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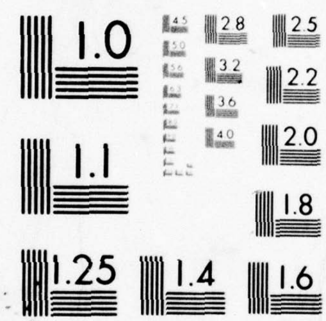

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Comprehensive Study of Water
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Puget Sound and Adjacent Waters

State of Washington

Appendix XI
Fish and Wildlife

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March 1970

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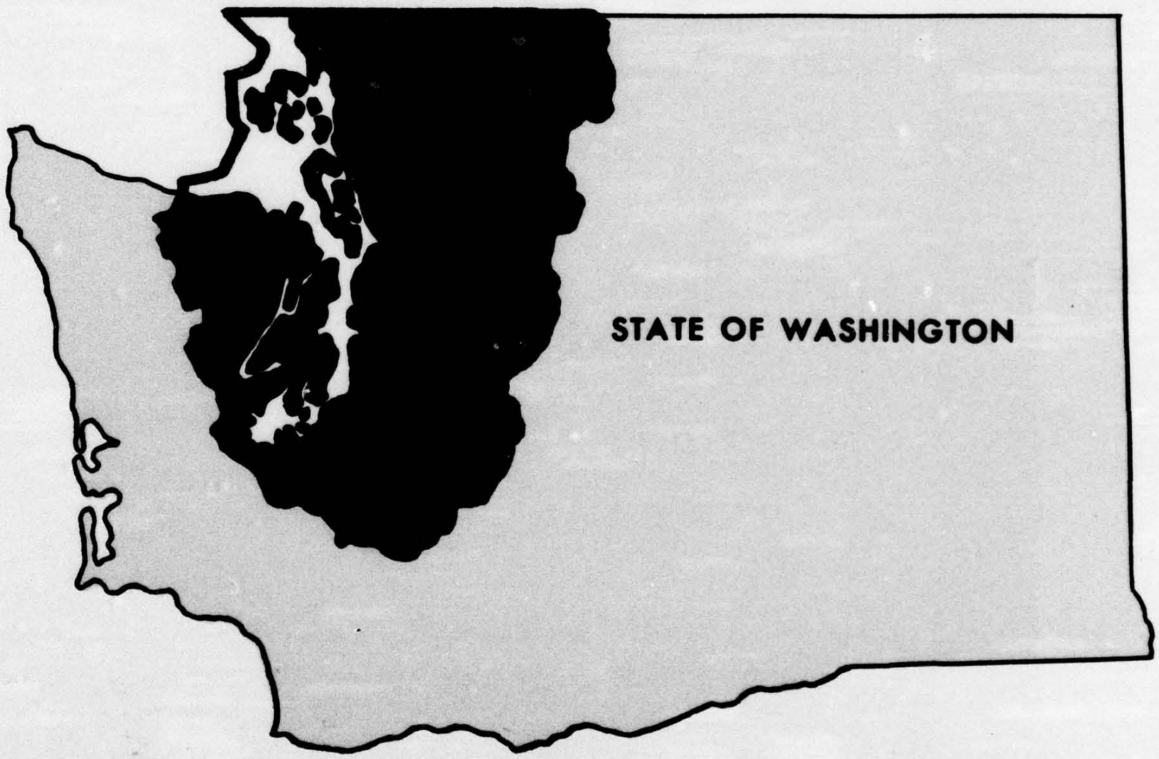

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Puget Sound and Adjacent Waters.

APPENDIX XI,

FISH AND WILDLIFE,

10 Alfred T. Neale, Sidney Steinborn, Lewis F. Kehne, L. B. Day
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FOREWORD

Appendix XI, Fish and Wildlife, contains a detailed report of one component of the Comprehensive Water Resource Study of Puget Sound and Adjacent Waters. It is one of fifteen appendices providing supporting data for the overall water resource study.

Appendix I contains a Digest of Public Hearings, Appendices II through IV contain results of environmental studies. Appendices V through XIV each contain an inventory of present status, present and future needs, and the means to satisfy the needs, based upon a single use or control of water. Appendix XV contains the formulation of basin plans.

The purpose of this appendix is to describe the uses of the Puget Sound Area by fish and wildlife, define the locations of greatest importance and overall utilization, and present a plan to conserve and enhance fish and wildlife that will meet short- and long-range needs for these valuable natural resources.

River basin planning in the Pacific Northwest was started under the guidance of the Columbia Basin Inter-Agency Committee (CBIAC), composed of the Governors of Washington, Idaho, Oregon, Montana, Utah, Nevada, and Wyoming and the representatives of six Federal departments and one Federal commission. The study was completed under the provisions of the Pacific Northwest River Basins Commission.

The CBIAC established a Subcommittee on Coordinated Planning in 1962, composed of key technical and administrative leaders of the Federal and State agencies with water resource planning and management responsibilities. One of the Subcommittee's main responsibilities was to establish a separate Task Force for major basin or subregional studies. A Task Force for Puget Sound and Adjacent Waters was established in 1964 for the purpose of making a water resource study of the Puget Sound Area, based upon guidelines set forth in Senate Document 97, 87th Congress, Second Session.

The Puget Sound Task Force consists of ten members, each representing a major State or Federal agency. All State and Federal agencies having some authority over or interest in the use of water resources are included in the organized planning effort.

The published report is contained in the following volumes:

SUMMARY REPORT

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I. Digest of Public Hearings
II. Political and Legislative Environment
III. Hydrology and Natural Environment
IV. Economic Environment
V. Water-Related Land Resources
   a. Agriculture
   b. Forests
   c. Minerals
   d. Intensive Land Use
   e. Future Land Use
VI. Municipal and Industrial Water Supply
VII. Irrigation
VIII. Navigation
IX. Power
X. Recreation
XI. Fish and Wildlife
XII. Flood Control
XIII. Water Quality Control
XIV. Watershed Management
XV. Plan Formulation

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INTRODUCTION

PURPOSE AND SCOPE

The purpose of the study was to develop a plan designed to meet short- and long-range needs for fish and wildlife of the Puget Sound Area. These resources have outstanding national significance, and the implementation of comprehensive basin plans will aid their conservation and development.

This appendix was prepared by the Fish and Wildlife Technical Committee, Puget Sound Task Force. Committee effort during the five-year review was directed by specific guidelines, including Senate Document 97, State legal obligation and resource responsibility, basic precepts of the Fish and Wildlife Coordination Act, and recommendations of the Senate Select Committee on National Water Resources.

Study scope involved the present status and future needs for fish and wildlife and means to satisfy these needs to meet anticipated demands. Resource requirements over a 50-year period, including individual needs within the eleven basins, were defined. Suitable enhancement measures were developed concurrently with those involving other water and related land resources and incorporated in the overall comprehensive plan. The fish and wildlife plan was coordinated with plans concerning river basins or water development proposals under separate study by the Bureau of Sport Fisheries and Wildlife and the Washington Departments of Fisheries and Game.

The study effort involved data review augmented by field investigations which were timed to coincide with seasonal life cycles and management cropping patterns of various species.

Study results: (1) facilitated planning essential to development of specific fish and wildlife measures, (2) served as background for future resource investigations, and (3) emphasized similar fish and wildlife needs in plans developed during other comprehensive studies conducted across the Nation.

AREA DESCRIPTION

A description of the Study Area, historical background, and various species involved, provides insight into the fish and wildlife aspects of the Puget Sound Area (Figure 1-1).

PUGET SOUND AND ADJACENT WATERS

The Puget Sound Area features a thriving cultural complex within a highly scenic setting. Defined by the Cascade Range on the east, and the Olympic Mountains and San Juan Islands on the west, it encompasses a large inland sea. Many streams course from relatively undisturbed headlands through steep canyons and broad valleys and enter Puget Sound or the inner straits. Lakes and islands dot the Area and tideflats reach out into the Sound at the mouths of rivers.

The climate is characterized by cool summers and relatively mild winters. Precipitation varies with elevation and the mountain systems.

Dense stands of coniferous timber occur principally in the uplands and mountains, and deciduous vegetation parallels most streams and occupies various logged areas. Most of the lowlands outside of urban and built-up areas are in agricultural use.

More than half of Washington's population of nearly three million people live within the Area—principally in municipalities on or near the Sound.

The economy is largely dependent on natural resources, including fish and wildlife. To varying degrees, these living resources are adversely affected by the rapid economic growth and development. Tourism and recreation rank third in importance and value in the overall economy of Washington, whose recreation potential is one of the highest in the Nation. Numerous consumer services and business activities in the Puget Sound Area are associated with

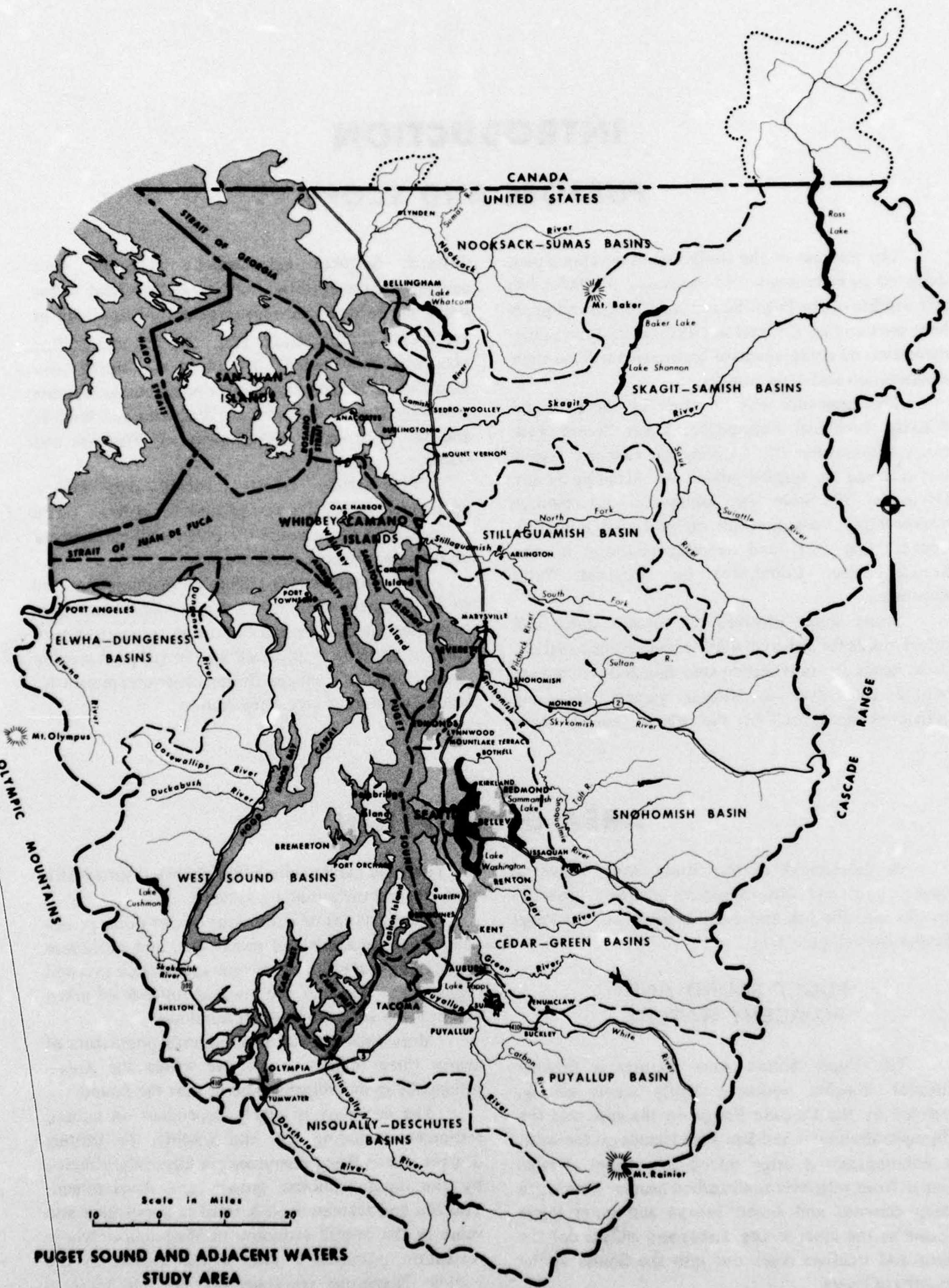


FIGURE 1-1. Basins in the Puget Sound Area

PHOTO 1-1. Significant recreation values accrue from wilderness trail rides, back country hunting, and high lake fishing. (U.S. Forest Service photo)

fish and wildlife resources. Excellent crabbing and clam digging, outstanding marine, stream, and lake angling, prime hunting for big game and upland game, and good waterfowl hunting afford the sportsman and recreationist ample opportunities. These benefits, and intangible and esthetic values, are partially responsible for the growing participation in outdoor recreation (Photo 1-1).

To satisfy the public need, the Washington Department of Game maintains several wildlife recreation areas, fish hatcheries and rearing ponds, game farms, and public hunting and fishing areas. A number of fish hatcheries and rearing areas and shellfish reserves are administered by the Washington Department of Fisheries. The Bureau of Sport Fisheries and Wildlife administers a national fish hatchery and several small national wildlife refuges. Public and private lands also provide for fish and wildlife production, as well as hunting and fishing.

Facilities involving resource biology, research, technology, environment, and economics are maintained by the Bureau of Commercial Fisheries, the Bureau of Sport Fisheries and Wildlife, the Washington Departments of Fisheries and Game, and other institutions and organizations.

HISTORICAL ASPECTS

A historical review of the Puget Sound Area, as it pertains to fish and wildlife, is essential to a full understanding of their present status and future importance.

In 1775, Spanish explorers landed on the coast of the Olympic Peninsula and took possession. Three years later, English Captain James Cook sailed into that area. Later, in the Orient, his men discovered the high value of sea otter pelts they had acquired from Northwest Indians. In the resulting fur and empire struggle, Spain was ousted, and the Indians bartered only with the English and with American traders, explorers, or seamen.

Beginning in the early 1800's, the fur trade expanded amid the influx of missionaries and explorers. At this time, all indigenous fish, shellfish, and wildlife were abundant in undisturbed natural habitat. The Indians were the first fishermen. White traders and settlers first purchased fish from the tribes, then did their own fishing. Some American traders salted barrels of salmon for use on their ships and for sale in the East, but the effort was limited; the Hudson's Bay Company shipped small quantities of salted salmon to England, Hawaii, and the Orient. In addition to salmon, the Indians harvested trout, lamprey, smelt, cod, halibut, herring, whales, and shellfish. They killed elk, deer, bear, and waterfowl. Animal antlers were used for tools, hides for shelter and clothing, bird skins for caps, and sea shells and animal claws for jewelry.

In 1846, Great Britain and the United States agreed on joint occupancy of the Oregon Country and the Puget Sound Area was rapidly settled. In 1849, the California gold rush precipitated a need for Area lumber and food. The extensive forest lands could supply the demand for timber and, after clearing, would support farming. In addition, fishing was a potential industry.

To solve the many Indian problems that existed, territorial Governor Stevens began, by early 1855, to make treaties with the main coastal tribes to establish legal title to settler claims. Stipulations included cash payment for their lands, and protection of Indian rights to hunt and fish at certain places.

Area fisheries originated about 80 years ago. In 1880, most of the fishermen were Indians using small boats and canoes. Gradually, various fish and wildlife species came into prominence as human populations and needs increased. As the years passed, production, harvest, and processing methods were developed to meet those needs. Simultaneously, however, the supply of fish and wildlife became more difficult to maintain. Exploitation, improper land development, population pressures, pollution—these were some of the obstacles.

In an effort to promote fish conservation, a law was enacted in 1871 to ensure unrestricted fish passage in streams. Six years later, salmon harvest was prohibited during certain seasons and fines were earmarked for a hatchery program. A Fish Commissioner was appointed to enforce these regulations. The position was abolished in 1881 and later reestablished under a Fish Commission. A Department of Fisheries and Game superseded the Commission in 1921, and 11 years later food fish and shellfish management was assigned to a Department of Fisheries, and management and harvest supervision of land animals, birds, and game fish, to a Department of Game.

Protective legislation for game animals and birds was enacted early and, in 1868, a closed season prohibited harvesting elk, deer, quail, partridge, prairie chicken, and grouse for sale. To enforce game laws, a State Game Warden and county deputy wardens were appointed. In 1899, the State Fish Commissioner was made ex-officio State Game Warden.

With increased obligations, Federal fish and wildlife agencies also grew in responsibility and stature. Underlying this growth was conservation legislation enacted by a progressive Congress. Further, various international agreements concerning common resources marked a milestone in fish and wildlife conservation.

Certain fish and wildlife problems prevalent during early years have persisted or intensified. In addition, other factors have contributed to the environmental change and resource decline. These include industrial and urban expansion, road construction, water-use development measures, agricultural practices, tideland encroachment, and multiple-use conflicts. Conservation interests have attempted to maintain a balance between these factors and fish and wildlife perpetuation.

Fish and game agencies have embarked on a resource program which has progressed from a period of over-exploitation to one of sound management and use geared to future needs. The support and cooperation of public interest groups have aided this endeavor.

FISH AND WILDLIFE RESOURCES

The combination of mild climate, sparsely populated uplands, diversified habitats, adequate productivity, and sound management produces an abundant variety of fish, shellfish, and wildlife.

Fish

Principal anadromous species of fish are chinook, coho, pink, chum, and sockeye salmon; steelhead and cutthroat trout; and Dolly Varden, of which several have national and international value (Photo 1-2). Resident fresh-water fishes include rainbow, cutthroat, brook, golden, and lake trout; Dolly Varden; grayling; mountain whitefish; kokanee; largemouth, smallmouth, and rock bass; warmouth; bluegill; black crappie; pumpkinseed; brown bullhead; and yellow perch. Various species support significant angler pressure.

Major species of marine fish contributing to sport and commercial fisheries in Sound waters or landed at its ports are Pacific halibut, Pacific cod, turbot, lingcod, sablefish, starry flounder, kelp greenling, Pacific herring, albacore, ratfish, skate, surf smelt, dogfish, Pacific hake, and numerous species of sole, rockfish, and surfperch.

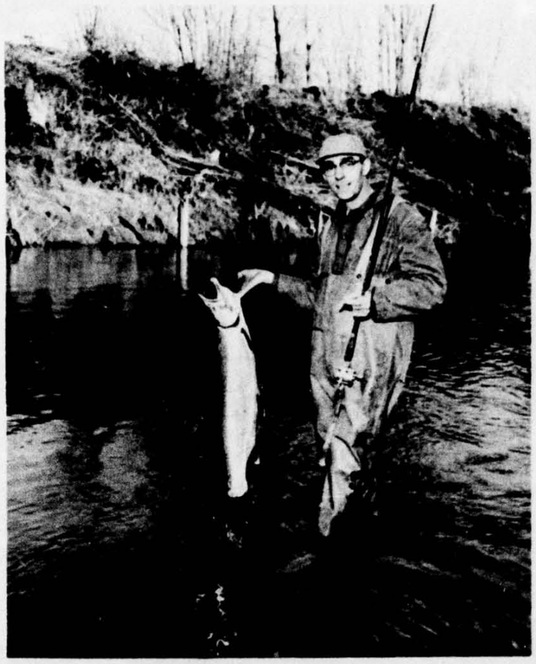


PHOTO 1-2. Steelhead provide a high value trophy for numerous anglers. (Washington Department of Game photo)

Beaches and estuaries are noted for their shellfish resources and support Pacific and native oysters; Dungeness crabs; littleneck, horse, jackknife, butter, Japanese littleneck, geoduck, softshell, and cockle clams; rock and Puget Sound pink scallops; Kamchatka or pinto abalone; and several species of shrimp. Octopi and squid are also important molluscs.

Wildlife

Principal big game are black-tailed deer, elk, black bear, mountain goat, and mountain lion. They afford quality hunting.

Blue grouse, ruffed grouse, ring-necked pheasant, California quail, mountain quail, cottontail, snowshoe rabbit, and band-tailed pigeon are the upland game of significant recreational value.

The Area supports a number of valuable fur animals including beaver, muskrat, mink, river otter, marten, lynx, weasel, skunk, bobcat, red fox, coyote, and raccoon. Harvest opportunities are excellent, and many fur animals are trapped each season.

Major waterfowl species include mallard, pintail, canvasback, ruddy duck, harlequin, ring-necked duck, wood duck, redhead, oldsquaw, bufflehead, widgeon, scaup, goldeneye, green-winged teal, shoveler, black brant, and Canada, lesser Canada, snow, cackling, and white-fronted goose. Merganser, scoter, common snipe, American coot, and whistling swan occur in lesser numbers. Waterfowl harvest is significant.

Shorebirds and seabirds frequent marine waters and tidal flats, and contribute substantially to outdoor recreational and esthetic values. Other wildlife occurs in varying numbers: wading and water birds—the herons and grebes; rodents—the mountain beavers and marmots; birds of prey—the hawks and owls; aquatic mammals—the seals and whales; and nuisance birds—the crows and starlings. All are members of the faunal complex.

In summary, the fish and wildlife resource is natural wealth—a living resource belonging to the people, who are charged with its perpetuation and wise use (Photo 1-3).

PHOTO 1-3. Benefits associated with fish and wildlife resources are many and varied. (Bureau of Sport Fisheries and Wildlife photo)

THE CHALLENGE

In the second century of progress, with its expanding human population and economic growth, it is essential that an optimum fish and wildlife plan be an integral part of future development. The goal of the fish and game agencies is conservation and enhancement of fish and wildlife to satisfy future demand.

The continuing demand for fish and wildlife in the Puget Sound Area is being met primarily by current and long-range programs of State and Federal management agencies. To these must be added resource facilities, programs, and projects resulting from comprehensive basin planning.

A challenge exists to plan wisely for the future necessities of fish and wildlife. Needs involving fish and wildlife of the Study Area must be met, if the public demand for the tangible and intangible benefits associated with these living resources is to be fulfilled. The Fish and Wildlife Appendix contains recommended measures designed to accomplish this.

BACKGROUND

SUPPORTING STUDIES

Most of the lands and waters in the Puget Sound Area are habitat for a large and varying number of fish and wildlife species. These living resources, because of their sport, commercial, and esthetic value, are being conserved and developed for use and appreciation by present and future generations.

Although standard management programs, involving streamflow measurements, creel and spawning surveys, range studies, improvement and development work, stocking, research, and harvest and regulatory aspects were a source of specific present status information, additional data concerning various basin planning aspects were required. To supplement available information, major study and field investigations covering a 4-year period (1965-1968) were conducted by the Washington Departments of Fisheries and Game, with funds from the Bureau of Sport Fisheries and Wildlife and the State of Washington. Studies involved species inventory and distribution, harvest and utilization, factors limiting production, stream environment, significance of artificial propagation, and inventory of beneficial development projects and locations.

The survey conducted for the Washington Department of Game in 1965 by Consulting Services Corporation, Seattle, was an invaluable source of data. It concerned fish and wildlife use by State residents during 1964, and updated information gathered by the Wallace Survey for 1954. It also provided some new information concerning sportsmen preferences and days spent by persons who may not hunt or fish, but derive pleasure from visiting fish hatcheries and game farms, bird watching, wildlife photography, and similar outdoor activities.

A special economic study subcontracted and financed under Puget Sound Study funding in 1967 provided a report by Drs. Crutchfield and MacFarlane, Department of Economics, University of Washington, involving economic valuation of Washington's 1965-1966 salt-water fisheries. This study provided a firm background and predictions of the fish and shellfish resource.

Basin planning information was adapted from study and survey results and refined for specific Area use. It provided significant insight into resource needs and a basis for angler and hunter use segments of this Appendix. These data were augmented and analyzed for use in Area projections of demand.

This Appendix is concerned primarily with conservation and enhancement of fish and wildlife to meet future demand. Although the various intangible values involved, and their importance, were recognized, no in-depth treatment was made of this aspect. However, pertinent statements concerning the magnitude and significance of such values appear in the text.

FISH AND WILDLIFE RESOURCES

Information concerning common or important fish and wildlife species appears under these groupings: fish–anadromous, resident (fresh water), marine, and shellfish; wildlife–big game, upland game, fur animals, waterfowl, and other wildlife.

FISH

The most important fish are salmon and searun trout. Their value, from a commercial and sport fisheries standpoint, greatly exceeds that of other species in the Area, and they have been accorded a greater degree of study and management (Photo 2-1). Their potential for increase is also greater and current management programs should realize this potential.

During 1965, the commercial catch of salmon in Puget Sound was approximately 20,070,000 pounds, with a fisherman value of $5,412,100. The sport angler use of salmon produced in Area waters was estimated at 888,000 angler-days annually, valued at $5,328,000.[1] In 1966, sport use of steel-

[1] *Based on values developed by subcommittee of Inter-Agency Committee on Water Resources. State value, based on 1967 study, is $24,864,000.*

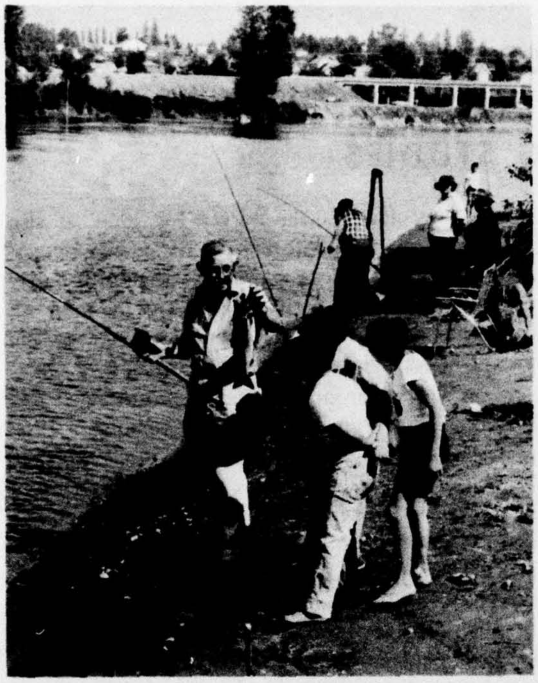


PHOTO 2-1. Anadromous fish support a growing angler pressure. (Washington Department of Game photo)

head trout was estimated at 793,600 angler-days, valued at $3,968,000; of searun cutthroat trout in salt water, 335,400 angler-days, $1,005,000; and of searun Dolly Varden in salt water, 17,000 days, $51,000.

Resident fishes in stream and lake waters support active sport fisheries. In 1966, estimated trout angler pressure was 953,100 angler-days, valued at $2,859,300, on streams, and 2,556,700 angler-days, valued at $5,113,000, on lakes. Angler use of spiny-rayed fish is included in the latter figures.

Most marine fish and shellfish exhibit relatively stable populations, contribute heavily to commercial and sport harvest, and possess great potential for satisfying future needs.

The commercial catch of marine fish, based on the year 1965, was approximately 74,450,000 pounds[1] with a fisherman value of $6,580,500. In 1965, sport use of marine fish was estimated at 73,000 angler-days,[2] valued at $219,000.

1 Includes landings of species caught in ocean waters.

2 Fractional count. Does not include estimated 848,900 incidental angler-days (that time attributed to marine fish harvest while actively engaged in angling for salmon).

During 1965, an estimated 6,776,500[1] pounds of shellfish were harvested commercially in the Puget Sound Area. Value to the fishermen was estimated at $1,244,600. Average annual sport use of shellfish in the Area is estimated at 121,000 man-days, valued at $181,500.

The extent of spawning and rearing habitat is the major critical factor in the production levels of fish and shellfish. It determines the number of individuals needed to perpetuate the stock involved and is the controlling factor in any harvest level established. Habitat status depends primarily on water of optimum quality and quantity. In addition, associated limiting conditions, both natural and artificial, adversely affect each species. The migratory habits of anadromous fish necessarily expose them to more limiting factors than resident species.

Modification or elimination of limiting factors to conserve and, in some instances, enhance fish and shellfish resources is often possible. Such beneficial action is being taken by fishery agencies with varying degrees of success. Some problems, however, have not been resolved and continue to adversely affect populations involved.

WILDLIFE

The prime value derived from wildlife is outdoor recreation (Photo 2-2). Although nonconsumptive use of the wildlife resource exceeds hunter use, the only documented gauge of such recreation created by individual wildlife species is derived from hunter harvest data. Puget Sound Area wildlife in order of most man-days recreation provided are: black-tailed deer, waterfowl, grouse, band-tailed pigeon, pheasant, rabbit, black bear, elk, quail, mourning dove, mountain goat, and mountain lion. Many non-hunted wildlife species, such as songbirds, shorebirds, squirrels, and chipmunks contribute significantly to the outdoor scene. Their undetermined esthetic value is a prime attraction of the Pacific Northwest. Future planning for wildlife species exhibiting the greatest outdoor recreation potential will receive maximum management emphasis.

It is difficult, under the present system of evaluation, for wildlife to compete with other resources for the use of land. As human population in the Area increases, competition for land will increase. A few huntable wildlife species can be produced economically under the concentrated management that must result from close competition among land

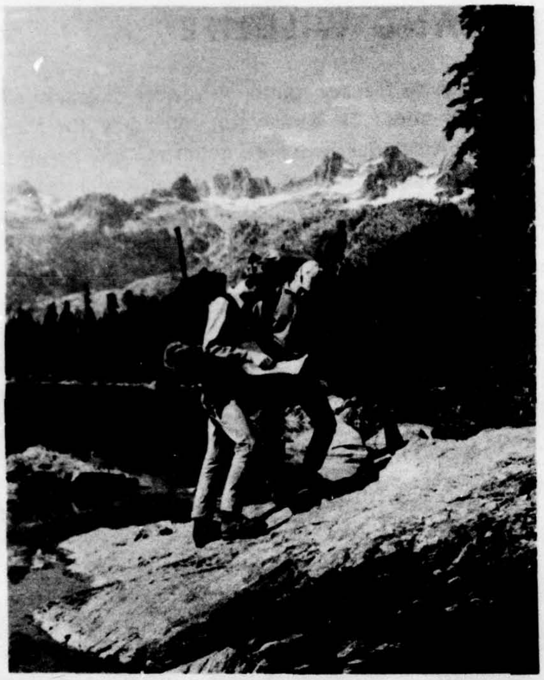


PHOTO 2-2. Hunting opportunities abound in the Puget Sound Area. (Washington Department of Game (photo)

users. However, populations of many species will decline. This decline can be somewhat offset by acquisition and development of key wildlife areas, intensive management of remaining habitat, artificial propagation of some species, and acquisition of public access rights to permit full utilization of the resources. It is probable that despite the assumption, for purposes of calculation, that supply and demand are equal now, demand far exceeds supply. Since demand for hunting is increasing, and the resource is dwindling, the spread between demand and supply in the Puget Sound Area will increase.

Present hunter use is estimated at 848,000 man-days annually. Even without further development and enhancement of the resource such use may increase in the future, but hunting would be of a lower quality than is acceptable under present standards.

MANAGEMENT RESPONSIBILITIES

Primary responsibility for management of fish and wildlife resources in the Puget Sound Area rests with two State agencies, the Washington Department of Fisheries and the Washington Department of Game. Federal and other State agencies also have areas of responsibility directly related to these resources. State agencies include the Department of Water Resources and Department of Natural Resources. Federal agencies include Bureau of Sport Fisheries and Wildlife, Bureau of Commercial Fisheries, Forest Service, and National Park Service. These agencies coordinate their planning and activities affecting fish and wildlife with the Departments of Fisheries and Game. Independent conservation organizations representing special interest groups and private landowners are taking an increased interest and sharing broadened responsibilities in fish and wildlife management. Many private landowners have recognized fish and wildlife in their overall resource management program and generally planning is coordinated with the various management agencies.

EVALUATION OF FISH AND WILDLIFE

Hunter- and angler-day pressure reflects the recreational aspects of fish and wildlife use. Benefits assigned to beneficiaries of federally financed water development projects must be expressed in comparable terms for project scoping and economic analysis purposes. Standards were set in 1964, valuing hunter- and angler-days on a scale of between $.50 and $6, depending on the quality of the recreation experience. These are the "Senate Document 97 values" or "Federal values" and are in essence values developed in 1960 by a subcommittee of the Inter-Agency Committee on Water Resources. They may be defined as " . . . the amount that the users should be willing to pay, if such payment were required, to avail themselves of the recreation resource." They are, therefore, net values above expenditures, and do not include either the value of the harvest or secondary values. These are the values used in this Appendix where recreational aspects of fish and wildlife are evaluated. Fishing values per angler-day are salmon, $6; steelhead trout, $5; resident trout in streams, $3; trout and spiny-rays in lakes and reservoirs, $2; marine fish, $3; and shellfish, $1.50. Hunting values are $6 per day for big game, $5 per day for waterfowl, and $4 per day for upland game. They, like the fishery values, are professed to be comparable to unit values of other water-use benefits.

Some Tables in the Appendix involving an evaluation of salmon include a "State value" as well as the "Federal value." The former, $28 per angler-day, is from a 1968 study by the Washington Department of Fisheries and the Department of Economics, University of Washington, Seattle. The results of this study were based on about 2,500 responses to questionnaires sent to 5,000 randomly selected Washington holders of salmon punch cards.

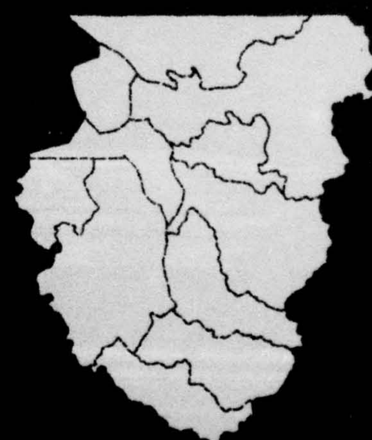
The survey was intended to estimate the average annual value that fishermen place on their privilege to fish for salmon in several geographically defined zones of Washington (including the Puget Sound Area). Because of the nonmarketable nature of sport fishing rights, economists are in agreement that some such (necessarily indirect) measure of the value fishermen place on these rights is needed for a proper estimate of the economic values of such fishing.

The fishermen surveyed were asked to indicate the least amount of money they would accept to forego their right to fish for salmon in Puget Sound for one year. Of those who fished for salmon in these waters during 1967, the average amount was $196. The average annual number of days fished in the Sound by these respondents was 6.9; hence, the average value per fishing day for sport salmon fishing in Puget Sound was estimated at $28. Whether $6, $28, or some higher value more nearly expresses the real value of a salmon fishing day is a moot question. The large spread in value ($6 Federal–$28 State) does, however, indicate that the "Federal value" may be much too conservative even if updated to reflect the decreased value of the dollar since 1960. This same situation also applies to the game fish and wildlife resource evaluations.

Commercial values of salmon are shown as ex-vessel values based on the prices received by fishermen. In some Tables a retail value is also shown for comparative purposes. The prices received by fishermen are the standards by which commercial values are measured in this Appendix. They are gross values, not strictly comparable with sport values, but, like the sport values, are probably conservative.

The tangible values discussed here are additive to the intangible or esthetic values of fish and wildlife which cannot be defined monetarily. Such values, however, are an integral part of resource worth and should be considered in the overall appraisal of fish and wildlife.

Puget Sound Area



PUGET SOUND AREA

PRESENT STATUS—FISH

INTRODUCTION

The geographical position and physical character of the Area provide a variety of highly diversified aquatic environments, each inhabited by a discrete combination of fish and/or shellfish populations specifically adapted to their natural habitat.

The Area is flanked on the east and west by prominent mountain ranges. In the past, glaciers forced their way between these ranges and carved out the Puget Sound Basin, a 2,500-square-mile area which is characterized by numerous inlets, bays, channels, and islands. The Sound is basically a deep body of water. There are no shoal areas in many shoreline reaches.

Prevailing onshore winds carry warm, moist air in from the Pacific Ocean. Annual rainfall in the lowlands, with some exceptions, ranges from 35 to 50 inches; in the foothills, 75 to 100 inches; and in the mountain areas 100 to over 200 inches, mostly in the form of snow.

Each mainland basin is drained by at least one major river system. The islands support relatively few small streams.

Most of the major streams entering Puget Sound, Hood Canal, and the straits originate in mountain glacier fields. Water from melting snowpack and glaciers provides river flow during the dry summer period. In fall and winter, rainfall amply supplies the numerous lakes and streams. These conditions promote diversified rivers and streams, which drain from the mountains to the estuarine and marine waters. Such fresh-water courses range from cold, swift-flowing, high-elevation streams to warmer, meandering, lowland valley rivers. Although basic fertility is greater in lowland waters, each of these watercourses is exceedingly important for the production of anadromous and resident fishes (Table 3-1, Exhibit 1). More than 2,800 lakes, ponds, and reservoirs, totaling over 115,000 surface acres, exist within Area boundaries. They range from the smaller, cold, high-mountain lakes to the generally larger, warmer, and more productive lowland valley waters. Approximately 40 percent of these lie at elevations greater than 2,500 feet. Similar to streams and rivers, the variety of environment afforded by the many lacustrine waters promotes extensive diversification in the kinds of fresh-water fishes common to the Area.

Also of great importance, particularly to anadromous species, are the estuarine areas at the river mouths which provide the critical transition zone for juvenile and adult fishes as they move from one environment to another.

The marine waters are bordered by some 2,167 miles of shoreline, which is approximately equal to the entire remaining coastline of the contiguous western United States. The basins' salt-water area encompasses some 1.6 million surface acres including Puget Sound, Hood Canal, and the eastern portion of the Strait of Juan de Fuca. The diverse marine environment produces a large variety of marine fish and shellfish.

Bottom topography and surface geographic configurations of the marine sector combine to create diverse hydrographic conditions, ranging seasonally from upwelling of cold, nutrient-rich, oceanic waters in the Strait of Juan de Fuca, to warm, highly-stratified, and less rich waters of the inlets and bays. Between these two extremes are the generally cool, well-mixed waters comprising much of the marine sector. Fresh-water influences from major rivers and independent streams vary considerably throughout the Area, generally causing lower salinities near the river mouths and in adjacent bays.

Composition and slope of intertidal bottoms range from oceanic to salt-marsh types depending on exposure to winds, waves, tides, and surface runoff conditions. Beach gradients vary from steep, narrow, and rubbly to moderately-sloped, rocky upper beach and low-gradient, sandy outer beach. Most of the beaches in the protected bays are gravel, gravel-sand, gravel-mud, and mud-silt grading generally in this order from high-tide to subtidal areas, and from mouths to heads of such bays. Subtidal bottoms range from mud and sand to gravel and boulders. Bottom contours generally reflect patterns similar to

TABLE 3-1. Distribution and density of more common anadromous and fresh-water fishes

Species	Basin										
	Nooksack–Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan
Coho salmon[1]	M	H	H	L	H	H	H	M	M	M	L
Chinook salmon (fall)[1]	M	H	M	–	H	H	M	H	M	M	–
Chinook salmon (spring)[1]	M	M	L	–	L	L	M	L	L	M	–
Pink salmon[1]	H	H	H	–	H	–	M	M	H	H	–
Chum salmon[1]	M	M	M	L	M	M	M	H	H	L	L
Sockeye salmon[1]	L	L	–	–	–	H	–	L	–	–	–
Steelhead trout[1]	M	H	H	L	H	H	H	M	H	M	L
Searun Dolly Varden[1]	L	H	M	–	M	L	L	L	M	M	–
Searun cutthroat trout[1]	L	H	H	L	M	L	L	M	H	M	L
Rainbow trout	M	H	M	M	H	H	M	H	M	M	M
Cutthroat trout	M	H	H	L	H	M	M	H	H	M	L
Brook trout	M	M	M	L	M	M	L	L	M	M	L
Dolly Varden	L	H	M	–	M	L	L	L	M	M	–
Kokanee	M	M	L	–	M	H	L	L	M	M	L
Coho salmon (landlocked)	–	–	L	–	M	L	–	–	L	–	–
Lake trout	L	L	–	–	L	L	L	–	–	–	–
Golden trout	L	L	–	–	L	–	–	–	–	–	–
Brown trout	L	L	–	–	L	L	–	–	–	–	–
Grayling	–	L	–	–	L	–	–	–	–	–	–
Whitefish	H	H	H	–	H	H	H	H	M	H	–
Largemouth bass	M	H	M	L	H	H	H	H	M	L	M
Perch	H	H	M	L	H	H	H	H	M	L	H
Crappie	M	M	L	L	H	H	H	H	M	L	M
Bluegill	L	L	–	L	L	L	L	L	–	–	L
Smallmouth bass	L	–	–	L	L	L	L	–	–	–	–
Rock bass and Warmouth	–	–	–	–	–	L	L	M	L	–	–
Pumpkinseed	M	M	M	L	M	H	H	H	M	–	L
Bullhead	H	H	M	H	H	H	H	H	M	L	M
Shad[1]	–	L	–	–	L	–	L	–	–	–	–
Sturgeon[1]	–	L	–	–	L	–	–	–	–	–	–
Carp	L	M	–	–	M	M	L	L	L	–	L
Sucker[2]	M	M	M	L	M	H	H	H	H	M	–
Sculpin[2]	H	H	H	H	H	H	H	H	H	H	H
Shiner[2]	L	M	L	–	L	M	L	L	M	M	–
Stickleback[2]	H	H	H	M	M	M	M	M	M	M	M
Dace[2]	H	H	M	–	M	M	M	M	M	–	–
Peamouth[2]	L	L	L	–	L	M	H	H	M	–	–
Squawfish[2]	L	M	L	–	M	H	M	M	M	L	–
Lamprey[1,2]	H	H	H	L	H	M	H	H	M	M	L

[1] Anadromous.

[2] Undesirable.

H High density of given species.

M Medium density of given species.

L Low density of given species.

TABLE 3-2. Life history of salmon, Puget Sound Area

Species	Life Phase	Small Tributary	Large Tributary	Main River	Estuary	Ocean	General Comments
Fall chinook	Mature Adults (spawning)	Some use.	30 to 60 days, fall.				Always die after spawning.
	Eggs & Larvae (incubation)	Some use.	90 to 150 days in gravel, winter.				Average 4,000 eggs per female.
	Juveniles (rearing)	Some use.	60 to 120 days, spring through summer.		30-60 days seaward migration.		Limited by loss of natural spawning and rearing areas.
	Growth to Maturity					1-5 years; 3 yrs. typical.	Range north to Alaskan waters. Some in Puget Sound.
	Maturing Adults		Return to original spawning grounds to complete life cycle, normally at age 4 years.				Average weights 20-25 lbs.
Spring chinook	Mature Adults (spawning)	Some use.	3 to 6 months, spring through early fall.				Always die after spawning.
	Eggs & Larvae (incubation)	Some use.	90 to 150 days, fall through mid-winter.				Average 4,000 eggs per female.
	Juveniles (rearing)	Some use.	Tend to spend 1 year in fresh water		30-120 days seaward migration.		Limited by loss of natural spawning and rearing areas.
	Growth to Maturity					1-5 yrs; variable; 3 yrs. typical.	Range north to Alaskan waters. Some in Puget Sound.
	Maturing Adults		Return to original spawning grounds to complete life cycle, normally at age 4 years.				Average weights 20-25 lbs.
Coho	Mature Adults (spawning)	30 to 60 days, late fall through early winter.		Some use, especially in side channels.			Always die after spawning.
	Eggs & Larvae (incubation)	80 to 150 days, winter.					Average 3,000 eggs per female.
	Juveniles (rearing)	12 to 14 months, spend entire year in stream.		Some use, extent unknown.	30-120 days seaward migration.		Populations limited by low summer flow conditions.
	Growth to Maturity					1-2 yrs. 2 yrs. typical.	Range north and south in ocean; some in Puget Sound.
	Maturing Adults	Return to original spawning grounds to complete life cycle, normally at age 3 years.					Average weights 8-10 lbs.
Pink	Mature Adults (spawning)	Some use.	30 to 60 days, early fall on odd years only.				Always die after spawning.
	Eggs & Larvae (incubation)	Some use.	90 to 150 days, winter.				1,500 to 2,000 eggs per female.
	Juveniles (rearing)		Move to sea soon after hatching.		Spend approximately 3-4 months in shoreline areas.		Little if any fresh-water growth.
	Growth to Maturity					Approx. 1 year.	Range generally north; mature at 2 yrs.
	Maturing Adults		Return on odd-number years to original spawning grounds to complete life cycle, always at age 2 years.				Average weights 5-6 lbs.
Chum	Mature Adults (spawning)	Some use.	Up to 30 days, late fall, early winter.				Always die after spawning.
	Eggs & Larvae (incubation)	Some use.	90 to 150 days, winter.				3,000 to 3,500 eggs per female.
	Juveniles (rearing)		Move to sea soon after hatching.		Spend approximately 3-4 months in shoreline areas.		Little if any fresh-water growth.
	Growth to Maturity					3-[illegible] yrs; variable.	Range north to Alaskan waters.
	Maturing Adults		Return to original spawning grounds to complete life cycle, normally at age 3 or 4 years.				Average weights 11-12 lbs.
		Lake Tributary	Lake	Main River	Estuary	Ocean	
Sockeye	Mature Adults (spawning)	3-4 months, late summer & fall.	Some shoreline spawning.	Main migration June, July, Aug.			Always die after spawning.
	Eggs & Larvae (incubation)	90 to 150 days, winter.					2,000-2,500 eggs per female.
	Juveniles (rearing)		1 to 3 years.	These areas used during seaward migration.			Some stay to maturity in lake (kokanee) to 2 lbs. weight.
	Growth to Maturity					2-3 yrs; variable.	Range generally north to Alaskan waters.
	Maturing Adults	Return to original spawning grounds to complete life cycle, normally at age 3 or 4 years.					Average weights 5-7 lbs.

those of the surrounding uplands.

The actual or potential productivity of the estuarine zones is closely related to the ratio of shoreline to water area—the longer the shoreline per unit of water area, the greater the productivity. In areas where favorable ratios occur, such as Skagit Flats and the Nisqually Delta, the diverse, sheltered, food-rich environment is a nursery area for many species of crustaceans, and marine and estuarine dependent fishes. Vegetative productivity in such areas also benefits wildlife.

The tides affect vegetative growth by decreasing or increasing the exposure of the algae and marsh plants and the quantity of phytoplankton that is favorably exposed to sunlight as the volume of water changes over the marshes and tidelands. In shallow water areas with good current, high salinity, low turbidity, and little affected by river surges, eelgrass and algae have formed dense bottom vegetation. This plant community provides an environment for numerous species of crustacea that support many species of fish (and wildlife).

Large tideflats and marshes are restricted to mouths of the principal rivers and smaller ones are situated at the head of many Hood Canal and South Sound inlets. Marsh vegetation occurs on the broad intertidal flats of soft sediments not too affected by waves and strong currents. Such marshes are extremely productive of organic matter, which contributes to the various food chains.

Shellfish populations on the intertidal and submerged land depend primarily on the water circulated over a much larger support or food producing area than that which is over the bed itself. Therefore, stream inflow and the circulation pattern of Puget Sound waters affect the Area's total biota.

Each of the marine fish and shellfish species is indigenous to areas with specific environmental characteristics and many are numerous in each environment type afforded within the Sound.

ANADROMOUS FISH

Inventory and Distribution

Anadromous fish utilizing fresh and salt waters in the Area include chinook, coho, pink, chum, and sockeye salmon; steelhead (summer and winter) and searun cutthroat trout; and one species of char, the searun Dolly Varden. Although the specific life history characteristics, behavior patterns, and water-use areas vary considerably for each of these fishes, and for different races of an individual species, their general life history patterns are similar (Tables 3-2, 3-3). Each is produced from eggs hatched in the gravel of fresh-water streams, and each spends some portion of its early life in these streams before migrating to the ocean. Following a period of extended feeding, growth, and development, all within the marine water environment, these fish then usually return to the stream from which they originated to repeat the cycle (Table 3-4).

The size of adult spawning populations returning to Area drainages depends upon many factors, such as the amount and type of spawning and rearing habitat available, natural flow patterns, number of fish stocked, sport and commercial harvest, and specific conditions which limit production.

Production and Propagation

Where total stream production per surface acre is indicated, salmonids are compared with other species. The salmonids included for this purpose are only those species residing approximately one year or more in streams and are not restricted to anadromous fish. Other species include all remaining stream residents except lampreys. Production per-surface-acre data are not separable by species.

Natural fish production in lake, pond, or reservoir habitat in the Puget Sound Area is highly significant and variable.

Natural potential production is the total fish population which could exist if limiting factors were corrected. It is equated only with fresh-water rearing, because the return of maturing anadromous fish results from the combined survival and production of fresh and salt water (Photo 3-1).

PHOTO 3-1. Sustained salmon production assures continued harvest. (Washington Department of Fisheries photos)

Clockwise from A:

Sockeye on spawning migration
Sport catch of chinook salmon
Commercial seine fleet on fishing grounds
Commercial gill netter
Sportsman landing salmon in Puget Sound
Fingerling salmon prior to seaward migration
Commercial seiner landing catch
Reef net boats
River sport fishery for pink salmon
Buying barge unloading salmon at dock

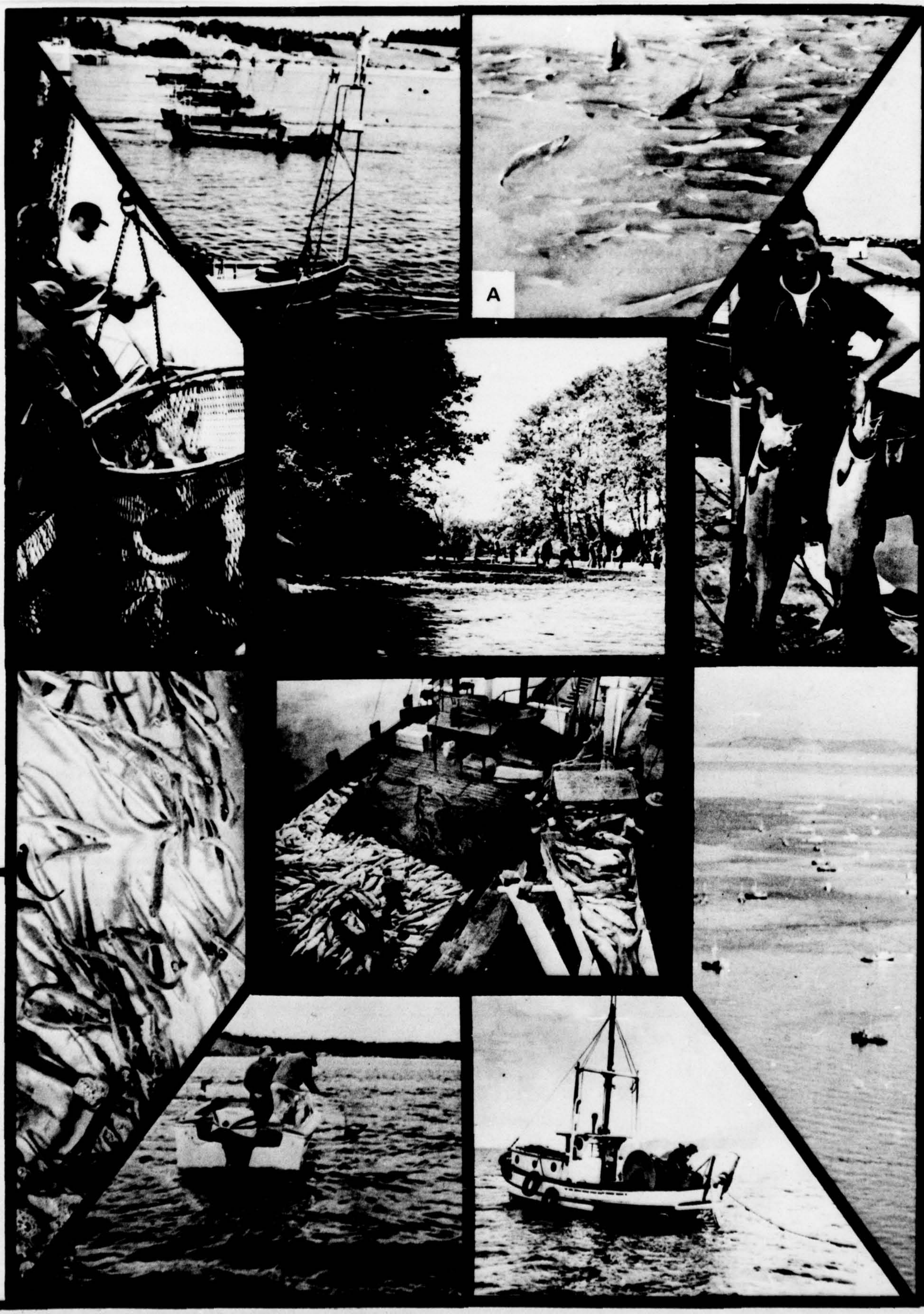

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TABLE 3-3. Life history of searun trout, Puget Sound Area

Species	Life Phase	Small Tributary	Large Tributary	Main River	Estuary	Ocean	General Comments
Summer steelhead	Mature Adults (spawning)	Up to 120 days, winter through spring; extensive use in side channels.					Do not die after spawning.
	Eggs & Larvae (incubation)	50 to 150 days, winter through spring.					Average 4,000 eggs per female.
	Juveniles (rearing)	Normally 2 years in fresh water, including lakes, ponds, and sloughs.			30-60 days seaward migration.		Limited by loss of rearing areas; attain length of 6-8 inches before migration to sea.
	Growth to Maturity					12-18 months; variable 1 to 3 years.	Range generally north and into Gulf of Alaska.
	Maturing Adults	Return approximately as much as 9 months prior to spawning to original rearing areas, normally at age 4 years.					Average weights 5-10 lbs.
Winter steelhead	Mature Adults (spawning)	Up to 150 days, winter through spring; extensive use in side channels.					Do not die after spawning.
	Eggs & Larvae (incubation)	50 to 150 days, winter through spring.					Average 3,500 eggs per female.
	Juveniles (rearing)	Normally 2 years in fresh water, including lakes, ponds, and sloughs.			30-60 days seaward migration.		Limited by loss of rearing areas; attain length of 6-8 inches before migration to sea.
	Growth to Maturity					17-24 months; variable 1/2 to 3 years.	Range generally north and into Gulf of Alaska.
	Maturing Adults	Return to original rearing area, normally at age 4 years.					Average weights 5-12 lbs.
Searun cutthroat	Mature Adults (spawning)	Up to 120 days, winter into spring.		Some use in smaller of these, and in side channels.			Do not die after spawning.
	Eggs & Larvae (incubation)	50 to 150 days, winter through spring.		Some use in smaller of these, and in side channels.			Average 750 eggs per female.
	Juveniles (rearing)	Usually 2 or 3 years in these areas, including lakes, ponds and sloughs.			During seaward migration.		Populations limited by low summer flow conditions.
	Growth to Maturity				Several feeding trips into tidal areas of rivers during each year.		Range generally through Puget Sound and along ocean coast.
	Maturing Adults	Return to original rearing area, to spawn normally at age 3 or 4 years; arrive lower river reaches in summer prior to spawning period.					Average weights 1/2-3 lbs.
Searun Dolly Varden	Mature Adults (spawning)		60-120 days, fall to early winter.				Do not die after spawning.
	Eggs & Larvae (incubation)		90 to 150 days, winter.				Eggs make up about 1/5 of body weight at 500-550 eggs/oz.
	Juveniles (rearing)		Usually 2 or 3 years, including some in lakes.		During seaward migration.		Populations limited by low summer flow conditions.
	Growth to Maturity				Approximately 6 months.		Range generally through Puget Sound and along ocean coast.
	Maturing Adults		Return to original rearing area, to spawn at age 3 or 4 years; arrive lower river reaches in summer prior to spawning period.				Average weights 2-8 lbs.

TABLE 3-4. Average annual anadromous fish spawning escapement, natural and (artificial)

Species	Basin											
	Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan	Totals[9]
Chinook	1,260	19,190	4,940	--	7,680	3,490	2,030	3,850	3,760	1,140	--	47,340
	(650)	(6,040)	(340)	(40)	(2,710)	(19,370)	(600)	(18,710)	(9,980)	(710)	--	(59,150)
Coho	7,410	49,290	21,200	100	36,440	32,480	7,570	4,890	74,460	2,540	50	236,430
	(2,110)	(11,550)	(2,510)	(280)	(13,200)	(50,890)	(9,990)	(3,870)	(25,330)	(1,200)	--	120,930)
Pink	73,130[1]	485,000[1]	268,750[1]	--	148,750[1]	--	14,750[1]	4,510[1,5]	187,010[1]	164,500[1]	--	1,346,400
Chum	54,860	115,940	8,400	50	21,150	16,680[2]	22,200	10,730	129,340	2,560	50	381,960
Sockeye	--	2,330	--	--	--	90,000[3]	--	--	--	--	--	92,330
Summer steelhead[6]	70	330	1,500	NA	1,700	90[4]	[8]	80	750	240	NA	4,760
Winter steelhead[6]	4,900	60,500	24,900	>500[8]	53,800	39,400[4]	26,500	7,300[7]	11,600	9,200	<500[8]	230,800
Searun cutthroat	26,600	75,300	59,300	23,500	48,500	45,800	19,900	27,600[7]	133,000	29,500	[8]	461,400
Searun Dolly Varden[8]												
Totals	170,990	825,470	391,840	23,970	333,930	298,200	103,540	46,640	575,230	211,590	100	2,981.5[10]

[1] Per odd year escapement.

[2] Green Basin only.

[3] Cedar Basin only.

[4] Does not include those fish utilizing independent drainages.

[5] Nisqually Basin only.

[6] Totals include natural and (artificial) escapement.

[7] Includes Nisqually Basin and independent drainages only—no valid totals established following fishway completion and stocking on Deschutes River.

[8] No valid totals established.

[9] Excludes figures with footnotes 7, 8.

[10] 1000—Rounded.

Salmon production occurs through natural spawning and rearing, assisted by artificial propagation. Natural production occurs in stream, river, and lake habitat as well as in the estuarine and marine waters of Puget Sound, Hood Canal, and the Straits of Juan de Fuca and Georgia. These natural habitats are utilized by all five species of salmon. Table 3-5 presents the average annual natural production for each species.

Artificial propagation of salmon occurs in 11 Washington Department of Fisheries hatcheries, a Bureau of Sport Fisheries and Wildlife hatchery, and experimental facilities at the University of Washington. Major production involves chinook and coho salmon, with a few facilities propagating some pink and chum salmon. In addition to its hatchery program, the Washington Department of Fisheries operates natural and artificial rearing impoundments designed to supplement natural rearing habitat. Also, artificial spawning "beaches" for sockeye salmon are maintained in the Skagit-Samish Basins in a cooperative effort with the Puget Sound Power and Light Company. The present salmon hatchery program involves planting fish into accessible streams not heavily populated by natural runs, into supplemental rearing impoundments, and into stream sectors where anadromous fish runs are blocked by barriers. Liberation data, covering State and Federal hatcheries, appear in Table 3-6. Such data do not include numbers of fish stocked in farm ponds.

Artificial propagation of salmon comprises a large portion of the total Area production of chinook and coho. For the period 1961 through 1965, total hatchery production (catch plus escapement) averaged 236,440 chinook salmon and 604,650 coho salmon annually.

TABLE 3-5. Average annual anadromous fish natural production (harvest plus escapement)

Species	Basin: Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan	Totals[5/]
Chinook	5,040	76,760	19,760	[1/]	30,720	13,960	8,120	15,400	15,040	4,560	[1/]	189,360[2/]
Coho	37,050	246,450	106,000	[1/]	182,200	162,400	37,850	24,450	372,300	12,700	[1/]	1,181,400[2/]
Pink	219,390	1,455,000	806,250	[1/]	446,250	--	44,250	13,530	561,030	493,500	[1/]	4,039,200[2/]
Chum	109,720	231,870	16,970	[1/]	42,290	33,360	44,390	21,460	258,670	5,120	[1/]	763,850[2/]
Sockeye	--	8,640	--	--	--	90,000	--	--	--	--	--	98,640[2/]
Summer steelhead	100	500	2,200	--	2,600	130	[3/]	130[4/]	650	360	--	347,700[2/]
Winter steelhead	7,300	90,800	37,300	>500[3/]	80,700	59,100	39,800	11,000[4/]	18,800	13,900	<500[3/]	347,400[2/]
Searun cutthroat	35,400	100,400	79,200	31,300	64,600	61,000	26,500	36,700[4/]	174,000	38,100	[3/]	610,500[2/]
Searun Dolly Varden[1/]												[3,6/]
Totals	414,000	2,210,420	1,067,680	31,300	849,360	419,950	200,910	74,840	1,400,490	568,240		7,237.2[7/]

1/ Production limited and therefore not determined by basin.

2/ Only averages are additive, since highs or lows do not necessarily occur in all basins in the same year.

3/ No valid totals established (harvest only for searun Dolly Varden).

4/ Includes Nisqually Basin and independent drainages only—no valid totals established following fishway completion and stocking on Deschutes River.

5/ Excludes figures with footnotes 3, 4.

6/ Area total, 100,000 fish, excluded. See footnote 5.

7/ 1000—Rounded.

TABLE 3-6. Average annual stocking of anadromous and resident fish, 1961-1965[1/]

Species	Number of Fish (1000)	Species	Number of Fish (1000)
Chinook salmon	36,345.8	Rainbow trout	5,622.1
Coho salmon	11,498.8	Cutthroat trout	971.9
Pink salmon	915.1	Brook trout	178.1
Chum salmon	2,745.3	Golden trout	10.8
Sockeye salmon	948.4	Kokanee	7,421.9
Steelhead trout	897.9	Coho salmon (landlocked)	233.0
Searun cutthroat trout[2/]	96.2		

1/ Anadromous trout data involve period 1962-1966. Resident game fish—rainbow (includes rainbow/steelhead hybrids), cutthroat, brook, golden, kokanee, landlocked coho—liberation data cover period July 1, 1966-June 30,1967. Does not include farm pond stocking.

2/ Annual stocking initiated in 1964, with most active program in 1966.

The combined natural plus artificial propagation production of salmon from Puget Sound waters for the period 1956-1965 averaged 425,800 chinook, 1,786,800 coho, 4,039,200 pink (odd years only), 763,920 chum, and 55,900 sockeye[1] annually.

Searun trout are produced naturally in significant numbers in 10 of the 11 basins (Table 3-5). All Area estuarine and marine waters contribute to their production. These fish are reared primarily in seven of the eight Washington Department of Game hatcheries in the Area. Additional facilities include the Bureau of Sport Fisheries and Wildlife and University of Washington hatcheries, several rearing impoundments, and two semi-natural rearing facilities where steelhead are the primary product. Average annual production for the period 1962-1966 was 358,700 winter steelhead, 6,700 summer steelhead, 647,200 searun cutthroat, and an estimated 100,000 searun Dolly Varden. These totals include harvested and spawning populations. Artificial propagation contributes almost 63 percent and 6.5 percent of the harvest and spawning population totals, respectively. Searun cutthroat are reared in only a few facilities, while Dolly Varden are not propagated artificially. Annual production from State-wide game-fish propagation facilities increased an average of 10.4 percent during the fiscal years 1961-1965.

Harvest

Commercial and sport harvest of salmon occurs primarily in the offshore ocean waters, the straits, and Puget Sound. Such harvest also occurs in the estuaries at the river mouths and in the rivers and tributary streams upstream to specifically designated boundaries.

Area produced salmon contribute heavily to commercial and sport fisheries off the Pacific Coast as well as to commercial, Indian, and sport fisheries within Area waters. Because of the complex and widely separated harvest of basin fish stocks, analysis on a basin basis is impractical; therefore, these harvest summaries are discussed under defined Area regulation boundaries.

Commercial Salmon Harvest. Salmon stocks originating from Area rivers and hatcheries are taken by commercial vessels throughout much of the length of the Pacific Coast. The various fisheries are regulated by up to ten different agencies. In addition to the value of the catch, numerous support facilities are provided, such as boat facilities, supplies for fishermen and their vessels, and many fisheries industries including fish processors and fish dealers.

[1] Significant increase occurred after 1965.

(1) Ocean Harvest. The Pacific Ocean commercial harvest of salmon produced in Area basins is by troll vessels fishing with hook and line along the coast. Fish from Area rivers and hatcheries have been taken in fisheries as far south as central California and as far north as the Gulf of Alaska (Figures 3-1, 3-2). The primary harvest area is the west coast of Vancouver Island and the Washington coast north of La Push. During 1965, approximately 1,827 troll vessels were licensed by the State of Washington to fish these waters. Comparable or greater numbers of trollers were licensed by the other coastal states.

Troll catch data for the Puget Sound District (Puget Sound and Juan de Fuca Strait) are included in Table 3-7, which presents the average annual commercial catch of salmon by species for the years 1935-1965. Primary Canadian ports of landing for troll-caught fish of Puget Sound origin are Ucluelet, Tofino, and Victoria on Vancouver Island, and Vancouver on the mainland. Neah Bay and Seattle are major landing ports in the district.

TABLE 3-7. Average annual commercial salmon catch in Puget Sound and Strait of Juan de Fuca, all gear, 1935-1965

Species	Fish (1000)	Pounds (1000)	Species	Fish (1000)	Pounds (1000)
Chinook	210	3,833	Chum	493	5,214
Coho	677	5,731	Sockeye	1,398	8,856
Pink	2,207 1/	12,661 1/			
			Totals	4,985	36,295

1/ Odd-year average only.

(2) Puget Sound Area Harvest. The commercial fisheries in Puget Sound[2] waters consist primarily of purse-seine and gill-net operations, which are closely regulated by the Washington Department of Fisheries and the International Pacific Salmon Fisheries Commission. The Commission was established in 1937 by treaty with Canada to manage sockeye runs to the Fraser River and its responsibilities were modified in 1957 to include pink salmon. Data concerning the average annual commercial catch of salmon by species, by management area (Figures 3-3, 3-4), are presented in Table 3-8.

[2] For Appendix purposes, Puget Sound included all United States marine waters east of the Bonilla-Tatoosh line at the entrance to Juan de Fuca Strait.

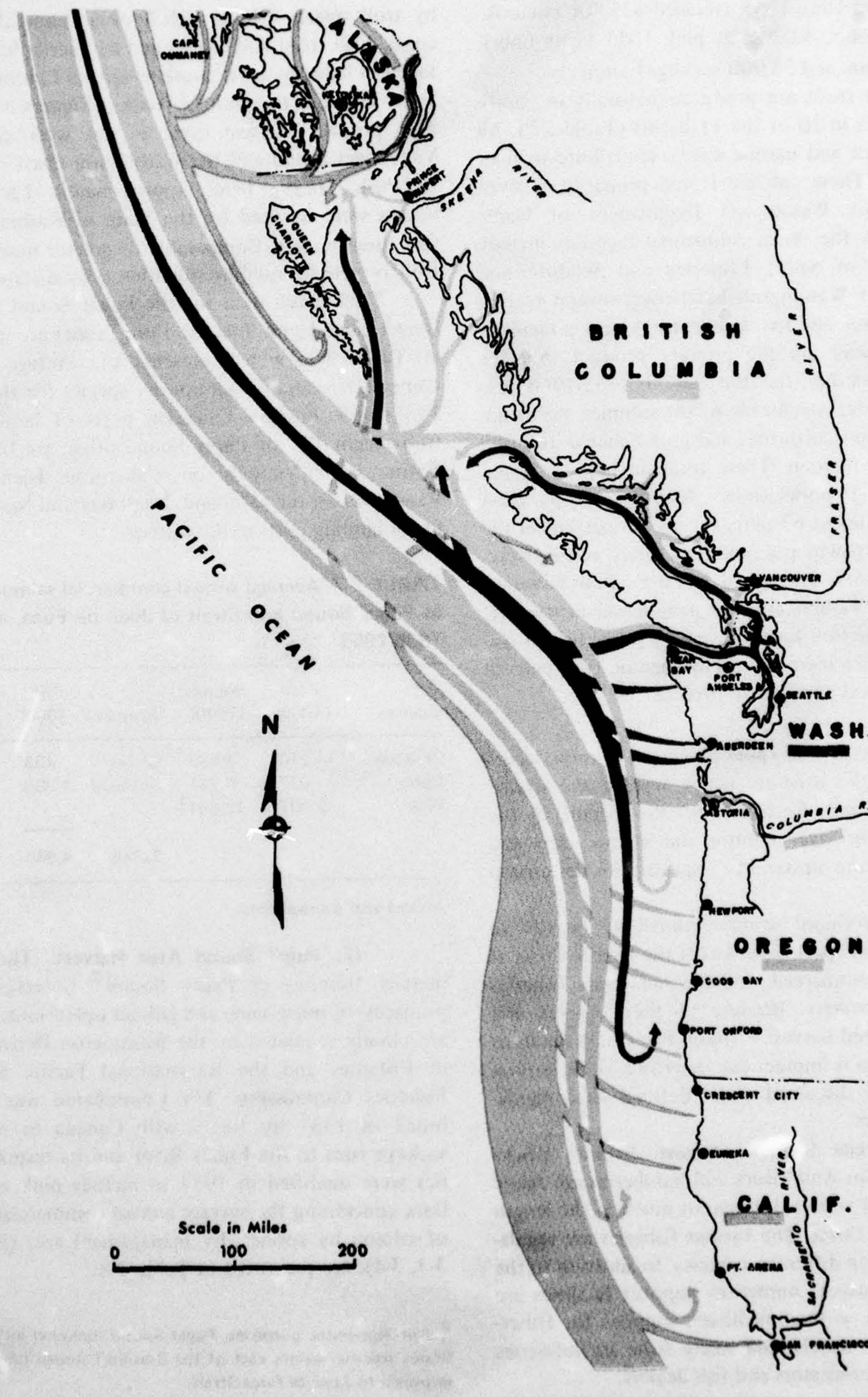


FIGURE 3-1. Migration patterns of chinook salmon—Pacific Coast

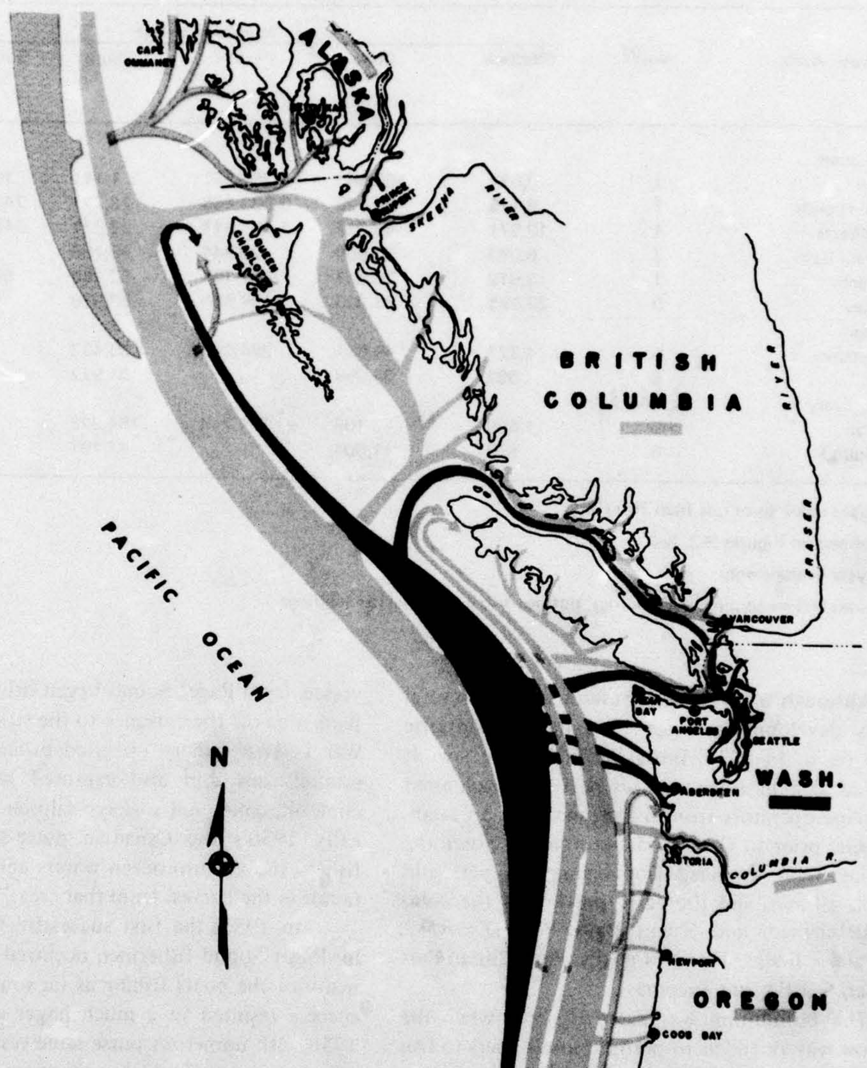


FIGURE 3-2. Migration patterns of coho salmon—Pacific Coast

TABLE 3-8. Average annual [1] commercial salmon catch, 1935-1966

Management Area	No.[2]	Numbers of Fish Chinook	Coho	Pink[3]	Chum	Sockeye	Totals[4] (1000–Rounded)
Strait of Juan de Fuca	1	3,571	107,983	352,357	1,111	18,759	483.8
San Juan Islands	1	6,175	80,292	2,002,466	23,777	746,527	2,859.2
Point Roberts	1	13,971	49,227	1,073,817	22,971	548,098	1,708.1
Bellingham Bay	7	6,283	22,900	26,844	28,100	--	84.1
West Beach	1	3,012	26,857	317,154	50,265	50,310	447.6
Skagit Bay	9	22,751	31,333	157,814	53,976	1,132	320.8
Port Susan-Port Gardner	5	4,227	49,551	284,129	39,493	--	377.4
Seattle	6	302	22,259	--	31,912	--	54.5
Port Discovery to Kingston	4,4a, 6	1,599	40,102	181,749	164,328	--	387.8
South Sound	6	977	11,054	--	41,187	--	53.2

[1] Excludes landings of less than 100 fish.

[2] As defined on Figures 3-3, 3-4.

[3] Odd-year average only.

[4] Includes Indian commercial landings, but not tribal personal use landings.

Although all regulations affect harvest, several primary developments since 1935 have had drastic effects on it. In 1934, Initiative 77 became law. It outlawed salmon traps and set nets and prohibited purse-seine operators from fishing inside of an established line prior to October 5. In effect, it closed the following areas to purse-seine fishing for pink and chinook salmon, and the early portion of the coho run: Bellingham and Skagit Bays; Port Discovery; Admiralty Inlet; Hood Canal; Port Susan-Port Gardner; Seattle; and Tacoma.

The prohibition was eased in 1949 when the initiative was amended to permit purse-seiners to fish in Port Discovery and Admiralty Inlet during August of odd-numbered years to aid in the pink salmon harvest. This resulted immediately in large catches of these fish; in 1963 approximately 740,000 were harvested in those areas.

The effect of the initiative was most evident in the chinook salmon catches when the Puget Sound harvest dropped more than one-half following the elimination of traps. Except for chinook, catches of other species were, in general, made by legal gear other than traps.

A second major legislative change which has affected the landings in the Strait of Juan de Fuca was the ocean closure on net fishing. Purse-seine vessels from Puget Sound began fishing the Swiftsure Bank area off the entrance to the strait prior to World War I. That fishery operated primarily during pink salmon runs, but also captured large numbers of chinook, coho, and sockeye salmon. Beginning in the early 1950's the Canadian purse-seine and gill-net fishery moved into ocean waters and became a major factor in the harvest from that area.

In 1955, the first successful gill-net operation by Puget Sound fishermen occurred in that area with many of the boats fishing as far south as La Push. Its success resulted in a much larger gill-net fishery in 1956 with numerous purse-seine vessels converting to gill nets, some of which were extra long. The fishery ranged as far as the north end of Vancouver Island and involved approximately 90 United States vessels, plus a larger number of Canadian vessels.

The knowledge of the damage of virtually uncontrolled fishing of the salmon runs prompted immediate action by all governments involved, and prior to the 1957 fishing season, all ocean waters west of the strait's entrance were closed to salmon net fishing by United States and Canadian fishermen.

The immediate effect of this closure was a large drop in the coho catch by Washington's fishing fleet. This decline was believed due to a number of causes including loss of a fishing area for harvesting salmon migrating south along the coast, or along the west coast of Vancouver Island. Another possible cause, particularly in Puget Sound coho catches, was the British Columbia net fishery in the strait. This fishery operated near the strait's entrance along the Canadian side, and the ocean closure did not seriously reduce fishing areas. Contrary to the United States harvest, the British Columbia fishery greatly benefited by the closure because it was able to operate without competition from the American fleet. The Canadian net fishery in the strait takes 300,000 to 500,000 coho salmon annually, before the runs reach the inner Sound where the major portion of the Washington net fishery occurs.

In the Sound, the State maintains numerous salmon preserves, designed primarily to protect salmon near the river mouths (Figures 3-3, 3-4). Several preserves have been enlarged since 1935, which has reduced the salmon harvest by gill nets in certain areas. In 1950, a large increase in the size of the Snohomish preserve for navigational purposes resulted in a virtual elmination of the chinook fishery in that area. In 1954, closure of the Bald Island area on the Skagit River resulted in a large reduction in the coho catch there.

Beginning in 1966, the Samish River salmon preserve was opened to gill-net fishing during the chinook run to harvest a greater portion of hatchery-produced chinook in that area. The opening resulted in a substantial increase in the catch of these fish from the Bellingham Bay area.

During 1965, there were 400 purse-seines, 906 gill-nets, 76 reef-nets, and 5 troll vessels (for lingcod only) licensed to fish in the Sound. The primary Area ports of landing are Blaine, Bellingham, Friday Harbor, Anacortes, La Conner, Port Townsend, Everett, Seattle, and Tacoma.

In addition to the above types of licensed commercial fisheries, unlicensed Indian fisheries have historically and are now harvesting salmon and steelhead commercially from fresh- and salt-water areas in the Puget Sound Area. Members of the Lummi, Nooksack (Nooksack-Sumas Basins), Swinomish (Skagit-Samish Basins), Tulalip (Snohomish Basin), Muckleshoot (Puyallup Basin), Nisqually (Nisqually-Deschutes Basins), and Skokomish (West Sound Basins) tribes are involved. These fisheries, in which gill nets, traps, dip nets, spears, set nets, or drag seines are employed, have not previously been regulated by the State because they operate under an 1855 treaty with the Federal Government.[1] A difficult management problem has evolved from the situation. Some tribes fish at strategic off-reservation areas, and in some rivers, such as the Nooksack, Puyallup, and Nisqually, it has been difficult to maintain adequate salmon and steelhead runs with certain segments of Indian fishing operations depleting escapement needed for seed stock.

The annual salmon harvest by Indians in the Puget Sound Area constitutes a significant portion of the total commercial catch for the Area. For the 32-year period 1935-1966 the Indian catch ranged from a low of 54,300 in 1935 to a high of 649,700 in 1963.[2] The average annual catch during this period was 175,700 salmon. During the base year 1965, a total of 148,700 salmon was landed by the Indian fisheries. A species breakdown of the catch reveals 12 percent chinook, 12 percent chum, 41 percent pink, 34 percent coho, and less than 1 percent sockeye salmon. The total Indian catch amounted to 15.8 percent of the entire Puget Sound commercial catch by all fishermen in 1965.

Sport Salmon Fishing.—Salmon stocks originated in the Puget Sound Area are taken by sport fishermen throughout the length of the Pacific Coast of the United States and Canada, as well as in the Sound marine and river waters (Table 3-9). In addition to the intangible esthetic value afforded by angling for these highly prized fish, numerous support facilities are maintained because of the presence of salmon. These include boat manufacture, sales, and facilities; charter businesses; fishing tackle manufacture and sales; bait and petroleum products; and resort facilities. The tourist attraction associated with these marine sport fisheries is also extremely important to the Area's economy.

In the marine environment nearly all of the salmon sport angling is from boats, whereas sport fishing from both streambanks and boats is common on fresh water. A recent State survey indicated that of 400,000 salmon sport fishermen in the marine environment in Washington in 1967, approximately 50 percent fished from private outboard boats, about

[1] The U.S. Supreme Court provided an interpretation of the Indians treaty rights in May 1968. It upheld the right of the State of Washington to regulate tribal fishing in the interest of conservation.

[2] Record numbers of pink salmon returned to Puget Sound that year.

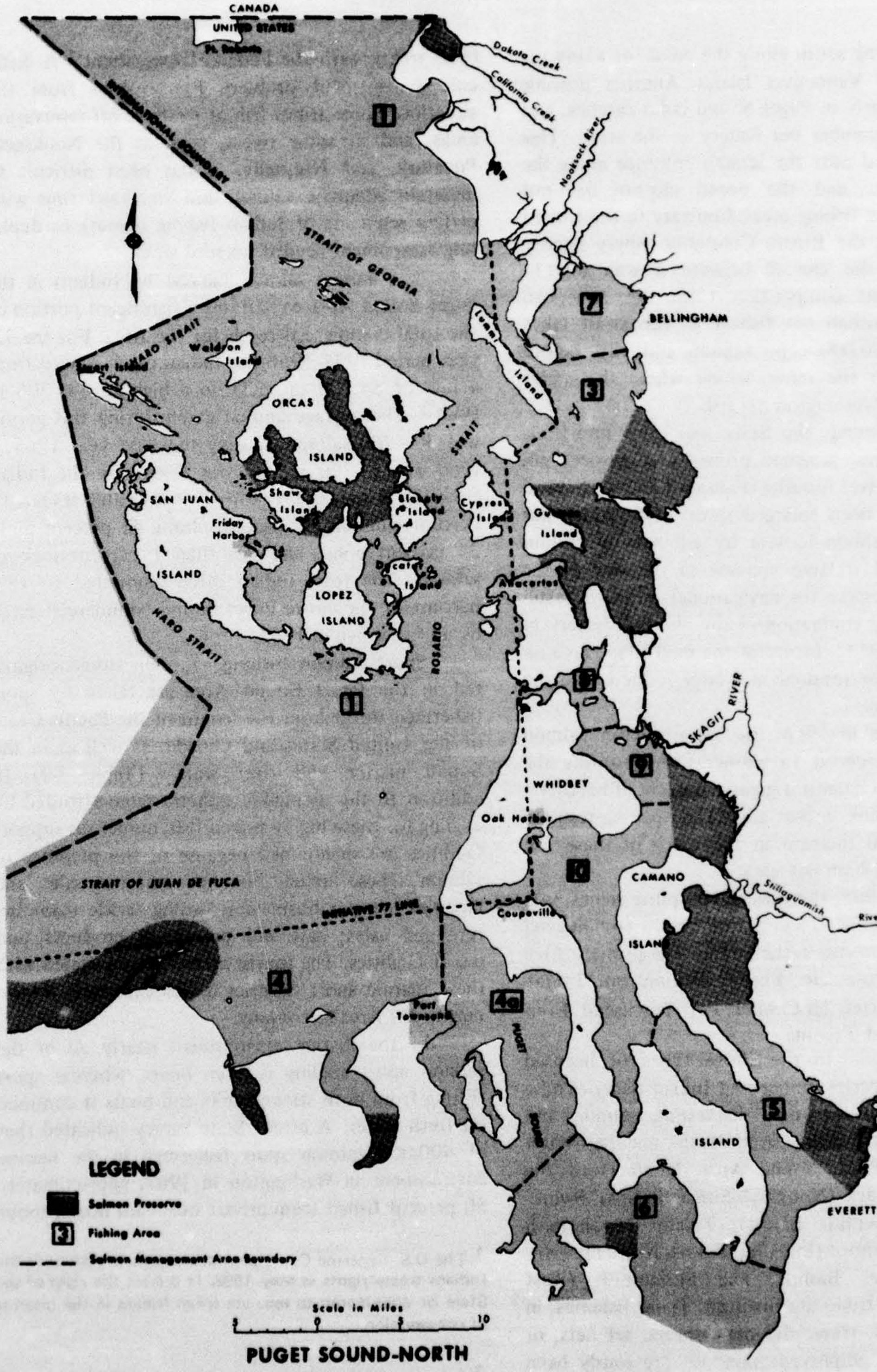


FIGURE 3-3. Commercial salmon fishing areas and preserves (1965)

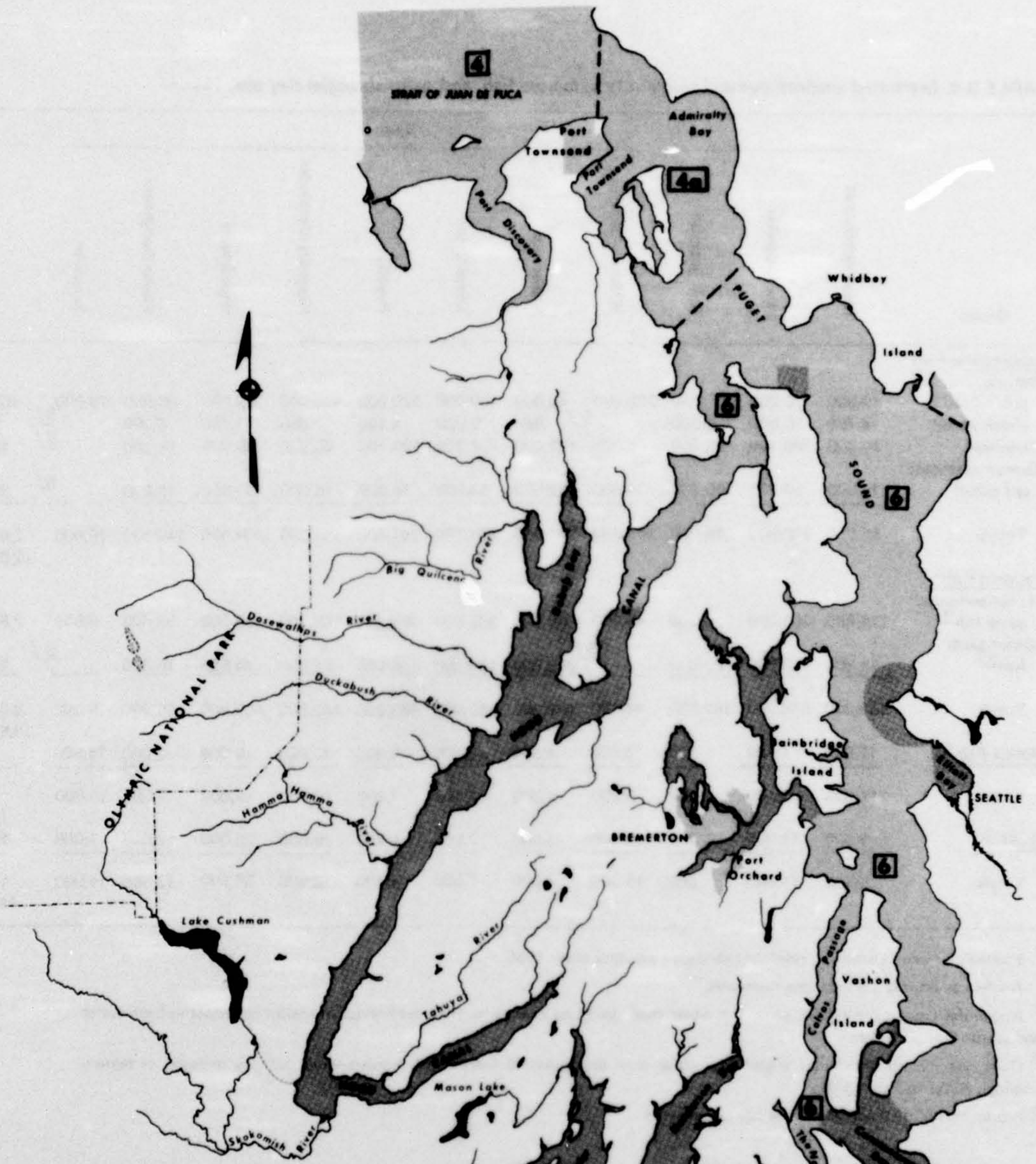


FIGURE 3-4. Commercial salmon fishing areas and preserves (1965)

TABLE 3-9. Estimated anadromous and resident fish, marine fish, and shellfish angler-day use, 1965[1]

Group	Basin: Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan	Totals
Anadromous Fish												
Salmon												
(salt water)	19,000	70,000	Few	120,000	40,000	100,000	120,000	100,000	83,000	90,000	79,000	821,000
(fresh water)	6,750	30,500	6,500	5/	880	8,000	4,100	550	1,750	8,000	5/	67,030
Steelhead	14,300	180,100	99,200	8,300	172,600	132,200	100,700	25,000	35,900	25,300	5/	793,600
Searun cutthroat (salt water)	16,800	50,300	50,300	16,800	33,500	33,500	16,800	16,800	83,800	16,800	5/	335,400
Totals	56,850	330,900	156,000	145,100	246,980	273,700	241,600	142,350	204,450	140,100	79,000	2,017,030 (2,017,000)
Resident Fish												
Trout and other game fish[2]	126,800	363,200	124,000	44,100	389,300	368,800	383,300	358,700	335,300	53,600	9,600	2,556,700
Other game fish[3]	61,500	153,500	63,800	5/	293,000	100,200	106,500	83,800	74,500	16,300	5/	953,100
Totals	188,300	516,700	187,800	44,100	682,300	469,000	489,800	442,500	409,800	69,900	9,600	3,509,800 (3,509,800)
Marine Fish[4]	12,000	1,400	100	3,200	4,300	12,400	3,800	10,000	9,000	2,000	14,800	73,000
Totals	12,000	1,400	100	3,200	4,300	12,400	3,800	10,000	9,000	2,000	14,800	73,000 (73,000)
Shellfish	9,500	11,000	200	15,000	3,000	7,500	4,700	18,600	28,000	12,500	11,000	121,000
Totals	9,500	11,000	200	15,000	3,000	7,500	4,700	18,600	28,000	12,500	11,000	121,000 (121,000)

1 Steelhead, searun cutthroat, resident fish angler use data cover 1966.

2 Angler use on lakes, ponds, and reservoirs.

3 Angler-days spent fishing for game fish other than steelhead in streams. Includes harvest of searun cutthroat in fresh water and searun Dolly Varden.

4 Does not include incidental angler-days (that time attributed to marine fish harvest while actively engaged in salmon angling). Refer to Table 3-16.

5 Production limited and angler use not determined.

37 percent fished from charter boats, nearly 18 percent fished from rental outboards, and about 16 percent fished from private cruisers. Nearly 26 percent fished for salmon in fresh water from boats or streambanks. The survey also revealed that many individual anglers fished in both salt water and fresh water or from more than one type of vessel in salt water. The same percentage ratios apply to Area salmon anglers except that ratio involving charter boats, as there are only a few operating in Area waters.

Rental boats are maintained by resorts and boathouses located near popular angling sites. These, usually 14- to 16-foot open craft, rent for fees ranging from $3 to $6 per day. Such fees do not include outboard motor rental. Private outboard boats are commonly trailered and launched at angling sites, moored on the water, or stored and launched from boathouses. Charter boats are among the largest of the vessels used for salmon angling and are operated by professional skippers who act as guides. Charter fees range from $10 to $15 per day per person. Gear and bait are available to charter anglers for additional cost. Charter boats are very important in the coastal sport fishing areas and in western Juan de Fuca Strait, but few operate on inner Puget Sound or among the San Juan Islands.

(1) Ocean Fishing.–During recent years, the sport fishery intensity pattern has shown marked changes. In 1950 only 7 percent of the angler use in all State marine waters occurred in the ocean as compared to nearly 27 percent in 1966. Total participation has shown an 80 percent increase since 1950 in the waters of the Sound and the Strait of Juan de Fuca. The increase in all marine waters during this same period was 100 percent.

Coastal salmon angling is concentrated in the vicinity of the Columbia River bar, off Grays and Willapa Harbors, off La Push, and in the vicinity of Cape Flattery. In Juan de Fuca Strait, heavy fishing pressure occurs in the vicinity of Waadah Island, Sekiu, Pillar Point, and the shoreline between Crescent Beach and Green Point (Elwha-Dungeness Basins).

Several factors have accounted for this significant shift of effort to coastal areas. The tendency for sport fishermen to seek new and better fishing sites is probably the foremost cause. When coupled with the increasing accessibility to new areas, expansion of facilities, and angler success averaging approximately one salmon per day, the reasons for the shift become apparent.

Expanding angler pressure on ocean waters is resulting in increasing harvest of Area-origin salmon. Although specific information on the contribution of these fish to the ocean fisheries is not available, it is believed they comprise a large part of the catch, especially in northern coastal areas.

(2) Puget Sound Area Fishing.–Washington anglers are oriented toward the marine environment because the Sound is adjacent to the State's population centers and offers compatible, near-lacustrine conditions for boating throughout the year. Before 1940, the marine sport fishery was largely confined to portions of Puget Sound near metropolitan centers. Elliott and Shilshole Bays at Seattle, the Narrows and Commencement Bay at Tacoma, and the waters surrounding southern Whidbey Island have been fished heavily by sportsmen for many years. Since 1945, with increased use of more powerful private boats, anglers are no longer confined to fishing waters in the immediate vicinity of established boathouses. Fisheries now exist in nearly all Sound waters where salmon can be caught (Figures 3-5, 3-6[1]).

The year round sport salmon fisheries in Area waters harvest two different "groups" of fish. Some chinook, coho, and pink salmon remain within Puget Sound their entire marine lives. These fish are caught throughout the year. The sport catches of chinook from November through June consist almost exclusively of "resident" fish. Dilution of the catch by adult chinook entering the Sound from the ocean on their spawning migration begins in July and continues through October. "Resident" fish comprise nearly all of the coho catch from January through mid-August. Mature ocean-reared coho begin their spawning migration during late August and their harvest on inner Sound waters continues through November. The Tacoma Narrows area formerly supported substantial numbers of "resident" pink salmon harvested largely from April through July. Ocean-reared pinks enter the Sound in late July, August, and September on odd-numbered years.

Catch fluctuations are attributed to catch regulations and stock strength. Both the total number of salmon caught and the catch/angler-day were reduced by approximately 50 percent after 1958.

The total salmon sport harvest in Area waters from 1959 through 1965 has averaged 200,000 fish annually while the catch/angler-day has been about 0.3 fish. The average annual salmon catch and catch/angler-day prior to 1959 were approximately double the above figures (Table 3-10). This substantial reduction is attributed to regulation changes and reduced numbers of fish.

Surveys indicate that the reduced coho harvest after 1958 was more the result of coincidental decrease in the numbers of "resident" fish than regulation changes. Also, chinook catches changed considerably following 1958, due to an increased size limit, which changed the timing and location of the fishery. The harvest of "resident" pink salmon was reduced by an increased size limit, established in 1958. Regulation changes had little effect on the harvest of ocean-reared salmon in inner Puget Sound since few of these fish fell within the length increase. Since 1958, angling effort on the Sound has become relatively stable. Expansion has not occurred due to the decline in the "resident" coho population and the increased length limit imposed that year.

The most important fresh-water salmon fisheries occur on the Skagit, Stillaguamish, and Nooksack Rivers, and on Lake Washington. Harvest data cannot be separated by species. Catches in the Skagit and Nooksack Rivers consist of coho, chinook, and pink

[1] Numbered areas also appear in Table 3-16.

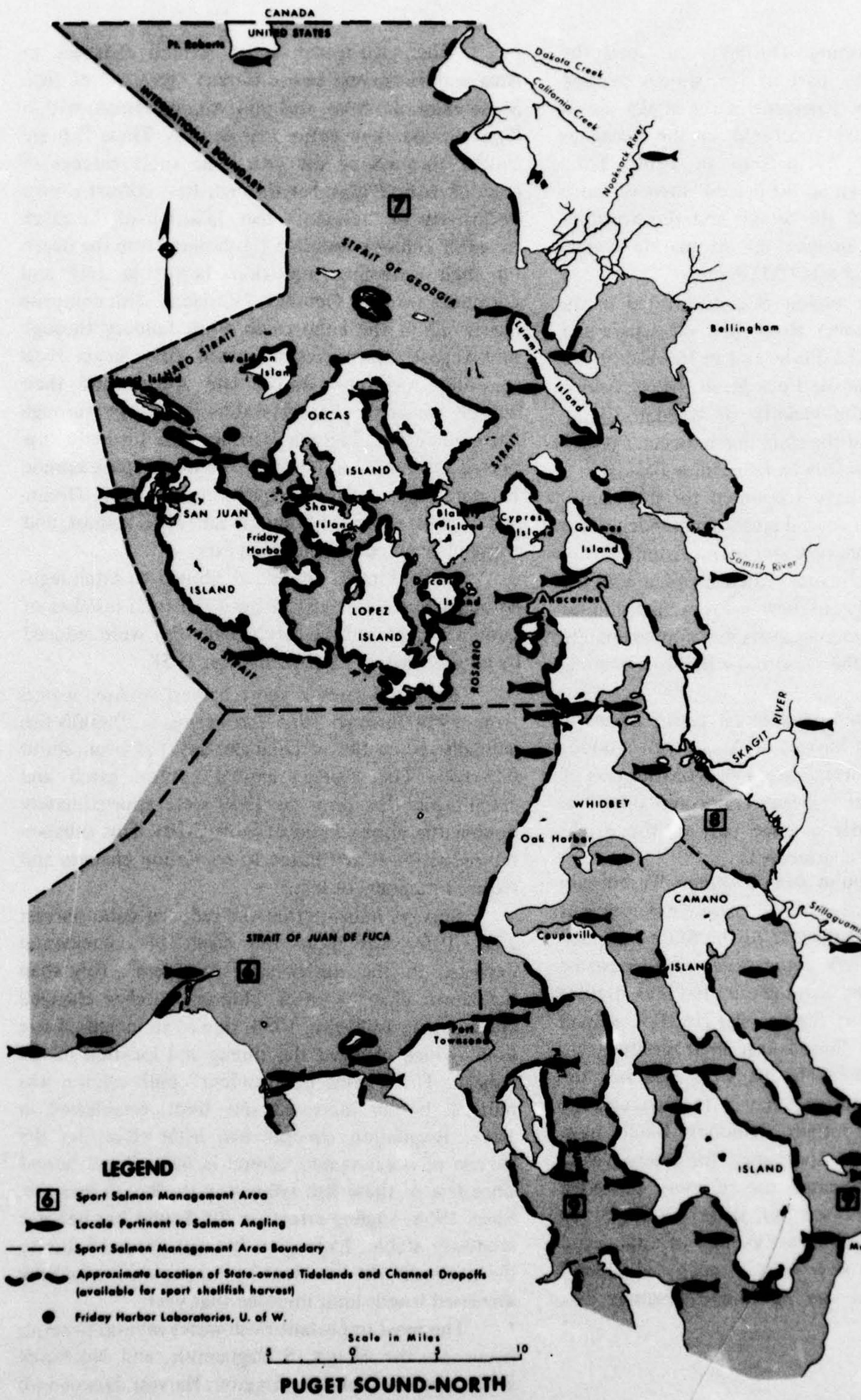


FIGURE 3-5. Sport salmon and shellfish areas (1965)

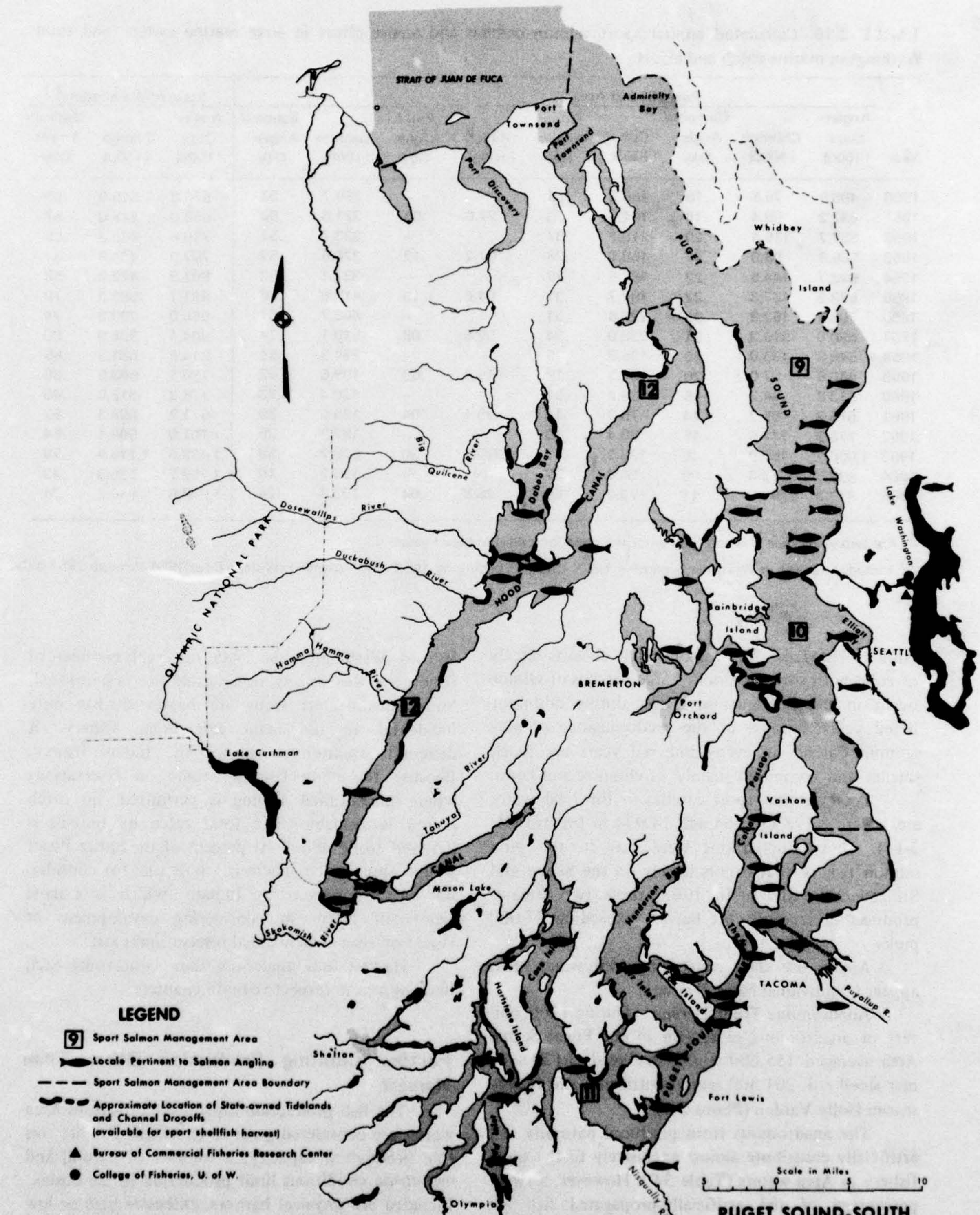


FIGURE 3-6. Sport salmon and shellfish areas (1965)

TABLE 3-10. **Calculated annual sport salmon catches and angler effort in Area marine waters, and total Washington marine catch and effort**

	Puget Sound Area									State of Washington[2]		
Year	Angler-Days (1000)	Chinnok (1000)	Chinook/ Angler-Day	Coho (1000)	Coho/ Angler-Day	Pink[1] (1000)	Pink/ Angler Day	Salmon (1000)	Salmon/ Angler-Day	Angler-Days (1000)	Salmon (1000)	Salmon/ Angler-Day
1950	498.9	79.5	.16	186.2	.35	--	--	265.7	.53	576.8	315.5	.55
1951	537.2	99.4	.18	194.6	.36	27.6	.05	321.6	.60	658.0	378.0	.57
1952	587.7	115.4	.20	218.3	.37	--	--	333.7	.57	716.6	463.3	.65
1953	565.8	95.3	.17	158.0	.28	67.2	.12	320.5	.57	707.0	434.3	.61
1954	623.7	144.5	.23	182.6	.29	--	--	327.1	.52	807.8	472.2	.58
1955	633.3	137.3	.22	197.7	.31	84.6	.13	419.6	.66	837.1	585.3	.70
1956	706.5	182.9	.26	220.8	.31	--	--	403.7	.57	956.0	703.9	.74
1957	690.0	219.3	.31	238.0	.34	52.8	.08	510.1	.74	964.1	868.9	.90
1958	540.8	139.0	.26	135.9	.25	--	--	274.9	.51	814.4	531.3	.65
1959	480.8	97.0	.20	87.3	.18	15.3	.03	199.6	.42	750.1	508.5	.68
1960	513.8	84.2	.16	36.2	.07	--	--	120.4	.23	778.3	312.0	.40
1961	675.2	95.2	.14	75.3	.11	25.1	.04	195.6	.29	971.2	508.3	.52
1962	776.9	117.5	.15	80.4	.10	--	--	197.9	.25	1,107.0	599.1	.54
1963	1,056.2	159.9	.15	128.2	.12	320.1	.30	608.2	.58	1,432.2	1,115.9	.78
1964	832.7	73.3	.09	56.6	.07	--	--	129.9	.16	1,252.7	535.8	.43
1965	817.3	93.9	.11	73.2	.09	28.8	.04	195.8	.24	1,278.8	940.2	.74

1/ Are two-year cycle fish and only enter the catch on odd-numbered years.

2/ Includes harvest at Westport beginning 1952, La Push beginning 1953, and Tokeland (Willapa Bay) 1954 through 1957 only.

salmon. The Lake Washington catch consists largely of coho with some chinook. Large catches of salmon occur in the Stillaguamish River during odd-numbered years, because of the predominance of pink salmon. Catches in even-numbered years are much smaller and composed mainly of chinook and coho.

Total salmon sport catches in the fresh-water areas were 3,798 in 1964 and 14,974 in 1965 (Table 3-11). These fluctuations were due to the pink salmon fishery that occurs largely on the Skagit and Stillaguamish Rivers. In 1963, these two streams produced a record sport harvest exceeding 27,000 pinks.

Angler use data concerning fresh-water areas appear in individual basin chapters.

Anadromous Trout Harvest.—During 1966, harvest of anadromous game fish in the Puget Sound Area averaged 155,600 winter steelhead, 3,120 summer steelhead, 201,300 searun cutthroat, and 10,000 searun Dolly Varden (Photo 3-2).

The anadromous trout produced naturally and artificially contribute almost exclusively to the sport fishery in Area waters (Table 3-9). However, a larger percentage of the artificially-propagated fish are harvested. Because steelhead were declared a game fish in Washington in 1935 no legal commercial fishery on this or any other game fish is permitted. Some anadromous trout are harvested, but only incidental to the main commercial fishery. A different situation exists for the Indian fishery. Because the main fishery occurs on reservations where unrestricted fishing is permitted, no catch record is available. The total catch by Indians is believed to be about 10 percent of the entire Puget Sound sport catch. There is a potential for considerably greater harvest by Indians, which is a most significant factor in considering development of stocks on rivers where tribal reservations exist.

Harvest and angler-use data concerning each basin appear in respective basin chapters.

Factors Limiting Production Other Than Harvest

The fish production capabilities of various Area waters are considered good to excellent. Despite this fine production capacity, a number of natural and man-made conditions limit production in the basins. Included are physical barriers, extensive high or low flows, poor water quality, lack of spawning and

PHOTO 3-2. Steelhead angling is a rewarding experience. (Washington Department of Game photo)

rearing areas, siltation, competition and predation, and conflicting watershed development. Discussion in basin chapters is confined to these particular factors, because each affords potential for being altered or eliminated to allow full utilization of the environment by fish.

Barriers occur naturally in precipitous headwaters of all the river systems. They are of secondary importance to the falls, restrictions, or cascades existing at a relatively low elevation, which frequently block large drainages to migrating fish. An example is Snoqualmie Falls (Snohomish Basin).

Flooding is particularly detrimental to anadromous fish production in the winter and spring when the eggs are in the gravel. Flood waters cause gravel movement and unhatched eggs are washed away or covered by rubble. Flooding also kills young fish by excessive silting and stranding.

Low summer flows cause loss of incubating and rearing habitat and alter environment to the extent that undesirable species become the primary inhabitants. These combinations usually result in starvation, predation, and higher disease rates. All occur to varying extent throughout the Area.

Clay and silt slides, such as those on the Stillaguamish River and the Taylor River (Snohomish Basin), cause compaction of spawning gravel and suffocation of imbedded eggs. Field and bank erosion

TABLE 3-11. Estimated annual fresh-water salmon sport fishery catches

Basin Stream or Lake	Numbers of Fish, by year 1964	1965	1966
Nooksack-Sumas			
Nooksack River	601	1,297	2,157
Skagit-Samish			
Skagit River 1/	1,658	4,803	3,638
Samish River 2/	40	481	285
Stillaguamish			
Stillaguamish River	156	4,741	259
Snohomish			
Snohomish River 1/	34	97	77
Skykomish River 2/	--	68	288
Snoqualmie River 2/	2	34	3
Tolt River 2/	--	3	18
Cedar-Green			
Lake Washington	685	1,872	1,797
Lake Sammamish 1/	14	198	203
Green River 2/	96	56	655
Puyallup			
Puyallup River 2/	374	722	1,360
Nisqually-Deschutes			
Nisqually River 2/	7	156	99
Deschutes River 2/	--	3	3
West Sound			
Big Quilcene River 2/	--	34	3
Dosewallips River	--	91	15
Duckabush River	--	28	--
Hamma Hamma River	17	28	--
Skokomish River 2/	26	163	12
Tahuya River 2/	--	6	--
Dewatto Creek 2/	--	3	--
Elwha-Dungeness			
Elwha River 2/	4	6	6
Dungeness River 2/	68	53	28
From Unknown Areas	16	31	18
Totals	3,798 (3,800)	14,974 (15,000)	10,924 (10,900)

1/ Certain areas open to jack salmon harvest only.

2/ Open to jack salmon harvest only.

causes similar problems.

Eggs and young of anadromous fish are preyed upon by sculpins, three-spined sticklebacks, squawfish, and to a limited extent by some older and larger salmonids. Predators also include various birds and mammals. Competition for living space and food comes primarily from resident fish.

Anadromous fish also suffer from limiting factors imposed by man. Although numerous and specific, most are a variation of one of four basic hazards–physical barriers, stream alterations, loss of streambed material, and pollution.

Man-made barriers exist on many streams and vary in size. Their purpose differs, but is usually for diverting or impounding water for municipal and industrial supply, production of electricity, reservoir recreation, flood control, or irrigation. Fish-passage facilities have been provided at very few–usually the smaller projects. In certain instances mitigation measures have been included in projects.

Stream alterations in general result in straightened stream courses with less length and more gradient. These projects destroy existing pool and riffle ratios essential to successful spawning and rearing. Flood control projects in particular restrict channels to maintain a self-cleaning status, but eliminate the potential for the streams involved to reestablish a satisfactory pool-riffle ratio.

Large amounts of gravel for construction are obtained from various streambeds. The removal of such material diminishes the spawning and food production potential in the work area and usually in areas immediately downstream. Dredging has a similar effect. Fundamentally, any removal of stream substratum upsets the stream's ecological balance and alters its productive potential for fish.

Pollution is an extremely important factor limiting fish production. Lower stream reaches and estuaries through which all anadromous fish must pass during their migrations and where industrial and urban development occurs are problem areas. Equally adverse situations exist on tributary streams in rural areas where organic and inorganic pollution problems arise. A relatively new kind of pollution is threatening the aquatic environment. Thermal pollution associated with certain industries promotes adverse changes in the natural ecological conditions. Water warmed by thermal powerplants with provision for only "once-through" cooling will result in production variations for certain fish species.

Beneficial Developments

The term "Beneficial Developments," as it pertains to fish resources, refers to projects, programs, or facilities designed (1) to achieve optimum production from existing environments, and (2) to increase production beyond the present level. Beneficial developments accomplished or under development are discussed in individual basin chapters.

RESIDENT FISH

Fish inhabiting the fresh waters are divided into five groups: salmonids in lakes, ponds, and reservoirs; other game fish in lakes; anadromous game fish;[1] game fish in streams; and undesirable fish.

Production of resident species is divided into three portions–that occurring in streams upstream from anadromous fish barriers; streams and sloughs downstream from such barriers; and lakes, ponds, and reservoirs. Within the last grouping, game fishes are separated into salmonids and landlocked salmon, while spiny rays include all other game fish.

Salmonids in Lakes, Ponds, and Reservoirs

Common salmonids in lakes include rainbow, cutthroat, and brook trout, kokanee, and coho salmon. The particular qualities of each lake determine which species will thrive, so brook and cutthroat are less frequently stocked in lakes, while rainbow are the backbone of the lowland lake planting program. Kokanee thrive only in large lakes or reservoirs with suitable thermal and chemical regimes plus adequate spawning areas and abundant food organisms, such as Lake Washington, Lake Whatcom, Lake Stevens, Sammamish Lake, and Lake Cushman reservoir. Coho have been stocked in selected lakes to provide variety in the creel and to experiment with their competitive and parasitic immunity qualities. Exotic species such as golden and lake trout and grayling have been stocked in a few alpine lakes on an experimental basis and to provide trophies for hardy sportsmen.

Salmonids in lakes provide more fish and fishing recreation than all other groups of game fish (Table 3-9, Photo 3-3).

Production is shown with harvest data, since it results primarily from growth of fry and fingerling

[1] Discussed in Anadromous Fish section.

originating in artificial propagation facilities. Production (exclusive of lampreys) varies from 10 to over 300 pounds per surface acre annually. Potential production in lowland lakes could be substantial.

Various harvest regulations provide the most fishing recreation with the highest quality.

Working through local Soil and Water Conservation Districts with assistance from the U.S. Department of Agriculture, private landowners have constructed about 800 farm ponds in the Area (Table 3-12). About one-half of these are located in the Nooksack-Sumas and West Sound Basins, and the remainder are scattered throughout the other basins. About one-third of the total are stocked or managed for trout. These ponds produce enough natural food annually to grow about 100 pounds of trout per surface acre. Although these have been used successfully and variably for private and public recreation, their relative contribution to public harvest has been small.

There are about 60 trout farms established within the Area providing fish to private waters for sport fishing or for commercial sale.

PHOTO 3-3. Lakes in Puget Sound Area produce well. (Washington Department of Game photo)

TABLE 3-12. Private farm ponds, 1965

Basin	Farm Ponds[1] (Number)
Nooksack-Sumas	233
Skagit-Samish	46
Stillaguamish	33
Whidbey-Camano	57
Snohomish	73
Cedar-Green	66
Puyallup	48
Nisqually-Deschutes	32
West Sound	114
Elwha-Dungeness	69
San Juan	24
Total	795

[1] Average 0.5 acres in surface area.

Several factors limit fish production and harvest in lakes. Certain types of pollution result in heavy algal and other aquatic growth, which reduces the area available to both fish and fishermen and occasionally causes fish mortality. Competition and predation by spiny-rayed and undesirable fish also occur. Parasitic organisms limit fish populations in many lakes.

Beneficial developments designed to combat limiting factors include chemical control of undesirable species and subsequent trout stocking. Occasionally, outlet screens and/or migration barrier dams are necessary to isolate the desirable species. Some screens block runs of anadromous fish to spawning areas, but this is generally a minimal loss. From the standpoint of angler use, the boat launch area acquisition and development program of the Washington Department of Game, other government agencies, and private enterprise, is a beneficial development.

Other Game Fish in Lakes

Spiny-rayed game fish in lakes, ponds, and reservoirs, including bass, perch, crappie, sunfish, and bullhead, are very prolific.

Harvest of these game fish exceeds 2.5 million annually. This harvest provides an important part of the more than 2.5 million angler-day pressure occurring on lakes, ponds, and reservoirs each year (Table 3-9).

Because they prey upon and compete with more popular game fish, these fish are, in many instances, limiting factors to salmonid production. They also limit their own production when overpopulation results in tremendous numbers of very small adult fish, which are capable of spawning and producing more young to further aggravate the problem.

In certain lowland lakes, these species have been eliminated to provide greater angling recreation for the public. A total of 151 lakes totaling 13,492 surface acres has been chemically rehabilitated and all but two restocked with trout. Killarney Lake (Puyallup Basin) and Munn Lake (Nisqually-Deschutes Basins) were restocked with bass, even though 90 percent of the lakes below 2,500 feet elevation contain bass or other spiny-rayed species. A statewide household survey (1965) revealed that nearly 4 percent of the Area's residents fished for spiny-rayed species in 1964. Underutilization of these species could be modified to more adequately harvest and control stunted populations.

Game Fish in Streams

Resident game fish in streams are primarily rainbow, cutthroat, and brook trout and whitefish, although occasionally one or more of the spiny-rayed fishes inhabit sluggish warm reaches of rivers and sloughs. Resident game fish thrive upstream from anadromous fish barriers, where there is no competition with sea-going salmon, trout, and char. Rainbow trout frequent the large rivers and streams while brook and cutthroat trout prefer smaller, sheltered streams in the foothills. Often, cutthroat and brook trout coexist in beaver ponds. Less hardy than the rainbow, they do not compete as well as in area environments and are often unsuccessful in rainbow-populated waters. Whitefish occur primarily in typically rainbow trout waters, often congregating in deep pools and drifts in the winter.

Generally, factors limiting resident stream fish are comparable to those affecting anadromous game fish production. A few differences of degree and type should be noted.

First, production of resident game fish in streams is limited by anadromous fish competition and, as such, their production is considerably less than that of anadromous game fish. Recent State studies revealed that 90 percent of all fish reared in sample sections downstream from anadromous fish barriers moved from the smaller streams to larger streams each winter. Exceptions to this exist on the larger rivers, particularly for whitefish. This was not confirmed for all situations and all species. More than 6.7 million resident trout are liberated annually from Area hatchery facilities (Table 3-6) to compensate for lost production, and approximately 3.1 million game fish other than steelhead and searun cutthroat are harvested from Area streams. Because hatchery contributions are divided between lakes and streams, and particularly since certain lake and pond fish stocks contribute most heavily to stream fisheries, valid estimates of total hatchery contribution to streams are not possible. Therefore, estimates of potential increased stream trout production (which may be increased substantially) and harvest would no more than parallel that of anadromous fish in any particular basin.

Second, the production of resident game fish in streams is somewhat underutilized, especially in the case of whitefish. It is estimated that less than 20 percent of the existing whitefish harvest potential is utilized annually. This, therefore, limits the potential for increasing production until an adequate base can be established. More than 953,000 angler-days annually are spent in pursuit of game fish in streams, of which whitefish anglers spend 17,000 (Table 3-9). A significant increase in whitefish harvest and angler-day use is possible. For the same reasons stated above, estimates of potential production values are not possible. However, guaranteed public access and hatchery stocking make stream fishing for game fish other than steelhead one of the greatest recreation potentials within the Area.

Third, while limiting factors are similar, some are more damaging to resident game fish. For instance, resident game fish must compete with anadromous game fish as well as undesirable species. In addition, pollution and physical barriers are more relative to resident species. Since migratory instincts are not strong, these fish must survive in areas of poor quality, where no anadromous fish exist, or where stream gradient is considerably steeper and barriers more frequent.

Fourth, beneficial developments require greater application for resident fish, since these species are most vulnerable to changes in the environment of standing water areas. In streams they usually benefit from developments designed primarily for anadromous fish. Fish-passage facilities are a notable exception to this, since once anadromous trout have access to resident trout waters, the resident species often suffer heavy competition and depletion.

Undesirable Fish

Undesirable species are indicated in Table 3-1.

These fish are considered undesirable because they prey on or compete with the more popular species of game fish and because there is little or no existing demand for them in the sport fishery. This does not preclude the possibility that at some future time they may become a valuable resource. Various species of undesirable fish occur in nearly every aquatic habitat.

Sculpins are widespread, and sticklebacks occur downstream from anadromous fish barriers in every stream system. Suckers, peamouth, and squawfish are abundant in lakes and rivers, and varied species of dace occur in most streams.

Many of the factors which inhibit salmonid production (such as pollution) greatly enhance the production of undesirable species which have a higher tolerance to poor water quality.

In certain streams, survey samples show undesirable fish production is the total production at one elevation and the opposite at another. Therefore, no area production values were determined. Production from average sections is shown in basin chapters.

Undesirable species have been eliminated from many small lakes and a few large lakes. Control measures are usually not attempted when major anadromous fish runs are present or where watersheds are extensive.

There are no harvest or potential production or harvest data for undesirable species, although some species (chub, suckers, squawfish) do provide a limited amount of incidental recreation while anglers are seeking game fish.

MARINE FISH

Inventory and Distribution

The marine fishes important to the Puget Sound Area include those in the open ocean and those inhabiting Area marine environment (Table 3-13, Exhibit 1). Large numbers of various ocean fishes are harvested by vessels based in Puget Sound, and are landed and processed at its major ports. Principal species include Pacific Ocean perch; petrale, Dover, and English sole; lingcod; true cod; and a variety of rockfishes. Within Area waters, the major marine food fishes include lingcod, Pacific cod, herring, flounder, surfperch, and a variety of rockfish and sole. In addition, many "scrap fish" species, such as dogfish, skate, ratfish, and hake, inhabit Area waters and are harvested for the animal food and fish meal industry.

Production and Propagation

Neither production levels nor individual population sizes for the various species were determined. An estimate of relative abundance is reflected in the harvest statistics; however, such data represent only those fish for which a commercial market or a specific sport interest has been developed. Numerous species, some having large populations, are unutilized and accordingly serve as potential resources for future commercial or sport use. Some are predacious pests.

With the exception of the herring propagation facilities at Whidbey Island, marine fishes are not propagated within the Area.

Harvest

Marine fishes inhabiting the outer Strait of Juan de Fuca and ocean waters are harvested principally by commercial fishermen, however, marine fishes inhabiting waters within Area boundaries are harvested by both commercial and sport fishermen (Tables 3-13, 3-9; Photo 3-4).

Commercial Marine Fish Harvest. The most important commercial gear for taking marine fishes is the otter trawl. Other gear, utilized to a much lesser degree, includes set lines, hand lines, troll lines, and jigger gear, drag seines, bottom sink set nets, and midwater trawls.

To ensure the conservation of the marine fish resource, the State imposes specific harvest regulations involving gear limitations, seasonal restrictions, and closed areas (Figures 3-7, 3-8[1]).

(1) Ocean Harvest. The majority of marine bottomfish harvested from ocean waters are taken by commercial trawlers. Generally, the species and quantity of these fish landed at Puget Sound ports are governed by fish processors, and depend largely on specific market demands. In 1965, approximately 47 licensed commercial trawlers fished the coastal waters from Oregon to southeast Alaska, landing their catches at major Puget Sound processing plants located at Blaine, Bellingham, Anacortes, Everett, and Seattle. Such catches make up the bulk of landings at these ports, with the 1965 total catch exceeding 73 million pounds (Table 3-14).

(2) Puget Sound Area Harvest. Commercial trawl vessels operate primarily in the northern portion of the Area's marine waters, particularly in the Nooksack-Sumas, Skagit-Samish, San Juan, Elwha-Dungeness, northern Whidbey-Camano, and West

[1] *Numbered areas also appear in Table 3-15.*

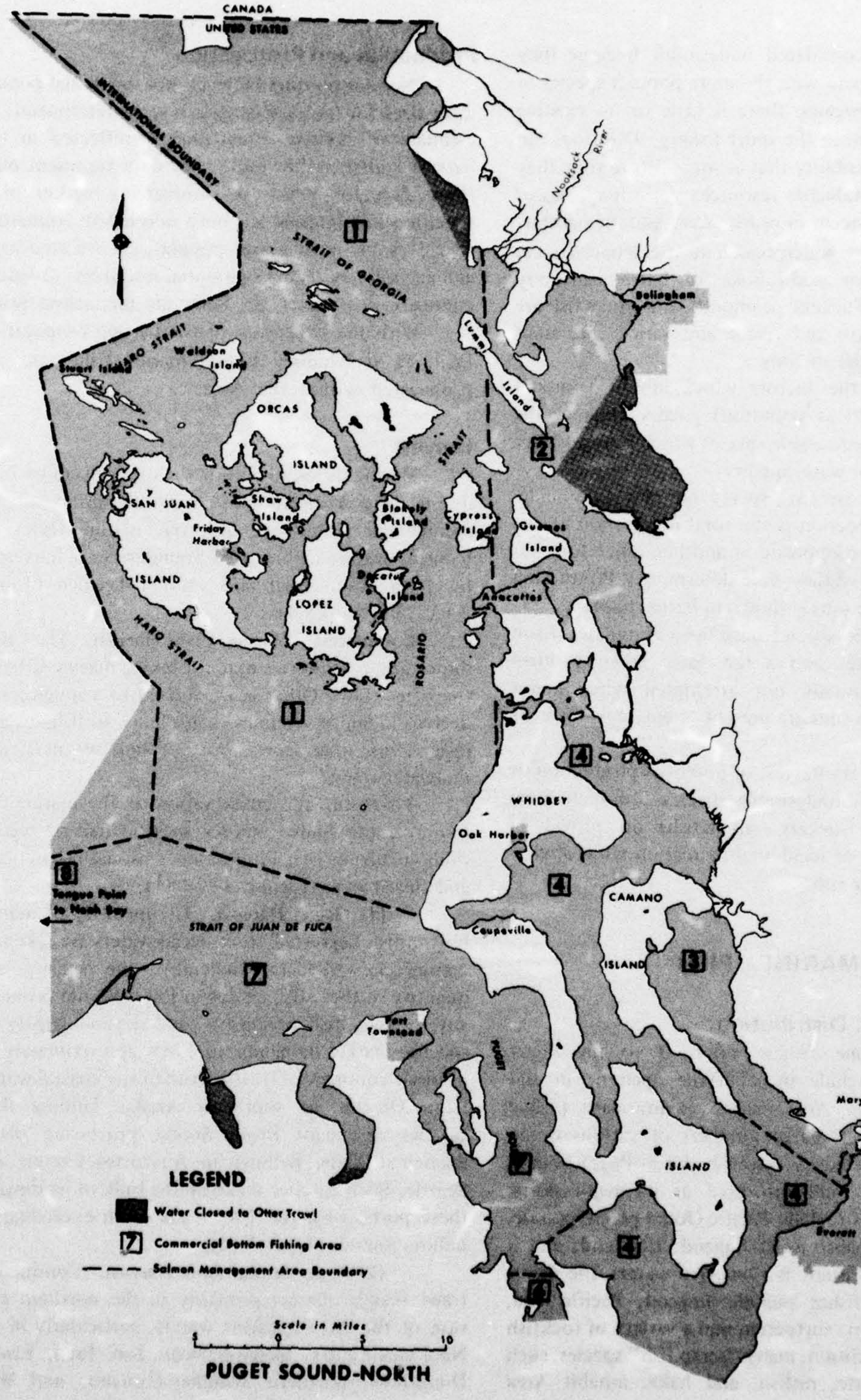


FIGURE 3-7. Commercial bottom fishing areas (1965)

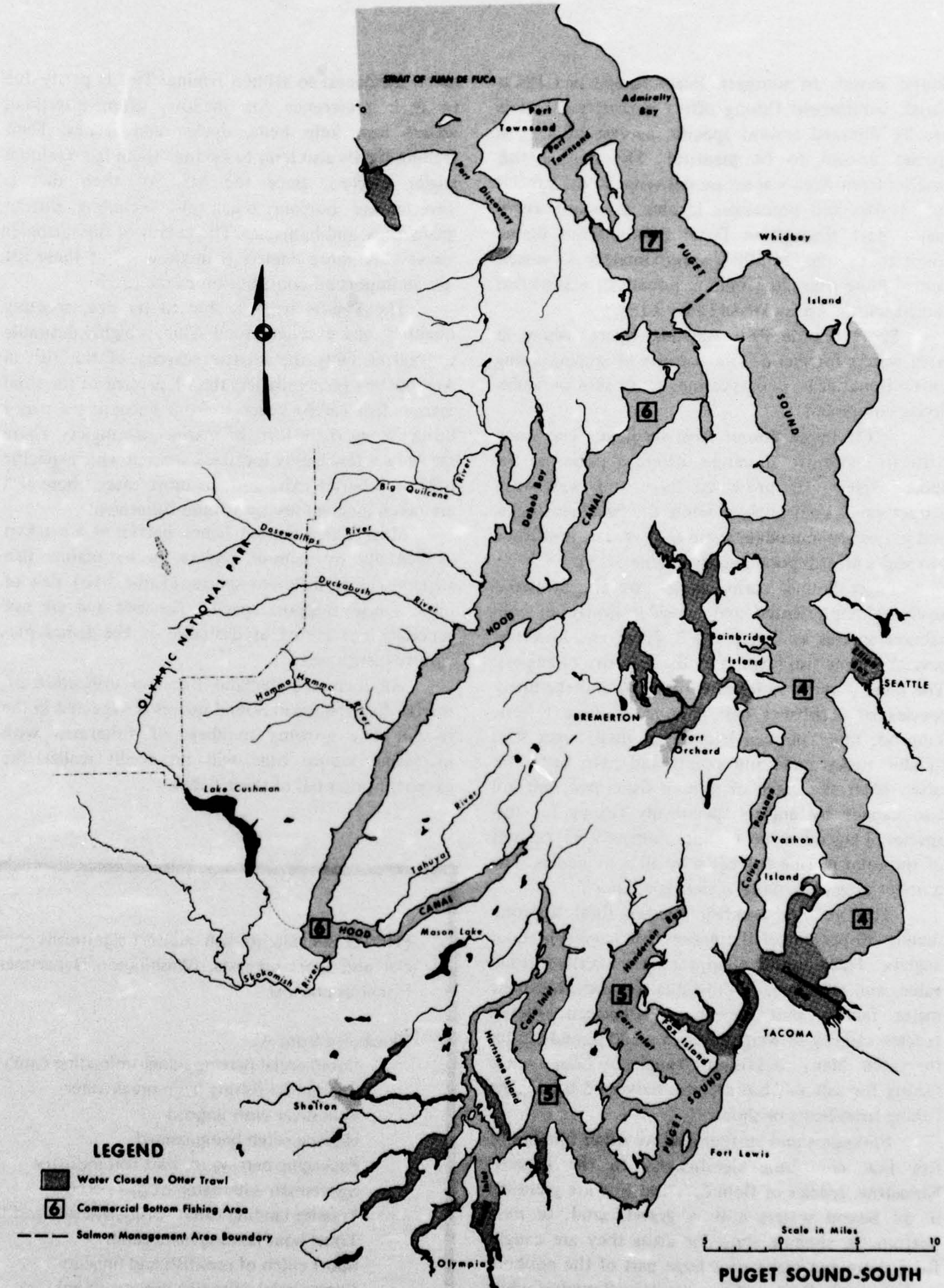


FIGURE 3-8. Commercial bottom fishing areas (1965)

Sound Basins. In southern Puget Sound and Hood Canal, commercial fishing effort is scattered and is usually directed toward specific harvest of various species known to be plentiful. The marine fish catches from Area waters are delivered to the various fish dealers and processors located at nearly every major port throughout Puget Sound from Blaine south to Tacoma. In 1965, approximately 43 vessels landed more than 20.5 million pounds of marine fish caught within Area waters (Table 3-15).

Sport Marine Fish Angling.—Sport fishing in Area waters for marine fish consists of angling, using conventional gear; and spearing, using skin or scuba diving equipment.

(1) Puget Sound Area Angling.—The Area, with its extensive shoreline, offers a potential for sport anglers. Its protected bays and waterways attract small boat anglers, while the beaches, docks, and jetties accommodate shore anglers. The multitude of species affords good angling (Table 3-13).

Puget Sound marine anglers are almost exclusively salmon-oriented and consider nearly all non-salmon species as "scrap fish." There are, however, several marine fish favored by the majority of anglers. The most popular varieties are lingcod and the many species of rockfishes that abound in these waters. Lingcod, more popular because of their larger size, inhabit rocky reefs and points and kelp beds and often enter the catch of salmon fishermen, but are also caught by anglers specifically fishing for this species. Lingcod make up approximately 15 percent of the total marine fish catch by all boat anglers. The number caught by shore anglers is unknown.

The various rockfish species total approximately 50 percent of the marine fish harvest by boat anglers. Their bass-like appearance, excellent food value, and widespread availability are considered the major factors that appeal to fishermen. Eleven species, ranging in weight from 2 to 20 pounds, enter the catch. Many rockfish are caught by boat anglers fishing for salmon, but are also harvested by anglers fishing from boats or shore.

Flounders and surfperches are other families of fish that contribute significantly to the harvest. Numerous species of flounders and sole are plentiful in all Sound waters with a gravel, sand, or mud bottom. In shallow shoreline areas they are caught from shore and make up a large part of the nonboat angler's catch. Boat anglers often take flounders while salmon fishing in deeper water.

The surfperches, in contrast, are very seldom taken incidental to salmon fishing. This is partly due to their preference for shallow, often intertidal, waters near kelp beds, docks, and jetties. Their feeding habits also tend to exclude them from salmon angler catches, since the bulk of their diet is invertebrate bottom organisms, including shrimp, pileworms, and barnacles. The extent of the surfperch harvest by shore anglers is unknown, but these fish are an important contribution to the catch.

The Pacific halibut, due to its size, sporting qualities, and excellent food value, is highly desirable to anglers. Only the relative scarcity of this fish in Area waters (generally less than 1 percent of the total marine fish catch) keeps it from becoming a major influence on the efforts of marine fish anglers. There are only a few highly localized areas in which specific halibut fisheries exist and, in most cases, these fish are taken incidentally by salmon fishermen.

Most other marine fishes harvested are taken incidentally by salmon anglers, or by marine fish anglers seeking different species (Table 3-16). Few of these species support specific fisheries and are not generally considered as desirable as the fishes previously mentioned.

An increased demand for, and utilization of, marine fish species in Sound waters is expected in the future. The growing numbers of fishermen with increasing leisure time will no doubt realize the excellent potential of these fishes.

PHOTO 3-4. Marine fish support significant commercial and sport harvests. (Washington Department of Fisheries photos)

Clockwise from A:

Commercial herring seiner unloading catch
Sportsmen fishing from breakwater
Skin diver with lingcod
Herring catch being landed
Packaging herring for bait fish industry
Sportsman with catch of pile perch
Trawler landing catch—primarily sole and flounder
Trawl boat landing hake catch
Sport catch of rockfish and lingcod
Commercial fillet line processing sole


A

TABLE 3-13. Relative abundance and utilization of common marine fish[1]

Basin

Species	Nooksack-Sumas Relative Abundance L	M	H[2]	Use Comm.	Sport	Skagit-Samish Relative Abundance L	M	H	Use Comm.	Sport	Stillaguamish Relative Abundance L	M	H	Use Comm.	Sport	Whidbey-Camano Relative Abundance L	M	H	Use Comm.	Sport
Pacific cod			x	x	x			x	x	x								x	x	x
Other codfishes			x		x		x		x	x						x			x	x
Pacific hake			x	x		x			x									x	x	
Lingcod			x	x	x			x	x	x								x	x	x
Greenling			x	x	x			x	x	x								x	x	x
Flounder			x	x	x			x	x	x								x	x	x
English sole			x	x	x			x	x	x								x	x	x
Other soles	x			x	x			x	x	x						x			x	x
Surfperch			x		x			x	x	x								x	x	x
Black rockfish			x	x	x			x		x								x	x	x
Copper rockfish			x	x	x			x		x								x	x	x
Canary rockfish			x	x	x			x		x								x	x	x
Quillback rockfish			x	x	x			x		x								x	x	x
Yellowtail rockfish			x	x	x			x		x								x	x	x
Other rockfishes			x		x		x		x								x			x
Pacific herring			x	x	x			x	x	x								x	x	x
Spiny dogfish			x	x				x	x									x	x	x
Ratfish		x		x				x	x								x		x	x
Skate		x		x																
Smelt		x			x											x				x

Species	Snohomish L	M	H	Comm.	Sport	Cedar-Green L	M	H	Comm.	Sport	Puyallup L	M	H	Comm.	Sport	Nisqually-Deschutes L	M	H	Comm.	Sport
Pacific cod		x		x	x		x		x	x			x	x	x		x		x	x
Other codfishes		x		x	x		x			x		x		x	x	x			x	x
Pacific hake			x	x			x		x			x		x			x		x	
Lingcod		x		x	x		x		x	x			x	x	x		x		x	x
Greenling		x		x	x			x	x	x			x	x	x		x		x	x
Flounder		x		x	x	x			x	x	x			x	x		x		x	x
English sole			x	x	x			x	x	x			x	x	x			x	x	x
Other soles		x		x	x	x			x	x	x			x	x		x		x	x
Surfperch			x	x				x	x	x			x	x	x		x		x	x
Black rockfish			x	x	x	x				x		x			x	x				x
Copper rockfish		x			x		x			x			x		x		x		x	x
Canary rockfish		x		x	x	x				x		x			x	x				x
Quillback rockfish		x			x		x			x	x				x	x				x
Yellowtail rockfish	x				x	x				x	x				x	x				x
Other rockfishes		x		x	x		x		x	x		x		x	x		x		x	x
Pacific herring		x		x	x			x	x	x			x	x	x			x	x	x
Spiny dogfish			x	x				x	x				x	x				x	x	
Ratfish			x	x		x			x			x		x		x			x	

Species	West Sound L	M	H	Comm.	Sport	Elwha-Dungeness L	M	H	Comm.	Sport	San Juan L	M	H	Comm.	Sport
Pacific cod			x	x	x			x	x	x			x	x	x
Other codfishes		x		x	x	x			x	x		x		x	x
Pacific hake			x	x				x	x		x			x	
Lingcod			x	x	x			x	x	x			x	x	x
Greenling			x	x	x			x	x	x			x	x	x
Flounder			x	x	x			x	x	x			x	x	x
English sole			x	x	x			x	x	x			x	x	x
Other soles		x		x	x	x			x	x		x		x	x
Surfperch			x	x	x			x	x	x			x	x	x
Black rockfish			x	x	x			x	x	x			x	x	x
Copper rockfish			x		x			x	x	x			x	x	x
Canary rockfish			x		x			x	x	x			x		x
Quillback rockfish			x		x			x	x	x			x		x
Yellowtail rockfish		x			x			x	x	x			x	x	x
Other rockfishes		x		x	x		x			x		x		x	x
Pacific herring			x	x	x			x	x	x			x	x	x
Spiny dogfish			x	x				x	x	x			x	x	
Ratfish		x		x			x		x	x			x	x	

[1] Excluding species not presently utilized by commercial or sport interests.

[2] L—Light, M—Medium, H—Heavy.

TABLE 3-14. Commercial marine fish landings at Area ports, 1965 1/

Species	Pounds	Species	Pounds
Sablefish	1,218,355	Hake	969,143
Flounder	696,957	Halibut	8,687,055
Lingcod	4,755,492	Herring	8,345,448
Rockfish 2/	20,460,654	Ratfish	1,317,450
Sole	9,243,788	Shark 3/	1,876,650
Pacific cod	9,936,594	Scrap fish 4/	2,685,200
Albacore	789,898	Miscellaneous 5/	2,627,170
Total			73,609,854 (73,610,000)

1/ Includes fish landed from ocean waters and only species for which more than 500,000 pounds were landed.

2/ Includes Pacific Ocean perch.

3/ Primarily dogfish. Also includes catches of sixgill and soupfin sharks.

4/ Mixed catches of dogfish, ratfish, skate, and shark.

5/ Includes 2,549,592 pounds of yellowfin, skipjack, and bluefin tuna.

Beginning in 1965, information on the marine fish sport fishery in Area waters was collected secondarily to sampling the salmon sport fishery. Data obtained only from boat anglers included catch, effort, and species composition information. In addition, catch was separated into incidental harvest (marine fish caught while actively angling for salmon) and specific harvest (marine fish caught while actively angling for species other than salmon).

Since most salmon fishermen consider the majority of marine bottomfish "undesirable," only a small percentage of the number caught is actually retained. Even anglers who specifically fish for marine fish keep only certain species and discard all others.

Based on a 1965 study, the harvest figures shown in Table 3-16 are separated by salmon management units which physically provide better division of Area marine waters than do the basin boundaries (Figures 3-5, 3-6). In the study, an estimated 848,856 angler-days (incidental and specific) were totaled, resulting in a harvest of 171,998 marine fish of mixed species, or 0.2 fish per angler-day.

In 1965, rockfish comprised the bulk of the total marine fish harvest, with approximately 50 percent (Table 3-16). Lingcod and greenling were second in total catch, making up 18.1 percent. The third group of fishes that occurred in large numbers in the catch was the flounders and soles, 15.2 percent. These three groups comprised over 80 percent of the total landings. Their popularity is believed due to their abundance and/or palatability as well as their sporting qualities. The other fishes listed in the table occurred less frequently in the catches and were usually kept only from a curiosity standpoint.

While these data give a quantitative view of the marine fish harvest, they represent only a segment of the angling population, and because the data cover only 1965 (plus data from study continuance in 1966), definite trends in the fishery have not been established.

(2) Puget Sound Area Spear Fishing. The extensive protected shoreline and abundant marine fish populations provide excellent recreation for sport divers. This sport is becoming increasingly popular, and has grown from an estimated 60 divers in 1949 to 1,865[1] in a 4-month period, January to May, 1965. Of this total, 1,358 (72.8 percent) were from Washington and 507 (27.2 percent), from Oregon. Based on the 1965 estimate, total harvest by Washington divers consisted of 22.1 percent lingcod, 19.7 percent rockfish, 18.0 percent flounders, 15.6 percent surfperch, 12.3 percent cabezon, 7.4 percent shellfish, and 4.9 percent kelp greenling. Because of the relative newness of this sport and its widespread distribution throughout the marine area, sufficient data to accurately determine angler-day participation are not presently available.

Factors Limiting Production Other Than Harvest

Various adverse factors limit production of Area marine fishes. Such factors are discussed in individual basin chapters.

Beneficial Developments

Other than the Whidbey Island propagation facilities for herring, no beneficial developments exist for marine fish species.

[1] Determined during a State study.

TABLE 3-15. Commercial fish catches1/

		Pounds of Fish							
Management Area	Year	English Sole	Rock Sole	Sand Sole	Flounder	Lingcod	Pacific Cod	Rockfish	Surf-perch
Northern Puget Sound and Strait of Juan de Fuca (areas 1,2,7)4/	1961	522,304	48,281	41,730	377,521	579,149	743,574	46,975	1,050
	1962	650,581	24,614	30,869	353,925	409,140	1,330,430	43,541	2,991
	1963	799,812	14,539	24,743	379,615	273,432	1,785,793	130,171	6,603
	1964	1,024,512	21,002	25,630	320,337	351,781	1,697,021	92,669	7,135
	1965	1,010,922	16,870	10,582	442,357	284,110	1,566,081	75,938	3,352
Central Puget Sound (areas 3,4)	1961	537,570	36,859	6,504	90,090	29,333	92,525	29,541	37,913
	1962	559,642	4,335	895	83,482	17,100	96,628	37,654	30,247
	1963	765,640	6,935	1,950	192,798	5,649	80,455	42,225	73,876
	1964	713,989	7,748	1,940	49,331	4,975	80,142	30,969	54,405
	1965	628,705	14,362	1,655	64,812	1,044	35,737	33,141	70,890
Southern Puget Sound (area 5)	1961	353,149	425	20,810	40,212	1,455	1,328	11,119	54,222
	1962	438,415	253	14,525	26,658	--	1,190	12,804	47,125
	1963	393,798	2,215	15,958	21,290	211	1,140	21,609	28,978
	1964	543,133	1,468	29,653	11,722	73	6,384	20,555	45,635
	1965	605,940	--	13,613	5,331	99	234	15,225	97,094
Hood Canal (area 6)	1961	--	5,195	--	11,342	5,463	--	1,350	72,735
	1962	5,775	10,050	--	--	644	4,054	8,560	93,220
	1963	1,330	1,740	--	573	4,497	--	6,794	42,638
	1964	--	--	--	30	588	--	960	22,884
	1965	22,580	--	--	248	2,785	5,775	6,859	38,596
Totals	1961	1,413,023	90,760	69,044	519,165	615,400	837,427	88,985	165,920
	1962	1,654,413	39,252	46,289	464,065	426,884	1,432,302	102,559	173,583
	1963	1,960,580	25,429	42,651	594,276	283,789	1,867,388	200,799	152,095
	1964	2,281,634	30,218	57,223	381,420	357,417	1,783,547	145,153	130,059
	1965	2,268,147	31,232	25,850	512,748	288,038	1,607,827	131,163	209,932

1/ Excludes salmon.

2/ Includes shad, sablefish, Dover sole, petrale sole, rex sole, butter sole, Pacific tomcod, pollack, halibut, eulachon, and sturgeon.

3/ Includes mixed catches of skate, ratfish, turbot, dogfish, and hake. Sometimes classed as mink food.

4/ Marine bottomfish fishing areas pictured in Figures 3-7, 3-8.

5/ 1,000–Rounded.

TABLE 3-15. (Continued)

Smelt	Herring	Miscellaneous Food Fish 2/	Dogfish	Ratfish	Miscellaneous Scrap Fish 3/	Totals
14,730	2,795,885	59,743	572,100	570,510	905,251	7,278,803
28,676	5,791,294	37,528	558,400	561,050	1,558,079	11,381,118
71,183	6,552,393	44,216	511,406	640,100	2,006,500	13,240,506
17,681	3,481,706	33,408	1,388,000	839,300	1,628,525	10,928,707
10,564	7,870,903	83,581	1,868,980	1,087,600	2,230,528	16,562,368
44,304	136,924	21,343	2,400	479,867	460,050	2,005,223
53,193	147,557	8,451	--	439,580	506,913	1,985,677
65,542	78,746	13,471	28,420	80,300	324,833	1,760,840
28,617	100,553	3,721	--	427,000	613,185	2,116,575
35,567	120,605	1,395	--	229,850	1,488,655	2,726,418
5,223	268,189	--	--	--	--	756,132
29,821	422,258	20	--	3,240	7,495	1,003,804
17,161	331,545	27	--	--	--	833,932
7,105	346,933	--	304,524	--	796	1,317,981
31,588	346,753	--	5,400	--	10,055	1,131,332
1,556	12,041	240	--	--	1,230	111,152
4,097	7,733	550	--	--	--	134,683
718	9,051	20	--	--	--	67,361
--	28,557	--	--	4,400	4,400	61,819
4,666	7,187	95	--	--	--	88,791
65,813	3,213,039	81,326	574,500	1,050,377	1,366,531	10,151.3 5/
115,787	6,368,842	46,549	558,400	1,003,870	2,072,487	14,505.2 5/
154,604	6,971,735	57,734	539,826	720,400	2,331,333	15,902.6 5/
53,403	3,957,749	37,129	1,692,524	1,270,700	2,246,906	14,425.1 5/
82,385	8,345,448	85,071	1,874,380	1,317,450	3,729,238	20,508.9 5/

TABLE 3-16. Marine fish sport angler use and harvest, 1965

	Management Area[1]								
Use and Harvest[2]	E. Juan de Fuca (Area 6)	San Juan Islands (Area 7)	Deception Pass (Area 8)	Admiralty Inlet to Port Susan (Area 9)	Seattle-Bremerton (Area 10)	South Puget Sound (Area 11)	Hood Canal (Area 12)	Totals[3]	Percent
Angler-Days									
Incidental	86,926	97,820	68,014	160,550	134,903	220,832	48,390	817,435	
Specific	2,168	11,779	1,366	4,330	1,385	10,326	67	31,421	
Totals	89,094	109,599	69,380	164,880	136,288	231,158	48,457	848,856 (848,900)	
Harvest									
Incidental	10,729	14,671	3,584	13,260	14,769	49,544	4,930	111,487	
Specific	6,979	14,971	2,506	6,746	9,025	20,157	127	60,511	
Totals	17,708	29,642	6,090	20,006	23,794	69,701	5,057	171,998 (172,000)	
Harvest (By Species)									
Rockfishes	8,843	11,423	2,688	8,422	8,484	41,875	3,934	85,669	49.9
Lingcod, Greenling	6,897	18,128	3,283	737	251	1,765	161	31,222	18.1
Flounders, Sole	1,916	--	--	4,971	11,009	7,512	773	26,181	15.2
Sablefish	--	--	--	2,886	3,452	6,395	189	12,922	7.5
Cods	52	--	119	771	598	11,103	--	12,643	7.4
Sculpins	--	91	--	2,205	--	1,051	--	3,347	1.9
Surfperch	--	--	--	14	--	--	--	14	0.0
Totals								171,998 (172,000)	100.0

[1] Areas (salmon management) are indicated on Figures 3-5, 3-6.

[2] Harvest is indicated in numbers of fish.

[3] Includes only landings from private and rental sport fishing boats.

SHELLFISH

Inventory and Distribution

The extensive shoreline border varies from shallow gradient tidelands to steep rocky beaches and cliffs. This varied environment supports a great diversity of molluscan (clams and oysters) and crustacean (crab and shrimp) shellfish species (Table 3-17, Exhibit 1). Figures 3-5, 3-6, 3-9, and 3-10 indicate some of the estuarine and marine areas vital to shellfish.

The most abundant hardshell clams are the native littleneck or rock, butter, horse, and Japanese littleneck or Manila. They are concentrated in the zone from about plus 4-foot tidal level to depths of more than 30 fathoms, and are most abundant on beaches composed of a porous firm mixture of gravel, sand, and mud. Other clams which are moderately abundant throughout the Area are the geoduck, softshell, cockle, and piddock. Recently, large numbers of geoducks have been found subtidally. The largest hardshell species (individual weights average 2-4 pounds), geoducks are actively sought by sport diggers.

Three varieties of oysters are abundant in the tidal zones. The native or Olympia oyster is indigenous to these waters and the other two, the Pacific and the Kumamoto, have been introduced and are partially maintained by seed shipments from Japan. The Pacific oyster has become well established in many areas and reproduces regularly in Hood Canal.

Miscellaneous molluscans of importance include abalones, scallops, mussels, squid, and octopi.

Dungeness crab and various shrimp species are the more important crustaceans. Crabs are distributed throughout various waters from tidal areas to more than 50 fathoms. Five edible varieties of shrimp occur in deeper water.

Shellfish inhabiting the intertidal zone are more vulnerable to obliteration, since nearly all species have a free-swimming pelagic stage and during the larval stages, abnormal water temperatures or poor water quality may drastically reduce population densities.

Production and Propagation

Complete shellfish production figures are not available. Harvest records reflect general abundance levels of various shellfish stocks, but only for those species harvested commercially, and even those are controlled by market demand.

The major portion of the commercial oyster landings, and to a lesser degree, clam landings, are from privately-owned "farms" (Figures 3-9, 3-10). This situation results from State tideland laws which provide for private ownership and/or leasing of inter- and/or subtidal lands. Owners determine if such lands should be utilized for shellfish production. This determination is the most important variable which controls clam and oyster production. As part of this same situation not all intertidal lands within the State are privately owned; some are set aside as public beaches or State, county, or municipal parks; some are owned by cities and/or port commissions; some are in oyster reserves (Figure 3-10); some are part of Federal installations; some are part of Indian reservations; and a very few have never been sold. Consequently, the full potential for clam and oyster production by conventional methods is limited by the use or nonuse decision of title holders.

Commercial oyster growers employ various artificial techniques to increase their stocks. The Pacific Coast oyster industry has long been dependent on annual oyster seed shipments from Japan. Since 1960, changes in seed price and unreliability of the Japanese supply have encouraged local seed propagation. Efforts and investment by enterprising oyster growers show that an adequate and reliable seed supply can be obtained from Sound waters. Private, State, and Federal researchers are developing profitable bivalve hatcheries, similar to those on the East Coast.

Other artificial culture methods used within the Area include dikes which improve tidelands for production, and intertidal racks, trays, and stakes which protect oysters from suffocation hazards caused by shifting sands and mud, or from mass dislocation by waves or tides.

Harvest

A large variety of shellfish stocks are harvested by commercial and sport fisheries (Tables 3-17, 3-18, 3-9; Photo 3-5). Species which inhabit the intertidal zone are more readily harvested. Commercial interests include shellfish growers, diggers, and fishermen. Sportsmen harvest shellfish either by digging, picking, or netting from accessible beach areas, or by skin or scuba diving in the deeper offshore waters (Figures 3-5, 3-6). On some Indian reservations shellfish are harvested for subsistence and commercial purposes by tribal members.

Commercial Shellfish Harvest.—Shellfish landings have increased slightly since 1961. Harvest of Pacific oysters constitutes the largest landings, averaging about 3.5 million pounds annually (Table 3-18). Hardshell clams and crabs are next in value with annual landings averaging 1.5 million pounds each. The combined take of oysters, clams, and crabs constitutes the bulk of the more than 6 million pounds of shellfish harvested each year. For this reason, in nearly all basins, the major emphasis is on molluscan rather than crustacean or other shellfish types.

Factors which influence the harvest of hardshell clams and oysters in Puget Sound are market demand, tideland ownership, and areas eliminated from shellfish production due to pollution.

Commercial harvest of crab and shrimp appears to be at or near potential. Crabs constitute approximately 25 percent of total shellfish landings and shrimp are heavily harvested by commercial fishermen. Other species such as scallops, octopi, and squid which are not harvested in great quantity are assumed to occur in either subcommercial numbers or, in the case of octopi, to have only limited demand. Potential for increased harvest of these species is unknown.

Sport Shellfish Harvest.—The sport harvest of shellfish is a major recreational activity. Diggers concentrate on favored beaches during low tide periods to harvest hardshell clams. Some species such as the geoduck can be dug only on extreme minus tides, and there are only about 20 such tides per year. Oysters, where available on public tidelands, are usually picked by hand. Significant numbers of crab and shrimp are taken with pots or ring nets in deep water, or by dip nets in beach areas.

There are no reliable data available on the total shellfish harvest by sportsmen; however, it is substantial. Except for crabs, oysters, and native little-

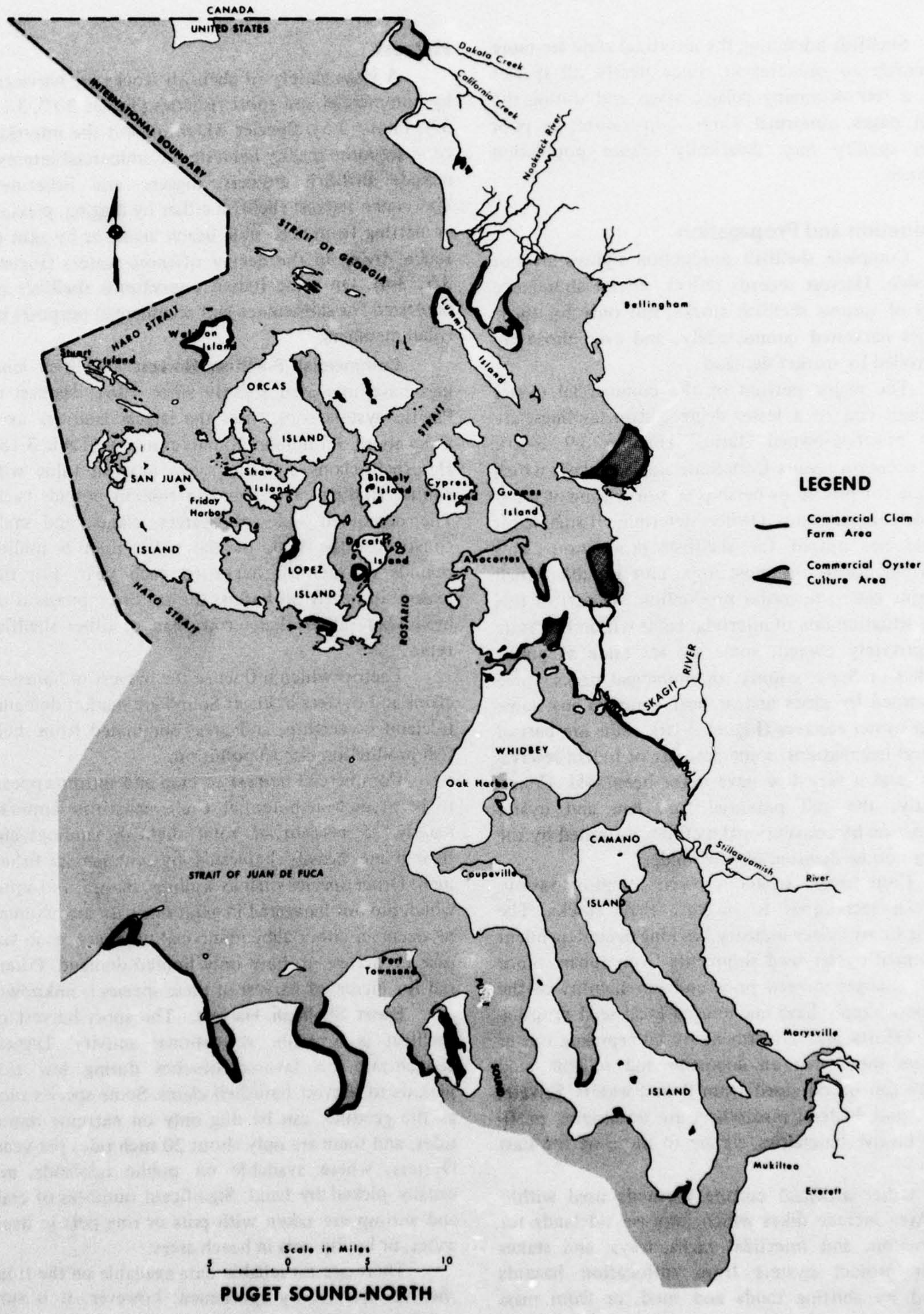


FIGURE 3-9. Commercial shellfish production areas (1965)

FIGURE 3-10. Commercial shellfish production areas (1965)

TABLE 3-17. Abundance and utilization of common shellfish and other marine invertebrates

Species	Basin																																			
	Nooksack-Sumas						Skagit-Samish						Stillaguamish						Whidbey-Camano						Snohomish						Cedar-Green					
	Abundance				Use		Abundance				Use		Abundance				Use		Abundance				Use		Abundance				Use		Abundance				Use	
	Few	Scattered	Moderate	Heavy	Commercial	Sport	Few	Scattered	Moderate	Heavy	Commercial	Sport	Few	Scattered	Moderate	Heavy	Commercial	Sport	Few	Scattered	Moderate	Heavy	Commercial	Sport	Few	Scattered	Moderate	Heavy	Commercial	Sport	Few	Scattered	Moderate	Heavy	Commercial	Sport
Crab																																				
Dungeness				X	X	X				X	X	X			X		X	X			X		X	X				X	X	X			X		X	X
Red			X			X			X			X			X			X		X				X			X			X						
Box	X					X													X					X												
Oyster																																				
Pacific				X	X	X			X		X	X		X			X	X		X			X	X	X				X	X						
Native		X			X	X													X				X	X	X				X	X						
Kumamoto		X				X																														
Clam																																				
Littleneck or Rock				X	X	X		X			X	X		X			X	X				X	X	X			X		X	X			X			X
Butter				X	X	X		X			X	X			X		X	X				X	X	X			X		X	X		X				X
Horse			X			X			X			X		X				X			X			X		X				X		X				X
Manila or Japanese littleneck		X				X								X			X	X		X			X	X	X				X	X		X				X
Geoduck				X		X	X					X	X					X			X			X	X					X		X				X
Softshell or Mud			X			X				X	X	X		X				X		X				X												
Cockle			X			X		X				X	X					X		X				X	X					X		X				X
Piddock or Boring		X				X														X				X												
Jackknife	X					X			X			X								X				X												
Mussel																																				
Blue				X		X			X			X			X			X			X			X			X			X			X			X
California		X				X														X				X												
Scallop																																				
Pink			X		X	X								X			X	X		X				X		X			X				X		X	X
Rock		X			X	X													X					X												
Shrimp																																				
Spot			X		X	X		X			X	X		X			X	X			X		X	X			X		X	X				X	X	X
Side stripe			X		X	X													X				X	X												
Coonstripe								X			X	X							X				X	X												
Pink 2/			X		X	X		X			X	X		X			X	X		X			X	X			X		X	X			X		X	X
Pink 3/																			X				X	X												
Abalone																																				
Kamchatka-Pinto																			X					X												
Red																				X				X												
Squid								X				X		X			X	X		X			X	X	X				X	X		X			X	X
Octopus			X		X	X			X		X	X			X		X	X				X	X	X	X				X	X			X		X	X
Sea cucumber			X			X	X					X		X				X			X			X	X					X			X			X
Sea urchin			X			X	X					X		X				X			X			X								X				X
Ghost shrimp																X		X							X					X						

1/ Hood Canal segment; C—Central Puget Sound-Kitsap Peninsula segment.

2/ *Pandalus borealis.*

3/ *Pandalus jordani.*

TABLE 3-17. (Continued)

Species	Puyallup Abundance: Few	Puyallup Abundance: Scattered	Puyallup Abundance: Moderate	Puyallup Abundance: Heavy	Puyallup Use: Commercial	Puyallup Use: Sport	Nisqually-Deschutes Abundance: Few	Nisqually-Deschutes Abundance: Scattered	Nisqually-Deschutes Abundance: Moderate	Nisqually-Deschutes Abundance: Heavy	Nisqually-Deschutes Use: Commercial	Nisqually-Deschutes Use: Sport	West Sound[1] Abundance: Few	West Sound[1] Abundance: Scattered	West Sound[1] Abundance: Moderate	West Sound[1] Abundance: Heavy	West Sound[1] Use: Commercial	West Sound[1] Use: Sport	Elwha-Dungeness Abundance: Few	Elwha-Dungeness Abundance: Scattered	Elwha-Dungeness Abundance: Moderate	Elwha-Dungeness Abundance: Heavy	Elwha-Dungeness Use: Commercial	Elwha-Dungeness Use: Sport	San Juan Abundance: Few	San Juan Abundance: Scattered	San Juan Abundance: Moderate	San Juan Abundance: Heavy	San Juan Use: Commercial	San Juan Use: Sport
Crab																														
Dungeness			X		X	X	X					X		H	C			HC				X	X	X				X	X	X
Red										X		X			H	C		HC			X			X		X				X
Box							X					X							X					X	X					X
Oyster																														
Pacific	X				X	X				X	X	X		C		H	HC	H			X		X			X				X
Native										X	X	X		HC			HC	HC							X					X
Kumamoto								X			X	X	C	H			HC													
Clam																														
Littleneck or Rock			X		X	X				X	X	X				HC	HC	HC				X	X	X			X		X	X
Butter			X		X	X			X		X	X				HC	HC	HC			X		X	X			X		X	X
Horse			X			X				X		X			HC		H	HC		X			X	X			X			X
Manila or Japanese littleneck	X				X	X				X	X	X				HC	HC	HC			X		X	X		X			X	X
Geoduck				X		X				X		X				HC		HC				X		X			X			X
Softshell or Mud										X	X	X		H	C			HC	X					X		X				X
Cockle	X					X				X	X	X		H	C			HC			X			X		X				X
Piddock or Boring		X				X		X				X		H				H		X				X						
Jackknife																			X					X	X					X
Mussel																														
Blue			X			X				X		X			HC			HC			X			X				X		X
California																					X			X				X		X
Scallop																														
Pink		X				X								H		C	HC	HC		X				X				X	X	X
Rock														C	H			HC		X				X				X		X
Shrimp																														
Spot		X				X			X		X	X		C		H	HC	HC		X			X	X			X		X	X
Side stripe													H				H	H												
Coon stripe															H		H	H		X			X	X			X		X	X
Pink[2]	X					X			X		X	X			HC		HC	HC		X			X	X			X		X	X
Abalone																														
Kamchatka-Pinto																										X				X
Red																									X					
Squid				X	X	X				X	X	X		H		C	HC	HC		X			X	X		X				X
Octopus			X		X	X				X	X	X		H	C		HC	HC				X	X	X			X			X
Sea cucumber		X				X				X		X			C	H		HC			X			X			X			X
Sea urchin		X				X				X		X		HC				HC		X				X				X		X

TABLE 3-18. Commercial shellfish landings

Management Area	Year	Pounds						
		Clams	Oysters	Crabs	Shrimp	Octopi	Squid	Totals[3]
Northern Puget Sound and Strait of Juan de Fuca (Marine bottomfish areas 1,2,7)[1]	1961	839,604[2]	434,271	1,532,008	5,661	15,586	--	2,827,130
	1962	758,443	430,432	905,263	1,910	99,440	--	2,195,488
	1963	640,045	445,369	1,375,128	5,775	38,472	--	2,504,789
	1964	530,396	425,740	1,431,495	5,427	28,291	--	2,421,349
	1965	519,138	556,354	1,442,288	1,925	26,855	3,237	2,549,797
Central Puget Sound (Marine bottomfish areas 3,4)	1961	141,191	163,489	85,692	2,893	72	--	393,337
	1962	132,251	170,863	109,018	6,223	678	--	419,033
	1963	241,609	273,895	154,143	13,029	2,765	--	685,441
	1964	218,457	241,549	132,344	10,847	427	138	603,762
	1965	139,541	288,162	108,050	5,082	57	--	540,892
Southern Puget Sound (Marine bottomfish area 5)	1961	249,425	2,250,220	--	--	322	446	2,500,413
	1962	287,256	2,667,980	--	--	1,116	13,525	2,969,877
	1963	382,440	2,578,240	--	--	1,273	278	2,962,231
	1964	402,985	2,730,656	--	--	1,266	662	3,135,569
	1965	544,920	2,510,611	--	--	232	188	3,055,951
Hood Canal (Marine bottomfish area 6)	1961	343,216	161,695	--	18,046	--	--	522,957
	1962	428,671	197,717	--	21,839	150	--	648,377
	1963	218,596	184,391	--	27,210	47	--	430,244
	1964	229,362	303,433	--	56,519	1,175	--	590,489
	1965	222,244	334,314	--	53,651	--	--	610,209
Totals	1961	1,573,436	3,009,675	1,617,700	26,600	15,980	446	6,243.8[4]
	1962	1,606,621	3,466,992	1,014,281	29,972	101,384	13,525	6,232.8[4]
	1963	1,482,690	3,481,895	1,529,271	46,014	42,557	278	6,582.7[4]
	1964	1,381,200	3,701,378	1,563,839	72,793	31,159	800	6,751.1[4]
	1965	1,425,843	3,689,441	1,550,338	60,658	27,144	3,425	6,756.8[4]

1/ Delineated on Figures 3-7, 3-8. These marine fish areas do not constitute shellfish management areas.

2/ Includes 1,608 pounds of scallops.

3/ Includes Indian reservation harvests.

4/ 1000–Rounded.

neck clams, the sport take of most species is believed to exceed that of the commercial harvest. Overall man-days of use attributed to shellfish sport harvest in the Area are estimated at 121,000 annually (Table 3-9).

Factors Limiting Production Other Than Harvest

Individual basin chapters describe the many and varied factors that limit the production of Area shellfish.

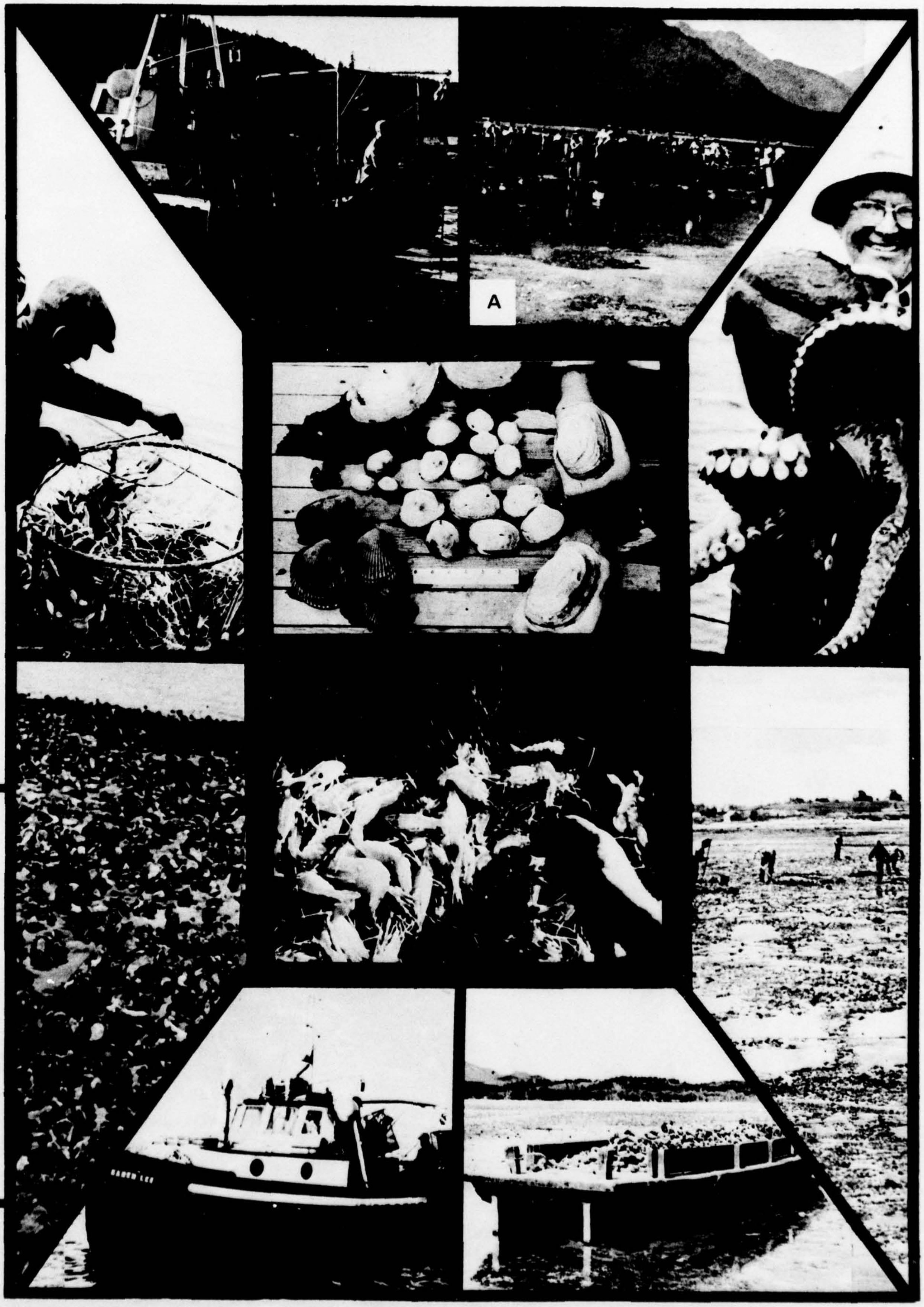
Beneficial Developments

Various projects, programs, or facilities benefit shellfish species in the Puget Sound Area. Such developments are discussed in respective basin chapters.

PHOTO 3-5. Shellfish harvest is a highly important activity. (Washington Department of Fisheries photos)

Clockwise from A:

- Sport geoduck clam diggers
- Commercially-caught octopus
- Commercial hardshell clam diggers
- Commercial oyster barge
- Commercial crab boat
- Oyster bed at low tide
- Commercial Dungeness crab fisherman with catch
- Commercial shrimp boat hauling pots
- Varieties of Area clams
- Puget Sound shrimp


A

FUTURE NEEDS—FISH

INTRODUCTION

This section includes estimates of present and future fishing demands for the target years in terms of commercial catch and sport fishermen use. Economic values of the Washington and Puget Sound Area commercial and sport fisheries are summarized. Comparisons of the Puget Sound Area, coastal, and Columbia River production and harvest of salmon are presented. Both demand and supply are evaluated in relation to the following fishery agency goals: (1) sustain salmon production at levels approximating the present commercial and sport catch per unit of effort, (2) develop new techniques and facilities to enhance and increase fish and shellfish production under natural and artificial environments, and (3) preserve and, where necessary, enhance estuaries, rivers, streams, and lakes to perpetuate anadromous and resident fishes and shellfish.

The expected future demand, the potential supply of and need for anadromous and resident fish, plus expected trends for marine fish and shellfish in the Puget Sound Area are detailed. Assumptions and projection forecasts are outlined wherever possible. Also included are appraisals of future problems and needs.

The Puget Sound Area is one of the most rapidly developing regions in the United States and is expected to continue growing in population and affluence. In the next 50 years if it experiences the predicted tremendous increase in industrialization, this could profoundly affect it, and its ability to supply fish, wildlife, and outdoor recreation[1] needs. Area population in 1963 was 1,870,000.[2] In 1980 such population is expected to increase to 2,727,000; by 2000 to 4,301,000; and by 2020 to 6,809,000. This growth represents an annual increase rate of 2.3 percent, as compared to the national increase rate of 1.7 percent. More important than the actual increase is the manner in which people will be distributed and their desire and ability to participate in the available forms of outdoor recreation such as fishing.

The central portion of the Puget Sound Area—King, Snohomish, Pierce, and Kitsap Counties—will grow more rapidly than the remainder of the Area. Portions of these counties will constitute a vast industrial, urban, and suburban sprawl and the people will live under the pressures of a modern metropolitan society. Moreover, they will have an increasing amount of leisure time which will be utilized in various types of outdoor recreation. A significant portion of this recreational time will be devoted to fishing (Photo 3-6).

[1] Fish and wildlife interrelationsip with various outdoor recreation aspects (Appendix X, Recreation).

[2] Population data from Appendix IV, Economic Environment

PHOTO 3-6. Additional boat launching and parking areas will be needed to help satisfy future angler demand. (Washington Department of Game photo)

Demand for salmon and anadromous trout at the target years is based on the projected population expansion in the Puget Sound Area and the State from the 1965 base year to 2020. The sport fishing participation rate has increased directly in proportion to the State population growth. Each year since 1960, over 10 percent of Washington State residents have fished for salmon and about 22 percent have fished for trout or other species. This represents a substantial increase in angler use over previous periods. Population growth, greater personal income, increased leisure time, greater mobility, improved and reasonably priced equipment, development of efficient charter boat service, improved accommodations at the ocean and straits' fishing centers, and other factors have stimulated this increase in demand. Publicity and advertising campaigns have promoted the bountiful recreational value of sport fishing in Washington waters. These factors are expected to stimulate even greater sport fishing participation in the future.

Factors that might minimize the rate of increase in fishing pressure would stem from: (1) imposing a license fee for salmon angling, (2) the inability to provide more fish for recreational use, resulting in a reduced catch per angler-day, and (3) excessive competition and congestion of boats and anglers at major fishing areas. The declining quality of the fishing experience or recreational value in these instances would soon reduce the economic value of the fishery.

SALMON, MARINE FISH, AND SHELLFISH

The Puget Sound commercial net fisheries and salmon industry are geared to harvest and process all the salmon allowable under sound management. The underharvest of chinook and coho salmon in marine waters near their home streams by sportsmen hinders management of the runs. Excess escapements must be harvested for full economic utilization of the stocks. Therefore, increased harvest is occasionally allowed within Puget Sound salmon preserves to utilize surplus fish. Future sport fisheries demands for more chinook and coho will result in harvesting fish that might be captured by other fisheries, unless the total production is substantially increased. Sockeye, pink, and chum salmon production will sustain the bulk of the commercial needs and demands of the future, while chinook and coho should continue to satisfy both commercial and sport demands in proportions at or near present levels.

An estimated $50 million are expended annually for sport salmon fishing in Washington. The net economic value of this fishery is estimated at $6 million annually,[1] where net value includes the benefits from the fishing experience which sportsmen receive over and above their actual fishing costs.

In 1965, the total Washington commercial fisheries were worth more than $18 million to the fishermen, had a wholesale value of $38.5 million and a retail value of $53.8 million. From this amount the commercial salmon catch amounted to over $8 million to fishermen, had a wholesale value of $15.2 million and a retail value of $21.3 million. The 1965 commercial harvest and value of food fish from the Puget Sound Area are shown in Table 3-19.

Estimates of the sport fisheries on marine fish and shellfish in the State indicate an average annual value exceeding $1.5 million with 871,050 man-days of effort for shellfish and over $203,000 with 149,900 angler-days for marine fish.

Pacific salmon forage great distances from their home streams. They range widely into the ocean feeding areas along the coast where they intermingle and mix with stocks from adjacent States and countries before returning on their spawning migrations. Chinook and coho are readily caught in the ocean hook-and-line fisheries, so harvest is widely distributed, but the major harvest of pink, chum, and sockeye salmon produced in Area drainages occurs in Area waters.

Chinook landed in the State of Washington originate in the Columbia River and its tributaries and in coastal rivers and streams as well as Area drainages. Investigations reveal a strong northward migration pattern of Columbia River chinook along the coast of Washington and British Columbia and into southeast Alaska (Figure 3-1). Chinook from the coastal rivers and the Puget Sound Area follow a similar pattern. A minor portion also migrates south to feed in waters off northwest Oregon, intermingling with Oregon and California stocks. It is estimated that over 50 percent of Washington-origin chinook head north and are taken in British Columbian and Alaskan waters. Since chinook salmon are vulnerable to these fisheries throughout the second, third, and fourth years of their ocean migration, extensive numbers are cropped

[1] State value, $28 per salmon angler-day, based on 1967 study.

TABLE 3-19. Commercial catch and value of food fish from Puget Sound Area, 1965[1]

Species	Pounds	Percent	Total Value to Fishermen[2]	Percent
Salmon	17,024,628	38.5	$4,493,849	70.8
Marine bottomfish	5,083,746	11.5	316,846	5.0
Herring	8,347,668	18.9	217,814	3.4
Other marine fish	7,044,021	15.9	79,392	1.3
Oysters	3,682,802	8.3	818,540	12.9
Other shellfish	3,068,956	6.9	418,956	6.6
Totals	44,251,821 (44,252,000)	100.0	$6,345,397 ($6,345,000)	100.0

1/All waters inside Cape Flattery.
2/Ex-vessel price.

in those waters. Of the total Washington landings of these salmon in 1965, 18 percent were caught by the Washington troll, 43 percent by net fisheries, and 39 percent by sportsmen.

Coho salmon are commercially important in the hook-and-line troll fishery and are attractive to sport fishermen. This species spends its first 12 to 14 months in inland streams, followed by two years in the ocean. Regulations limit harvest to the third year of life. Investigations indicate that the travel paths of Washington-origin coho from the Columbia River extend southward, intermingling with Oregon and California stocks (Figure 3-2). Washington coho originating in coastal and Puget Sound streams also generally move southward to waters off northwest Oregon, however, the greatest abundance is off the Washington coast and Vancouver Island where they intermix with coho salmon from British Columbian streams.

Studies have revealed that over 40 percent of Columbia River coho are harvested off the Oregon coast and 50 percent are taken at the mouth of that river. Coastal and Puget Sound coho contribute equally as heavily to Washington and British Columbia ocean fisheries. The contribution rate of Puget Sound coho to marine fisheries is being analyzed. In 1965, 46 percent of the coho landed by Washington fishermen were taken by the troll fishery, 25 percent by the net fisheries, and 29 percent were harvested by sportsmen.

Since the ocean fisheries of the neighboring States and provinces harvest chinook and coho originating in Washington streams so extensively, the complexities of supplying more fish for the Washington commercial and sport fisheries are compounded. Determination of the total Washington demands for salmon at the target years have not included consideration of the catches resulting from these fisheries (Table 3-20). Therefore, it is estimated that, realistically, ocean fishery demands will be double those projected from State population increases.

It is anticipated that numbers of salmon and resident trout[1] required from Bureau of Sport Fisheries and Wildlife hatcheries for stocking Area waters under Federal responsibility and for satisfying State cooperative programs will increase (Table 3-21). These needs will be the result of the expanding human populations and increased fishing waters accessible to the general public under intensive management. Primary demand for salmon and resident trout will lie in basins on the Area's east side.

Total projected need for hatchery salmon production, covering areas of Federal responsibility, is included in State estimates.

The production of Quilcene National Fish Hatchery has been partially committed to coastal areas. Beginning about 1971, such production would be absorbed by needs of expanding Indian, military, national park, and State programs within the area covered by the Puget Sound Study. By 1980, a major

[1] Discussion of resident trout needs under the Federal program is included here; such needs are referred to under the corresponding section in Means to Satisfy Needs–Fish chapter.

TABLE 3-20. Present and projected demand and supply of chinook and coho salmon produced in Washington

		Numbers of Fish							
		Projected Demand (1000)				Projected Supply 1/ (1000)			Deficiency @ Target Year (1000)
Year	Species	Sport	Commercial	Escapement	Total	Natural	Hatchery	Total	
1965	Chinook	240.0	350.0	118.0	708.0	348.0	360.0	708.0	--
	Coho	601.0	1,500.0	700.3	2,801.3	961.3	840.0	2,801.3	--
1980	Chinook	345.0	545.0	178.0	1,068.0	350.0	720.0	1,070.0	--
	Coho	861.0	2,149.0	1,003.3	4,013.3	2,000.0	1,680.0	3,680.0	333.3
2000	Chinook	554.0	875.0	285.8	1,714.8	350.0	720.0	1,070.0	644.8
	Coho	1,382.0	3,449.0	1,610.0	6,441.0	2,000.0	1,680.0	3,680.0	2,761.0
2020	Chinook	810.0	1,279.0	417.8	2,506.8	350.0	720.0	1,070.0	1,436.8
	Coho	2,023.0	5,049.0	2,690.7	9,762.7	2,000.0	1,680.0	3,680.0	6,082.7

1/ Based on existing facilities only.

TABLE 3-21. Present and projected demand for federally-reared resident trout in Area waters

	Program			
	Federal		State Cooperative	
Year	Trout (1000)	Angler-Days (1000)	Trout (1000)	Angler-Days (1000)
1965	142.8	41.0	217.7	62.2
1980	285.6	72.6	524.7	164.2

portion of the salmon and trout production from the Quilcene hatchery again will be absorbed in waters outside the Area. At that time salmon will constitute the major production at this facility. To fulfill the salmon and trout requirements (equal production) in the Area by 1980 two additional hatcheries will be needed.

Fishing in national park and military areas is expected to expand at a rate relative to the surrounding areas. Military programs on areas not now under cooperative management assistance will soon make available new waters for public fishing. In addition, public access to fishing waters on Indian reservations is expected to improve in the future as the tribes complete developments of their recreational resources for maximum economic returns. Angler use on these areas will accelerate at a rate exceeding that of the surrounding areas until sometime between 1980 and 2000, at which time angler use may be comparable.

The commercial demand for marine fish from Puget Sound waters is expected to increase slightly over the next few years with major demands arising from the ocean fisheries. The overall demand for food fish will probably increase at a rate roughly comparable to that of the United States population growth. Many of the processing industries located throughout the Area are expanding their operations and will continue to expand as the demand for the product continues to rise.

A significant increase in sport fishermen demand for marine fish, and for access to good marine fishing grounds, is anticipated. This demand will exceed the projected population growth rates and will undoubtedly have a major impact near the metropolitan areas. Marine anglers desiring to fish from piers or boats, and spear fishing enthusiasts will contribute to this demand. Little is known concerning total sport effort for marine fish in Puget Sound. Studies are vitally needed to formulate specific plans for future development of this potentially enormous fishery.

Commercial shellfish demands within the United States are expected to increase over the next few years at a rate comparable to that of the national population growth. However, if production techniques, particularly those involving oyster culture are perfected, Puget Sound waters have the potential to produce shellfish poundages equal to the annual United States production of all fishery products (estimated at 6 billion pounds).

Sport harvest demand for shellfish is expected to increase at approximately the same rate as that of the Puget Sound population growth. Little is known concerning sport effort for shellfish in the Area, although it is estimated that over 121,000 man-days are expended annually. Surveys and investigations are needed to formulate specific plans for future development of this fishery.

The quantity of Area-produced salmon that will be demanded and supplied and the resultant deficiencies for each of the target years are projected in Table 3-22. To project a base, averages for each species were computed. Therefore, the total demand equals the total supply for the base year, 1965, even though there may or may not have been a deficiency.

Commercial and sport harvest and projections for future demands are based on current harvest in relation to Area population increases. The chinook and coho salmon demands represent numbers of fish required for increased Area harvest plus numbers of fish required in ocean fisheries, thus maintaining the highly significant contribution to these fisheries from basin streams. Again, these demands are minimal since they do not consider fishing mortalities ascribed to "non-Washington" fisheries.

Specific assumptions were formulated as constants to establish base figures for demand projections. Realistically, several of these assumptions include ratios that will change when salmon production is significantly increased. Some of these ratio changes have been incorporated in the development of the section Means to Satisfy Needs–Fish. It is assumed in calculating the quantity of fish supplied at the target years that:

(1) The numbers of sport salmon fishermen will increase at a rate above that of the projected Area population growth.

(2) Angler success ratios will be maintained at

TABLE 3-22. Present and projected demand and supply of Area-produced salmon

		Numbers of Fish							
		Projected Demand				Projected Supply			
Year	Species	Sport[1]	Commercial	Escapement	Total	Natural	Hatchery[2]	Total	Deficiency @ Target Year (1000)
1965	Chinook	110,000	210,850	106,950	427,800	189,360	238,440	427,800	--
	Coho	247,540	1,447,940	423,870	2,119,350	1,181,420	937,930	2,119,350	--
	Pink[3]	115,790	2,577, 010.	1,346,400	4,039,200	4,039,200	--	4,039,200	--
	Chum	--	381,850	381,850	763,700	763,700	--	763,700	--
	Sockeye[4]	--	--	--	--	--	--	--	--
1980	Chinook	213,400	263,560	158,990	635,950	189,360	448,820	638,180	--
	Coho	397,980	1,809,930	551,980	2,759,890	1,181,420	1,414,780	2,596,200	163.7
	Pink	193,730	3,221,260	1,704,500	5,119,490	4,039,200	9,000	4,048,200	1,071.3
	Chum	--	447,310	447,310	894,620	763,700	--	763,700	130.9
	Sockeye	--	264,600	98,000	362,600	362,600	--	362,600	--
2000	Chinook	337,310	369,250	235,520	942,080	189,360	448,820	638,180	303.9
	Coho	629,080	2,535,720	791,200	3,956,000	1,181,420	1,414,780	2,596,200	1,359.8
	Pink	306,220	4,512,980	2,409,600	7,228,800	4,039,200	9,000	4,048,200	3,180.6
	Chum	--	626,680	626,680	1,253,360	763,700	--	763,700	489.7
	Sockeye	--	370,700	137,300	508,000	362,600	--	362,600	145.4
2020	Chinook	534,180	517,630	350,600	1,402,410	189,360	448,820	638,180	764.2
	Coho	996,230	3,554,700	1,137,730	5,688,660	1,181,420	1,414,780	2,596,200	3,092.5
	Pink	484,940	6,326,550	3,405,750	10,217,240	4,039,200	9,000	4,048,200	6,169.0
	Chum	--	878,520	878,520	1,757,040	763,700	--	763,700	993.3
	Sockeye	--	519,670	192,470	712,140	362,600	--	362,600	349.5

1/ Includes number needed to increase Puget Sound sport catch to one fish per angler-day by 1980.

2/ Includes fish to be provided by anticipated hatchery expansion program for year 1980.

3/ Odd-numbered years only.

4/ Harvest regulated to achieve total base production of 362,600.

a level near one fish per angler-day.

(3) Anadromous fish catch-to-escapement ratios will remain constant at all target years.

(4) Artificial propagation techniques for chum and pink salmon will be perfected by 1985.

(5) Streamflows will be sustained at levels commensurate with fish needs.

(6) Major water pollution throughout the Area will be controlled by 1980.

(7) Artificial propagation of anadromous fish will not fall below present levels.

(8) Sport and commercial fisheries of Puget Sound will continue to harvest the same proportion of Canadian- and Oregon-origin salmon as at present.

(9) Canadian and Oregon sport and commercial fisheries will not harvest a greater proportion of Puget Sound-origin salmon than at present.

(10) Natural production of salmon will remain constant during the period of analysis.

(11) Since each salmon species migrates differently and is harvested during a different season and year class and at a different location, the demands for one species or race can be satisfied only by that species or race and not by substitution of another.

In general, supplies of marine fish and shellfish are expected to remain relatively constant at designated target years. Although some stocks will be depleted in many individual parts of the Area, utilization of unexploited production areas plus harvest of presently underutilized species should more than compensate for any losses. The full production potential of the Area's fresh-water and marine environments is not realized. Therefore, these environments should be managed insofar as possible to achieve this production.

SALMON

Harvest

Commercial Harvest Trends.—The Puget Sound net fishery is decreasing, while the sport fishery is increasing. Reduction of spawning and rearing areas has placed considerable dependency upon fish hatcheries and the Fraser River runs of pink, sockeye, and chum salmon.

Harvest levels will undoubtedly experience increases in some areas. These increases, however, are limited in scope and are not expected to affect the overall trend of decreasing commercial catches. This trend can be modified or partially reversed by increased numbers of hatcheries and other methods of artificially supplementing the natural salmon runs, but only at a very high cost. These methods of supplementing the natural runs are not expected to compensate indefinitely for the losses due to increased human population and industrialization.

Limitation of boat numbers in the various fisheries is likely to occur in the near future and will probably result in increased economic benefits for the remaining vessels, but this is not likely to reverse the expected trend of fewer fish for the commercial net fisheries.

Indian commercial fishery trends have indicated little change or variation; however, future direction may not be so static. The overall abundance of fish will be the major factor influencing catches. For the years of record, 1935 to 1965, the total salmon harvest by Indian fisheries remained remarkably stable. High- and low-catch years occurred, but these probably reflect only annual fluctuations in salmon abundance, periodic fishing effort, or climatological conditions.

Sport Fishing Trends.—For the State's marine waters, including those outside of the Puget Sound Area, projected population trends and division of catch show that the continued stability of the total harvest will result in an increasing sport catch. The catch per angler-day, however, shows a declining trend despite a harvest which, in some years, rivals that made by the commercial fishery.

In the years 1938 to 1950, the number of angler-days was relatively low, the bag and size limits more liberal, and the catch per angler-day relatively high. From 1951 to 1957, ocean fishing areas began to prosper with the opening of "new" areas to sport fishermen and a large increase in charter boats. The catch per angler-day increased dramatically and resulted in increasing pressure on the ocean's salmon stocks. The decline in angler-days and corresponding catch from 1958 to 1960 resulted from a change in size limit regulations. From 1961 to 1965, the trend of angler-days increased sharply and the sport catch increased, but the catch per angler-day decreased. The mean catch per angler-day has been slightly over 0.6 fish for the years of record.

Projecting the trend and assuming no change in total production, the catch per angler-day will decrease to less than 0.4 fish by 1985. Even though this catch rate can sustain a healthy fishery, many fishermen will undoubtedly find the "quota" too small to justify enthusiastic participation. However, if the catch per angler-day remains constant at over 0.6 fish, the sport catch will approximate 1.5 million fish each year. As the total commercial and sport catch of chinook and coho now averages 2 million fish annually, a projected sport catch of 1.5 million fish must be provided by that portion presently harvested by the commercial fishery or will necessitate a dramatic increase in salmon abundance to supply both fisheries.

Future trends of fresh-water sport fishing for salmon point toward more liberal angling regulations, and this is expected to greatly increase future harvest.

MARINE FISH

Harvest

Commercial Harvest Trends.–The recent general trend for marine fish harvest and consumption has been gradually upward, paralleling the population growth. Studies have indicated that total fish consumption throughout the Nation will, in the near future, increase at approximately the same rate as population, with greater increases in demand for the relatively high-valued species and for those that lend themselves to convenient storage and preparation. The future of the trawl fishery is expected to be good, and large-scale technological advances in harvest equipment and methods and in efficient processing of highly competitive marketable products are anticipated.

Increasing market demand is expected in the future for fish meals, fish protein concentrates, and animal feeds, which, in turn, will lead to increased harvest of low-value species, such as hake. If such advances are achieved in the fishery, the overall demand for Pacific Coast marine bottomfish could expand significantly faster than the overall United States demand for these fish.

The major portion of any future increase in marine fish harvest would necessarily come from Pacific Ocean waters, and would be landed, processed, and marketed through the larger Puget Sound ports. The expected general trend is for landings of marine fish from within Area waters to increase at a relatively slower rate than those of ocean landings.

Sport Fishing Trends.–During past years, the sport angling effort for marine fish has not been investigated thoroughly enough to establish definite trends in the fishery. Future growth of this particular fishery is expected to be rapid. The development of specialized light tackle, the increase in numbers of fishing access areas, the overcrowding in other fisheries, and the overall need for increasing outdoor recreation activity will tend to promote marine fish angling in Area waters.

The sport of underwater spear fishing will definitely grow along with the Area's population. Additional information will be required for proper management of this activity.

SHELLFISH

Harvest

Commercial Harvest Trends.–There has been a slight decline in commercial shellfish landings. Associated with increased population, higher per-capita income, and greater demands for good quality shellfish products, an increased harvest in the near future is anticipated. However, the long-term outlook is not so clear. Destruction of tidelands and marshlands, pollution, and encroachment by industrial and urban development adversely affect shellfish production. Thus, little or no increase in overall future landings is predicted. However, an increase is predicted for oysters, if raft and rack culture is expanded. Cropping recently discovered subtidal geoduck populations may result in a major increase in shellfish harvest.

Sport Harvest Trends.–The sport take will increase significantly in the future, and there will be many problems. Some of the increase may be at the expense of the commercial catch, but only in the case of crab and shrimp might this be significant, since the bulk of the commercial shellfish landings is from private or leased land. Probably much of the increased sport harvest of crab and shrimp will be supported by small isolated subpopulations which are not commercially harvested at present. Regardless of how the sport catch of shellfish occurs, present trends indicate that the demand will accelerate, and probably at a greater rate than that of the more conventional hook-and-line sport fisheries.

The steady expansion of the sport razor clam fisheries, outside of Area boundaries, has competed with the growth of sport shellfish harvests within Puget Sound. However, as limitations are applied to these outside razor clam fisheries, more effort for shellfish is anticipated on Area beaches.

RESIDENT AND ANADROMOUS GAME FISH

Based on current trends of 13.1 percent of the population purchasing fishing licenses, approximately 357,000 licensed fishermen will reside in the Area in 1980, 564,000 by 2000, and 892,000 by the year 2020.[1]

Clearly, the economic value of such wide participation will continue to be extremely significant. In order for the recreational and economic value of sport fishing to remain static, current and future sportsmen's preferences and success rates must be maintained.

In the past 20 years sportsmen have shown a rapidly growing interest in catching anadromous trout. The Washington Department of Game has developed steelhead runs that continue to increase in popularity and searun cutthroat fisheries are being developed by a similarly intensive program. Interest in these fish can be expected to increase over the next 50 years. Other game fish, such as spiny-rays, whitefish, and Dolly Varden will undoubtedly support a manifold increase in pressure. Alpine lake fishing will also increase with improved outdoor equipment and public access. Lowland lake, stream, and beaver pond trout fishing will increase in popularity, but will not manifest the surging interest expected for other types of fishing. However, increased production, both from natural areas and particularly from artificial or semi-artificial propagation facilities, will be necessary to maintain angler success.

[1] Demand represented by those anglers under 16 years of age who do not require a license to fish is reflected in future fish needs.

Projected demand, in numbers of fish (harvest) and angler-days for resident and anadromous game fish, is indicated in Table 3-23.

This represents a demand increase of 2,557,000 angler-days for steelhead; 1,069,000 days for searun cutthroat; 3,041,000 days for stream salmonids; and 8,179,000 days for trout and other game fish in lakes, between 1966 and 2020. At the present level of fishing success, catches of an additional 485,000 steelhead, 682,000 searun cutthroat in salt water, 9,953,000 stream salmonids, 27,152,000 trout in lakes, and 8,454,000 game fish of other species in lakes would result from such use by the year 2020 (Table 3-24).

PROBLEMS AND CONFLICTS

Population increases with associated industrial and urban expansion will present numerous problems and conflicts affecting the overall demands for fish and shellfish resources, and will reduce the natural production capacities of fresh- and salt-water environments. Since, generally, demands are expected to *increase at rates greater than human population* growth, greater numbers and/or availability of anadromous fish, resident fish, marine fish, and shellfish will be required. At the same time, the effects of human population growth will in most cases tend to reduce the production potential for these fishes and restrict access to fishing waters (Photo 3-7).

TABLE 3-23. Present and projected demand for resident and anadromous game fish 1/

Year	Steelhead Trout: No. of Fish (1000)	Steelhead Trout: Angler-Days (1000)	Searun Cutthroat Trout: No. of Fish (1000)	Searun Cutthroat Trout: Angler-Days (1000)	Stream Salmonids: No. of Fish (1000)	Stream Salmonids: Angler-Days (1000)	Trout in Lakes: No. of Fish (1000)	Trout in Lakes: Angler-Days 2/ (1000)	Other Game Fish in Lakes: No. of Fish (1000)	Other Game Fish in Lakes: Angler-Days (1000)
1966	158.7	793.6	201.3	335.4	3,110	953.1	8,484	2,556.7	2,547.4	--
1980	265	1,332	351	558	5,194	1,588	14,168	4,269	4,254	--
2000	403	2,095	552	877	8,164	2,497	22,273	6,710	6,688	--
2020	644	3,351	883	1,404	13,063	3,994	35,636	10,736	11,001	--

1/ Does not include angler use attributed to Area waters under Federal responsibility.

2/ Includes "Other Game Fish in Lakes" angler-days.

TABLE 3-24. Projected need for resident and anadromous game fish 1/

Year	Steelhead Trout: Number of Fish (1000)	Steelhead Trout: Angler-Days (1000)	Searun Cutthroat Trout: Number of Fish (1000)	Searun Cutthroat Trout: Angler-Days (1000)	Resident Trout 2/: Number of Fish (1000)	Resident Trout 2/: Angler-Days 3/ (1000)	Other Game Fish in Lakes: Number of Fish (1000)	Other Game Fish in Lakes: Angler-Days (1000)
1980	106	539	141	222	7,768	2,347	1,707	--
2000	244	1,301	342	541	18,843	5,697	4,140	--
2020	485	2,557	682	1,069	37,105	11,220	8,454	--

1/ Does not include angler use attributed to Area waters under Federal responsibility.

2/ Includes stream salmonids and trout in lakes.

3/ Includes "Other Game Fish in Lakes" angler-days.

PHOTO 3-7. Industrial development fronting rivers and estuaries conflicts with production and use of fish and shellfish. (Washington Department of Game photo)

To maintain future production at present levels requires satisfaction of some very critical physical, chemical, and biological needs. These principally involve preserving sufficient good quality production areas. However, simply maintaining the present fish and shellfish production levels will not meet the anticipated future demands. Necessary production increases will require changes involving the correction or elimination of limiting factors wherever possible, enhancement of natural environments, and expansion of artificial propagation facilities. Also, present management regulations will not be adequate to provide maximum use in the future. This will require changes in fishing areas and in harvest methods, and increased utilization of many species.

Major problems to be considered in any future planning must include factors (other than harvest) which limit fish and shellfish production (Table 3-25). Some of these limitations occur naturally, while others are imposed or aggravated by man's activities. Each of the basins has, and will continue to have, specific limiting conditions peculiar only to that area.

Some of the more significant conditions which limit fish and/or shellfish production, and which are common to most basins are categorized in the following section. Problems and conflicts specific to individual basins appear in respective basin chapters. It is imperative that many of these individual problems and conflicts be resolved prior to formulating plans for meeting future demands for fish and shellfish. This responsibility lies with fishery managers in cooperation with all other users of water and related land resources and their regulatory agencies.

TABLE 3-25. Major factors limiting fish and shellfish production

	Limiting Factors[1]								Fish Life Affected			
Basin	Flooding	Low Summer Flows	Natural Barriers	Manmade Barriers	Erratic Streamflows	Unstable Streambed	Production Area Loss	Poor Water Quality	Anadromous Fish	Resident Fish	Marine Fish	Shellfish
Nooksack-Sumas	X	X	X		X	X	X	X	X	X	X	X
Skagit-Samish	X	X	X	X	X		X		X	X	X	X
Stillaguamish	X	X	X					X	X	X	X	
Whidbey-Camano		X							X	X		
Snohomish	X	X	X	X	X		X	X	X	X	X	X
Cedar-Green	X[2]	X		X			X	X	X	X	X	X
Puyallup	X	X		X	X	X	X	X	X	X	X	X
Nisqually-Deschutes	X[3]	X	X[3]	X[3]	X[3]		X		X	X		
West Sound	X	X	X			X	X	X	X	X	X	X
Elwha-Dungeness	X	X	X	X				X	X	X	X	X
San Juan		X							X	X		

[1] Further defined in each basin chapter.

[2] Green Basin only.

[3] Nisqually Basin only.

Conflicting Land and Water Uses

(1) The practice of building industrial complexes and private residences on the flood plains requires special flood control protection. This frequently leads to emergency control measures which alter river channels or encroach on the river boundaries, and reduce and degrade the area for fish production. Development adjacent to lakes and streams restricts public access to desirable fishing areas, destroys habitat, and/or lowers water quality.

(2) Removal of riverbed materials, particularly gravel, reduces and degrades spawning and rearing area and causes continuous and excessive bedload movement. Fish egg and larva mortalities are generally high where shifting gravel conditions occur. The loss of suitable gravel from bars forces superimposition of eggs in remaining areas. Large numbers of salmonid fry and fingerlings are invariably trapped and die in the pits and pockets left by gravel excavations of riverbanks when rivers recede.

(3) Logging and timber management practices sometimes conflict with fish requirements. Poorly laid-out, extensive clear-cutting creates excessive intermittent runoff, and increases streamside erosion and stream siltation. Inadequate cleanup of logging debris contributes to anadromous fish migration barriers. Clear-cutting adjacent to streambanks eliminates shade and cover resulting in rising water temperatures, losses of terrestial and aquatic food organisms, and increased predation. The use of streams for yarding logs, improper logging road construction where sloughing and erosion cause serious silting and muddying of adjacent streams, and careless defoliating and pesticide spraying all adversely affect fish resources.

(4) Improper farming practices tend to eliminate streambank cover, causing bank erosion and loss of fish habitat.

(5) Improper bridge or culvert installation often creates barriers to upstream migrating salmonids and can, under certain flow conditions, cause washouts that result in excessive erosion and heavy siltation downstream. Lack of slotted weirs within some culverts prevents stable stream velocities. Inadequate size or number of culverts are also detrimental factors.

(6) Dumping of garbage and scrap into rivers, or placing unsuitable materials along riverbanks for erosion control, often create highly detrimental conditions. These materials settle out in the spawning reaches or in the deep holding pools and limit fish use or migration.

(7) Dam construction on major streams has created extreme fish problems, and reduced the anadromous fish and stream trout production area. Fish passage, loss of spawning area, habitat alteration, and water quality changes are major problems associated with such construction. Operation of hydroelectric powerplants in meeting peak power requirements may cause fluctuations in stream levels, thus reducing fish rearing and recreation potential.

(8) Flood control measures including channel straightening, narrow diking, removing streambed material, and replacing natural streambank foliage with rip-rap are most often detrimental to fish production. Large production losses may occur when natural streambed controls are removed, and the natural pool-riffle character of feeding, spawning, and rearing areas is altered.

(9) Over-appropriation of waters from basin drainages for any use seriously affects the streams' capacity to produce fish, particularly during the critical late summer low flow periods. Adult fish access and juvenile fish rearing are also adversely affected.

(10) Municipal and industrial water supply projects, which tap river headwaters, reduce the quantity of fish production water remaining in the rivers downstream, and often block or inundate upstream production habitat.

(11) Building of piers, wharves, fills, and bulkheads associated with business and private residence construction can result in losses to natural fish and shellfish production areas.

(12) Extensive river and harbor dredging, with disposal in water, destroys aquatic food supplies, thus limiting fish and shellfish production potential.

(13) Closure of publicly owned land to the public in municipal water supply watersheds limits satisfaction of angler needs for fish, fishing areas, and other outdoor recreation.

(14) Diversions of water from one stream system to another interfere or otherwise hinder the homing of anadromous fish.

(15) Introduction of competitive or undesirable species could cause stunting and/or low survival of desired fish in lowland lakes and reservoirs.

(16) Residential development adjacent to streams and lakes will continue to alter natural environments, reduce available fish habitat, and limit public access.

(17) Poorly located, inadequately constructed, and improperly maintained roads contribute silt to

streams, result in streamside vegetation losses, causing reduction in fish food and cover, and result in spawning and rearing area losses through badly located channel changes.

Poor Water Quality

(1) Intermittent and seasonal pollution in streams, lakes, and estuaries results in water quality inimical to fish and shellfish life. Effluents from agricultural, industrial, and sewage disposal sources are particularly detrimental to aquatic life. The buildup of sludge and heavy waste in many estuaries limits anadromous fish, shellfish, and marine fish production.

(2) Glacial stream siltation adversely affects fish habitat and sport fishing.

(3) Unregulated application of pesticides and herbicides on forested lands and lower valley agricultural areas may endanger salmonid production in adjacent streams.

(4) Extensive alteration of the aquatic environments such as subimpoundment construction, channel straightening, deepening, or extensive land clearing, often results in significant changes in water temperatures. Sometimes these changes promote near lethal temperatures for some fish species, and nearly always they alter the natural ecological character of the environment and usually result in losses to the more valuable species.

(5) Streambank erosion and earth slides cause deleterious siltation and spawning bed compaction.

(6) Proposed sites for thermonuclear and fossil fuel powerplants within the Area must be assessed in relation to altering fish and shellfish habitat. Water temperature increases from discharged cooling waters, water withdrawal (intake location and design), and chemicals used in flushing are major considerations relative to fish and shellfish life and environment.

(7) Open-pit or strip mining causes severe damage to the natural environment. Such activities frequently result in complete loss of aquatic life in local waters, with harmful lasting affects prevailing many miles downstream.

(8) Accidental discharges of petroleum products, pulp wastes, and other industrial chemicals can cause both long and short term losses to aquatic life.

Social and Psychological Considerations

(1) Adverse reactions to any management changes involving redistribution of fish to the various commercial, sport, and Indian fisheries are expected.

(2) Considerable opposition is expected to any restrictions placed on land or water management practices to favor fish, shellfish, or fisheries development. This would include regulation of stream modification, summer home development, and removal of water from upper river areas. The acquisition of areas for public access to streams, lakes, and salt water will also face opposition from special interest groups.

(3) Demand on the productive capacity of lakes will increase through fishing pressure, and result in lower success rates and increasingly crowded access areas.

(4) Deliberate introduction of competitive and undesirable fish species is causing stunting and/or low survival of more desired game fish species in lowland lakes and reservoirs.

Political, Legislative, and Policy Considerations

(1) Occasionally, organized special interest groups and local governmental agencies use political pressure to influence operations which are normally controlled by State fish and game agencies, because they conflict with basic fish and shellfish needs and efficient resource management.

(2) There are legal questions concerning agency responsibility for public access abuses which threaten to curtail fishing access programs.

Existing laws and their implementation do not adequately protect fish and shellfish against removal of streambed gravel, indiscriminate alteration of stream channels or beach areas, logging practices that damage natural fish habitat, improper or untimely road and bridge construction, excessive removal of river water, intensive development of flood plains and tidelands, or much of the municipal, industrial, and agricultural pollution which commonly occurs throughout the Area.

Increased future demands will necessitate alterations in harvest emphasis and distribution to the various fisheries, as well as changes in allowable fishing areas and in methods of harvesting fish and shellfish. Such changes will, in most cases, require new legislation.

MEANS TO SATISFY NEEDS—FISH

INTRODUCTION

The primary responsibility for management rests with two State agencies, the Washington Department of Game and the Washington Department of Fisheries. Federal agencies, by virtue of land ownership, laws, and treaty obligations, also have certain managerial responsibilities for fish.

In the basin chapters of this appendix, projects and programs proposed to enhance salmon, and those proposed to enhance game fish, are carried under separate headings according to departmental responsibility. Proposed projects and programs of the U.S. Forest Service and Bureau of Sport Fisheries and Wildlife (beyond continuance of present hatchery and research programs) are also indicated separately. These will help to satisfy the needs indicated but effects have not been evaluated.

Future fish and shellfish production levels must be raised to meet increasing demands. There are numerous opportunities for providing such increases within the Puget Sound Area. One will be to obtain the greatest possible production from natural habitat and from existing artificial propagation facilities. In many cases, implementing projects or programs to achieve fish and shellfish increases will require reduction or elimination of conditions which limit production. After natural production capabilities have been fully utilized, additional needs should be met through increased artificial propagation.

Before developing a plan for future production increases, it is essential to consider carefully measures necessary to ensure maintenance of present production levels and provide opportunity for enhancement. Such measures must include implementing programs to protect and enhance the habitat utilized by fish and shellfish. Preservation of quality environment and maintenance of water quality suitable for continued production of these resources should be primary considerations.

Attrition of fish and shellfish production areas must be stopped to maintain production levels and increase future production through improvement. Implementation of multiple-use resource zoning codes for river flood plains, and lake shore and marine shoreline areas will be a major step toward achieving preservation and protection of aquatic environments. Also, it will be necessary to more effectively coordinate the activities of the various agencies concerned with water use development, gravel removal operations, marine and fresh-water dredging, logging, road-building, and disposal of waste materials, so that fish and shellfish resources and habitat are adequately protected.

Another measure needed to maintain production levels, and provide for future increases in fish production, will be to establish sufficient flow levels in every major fish production stream to provide for fish transportation, spawning, and rearing. This will require extensive river profile and flow measurements in all basins to determine flow levels necessary to achieve these optimum conditions. Once determined, these levels must be maintained to supply present levels of use as well as afford increases in the future.

Tentative streamflow schedules, indicating those flows required to maintain fish production levels in the basins, appear in the individual basin chapters. Flows presented for the period July through October are those which, under present conditions, occur as monthly means approximately 50 percent of the years of record from U.S. Geological Survey gage readings. These rearing, adult migration, and spawning flows take into consideration natural fluctuation—in some water years the flow will be lower, and in others it will be higher. Flows presented for the period November through June occur naturally much more often than 50 percent of the water years. These flow figures were arbitrarily reduced to a level considered adequate for successful egg incubation.

All flows correspond to stream levels measured at specific gage stations. Often these stations are not located within actual spawning and rearing areas. It is assumed, however, that if these flows are achieved at the stations indicated, corresponding flows over the major fish use areas will be adequate to maintain present fish production levels.

One of the most important measures to insure maintenance of and provide protection for fish and shellfish was the adoption of joint Federal-State water quality standards for the interstate and coastal waters of Washington according to the Water Quality Act of 1965. Fish and wildlife are among the uses classified in "Water Quality Standards for Interstate and Coastal Waters of the State of Washington and a Plan for Implementation and Enforcement of Such

Standards, December 1967."[1] Implementation and enforcement of such standards must include consideration of the total environment of fish, (wildlife), and aquatic organisms and the complex interrelationship of land and water development on fish and shellfish (and wildlife) resources. The State has completed hearings preparatory to setting water quality standards on its intrastate waters.[2] Adoption of these standards will further help to insure preservation of fish production habitat. Additional information, particularly concerning thermal pollution and effects of combinations of pollutant materials introduced into a specific aquatic habitat, is needed in many areas.

There are many opportunities for increasing fish and shellfish production, which should be implemented as soon as measures to safeguard resource production are in force.

SALMON, MARINE FISH, AND SHELLFISH

Water and related land resources and their uses interact in complex ways in response to natural or man-caused actions. Any significant use or program can affect one or more uses or cause problems that affect any beneficial use. Activities on inland streams determine the limits within which estuarine activities are conducted and affect various environmental, natural resource, and other aspects.

Studies to develop a coordinated and integrated plan, adapted to the capabilities and limitations of the fish and shellfish (and wildlife) resources and environments, are needed. Planning must involve areas large enough to contain a full comprehension of the problems and large enough to make solutions effective; require simultaneous planning for land and water uses; be based on long-range forecasts of changing social-economic-industrial needs and resources; and be part of a continuing process involving formulating and updating plans and implementing essential measures.

The information contained in this appendix is a first step in such planning. However, more detailed information is needed concerning: (1) the limiting factors involved; (2) understanding the relations and changes involving the three major environmental interfaces of water, land, and air; (3) understanding the biological, physical, economic, and institutional processes and interaction within the environments involved; and (4) appraising the present and future potential of the areas involved.

Specific investigations concerning fish and shellfish resources and habitat should be completed before protective measures and measures to satisfy anticipated demand for such resources are formulated and recommended for implementation.

Biological studies should be conducted to:

(1) determine fish and shellfish habitat areas necessary to maintain present levels and future use.

(2) determine the relationship of intertidal areas to open water productivity.

(3) determine seasonal populations of fish and shellfish of different ecological areas.

(4) determine the degree to which fish and shellfish and their respective food chains depend upon the estuarine and marine environment.

(5) determine rates of oxygen reduction and effects on key species of fish and shellfish produced in the various ecological areas.

Hydrological studies should be conducted to:

(1) determine circulation, flushing, and tidal transport patterns.

(2) determine sediment loads, deposition, and degree of scouring within the estuarine environment.

(3) improve understanding of fresh- and salt-water interrelationships.

Study costs have not been determined but the need for such investigations is paramount. Analysis of findings will enable fishery agencies to develop criteria to ensure environmental quality and resource proposals designed to meet future needs.

Additional beneficial developments are discussed below by major fish group.

Salmon

A variety of projects and programs can be implemented to increase anadromous fish stocks. These include projects to enhance natural environments such as opening new stream areas for spawning and rearing, controlling excessive floods or earth slides, augmenting critical low flows, loosening compacted spawning gravels, and enhancing fish production habitat. Also, numerous projects such as hatchery developments, natural spawning channel or egg incubation channel installations, and controlled artificial rearing impoundments can be used to increase

[1] Criteria pertaining to fish and wildlife appear in Appendix XIII, Water Quality Control.

[2] Water quality standards will be considered jointly with proposed cross-sectional stream surveys.

production. Several of the many possible plans for meeting needs during the target years are discussed below, and are described in greater detail in the discussion of means to satisfy needs by individual basins.

Natural Production Opportunities.—There are many areas where better use of the habitat can be realized, or where enhancement programs could serve to increase anadromous fish production significantly.

Suitable habitat for fish production upstream from barriers to anadromous fish should be utilized. This can be accomplished either by removing or bypassing blocks to allow natural spawning and rearing, or by instituting planting programs that utilize the available rearing potential upstream from such blocks. Many barriers can be bypassed with fish ladders or by use of trap-and-haul facilities (Photo 3-8). Intensive fish stocking programs would require that existing hatchery facilities be expanded, specifically for egg taking, incubation, and early rearing prior to planting. Many barriers, particularly man-made structures such as dams, will also require special facilities to safely pass juvenile fish. Careful consideration should be accorded the location, design, and operation of water-use developments to minimize losses of or enhance fish production. Emphasis should be placed on opening new production habitat in the Elwha-Dungeness, Puyallup, Snohomish, West Sound, and Cedar-Green Basins. Fish production potential upstream from barriers could provide an estimated minimum production increase of 360,000 salmon annually at a capital cost of $3,159,000 by 1980; and 195,000 salmon at a cost of $2,250,000 in the 1980-2000 period. Feasible projects would be completed by the year 2000.

Anadromous fish are blocked in many streams by deposits of logging debris or other material. Removal of these jams on 40 streams would open 132 miles of potentially productive spawning and rearing habitat. Estimated capital cost of this program would be $52,000, and estimated production increase, 55,600 salmon annually.

Damaging floods and unstable streamflows should be eliminated or curtailed on major streams having otherwise good fish production potentials. Flood control and flow stabilization projects could include impoundments, either on upper reaches of mainstem rivers or in off-river areas; flood flow diversions with piping or canal systems; or placement of high water overflow channels in critical reaches. Such controls would be highly beneficial for streams in the Nooksack-Sumas, Skagit-Samish, Snohomish, and West Sound Basins. Simply controlling major flood flows over some 660 miles of Puget Sound Area drainages could provide an estimated minimum production increase of more than 211,000 salmon annually.

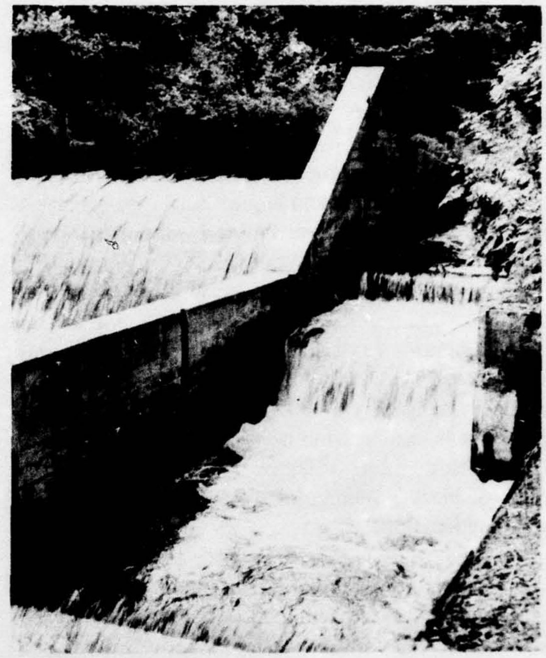


PHOTO 3-8. Fish-passage facilities are effective at some barriers. (Washington Department of Game photo)

Extreme low streamflows should be augmented where necessary throughout the Area.[1] Naturally-occurring low summer flows, common to at least some reaches of virtually every river drainage, can usually be increased only by creating impoundments. Unfortunately, unless site location and project operations are closely coordinated with fish requirements, such projects can be highly detrimental to fish production. Unusual flow fluctuation or extreme low flow conditions resulting from hydroelectric power peaking, flood control, or irrigation projects, must be coordinated with fish needs to insure sufficient good quality water in the streambed involved to adequately protect fish life. Such conditions are prominent in all

[1] Flows essential to fish use based on gage data from Appendix III, Hydrology and Natural Environment.

basins except the Stillaguamish, San Juan, and Whidbey-Camano. Low flow augmentation projects over an estimated 600 miles of basin drainages could provide a minimum production increase of 394,500 salmon annually.

Another measure to conserve water in fish production streams would require better coordination in restricting water removal, and supporting these regulations by strict enforcement.

Fish production streams adversely affected by unstable streambeds, imbalance of spawning and/or rearing area, or associated environmental conditions which tend to limit production, should undergo changes designed to enhance their productivity. Streambeds can be stabilized and pool-riffle conditions made more effective for fish production through placing submerged weirs or bed controls at strategic locations.

Conditions which contribute to the productivity of the aquatic environment such as basic water productivity, water temperature, amount of shade and cover, and natural food production, should be supplemented or enhanced wherever possible to increase the overall productivity of streams. The planting of suitable vegetative cover can in many areas increase production by providing protection, increased food production, and stabilized temperature conditions for rearing fish. Also, methods are being developed to artificially control water chemistry, making the habitat more conducive to fish production. Although each of the basins contains numerous streams in which production could be increased through any one or a combination of the above mentioned enhancement projects, prime areas for such projects are located in the Stillaguamish, Skagit-Samish, Snohomish, and West Sound Basins. If habitat enhancement is accomplished over 318 miles of 137 Area streams, an estimated 757,000 additional salmon could be produced annually at an estimated capital cost of $1,043,000. These projects are proposed for the 1980-2000 period.

Unstabilized clay slides on both North and South Forks of the Stillaguamish River degrade the scenic beauty of downstream portions of the river and reduce its value as production habitat and fishing water. These slides should be controlled at the earliest possible date, and such control is proposed before 1980. Cost of this project is carried under developments for salmon enhancement. Benefits to salmon production would be an estimated 458,300 fish annually.

Artificial Propagation Opportunities.— Throughout the Puget Sound Area there are many sites with sufficient land and good quality water sources for the development of artificial propagation facilities for salmon, including hatcheries, egg incubation or spawning channels, and controlled artificial rearing impoundments.

To meet needs for salmon, it will be necessary to construct 12 new hatcheries between 1980 and 2000 to realize a return of an estimated 596,000 salmon annually at a capital cost of $8,160,000. Similarly, during the 2000-2020 period, an estimated 31 additional hatcheries, or equivalent production facilities, will be needed to produce an additional 1,389,000 salmon annually at an estimated capital cost of $31,620,000.

Numerous sites for development of eyed-egg incubation channels or artificial channels in which adult salmon can spawn naturally are located throughout the Area. More than 140 miles of such sites, with suitable land area and water source, have been noted. Channel developments of this type would principally benefit chum and pink salmon. An estimated two miles of spawning channel to produce 240,000 pink and chum salmon annually will be needed by 1980, primarily to perfect techniques of channel operation. Capital cost is estimated at $1,400,000. Between 1980 and 2000, an additional 10 channels with an estimated annual 1,200,000 pink and chum production capacity will be needed at an estimated cost of $7,000,000. In the 2000-2020 period, seven more channels will be needed for pink and chum, and one for sockeye. Total capital cost is estimated at $5,600,000 and production at 990,000 fish annually. This assumes that necessary research is performed in the near future to determine techniques to achieve the indicated production levels.

The Puget Sound Area contains many sites suitable for development of controlled natural rearing impoundments. More than 30 sites covering over 650 surface acres have been charted. Development of such impoundments would enhance principally chinook and coho salmon. It is estimated that impoundments totaling 70 surface acres would be needed between 1980 and 2000. Estimated capital cost would be $385,000 and average annual production, 63,000 salmon. An additional 600 surface acres of ponded area would be needed between 2000 and 2020 at an estimated capital cost of $3,306,000. Estimated annual production would be 712,000 returning salmon.

The projects and programs listed above would supply slightly more than the needs indicated in Table 3-22. This is not apparent from the production (catch plus escapement) figures listed in this section, or under individual basins, which are somewhat lower than needs expressed in the table. This anomaly results because the expressed needs are based primarily on 1965 catch to escapement ratios which are lower than anticipated catch to escapement ratios for the artificially-produced salmon which are destined to satisfy much of the need in the future. As an example, the 1965 catch to escapement ratio for pink salmon, which are produced naturally, was about 2:1. The catch to escapement ratio estimated for artificially produced pink salmon in the future; however, is 5:1. Thus, if 60,000 pink salmon were produced naturally, 20,000 would be required to perpetuate the run and 40,000 could satisfy harvest need. If, in the future, 60,000 pink salmon are produced artificially, only 10,000 would be required to perpetuate the run, and 50,000 could be used to satisfy need.

Production benefits from projects listed can be achieved only if the overall comprehensive plan provides for the necessary habitat quality for fish production. If the plan, for any reason, results in less than required conditions, alternate projects or programs would have to be undertaken to achieve required production increases.

In addition to the programs and facilities outlined above, certain measures are needed to satisfy anticipated requirements for salmon and resident trout[1] for stocking Area waters under Federal responsibility, and for meeting State commitments.

Primary demand for salmon and resident trout will lie in the basins on the east side of the Area, and the Federal Government will provide assistance to Federal and State cooperative areas. The total projected need in 1980 for resident trout will require construction of a facility with a production of 700,000 legal-size fish annually. The capital cost of the hatchery is estimated at $2,250,000 and the annual operation and maintenance cost, $161,000. Facility location would depend upon fish distribution needs, suitable land, and an adequate water supply of acceptable quality. Benefits from the hatchery development in angler-days have not been determined, but such use will help satisfy overall demand. Plans for artificial propagation facilities have not been formulated beyond 1980, but similar development may be expected in subsequent periods.

Means to satisfy hatchery salmon production needs, covering areas of Federal responsibility, have been included under State proposals.

Marine Fish

In considering means to satisfy needs for marine fish, emphasis must be directed toward maintaining and improving existing production habitat. Also, the opportunities for sport harvest of these valuable food fishes should be increased wherever possible. Implementation of measures to protect the marine environment, particularly water quality, will be absolutely necessary to maintain existing marine fish production levels and provide for any future production increases.

Habitat Improvement.–The construction of both single-purpose and multipurpose piers and jetties would enhance marine fish production within the immediate area. The placement of marine fish production "reefs" should be encouraged, particularly in areas adjacent to the major population centers.

This involves creating attraction and protection mounds of select submerged junk metal, rock, or concrete in waters suitable for marine fish. Such structures would provide increased habitat as well as increased fishing opportunity for boat anglers and for the ever increasing numbers of sport divers and spear fishermen. Such areas could be designated specifically for use by one or the other of these types of fishermen.

Fisherman Access Development.–The sport fishery for marine fish is expected to increase at a faster rate than population growth. It will be necessary to develop additional fishing access to accommodate this expanding activity. Such development should include boat launching facilities as well as fishing piers or jetties designed specifically for use by sportsmen and located relatively near major metropolitan areas. In addition, fisherman access facilities should be incorporated in the development of jetties or piers by private or municipal interests, to achieve multiple use benefits. Boat charter services specifically for marine sport fishing should be encouraged and special areas set aside for such fisheries.

[1] Discussion of resident trout measures under the Federal program is included here and referred to under the section Game Fish–Artificial Propagation.

Artificial Propagation.—If the need arises, artificial propagation measures for marine fish would be investigated. Although such a situation appears unlikely, studies of methods and procedures for such measures are in progress. Within the Area there are many sites with sufficient land and adequate water supply for such programs. Semi-artificial propagation (for herring production) is already underway in Puget Sound waters.

Assuming that, in 1965, sport anglers fully utilized the popular marine fishing areas available, requirements for new marine fish production and fishing facilities in the Area should approximate those appearing in Table 3-26. Forty-five of the access areas are proposed for acquisition and development before 1980 in the Game Fish section (Means to Satisfy Needs—Fish chapter), but supply and use data are not deemed sufficient for planning beyond this period.

Shellfish

Means to satisfy demands for shellfish should accord equal emphasis to commercial and sport use. Primary importance should be given to maintaining existing production habitat. Implementing projects and programs necessary to protect the marine environment, with particular emphasis on water quality and preservation of natural beach and intertidal zones, will be necessary to maintain shellfish production levels, and to provide suitable environments for increased production.

Alteration of Production and Harvest Techniques.—A significant increase in commercial oyster production is possible by adopting a two-dimension system such as that used to provide a high proportion of Japanese oyster production. This is achieved by use of floats from which oysters grow suspended on wires and ropes. There are many advantages to this

TABLE 3-26. Estimated future needs in marine fish angler-days, and means to satisfy production and fishing needs

1980	2000	2020
	Angler-Days (1000)	
906.0	1,807.2	2,876.8
	Means to Satisfy Needs	
Construct or make available an additional 2.3 miles of fishing piers or jetties.	Construct or make available an additional 4.6 miles of fishing piers or jetties.	Construct or make available an additional 7.4 miles of fishing piers or jetties.
Construct 1.2 miles of fishing "reefs."	Construct 2.3 miles of fishing "reefs."	Construct 3.7 miles of fishing "reefs."
Develop 60 marine fishing access areas.	Develop 120 marine fishing access areas.	Develop 190 marine fishing access areas.
Development emphasis should be in Nooksack-Sumas, Snohomish, San Juan, Whidbey-Camano, Cedar-Green, and Puyallup Basins.	Development emphasis should be in Skagit-Samish, San Juan, Whidbey-Camano, Snohomish, Cedar-Green, Puyallup, Nisqually-Deschutes, Elwha-Dungeness, and West Sound Basins.	Development emphasis should be in San Juan, Whidbey-Camano, Nisqually-Deschutes, West Sound, and Elwha-Dungeness Basins.

method, but market practices and navigation and zoning requirements have impeded its widespread use in this area. A reasonable production estimate based on Japanese culture and results of local experiments indicates a potential of 32,000 pounds of oyster meat per surface acre of water per year. Therefore, potential oyster production from Puget Sound[1] is conservatively estimated at 6 billion pounds of meats annually. This approximates the total annual United States fish production and presupposes that all the estuary waters would be acceptable and only used for oyster production. The potential becomes particularly attractive when considered in the light of increasing international problems of ownership, competition, and conservation of fisheries on the high seas.

Harvest of Unutilized Stocks.—Shellfish harvest will increase in the future. Past exploratory work indicates subtidal clam populations of unknown size and distribution. Currently, an exploratory program is being conducted by the Washington Department of Fisheries to locate and evaluate such clam beds. Once defined, these lands will be available for lease and harvest by commercial interests, and will provide new grounds for sport harvest by skin and scuba divers (Photo 3-9). A number of shellfish species, such as horse and butter clams, are not fully utilized, and others, such as mussels, piddocks, and softshell clams, are not commercially cropped. Slight changes in commercial market and sport demand, or in harvesting and processing technology, could result in greater use of these resources.

PHOTO 3-9. Newly discovered shellfish beds will attract sport divers. (Washington Department of Commerce and Economic Development photo)

Stocking Programs.—Put-and-take stocking programs would distinctly benefit sport shellfish harvest. These would be initiated in areas close to major metropolitan centers wherever possible, and would provide sport harvest for large numbers of people.

Habitat and Stock Improvements.—Increases in production are expected from results of research studies designed to develop measures to enhance natural seeding and productivity of marine waters, and to control shellfish predators.

Intertidal clam ground has been built with earth-moving equipment by several clam farmers, and may be used to increase production in certain areas. Such methods might also be applied to increase sport harvest.

The potential for increased clam and oyster production in Puget Sound is based on a sustained seed supply. In fact, the long dependence of the Pacific Coast oyster industry on annual seed shipments from Japan may be nearing an end. Increased prices and uncertain quantities of Japanese seed have stimulated efforts and investment by enterprising Washington oyster growers to develop techniques for producing an adequate seed supply in local waters. Private, State, and Federal research to uncover methods of developing economically operative clam hatcheries is also underway. Several such hatcheries are situated on the East Coast, and similar facilities could be developed in the Puget Sound Area.

Under private ownership, tidelands unsuited for clam or oyster production can be improved and cultivated as in conventional land farming. The most striking example is the manmade oyster dike system in southern Puget Sound. The enhancement of tideland production, however, assumes many forms. Oysters are being cultured on a small scale on intertidal racks, trays, and stakes which protect young and even older oysters from the hazards of suffocation in shifting sands and soft mud, or mass dislocation by waves or tides. With increased market demand, production could be increased on much of the land now considered marginal or unsuited for shellfish culture and needs for shellfish in 1980, 2000, and 2020 could be met.

[1] Includes only that area south of a line between a point near Port Townsend to Partridge Point (Whidbey Island), in water between 2 and 20 fathoms in depth.

A recent State-Federal preliminary study was conducted on Swinomish and Lummi Indian Reservation tidelands to determine their shellfish production potential. Survey results indicated that certain of these lands would be suitable for some form of oyster or clam culture.

Summary—Salmon, Marine Fish, and Shellfish

The demand rate as calculated is considered minimal. The supply of fish and shellfish to meet these demands must be attained through extensive enhancement projects and programs. Technological breakthroughs are imminent, providing further scientific studies are authorized. Therefore, specific enhancement programs and facilities can supply virtually any projected demand as long as the public desires and is willing to pay for added production and required developments.

GAME FISH

Plans for projects and programs for increasing game fish resources and enhancing the fishery for these resources have been developed for the pre-1980 period and are summarized below for the Puget Sound Area.[1] These project and program recommendations do not consider benefits which might accrue to anadromous trout from measures which are undertaken to benefit salmon. Neither do they preclude certain losses, which might be occasioned by indigenous or resident fish, from developments for anadromous fish. It is not the intent of any fisheries research or management program to detract from any existing program. If production benefits from listed projects do not provide a significant overall benefit to the fish resource, alternate projects or programs must be implemented to compensate for as well as achieve required production increases. Some of these programs should be continued through subsequent periods, and a continuing series of similar projects and programs carried out as needs for fish and fishery development increase.

Perhaps the most important, and potentially the least costly programs for increasing the supply of game fish are basic research studies, especially those designed to develop new or improved fish management techniques. These and other nonstructural measures for enhancing fish resources are as follows:

[1] **Washington Department of Game figures do not include estimated expenditures for investigations, surveys, and plans. Similar data for subsequent periods are not available.**

Nonstructural Enhancement Measures

(1) Development of Lake and Stream Fertilization Techniques.—This could double trout production in lakes, ponds, and reservoirs, and increase resident and anadromous fish production in rivers and streams. Savings could be substantial, because much of the need for hatchery development would be eliminated. Cost of this study for the Area is estimated at $100,000 for the initial year.

(2) Development of New Fish Toxicants and Lake and Stream Rehabilitation Methods.—Economical toxicants that disintegrate rapidly, particularly those that are selective as to species, are urgently needed. Initial year study cost is estimated at $80,000. Development of new fish toxicants and new fertilization techniques would eliminate much of the need for new hatcheries required to meet increased future need for trout for lake fishing. Operation and maintenance costs for hatchery production would be reduced proportionately, but rehabilitation and fertilization costs would increase.

(3) Development of Fish Disease Control Program For Lakes.—A satisfactory solution to the trout disease problem in lakes would reduce hatchery requirements, or would permit increased trout harvests. Area cost for this research program is estimated at $120,000.

(4) Cross Sectional Surveys of Streams.—This is a basic need and must be accomplished before optimum streamflows can be determined precisely. Benefits would accrue to both sport and commercial fisheries as well as to most other water users. This would be a joint program by the Washington Departments of Game and Fisheries with an estimated total cost of $388,000.

(5) Fish Populations Analysis and Development of Effective Fish Management Programs.—To satisfy future needs for fish, it will be necessary to manage all major lakes, streams, and reservoirs to the greatest advantage. This study, coupled with the studies previously mentioned, is necessary to achieve optimum fish production in Area waters. Estimated cost of this program is $25,000.

(6) Stimulation of Interest in Spiny Ray Fishing.—Bass, crappie, sunfish, bullhead, and perch, are not now as popular as the salmonids, and in many lakes and a few streams, are underharvested. Promoting angling for these fish would relieve fishing pressure on trout, and also lead to better utilization of the resource (Photo 3-10). Estimated cost of this program is $20,000.

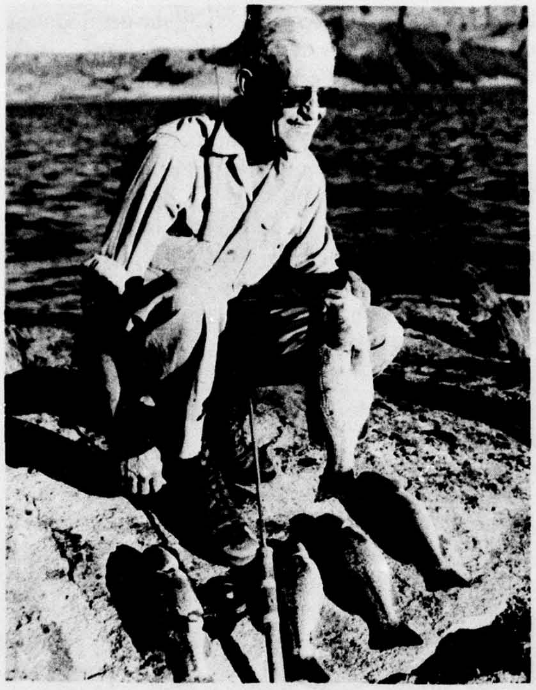


PHOTO 3-10. Much greater angler use of spiny-rayed fish is feasible and desirable. (Washington Department of Game photo)

(7) Fisherman Access to Closed Watersheds.—Nine watersheds, totaling 609 square miles, are closed to use for any form of outdoor recreation. This is a waste of resources, which may continue in the future at an accelerated pace as municipal and industrial water needs increase. Costs of this program are unknown, but would include costs for public access facilities, and costs for water treatment, depending on the degree of treatment required.

Fisherman Access

One of the most pressing needs in the Puget Sound Area is acquisition and development of fishing access areas to fresh and marine waters (Photo 3-11). Although many public access points have been developed in the Area, many more are needed to avoid overcrowding and assure full utilization of fish resources.

(1) Access to Lakes.—Many lakes, particularly those at low elevations, are closed to the public, and consequently receive relatively little use. By 1980, access rights should be acquired and access areas developed on 87 of these lakes at an estimated total cost of $1,675,000.

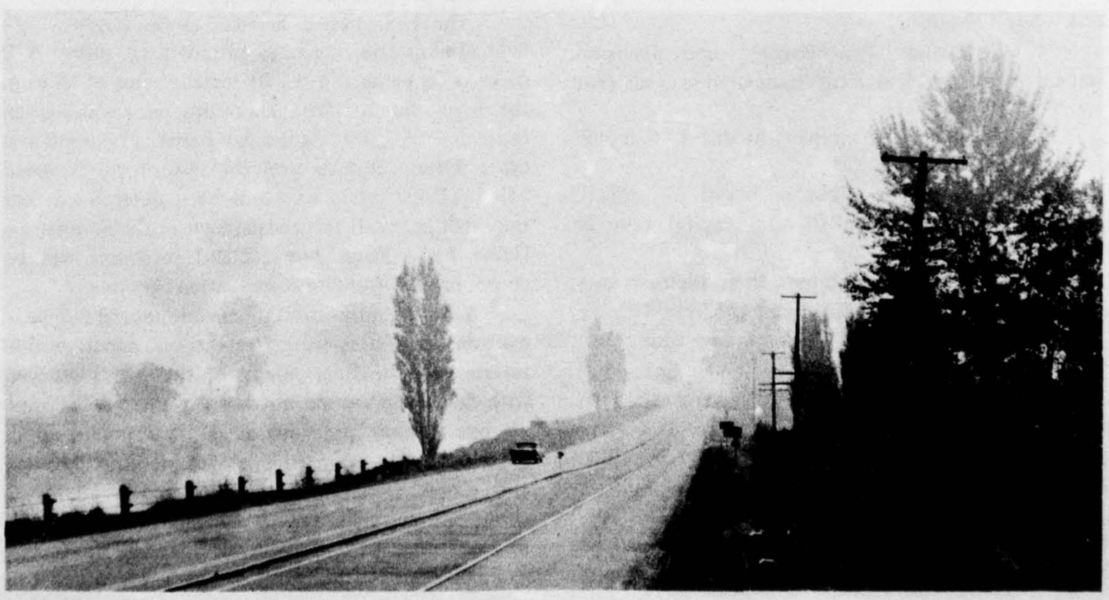


PHOTO 3-11. Limited access highways often eliminate traditional angling spots. (Washington Department of Game photo)

(2) Access to Streams.—As with lakes, many river reaches receive very little fishing pressure because streambanks are privately owned. Specific sections of riverbanks should be acquired for the use of bank fishermen, and boat launching ramps, parking areas, and sanitary facilities constructed. Public access rights to 510 miles of stream should be acquired prior to 1980, and the areas developed for the use of fishermen, hunters, boat owners, and picnickers. Estimated cost of this program is $8,798,000.

(3) Access to Salt Water.—Access to salt water is very restricted. More public boat launching areas and public beaches and flats are needed to adequately serve the public, and to secure better utilization of fish, shellfish, and waterfowl. A total of 45 areas that will afford access to salt water should be acquired by 1980. Estimated cost is $1,570,000.

Structural Measures for Habitat Development

Most fish habitat can be improved. Unfortunately, many of the possible improvements are so costly that they can not be economically justified. The projects listed below are believed to be economically feasible, and some will furnish incidental benefits in hunting, boating, and other forms of outdoor recreation.

(1) Enlarge, control the water level, and develop a fishery on eight lakes. Estimated capital cost totals $645,000.

(2) Construct fish-passage[1] and diversion screening at two locations. Estimated capital cost totals $100,000.

(3) Construct fishing piers at one lake. Total cost is estimated at $65,000.

(4) Correct clay slide problems at several stream locations. Estimated total capital cost is $2,400,000.

(5) Correct gravel compaction problems in two streams. Estimated total capital cost is $20,000.

(6) Rehabilitate and fertilize one lake. First year cost is estimated at $10,000.

(7) Augment low flows in several streams. Costs are undetermined.

Artificial Propagation

At the present level of stream and lake productivity, most of the future need for trout must be satisfied by artificial propagation. If the natural productivity can be increased, as by the development of new management techniques, propagation costs would be less than those proposed. Essential projects are as follows:

(1) Construct new trout hatcheries, and expand existing hatcheries in nine basins at an estimated total cost of $14,272,000.

(2) Construct spawning channels in two basins at an estimated total cost of $195,000.

(3) Construct rearing ponds for steelhead and searun cutthroat in eight basins at an estimated total cost of $1,515,000.

(4) Develop salt-water rearing areas for searun cutthroat trout in two basins at an estimated total cost of $150,000.

The following section, Summary–Game Fish, indicates future needs in angler-days that will be supplied by projects and programs listed above. Responsibility for these projects and programs has not been assigned on an agency basis, but rests largely with the Washington Department of Game.

Federal agencies have certain fish management responsibilities within the Area and some maintain research and propagation facilities. For ease of discussion, data concerning artificial propagation of resident trout at proposed national fish hatchery facilities appear in the section Salmon, under Artificial Propagation Opportunities.

The U.S. Forest Service, as the largest single land-administering agency, proposes to survey 530 miles of streams and 5,270 surface acres of lakes in the Area prior to 1980. These programs will cost an estimated $58,000. Angler-day benefits of these and other Forest Service projects and programs listed below (Table 3-27) have not been determined, but they will help satisfy needs shown in the Summary–Game Fish. These projects and programs will be coordinated with State conservation agencies.

A significant portion of current natural fish production, as well as fishing recreation, occurs within private land holdings. Many of the ponds stocked with fish, however, are not open to the public. Some are operated as fee-fishing areas. Farm ponds, developed under U.S. Department of Agriculture cooperative programs, are being constructed at a rate of about 125 per year. This or a higher rate is expected to continue at least through the year 1980, resulting in 3,000 ponds (1,500 surface acres). The number of available sites and water will become limiting some time beyond 1980, at which time the rate of farm pond construction will decrease substantially.

[1] Impact on resident fish and potential introduction of undesirable species must be considered.

TABLE 3-27. Future fish habitat improvement proposed by U.S. Forest Service

Project or Program[1]	Unit	1980 Number	1980 Capital Cost (1000)	2000 Number	2000 Capital Cost (1000)	2020 Number	2020 Capital Cost (1000)
Clear stream channels	mile	123	$ 246.0	114	$ 228.0	113	$ 226.0
Remove debris from lakes	acre	416	416.0	100	100.0	100	100.0
Fertilize lakes	acre	580	399.0	972	668.7	922	634.3
Totals			$1,061.0		$996.7		$960.3

[1] Projects and programs are in addition to Forest Service proposals contained in other appendices.

About 1/3 to 1/2 of these ponds (500–750 surface acres) will be stocked with fish. Although the long-range outlook, beyond 1980, forecasts a ceiling in number of ponds, the amount of fish produced per surface acre can be expected to increase five- to tenfold as private pond owners realize more intensive management techniques can be successfully applied. At the same time, the proportion of farm ponds stocked with fish can be expected to increase as the competition for fishing waters becomes more keen. A corresponding increase is expected in the number of fee fishing enterprises to meet the demand for this kind of fishing.

Summary—Game Fish

As with food fish, the game fish demand rate as calculated is considered minimal and the demands are intended to be met by the specific programs of structural or nonstructural enhancement measures. These program measures are intended to satisfy the projected demand only to the extent that the public desires and is willing to pay for added production and required developments.

Satisfaction of need for sport fishing prior to the year 1980 is shown by angler-days in Table 3-28.

Projects planned for periods after 1980, which may include some of the aforementioned projects and programs, have not been evaluated, nor have costs been estimated. However, a listing of proposals for the 1980-2000 and 2000-2020 periods appears in each basin chapter.

TABLE 3-28. Satisfaction of need for sport fishing, pre-1980

Basin	Angler-Days (1000) Need	Enhancement[1]	Difference[2]
Nooksack-Sumas	147.0	209.0	62.0
Skagit-Samish	500.5	521.35	20.85
Stillaguamish	226.0	297.0	71.0
Whidbey-Camano	46.4	85.0	38.6
Snohomish	595.2	725.5	130.3
Cedar-Green	425.2	500.1	74.9
Puyallup	407.0	415.2	8.2
Nisqually-Deschutes	324.5	441.15	116.65
West Sound	354.8	364.3	9.5
Elwha-Dungeness	75.1	95.9	20.8
San Juan	6.4	12.9	6.5
Totals	3,108.1 (3,108)	3,667.4 (3,667)	559.3 (559)

[1] From proposed fish enhancement projects and programs.
[2] Would be reflected as satisfaction of need in post-1980 years.

PRESENT STATUS—WILDLIFE

INTRODUCTION

Wildlife is a natural resource and consequently, a product of the land, vegetative cover, and waters thereon. The species and number of animals or birds present in an area are dependent upon the quality and quantity of the habitat. The three basic elements of habitat—food, cover, and water—vary in type, quantity, and quality as a result of climatic conditions, soil, and topography. Climate, for example, ranges from the mild weather at the Sound to severe mountain weather. The varied climate, topography, and vegetative cover of the Puget Sound Area provide natural environmental conditions favorable to a wide variety of wildlife species (Exhibit 1). These are grouped by gross characteristics into five major divisions—big game, upland game, fur animals, waterfowl, and other wildlife. Individual species abundance, characteristic requirements, limiting factors, and value are detailed generally under these major headings in this chapter, and with the exception of other wildlife, in greater detail within the individual basin chapters.

The natural vegetative cover of the Area was predominately evergreen forest. Therefore, the native terrestrial wildlife species were adapted to and dependent upon such vegetation for survival. As man moved in and cleared large lowland areas for farming, the food and cover vital to native wildlife species were reduced and so were the forest-dependent birds and animals on these lands. Man's natural desire to hunt stimulated the introduction of new varieties of wildlife adapted to living in farmed areas to fill this void.

Changes in ground or aquatic vegetation alter the kind and abundance of wildlife use. Such changes may result in an improvement of conditions for wildlife or may be detrimental, but total elimination of vegetative cover eliminates the wildlife dependent thereon. Each unit or area of habitat has a specific capacity to support wildlife. Contrary to popular belief, wildlife cannot move to another area and survive, if their home territory is denuded of vegetation for some other use. These adjacent lands are already supporting wildlife at the habitat carrying capacity. Consequently, additional animals crowded into an area or an equal number of such animals or birds are lost during the first critical period—usually winter. The capacity is not changed by more animals moving in, but rather may be decreased by overuse.

Uses of wildlife are both consumptive and nonconsumptive. Universally in the past, hunting recreation resulting from harvest has been the sole gauge of management success and often the only measure of wildlife values. Recent studies, however, indicate nonconsumptive use, including photography, viewing, and visiting management installations equals or actually exceeds consumptive use. A survey by Consulting Services Corporation, Seattle, Washington, based on 1964 data, showed 5,480,000 days[1] of nonconsumptive use annually in the State, compared with 4,994,700 days of hunting. A significant portion of such use occurred within the Puget Sound Area. This use consisted of trips away from home specifically to view or photograph wildlife and did not include the countless hours of enjoyment people gained from observing and hearing songbirds at their residences.

In 1964, recreation-days (nature study, visitations) at the national fish hatchery and various national wildlife refuges in the Puget Sound Area were estimated at 7,550.

In modern society, hunting for food is unnecessary; hunting has instead become a form of recreation. Most modern sportsmen enjoy more the association of natural environment and test of skills associated with hunting than the actual consumption of game. For this reason, a large number of hunters use cameras or less effective weapons such as bows, muzzle-loaders, or falcons for hunting purposes.

Hunters should be credited for much of the present wildlife supply. Hunting license fees and taxes on sporting arms and ammunition, without the aid of general tax monies, support the entire wildlife management program which benefits nongame and game species. Conservation law enforcement, management of key ecological areas to conserve and enhance wildlife, introduction of exotic species, and extensive research, are examples of management programs attributable to the hunting fraternity.

Wildlife management is largely a problem of habitat. Increasing human populations exert greater

[1] Includes 733,000 recreation-days visiting State fish hatcheries and/or game farms.

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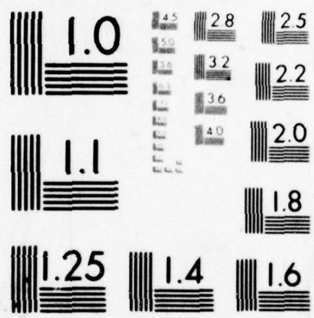


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

demand on the resource while decreasing the area inhabited by animals and birds. Many new residents in the State desire to hunt on a basis comparable to that of existing residents, yet urban and industrial expansion required for population growth erodes the natural supply of wildlife through loss of habitat. This competition for space is direct and occurs in most critical wildlife areas. Bird and animal species have adapted various means of survival during critical weather or food shortage periods. Those which do not migrate or hibernate occur only at low elevations where persistent snow does not interfere with their daily food requirements. Animals which migrate use high areas in summer and fall, but must move to lower areas as snow covers their food supply. Human population demands–agricultural, urban, and industrial–occur almost exclusively at low elevations. Competition, therefore, is direct, and as human populations increase, area critical to wildlife survival is significantly decreased.

Game agencies are moving into an era of concentrated management or farming of key ecological areas to maintain the current wildlife level. Game harvest and hunter recreation levels in the past 20 years have been maintained and even increased in the face of decreasing habitat by a more complete use of the resource. Hunting seasons have been liberalized and new seasons initiated. There is a definite limit, however, to this management measure. Efforts are being directed toward maintaining and, wherever possible, increasing wildlife production on remaining high potential or key wildlife lands.

BIG GAME

Black-tailed deer, elk, bear, mountain goat, and mountain lion inhabit the timbered sectors. Deer are the most numerous and widespread, but elk, black bear, and mountain goat, although usually requiring slightly more remote areas, are also common. Average annual hunter use data (hunter-days) are shown in Table 3-29.

Brush and forest lands are the principal habitat for deer, and except for large solid agricultural blocks and densely populated urban and industrial areas, these animals inhabit the entire Area. Numbers of this most important big-game species are regulated by the amount and quality of their winter habitat. Changes in land use for urban, industrial, or agricultural purposes reduce habitat, while logging and other forest management practices may enhance the quality and quantity of forage. For example, low-growing shrubs and forbs which deer require for food must have direct sunlight to thrive; therefore controlled logging has been a prime factor in the improvement of deer habitat.

Availability of forage in winter is governed, as is animal movement, by snow depth and persistency. Snow of sufficient depth to cover big-game feed as well as hamper their travel in search of suitable forage normally occurs at about 2,000 feet elevation and may persist for extended periods as low as 1,000 to 1,500 feet elevation along the east slopes of the Olympics. Animals which use higher areas in summer and fall must move to lower elevations as their food supply is covered. This concentrating effect of weather is more pronounced during severe winters, emphasizing the value of low-lying areas for survival of big-game populations (Photo 3-12).

The elk is perhaps the only common big-game animal not generally distributed throughout its entire potential range. As evidenced by fossil remains in various locations of the Area not currently inhabited by elk, these animals were extirpated from various

PHOTO 3-12. Game numbers are regulated by the quantity and quality of winter forage. (Washington Department of Game photo)

TABLE 3-29. Average annual hunter use[1] –big game, upland game, and waterfowl, 1961-1965

Wildlife Group	Basin: Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan	Totals
Big Game												
Deer	23,200	48,000	16,000	22,500	35,800	18,000	30,200	28,600	72,000	6,000	20,800	321,100
Elk	975	--	--	--	--	2,300	3,900	5,500	4,700	1,500	--	18,875
Mtn. goat	260	600	100	--	450	--	100	--	--	--	--	1,510
Bear	1,575	7,700	1,180	--	3,600	600	1,575	1,100	2,800	500	--	20,630
Mtn. lion	100	250	100	--	100	100	--	--	100	100	--	850
Totals	26,110	56,550	17,380	22,500	39,950	21,000	35,775	35,200	79,600	8,100	20,800	362,965 (363,000)
Upland Game												
Grouse	8,400	19,200	7,200	250	12,800	8,500	10,200	12,000	11,700	2,400	--	92,650
Pheasant	7,100	7,100	2,900	5,600	7,200	3,700	10,000	3,700	4,600	4,000	1,000	56,900
Quail	100	230	300	770	1,150	300	1,150	300	900	150	150	5,500
Bandtail	4,300	8,750	8,400	1,700	16,250	6,400	6,700	6,000	11,100	1,700	670	71,970
Dove	200	350	100	50	450	600	300	300	100	--	--	2,450
Rabbit	3,600	2,200	850	11,100	1,100	800	1,550	600	800	225	25,000	47,825
Totals	23,700	37,830	19,750	19,470	38,950	20,300	29,900	22,900	29,200	8,475	26,820	277,295 (277,300)
Waterfowl												
Ducks, Geese	25,000	65,000	17,200	12,600	20,500	13,400	9,000	14,000	20,000	9,100	1,900	207,700
Totals	25,000	65,000	17,200	12,600	20,500	13,400	9,000	14,000	20,000	9,100	1,900	207,700 (207,700)

[1] Nonconsumptive recreational use equals, or exceeds hunter-day use.

segments of their historic range at an early date. By the early 1900's elk were found only in the West Sound and perhaps the Elwha-Dungeness Basins. Subsequently, trapping and transplanting from other areas to the Puget Sound Area have established elk in numerous additional locations including the Nooksack-Sumas, Cedar-Green, Puyallup, and Nisqually-Deschutes Basins.

Deer and elk utilize similar habitat and compete for available food. The size and mobility of elk and their capacity to assimilate forage of lower nutritive value enable them to outcompete deer. Numerically, more deer can be maintained in a given area, however, and they cause less serious agricultural damage problems. Consequently, deer are maintained over wide areas where elk may be incompatible due to proximity of agricultural lands.

Big-game populations, have remained fairly stable, indicating annual losses are being offset by present production. The primary governing factor of habitat is food; therefore, much of the annual production, which exceeds the food supply, can be harvested by hunting.

Mortality in mature animals occurs primarily in late winter and early spring, whereas mortality in young animals is rather general throughout the first year and exceeds that of older age classes. As harvest is the principal gauge of management success, doe-fawn ratios determined just prior to the hunting season are most significant.

To maintain greater productivity of deer and elk herds, an uneven sex ratio is achieved by a combination of males-only seasons and brief either-sex hunts. Annual harvest fluctuates with the length and date of the hunting season. Factors having the greatest influence on annual harvest are: (1) the extent of area open to either-sex hunting; (2) the length of the either-sex season; and (3) the number of male animal hunting days allowed.

Mountain goat have very specific habitat requirements and, consequently, are not widespread. Natural features of the precipitous terrain they inhabit regulate their numbers. They require steep rocky slopes where, within a relatively restricted area, yearlong forage requirements are met. Wind-swept bluffs provide protection from natural enemies and feed during severe weather. Due to the severity of their habitat, natural losses of goats are high. However, due to an abundance of rocky, precipitous mountains the Puget Sound Area has a very high population of these unique animals in comparison with other areas of the Nation. Washington leads all States in numbers of mountain goat, and nearly one-half of it's goat population inhabits the Puget Sound Area.

The mountain goat harvest is controlled by restricting hunters. Special permits are authorized by lot drawing for each management unit. The number of mountain goats harvested is not indicative of the population potential, as the limited numbers of this highly-prized animal are managed for trophy hunting.

Like deer and elk, bear numbers are related to the amount of woodland habitat. Although their range is somewhat less restricted, due to an ability to hibernate, highest densities occur at low elevation where weather is less severe and food more abundant. Due to their extremely secretive nature, and the dense cover which they inhabit, censusing of these animals is virtually impossible. However, population estimates are determined from their reproductive potential and ability to maintain existing numbers under present hunting intensity. National figures indicate Washington harbors more black bear than any other State. Outstanding bear hunting adjacent to a major metropolitan area is unique to the Puget Sound Area. These animals have been managed by imposing long seasons without restrictions concerning numbers taken per hunter.

Black bear numbers are influenced by logging or fire. Reduction of the dense forest canopy increases growth of ground vegetation and allows an increase in bears, as it does deer and elk. Evidence of bear damage in large dense stands of 30- to 40-year-old conifers is considered to demonstrate a food shortage. Feeding on the sap layer of such trees occurs primarily in April and May, at a time when bears emerge hungry from hibernation and prior to succulent growth of annual or perennial vegetation. Progressively less food is available to these animals as trees increase in size and shade out ground vegetation.

Mountain lion require an extensive home range and, therefore, numbers of this largest of native predators are never great in comparison with other animals. However, they have an ability to increase rapidly when food is abundant. Due to their predatory nature, they have been rigidly controlled in and near inhabited areas. High, remote sectors in the Area, however, provide the seclusion necessary for this wildest of big-game animals and they occur in most of the basins.

Increased accessibility to remote areas by road and snowmobile plus a growing demand for a unique hunting experience have increased hunting pressure on mountain lion in recent years. An indicated population decline precipitated a change in its classification by the Washington Game Commission in 1966. To control hunting intensity and prevent an overharvest of this magnificent animal, it's classification was changed from predatory animal–open to unrestricted hunting–to game animal with hunting seasons and bag limits regulated.

Specific areas managed exclusively or primarily for the benefit of big game have not been established in the basins. Liberalization of hunting seasons and the more efficient utilization of game resources are the principal management goals. Either-sex deer seasons have increased annual harvest and reduced natural losses. Other hunting seasons have been lengthened, allowing greater participation in the sport of big-game hunting and, within limits, an increase in harvest. Both the area and number of permits authorized for mountain goat hunting have been increased.

General changes in timber management including reduction of fire have reduced the productivity of the area for big game. However, sustained yield timber management and a change to small-area logging have beneficial aspects. Small-area timber harvest increases "edge" habitat and sustained yield logging tends to promote a sustained yield of big game.

UPLAND GAME

The varied species of upland game are the most widely distributed of the major game groups. Native species utilize the remaining native habitat, and introduced exotics have been established in the agricultural areas. Introduced varieties include ring-necked pheasant, California and mountain quail, gray (Hungarian), red-legged, bamboo, and chukar partridge, cottontail, and "San Juan" rabbit (a feral domestic). Native upland game are blue and ruffed grouse, band-tailed pigeon, mourning dove, and snowshoe rabbit. Rabbits are the most prolific game animals. Annual production of upland game is influenced significantly by spring and early summer weather conditions. Exotic game birds, particularly, are very susceptible to cold, wet weather shortly after hatching. Hunter use data involving the major upland-game species are shown in Table 3-29. Although upland-game hunting seasons have been progressively liberalized, population levels have remained fairly constant in recent years. There is no open season on the remnant populations of gray partridge.

The two species of grouse are the most abundant upland game. Both are dependent on woodland habitat. Ruffed grouse frequent the deciduous-conifer woodland along streams and lakes, as well as woodlot habitat within and adjacent to agricultural areas. Blue grouse prefer open ridges and sparsely timbered burned or logged mountain slopes. Ruffed grouse are generally more accessible to hunters than blues, because of the common practice of locating roads near watercourses. Grouse hunters' families often accompany them for a day's outing in the woods. The hunter use figure is therefore not a true indication of the outdoor recreation stimulated by grouse hunting.

Band-tailed pigeon, mountain quail, and snowshoe–like grouse–are dependent on native woodland for habitat. All the native wildlife species and mountain quail populations respond to logging. Increased quantity and nutritive value of various low-growing forbs and shrubs resulting from opening the forest canopy increase wildlife capacity. Harvest is enhanced by greater accessibility and higher game density. Slash burning following logging, a practice reduced in recent years and threatened with further reduction for air pollution abatement, also benefits native wildlife.

Virtually all the introduced wildlife species are upland varieties. Early introductions, prior to establishment of governmental game authority, were by private individuals, but in later years county, State, and Federal game agencies have concentrated efforts to fill uninhabited ecological niches by introducing foreign game species. The ring-necked pheasant, California and mountain quail, gray partridge, and cottontail are examples of successful introductions in the Area (Photo 3-13). These species, except mountain quail, were imported to utilize the open areas, fence row cover, and edge created by agricultural activity. Larger farm acreages, emphasis on clean farming, and a shift from cereal grain production in recent years have reduced the potential of such areas for these beautiful and sporty exotic varieties.

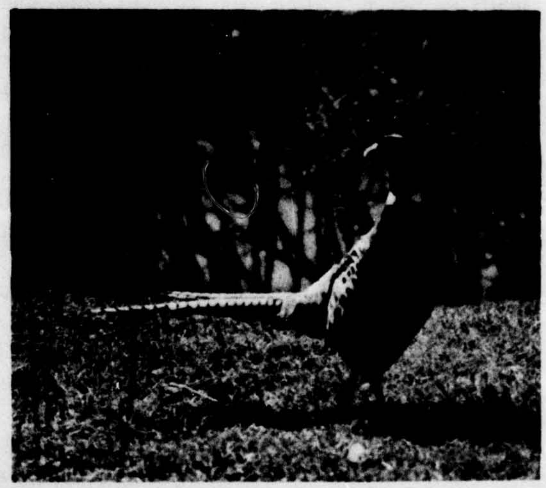


PHOTO 3-13. Ring-necked pheasants provide significant hunter recreation. (Washington Department of Game photo)

The Washington Department of Game is continuing to experiment with the introduction of exotic upland game to enhance hunting. Species under study, in addition to continued efforts on previously mentioned varieties, include Japanese green pheasant, white-crested Kalij, Chilean tinamou, and Erkels francolin.

Band-tailed pigeon and a limited number of mourning dove–both migratory species–nest in the Area and remain into September (the hunting season) before moving south to winter. Pigeon density and residence period are apparently regulated by availability of food. Pigeons feed on wild berries and agricultural waste extensively during summer and early fall, moving often to locate suitable feeding areas. A few bandtails are year round residents in the metropolitan Seattle area (Cedar-Green Basins), feeding on berries of ornamental trees and shrubs almost exclusively.

FUR ANIMALS

A rich fur trade stimulated the early settlement of the Puget Sound Area. Trapping is still primarily a commercial venture, but rarely serves as more than a casual source of income. Pelt prices have not kept pace with the upward economic trend, and year round employment has generally replaced the seasonal employment common during early years of growth in the Northwest.

Fur animals which inhabit the Area include beaver, muskrat, mink, river otter, marten, weasel, skunk, raccoon, opossum, bobcat, lynx, red fox, and coyote. These animals are widely distributed, except in concentrated urban areas and large open water expanses of the Sound. Fur-animal distribution is oriented with three basic habitat types. Beaver, muskrat, mink, raccoon, and river otter occur in and along water areas throughout the Area. Red fox, opossum, and skunk are found in lowland areas and bobcat and coyote are inhabitants of the foothill and mountainous regions. Marten are numerous at high elevations, where lynx may also occur. Data concerning economically important fur-animal harvest and annual pelt values are shown by basin in Table 3-30.

The muskrat, like many other rodents, is a prey species–being the food of a wide variety of other animals. Thus, it has a high reproductive rate. Mink are subject to less predation than muskrat and consequently, require less production to maintain their populations. Other fur bearers have reproduction rates comparable to that of mink.

Fur-animal harvest and relative abundance are indicated by trapper reports required of each licensed trapper. Trapper effort, however, is influenced by fur prices, access, and the local employment and economy level, and is not always of the same intensity.

The 1963 Legislature authorized the trapping of beaver by licensed trappers under regulation of the Washington Department of Game. Prior to this legislation, all beaver were cropped by Department personnel or contract trappers whose activities were rigidly controlled. The effect of this change is not fully known; however, the number of beaver taken has decreased during the past four seasons (1963-64 to 1966-67).

Pelt values of the individual fur bearers vary with current fashions, but traditionally, pelts of the water-dwelling or water-oriented species bring the highest prices. During the 1965-1966 trapping season, 95 percent of the sale revenue from pelts taken in the State was from fur animals which live in or are closely

TABLE 3-30. Average annual fur-animal harvest and pelt value, 1961-62 to 1965-66

Basin	Harvest				Pelt Values[1]
	Beaver	Muskrat	Mink	River Otter	
Nooksack-Sumas	300	750	150	-	$ 8,000
Skagit-Samish	360	1,800	215	10	10,000
Stillaguamish	350-400	1,600	300	-	10,000
Whidbey-Camano	30	200	140	-	2,300
Snohomish	475	2,300	175	15	13,170
Cedar-Green	140	2,580	110	10	8,000
Puyallup	260	800	50	10	6,000
Nisqually-Deschutes	650	2,100	70	25	15,000
West Sound	1,180	1,030	75	125	15,200
Elwha-Dungeness	70-100	500	25	17	2,675
San Juan	-	225	125	15	2,200
Totals	3,815- 3,895 (3,900)	13,885 (13,900)	1,435 (1,400)	227 (230)	$92,545 ($92,500)

[1] Includes all fur animals.

associated with water. Trappers concentrate on these water-dependent species, which afford the greatest return for effort expended.

Employment and economy level in rural areas influence the effort directed toward trapping. Trapping effort and pelt sales increase during otherwise poor economy years. Trapping serves as a secondary or emergency source of income to adults and provides spending money and vigorous recreation for many young boys.

The economically important fur bearers require native marsh and riparian habitat in which to thrive. Such areas are limited in nature, and it is in these areas that the most intensive manmade developments have occurred. Conflicting interests which include waterfront homesite and industrial development, flood control measures, and agricultural drainage all tend to reduce fur-animal habitat.

Domestic fur, particularly mink, produced by private fur farmers now supplies the fur garment industry with a large portion of its needs. Hybridization of mink has produced numerous very popular color phases which normally bring higher prices than wild-trapped furs.

In past years, the State engaged in an active program of live trapping and transplanting beaver to reestablish populations in all potential beaver habitat. Currently, problem beaver are live-trapped and moved to areas in which stocks may have been depleted.

WATERFOWL

The Puget Sound Area is principally a resting and wintering area for large concentrations of ducks and geese produced in British Columbia, the Northwest Territories, Alaska, and eastern Russia (Photo 3-14). Species and relative abundance of these wintering populations are determined during a mid-winter Federal-State survey. An estimated 354,500 ducks and 49,200 geese winter here each year and approximately an equal number delay their migration for a period up to a month or more prior to drifting farther south to spend the remainder of the winter. Local production, consisting primarily of mallard and wood duck, is approximately 60,800 birds annually.

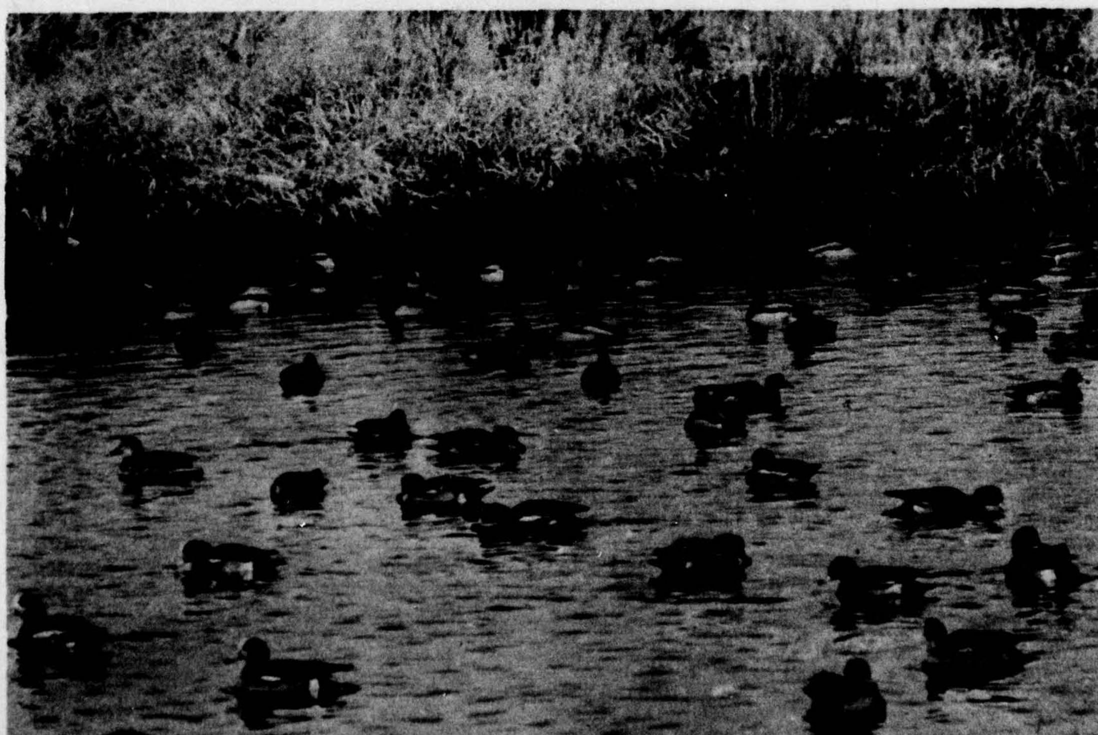


PHOTO 3-14. Puget Sound waters attract waterfowl. (Bureau of Sport Fisheries and Wildlife photo)

The large protected salt-water area of the South, with its extensive shoreline and abundant shoal-water estuaries, provides ideal feeding and resting area for water-associated birds. Dabbling ducks (mallard, teal, pintail, and widgeon) concentrate in the tidal zone near the river mouths and do much of their feeding inland. As temporary water in fields increases, these populations disperse gradually into the river valleys and use fresh-water areas more extensively. Waste from cereal grain production is perhaps the most important winter food of mallard and pintail. Widgeon depend on grass and emergent vegetation and teal rely almost exclusively on minute shoal-water aquatic plants and animals. Diving ducks, such as scaup, bufflehead, and scoters, are generally distributed throughout the Sound and the larger inland lakes.

A large flock of snow geese and small numbers of Western Canada geese winter in the Sound–resting in open salt-water bays and feeding in or near the tidal zone. Lesser Canada geese migrate through the Sound during the hunting season enroute to eastern Washington wintering areas. These wary "honkers" provide scattered hunting in several of the larger river valleys draining the Cascade slope. Brant use virtually the entire Puget Sound Area sometime during the winter period. These small marine geese remain entirely on salt water and depend heavily on submerged eelgrass beds for survival. A few whistling swan occur in the northern part of the Area on inland waters. Common snipe, a migratory species, occur in all basins. Each year an estimated 22,400 (based on 1961-1966 period) are taken incidental to waterfowl and upland game harvest.

Waterfowl hunting in and adjacent to the Sound is a major recreational activity in fall and early winter. In addition to the numerous and varied species of ducks, snow geese and brant provide a unique hunting experience. A flock of 20,000 to 30,000 snow geese, the only major concentration of these geese found in Washington, normally winters in Skagit Bay. They are difficult to bag and are the most highly prized of the waterfowl species, but the dabbling ducks provide the most recreation. Nearly one-third of the State's duck and goose hunting occurs in the Puget Sound Area. Average annual recreational use (hunter-days) stimulated by waterfowl is indicated in Table 3-29

OTHER WILDLIFE

Numerous other species of wildlife not classed as fur animals or game inhabit the Area. This widely diverse group includes the songbirds, birds of prey, shorebirds, pelagic birds, numerous forest rodents, the insectivores (moles and shrews), as well as amphibians and reptiles. No other wildlife group is as universally available for public enjoyment or scientific study.

There is no accurate measure of present or future value of these resources (Photo 3-15). Man's use is mainly through viewing, hearing, or filming the array of colors and peculiar characteristics displayed by individual birds and animals of this group. Academic study at all education levels involving life histories, distribution, classification, and ecology is also an important use. In contrast to the esthetic value of this wildlife group the English sparrow, starling, pocket gopher, meadow mouse, mole, porcu-

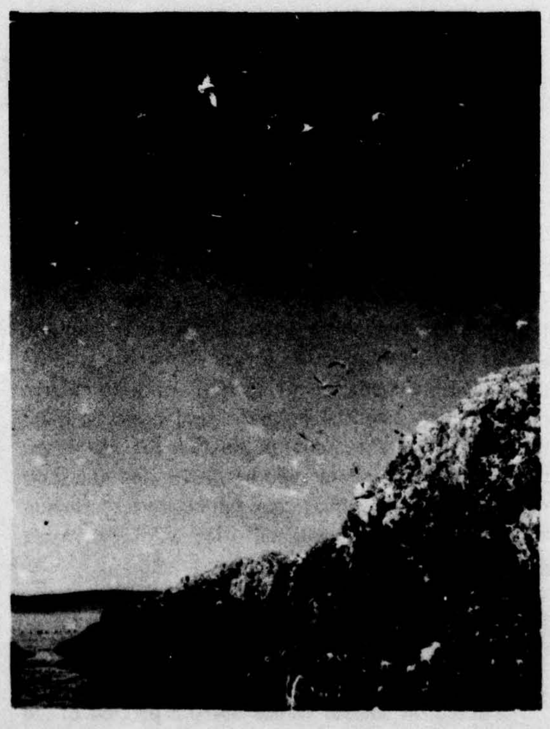


PHOTO 3-15. Island refuges support many species of colonial birdlife. (Bureau of Sport Fisheries and Wildlife photo)

pine, and the old world rats and mice exert an adverse economic impact. Damage to agricultural crops and forest reproduction by some of these species is an ever present problem.

Like game and fur animals, this group is most numerous in lowland areas, where many are closely associated with human activity. Songbirds utilize small remaining areas of natural habitat as well as modern landscaped lots within concentrated urban developments. The presence of individuals of this miscellaneous group is so taken for granted that very few people have been concerned for their survival. A species that is so few in numbers or so threatened by current circumstances as to be in danger of extinction is the American peregrine falcon. Species proposed for consideration as rare or endangered, but require additional information to determine their status, include the fisher, American osprey, (and white sturgeon). Most of the bird species are protected by State and Federal law.

Loss of habitat continues to be the major threat to maintenance of existing population levels. The elimination of natural cover to accommodate an increasing human population depletes required food and cover areas for wildlife. Shore- and marsh-dependent species are the most seriously affected by such activities. Marsh and estuarine areas are the richest in animal life, yet are the most restricted in nature. Drainage and diking projects for industrial and agricultural developments are seriously reducing such areas. Concentrated residential development along lake shores and riverbanks reduces the use of such areas by aquatic associated wildlife.

Management programs for big game, upland game, and waterfowl directly and indirectly benefit other wildlife.

FUTURE NEEDS—WILDLIFE

INTRODUCTION

The rapid development of the Puget Sound Area, accompanied by the tremendous surge in population, will have a definite impact on wildlife and its environment in the future. To satisfy wildlife demand game management agencies need to enlarge or implement essential programs and projects. More important than the actual population increase is the manner in which people will be distributed and their needs and ability to participate in outdoor recreation activities such as hunting and other wildlife-oriented recreation.

RESOURCE DEMANDS AND NEEDS

Based on current trends of 10.5 percent of the population purchasing hunting licenses, approximately 286,000 licensed hunters will reside in the Puget Sound Area in 1980. By 2000, the number is expected to increase to 452,000. This will increase to 715,000 hunters by the year 2020.

Clearly, the economic value of such wide participation will continue to be extremely significant. In order for the recreational and economic value of hunting to remain at its present level, current and future sportsmen preferences and success rates must be maintained.

Significant increases in demand are expected for individual species. Satisfaction of future needs to the year 1980 will require an additional annual harvest of 15,000 deer, 59,000 grouse, 231,000 waterfowl, and 35,000 pheasant, plus smaller numbers of bear, elk, quail, pigeon, dove, rabbit, and the various fur animals (Photo 3-16). Little used species such as diving ducks, and predator species such as bobcat, coyote, fox, and crow will play an ever increasing role in meeting the future needs for outdoor recreation by a rapidly expanding population.

In this study, need has been projected to the target years (Table 3-31), but means to satisfy needs have been determined only through 1980.

TABLE 3-31. Present hunter demand, and estimated future need and demand

Basin	Hunter–Days[1/] (1000)						
	1965	1980		2000		2020	
	Demand	Need	Demand	Need	Demand	Need	Demand
Nooksack-Sumas	74.7	69.5	144.2	89.5	233.7	54.7	288.4
Skagit-Samish	159.1	148.0	307.1	190.7	497.8	116.5	614.3
Stillaguamish	54.2	50.4	104.6	65.0	169.6	39.7	209.3
Whidbey-Camano	54.6	50.8	105.4	65.5	170.9	39.9	210.8
Snohomish	99.3	92.3	191.6	119.0	310.6	72.7	383.3
Cedar-Green	54.6	50.8	105.4	65.5	170.9	40.0	210.9
Puyallup	74.7	69.5	144.2	89.5	233.7	54.7	288.4
Nisqually-Deschutes	72.1	67.1	139.2	86.4	225.6	52.8	278.4
West Sound	128.8	119.8	248.6	154.4	403.0	94.3	497.3
Elwha-Dungeness	25.7	23.9	49.6	30.8	80.4	18.8	99.2
San Juan	49.5	46.0	95.5	59.3	154.8	36.2	191.0
Total	847.3	788.1	1,635.4	1,015.6	2,651.0	620.3	3,271.3

[1/] Do not reflect hunter-days for mountain lion.

PHOTO 3-16. Good quality habitat is a basic wildlife need. (Washington Department of Game photo)

PROBLEMS AND CONFLICTS

Problems will be created by the simultaneous increase in people and their recreational demands on the wildlife resources. The most obvious problems will be the immediate and direct conflicts with wildlife carrying capacity (Photo 3-17). Many more are subtle but equally harmful. Problems and conflicts specific to individual basins appear in respective basin chapters. The resolution of these problems will require cooperation by State and Federal wildlife conservation agencies, community planners, construction agencies, and landowners. A general listing of the most direct conflicts is as follows:

(1) Flood control, water storage, or hydroelectric developments and power peaking operations destroy wildlife habitat and reduce recreation potential.

(2) Channel and streambank rectification projects are not usually compatible with wildlife needs.

(3) Industrial and/or residential development along streams and lakeshores restricts public access to desirable hunting areas, destroys wildlife habitat, and may lower water quality.

(4) Highway and other construction projects destroy wildlife habitat.

(5) Mining operations disturb or destroy wildlife habitat.

(6) Some timber management and logging practices reduce wildlife potential and contribute to erosion.

(7) Organic, inorganic, and thermal pollution of streams, lakes, and estuaries renders habitat unsuitable for wildlife.

(8) Use of improper material for streambank protection causes water quality deterioration.

(9) Closed watersheds for municipal water supply limit outdoor recreation and realization of hunting potential.

(10) Some farming practices eliminate streambank and field "edge" cover, cause streambank erosion, and cause losses of wildlife habitat.

(11) Natural wetlands that are essential habitat for fur animals, waterfowl, and other waterbirds are being drained.

(12) Legal questions regarding agency responsibility for public access abuses threaten to curtail hunter access programs.

(13) The conservative approach by much of the general public to hunting results in underuse of renewable wildlife resources.

(14) Restriction of access reduces hunting and other outdoor recreation on private lands.

(15) Use of tidelands for agriculture, residential development, or industry seriously reduces waterfowl, fur-animal, and shorebird habitat.

PHOTO 3-17. Intensive urban and industrial developments eliminate wildlife (Washington Department of Game photo)

MEANS TO SATISFY NEEDS—WILDLIFE

INTRODUCTION

Meeting future wildlife oriented recreation needs depends upon the mutually cooperative efforts of all entities responsible for wildlife habitat protection and enhancement. A major responsibility is to conserve, protect, and perpetuate wildlife through regulations and sound continuing management programs to provide the maximum wildlife oriented recreation. The responsibility for maintaining and improving these resources of the basins for future generations to enjoy is shared with every individual and organization, and is not solely that of the agency directly charged with their management. Acknowledgement of need by planners and developers as well as an awareness and involvement by citizens will determine the future availability of these resources.

Foremost emphasis must be directed to preservation of existing habitat (Photo 3-18). Maximum potential of key wildlife areas must be realized and better use and enhancement of the resources of all areas will be required to satisfy demand. The greatest potential for wildlife as well as agricultural, urban, and industrial development lies in low elevation areas, for which there is direct competition. Forest management should be developed to maximize big-game and native upland-game production and utilization in a manner most compatible with other forest uses. Future industrial and urban development of salt-water bays must ensure preservation of marsh and key estuarine areas vital to waterfowl, shorebird, and fur-animal survival. Farming practices which retain interspersed upland-bird cover and natural stream-bank habitat should be encouraged. Hydroelectric and flood control projects which inundate key wildlife habitat must be avoided, and where the development of one resource depletes another, replacement must be provided. Conservation and enhancement of the renewable wildlife resource must be a foremost consideration in planning and management.

PHOTO 3-18. Tidelands are vital to a variety of wildlife (snow geese-center). (Washington Department of Game photo)

Access to public and private lands for wildlife observation and hunting must be an important consideration if maximum use of the resources is to be realized. The overall attractiveness of the basins can only be maintained by continued availability of high quality recreation opportunities. Leisure time activities are assuming greater importance, so planning for this use must assume a high priority.

Federal assistance in meeting future needs for wildlife would be supplied through regularly appropriated funds in the case of the land management agencies and through financial participation programs.

ESSENTIAL GENERAL CONDITIONS

Large acreages of game habitat and numerous public access areas are owned or controlled by Federal and State management agencies, but a significant portion of the current game production and hunting occurs on private lands. To meet the projected future demand on wildlife resources existing habitat must be maintained and improved. To assist in achieving this, the following general conditions must be met:

(1) Acquire and develop suitable lands for public access, habitat improvement, and artificial propagation facilities on a continuing basis.

(2) Provide for public hunting and nature-oriented recreational use of closed watersheds.

(3) Acquire and develop key habitat for big game, waterfowl, fur animals, and upland game.

(4) Develop programs integrating habitat improvement with other land uses and developments.

(5) Acquire right of entry for hunting on private lands through cooperative programs with landowners.

(6) Effect legislation to control unrestricted development and preserve the quality and outdoor recreation potential of estuaries, flood plains, and tidelands.

(7) Preserve remaining wetland areas.

(8) Expand wildlife observation programs.

(9) Expand propagation facilities for wildlife commensurate with demand.

(10) Include wildlife-oriented recreation as an integral part of Area planning for urban and industrial expansion.

(11) Control all types of pollution.

(12) Coordinate logging practices with wildlife needs.

(13) Use water resources more efficiently and establish and enforce minimum flow standards for wildlife resource protection.[1]

(14) Coordinate construction, development, and channel alteration projects with wildlife needs.

(15) Conduct research to determine the most effective and feasible means to improve wildlife habitat, hunting, and trapping.

(16) Readjust hunting and trapping regulations to increase harvest where wildlife populations warrant.

(17) Emphasize teaching of modern wildlife conservation principles in schools. The renewable aspect of wildlife resources must be stressed to promote adequate harvest and maintain healthy wildlife populations through habitat preservation.

(18) Establish green belt zoning plans to protect critical ecological areas.

(19) Encourage farming practices which maintain wildlife cover and other essentials of wildlife habitat.

(20) Conduct further biological and hydrological studies of the estuarine-tideflat-adjacent land complex to determine protective resource measures, how such measures help meet future demand, and the resource interrelationship with future municipal and industrial development.

PLANNED DEVELOPMENTS

Most of the hunting and trapping in the Puget Sound Area occurs on private land. Present trends indicate that while the total acreage of private land will remain fairly constant, the average size of individual ownership tracts will become smaller. Areas of land now used for hunting may become rural or urban homesites on small (5 to 10 acre) acreages. Past experience has shown that with this small ownership pattern, people seek to attract various forms of wildlife, principally for their esthetic values.

While the total acreage devoted to wildlife declines under this type of ownership, the intensity of management may increase. This could result in an overall population increase for non-hunted species having a short mobility radius and a high tolerance to man.

[1] Reference to the interrelationship of water quality standards and wildlife resources and habitat appears in the Introduction section, Means to Satisfy Needs–Fish chapter.

Demands for land will soon put many waterfowl hunting areas into competition with industry and housing developments. As competition increases and land prices escalate, many hunting areas may disappear; thus putting more hunting pressure and demands on remaining areas. To satisfy the demand for more hunting on less land, intensive management, including food plantings and water-level controls, will be undertaken.

Table 3-32 indicates need in hunter-days by basin, and enhancement estimated to result from publicly-financed projects and programs for wildlife proposed to help satisfy needs. It is obvious from the table that to satisfy needs for 1980 either hunter success, that is, game kill per hunter-day, must be lowered, more hunters must leave the basins to hunt, or projects and programs to enhance hunter use must be expanded beyond the point envisioned here. It is doubtful that program expansion is economically feasible under present standards for evaluating wildlife use, and with spiraling land and development costs.

TABLE 3-32. Satisfaction of need for hunting, pre-1980

	Hunter–Days (1000)		
Basin	Need	Enhancement 1/	Difference
Nooksack-Sumas	69.5	59.8	- 9.7
Skagit-Samish	148.0	102.7	-45.3
Stillaguamish	50.4	27.3	- 23.1
Whidbey-Camano	50.8	42.0	- 8.8
Snohomish	92.3	62.7	-29.6
Cedar-Green	50.8	43.9	- 6.9
Puyallup	69.5	49.9	-19.6
Nisqually-Deschutes	67.1	66.4	- .7
West Sound	119.8	87.0	-32.8
Elwha-Dungeness	23.9	22.5	- 1.4
San Juan	46.0	42.5	- 3.5
Totals	788.1 (788)	606.7 (607)	-181.4 (-181)

1/ From measures indicated in the General Programs and Specific Programs and Projects sections.

A relatively larger spread between demand (need) and supply (enhancement) will probably occur in subsequent periods, but plans have not been formulated beyond 1980.

Puget Sound is a primary migration and wintering area for waterfowl and other migratory birds of the Pacific Flyway. The varied habitats of the Sound provide seasonal requirements for these birds; therefore, it contributes to hunter use and other outdoor recreational use that occurs elsewhere in the flyway. Preserving strategically-located and dwindling habitat is of prime consideration and is an integral part of present and future management plans. Acquisition would prevent destruction of existing habitat, provide for additional habitat development, afford opportunities to accommodate larger numbers of ducks, geese, and other migratory birds, and provide additional areas for all forms of nature-oriented recreation.

The Bureau of Sport Fisheries and Wildlife has conducted preliminary studies of several areas important to ducks, geese, brant, and shorebirds. The areas possessing significant resource and habitat preservation and development potential are: Nisqually Flats (Nisqually-Deschutes Basins), Port Susan (Stillaguamish and Snohomish Basins), Padilla Bay (Skagit-Samish Basins), Samish Bay (Skagit-Samish Basins), Elk Marsh (Nooksack-Sumas Basins), and Union Bay and Indian Island (West Sound Basins). All areas studied possess valuable migratory bird habitat, and provide hunting and other nature-oriented recreation.

As part of a long-range acquisition program, current management plans are to acquire and develop a minimum of 4,000 acres in the above designated areas prior to 1980 at an estimated cost of $2 million. Immediate development is not envisioned for some lands, such as various State-controlled tidelands, which can support waterfowl use in an undeveloped state. The primary need is to acquire the desired acreage–development of such lands, if necessary, can be accomplished at a future time. Certain lands acquired would be farmed for waterfowl food production. Others would serve to reduce crop depredations on adjacent agricultural areas. Acquisition and development costs are considered part of the overall estimates for waterfowl projects and programs in the Puget Sound Area. Basin chapters define individual measures.

Nisqually Flats and its ecological and biological features, considered for possible inclusion into the National Wildlife Refuge System, are highly significant. Therefore, future resource planning emphasized that steps should be taken to safeguard the Nisqually River delta, the only unspoiled estuarine area remaining in southern Puget Sound. The flats are an important stopping point between Skagit Flats and the Columbia River lowlands for waterfowl. Measures other than land acquisition include consideration of the fact that county and local planners through flood plain management and resource zoning could aid in preserving this unique area. It could be zoned for agriculture and certain related uses. This land use classification would avoid costly land acquisition yet preserve many of the ecological values important to fish and wildlife resources, as well as those involving open space, esthetics, and outdoor recreation.

Similar consideration should be accorded the other areas studied and an appropriate action program developed for each.

Another area investigated by the Bureau of Sport Fisheries and Wildlife was Ebey Island (Snohomish Basin). Because of its proximity to Everett, this area has good potential for nature-oriented recreation and could increase benefits to waterfowl resources of the Pacific Flyway. Further study would be required to define specific protective and enhancement measures to meet anticipated future demand.

Hunter-day benefits have not been assigned to these various waterfowl development proposals but, if realized, such use will satisfy some of the future need. Future Bureau plans, concerning waterfowl needs in 2000 and 2020, are not known at this time.

The following national wildlife refuges are currently under study to determine the possibility of their inclusion in the National Wilderness Preservation System: Smith Island (Whidbey-Camano Islands), Matia Island (San Juan Islands), Jones Island (San Juan Islands), and certain satellite units of the San Juan (San Juan Islands, Skagit-Samish Basins). This could alter their future status and development proposed for them.

The U.S. Forest Service, as part of the multiple-use concept, has programmed wildlife habitat management work on lands under its jurisdiction. Benefits from these projects and programs have not been estimated in hunter-days, but such use will help meet needs for wildlife shown in Table 3-32. The following tabulation (Table 3-33) indicates projects and programs under consideration by the Forest Service for the development period.[1]

[1] Projects and programs are in addition to Forest Service proposals contained in other appendices.

TABLE 3-33. Proposed wildlife enhancement projects and programs of U.S. Forest Service

		1980		2000		2020	
Project or Program	Unit	Amount	Capital Cost	Amount	Capital Cost	Amount	Capital Cost
Surveys and Plans							
Conduct Range analysis							
Deer	acre	670,660	$ 67,300	Survey and planning work is not			
Elk	acre	249,160	25,000	carried forward to these time periods.			
Mountain goat	acre	394,770	39,400	Similar work here is probable.			
Special	acre	12,010	1,300				
Conduct upland-game habitat surveys	acre	900,000	45,000				
Develop habitat management plans	each	90	45,000				
Subtotal			$223,000				
Big-game Habitat Improvement							
Seed and plant forage	acre	6,955	$ 695,500	5,835	$ 583,500	5,710	$ 571,000
Release forage	acre	2,970	74,300	5,750	143,700	2,880	72,000
Create permanent openings	acre	1,810	181,000	8,270	827,000	6,620	662,000
Subtotal			$950,800		$1,554,200		$1,305,000
Waterfowl Habitat Improvement							
Construct shallow impoundments	acre	80	$ 61,000	--	-	-	-
Develop food plantings	acre	20	2,000	--	-	-	-
Develop nesting facilities	each	220	11,000	160	$ 8,000	-	-
Subtotal			74,000		$8,000		
Total			$1,247,800				

GENERAL PROGRAMS

Large amounts of game habitat are unavailable to hunters, or not used to full capacity. These include private farm- and timberlands, municipal water-supply watersheds, and tidelands. Opening these lands to hunting would provide large benefits from both naturally-produced and released game at reasonable cost. Many areas not now under private hunting lease could probably be opened under cooperative agreement between owners and the Washington Department of Game. Such agreements would provide access for hunting, and other wildlife-associated recreation, in return for hunter control and insurance against vandalism. Similar cooperative programs requiring preservation of key habitat could be carried out on a subsidy or donation basis. Benefits from the above programs are estimated at 58,200 hunter-days annually, valued at $232,300 by 1980. Costs are estimated at $41,000 annually.[1]

Wildlife is a renewable resource, and may usually be cropped on an annual basis if managed for its highest return. Large benefits in increased hunter use may be obtained if the public can be educated to this concept, and game managers are allowed to set seasons, limits, and other regulations that will produce the highest return from the resource. An educational program to encourage this would cost an estimated $50,000 and would result in about 291,600 hunter-days, valued at $1,498,000 annually by 1980.

Wildlife research is needed in several fields including habitat improvement, development of more efficient census techniques, and development of compatible forest-wildlife programs. This research would cost an estimated $115,000, and would be essential if indicated values from other projects and programs are to be realized.

Further studies of the estuarine-tideflat-adjacent land complex in Puget Sound vital to wildlife, fish, and associated marine animal and plant life are essential. Such studies are necessary to determine additional protective measures for these resources and their habitat, how such measures can help fulfill future demand, and the interrelationship of these resources and future industrial and municipal development of this complex.

[1] Washington Department of Game cost figures do not include estimated expenditures for investigations, surveys, and plans.

The investigations, by category, include the following tasks:

Biological

(1) determine wildife (and fish) habitat areas of primary importance needed to maintain and increase present population levels.

(2) determine the relationship of intertidal areas to the productivity of the open waters.

(3) determine seasonal populations of aquatic flora and fauna of different ecological areas.

(4) determine the degree to which certain selected wildlife (and fish) species and the respective food chains depend upon the estuarine and marine environment.

(5) determine rates of oxygen reduction and effects on key species of animals and plants produced in the various ecological areas.

Hydrological

(1) determine circulation, flushing, and tidal transport patterns.

(2) determine sediment loads and deposition and scouring patterns within the estuarine areas.

(3) improve understanding of fresh- and salt-water interrelationships.

The somewhat limited areas involved, coupled with the many values—biological, recreational, historical, ecological, scenic, educational, economic—amply justify such studies. Costs of conducting these investigations, which are similar to and interrelated with those listed in the chapter Means to Satisfy Needs—Fish, under Salmon, Marine Fish, and Shellfish, are unknown. Primary study justification appears in the fisheries chapter indicated.

SPECIFIC PROGRAMS AND PROJECTS

Proposals for the pre-1980 period call for purchase and development of 34 salt-water access areas. These areas would be acquired primarily for fishing, and costs are assigned to that function, but many of them would be used by hunters and incidental benefits of an estimated 35,800 hunter-days annually valued at $180,000 would accrue.

The amount of big-game winter range limits animal numbers. Since it lies at relatively low elevations, it is subject to loss from water development projects, improper logging, construction of homes and industries, and other factors. In some areas proper management of this key habitat can serve to increase big-game numbers over wide ranges. Acquisition of one winter range area for elk is proposed before 1980. Cost of acquisition is estimated at $190,000 and the estimated annual benefit would be 9,300 hunter-days, valued at $55,700.

Demand for upland-game hunting in the Puget Sound Area is much higher than the supply so it is necessary to supplement natural production with game farm birds (Photo 3-19). To increase natural production, furnish hunting area, and provide release sites for game farm birds, acquisition and development of seven strategically located upland-game bird habitat development areas are proposed. These areas would average 600 acres each in size. Capital cost for the seven areas is estimated at $1,332,000 and annual benefits, 53,600 hunter-days, valued at $214,500.

PHOTO 3-19. Game farms increase upland game production and assure continued hunter benefits. (Washington Department of Game photo)

To satisfy needs for upland game will require expansion of existing game farms and development of new facilities. Capital cost of this expansion would be an estimated $800,000. Annual benefit would be an estimated 38,900 hunter-days valued at $155,800, in addition to benefits included under other projects and programs.

Band-tailed pigeons congregate at mineral springs and favorite feeding and roosting areas. Most of this habitat is privately owned, thus subject to destruction, and a relatively small amount is open to public hunting. Acquisition and development of key habitat, coupled with better hunting regulations, would produce benefits estimated at 30,600 hunter-days annually, valued at $132,800. Capital cost is estimated at $650,000.

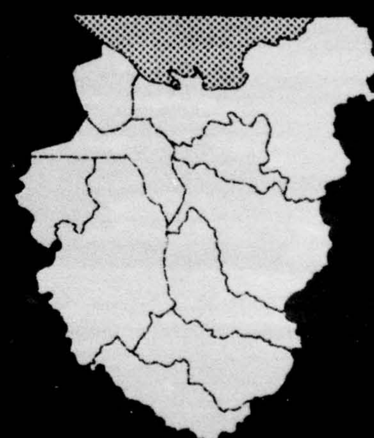
Drainage and filling of wetlands for industrial, agricultural, and other purposes have accelerated in recent years, and loss of waterfowl habitat is expected to continue in the future. Much of the better habitat is leased by private individuals or clubs for members-only hunting and is not accessible to the general public. Acquisition and development of key habitat are proposed for conservation of waterfowl stocks, and to provide public hunting. An estimated 20,000 acres would be acquired and developed by 1980 at a cost of $11,315,000. The benefit is estimated at 186,200 hunter-days annually, valued at $927,900.

Incidental benefit to fur animals will result from many of the above projects and programs. The specific effect on future trapping and wild fur harvest, however, has not been estimated due to the many factors which influence trapper effort. Domestic fur production is expected to continue to supply the garment industry with a large portion of its needs.

Retention of fur-animal habitat and a significant wild fur-bearer population is an essential item in Area environment. The nonconsumptive value of these animals, including academic study, will become increasingly significant.

Potential beneficial developments for big game, upland game, and waterfowl would directly or indirectly benefit other wildlife, as well as one or more of the major wildlife groups. For example, acquisition and development of key habitat for waterfowl would help fulfill essential food, cover, and production needs of aquatic fur animals, upland game, and other wildlife. No specific programs for this latter wildlife group have been determined.

Nooksack-Sumas Basins



NOOKSACK—SUMAS BASINS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Nooksack River and its tributaries comprise the largest river system in these two Basins (Figure 4-1). In addition, nine smaller independent drainages enter Puget Sound. Nonstream fresh waters include 144 lakes and reservoirs (7,900 surface acres) and about 233 farm ponds (117 surface acres). These systems provide suitable spawning and rearing area for anadromous and resident fishes, and each contributes to the specific ecological makeup of estuarine and marine waters at its confluence with salt water. Portions of the Sumas and Chilliwack River drainages, part of Canada's Fraser River system, extend into these Basins, and upper reaches of Fishtrap and Bertrand Creeks, both Nooksack tributaries, lie in Canada. Fishery management includes the United States' sectors of the Sumas and Chilliwack systems.

Salt-water areas important to the marine fish and shellfish resources include Bellingham, Chuckanut, Samish, Birch, Semiahmoo, and Boundary Bays, Drayton Harbor, and the open waters. Each of these areas, plus the beaches and bays of Lummi and two smaller nearby islands, provides environment necessary to support the great variety of marine life present.

The Nooksack River system has three principal forks, each originating on the high slopes of the Cascade Range. Upper reaches of the North, Middle, and South Forks feature pool and riffle areas as well as rapids and cascades. At lower elevations, these streams present a moderate gradient, broad riffles and, in certain reaches, divided channel areas highly suitable for fish production. Flowing westward through mostly steep, heavily-forested terrain, the North and Middle Forks converge on a relatively broad valley floor about 5 miles upstream from the community of Deming, forming the mainstem Nooksack. The South Fork confluence is 1.5 miles upstream from Deming. The Nooksack features numerous broad riffles, divided channels, and moderate gradient, coupled with gravel and flow conditions essential to spawning fish. The Lummi River, presently a high water channel, leaves the Nooksack about 3 miles upstream from its mouth and enters Lummi Bay.

The upper sectors of the Sumas and Chilliwack River systems are predominantly lowland streams with meandering pool and gravel riffle character highly suitable for fish production.

Independent drainages are formed by springs, headwater lakes, or surface runoff from partially-timbered hillsides. They exhibit varying amounts of pool-riffle area, coupled with moderate gradient.

Lakes range from the generally larger, warmer lowland waters to the small, cold, high-mountain types. Lake Whatcom, located just east of Bellingham, is the largest, encompassing more than 5,000 surface acres and offering the greatest variety and extent of shallow and deep water environments. Lake Terrell is the second largest, presenting about 450 surface acres of mostly shallow water habitat.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in fair to good numbers throughout the Basins.

Anadromous Fish—Five Pacific salmon utilize the Nooksack-Sumas drainages. They include chinook, coho, pink, chum, and sockeye. Anadromous game fish inhabiting the streams are steelhead and searun cutthroat trout, and searun Dolly Varden. These fish migrate, spawn, and rear in some 89 miles of the river including portions of the North, Middle, and South Forks, and 79.1 miles of tributaries (Figure 4-1). Only coho and chum salmon inhabit the smaller, independent drainages while all of these streams support spawning runs of the three trout. The accessible reaches provided by these independent drainages total approximately 94 miles. Coho salmon, steelhead, and searun cutthroat trout also spawn and rear in portions of the Sumas River for approximately 13 miles within the Basin. Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

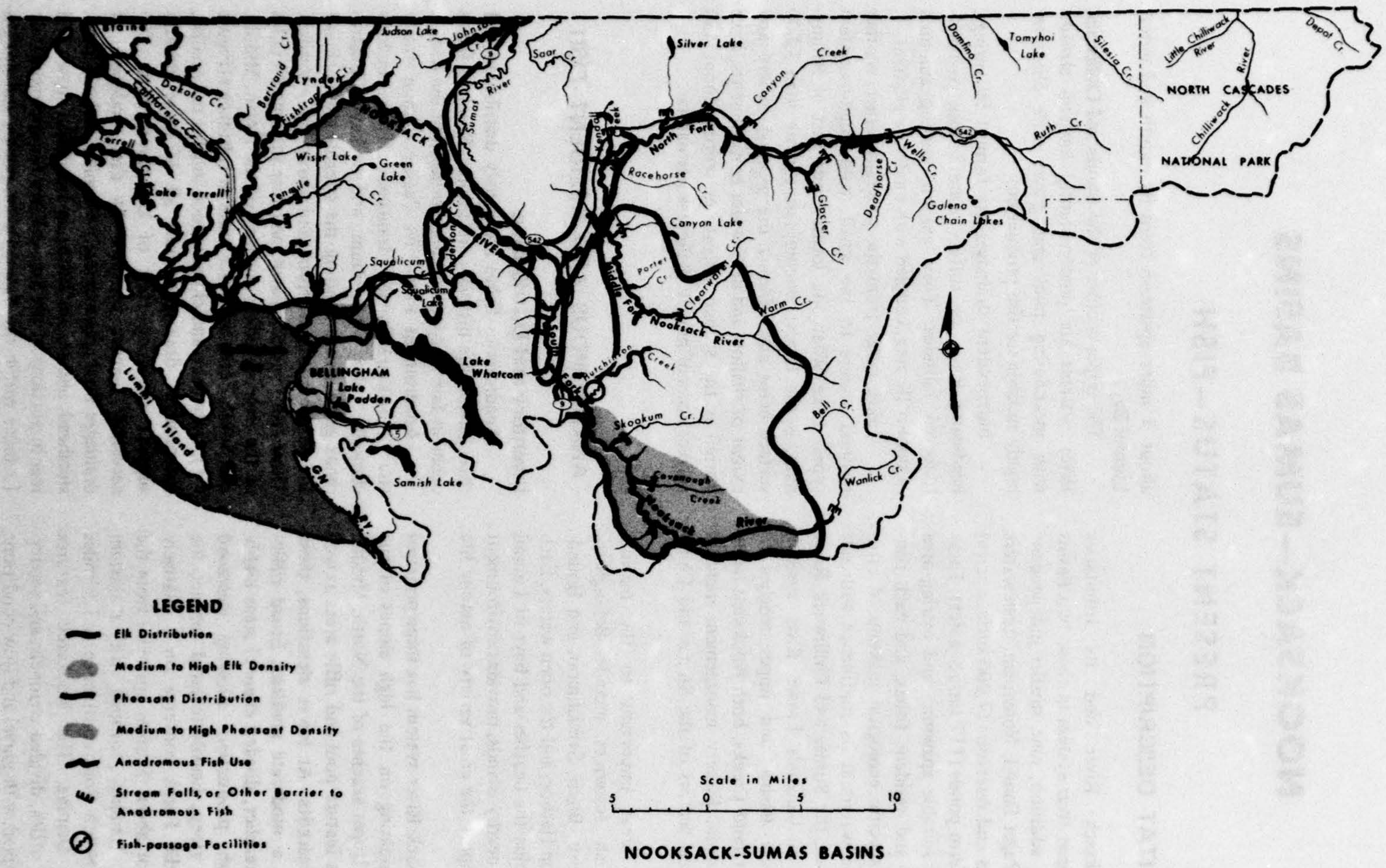


FIGURE 4-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

Upstream migration timing overlaps considerably, as shown in Table 4-1. Adults of one or more species enter the systems every month.

During the summer, May through August, the early running species remain in deep holes enroute to their spawning grounds.

Spawning chinook salmon utilize various sections throughout the accessible length of the North, Middle, and South Forks, and portions of the mainstem Nooksack. In the North Fork, chinook spawn on riffles and in side channels from the Excelsior Powerhouse, near Wells Creek, downstream 23 miles to the Middle Fork confluence. The lower 7 miles of the Middle Fork, downstream from the city of Bellingham Diversion Dam near Clearwater Creek, are used by chinook spawners. The lower 23 miles of the South Fork mainstem, downstream from the falls, support moderate numbers of summer and fall chinook. The upper 10-mile section is used principally by spring chinook. In the mainstem Nooksack, downstream from the North and Middle Fork confluence, chinook spawn to within 1 mile of Bellingham Bay.

Nooksack River tributaries inhabited by chinook spawners include, in downstream order, Glacier, Cornell, Canyon, Maple, Kendall, and Racehorse Creeks on the North Fork; Porter and Canyon Creeks on the Middle Fork; Skookum and Hutchinson Creeks on the South Fork; and Fishtrap and Bertrand Creeks on the lower Nooksack.

Virtually no chinook spawning occurs in basin drainages other than the Nooksack River system, since each of these streams exhibits very low flows during the adult migration period. Limited, but highly important, rearing occurs in all estuaries.

All accessible streams are utilized by coho salmon. Nooksack River tributaries serve as principal coho spawning grounds. In addition, coho spawning occurs in the mainstem Nooksack and in each of its forks, particularly in areas where channel splitting creates smaller watercourses providing more suitable spawning conditions. Such areas are present throughout much of the North Fork, along most of the lower Middle Fork, and in intermittent sections of the lower South Fork and upper mainstem Nooksack. Coho spawning in the independent drainages is generally quite restricted, due to limited spawning material.

Pink salmon spawning occurs almost exclusively in the mainstem Nooksack. Nearly every accessible tributary receives some use; those that enter the upper North Fork support the heaviest spawning concentrations. Pink salmon also spawn on the riffles and in side channels of the mainstem North Fork, in portions of the lower Middle and South Forks, and in the Nooksack. Some of the more important spawning tributaries include Deadhorse, Cascade, Thompson, Gallop, Cornell, Canyon, Wildcat, Maple, and Kendall Creeks on the North Forks, and Hutchinson Creek on the South Fork. Small numbers of spawning pink salmon occur in drainages other than the Nooksack River, however, no established runs are known.

Nearly all the streams receive spawning chum salmon. In the Nooksack River system, these fish utilize the river, the three forks, plus tributary streams as far upstream as Cornell Creek on the North Fork, Porter Creek on the Middle Fork, and Hutchinson Creek on the South Fork. The majority of spawning occurs on riffles and in side channels of these forks and in the Nooksack to within 1 mile of Bellingham Bay. Other drainages receive small to moderate chum runs annually.

At least one section of the Nooksack system supports a small run of sockeye salmon. It is a half-mile-long side channel of the North Fork, located 3.5 miles upstream from the town of Glacier. Other stream sections, and some tributaries, in both the North and South Fork Nooksack, also receive limited sockeye runs.

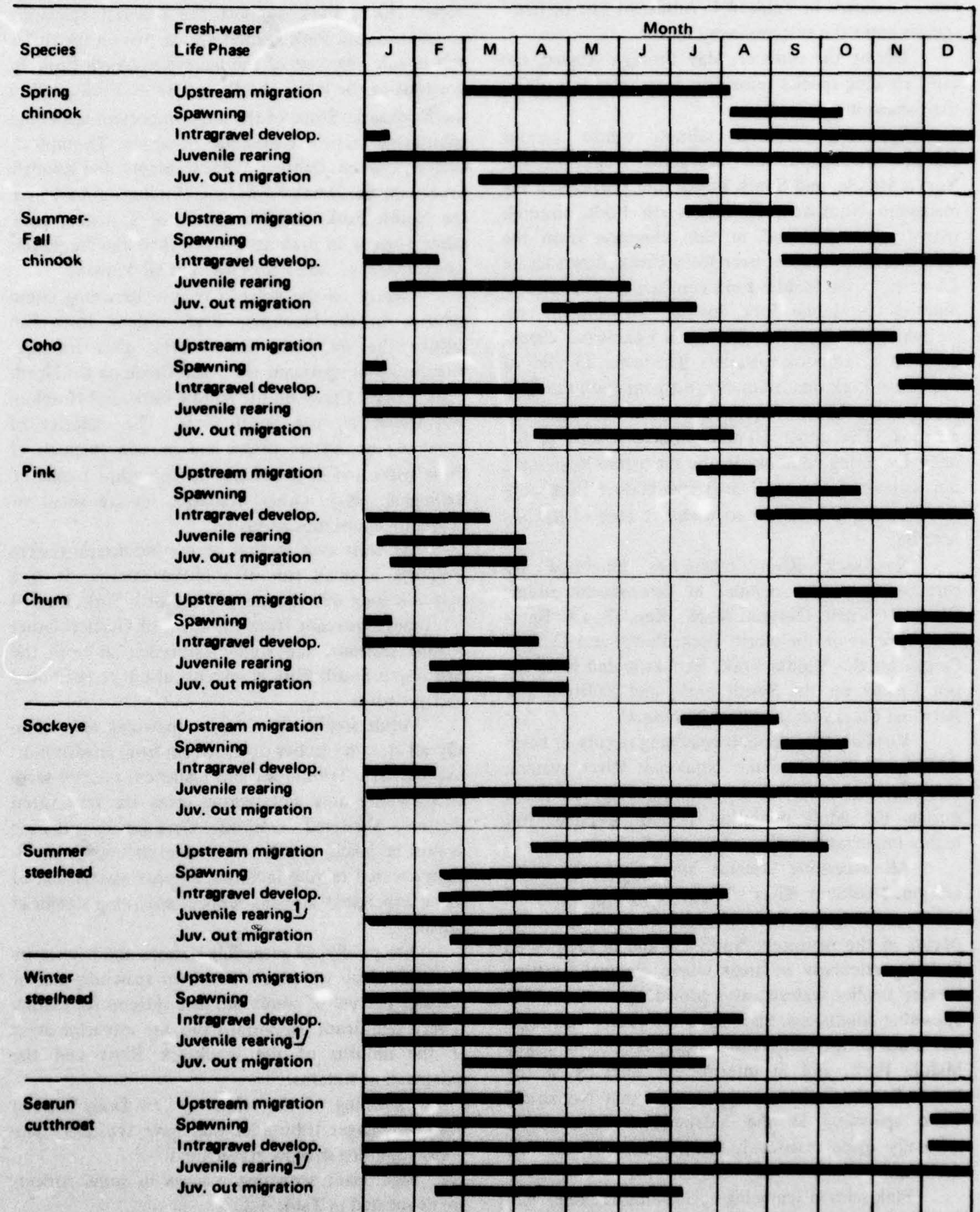
Adult steelhead utilize as spawning area virtually all stream reaches downstream from anadromous fish barriers. Tributaries and mainstem reaches serve as spawning area and rearing areas are very often shallow, sheltered sections. Occasionally, rearing occurs in lakes, ponds, or in semi-natural or artificially-created rearing facilities. Approximately half of the independent streams support spawning steelhead runs.

Essentially, all accessible streams and tributaries are utilized by searun cutthroat for spawning and/or rearing. The use of ponds and lake systems for rearing is very significant. Important too, are estuarine areas at the mouths of the Nooksack River and the independent streams.

Spawning of the relatively few Dolly Varden occurs in larger tributaries that have typically deep pools adjoining shallow gravel areas.

Significant spawning reaches in some streams are delineated in Table 4-2.

TABLE 4-1. Timing of salmon and searun trout fresh-water life phases in Nooksack-Sumas Basins



1/ Normally extends over a two-year period.

TABLE 4-2. Significant spawning reaches for anadromous fish and resident game fish, Nooksack-Sumas Basins[1]

Stream	Section	Stream Mileage	Type of Spawning Area
Nooksack R.	Point near mouth to Nugents Br.	1.0-26.0	Occasional riffles, few channel splits
	Nugents Br. to S. Fk.	26.0-32.0	Many broad riffles and long glides
	S. Fk. to M. Fk.	32.0-35.0	Many riffles, considerable channel splitting
North Fork	M. Fk. to Glacier	0.0-16.0	Many riffles, much channel splitting
	Glacier to Nooksack Camp (USFS)	16.0-20.0	Intermittent patch gravel, few riffles
	Nooksack Camp to Excelsior Powerhouse	20.0-22.0	Many riffles, occasional side channels
Middle Fork	Mouth to Mosquito Lake Road Br.	0.0-4.5	Many broad riffles and glides, much channel splitting
	Mosquito Lake Road Br. to Diversion Dam	4.5-6.5	Few riffles, some patch gravel
South Fork	Mouth to Acme	0.0-8.0	Many broad riffles and long glides, few channel splits
	Acme to Cavanaugh Cr.	8.0-15.0	Many riffles and glides, occasional side channels
	Cavanaugh Cr. to falls	15.0-29.0	Few riffles, some patch gravel, little channel splitting

[1] Additional spawning area is provided by virtually all tributaries entering within described reaches.

Intragravel egg development occurs over an 11-month period, because of the overlapping spawning time of various species.

"Out migration" for all species occurs mainly during the period February-June, corresponding with high spring runoff. Some intrariver migration occurs during other months, but this is primarily a natural redistribution of juvenile salmonids within the stream systems. Certain downstream migrants spend considerable time in fresh water and in the highly important acclimation areas of the estuaries. The juvenile salmonids, after adjusting to the salt-water environment, disperse into the Strait of Georgia, the Strait of Juan de Fuca, and the ocean.

Estimated numbers of anadromous fish produced within basin waters and surviving to return as spawners are presented in Table 4-3.

Resident Fish—Resident fish spawn and rear upstream and downstream from anadromous fish barriers (Table 4-2). Rainbow trout occur in measurable numbers in half of the streams. Most of the streams are not typical rainbow waters since they are small, however, they are fast flowing and have suitable temperatures.

Suitable habitat is afforded cutthroat trout in most of the streams and these fish maintain near-optimum populations in waters upstream from anadromous fish barriers. Streams at higher elevations, especially North Fork tributaries, support sizeable populations of brook trout. The only lower-elevation stream where these fish are found is Hutchinson Creek. Dolly Varden occur primarily within the Nooksack River.

TABLE 4-3. Anadromous fish spawning escapement, natural and (artificial), in Nooksack-Sumas Basins

Species	Range[1]	Average (Annual)
Chinook	420-2,390 (520-850)	1,260 (650)
Coho	1,850-14,820 (1,740-3,200)	7,410 (2,110)
Pink	12,500-150,000	73,130[2]
Chum	14,260-145,380	54,860
Summer steelhead[3]	20-120	70
Winter steelhead[3]	4,300-5,600	4,900
Searun cutthroat[3]	23,800-30,200	26,600
Searun Dolly Varden[4]		

[1] Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

[2] Per odd-year escapement.

[3] Totals include natural and (artificial) escapement.

[4] No valid totals established.

Kokanee inhabit several of the larger lakes and spawn in inlet streams. Brannian Creek, tributary to Lake Whatcom, is a typical example. Mountain whitefish are present in sizeable numbers in the Nooksack system and independent systems. Largemouth bass, yellow perch, black crappie, pumpkinseed, and brown bullhead are abundant in many of the lowland lakes and are entirely self-sustaining.

Less desirable fishes, including suckers, sculpins, dace, and threespine sticklebacks generally are scattered throughout many of the inland waters. Sticklebacks are most common in Silver, Fishtrap, and California Creeks, and Johnson Creek of the Sumas River system. Sculpins are most frequent in Smith Creek, Lake Whatcom tributary. Shiners have become established only in Ten Mile Creek. Suckers occur throughout the Basins' lakes and large streams.

Production

A major water diversion project on the Middle Fork Nooksack River restricts the fish production potential of that stream. Average stream production per surface acre within the South Fork drainage is considerably higher than that of either the North Fork, Middle Fork or mainstem Nooksack. Their reduced production is caused by headwaters contributing glacial silt and extremely cold water during the summer growth season. The independent drainages and lower elevation tributaries are also considerably more productive.

Based on a 1966 stream survey, production varied from essentially zero to over 750 pounds of fish per surface acre. The average was 218 pounds. Salmonid populations equalled 200.5 pounds per surface acre, while other or undesirable species excluding lampreys comprised the remaining 17.5 pounds.

Anadromous Fish–Total salmonid production depends largely on levels of natural spawning and rearing success. The relatively good quality and generally undisturbed character of much of the aquatic habitat promote such success, particularly from the North Fork.

The Basins are a productive winter steelhead area and the South Fork also contributes significant numbers of summer steelhead. Steelhead production approaches the natural potential. During 1962-1966, the average annual natural production of steelhead approached 7,400 adults. Estimates indicate that summer steelhead contributed approximately 10 percent of this total. Potential natural production is anticipated to be somewhat greater than the current number of steelhead produced.

Production of searun cutthroat trout is substantial; the average annual production is calculated at 35,400. Potentially greater numbers of this important fish could be produced.

Fish production data are shown in Table 4-4.

TABLE 4-4. Anadromous fish natural production (harvest plus escapement), Nooksack-Sumas Basins

Species	Range[1]	Average (Annual)
Chinook	1,680-9,560	5,040
Coho	9,250-74,100	37,050
Pink	37,500-450,000	219,390
Chum	28,530-290,760	109,720
Summer steelhead	40-190	100
Winter steelhead	6,400-8,400	7,300
Searun cutthroat	31,700-40,200	35,400
Searun Dolly Varden[2]		

[1] Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

[2] Production limited and therefore not determined.

Resident Fish–Most streams upstream from anadromous fish barriers are cold, small, precipitous, and are producing their natural potential. Often, their recruitment originates in headwater lakes or ponds and on occasion from trout liberations. Exceptions are those streams originating from glaciers on Mount Baker. The average yield of streams sampled (exclusive of lampreys) was usually less than 29 pounds per surface acre. Less than 10 percent of this total was competitive fish, most frequently sculpin.

Stream reaches downstream from migration barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, there is no distinction between production of resident and anadromous game fish. The average standing crop produced (which did not include hatchery fish) varies between 29 and 770 pounds per surface acre, with higher production occurring in tributaries and independent drainages.

Because lake and pond habitats are planted frequently and managed for salmonids and/or spiny rays, production data are indicated in the Harvest section. Total harvest of certain standing waters varies from one season to another and may vary from less than 10 to nearly 100 pounds per surface acre annually. Potential production could be substantial.

The farm ponds managed for trout produce enough natural food annually for about 100 pounds of trout per surface acre. Potentially, production could be increased.

Propagation

The State maintains the Nooksack Salmon Hatchery on Kendall Creek (Figure 4-2). The station

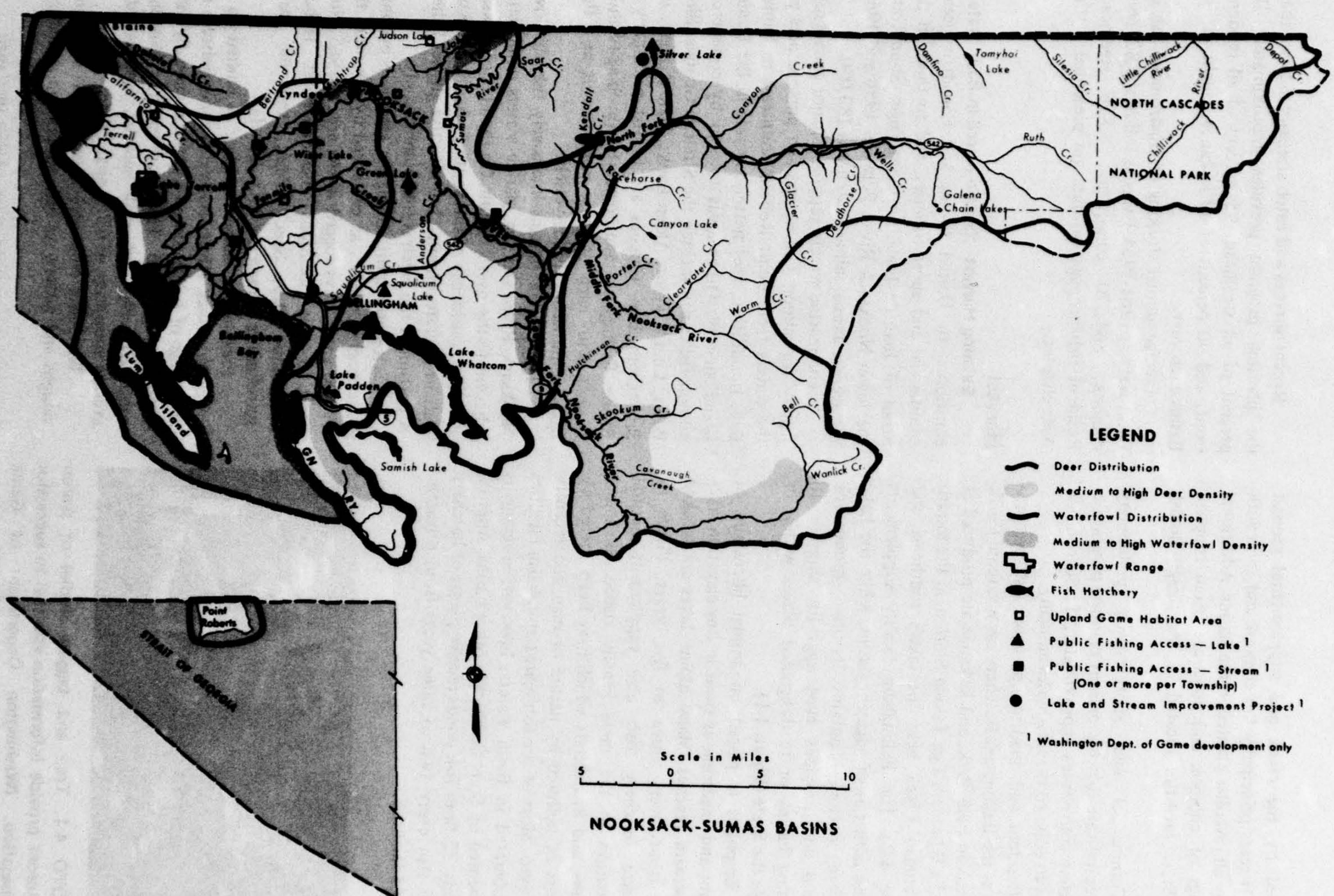


FIGURE 4-2. Wildlife distribution, and fish and wildlife developments (1965)

is served by the creek and supplemental ground water. It rears principally fall chinook and coho with virtually all juveniles planted in the Basins. Additional plantings of chinook and coho are often supplied from State facilities located in the Skagit-Samish Basins.

Commercial and sport catch preliminary statistics indicate that the present planting program in the Basins contributes approximately 1,950 chinook and 8,440 coho to these fisheries annually.

Resident and anadromous game fish are produced at the Bellingham Hatchery on Whatcom Creek in Whatcom Falls Park, and kokanee are produced at the Lake Whatcom Egg Taking Station, at the mouth of Brannian Creek near the lake's southeast end (Figure 4-2). The Bellingham facility supplements planting activities of adjacent basins, while the Lake Whatcom station maintains its own broodstock program and provides eyed eggs for shipping to adjoining basins or to designated places within or outside the State (Photo 4-1).

Emphasis is placed on annual liberations of resident and anadromous trout in low elevation lakes and stream reaches. Many alpine lakes are stocked with trout every three to five years. Plants of legal-size hatchery fish also supplement natural production in the most heavily fished lakes and streams, and in habitats which have been altered by barriers or polluted by nature or man. and recently improved. Most of the fish reared at in-basin facilities are liberated in Basin waters, however, stocking is augmented by State facilities in other basins. Approximately 72 farm fish ponds receive plants of hatchery game fish every two to three years from privately-owned facilities.

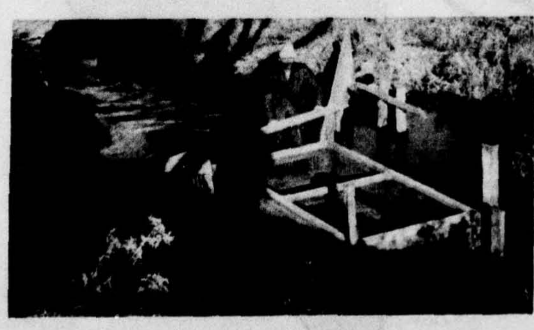


PHOTO 4-1. Trap and tagging studies of searun cutthroat provide information essential to successful propagation. (Washington Department of Game photo)

Recent surveys and catch statistics indicate that the planting program provides approximately 10 percent of all steelhead, 95 percent of all resident trout, and 90 percent of all kokanee caught in the Basins each year.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 2,827,990 chinook; 864,270 coho; and 8,856 steelhead. Resident fish propagation data are presented in the Area chapter.

Harvest

Existing Harvest—Salmon reared in Basin waters contribute to United States and Canadian ocean commercial and sport fisheries, and to those in the Strait of Juan de Fuca, northern Puget Sound, and the lower Nooksack River. Between 1956 and 1965, the average annual salmon catch was 183,090.

The marine waters support a major commercial fishery for salmon. Gill netters and purse seiners ply the waters from Point Roberts southeast to Samish Bay. In addition, reef netters operate in the Lummi Island vicinity. Other areas favored by commercial salmon fishermen include the Strait of Georgia, Birch Point, Cherry Point, Alden Banks, Hale Passage, and Bellingham Bay. Catches are landed principally at Blaine, Bellingham, and Anacortes (in Skagit-Samish Basins), with each of these ports serving as a fleet base for numerous fishing vessels.

The Lummi Indians intensively fish the lower Nooksack River and the marine waters immediately adjacent to the river's mouth. On the upper Nooksack near the confluence of the South Fork, the Nooksack Indians operate a limited but effective gill net fishery. A portion of the catch is sold commercially.

Salt-water sport fishing for salmon is becoming increasingly popular, as evidenced by the more than 19,000 angler-days logged in the area in 1965. Noted sport fishing locations include Point Roberts, Chuckanut Bay, Sandy Point, and the waters surrounding Lummi and Eliza Islands.

Fresh-water salmon angling is limited to the lower Nooksack River. Harvest records indicate that an average of 1,350 salmon was taken annually during 1964 through 1966. This sport catch, consisting of coho, chinook, and pink salmon, represented an average annual use of 6,750 angler-days.

The lower Nooksack River and its surrounding sloughs and waterways also support an annual sport

[1] Anadromous trout data involve period 1962-1966.

smelt fishery. This is usually of short duration. Angler-days involved were not determined.

A questionnaire survey (1966) indicated that an average use of 14,300 angler-days resulted in a harvest of approximately 2,850 steelhead. Of this number, approximately 300 angler-days of effort resulted in a catch of about 60 summer steelhead. Natural production contributes almost 90 percent of the total steelhead catch. No commercial landings are recorded, however, Indian fishermen harvest this species.

Survey data (1966) also indicate that 16,800 angler-days were spent in the pursuit of searun cutthroat in salt water, with a total harvest of 10,100 fish. Natural production supports the total fresh- and salt-water searun cutthroat harvest. Harvest of these fish in fresh water and the take of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of 1966 survey data, 126,800 angler-days were spent fishing in the lakes, ponds, and reservoirs, and a total harvest of 450,650 trout and 83,600 other game fish realized. Similarly, 61,500 angler-days were spent fishing for game fish other than steelhead in the streams and 190,600 were harvested. An estimated 10 percent of this total is the whitefish harvest.

Potential Harvest—The natural production capacity of anadromous fish within the Basins, if fully utilized, could provide an increased harvest of all species. A discussion of salmon harvest trends appears in the Area chapter.

Potential harvest of natural steelhead production could be increased, although it is difficult to estimate the degree of improvement, because artificial propagation already places additional fishing pressure on natural populations.

Searun cutthroat harvest has not reached its full potential, because of the unique stream fishery, brief season, and popularity of winter steelhead angling. Estimates indicate that this population could support additional harvest.

The production and subsequent harvest of resident salmonids in streams are not expected to change, subject to the same exclusions noted for anadromous fish. An exception is the harvest of mountain whitefish, which is estimated to be less than 20 percent its potential. Because this total harvest is not separable from stream resident fish harvest data, present and potential harvest values were not determined. Potential harvest of resident salmonids in lakes, ponds, and reservoirs could be increased substantially.

Factors Limiting Production Other Than Harvest

Various alterable conditions limit fish production (Table 4-5).

Detrimental Streamflow—Many steep-sloped drainages create fast runoff conditions, causing intensive early winter and spring flooding, followed by intermittent and low summer flows. This problem is particularly severe on the North Fork Nooksack, many of its tributaries, and certain independent drainages (Photo 4-2).

Such conditions are aggravated in drainages experiencing heavy logging, which also accelerates runoff. This problem is serious on numerous tributaries of the upper North, Middle, and South Forks of the Nooksack River, and many of their feeder streams. In addition, reduced flows in many of the lowland streams are attributed in part to ground cover removal, a condition which is worsening because of population growth.

Poor Water Quality—Streams exhibiting questionable water quality are located primarily in the lowland drainages, and include the lower mainstem Nooksack and its tributaries, and the independent streams. Here, in closer contact with man's activities, the more sluggish waters readily accumulate undesirable pollutants. Such materials include harmful municipal or industrial effluents, crop and pest control sprays, excessive organic or inorganic fertilizers, and waste materials ranging from leachings to land excavation spoils.

Some harmful industrial and municipal discharges empty directly into the estuarine waters, particularly in Bellingham Bay. Studies conducted

PHOTO 4-2. Typical flood plain channel shifting. (Washington Department of Fisheries photo)

TABLE 4-5. Alterable factors limiting anadromous and resident fish production in Nooksack-Sumas Basins

	Limiting Factor 1/											Species Affected						
Stream	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Unstable Streambed	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes 2/	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Nooksack R.	X									X	X	X	X	X	X	X	X	X
North Fork	X			X	X	X					X	X		X	X	X	X	X
Deadhorse Cr.		X												X		X		X
Cascade Cr.		X			X									X				X
Glacier Cr.	X			X	X	X		X			X	X	X	X		X		X
Gallop Cr.		X						X						X				X
Cornell Cr.	X	X			X								X	X	X	X		X
Hedrick Cr.		X					X						X	X		X		X
Canyon Cr.	X			X		X							X	X	X	X		X
Boulder Cr.	X	X		X	X			X	X		X		X	X	X	X		X
Maple Cr.		X				X	X						X	X	X	X		X
Kendall Cr.		X										X		X				X
Kenny Cr.		X												X				X
Bell Cr.		X												X				X
Middle Fork	X	X	X	X	X						X	X		X	X	X		X
Porter Cr.	X	X		X	X						X		X	X	X	X		X
Canyon Cr.	X	X			X				X		X	X	X	X	X	X		X
South Fork		X			X							X		X	X	X		X
Cavanaugh Cr.		X						X					X	X		X		X
Edfro Cr.		X					X		X				X	X		X		X
Skookum Cr.	X			X		X		X				X	X	X	X	X		X
Saxon Cr.		X											X	X		X		X
Hutchinson Cr.		X				X						X	X	X	X	X	X	X
Smith Cr.		X											X		X	X	X	X
Anderson Cr.		X	X							X			X		X	X	X	X
Fishtrap Cr.		X	X							X			X		X	X	X	X
Bertrand Cr.		X	X							X			X		X	X	X	X
Ten Mile Cr.		X	X							X			X		X	X	X	X
Independent Drainages																		
Dakota Cr.		X						X		X			X		X	X	X	X
California Cr.		X						X		X			X		X	X	X	X
Terrell Cr.		X	X										X		X	X	X	X
Silver Cr.		X						X		X			X		X	X	X	X
Squalicum Cr.		X	X							X			X			X	X	X
Chuckanut Cr.		X											X		X	X	X	X
Whatcom Cr.		X	X							X			X			X	X	X
Sumas R.		X						X		X	X		X			X	X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

here in 1962 revealed that poor water quality areas within the bay were extremely damaging to young salmonids. More recent studies indicated that juvenile salmonids, apparently migrating from the Nooksack River, come in contact with these polluted areas.

Some of the higher elevation, glacial streams on the North Fork experience temperatures low enough to limit food production and restrict the kinds and numbers of fish inhabitants.

Physical Barriers—Physical barriers which reduce potential fish production include the falls on the North and South Forks of the Nooksack and the barriers on tributaries as shown on Figure 4-1.

Upstream from these particular blocks are an additional 40 miles of good quality spawning area. Less suitable production area is situated upstream from the barriers imposed by the Middle Fork diversion dam, and the falls-cascade sections of Glacier, Canyon (North Fork), and Skookum Creeks. These and other precipitous glacier-fed streams limit both spawning and rearing.

Regulated flows from the Puget Sound Power and Light Company's Nooksack powerplant and the Middle Fork diversion dam (municipal and industrial water) cause stranding and/or flushing of both immature and adult fish immediately downstream.

No major logjams exist. Intermittent log or debris barriers are commonly formed on many of the smaller tributaries, however, the majority present little or no problem to fish production.

Conflicting Watershed Developments—Water is diverted from the Middle Fork dam and piped to Lake Whatcom for municipal and industrial use. The greatly reduced flows downstream in the lower Middle Fork result in critical conditions for fish during summer months. Much of the northern part of the Basins is agriculturally developed. Consequently, the natural flows of nearly all the streams are badly depleted in summer due to irrigation withdrawals. This use, resulting in diminished flows, adversely affects anadromous and resident fish production.

The development of riverfront property for summer or permanent homes is underway. It will result in increased demands for streambed channeling and diking, which are not compatible with fish needs.

Other physical alterations include river levee construction, revetment work, and extensive gravel removal operations on the lower mainstem Nooksack.

Limited Spawning and Rearing Areas—Summer and early fall rearing habitat is often severely limited in the lower Middle Fork by the diversion of water to Lake Whatcom reservoir.

Competition and Predation—Throughout early rearing, juvenile salmonids compete with a variety of other fishes, including suckers, sticklebacks, sculpins, and dace. In Lake Whatcom, various spiny rays are an added menace to its salmonid populations. Undesirable predators inhabiting the estuarine and marine waters are dogfish and hair seals. Certain birds also prey on salmonids.

Beneficial Developments

Accomplished and Continuing—Enhancement projects for anadromous fish have involved beaver dam and logjam removal, road culvert repair, and minor fishway construction. The majority of these activities have been on North Fork tributaries and on streams entering the mainstem Nooksack downstream from Deming. Fish-passage facilities have just been completed on Hutchinson Creek. Stream clearance and fishway construction are continuing programs. Various land management agencies, in cooperation with the State, do stream clearance work.

Beneficial developments include artificial propagation facilities, lake rehabilitation, access area development, stream and lake improvement, and fisheries research.

Regulations provide adequate spawning and rearing protection of the unique cutthroat trout stock in Lake Whatcom. This has sustained a good fishable population within the lake and an accessible egg source for supplemental stocking programs.

Waters which have been chemically rehabilitated for trout management include Mirror, Toad, and Silver Lakes, Lake Fazon, and Lake Terrell. While only Silver Lake required screening, both it and Lake Terrell required barriers. Various stream and lake improvement projects are indicated on Figure 4-2.

Special use is made of Lake Terrell lying within the State's Lake Terrell Game Range. A "catch and release" trout fishing program has been successfully instituted on searun cutthroat trout within the lake. Also, the immature searuns can migrate to the ocean and return, entering the marine harvest again as still larger fish.

Fishermen access sites exist at Silver, Toad, and Wiser Lakes, Lake Fazon, Lake Whatcom, and on Fishtrap Creek and the Nooksack River (Figure 4-2). Additional private and public developments supplement this program.

Continuing chemical and biological research of Lake Whatcom is important to game fish habitat from the standpoint of lake and reservoir management.

Under Development–No beneficial projects are under development at the present time.

MARINE FISH AND SHELLFISH

Habitat Description

Various environmental conditions determine marine fish and shellfish distribution. The marine area is principally part of the Strait of Georgia system. Waters are generally typical of deep oceans, with low temperatures and high salinity, and are extremely rich in nutrient salts. The northern waters around Point Roberts and in Boundary Bay are affected to some extent by the Fraser River discharge. Also, the various bays and estuaries from Blaine to Anacortes (Skagit-Samish Basins) are influenced by river runoff, tidal currents, and mainland and island topography. These shoreline waters are relatively shallow, and warmer and less saline than the marine area.

Inventory and Distribution

Marine Fish–The diverse marine environment plays a vital role in providing suitable living area for an extensive variety of marine fishes, including cod, hake, lingcod, greenling, flounder, sole, surfperch, rockfish, herring, dogfish, ratfish, skate, and smelt.

Marine fish population is discussed in the Area section concerning production of these species.

Shellfish–The Nooksack-Sumas Basins' boundary for shellfish differs from the established basin boundary in that it encompasses marine waters and shoreline extending from the Canadian border to Langley Point (Skagit-Samish Basins), and includes Lummi, Portage, Cypress, Sinclair, Guemes, and several smaller islands. The partially protected waters of Portage, Bellingham, Chuckanut, Samish, Padilla, Fidalgo, and Burrows Bays are the major shellfish producing areas.

Principal species of shellfish and other marine invertebrates are Dungeness and red crabs; Pacific, native, and Kumamoto oysters; littleneck, butter, horse, Manila, geoduck, cockle, piddock, and softshell clams; blue and California mussels; pink and rock scallops; spot, side stripe, and pink shrimp; octopi; sea cucumbers; and sea urchins.

Vast quantities of Dungeness crabs inhabit Boundary, Semiahmoo, Birch, Lummi, Bellingham, Samish, and Padilla Bays, and the channels between the islands and mainland. Red crabs are moderately abundant near the oyster and clam beds, and large box crabs are scattered in deep water.

Historically, the native Olympia oysters occurred in commercially significant numbers in Drayton Harbor, and Samish and Fidalgo Bays. Their present range is limited to Samish Bay (Figure 3-9). The Pacific oyster commercial beds range from Drayton Harbor, Clayton Beach south to the southern portion of Samish Bay, and William Point to Bay View in Padilla Bay. Lesser quantities inhabit Birch, Lummi, and Bellingham Bays; the west side of Samish Bay; and areas along rocky points and beaches. Kumamoto oysters, introduced into Samish Bay, are increasing.

Clam populations are extensive throughout the marine area. Butter and littleneck clams are abundant in the Blaine-Point Roberts area; Birch, Portage, Bellingham, Samish, and Padilla Bays; and on all island shorelines. There are lesser numbers of other hardshell clams in these same areas. Blue mussels are numerous in the northern waters, particularly where piling and large boulders extend below the high tide mark. Scattered numbers of California mussels inhabit the same areas. Pink scallops are found in scattered concentrations on the sandy-mud bottoms of the deep edges of the bays and along the rocky channel bottoms below depths of 80 feet. Only small quantities of rock scallops inhabit these waters.

Spot, pink, and side stripe shrimp are known to dominate the shrimp populations, particularly in Bellingham Bay. Shrimp beds normally occur at depths of 100 to 600 feet.

Octopi, unique marine animals, are moderately abundant at depths from high tide to 150 feet. Sea cucumbers and sea urchins occur in concentrated groups throughout the marine sector.

Production

Marine fish and shellfish production was not determined.

Propagation

Marine fish are not propagated within the Basins.

The majority of the private oyster culture sites are located in the semi-protected waters of Boundary, Birch, Samish, Padilla, and Fidalgo Bays. These areas, and some public beaches, receive occasional "seedings" using spat from State-controlled reserves.

Harvest

Marine Fish–Marine fish are harvested by commercial and sport fishermen. Commercial fishing effort is directed from the ports of Blaine, Bellingham, and Anacortes, each of which serves moderate to large fishing fleets.

The commercial marine fish harvest is conducted principally by otter trawl vessels, however, a few hook and line vessels also operate within Basin waters. More than a half dozen major fish landing points are located at the above ports, with at least three of the larger dealers and processors receiving marine fish landings from smaller vessels fishing Puget Sound waters and larger trawlers fishing the ocean from the Columbia River north to Alaska. Principal species taken within Basin waters include lingcod, Pacific cod, sole, and rockfish.

The commercial herring harvest is also significant. Large seine vessels, operating mainly out of Bellingham, fish the waters of outer Bellingham Bay to the San Juan Islands, and north toward Blaine and the lower Strait of Georgia. Major landings are made at the home port with some catches shipped to Blaine, Anacortes, Everett, and Seattle.

Sport fishing for marine fish includes angling throughout the marine waters and spear fishing performed mainly in the semi-protected waters adjacent to mainland and island shorelines. Considerable effort is expended in the sport harvest of marine fishes throughout northern Sound waters, as reflected by the nearly 12,000 angler-days recorded in 1965. Lingcod and rockfish species are the principal fish sought by sportsmen.

Shellfish–Commercial and sport harvest of shellfish is considered moderate to heavy with principal emphasis on crabs and oysters.

A moderately intense commercial fishery for Dungeness crab provides the largest shellfish landing, with smaller landings of oysters, octopi, and some hardshell clams. The Port of Blaine receives the majority of these landings, with Bellingham and Anacortes receiving only limited numbers of shellfish.

Sport harvest of shellfish is concentrated mainly on crabs, with smaller quantities of hardshell clams and oysters also taken. Intensive sport harvest occurs on virtually all public access beaches from Point Roberts southeast to Samish Bay. Favorite locations include Boundary, Birch, Chuckanut, and Samish Bays. Man-days of use attributed to shellfish harvest are estimated at 9,500 annually.

Harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish–The principal factors influencing marine fish production are poor water quality, tideland development, and competition and predation.

1. Poor Water Quality–Certain estuarine and marine waters are strongly influenced by industrial pollution. This is particularly true in Bellingham Bay.

Additional factors affecting marine water quality include excessive siltation from high river flows, introduction of wastes from beach property developments, disposal of dredged spoils, and occasional washing or disposal of oil or other toxic materials from local ship and barge traffic. The combined effects of poor water quality are undetermined. However, the elimination of certain fish populations and the loss or severe reduction of marine habitats are apparent in specific areas of Bellingham and Fidalgo Bays, and in Guemes Channel near Anacortes.

2. Tideland Development–In addition to affecting water quality, urban and industrial developments are limiting marine fish through attrition of some natural production areas. Landfill and dredged spoil deposition activities and extensive dike and breakwater construction seldom incorporate basic fish needs, and are often detrimental, particularly to juvenile marine fishes.

3. Competition and Predation–Dogfish and sculpin prey on marine fishes. Also, heavy concentrations of these fish frequently replace more desirable fishes such as rockfish, cod, or sole.

Shellfish–Principal factors limiting shellfish production include poor water quality, adverse physical conditions, tideland development, and competition and predation.

1. Poor Water Quality–Poor water quality conditions, generally the same as those influencing anadromous and marine fishes, adversely affect shellfish to a greater degree. They include harmful industrial effluents, excess siltation, dredged spoil disposal, and toxic materials flushed from local ships and barges.

Sewage treatment facilities are generally lacking throughout much of the Basins. This seriously limits commercial oyster production in some areas. For example, the Blaine area, which is excellent for seed oyster culture, is of negative value for fattening. Oysters from this area are transferred to Similk Bay

(Skagit-Samish Basins) and harvested only after bacterial counts meet public health standards.

Another water-associated problem is the fresh-water discharges from the Nooksack River and the Samish River (in Skagit-Samish Basins), which tend to stratify over the heavier salt water. This fresh-water layer generally prevails within the bays to depths of several feet. Thus, the semi-protected tidelands have less saline waters than the outer beaches experiencing stronger currents. This condition limits the variety of shellfish found here.

Marine water temperatures are generally colder than the average for Puget Sound. This is particularly true in certain areas where strong currents maintain a high degree of circulation, keeping the colder marine waters in contact with shallower beach areas. Such conditions often account for the lack of phytoplankton blooms during summer cycles.

2. Adverse Physical Conditions–At Point Roberts and Boundary and Lummi Bays, the broad exposure of extensive sandy beaches to southerly storms is not conducive to the production of the more fragile shellfish species.

Estuarial silt deposits, composed principally of river-transported material, reduce suitable bottom strata and diminish shellfish productivity.

3. Tideland Development–Attrition of shellfish producing tidelands is increasing rapidly as urban and industrial expansion continues. This is particularly true where extensive breakwater or landfill projects are located. Prime examples are Boundary, Birch, and Bellingham Bays.

4. Competition and Predation–Periodic increases in starfish, moon snail, and ghost shrimp numbers often result in heavy predation and infestation of shellfish, particularly clams and oysters. Oyster drill colonies occasionally inhabit good production areas, destroying large quantities of this highly prized mollusc. Also, occasional large increases in red crab numbers cause severe declines in other shellfish stocks. Octopi prey heavily on prime crab populations.

Beneficial Developments

The only beneficial development programs underway are those associated with commercial oyster production. In privately-managed "cultured" beach areas, the aforementioned competition or predation factors are generally controlled to insure maximum production. Research on the chemical control of predators and competitors will result in measures to control such factors over the many miles of "noncultured" beaches.

FUTURE NEEDS–FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The 1963 census ranked the Nooksack-Sumas Basins fifth in population (74,600 persons). The present growth rate is moderate, but is expected to increase rapidly. Projections forecast a population of 91,600, 123,500, and 168,700 for the years 1980, 2000, and 2020, respectively. Major increases will be directly related to new industrial development planned for the Basins. Most industrial growth is expected to occur in the Bellingham area, particularly northwest toward Blaine. Local planning groups propose that much of the lower Nooksack valley, as well as the low flatland north of Bellingham, be maintained as agricultural land, especially in the Ferndale, Lynden, and Everson areas.

Urban and suburban development and expansion are expected to concentrate throughout the lower valley areas nearer the major metropolitan and industrial zone. Suburban development will also cover much of the surrounding lowland hillsides. Summer and recreation home development, plus year round resident homebuilding, will also increase in the upper drainages. Homesites are expected to be concentrated contiguous to the streams, rivers, and lakes, and along the marine shoreline.

The uncrowded and nearly undisturbed natural characteristics of the Basins, and their location near heavily populated areas such as Bellingham, Everett, Seattle, and Vancouver, B.C., make them valuable for all forms of outdoor recreation. Highway and road systems throughout the Basins provide generally good access to the area's attractive recreation facilities.

With an expected large increase in demand for outdoor recreation, coupled with increased population and more leisure time, it is anticipated that pressure on fish resources will accelerate at a rate much greater than population growth. This will be especially true for Nooksack River-produced salmon that are heavily harvested in salt-water areas outside the Basins, since these areas will experience very heavy increases in demand from both commercial and sport fishermen.

RESOURCE DEMANDS AND NEEDS

The Nooksack-Sumas Basins support a very heavy commercial fishery for salmon, marine fish, and shellfish. Commercial harvest, processing, and distribution of fish and fish products is a major industry. In addition, the Lummi and Nooksack Indians harvest large numbers of salmon from the Nooksack River annually. These fisheries have remained relatively constant and will probably continue to do so, at least in the near future.

Sport fishing for salmon occurs throughout the marine areas as well as in the Nooksack River. Such effort is particularly heavy in the Lummi Island area and in the waters immediately north of the San Juan Islands. Each year additional sport fishing pressure is experienced throughout the area, with increased effort in high pink salmon years.

Basin salmon production provides large numbers of fish to the commercial and sport fisheries. During pink salmon years, harvest is even greater. These catches represent a highly significant contribution toward meeting overall Pacific Northwest demands for fish. As demands continue to increase, it will be necessary to develop projects and implement programs that will best utilize the fish production potential within the Basins.

Large numbers of marine fish are harvested commercially from Basin waters and sport fishing effort for these fish is moderate. The same is true for shellfish, with particular emphasis by both commercial and sport fishermen on the abundant crab populations. It is anticipated that future demands for marine fish and shellfish will increase very rapidly with particularly heavy demand from sport fishermen.

The ports of Blaine and Bellingham have excellent protected moorages for commercial vessels, plus boat building, boat repair, and marine engine and equipment facilities. In addition, these major fish landing areas serve a number of fish dealers and processers, at least two of which are among the largest in the Puget Sound Area. It is anticipated that the fishing industry will continue to expand in these Basins. This is especially true for that segment of the industry handling marine bottomfish, because they have a particularly high market potential. Generally, the same situation holds true for the commercial shellfish industry with expectations of increased market demands in the future.

Future game fisheries demands and problems will stem equally from the popularity of the resources for sportsmen from the Nooksack-Sumas Basins and from adjacent heavily populated areas. Anadromous and resident game fish attract equally large numbers of sportsmen. Numerous streams and lakes provide excellent fishing for resident species. Alpine lakes are managed intensively and success rates reflect this program. It is estimated that, by 1980, Basin lakes must provide an additional 302,000 trout and 39,250 game fish of other species to the creel annually. This is an additional 43 fish per surface acre. Similarly, streams must provide an additional 88,500 resident trout and whitefish and 2,670 steelhead to the creel annually (Photo 4-3).

The sport fisheries for salmon, steelhead, marine fish, resident game fish, and shellfish are playing an expandingly significant role in these increasingly recreation-oriented Basins. Good boating facilities and adequate fresh- and salt-water access support this expansion. The extensive variety, availability, and abundance of desirable fish and shellfish also promote a high degree of recreation usage. With an expected upsurge in demand for outdoor recreation it is anticipated that sport fishing needs will accelerate much faster than population growth. Based on harvest surveys, residents' use of the resource will approximate that of the present. This means that about 50 percent of all Basin harvest and 40 percent of Basin utilization of game fish other than steelhead is by people from outside the Basins.

To meet the expected large increases in demand for fish resources, problems and conflicts affecting such resources will have to be resolved and projects and programs that will best meet all future demands implemented. Table 4-6 indicates present and projected demands and needs for game fish in angler-days.

TABLE 4-6. Present and projected sport fishermen use (game fish), Nooksack-Sumas Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	219.4
1980	147.0	366.4
2000	209.6	576.0
2020	345.6	921.6

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish resources of the Nooksack-Sumas Basins are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to these Basins.

Conflicting Land and Water Uses

(1) The disposal of dredged or land spoil in the estuarine and marine waters of Bellingham and Boundary Bays is at times highly detrimental. Such materials adversely affect anadromous fish, marine fish, and shellfish.

(2) Excessive water diversions from the Middle Fork Nooksack and from many of the smaller independent streams severely limit the fish production capacity of these waters.

(3) In some areas of the Nooksack River watershed, improper logging practices conflict with fish requirements. Extensive clear-cutting has created

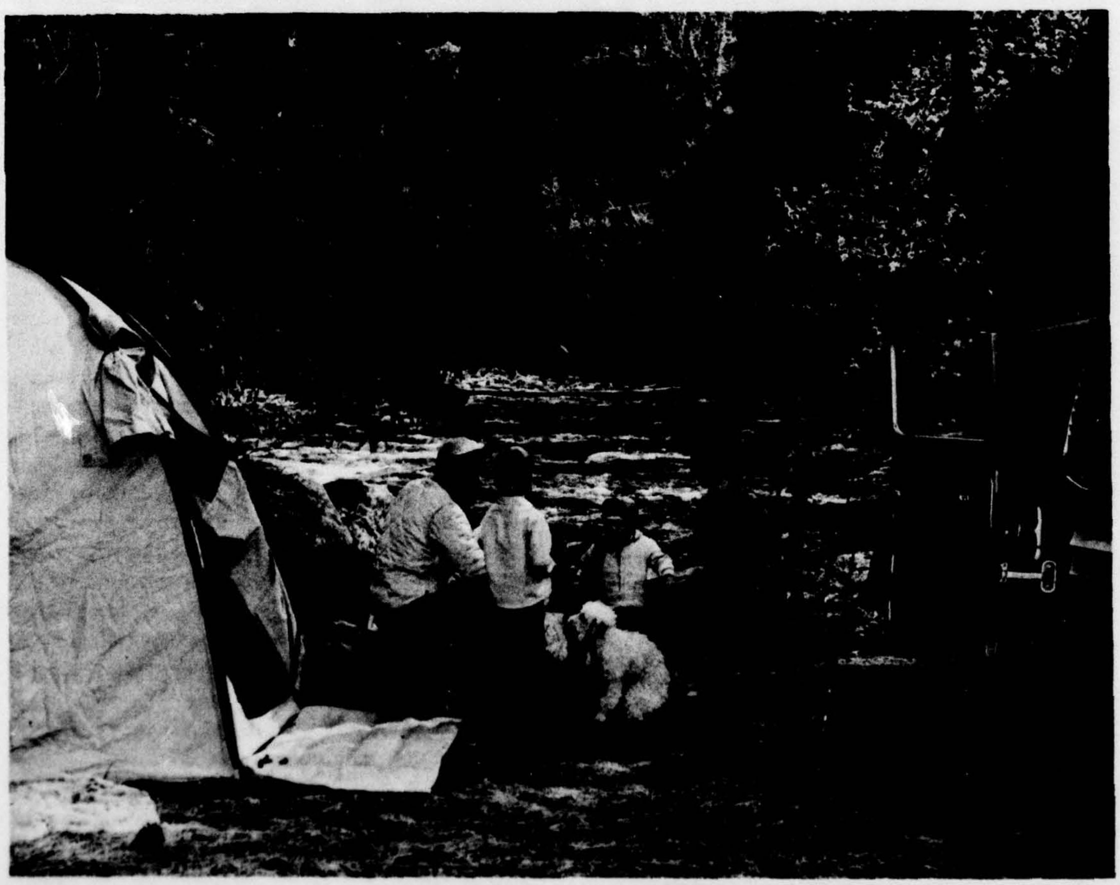


PHOTO 4-3. Family use of streamside fishing spots is increasing each year. (Washington Department of Game photo)

excessive localized intermittent runoff and increased streamside erosion and stream siltation. Clear-cutting adjacent to streambanks eliminates shade and cover, and results in rising water temperatures, losses in terrestial and aquatic food organisms, and increased predation. The use of streams for yarding logs and improper road construction adjacent to streams adversely affect fish resources.

(4) Dams being considered for the North Fork and South Fork Nooksack River would seriously reduce anadromous fish populations unless efforts are made to coordinate their location and operational patterns with requirements for fish. No successful method exists for safely passing downstream migrants over high dams. Dam development on upper river reaches would reduce resident fish spawning and stream fishing area. River reservoirs generally would provide limited angling recreation, due to extended retention of glacial silt.

(5) Log boom storage in portions of Bellingham Bay is detrimental to marine fish and shellfish populations within the immediate area.

Poor Water Quality

(1) Occasionally, intermittent pollution occurs in the lower Nooksack River, in some of the smaller lowland independent drainages, and in the estuarine and marine waters of Bellingham and Boundary Bays. This often results in water quality inimical to fish and shellfish survival. Effluents from agricultural and industrial sources as well as from sewage disposal are particularly detrimental to aquatic life. Buildup of sludge and heavy waste in the estuaries can be highly deleterious and limits marine fish and shellfish production.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Nooksack-Sumas Basins. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential enhancement programs for anadromous fish include stabilizing streambed and streamflow, particularly in the North Fork and in some of its major tributaries. Prior to this, streamflow requirements necessary to maintain and enhance production must be accurately determined. This will require cross-section studies to define stream and streambed character at various flow levels. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been established for the Nooksack River and its North, Middle, and South Forks (Table 4-7). It is assumed that the

TABLE 4-7. Tentative flow schedule required to maintain fish production levels, Nooksack-Sumas Basins

Stream 1/	Flows (cfs) by Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Nooksack R. (Deming)	2,000	2,500	3,000	3,000	3,000	2,500	3,000	4,000	3,500	2,500	1,800	1,600
North Fork (Point near Glacier)	600	600	600	600	800	500	600	800	1,000	800	700	500
Middle Fork	400	450	500	500	500	350	350	450	500	450	350	350
South Fork (Wickersham)	600	700	800	800	750	600	750	900	600	350	200	340

1/ Locations are existing U.S. Geological Survey gaging stations.

amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

Streamflow controls might be achieved through the development of overflow channels, flood-flow diversions, or impoundments. Streambed controls could be achieved through selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools and riffles where they are now unstable or lacking.

Enhancement programs should also include passage facilities or annual planting programs designed to utilize available spawning grounds upstream from North and South Fork Falls; upstream from falls and cascades on the North Fork's Maple and Canyon Creeks; and upstream from cascades on Canyon Creek, a South Fork tributary. Fish stocking programs would be initiated prior to installing passage facilities.

Rigid controls against the excessive removal of water, for any purpose, from natural flowing streams within or upstream from fish production habitat should be enforced. Special attention should be accorded a study for the use of dual water systems (consumptive/nonconsumptive).[1]

Programs designed to benefit anadromous fish must include implementing water quality controls along the lower Nooksack River and in Boundary, Birch, and Bellingham Bays. Additional programs needed include establishing permanent flood plain zoning, and achieving better coordination between fish requirements and flood control channeling, riverbed gravel removal, and watershed logging practices.

Projects for artificial propagation should include development of production stations such as hatcheries, eyed-egg incubation facilities, or spawning channels, and creation of off-river rearing areas. Suitable land and water supplies are available for such facilities along much of the upper North Fork upstream and downstream from the falls, and on Glacier, Cornell, and Canyon Creeks, all tributary to the North Fork; on Canyon and Bear Creeks, tributary to the Middle Fork; and along the South Fork downstream from Cavanaugh Creek, as well as on Skookum and Hutchinson Creeks, South Fork tributaries.

[1] Whereby waters from domestic and industrial use can be reused for irrigation and nonconsumptive purposes.

MARINE FISH

Beneficial development projects for the enhancement of marine fish could include creation of additional habitat and new fishing areas through selective placement of rock jetties or submerged automobile bodies.

A much needed program benefiting these fish involves establishing and implementing water quality controls on the estuarine and marine waters of Boundary, Birch, Lummi, Bellingham, and Samish Bays. Without such controls, a drastic reduction in marine fish is foreseen for these waters.

Natural production is adequate now, but artificial propagation may be needed in the future.

The development of fishing piers and access facilities for sport fishermen should be stressed. Such facilities could be incorporated into construction of boat basins, marinas, and shipping piers.

SHELLFISH

In addition to implementing water quality controls for the area, potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents now limit production; the study and implementation of techniques to eliminate or control natural predators; and the alteration of environment to promote increased natural production. The latter might be accomplished by heating controlled salt-water areas or by adding nutrients that are deficient or lacking.

There is considerable potential for increased development of raft and rack oyster culture. This production method would allow full utilization of almost all marine waters to depths of at least 100 feet, and would significantly increase production. Also, many beach areas appear suited for put-and-take shellfish stocking programs.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Nooksack-Sumas Basins offer many opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. Major potential developments, including an indication of priority, are categorized in Table 4-8 and defined by stream in Table 4-9.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the potential developments listed. Nearly all of these developments are goals in long-range planning programs and are acted upon as monies, manpower, and time permit.

A number of potential developments are included in a preliminary plan for increasing salmon production levels to meet overall Pacific Northwest demands for fish resources in the future. These proposals, and salmon production increases, are indicated by target years in Table 4-10.

Table 4-11 shows estimated annual benefits in terms of sport and commercial harvest for the same projects. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate, and needs are not so critical as for salmon.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

All developments should be planned to permit enhancement of fish habitat. This will be particularly important where port facilities and industry plan to expand to meet future population demands. The recreation potential of rivers and lakes should be preserved. People will be attracted to the Basins if sport fishing, including the right of access, is available in adequate quantity and desirable quality.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

Thermal powerplant sites should be carefully selected to minimize damage to the fish production potential and water cooling requirements must be included in the construction plans.

Logging practices that will insure maintenance of spawning and rearing areas should be emphasized.

All lakes and streams should be protected from over-diversion for municipal, irrigation, and industrial uses. Fisheries values of these waters should be given equal consideration with other water uses. It is recognized that flood control can benefit flood plain uses. However, all available means to limit flood damage should be examined prior to constructing dams that destroy fish habitat. Outdoor recreation planning, including fishing, should be a high priority program in any basin plan. Therefore, flood plain lands should be zoned for agriculture and recreation rather than for industrial and urban use.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Public access areas, totaling 5,370 surface acres, are proposed on Squalicum, Fountain, Jorgenson, Green, Barrett, Judson, Mirror, and Tennant Lakes, Brennan and Ferguson Ponds, Lake Whatcom, and Lake Padden. Ultimately, all significant lakes and key portions of streams and salt-water areas should have assured public fishing access.

(3) Completion of fishing piers and accompanying habitat development are recommended for points fronting Lake Whatcom.

(4) Streambank angler access on 50 miles of main rivers and tributary streams (of a total of 165 miles) should be purchased and developed, as funds become available.

(5) Public access to salt water is proposed at Lehoe, Lummi, Clayton, and Chuckanut Bays, Eliza and Chuckanut Islands, Neptune Beach, Lummi Rocks area, Semiahmoo Spit, Point Roberts, Hale Passage, Point Francis, and Salt Water Pond.

(6) A lake improvement project is recommended at Barrett Lake where a small concrete and earthfill dam, with accompanying fish-passage and trapping facilities, will double the size of the lake.

(7) A combination stream and lake improvement project on Skookum Creek and Musto Marsh Ponds would include an earthfill dam forming two lakes which would increase overall stream production.

(8) Propagation sites for rearing of anadromous game fish, including development of Athearns Pond, a tributary of the South Fork Nooksack River near Saxon, is proposed. Subsequent liberations and adult

TABLE 4-8. Potential developments for production and use of salmon, marine fish, and shellfish, Nooksack-Sumas Basins

Beneficial Development	Priority		
	Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Expand hatchery facilities	X		
Develop clam hatchery for restocking public clam beaches	X		
Improve public beaches for clam production		X	
Construct fish-passage facilities	X	X	
Plant salmon upstream from obstructions	X	X	
Improve stream and streambed conditions	X	X	X
Develop marine fish production habitat	X	X	X
Develop new salmon production stations		X	X
(2) Acquisition			
Evaluate potential salmon propagation sites	X		
Acquire and develop six salt-water public access sites	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Acquire 5 miles of additional tideland for public use		X	
Purchase suitable land for propagation sites and procure water	X	X	
Procure riverbank public access sites and develop facilities	X	X	
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Promote effective Indian fishery conservation measures	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits, and reserve such lands for public use except as required by specific circumstances	X		
Develop subtidal park for skin divers		X	
Implement necessary fishery management regulation changes	X	X	X
Promote increased shellfish production techniques	X	X	X
(4) Coordination and Legislation			
Develop effective flood plain zoning codes	X		
Coordinate all operations and activities on streams, i.e., gravel removal, logging, flood control	X	X	X
Implement necessary quality controls for fresh and salt water	X	X	X
(5) Additional Studies			
River cross-section and profile measures	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Gravel cleaning and decompaction techniques	X	X	
Stream fertilization		X	X

TABLE 4-9. Potential beneficial developments for fish, Nooksack-Sumas Basins

	Enhancement Measure									Species Benefited						
Stream	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Nooksack R.				X						X	X	X	X	X	X	X
North Fork	X			$\boxed{X}$	$\boxed{X}$		X	X	X	X	X	X	X	X	X	X
Deadhorse Cr.					X						X	X		X		X
Glacier Cr.	X	X		X			X	X	X		X	X		X		X
Gallop Cr.		X									X	X		X		X
Cornell Cr.		X		X			X	X	X		X	X	X	X		X
Canyon Cr.	X			X			X	X	X		X	X	X	X		X
Boulder Cr.		X		X			X	X	X		X	X	X	X		X
Maple Cr.	X				X				X		X	X	X			X
Kendall Cr.					X					X			X	X	X	X
Racehorse Cr.		X			X		X	X	X	X	X	X	X	X	X	X
Middle Fork				X	X					X	X	X	X	X	X	X
Bear Cr.									X		X			X	X	X
Porter Cr.		X		X					X		X	X	X	X		X
Canyon Cr.		X		X			X	X	X	X	X	X	X	X	X	X
South Fork	X				X		X	X	X	X	X	X	X	X	X	X
Cavanaugh Cr.		X							X		X			X		X
Skookum Cr.						X	X	X	X		X	X	X	X		X
Hutchinson Cr.	$\boxed{X}$		X		X				X		X	X		X	X	X
Fishtrap Cr.		X						X	X		X		X	X	X	X
Bertrand Cr.		X						X	X		X		X	X	X	X
Ten Mile Cr.		X						X	X		X		X	X	X	X
Independent Drainages																
Dakota Cr.		X						X	X		X		X	X	X	X
California Cr.		X							X		X			X	X	X
Squalicum Cr.		X							X		X		X	X	X	X

$\boxed{X}$ Priority project.

TABLE 4-10. Estimated total salmon production increases in Nooksack-Sumas Basins, by project or program, to satisfy needs[1/]

Project or Program, and Year	Species and Number			
	Chinook	Coho	Pink	Chum
Pre-1980				
Supply flood control and augment flows, N. Fork	1,800	6,000	9,300	1,000
Subtotals	1,800	6,000	9,300	1,000
1980-2000				
Provide fish passage over major barriers, 54 stream miles	11,900	55,500	10,500	--
Improve fish habitat, 14 streams, 23 stream miles	1,700	40,000	28,200	8,600
Construct hatchery	--	51,000	--	--
Augment flows, S. Fork and M. Fork, and tributaries	3,600	19,000	9,600	--
Supply flood control, Nooksack, M. Fork, and tributaries	900	4,300	2,900	1,900
Construct spawning channel, 1 mile	--	--	120,000	--
Subtotals	18,100	169,800	171,200	10,500
2000-2020				
Construct 3 hatcheries or equivalents	18,000	127,500	--	--
Develop rearing facilities, 100 acres	30,000	85,000	--	--
Subtotals	48,000	212,500	--	--
Totals	67,900	388,300	180,500	11,500

[1/] Average annual production (catch plus escapement) at end of each period.

TABLE 4-11. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, Nooksack-Sumas Basins

Project or Program, and Year	Annual Benefits						Costs	
	Commercial Harvest			Sport Harvest				
	No. of Fish	Value		No. of Fish	Value		Capital	O&M (Annual)
		To Fishermen	Retail		Federal	State		
Pre-1980								
Supply flood control and augment flows, N. Fork	11,300	$ 24,100	$ 69,500	1,450	$ 8,900	$ 40,700	2/	2/
Subtotals	11,300	$ 24,100	$ 69,500	1,450	$ 8,900	$ 40,700	--	--
1980-2000								
Provide fish passage over major barriers, 54 stream miles	50,200	$ 162,100	$ 355,800	10,000	$ 60,400	$ 280,600	$ 511,000	$ 12,000
Improve fish habitat, 14 streams, 23 stream miles	50,400	116,600	293,600	6,000	36,000	169,300	70,000	1,400
Construct hatchery	37,300	118,300	228,100	6,400	38,300	178,700	1,020,000	60,000
Augment flows, S. and M. Fork and tributaries	20,800	56,700	137,700	3,500	21,100	99,200	2/	2/
Supply flood control, Nooksack, M. Fork, and tributaries	6,200	16,100	39,500	800	5,000	23,000	2/	2/
Construct spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,400	700,000	14,000
Subtotals	260,600	$ 535,800	$1,256,100	31,000	$186,600	$ 871,200	--	--
2000-2020								
Construct 3 hatcheries or equivalent	103,200	$ 361,100	$ 726,600	21,700	$129,900	$ 606,200	$3,060,000	$180,000
Develop rearing facilities, 100 acres	78,500	305,200	639,300	20,100	120,500	562,200	550,000	100,000
Subtotals	181,700	$ 666,300	$1,365,900	41,800	$250,400	$1,168,400	$3,610,000	$280,000
Totals	453,600	$1,226,200	$2,691,500	74,250	$445,900	$2,080,300	--	--

1/ Anadromous trout benefits not included.

2/ Multi-purpose project. Separable costs, if any, have not been determined.

returns would provide fishing on the Nooksack mainstem and the South Fork.

(9) Storage projects should be located off the main streams to permit redistribution of undesirable streamflows.

(10) Hatchery facilities should be expanded or rearing ponds developed for steelhead and searun cutthroat.

(11) Hatchery facilities should be expanded to provide increased harvest in lakes and streams.

(12) Lake and stream fertilization techniques and new management techniques should be developed to assure greater fish productivity.

(13) New methods of lake and stream rehabilitation, including specific fish toxicants, should be developed.

(14) Fish disease and parasite control programs should be developed for lakes.

Table 4-12 indicates estimated annual benefits and costs of specific projects and programs proposed for the Nooksack-Sumas Basins prior to 1980 to satisfy needs for game fish. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Developments planned for periods after 1980, which may include some projects and programs listed above, have not been evaluated, nor have costs been estimated. However, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table.

TABLE 4-12. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Nooksack-Sumas Basins, pre-1980

	Annual Benefits		Costs	
Project or Program	Angler-Days	Value	Capital	O&M (Annual)
Lakes				
Acquire and develop public access, 12 areas	25,000	$ 50,000	$ 220,000	$ 2,000
Enlarge Barrett Lake	3,000	6,000	75,000	--
Develop new fish toxicants	40,000	80,000	10,000	10,000
Develop lake fertilization techniques	60,000	120,000	10,000	10,000
Construct hatchery	1/	1/	240,000	20,000
Subtotals	128,000	$256,000	$ 555,000	$ 42,000
Streams				
Acquire and develop streambank access, 50 miles	8,000	$ 24,000	$ 790,000	$ 2,000
Construct steelhead rearing pond	16,000	80,000	75,000	9,000
Conduct stream cross-section surveys	1/	1/	10,000	--
Construct hatchery	45,000	135,000	600,000	50,000
Subtotals	69,000	$239,000	$1,475,000	$ 61,000
Salt Water				
Acquire and develop public access, 14 areas	12,000	$ 36,000	$ 600,000	$ 2,000
Subtotals	12,000	$ 36,000	$ 600,000	$ 2,000
Totals	209,000	$531,000	$2,630,000	$105,000
Lakes (Alternate to above lake proposal)				
Acquire and develop public access, 12 areas	25,000	$ 50,000	$ 220,000	$ 2,000
Enlarge Barrett Lake	3,000	6,000	75,000	--
Construct hatchery	57,000	114,000	750,000	62,500
Subtotals	85,000	$170,000	$1,045,000	$ 64,500

1/ Included with other development benefits.

Projects and Programs, 1980-2000

(1) Construct and operate hatcheries to meet fishing demands on lakes and streams.

(2) Construct and maintain fishing piers on Lake Whatcom and Samish Lake.

(3) Complete projects and programs not completed by 1980.

(4) Continue fisheries research.

(5) Develop new programs needed to meet fish resource needs.

(6) Investigate biological controls for spiny-rayed game fish and stimulate public interest in their harvest.

Projects and Programs, 2000-2020

(1) Complete programs and projects not completed by 2000.

(2) Develop new programs as required.

(3) Continue research in game fish management.

Approximately 270,000 acres in these Basins are under U.S. Forest Service and National Park Service administration. Forest Service planning for fish resource enhancement has not as yet progressed beyond 1980, but projects and programs similar to those listed in Table 4-13 are probable during later time periods. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 4-13. Fishery enhancement projects and programs of U.S. Forest Service proposed for Nooksack-Sumas Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Conduct stream surveys	mile	6	$ 200
Clear stream channels	mile	5	10,000
Total			$10,200

PRESENT STATUS—WILDLIFE

INTRODUCTION

The combination of varied topography, moderate climate, and suitable habitat within the Nooksack-Sumas Basins provides environmental conditions favorable to many wildlife species. Their effects on the type and quantity of wildlife are emphasized in the Area chapter, Present Status–Wildlife.

The whole spectrum of geographic land forms lies within the Basins, extending from the rugged, mountainous area of Mount Baker and its associated peaks west through the area of irregular timber-covered foothills to the level farmland on the flood plain. The wide variety in land form and elevation causes variable weather.

BIG GAME

Black-tailed deer are the most numerous and widespread of the big-game animals, occurring predominantly in the open timbered areas. Elk, mountain goat, and black bear are also present in significant numbers. Mountain lion range within the Basins.

Inventory and Distribution

Highest deer numbers per unit of area occur in that portion of the South Fork Nooksack watershed in Skagit County (Figure 4-2). A high percentage of this area, within the elevational range at which deer can winter, has been logged within the last 30 years. Based on its deer densities, it supports an estimated 1,030[1] of these animals (Photo 4-4). Deer number approximately 2,100 in the Lake Whatcom independent drainage, and in the Terrell Creek-California Creek-Dakota Creek independent watersheds, there is a calculated total of 1,600. In the remainder of the Nooksack watershed, including the main river, Middle Fork, and lower South Fork areas, an estimated 5,960 are present. Thus, the current deer population totals approximately 10,700 animals.

[1] Game numbers vary throughout the year; therefore, figures designate late September-early October populations.

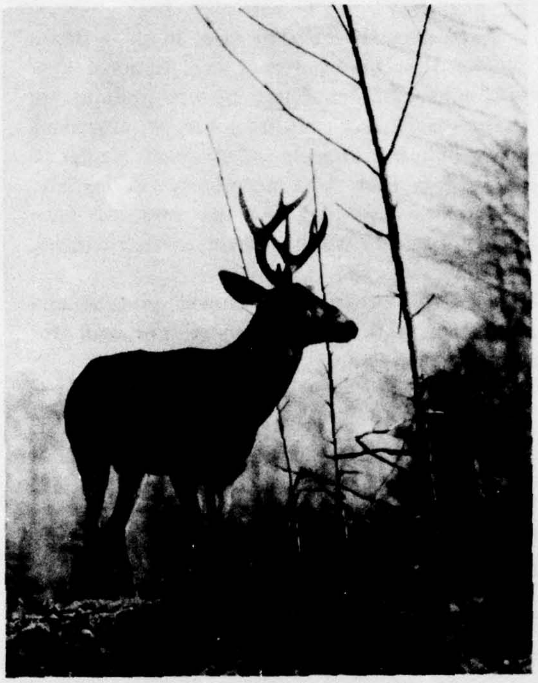


PHOTO 4-4. Black-tailed deer—abundant throughout the Area—stimulate more outdoor recreation than any other wildlife species. (Washington Department of Game photo)

The elk are descendants of 23 animals introduced into the Basins during 1946 and 1948. This introduction was a mixed stock of Roosevelt and Rocky Mountain elk.

The present population totals approximately 400 animals. Most of them occur between the upper Middle Fork and upper South Fork of the Nooksack River, and generally east of Wickersham and west of Mount Baker (Figure 4-1). Because the herd is newly established, its numbers are not limited by existing habitat. It is believed that these animals have not dispersed fully into adjacent areas. The South Fork Nooksack drainage, from Skookum Creek upstream, is the prime wintering area for elk. The heaviest winter use occurs in the area from Skookum to Howard Creeks.

The rugged, precipitous, rocky slopes of the Mount Baker-Mount Shuksan complex are ideal habitat for mountain goats. Included are the uppermost reaches of the Nooksack and its Middle and South Fork watersheds. This range supports a thriving population of approximately 800 of these magnificent animals.

Black bear frequent the forested areas and their population is estimated at 800-1,000 animals.

The upper reaches of these Basins include many remote areas inhabited by mountain lions. It is believed that some interchange of these animals occurs with those in the adjoining Skagit-Samish Basins, and British Columbia. An estimated 10 to 20 lion range primarily within the Nooksack-Sumas Basins.

Limiting Factors

Various factors limiting big-game populations are discussed in the Area chapter, Present Status—Wildlife.

Production

Doe-fawn ratios determined just prior to the hunting season indicate an average annual increase of 3,000 deer over the spring population.

Elk productivity and survival rate are believed high, because the herd is newly established in prime habitat. It is estimated that this herd is increasing at a rate of 25 percent annually, which would constitute nearly 100 animals.

Late summer surveys of mountain goats reveal 29 kids per 100 adults, which represents 180 young annually.

The annual production of black bear is approximately 250 animals. Based on harvest sustained, such productivity is considered stable.

Annual production of mountain lion is adequate to sustain current populations.

Harvest

Average annual harvest of big game during the period 1961-1965 was as follows: 1,160 (black-tailed deer); 10 (elk); 28-30 (mountain goat); 150-250 (black bear); and 2 (mountain lion).

The elk herd has supported a constant increased harvest in recent years (1961-1966), indicating a steady population increase. Also, its range has been extended during this period.

Mountain goat harvest is controlled by special permit. The take has increased as additional areas were opened to hunting this unique big-game animal.

It is believed that black bears sustain a 20 to 25 percent harvest annually in areas of medium to high density. Bears and mountain lions are apparently being harvested at or near maximum numbers in accessible areas.

Average annual hunter-days use devoted to harvest of big game in the Basins is 23,200 (deer); 975 (elk); 260 (mountain goat); 1,575 (black bear); and 100 (mountain lion).

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

The elk herd in the South Fork Nooksack drainage is the result of a trapping and transplanting program.

Other beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

Native upland-game species inhabit the remaining native habitat and introduced exotics use the agricultural area. The introduced species include ring-necked pheasant, California quail, gray partridge, and cottontail. Native upland game are blue and ruffed grouse, snowshoe rabbit, band-tailed pigeon, and mourning dove.

Inventory and Distribution

Pheasant (Figure 4-1), and small populations of gray partridge and California quail are found throughout the agricultural land, which constitutes 20 percent of the Basins. Highest densities occur in the area south and west of Lynden and around Lake Terrell. The estimated wild population of 17,000 pheasants is supplemented annually by game-farm-reared birds. Estimated populations of gray partridge and quail are 1,000 birds each.

Grouse are the most numerous upland birds and both species are distributed throughout the Basins wherever suitable habitat exists. Based on recent density studies, a spring population of approximately 14,000 ruffed grouse was determined. This would result in a fall population of 35,000. A conservative estimate of the blue grouse population, based on existing data, is 17,000 birds.

Both cottontail and snowshoe rabbit are abundant. The cottontail population is closely related to the degree of local agricultural activity. Population densities are influenced by the quantity of edge and fence row cover created by diversified farming. The snowshoe is confined to typical evergreen-hardwood forest habitat. The rabbit population has not been determined.

The numbers of mourning dove and band-tailed pigeon were not determined.

Limiting Factors

Introduced upland-game species, all dependent upon agricultural activity, are most seriously affected by changes in farming practices and crops raised. The change from cereal grain production to grazing, in the past 20 to 30 years, has reduced the productivity of the area for these species. Wildfire control and reduced emphasis on slash burning after logging have reduced the productive potential of wooded areas for native upland game.

The Area chapter, Upland Game, treats band-tailed pigeon limiting factors.

Production

The average wild production of pheasant is estimated at 8,000-10,000 annually. Based on the present population level, it is estimated that between 500 and 600 gray partridge and quail are produced each year. The average annual production of grouse, based on their reproduction rate, would be 21,000 ruffed and 10,000 blue grouse. Production estimates were not determined for rabbit, band-tailed pigeon, snipe, or mourning dove.

Harvest

The average annual pheasant harvest is 5,000 birds, which consists of about 3,700 wild cocks and 1,300 fall-released game farm-reared males. Ruffed grouse are generally more accessible than blues and consequently, more are bagged. The average annual grouse harvest of 5,050 is composed of 4,200 ruffed and 850 blues.

Approximately 6,500 rabbits, primarily cottontail, are taken each season. The annual harvest of snowshoe is small. Approximately 125 quail, 5,000 band-tailed pigeons, and 800 mourning doves are bagged annually by hunters.

Average annual hunter-days use devoted to harvest of upland game in the Basins is 3,600 (rabbit); 7,100 (pheasant); 100 (quail); 8,400 (grouse); and 4,500 (pigeon and dove).

Propagation

The wild pheasant population is supplemented annually by 3,800 birds from State-operated game farms. Approximately 2,100 are released as mature cocks immediately prior to the hunting season, and the remaining 1,700, primarily hens, are planted in the spring and early summer as additional brood stock. Small numbers of quail, and gray, red-legged, and bamboo partridge are propagated on various State game farms and are released in the Basins periodically. One private game farm in Whatcom County raises a limited number of quail commercially.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases.

The Lake Terrell Game Range is operated by the State primarily to increase waterfowl food and create public hunting. This 926-acre area and 500 acres of adjacent industrial land are used extensively as a planting site for game-farm-reared pheasant. The two areas receive heavy use from both waterfowl and upland-game hunters.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 200 acres of wildlife habitat development and 725 acres of wildlife habitat preservation, all located north of Bellingham.

FUR ANIMALS

A variety of fur animals inhabit the Nooksack-Sumas Basins. These include beaver, muskrat, mink, river otter, marten, weasel, skunk, raccoon, opossum, bobcat, lynx, red fox, and coyote.

Inventory and Distribution

The majority of the shallow lakes, ponds, and low gradient creeks of Whatcom County are within the Nooksack watershed. Consequently, the majority of the beaver, muskrat, and mink occur here. On the basis of harvest sustained, individual population estimates are: 1,200-1,500 (beaver); 8,000-10,000 (muskrat); and 800-1,000 (mink). The other species occur in varying numbers.

Limiting Factors

Man's encroachment on fur-animal habitat is the primary limiting factor. The fur bearers which provide the greatest monetary return to the trapper require principally marsh-type habitat for food and cover. The abundance and quality of shallow water areas are the principal regulating factors governing fur-animal numbers.

Agricultural practices on the lower Nooksack have resulted in loss of marsh and swamp areas through draining. Stream realignment and removal of bank vegetation accompanied by riprapping for flood control have resulted in additional loss of fur-animal habitat.

Production

Population levels of the most valuable fur animals indicate the following production available for the fall trapping season: 450-600 (beaver); 6,000-7,500 (muskrat); and 400-500 (mink). Varying numbers of the other species are produced.

Harvest

Annual beaver harvest has fluctuated subsequent to the 1963 legislative change, but no definite trend is indicated. The average annual catch during the period 1963-64 to 1966-67 was 300.

In recent years (1961-62 to 1965-66) about 750 muskrat, 150 mink, 50 red fox, and 75 raccoon have been taken annually. It is doubtful if any of the fur animals, other than beaver, are being harvested to the full extent of their potential. Muskrat are trapped by the casual trapper and, consequently, the take varies widely. The remaining fur bearers are taken only incidentally. For the past several seasons (1961-62 to 1965-66), trappers have received approximately $8,000 annually from the sale of wild-trapped fur-animal pelts.

Propagation

Within the Basins, 16 ranchers engage in commercial mink production.

Beneficial Developments

Maintenance of native marsh by State management of the Lake Terrell Game Range to enhance waterfowl also benefits fur animals.

Other beneficial developments are described in the Area chapter, Fur Animals.

WATERFOWL

Agricultural areas in the lower Nooksack valley adjacent to the bays provide important feeding areas for migratory waterfowl. All the major waterfowl areas of Whatcom County occur within the Basins. Since 1960, this county has been one of the principal waterfowl harvest areas in western Washington.

Inventory and Distribution

The bulk of the waterfowl using the Basins are fall and winter migrants attracted to the agricultural areas of the Nooksack delta. Inland feeding areas are centered around the Lake Terrell Game Range and the Lynden agricultural area. Important resting areas include Drayton Harbor, and Birch, Bellingham, and Lummi Bays. Figure 4-2 indicates the medium to high waterfowl density areas.

January waterfowl counts reveal an annual average of 30,000 birds. The 1965 Whatcom County survey is indicative of the species and their relative abundance (Table 4-14).

TABLE 4-14. January Waterfowl Survey, Whatcom County, 1965

Species	Number	Species	Number
Eider and Scoter	15,360	Oldsquaw	130
Scaup	6,300	American widgeon	106
Bufflehead	2,427	Merganser	67
Mallard	1,831	Ring-necked duck	7
Goldeneye	1,291	Redhead	4
Coot	900	Black brant	430
Pintail	495	Total	29,348

Prior to the winter survey, waterfowl have been exposed to almost three months' hunting. An undetermined number of birds pass through the Basins during fall and early winter while enroute southward. The survey does not indicate the total number which use the area as a winter feeding station.

Limiting Factors

Availability of food and adequate water resting areas are the prime factors governing migratory waterfowl abundance. Agricultural practices in the Basins have resulted in a decrease in the cereal grain acreage. Reclamation of marsh and swamp lands through drainage and other activities has had a detrimental effect on waterfowl populations. The loss of these areas for breeding, nesting, and rearing has resulted in fewer waterfowl in the Pacific Flyway.

Production

Waterfowl production is limited. Average annual production, based on breeding habitat types and productivity of each, is 2,500 ducks. The mallard is the predominant species raised, with wood duck and teal next in order of abundance.

Harvest

Essentially all of the Whatcom County waterfowl harvest occurs in and adjacent to the Nooksack delta. Recent years' harvest records indicate an average annual harvest of 32,460 ducks and 1,000 geese, resulting in about 25,000 hunter-days.

Propagation

Waterfowl are not artificially propagated in the Basins.

Beneficial Developments

Administration and management of 926 acres of optimum waterfowl habitat, including Lake Terrell and surrounding cultivated lands, increase duck production, winter carrying capacity, and hunting in the Nooksack delta. Wiser Lake is maintained as a State game reserve (closed to hunting) to provide necessary resting area for ducks using the agricultural lands near Lynden. Both developments lengthen the period wintering waterfowl remain in the Basins.

Conservation practices applied to agricultural lands of direct benefit to waterfowl include 1,164 acres of wildlife wetland development, located in the western third of the Basins.

OTHER WILDLIFE

The many and varied birds and animals in the Basins not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

The Nooksack-Sumas Basins are currently experiencing moderate industrial and residential expansion in the Bellingham-Blaine area. As such expansion continues, there will be competition and conflicts of interest for available area. Outdoor recreation, agriculture, and forest products will remain major contributors to the economy.

Most of the present demand on the Basins' wildlife resources is from local inhabitants of Whatcom County. However, with expansion of urban centers to the south and improved arterials, utilization of the Basins' outdoor recreation assets is expected to increase much more rapidly than their population. Demand on wildlife resources will approximately double by 1980. To maintain comparable hunting, it will be necessary to provide an additional annual harvest of 1,100 deer; 200 bears; 40 elk; 20 mountain goats; 4,700 grouse; 4,600 pheasants; 5,000 rabbits; 31,000 ducks; 800 geese; and 4,000 band-tailed pigeons by 1980. As population,[1] leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately.

[1] Population forecasts shown in Future Needs—Fish.

Table 4-15 indicates present and projected demands and needs for hunting in hunter-days.

TABLE 4-15. Present and projected hunter use in Nooksack-Sumas Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	74.7
1980	69.5	144.2
2000	89.5	233.7
2020	54.7	288.4

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Nooksack-Sumas Basins is to be satisfied. Problems and conflicts discussed in the Area chapter apply to these Basins.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basins during the target years (Photo 4-5).

PHOTO 4-5. Preservation of essential wetlands assures continued waterfowl production. (Washington Department of Game photo)

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 4-16 indicates projects and programs proposed for these Basins to satisfy 1980 needs. Similar data for subsequent periods are not available, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from non-hunting use of wildlife such as trapping, wildlife

TABLE 4-16. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Nooksack-Sumas Basins, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs 1/: Capital	Costs 1/: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	12,200	$ 48,600	--	2/
Develop educational program to stress renewable aspects and proper harvest of wildlife	22,600	116,400	$ 5,000	--
Develop new methods for wildlife population analyses, habitat improvement techniques, and compatible forest-wildlife practices	3/	3/	2/	$20,000
Specific Programs and Projects				
Acquire salt-water access for waterfowl hunting	9,600 4/	48,000 4/	5/	5/
Acquire and develop waterfowl and fur-animal habitat, 1,900 acres	27,200	136,000	725,000	10,000
Acquire and develop band-tailed pigeon area, 200 acres	5,000	19,200	100,000	5,000
Enlarge game farm to produce additional 3,000 pheasants	6/	6/	30,000	9,000
Totals	76,600	$368,200	$ 860,000	$44,000

1/ Do not include survey and plan costs.

2/ Included with other General Program costs.

3/ Benefits would be widely distributed, but are partially included under other projects and programs in this table.

4/ Includes off-project benefits.

5/ Costs included in those shown in Table 4-12. These would be multipurpose areas.

6/ Benefit is included under other programs and projects.

photography, viewing, and dog training, nor does it include incidental recreation benefits that will accrue from use of wildlife areas for swimming, boating, picnicking, hiking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Continue wildlife management research and develop new programs as required.

(3) Complete programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Complete programs and projects not completed prior to 2000.

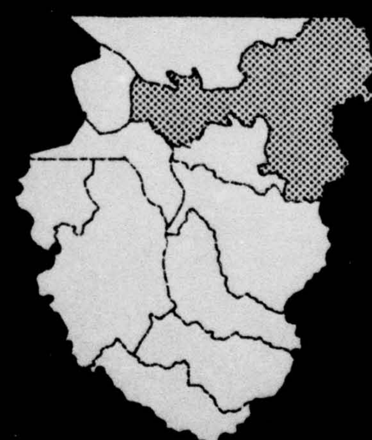
(3) Continue research for new techniques in wildlife management and harvest.

Table 4-17 indicates projects and programs for wildlife enhancement planned by the U.S. Forest Service in the pre-1980 period. Plans have not been developed beyond that point, but similar activities may be expected in subsequent periods. Hunter-day benefits from these projects and programs have not been determined, but they will help satisfy overall demand.

TABLE 4-17. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Nooksack-Sumas Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Surveys and Plans			
Conduct range analysis			
Deer	acre	10,540	$1,100
Mountain goat	acre	6,320	600
Special	acre	1,470	200
Conduct upland-game habitat surveys	acre	81,050	4,100
Develop habitat management plans	each	1	500
Release forage for big game	acre	39	1,000
Total			$7,500

Skagit-Samish Basins



SKAGIT—SAMISH BASINS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Skagit-Samish Basins represent the largest unit within the Puget Sound Area. Within their boundaries exist a multitude of rivers, streams, and lakes, and a relatively large and vital segment of marine water, including several large islands. The boundaries encompass the Skagit River system lying within the United States, and a moderate-sized drainage, the Samish River system, plus several smaller independent drainages including Joe Leary and various sloughs (Figure 5-1). Nonstream fresh-water areas include 450 lakes and reservoirs (25,160 surface acres) and 46 farm ponds (23 surface acres). The various systems provide excellent spawning and rearing area for anadromous and resident fishes, and each contributes to the specific ecological makeup of estuarine and marine waters at its confluence with salt water.

The marine waters are vital for anadromous fish, marine fish, and shellfish. The deeper salt-water areas support large populations of various marine fish. The tidelands of Skagit, Padilla, and Samish Bays, the island beaches, and the mainland shorelines, support extensive shellfish stocks. In addition, the partially enclosed or semi-protected estuaries, into which the rivers drain, provide necessary fresh-salt-water conversion area for the anadromous species.

The Skagit River headwaters lie in Canada. After crossing the international boundary, the river flows generally southwest through a reservoir complex to its junction with the Cascade River. The Cascade contains numerous pool-riffle areas highly suitable for fish use. Continuing downstream in a westerly course, the Skagit is joined by the Sauk River, which exhibits excellent pool-riffle characteristics. The Baker River drainage, containing two major hydroelectric power developments, meets the Skagit at Concrete. The main river then flows west to Sedro Woolley where it turns generally south to its confluence with Skagit Bay. The entire Skagit, downstream from Newhalem to Sedro Woolley, affords highly suitable spawning and rearing area for anadromous and resident fishes. Downstream from Sedro Woolley, the river meanders, is generally slow moving, and contains extensive long deep glides and pools. At a point approximately 7 miles upstream from salt water, it divides into numerous distributaries, including the North and South Forks.

The Samish River system originates immediately above the broad flat valley east of Lake Whatcom (Nooksack-Sumas Basins). From here the river flows generally south and then west, curving northwest to its confluence with Samish Bay. The major portion of the mainstem Samish contains extensive pool-riffle characteristics necessary to support the abundant fish populations. Friday Creek, its largest tributary, originates in Samish Lake and flows south to the mainstem. Numerous resident fish stocks and various anadromous species occur in the Friday Creek system.

With the exception of Colony Creek, none of the small basin drainages entering salt water independent of the Skagit and Samish Rivers is a significant production area for anadromous or resident fish.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in large numbers throughout the Basins.

Anadromous Fish—All five Pacific salmon utilize the various drainages. These include spring and fall races of chinook, coho, pink, chum, and sockeye salmon. In addition, each of the anadromous game fish occurs here, including summer and winter steelhead and searun cutthroat trout, and searun Dolly Varden (Figure 5-1).

The Skagit River receives runs of all the salmon and anadromous trout species. Approximately 100 miles of the mainstem, upstream to Gorge Dam, are accessible to them. An additional 400 miles of naturally accessible stream area are provided by the many Skagit River tributaries, including 20.7 miles of the mainstem Cascade River, and 43.3 miles of the

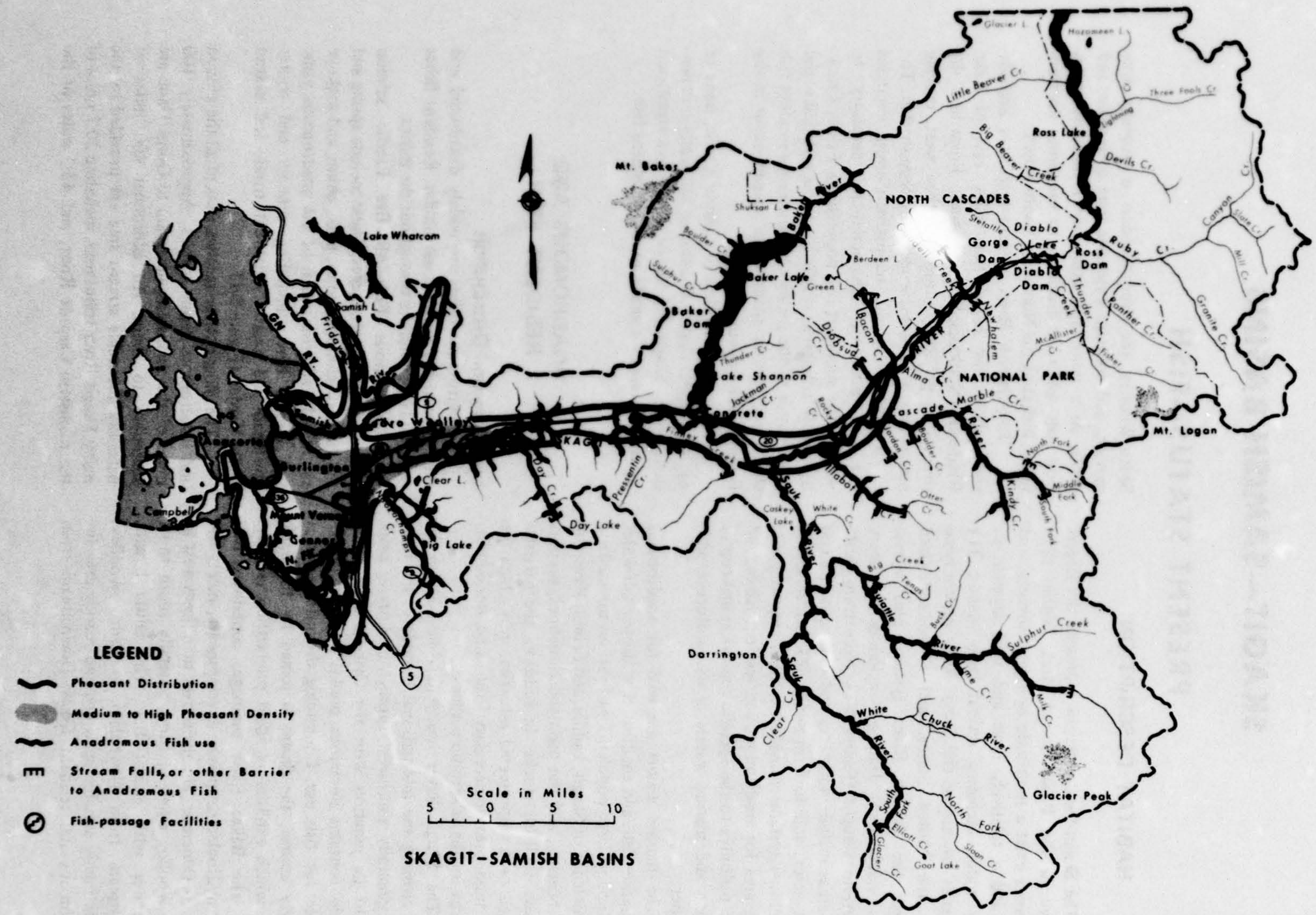


FIGURE 5-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

Sauk River. The Baker River, through the operation of fish-passage facilities, provides an additional 14.4 miles of suitable anadromous fish habitat upstream from Upper Baker Dam.

The Samish River system is inhabited by fall chinook, coho, and chum; and by the three anadromous trout species. Occasionally, some pink salmon have been observed in this system; however, no permanent runs are established. The mainstem Samish and certain portions of Friday Creek are accessible to chinook salmon for approximately 23 miles. Approximately 21.9 miles of the mainstem Samish River, plus an additional 35.4 miles of accessible tributaries, are available to coho and chum salmon, steelhead and anadromous cutthroat trout, and Dolly Varden.

The Colony Creek drainage supports runs of coho and searun cutthroat.

Overlapping of spawning and rearing areas of the various salmon and trout species occurs throughout the Basins. In general, chinook, chum, and pink salmon as well as steelhead utilize the Skagit and its larger tributaries, while the remaining steelhead and other species use the tributaries and sections of the mainstem.

An estimated 131.4 miles of stream are utilized by chinook spawners throughout the Basins. This includes 70.5 miles of the Skagit River between Newhalem Creek and Sedro Woolley, 20.8 miles of the Cascade River, 17.1 miles of the Sauk River, and 23 miles of the Samish River. In addition, nearly all of the larger tributary streams throughout the Basins support populations of spring or summer-fall chinook. Some spring chinook are trapped downstream from Lower Baker Dam and trucked to a point upstream from Upper Baker Dam.

Pink salmon production is limited to the Skagit River system. Spawning in the mainstem occurs from a point upstream from the Cascade River downstream for 54.5 miles to a point downstream from Day Creek. Numerous tributary streams also support moderate to high populations.

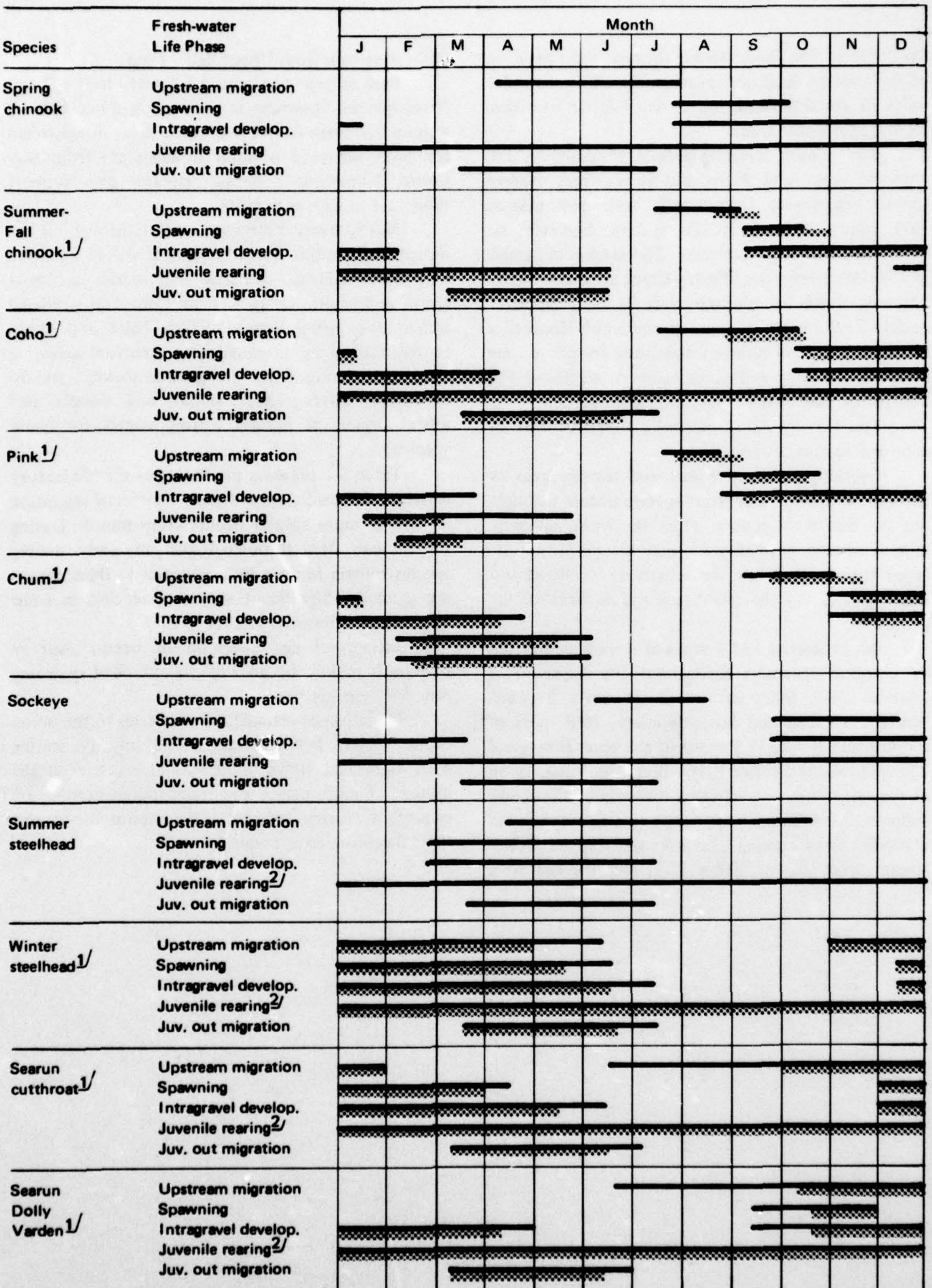
Nearly every accessible stream throughout the Skagit and Samish River systems is shared by coho and chum salmon, steelhead and searun cutthroat trout, and searun Dolly Varden. Coho and steelhead utilize the tributaries to Baker Lake and those upstream from this impoundment. Artificial spawning "beaches" maintain the indigenous sockeye run to the Baker River. Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

Table 5-1 presents the timing of the life history activities of anadromous fishes. Upstream migration of one or more species occurs every month. During the summer, May through August, the early-running species remain in deep holes enroute to their spawning grounds. Significant spawning reaches in some streams are delineated in Table 5-2.

Intragravel egg development occurs over an 11-month period, because of the extended spawning time for most species.

Migration of juveniles of all species to the ocean occurs mainly between March and July, coinciding with high river flows. Sloughs and estuaries at the mouth of each major and independent stream are important rearing areas for anadromous fish during their transition to salt water.

TABLE 5-1. Timing of salmon and searun trout fresh-water life phases in Skagit-Samish Basins



1/ Symbol ▒▒▒ indicates Samish River segment for this species; symbol ▬▬ indicates Skagit River segment.

2/ Normally extends over a two-year period.

TABLE 5-2. Significant spawning reaches for anadromous fish and resident game fish, Skagit-Samish Basins[1]

Stream	Section	Stream Mileage	Type of Spawning Area
Skagit R.	Burlington to Sedro Woolley	15.0-20.0	Few broad riffles, many long slow glides
	Sedro Woolley to Marblemount	20.0-69.0	Many broad riffles and beach gravel bars
	Marblemount to Gorge Powerhouse	69.0-84.0	Many riffles, some beach gravel bars
Cascade R.	Mouth to forks	0.0-17.0	Some riffles, considerable patch gravel
	S. Fk. mouth to M. Fk.	0.0-2.0	Few riffles, some patch gravel
Sauk R.	Mouth to Darrington	0.0-18.0	Occasional broad riffles and long glides
	Darrington to forks	18.0-34.0	Intermittent riffles and glides, some patch gravel
North Fork	Mouth to falls	0.0-1.0	Few riffles, some patch gravel
South Fork	Mouth to cascades	0.0-1.0	Few riffles, some patch gravel
Suiattle R.	Mouth to point upstream from Milk Cr.	0.0-27.0	Some riffles, intermittent patch gravel
White Chuck R.	Mouth to Camp Cr.	0.0-9.0	Few riffles, intermittent patch gravel
Baker R.	Baker Lake to Pass Cr.	0.0-8.0	Many riffles and short glides, much patch gravel
Samish R.	Allen to Interstate Hwy. 5	5.0-7.0	Few scattered riffles, long slow glides, some patch gravel
	Interstate Hwy. 5 to Prairie	7.0-18.0	Considerable riffle and patch gravel areas
	Prairie to Saxon	18.0-25.0	Intermittent riffles and patch gravel

1/ Additional spawning area is provided by virtually all tributaries entering within described reaches.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 5-3.

Resident Fish—Resident species, including competitive or undesirable fishes, spawn throughout the Basins (Table 5-2). Rainbow trout are abundant in most drainages. Many of the streams are typical rainbow waters, because of adequate flows, suitable gradient, and optimum temperatures for good production. Excellent habitat is afforded cutthroat trout in these streams. Their production is high, particularly in areas upstream from fish barriers. Brook trout, an introduced species, are numerous in specific waters. Dolly Varden inhabit the Skagit and its larger tributaries, such as the Sauk River. Brown trout are restricted to certain waters; they are most common in Baker Lake. Small populations of Arctic grayling and golden trout occur in higher elevation lakes and in sectors of the lake outlets.

Kokanee inhabit several larger lakes and spawn in streams tributary to these lakes, as well as in spring seepage areas of Baker and Samish Lakes. Mountain whitefish are distributed throughout the mainstem Skagit and Samish Rivers, as well as in larger

TABLE 5-3. Anadromous fish spawning escapement, natural and (artificial), in Skagit-Samish Basins

Species	Range[1]	Average (Annual)
Chinook	10,360-40,690 (4,410-9,230)	19,190 (6,040)
Coho	7,390-170,540 (8,760-18,630)	49,290 (11,550)
Pink	150,000-1,190,000	485,000[2]
Chum	18,500-237,670	115,940
Sockeye	450-8,250	2,330
Summer steelhead[3]	220-480	330
Winter steelhead[3]	44,700-75,300	60,500
Searun cutthroat[3]	54,500-91,600	75,300
Searun Dolly Varden[4]		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

2/ Per odd-year escapement.

3/ Totals include natural and (artificial) escapement.

4/ No valid totals established.

tributaries. Largemouth bass, yellow perch, pumpkinseed, black crappie, and brown bullhead are abundant throughout the lower elevation lakes managed for mixed species.

Suckers, squawfish, sculpins, dace, peamouth, sticklebacks, and shiners generally are classified as undesirable species, but are adaptable fish and are found scattered throughout many Basin waters. Sticklebacks inhabit many river sloughs and lower tributaries. Sculpins are widespread and shiners have become established in larger lakes and some sloughs. Squawfish and suckers spawn in lake and stream systems.

Production

Based on a 1966 survey, stream production of fish varied from essentially zero to over 685 pounds per surface acre. The average was 275 pounds. Salmonid production was 227 pounds per surface acre, while other or undesirable species comprised the remaining 48 pounds.

Anadromous Fish–Fish production in the various drainages is highly significant. Natural production of the Skagit-Samish Basins contributes an estimated 50 and 30 percent, respectively, of the steelhead catch and over 90 percent of the searun cutthroat harvest.

Fish production data are presented in Table 5-4.

TABLE 5-4. Anadromous fish natural production (harvest plus escapement), Skagit-Samish Basins

Species	Range[1]	Average (Annual)
Chinook	41,440-162,760	76,760
Coho	36,950-852,700	246,450
Pink	450,000-3,570,000	1,455,000
Chum	37,000-475,340	231,870
Sockeye	1,670-30,530	8,640
Summer steelhead	330-720	500
Winter steelhead	67,100-112,900	90,800
Searun cutthroat	72,900-122,100	100,400
Searun Dolly Varden[2]		

[1] Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

[2] Production limited and therefore not determined.

Resident Fish–Most Basin streams upstream from anadromous fish barriers are cold, small, and precipitous and are producing their natural potential. Often, their recruitment comes from headwater lakes or ponds and, on occasion, from plants of hatchery-reared trout. Exceptions are those streams originating from glaciers on Mount Baker, Glacier Peak, and other glacier fields along the Cascade crest (Photo 5-1). The instantaneous standing crop of Basin streams (exclusive of lampreys) was usually less than 75 pounds per surface acre. Approximately 10 percent of this production consists of sculpin.

Stream reaches downstream from migration barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The average standing crop produced (which excludes hatchery fish) varies between 90 and 690 pounds per surface acre. Hatchery-reared resident and anadromous trout are also planted in these areas.

Because lakes, ponds, and reservoir habitats are planted so frequently and managed for salmonids and/or spiny rays, actual production figures are shown in harvest data. Certain lakes' total harvest

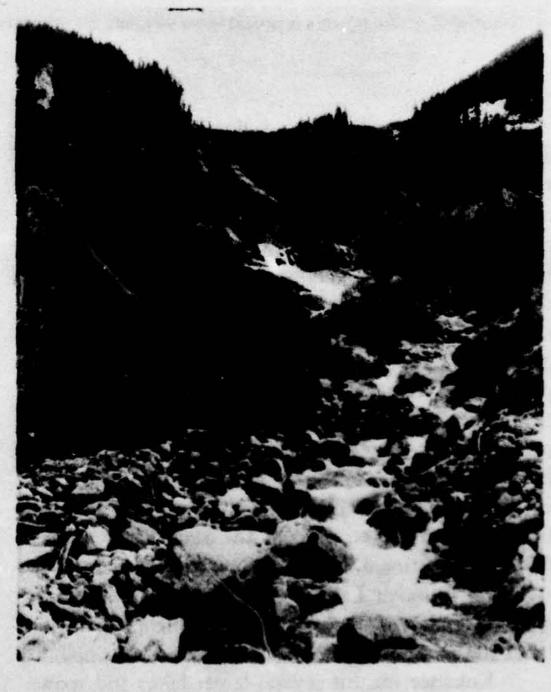


PHOTO 5-1. High headwaters provide essential summer flows to key lowland stream production and angling areas. (Washington Department of Game photo)

varies from one season to another and may vary from less than 10 to nearly 300 pounds per surface acre annually. Potential production could be substantial.

Propagation

Salmon propagation is supplemented through the operation of a fish farm and two salmon hatcheries, one located on the upper Skagit River and the other on the Samish River (Figure 5-2). Additional propagation is occasionally achieved by plantings of juvenile salmon originating from facilities in other basins.

The Washington Department of Fisheries maintains and operates the Skagit Salmon Hatchery near Marblemount. This station is served by Jordon and Clark Creeks, Cascade River tributaries. Fall chinook and coho are the principal salmon species produced here, with virtually all fish planted in the Skagit River system.

The other State-operated hatchery is located on Friday Creek, Samish River tributary near Belfast. This station also handles principally fall chinook and coho salmon, with most fish released directly into the Samish River system, and some into other nearby drainages.

Sockeye salmon propagation is supplemented in the Basins by the Washington Department of Fisheries' salmon spawning "beaches" located at Baker Lake.

The Newhalem Ponds rearing area is located adjacent to the Skagit River near Newhalem. It has been planted annually with an average of 121,530 coho. These fish have been reared initially at the Skagit Salmon Hatchery and are included in its total fish plants.

Commercial and sport catch preliminary statistics indicate that the Basins' planting program contributes approximately 22,500 chinook, 46,000 coho, and 1,050 sockeye to these fisheries annually.

There are no game fish hatcheries in the Basins. However, annual plantings of fingerling and legal-size trout from other hatcheries are made in the most heavily fished lowland lakes and streams, and in habitats which have been altered by barricades or polluted by nature or man and recently improved. Alpine lakes are stocked with small fish every three to five years or as necessary.

The Washington Department of Game operates a semi-natural steelhead rearing pond at Barnaby Slough near Rockport (Photo 5-2). It is connected to the Skagit River via Lucas Slough and more than 200,000 steelhead smolts have been liberated from it in one rearing season.

Recent survey and catch statistics indicate that the Basins' planting program provides approximately 50 percent of all steelhead, 10 percent of all searun cutthroat, 80 percent of all resident trout, and 90 percent of all kokanee harvested in their waters annually.

Average annual stocking of anadromous fish in Basin waters, 1961-1965[1] was as follows: 5,606,935 chinook; 2,191,453 coho; 944,234 sockeye; 226,255 steelhead; and 15,754[2] searun cutthroat. Resident propagation data are presented in the Area chapter.

Harvest

Existing Harvest—Salmon produced or reared in Skagit-Samish Basins' waters contribute to United States and Canadian ocean sport and commercial fisheries, and to those in the Strait of Juan de Fuca and northern Puget Sound. The average annual contribution (all species) to these fisheries has in recent years (1956-1965) been 1,034,800 salmon.

The marine waters support a moderate to heavy commercial fishery for salmon. Gill net vessels are the principal commercial craft used, operating in northern Skagit Bay, the eastern side of Rosario Strait, and the southern half of Samish Bay. Purse seiners also fish the area, utilizing waters near William Point in the south Samish Bay area. Catches are generally landed at ports from Blaine south to Everett, with some vessels hauling salmon to Seattle.

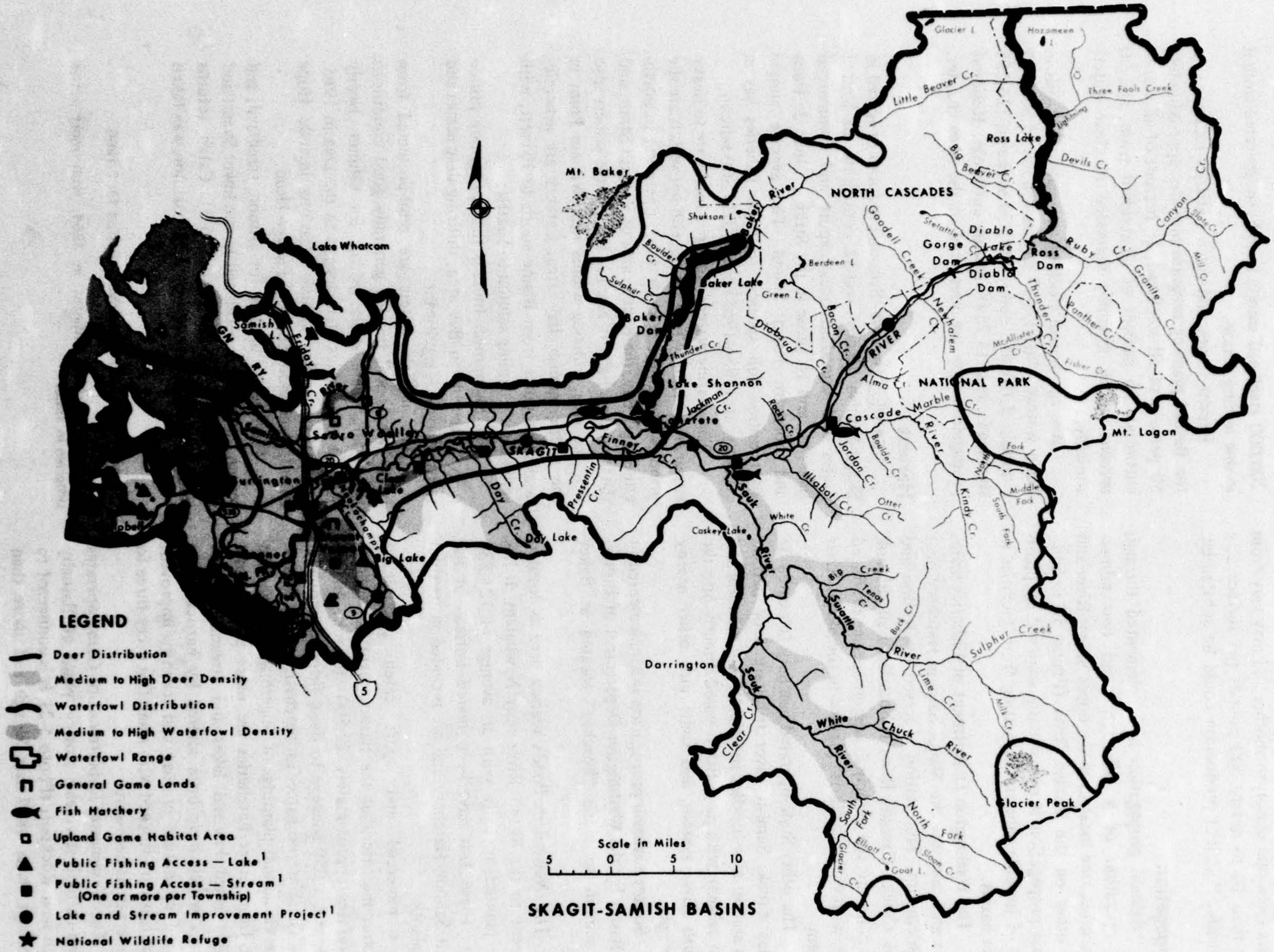
The Swinomish Indians fish for salmon principally in the Skagit Bay area, utilizing drag seines and traps. Harvest is significant.

The marine waters are semi-protected from heavy winds and provide generally good conditions for a large-scale sport fishery for salmon. Nearly 70,000 angler-days were logged in the area in 1965. Especially popular fishing locations include Hope Island, Deception Pass, and Fidalgo Head.

Fresh-water angling for salmon, steelhead, and searun cutthroat is permitted in the lower Skagit and lower Samish Rivers (Photo 5-3). Catch returns indicate that an average of 3,370 salmon was taken

[1] Anadromous trout data involve period 1962-1966.

[2] Annual stocking initiated in 1964, with most active program in 1966.



[1] Washington Dept. of Game development only.

FIGURE 5-2. Wildlife distribution, and fish and wildlife developments (1965)

PHOTO 5-2. Releases from Barnaby Slough (left foreground) provide additional steelhead for Skagit River anglers. (Washington Department of Game photo)

annually from the Skagit River from 1964 through 1966. The catch was composed of adult and jack chinook and coho, plus pink salmon. According to harvest records, the Samish River catch averaged 270 salmon annually during the 1964 through 1966 fishing seasons. This catch was composed of chinook and coho jacks. The overall salmon fishing effort in the Basins represented an average annual use of 30,500 angler-days.

In 1966, steelhead trout angling on the Skagit and Samish Rivers totaled 180,100 angler-days, resulting in a harvest of 36,000 fish. Of this total, 550 angler-days were required to catch about 100 summer steelhead. The Skagit Basin produced over 85 percent of this catch. Searun cutthroat harvest data, covering the Skagit and Samish Rivers, reveal 50,300 angler-days were spent in 1966 to catch 30,200 fish. No commercial steelhead landings are recorded; however, Indian fishermen harvest this species.

In 1966, resident fish in lakes, ponds, and reservoirs supported 363,200 angler-days for a total harvest of 1,413,300 trout and 169,000 other game fish. Similarly, 153,500 angler-days were spent fishing for game fish other than steelhead in streams and 508,300 were harvested. Whitefish comprise only one percent of this total.

Potential Harvest–The natural salmon, steelhead, and searun cutthroat production capacity of the Basins, if fully utilized, could provide an increased harvest of all species. Salmon harvest trends are discussed in the Area chapter. The production and subsequent harvest of resident salmonids in streams are not expected to change, subject to the same exclusions noted for anadromous fish. An exception

PHOTO 5-3. Fresh-water angling for salmon is an outstanding sport. (Washington Department of Fisheries photo)

is the whitefish harvest, which is estimated to be less than 10 percent its potential. Because this total harvest is not separable from stream resident fish harvest data, present and potential harvest values were not determined. Potential harvest of resident salmonids in lakes, ponds, and reservoirs could be increased substantially.

Factors Limiting Production Other Than Harvest

Table 5-5 presents major limiting factors considered alterable.

Detrimental Streamflow—Seasonal flooding occurs in virtually all major drainages. It affects fish production on the mainstem Skagit and lower Sauk Rivers and their larger tributaries, and on the mainstem Samish River. Many of the smaller drainages also experience intensive runoff, particularly where extensive logging has occurred over their steep upper slopes.

Seasonal low flows are common in most streams, but are especially harmful to fish life in the small to medium-sized Skagit River tributaries and in the Samish River and its tributaries. In the Samish River, an inadequate flow of 12 cfs has been allocated to anadromous and resident fish; the major part of the river's flow is diverted for irrigation.

In the Skagit River a significant limiting factor is created by the diurnal power peaking discharges from the dams located upstream from Newhalem. Extreme flow fluctuations strand large numbers of rearing and migrating fish along dewatered bank areas. These fluctuations simultaneously reduce the total effective rearing area.

Poor Water Quality—Water quality throughout the Basins is generally good, aside from the natural "glacial flour" conditions existing in such streams as the Suiattle and White Chuck Rivers. Some excessive siltation also occurs in streams where logging or road construction practices have denuded streambanks. Some domestic and industrial wastes are released into the Skagit, Sauk, and Samish Rivers; however, such releases have not been especially limiting to anadromous and resident fish production. Pollution problems result from residential and industrial expansion in the lower Skagit and Samish valleys, and adjacent to lower elevation lakes. Also, one aspect of pollution is the increasing use of various chemical sprays on agricultural land bordering the lower Skagit and Samish Rivers.

Some of the smaller lowland tributaries to the Skagit River, particularly Nookachamps Creek, exhibit high temperatures during the summer. The Samish River and its lower tributaries also experience high temperatures during the summer period. However, lethal levels are seldom reached.

Physical Barriers—In the Skagit River, anadromous fish runs are blocked by Seattle City Light's Gorge Dam. Another major barrier is Puget Sound Power and Light Company's Baker River dam complex. Minor dams and diversions are located on some of the Basins' smaller streams and tributaries; however, they are not significant fish barriers.

Within the Skagit Basin, natural barriers partially or totally block 16 miles of potentially usable stream area to anadromous fish. Falls and cascades delay, and often completely block, upstream migrating fish on many of the Basins' higher-elevation streams. Partial barriers exist on Finney and Bacon Creeks and the Cascade River as well as on a number of upper Suiattle River tributaries. Total barriers block significant anadromous fish use areas on the North Fork Cascade River, on the North and South Forks Sauk River, and on some of the larger Suiattle tributaries.

TABLE 5-5. Alterable factors limiting anadromous and resident fish production in Skagit-Samish Basins

Stream	Limiting Factor[1]											Species Affected							
	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Unstable Streambed	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes[2]	Chinook	Coho	Pink	Chum	Sockeye	Steelhead	Searun Cutthroat	Resident Trout
Skagit R.	X	X	X								X	X	X	X	X	X	X	X	X
Nookachamps Cr.	X	X				X				X			X				X	X	X
Hansen Cr.		X			X				X				X				X	X	X
Gilligan Cr.		X	X	X									X		X		X	X	X
Day Cr.						X						X	X	X	X		X	X	X
Jones Cr.				X		X	X		X				X	X	X		X	X	X
Muddy Cr.	X	X		X					X		X		X	X	X		X	X	X
Savage Cr.		X							X				X				X	X	X
Grandy Cr.	X	X		X	X				X	X	X	X	X	X	X		X	X	X
Pressentin Cr.		X		X	X			X	X		X		X	X	X		X	X	X
Finney Cr.		X							X			X	X	X	X		X	X	X
Baker R.			X									X	X	X		X	X		
Sulphur Cr.						X		X	X				X				X		X
Boulder Cr.						X		X	X				X				X		X
Swift Cr.						X		X	X				X				X		X
Jackman Cr.	X	X		X						X	X			X	X		X	X	X
Sauk R.	X				X	X				X	X	X	X	X	X		X	X	X
Suiattle R.									X	X		X	X				X		X
Big Cr.						X						X	X				X		X
Tenas Cr.						X		X				X	X				X		X
Straight Cr.						X						X	X				X		X
Buck Cr.						X		X				X	X				X		X
Lime Cr.					X	X		X				X	X				X		X
Downey Cr.						X		X				X	X				X		X
Sulphur Cr.						X		X				X	X				X		X
Dan Cr.	X				X						X	X	X	X	X		X	X	X
White Chuck R.								X	X	X		X	X	X			X		X
Illabot Cr.	X			X		X		X			X	X	X	X			X	X	X
Cascade R.						X	X				X	X	X	X	X		X	X	X
North Fork						X						X	X				X		X
Diobsud Cr.		X		X		X			X			X	X	X	X		X	X	X
Bacon Cr.						X		X				X	X	X	X		X		X
Goodell Cr.				X				X	X			X	X	X	X		X		X
Samish R.	X	X	X	X	X		X			X	X	X	X		X		X	X	X
Thomas Cr.	X	X		X	X					X			X		X		X	X	X
Friday Cr.	X											X	X				X	X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

Conflicting Watershed Developments—Logging has been one of the most significant conflicting factors and will continue to be an important consideration in the future. Extensive clear-cutting in the foothill areas has influenced runoff patterns, and almost always degraded stream quality with respect to capacity for producing anadromous fish.

Hydroelectric power development includes two dams on the Baker River and three dams on the Skagit River. These installations and their operations adversely affect anadromous fish production by influencing adult and juvenile migration patterns and altering natural river conditions including flow, water quality, streambed gravel composition, and availability of suitable spawning areas.

Water removal from Basin drainages for municipal, industrial, and agricultural purposes is a limiting factor on only a few streams. Most affected is the Samish River, where natural low flows already limit fish production.

Residential permanent and summer home development is accelerating throughout the Basins, particularly on land contiguous to rivers and streams. This usually results in emergency demands for stream channeling and diking, with little or no consideration for measures to protect fish life.

Gravel removal from natural streambeds, for use as building and construction material, or as a flood control measure, reduces available spawning area. Most of this activity occurs in lower river areas.

Limited Spawning and Rearing Areas—Streams experiencing very low summer flows or extreme flow fluctuations are limited in total effective rearing area. The higher elevation mountain streams, having steeper gradients, also have limited rearing potentials. Usable spawning area in the Skagit River is limited because of extreme diurnal fluctuations in water level. Limited spawning areas also exist in some of the high-gradient streams located in the upper watersheds, particularly the higher elevation Suiattle and Baker River tributaries.

Competition and Predation—Competition and predation are moderate in the streams, and not extremely limiting to anadromous fish production. The large variety and abundance of fish species present some limitation on anadromous fishes. However, many of these less desirable species are more readily available to nonfish predators, thus relieving some of the predation pressure on young salmon and trout.

Beneficial Developments

Accomplished and Continuing—Enhancement projects for anadromous fishes have involved intermittent logjam and beaver dam removal, road culvert repair, and installation and operation of fish-passage facilities. At present, the State attempts to clear all major barriers as they occur. Various Federal land management agencies, in cooperation with the State, also engage in this activity. The major fish-passage facility is the trap and haul operation at the Baker River hydroelectric power projects, which transports migrating fish to and from production areas.

Lakes which have been chemically rehabilitated for trout management include Heart, Pass, Everett, Vogler, Beaver, Clear, Erie, McMurray, Cain, and Reed. While only Heart, Erie, and Pass Lakes required screening, McMurray Lake required a screen and barrier. Figure 5-2 indicates the location of various lake and stream improvements.

Fishermen access developments exist at Beaver, Big, Campbell, Clear, Erie, Heart, McMurray, Sixteen, Vogler, Cain, and Samish Lakes (Figure 5-2). Stream access areas include numerous sites developed primarily for boat launching on the Skagit and Sauk Rivers, while those on the Samish River are primarily for streamside fishing use. Additional private and public developments supplement this program.

Under the Wild and Scenic Rivers Act, portions of the Skagit River drainage have been designated for study for possible inclusion in the National Wild and Scenic Rivers System.

Under Development—Acquisition proceedings are underway to purchase and develop a semi-natural steelhead rearing area equal in size and contiguous to Barnaby Slough. Summer steelhead and/or searun cutthroat trout would be reared here.

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters are generally restricted to the more shallow expanses of Skagit and Samish Bays, and Rosario Strait. Moderate depths occur only in the northwest sector, at the southern end of the Strait of Georgia near Cypress Island. Here, readings of 60 fathoms have been recorded.

Inventory and Distribution

Marine Fish—Because of the somewhat restricted environmental types, the variety of marine fish is more limited than in some of the more diversified environments of other basins. Even so, most marine fishes common to other basins are also found throughout this area. These include principally members of the cod family, lingcod, greenling, flounder, sole, surfperch, rockfish, herring, dogfish, and ratfish.

Marine fish population is discussed in the Area section concerning production of these species.

Shellfish—Beaches comprising the Skagit-Samish Basins' shellfish area extend from Deception Pass on the southwest along the shoreline to Stanwood (Stillaguamish Basin). Shoreline areas involved extend northward to Langley Point. The major portion of the bays and beach areas is composed of a silty clay with some sand. The Skagit Flats, from Swinomish Slough to Stanwood, are exposed at mean lower-low water for distances from 1.5 to 2 miles bayward. They extend to at least a minus 2-foot tide level with no major change in slope or composition.

The estuarine and marine areas are directly influenced by Skagit River discharges and by tidal action. Salinities, therefore, vary widely from one location to another. The broad shallow flats and water conditions in this area are conducive to good shellfish production.

Dungeness crabs are abundant in the vicinity of Similk Bay, and in the Hope Island-Seal Rocks area in Skagit Bay. The smaller red crabs are also found in moderate abundance in the shallow waters of the Skagit Flats.

The broad, shallow beaches in the northern marine area provide ideal oyster production grounds. Although this area is exposed to considerable wind and wave action, this apparently does not pose a problem due to the mud bottom. Pacific oysters are grown in moderate abundance along Dewey Beach, in Similk Bay, and on the gravelly and mud beaches from Skagit Island to the Swinomish Flats.

Hardshell clams inhabit much of the marine waters. The native littleneck, butter, and Manila clams are prevalent in the northern portion of Skagit Bay and from Dewey Beach to the Swinomish Flats. Horse, jackknife, and softshell clams are abundant in the mud and silt flats of Skagit Bay. Only a few isolated geoducks occur here, and these exist below the mean lower-low water mark. The common blue mussels are only found in moderate abundance in the more saline waters.

Isolated beds of spot and coon stripe shrimp occur in significant numbers in the main channel off Similk Bay. Smaller populations of the smaller pink shrimp also occur in the same general area.

Although seasonal populations of squid inhabit the marine waters, it is unknown whether significant quantities exist here the year round. Octopi are found in moderate numbers in the northern marine area, principally in the swifter, deeper waters around Deception Pass, and Skagit and Hope Islands. Sea cucumbers, sea urchins, and ghost shrimp are present in scattered concentrations. Ghost shrimp are numerous in various sections of the Skagit Flats.

Production

Information is not available concerning numbers of marine fish and shellfish produced.

Propagation

Marine fishes are not propagated within Basin waters.

Shellfish culture programs are quite extensive throughout the marine sector. Privately managed oyster beaches are situated in Skagit Bay and its surrounding tidelands. Occasionally these production areas receive "seed" stock from State-owned oyster reserves located outside the Basins, and from purchase of foreign seed stock. Primarily, however, shellfish populations are maintained through natural "settings".

Harvest

Marine Fish—Marine fishes support moderate to heavy commercial and sport fishing effort. Commercial harvest is conducted principally by otter trawl vessels and favorite fishing areas include eastern Rosario Strait, Skagit Bay, and southern Samish Bay. Catches are landed at ports from Blaine south to Seattle. Principal species taken include lingcod, Pacific cod, sole, and rockfish.

Sport fishing for marine fish is performed throughout the marine waters by angling and by skin diving and spear fishing in the more protected waters adjacent to the shorelines. Generally, the more popular fishing areas are those where sport salmon harvest is greatest. Principal marine fishes sought include lingcod, flounder, sole, and a variety of rockfish. The estimated angler-day use involved exceeds 1,400 annually.

Marine fish harvest potential was not determined.

Shellfish—Commercial and sport harvest of shellfish is considered moderate. Commercial harvest includes oysters cultured on private beaches scattered throughout the Basins' marine sector.

Sport harvest of shellfish is concentrated mainly on crabs and hardshell clams, with major effort occurring on virtually all public access beach areas. Sportsmen expend an estimated 11,000 man-days of effort on shellfish each year.

Harvest potential for shellfish was not determined.

Factors Limiting Production Other Than Harvest

Marine Fish—The principal factors influencing marine fish production are poor water quality and tideland development.

(1) Poor Water Quality—Only occasional instances of water degradation, such as oil spills and siltation, adversely affect water quality in the marine environment.

The estuarine and marine waters are strongly influenced by surface runoff from the Skagit and Samish Rivers. The principal undesirable condition is excessive silt deposition. In addition, the marine water quality is sometimes degraded by disposal of dredged spoils, direct introduction of untreated domestic and industrial waste, and occasional spilling or washing of oil or other toxic materials from local barges or ships.

(2) Tideland Development—In addition to affecting water quality, urban and industrial development limits certain marine fishes through attrition of natural production areas. Spoil disposal and construction of landfills, extensive breakwaters, piers, and dikes have seldom incorporated fish needs to date, and can be detrimental, particularly to juvenile marine fishes. Such encroachment is particularly evident in the Anacortes-Fidalgo Bay area.

Shellfish—Principal factors limiting shellfish production include poor water quality, adverse physical conditions, tideland development, and competition and predation.

(1) Poor Water Quality—Water temperatures are generally low in the northern portion of Skagit Bay near the Swinomish Indian Reservation during the principal growing season, resulting in poor spat growth.

Conditions similar to those described for marine fish also affect shellfish. Sour, stagnant, decomposing materials create conditions detrimental to clam habitat.

(2) Adverse Physical Conditions—Wind and wave action is particularly harmful to oysters in the Similk Bay and Skagit Bay areas, particularly on the hard gravel beaches. Another major limiting factor for shellfish is attributable to soft mud areas in the Skagit Flats.

(3) Tideland Development—Clam and oyster production is particularly restricted due to the limited tidelands suitable for this purpose. Such areas continue to dwindle through attrition of beach and tideland associated with increased urban and industrial development.

(4) Competition and Predation—The Skagit Flats' soft mud areas are infested with ghost shrimp and burrowing worms; large beds of sand dollars which prevent clam and oyster production; moon snails that feed on the clam populations; and summer blooms of green sea moss which smother the seed oysters.

Beneficial Developments

There are no specific Basin projects for the beneficial development or enhancement of marine fishes.

Shellfish enhancement techniques, such as spat collectors and predator controls, are implemented at private oyster culture areas.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The 1963 population census ranks the Skagit-Samish Basins with 53,800 people as one of the moderately inhabited areas as compared to other basins in the Puget Sound Area. Projections indicate populations of 64,200, 86,500, and 118,200 in 1980, 2000, and 2020, respectively. Major population increases will be directly related to new industrial development. This expansion, along with community and suburban developments, will be distributed principally throughout the lower Skagit and Samish River valleys. Local planners are proposing that much of the rich agricultural land in both valleys be maintained for farming. However, unless zoning ordinances are enforced, considerable urban sprawl is expected to occur over the entire lower valley floors, as well as over much of the surrounding lowland hillsides. Summer-recreation home development and construction of year round residences will increase rapidly in areas adjacent to streams and rivers, especially over the upper Skagit and Samish River watersheds. Industrial development is expected to occupy much of the lower valleys adjacent to these rivers.

Although the upper reaches of the Skagit River are somewhat remote from major population centers, this Basin is one of the most popular recreation areas in the State. The Basins' tremendous expanse, with their highly diversified stream types, offers nearly unlimited outdoor recreation opportunities. The recent establishment of the North Cascades National Park and Ross Lake National Recreation Area will encourage additional visitation to the Basins, as would the designation of the Skagit River and certain of its tributaries as national wild and scenic rivers. The highway and road systems provide generally good access to the Basins' waters. With an expected upsurge in outdoor recreation demand, associated with increased population and more leisure time, sport fishing pressure within the Basins is expected to accelerate at a rate much greater than that of population growth. Also, within Basin marine waters, as well as in all salt-water areas where Skagit and Samish River salmon are harvested, there will be a marked increase in demand for such fish by both commercial and sport fishermen.

The expected increased development of private beach property and expanded industrial facilities will create additional pressures on marine fish and shellfish. Attrition of beach, tideland, and marine water areas will tend to reduce the production capacity of marine fish and shellfish, and the associated population increase will cause additional pressure, particularly through demands from sport fishermen.

RESOURCE DEMANDS AND NEEDS

Basin waters support moderate to heavy commercial fisheries for salmon, marine fish, and shellfish. Streams produce significant numbers of salmon that enter commercial and sport fisheries both within and outside the Basins. The Swinomish Indians, fishing the lower Skagit River and the estuarine waters of Skagit Bay, harvest a considerable quantity of salmon and steelhead annually. This fishery has remained relatively constant in the past, and is expected to continue to do so, at least in the near future.

Sport fishing for salmon in Basin waters is significant, with effort concentrated in the lower reaches of the Skagit River, and in the estuarine and marine waters of Skagit Bay. Each year this angler pressure increases. The numerous boathouses and local resort facilities are almost entirely dependent upon seasonal returns of adult anadromous fish to the Basins' rivers.

Commercial and sport catch of salmon is large, especially during pink salmon years. This catch represents a highly significant contribution toward meeting overall Pacific Northwest demands for fish resources. As demands continue to rise, it will be necessary to resolve problems and conflicts relating to fish production, and to develop projects and implement programs that will best utilize the production potential of the Skagit and Samish River systems.

Marine fish and shellfish contribute at moderate to heavy levels to sport and commercial fisheries. These fisheries are expected to become more and more significant in the near future. It is expected that demands for increases in production will be especially strong from sportsmen.

The Skagit, Samish, and Sauk Rivers are extremely productive and popular sport fishing waters, and natural production is augmented by an artificial propagation program. Resident game fish are abundant upstream from anadromous fish barriers. There is prime fishing in reservoirs such as Diablo, Ross, and Baker Lakes, and in many alpine and lowland natural lakes. Based on harvest surveys, residents' use of the resource will approximate that of the present. This means that approximately 50 percent of all harvest and 75 percent of utilization of game fish other than steelhead, is by people from outside the Basins. It is estimated that, by 1980, lakes must provide an additional 850,000 trout and 178,750 game fish of other species to the creel each year. This is an increase of 41 fish per surface acre. Similarly, streams must support an additional yearly harvest of 346,000 resident trout and whitefish and 25,850 steelhead. As population, leisure time, and demand for outdoor recreation increase in nearby basins and the State as a whole between 1980 and 2020, the need for game-fishing recreation will increase proportionately. Table 5-6 indicates present and projected demands and needs for game fish in angler-days.

TABLE 5-6. *Present and projected sport fishermen use (game fish) in Skagit-Samish Basins*

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	747.0
1980	500.5	1,247.5
2000	713.6	1,961.1
2020	1,176.7	3,137.8

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish resources of the Skagit-Samish Basins are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to these Basins.

Conflicting Land and Water Uses

(1) Seattle City Light's power peaking operations downstream from Gorge Dam on the Skagit River result in excessive adult and juvenile salmonid mortalities because of the extreme diurnal fluctuation in river flows. Receding waters on the shallow sloping banks and bars of the river often disrupt natural spawning, and throughout the year strand large numbers of juvenile fish which are taken by predators or die from extreme temperatures or lack of oxygen.

(2) At scattered points throughout the Skagit River watershed, improper logging practices have conflicted with fish requirements. Improperly managed, extensive clear-cutting creates excessive intermittent runoff and increases streamside erosion and stream siltation. Clear-cutting adjacent to streambanks eliminates shade and cover and results in rising water temperatures, losses of terrestial and aquatic food organisms, and increased predation. The use of streams for yarding logs and improper road construction where sloughing and erosion cause serious silting and muddying of adjacent streams adversely affect fish resources.

(3) Any over-appropriation of waters from Basin drainages, particularly from the Samish River and its tributaries, and from some of the small to moderate-sized tributaries of the Skagit River system, seriously affects the streams' capacity to produce fish. This is especially critical during late summer low flow periods.

(4) Dams being considered for the Sauk River would destroy fish habitat. The lower Sauk Dam would also eliminate this river's anadromous fish runs. No successful method exists for passing downstream migrants over high dams. The upper Sauk Dam would destroy fish habitat as well as pose problems related to homing instincts of anadromous fish, particularly if water is diverted to the Stillaguamish River.

(5) Dams being considered for the Cascade and Suiattle Rivers would destroy fish habitat. The reservoirs would have limited recreation use due to heavy glacial siltation.

Poor Water Quality

(1) Intermittent and seasonal pollution occurs in the lower Skagit and Samish Rivers and in their estuarine waters. This sometimes results in water quality that inhibits fish and shellfish production. Effluents from agricultural, industrial, and municipal sources are particularly detrimental to aquatic life. Also, the buildup of sludge and heavy waste in estuaries limits natural shellfish and marine fish production.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Skagit-Samish Basins. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential projects for enhancement of anadromous fish include permanent fish-passage facilities at a partial barrier in the Cascade River, and possibly at a series of small falls in the North Fork Cascade. The feasibility of passing fish at the North Fork barrier must be more thoroughly investigated.

Other potential enhancement projects should include the improvement of stream and streambed conditions in many of the smaller Skagit River tributaries, as well as in streams tributary to the Cascade, Sauk-Suiattle, and Baker Rivers. Stream sections along the lower Samish River and some of its larger tributaries should also be improved. In addition, projects to curb excessive flood damage that occurs on the Skagit, Sauk, White Chuck, and Samish Rivers, on Grandy Creek, and in a few of the smaller drainages should be undertaken. The proposed Avon Bypass near Mount Vernon should relieve much of the lower valley flooding.

Streambed controls could be achieved by selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools and riffles where they are now unstable or lacking. Streamflow controls might be achieved through the development of overflow channels, flood flow diversions, or impoundments on the main rivers or in potential off-river areas.

There is potential for increasing artificial propagation at existing facilities, and in developing any of the numerous artificial propagation sites throughout the Basins. Many sites are suitable for development of hatcheries, eyed-egg incubation channels, spawning channels, or controlled impoundments for off-river rearing (Photo 5-4). Suitable sites for such facilities are located along much of the Skagit, Cascade, Sauk, and Samish Rivers, and along many of the moderate-sized tributaries to these rivers. Further investigation will be necessary to determine the most feasible sites for artificial propagation projects.

PHOTO 5-4. Hatchery development is a primary means of satisfying increasing angler demand. (Washington Department of Game photo)

One beneficial program closely associated with artificial propagation would be fish liberation in stream areas presently blocked to anadromous species, specifically those deemed economically unfeasible to ladder but containing substantial rearing area. Such areas exist in the North Fork Cascade and the North and South Fork Sauk River, and in Illabot, Finney, and Day Creeks.

Close coordination and liaison between fishery agencies and Seattle City Light is essential to prevent flow releases from the upper Skagit River dams from damaging fish resources. Studies are needed to determine if decreasing the magnitude and/or reducing the abruptness of water releases from power peaking generation will be more compatible with fish production than the present operation.

Additional programs beneficial to anadromous fish in the Skagit-Samish Basins should include implementation of water quality controls in the Skagit and Samish Rivers, and in the estuarine and marine waters. Also needed are programs to establish permanent flood plain zoning that would restrict indiscriminate riverside construction projects which nearly always reduce the quantity and quality of fish production habitat, and usually require flood protection remedies. Better coordination of flood control channeling projects, riverbed gravel removal operations, and watershed logging and land clearing practices, so that such operations are compatible with fish habitat requirements, is essential.

Another much needed program is the setting of rigid controls on the removal of water, for any purpose, from natural flowing streams. An extensive evaluation of new means for obtaining future municipal and industrial water supplies should be conducted in conjunction with this. Subjects deserving study include potential use of dual water systems (consumptive/irrigation and sewage) and possible use of desalted marine water as a byproduct of any proposed thermonuclear powerplants.

Other enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish populations, including control of forest and agricultural spraying, as well as curtailing the disposal of untreated municipal and industrial wastes; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to ensure protection of fish resources; (3) guide management to promote effective regulation for all fisheries, and provide necessary changes in fishing areas and harvest methods, thus yielding greater maximum benefit from available stocks; and (4) perform studies and obtain information necessary in achieving the most efficient management possible, including specific streamflow data (river cross-section measurements) to determine flow levels necessary for fish, and to provide methods and techniques for altering streamflow and streambed conditions to increase the productive capacity of aquatic environments. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, are shown on Table 5-7. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

MARINE FISH

Enhancement projects for marine fishes in the Skagit-Samish Basins could include creation of additional habitat and new fishing areas through selective placement of rock jetties or submerged automobile bodies. Another program benefiting these fish would be to establish and implement water quality controls in the estuarine and marine waters. Without such controls a drastic reduction in marine fish populations is foreseen.

Natural production is adequate at the present time, but artificial propagation will be instituted as required.

SHELLFISH

Potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents now limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. The latter might be accomplished by heating controlled salt-water areas or by adding nutrients.

The marine waters hold considerable potential for expanded development of rack and raft oyster culture, and many of the public access beach areas are suitable for put-and-take clam stocking programs.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Skagit-Samish Basins offer many opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. Major potential developments, including an indication of priority, are categorized in Table 5-8 and defined by stream in Table 5-9.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the developments listed. Nearly all of the major proposals are included as goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of potential developments are included in a preliminary plan for increasing salmon production levels to meet overall Pacific Northwest demands for fish resources in the future. These proposals, and salmon production increases, are indicated by target year in Table 5-10.

Table 5-11 shows estimated annual benefits and costs in terms of sport and commercial harvest for the same projects. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate and needs are not so critical as for salmon.

TABLE 5-7. Tentative flow schedule required to maintain fish production levels, Skagit-Samish Basins

Stream[1]	Flows (cfs) by Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Skagit R.												
(upstream from Alma Cr.)	4,000	4,400	4,500	4,500	4,500	3,900	4,600	6,600	7,000	6,000	3,600	3,000
(point near Concrete)	11,500	12,000	12,000	12,000	11,500	10,500	12,000	13,000	15,000	12,000	9,000	7,900
Cascade R.	700	700	700	700	625	500	800	1,200	1,400	1,100	800	650
Sauk R.												
(upstream from White Chuck R.)	800	1,000	1,000	1,000	900	660	1,000	1,300	1,500	1,000	500	430
(point near Sauk)	2,800	3,700	3,700	3,700	3,500	2,800	3,500	4,500	5,200	3,500	2,500	2,000
Suiattle R.	1,100	1,150	1,150	1,150	1,150	1,100	1,400	1,800	2,100	1,800	1,300	1,000
Samish R.	130	300	400	400	400	330	250	150	100	50	35	40

1/ Locations are existing U.S. Geological Survey gaging stations.

TABLE 5-8. Potential developments for production and use of salmon and shellfish, Skagit-Samish Basins

Beneficial Development	Priority		
	Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Provide fish-passage facilities on Cascade River	X		
Restock clam beaches	X		
Improve public beaches for clam production		X	
Expand existing artificial production facilities	X	X	X
Improve stream and streambed conditions	X	X	X
Plant salmon upstream from obstructions	X	X	X
(2) Acquisition			
Evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop 6 salt-water public access sites for fishing (and waterfowl hunting)	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Acquire 5 miles of additional beach area for public use		X	
Procure riverbank public access sites	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Promote Indian fishery conservation measures	X		
Develop subtidal park for skin divers		X	
Implement fishery management regulation changes	X	X	X
(4) Coordination and Legislation			
Promote effective flood plain zoning codes, including recommending upper Skagit as "wild river" area	X		
Coordinate all operations and activities on streams, i.e., gravel removal, logging, flood control	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross-section and profile measures	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Stream and streambed improvement techniques	X	X	

TABLE 5-9. Potential beneficial developments for fish, Skagit-Samish Basins

Stream	Enhancement Measure									Species Benefited							
	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Sockeye	Steelhead	Searun Cutthroat	Resident Trout
Skagit R.				$\boxed{X}$	$\boxed{X}$	X	X	$\boxed{X}$	X	X	X	X	X	X	X	X	X
Nookachamps Cr.					X		X	X	X		X				X	X	X
Hansen Cr.		X									X				X	X	X
Gilligan Cr.		X									X		X		X	X	X
Day Cr.		X				X	X	X	X			X	X				X
Jones Cr.					X						X	X			X	X	X
Muddy Cr.									X		X				X		X
Savage Cr.		X	X								X				X	X	X
Grandy Cr.		$\boxed{X}$		X					X	X	X	X	X		X	X	X
Pressentin Cr.		X									X	X	X		X	X	X
Finney Cr.			$\boxed{X}$		X				X	X	X	X			X	X	X
Baker R.							X	X						X			
Sulphur Cr.		X									X			X			X
Boulder Cr.		X									X			X			X
Swift Cr.		X									X			X			X
Jackman Cr.		X									X	X	X		X	X	X
Sauk R.				X	X	X	X	$\boxed{X}$	X	X	X	X	X		X	X	X
Suiattle R.				X			X	X				X	X				
Big Cr.									X	X	X				X		X
Tenas Cr.			X							X	X				X		
Straight Cr.			X							X	X				X		
Buck Cr.			X							X	X				X		
Lime Cr.		X	X							X	X				X		X
Downey Cr.			X							X	X				X		
Sulphur Cr.			X							X	X				X		
Dan Cr.		X	X	X						X	X	X	X		X	X	X
White Chuck R.		X		X						X	X	X			X		X
Illabot Cr.		X	X							X	X				X		X
Cascade R.	$\boxed{X}$		X			X	X	X	X	X	X	X	X		X		X
North Fork	X									X	X				X		X
Diobsud Cr.		X	X							X	X	X	X		X	X	X
Bacon Cr.		X	$\boxed{X}$				X	X		X	X	X	X		X	X	X
Goodell Cr.		X								X	X	X	X		X	X	X
Samish R.			X	X	X				X	X	X	X	X		X	X	X
Thomas Cr.		X									X		X		X	X	X
Friday Cr.					X				X		X				X	X	X

$\boxed{X}$ Priority project.

TABLE 5-10. Estimated total salmon production increases in Skagit-Samish Basins, by project or program, to satisfy needs[1]

Project or Program, and Year	Species and Number				
	Chinook	Coho	Pink	Chum	Sockeye
Pre-1980					
Provide fish passage, Cascade Falls	800	1,500	3,000	1,000	--
Supply flood control and augment flows	10,000	12,000	22,500	5,000	--
Subtotals	10,800	13,500	25,500	6,000	--
1980-2000					
Provide fish passage, N. Fk. Cascade R.	800	7,500	--	--	--
Improve fish habitat, 18 streams, 38 stream miles	4,700	24,200	20,600	5,200	--
Clear channels, 13 streams, 38 stream miles	4,000	11,100	3,800	2,000	--
Supply flood control, 6 streams, 79 stream miles	1,400	3,700	3,400	1,200	--
Augment flows, 6 streams, 69 stream miles	2,600	15,300	7,100	--	--
Construct 2 hatcheries	--	102,000	--	--	--
Construct spawning channel, 2 miles	--	--	120,000	--	120,000
Subtotals	13,500	163,800	154,900	8,400	120,000
2000-2020					
Construct 6 hatcheries or equivalent	36,000	153,000	--	--	--
Develop rearing facilities, 130 acres	40,000	110,500	--	--	--
Construct spawning channel, 2 miles	--	--	240,000	--	--
Subtotals	76,000	263,500	240,000	--	--
Totals	100,300	440,800	420,400	14,400	120,000

1/Average annual production (catch plus escapement) at end of each period.

TABLE 5-11. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, Skagit-Samish Basins

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Provide fish passage, Cascade Falls	3,800	$ 7,100	$ 23,700	500	$ 2,900	$ 14,600	$ 30,000	$ 600
Supply flood control and augment flows	25,300	84,300	237,300	4,800	29,100	152,400	2/	2/
Subtotals	29,100	$ 91,400	$ 261,000	5,300	$ 32,000	$ 167,000	--	--
1980-2000								
Provide fish passage, N. Fk. Cascade R.	5,500	$ 18,800	$ 37,400	1,100	$ 6,600	$ 30,700	$ 25,000	$ 500
Improve fish habitat, 38 stream mi.	34,400	82,400	213,800	4,800	28,500	133,100	154,000	3,200
Clear channel, 38 stream mi.	12,900	42,500	92,800	2,500	15,100	70,000	14,800	3,000
Supply flood control, 79 stream mi.	6,000	15,700	40,200	900	5,600	25,400	2/	2/
Augment flows, 69 stream mi.	16,200	44,400	106,000	2,500	16,400	70,300	2/	2/
Construct 2 hatcheries	74,700	236,700	456,200	12,800	76,600	357,400	2,040,000	120,000
Construct spawning channel, 2 miles	195,700	347,100	1,018,800	4,300	25,800	120,400	1,400,000	28,000
Subtotals	345,400	$ 787,600	$1,965,200	28,900	$174,600	$ 807,300	--	--
2000-2020								
Construct 6 hatcheries or equivalent	131,500	$ 484,500	$ 995,000	30,500	$182,800	$ 853,100	$6,120,000	$360,000
Develop rearing facilities, 130 acres	102,600	400,300	839,400	26,400	158,400	739,400	715,000	130,000
Develop spawning channel, 2 miles	191,400	132,000	650,800	8,600	51,600	240,800	1,400,000	28,000
Subtotals	425,500	$1,016,800	$2,485,200	65,500	$392,800	$1,833,300	$8,235,000	$518,000
Totals	800,000	$1,895,800	$4,711,400	99,700	$599,400	$2,807,600	--	--

1/ Anadromous trout benefits not included.

2/ Multipurpose project. Separable costs, if any, have not been determined.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Flood control in the Basins should include construction of Avon Bypass and additional dike work. Flood plain lands should be zoned for agriculture and outdoor recreation so that flooding would affect undeveloped land, not industrial or urban areas.

Portions of the Skagit River and its tributaries should be included in the National Wild and Scenic Rivers System.

Outdoor recreation planning, including fishing, should be a high priority program in any basin plan. Emphasis must be placed on acquiring public access to lakes, streams, and salt water. The overall attractiveness of these Basins, as well as the Puget Sound Area, as a national recreation resource, will be partially determined by the availability of good fishing opportunities.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Public fishing access areas are proposed for Phebe, Devils, Ten, Day, and Green Lakes, and Upper Baker reservoir. Diablo Lake (Reservoir), and Gorge Lake (Reservoir). Ultimately, all significant lakes and key portions of streams and salt-water areas should have assured public access for fishing.

(3) Construction of public fishing piers at specific sites at Samish Lake is proposed.

(4) Streambank angler access easements on 75 miles of main rivers should be secured.

(5) Salt-water public access and developments primarily for boat launching are proposed for areas on Vendovi, Burrows, Allan, Young, Strawberry, and Jack Islands (all in the Deception Pass and Anacortes areas).

(6) Controlled release of adult steelhead and enlarged spawning channel sections are recommended for Lucas Slough, the outlet of Barnaby Slough.

(7) Preliminary work is underway on the acquisition and planning for development of a slough contiguous to Barnaby Slough. This is being programmed for the rearing of summer steelhead and/or searun cutthroat trout as well as experimental studies with resident-anadromous hybrid game-fish combinations.

(8) A summer steelhead rearing pond should be constructed in the Skagit Basin.

(9) New techniques and products for lake and stream rehabilitation, including fish toxicants selective as to species, should be developed.

(10) New management techniques should be developed to assure greater productivity of lake environments and increased angler use on lakes.

(11) Fish population analyses of rivers and tributary streams should be continued to determine areas where new management practices may be implemented.

(12) New hatcheries will be required to provide for increased harvest of trout in lakes and streams.

(13) Disease control and parasite programs should be developed for lakes to permit increased survival of game fish populations.

Table 5-12 indicates estimated annual benefits and costs of specific programs and projects proposed for the Skagit-Samish Basins to satisfy needs for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Subsequent developments, which may include some listed above, have not been evaluated nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected. That is, benefits from constructing a hatchery may depend on first solving fertility, disease, and public access problems. In such cases, items showing costs will not necessarily show benefits, because the latter are included under other projects or programs.

TABLE 5-12. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Skagit-Samish Basins, pre-1980

Project or Program	Annual Benefits: Angler-Days	Annual Benefits: Value	Costs: Capital	Costs: O&M (Annual)
Lakes				
Acquire and develop public access, 8 lakes	59,400	$ 118,700	$ 128,000	$ 1,000
Construct fishing piers, Samish Lake	5,000	10,000	65,000	--
Develop new fish toxicants	102,500	205,000	10,000	10,000
Develop new fertilization techniques	1/	1/	10,000	10,000
Develop means to control fish diseases and parasites	40,000	80,000	20,000	--
Construct trout hatchery	37,000	74,000	850,000	71,000
Subtotals	243,900	$ 487,700	$1,083,000	$ 92,000
Streams				
Construct summer steelhead rearing pond	50,000	$ 250,000	$ 60,000	$ 33,000
Construct winter steelhead rearing pond	80,000	400,000	150,000	70,000
Acquire and improve streambank access, 75 stream miles	2/	2/	1,396,000	7,500
Construct trout hatchery	103,000	309,000	2,000,000	170,000
Subtotals	233,000	$ 959,000	$3,606,000	$280,500
Salt Water				
Acquire and develop public access, 6 areas	44,500	$ 133,500	$ 142,000	$ 1,500
Subtotals	44,500	$ 133,500	$ 142,000	$ 1,500
Totals	521,400	$1,580,200	$4,831,000	$374,000
Lakes (Alternate to above lake proposal)				
Acquire and develop public access, 8 lakes	59,400	$ 118,700	$ 128,000	$ 1,000
Construct fishing piers, Samish Lake	5,000	10,000	65,000	--
Construct trout hatchery	179,000	358,000	2,800,000	234,000
Subtotals	243,400	$ 486,700	$2,993,000	$235,000

1/ Included with benefits from new fish toxicants.

2/ Included with benefits from propagation and rearing facilities.

Projects and Programs, 1980-2000

(1) Construct and operate a game fish hatchery.

(2) Construct a searun cutthroat rearing pond.

(3) Continue purchase and development of streambank and lake access areas.

(4) Continue research in game fisheries management.

(5) Complete programs and projects not completed prior to 1980.

(6) Develop new projects and programs as required.

Projects and Programs, 2000-2020

(1) Complete programs and projects not completed prior to 2000.

(2) Develop new projects and programs as required.

(3) Continue fisheries research.

Approximately 1,374,000 acres of these Basins are under U.S. Forest Service and National Park Service administration. Forest Service planning for fish resource enhancement has not as yet progressed beyond 1980, but projects and programs similar to these indicated in Table 5-13 are probable during later time periods. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 5-13. Fishery enhancement projects and programs of U.S. Forest Service proposed for Skagit-Samish Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Conduct stream surveys	mile	73	$ 2,200
Conduct lake surveys	acre	2,193	17,500
Fertilize lakes	acre	26	17,900
Clear stream channels	mile	1	2,000
Total			$39,600

PRESENT STATUS—WILDLIFE

INTRODUCTION

The Basins are the largest in the Area and, similar to other major East Sound watersheds, extend from the Cascade crest westerly through rugged timbered foothills and river flood plain farmlands to tidal marshes and offshore islands. Because of the wide variety in land form and elevation, there is a wide range of weather. Vegetation and wildlife vary considerably as do the climate and topography.

BIG GAME

Big game is usually associated with woodland cover and therefore is an important wildlife resource in these Basins, as nearly 95 percent of the land supports some type of timber or woodland cover. The three most important species are black-tailed deer, black bear, and mountain goat (Photo 5-5). Mountain lion inhabit the remote areas. An occasional elk may cross the ridge separating the Nooksack and Baker River drainages, but there is no known resident herd in the area.

Inventory and Distribution

Deer occur throughout the Basins with the exception of urban and intensively farmed areas. The highest concentrations, particularly at the upper extremities of the drainages, generally occur along the low sidehills and streamcourses (Figure 5-2). The deer population, production, and harvest of the Basins and their major divisions are shown in Table 5-14.

The bulk of the Skagit River drainage is a highly productive deer area. Two-thirds of the Basins' deer population occur in the Skagit County portion, which represents only 46 percent of the total land area. The important contributing factor is elevation—63 percent of the woodland cover is below 2,000 feet elevation—where favorable climatic conditions enable deer to winter more successfully. This area supports approximately 13,600 animals. The part of the Skagit drainage in Whatcom County consists mainly of high mountainous terrain. Only about 10 percent of the total area is usable deer habitat, which maintains a population of approximately 2,300 animals. In the Snohomish County portion—upper Sauk and Suiattle River drainages—only 11.4 percent of the area is

TABLE 5-14. Deer population, production, and harvest, in Skagit-Samish Basins, 1961-1965

Drainage and (County)	Population[1] (Total)	Production (Ave. Annual)	Harvest (Ave. Annual)
Skagit R. (Skagit)	13,600	4,150	1,600
Skagit R. (Whatcom)	2,300	700	300
Sauk-Suiattle R. (Snohomish)	2,300	700	200
Samish R. (Skagit-Whatcom)	2,800	850	300
Totals	21,000	6,400	2,400

[1] Game numbers vary throughout the year; therefore, figures designate late September-early October populations.

PHOTO 5-5. More abundant than in any other State, black bear are common throughout Area woodlands. (Washington Department of Game photo)

below 2,000 feet elevation. It supports a deer population exceeding 2,300.

The Samish River drainage maintains approximately 2,800 deer. Some of the mildest weather of the Basins occurs here. This weather factor and high quality habitat make the area highly productive.

The Basins' deer population exceeds 21,000 animals.

Much ideal mountain goat habitat is situated in the rugged eastern portion of the Basins. Many such areas exist in the Sauk and Suiattle River drainages and in the vicinity of Ross Lake. Survey data indicate that approximately 1,050 mountain goats inhabit the Basins, more than in any other basin.

Black bears frequent the forested areas throughout the Basins. Population and harvest estimates for the major divisions of the two Basins are shown in Table 5-15.

TABLE 5-15. Bear population and harvest, Skagit-Samish Basins, 1961-1965

Drainage and (County)	Bear Habitat (% by County)	Population (Total)	Harvest (Ave. Annual)
Skagit-Samish R. (Skagit)	86	2,400	490
Baker-Skagit R. (Whatcom)	45	900	180
Sauk-Suiattle R. (Snohomish)	36	900	180
Totals		4,200	850

An estimated 15 to 20 mountain lions range within the Basins.

Limiting Factors

Various factors limiting big-game populations appear in the Area chapter, Present Status–Wildlife.

Production

Deer production estimates for divisions within the Basins are shown in Table 5-14.

Late summer counts of mountain goats reveal 29 kids per 100 adults, which results in about 235 young annually.

The estimated annual production of black bear is 850-980 animals.

Harvest

Management data indicate an average annual deer harvest of 2,400 animals. The harvest in major divisions of the Basins is shown in Table 5-14. Average annual hunter-day use is 48,000.

Much of the high roadless area in the upper Skagit and Sauk River drainages is included in a September buck season. Grouse, bear, and mountain goat are also legal game during this period. These high elevation areas display their full array of fall colors in September, creating the ultimate in outdoor enjoyment for persons who appreciate nature and prime hunting. Severe weather often renders these areas inaccessible during the regular October hunting season.

The goat harvest has increased steadily for the past several years. The 1962 harvest was 27 goats and the 1963 harvest, 35. In 1964, the hunting area was enlarged and the take increased to 54, and in 1965 another increase resulted in an all-time high of 68 animals harvested. The average annual number of mountain goats harvested is not indicative of the population present. The bulk of the goat habitat is difficult to reach, because of rugged terrain and lack of aceess roads and trails. An estimated 600 hunter-days annually are expended in the pursuit of these animals.

Bears are apparently being harvested at or near maximum numbers in accessible areas. A number of hunters train and maintain dogs for bear hunting. Bear harvest in the Basins, by divisions, is shown in Table 5-15. Average annual hunter-day use is 7,700.

Approximately two to five mountain lions are taken each year, representing 250 hunter-days.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

Beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

Native upland game include blue and ruffed grouse, snowshoe rabbit, mourning dove, and band-tailed pigeon. These birds and animals inhabit the evergreen-hardwood forest habitat. Introduced species, including ring-necked pheasant, California quail, gray partridge, and cottontail are established in agricultural areas.

Inventory and Distribution

The most numerous upland birds are the two species of grouse, which are distributed throughout the Basins wherever suitable habitat exists. A ruffed grouse population of 78,000 and a minimum blue grouse population of 74,000 are estimated.

A few gray partridge occur throughout the agricultural areas.

Table 5-16 presents the distribution of upland game birds by county.

With the exception of a small local area extending north and east of the town of Darrington along the Sauk River, all pheasant range occurs on agricultural lowlands within the main Skagit-Samish River valley. Fair concentrations of pheasant inhabit the Skagit Game Range near Conway, the Pleasant Ridge area, and the agricultural area east of Sedro Woolley. Medium densities exist north of Mount Vernon to Allen and west to Bay View (Figure 5-1). The remaining pheasant range, which extends from Fidalgo Island east through the Skagit River valley to Marblemount, is considered low density. An estimated fall population exceeding 18,000 wild

TABLE 5-16. Distribution, population, and average annual harvest of upland game birds in Skagit-Samish Basins, 1961-1965

	Ruffed Grouse		Blue Grouse		Pheasant		Quail		Pigeon	Dove
County	Pop.	Harvest	Pop.	Harvest	Pop.	Harvest	Pop.	Harvest	Harvest	Harvest
Whatcom	5,300	500	15,000	780	--	--	--	--	--	--
Skagit	65,000	6,400	37,000	1,850	22,000	5,000	2,800	300	--	--
Snohomish	7,700	800	22,000	1,120	--	--	--	--	--	--
Totals	78,000	7,750	74,000	3,750	22,000	5,000	2,800	300	10,500	1,500

pheasant is supplemented by annual releases of game-farm birds.

Significant numbers of California quail inhabit the Fidalgo Island-Pleasant Ridge area, and an occasional convey occurs in various other lowland areas. A population of 2,800 is estimated.

Rabbit inhabit every type of vegetative habitat and rival grouse in overall abundance. The cottontail is prevalent in and near agricultural areas, and the snowshoe occurs in virtually all forested areas. Populations were not estimated.

Population estimates were not determined for band-tailed pigeon or mourning dove.

Limiting Factors

The exotic or introduced wildlife species are most seriously affected by agricultural changes. A progressive change in the past 25 years from high production of cereal grains, primarily oats, to more specialty crops such as peas, sweet corn, and strawberries, has reduced the area potential for introduced upland-game species. The use of insecticide sprays necessary to economically produce these specialty crops is a potential wildlife hazard.

Rigid and effective control of wildfire and reduced emphasis on slash burning after logging have reduced the carrying capacity of wooded areas for native upland game, particularly grouse.

Limiting factors involving band-tailed pigeon appear in the Area chapter, Upland Game.

Production

The average annual production of the various upland-game species is 10,000 (wild pheasant); 42,000 (blue grouse); 42,000 (ruffed grouse); and 1,700 (quail). Production estimates were not determined for rabbit, mourning dove, or band-tailed pigeon.

Harvest

Approximately 5,000 pheasants are harvested annually, 1,300 of which are the direct return of mature roosters released immediately prior to the hunting season. Only 300 quail are taken by hunting, as populations are relatively low, and although sporty, the prize is small. The Basin grouse harvest of 11,500 consists of 7,750 ruffed and 3,750 blues. A total of 10,500 band-tailed pigeon and 1,500 mourning dove is bagged each year. A county breakdown of the upland game bird harvest, (average of years 1961-1965) is shown in Table 5-16. The rabbit harvest averages 4,000 animals annually, most of which are cottontail.

Average annual hunter-days use devoted to harvest of upland game in the Basins is 2,200 (rabbit); 7,100 (pheasant); 230 (quail); 19,200 (grouse); 8,750 (band-tailed pigeon); and 350 (mourning dove).

Propagation

The wild pheasant population is supplemented annually by about 3,400 birds from State-operated game farms within the Puget Sound Area. Approximately 2,200 of these birds are released as mature cocks immediately prior to the hunting season, and the remaining 1,200 are planted in the spring and early summer as additional broodstock. Small numbers of quail and gray, red-legged, and bamboo partridge are propagated on various State game farms and are released periodically within the Basins.

Two private game breeders within the Basins raise limited numbers of pheasant, quail, chukar, and gray partridge for sale.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases.

The Skagit Game Range, operated by the Washington Department of Game primarily to increase waterfowl food and maintain and create public hunting, is the major development for wildlife. This 12,192-acre area includes most of the tidal marsh of the North and South Forks Skagit River and about 500 acres of irrigable diked land. The diked portion is used extensively as a planting site for game-farm-reared pheasants. In addition to the game range, there are six upland-game habitat plots totaling over 57 acres in the Basins. These plots are maintained in near native grass-shrub cover to insure available undisturbed nesting cover.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 350 acres of wildlife habitat development and 1,200 acres of wildlife habitat preservation, located throughout the Basins.

FUR ANIMALS

A major portion of the Basins remains in a near natural state. This, coupled with the overall size and diversity of habitat and climatic conditions, creates favorable habitat for a wide variety of native fur animals. Beaver, muskrat, mink, river otter, marten, weasel, skunk, raccoon, opossum, bobcat, lynx, red fox, and coyote are all relatively abundant.

Much of the overall land area, including the upper Skagit, Baker, and Sauk River drainages, is extremely rugged, and lies at a relatively high elevation. These environs are the principal habitat of marten and lynx. The other fur animals are much more prevalent at lower elevations, where more moderate climate prevails.

Inventory and Distribution

Nearly all of the mink and muskrat and approximately 65 percent of the beaver of Skagit County are found in the Basins. These species are most abundant in the lowland marshes, sloughs, and lakes and along the lower reaches of meandering streams. Estimated populations are: 1,800-2,000 (beaver); 17,000-20,000 (muskrat); and 1,100-1,200 (mink). Populations of the other fur-animal species were not determined.

Limiting Factors

The fur animals most highly prized by the fur industry are water oriented, requiring principally marsh type habitat. Such areas are most prevalent in or near the flood plains of lower watercourses; here the most intensive manmade developments have occurred. Drainage and diking projects to increase agricultural land and flood control measures resulting in loss of riparian habitat, are the prime limiting factors in fur-animal production.

Production

Annual production of the various fur animals is considered stable, with the possible exception of beaver. Readily accessible beaver colonies have been trapped heavily in the past four trapping seasons (1963-64 through 1966-67). Fall beaver populations consist of 30 to 40 percent young of the year, which indicates a production of 550 to 750 annually. An estimated 12,000 to 14,000 muskrat and 500 to 700 mink are produced annually. Other members of the fur-animal group have reproduction rates comparable to that of mink.

Harvest

The number of beaver taken in these Basins has decreased during the past four seasons (1963-64 through 1966-67). This decrease is believed due to several factors, including a loss of interest in trapping these animals, overcropping of readily accessible colonies, and very low harvest in remote areas. The average annual catch has been 360.

In recent years, about 1,800 muskrat, 215 mink, and 10 river otter have been trapped annually. The other fur animals are taken only incidentally. It is doubtful if any of the fur bearers other than beaver are cropped to the full extent of their potential.

Income derived from trapping the three major fur animals—beaver, muskrat and mink—has averaged over $10,000 annually during the past three seasons (1964-65 through 1966-67).

Propagation

Three private mink ranches produce pelts for the commercial market.

Beneficial Developments

Beneficial developments are discussed in the Area chapter, Fur Animals.

WATERFOWL

The Skagit-Samish delta, including the brackish sloughs, marshes, and adjacent Skagit, Samish, and Padilla Bays, is perhaps the most important winter concentration area for waterfowl on the West Coast of the United States and Canada. No other area in Washington attracts snow geese for more than a few days, yet 20,000 to 30,000 of these fascinating birds make the annual flight from nesting islands off the northeast coast of Russia to winter in Skagit Bay (Photo 5-6). Black brant frequent Padilla and Skagit Bays, and numerous species of ducks use the entire lowland area and adjacent estuaries extensively. Skagit County leads all western Washington counties in waterfowl harvest and ranks second in the State.

Inventory and Distribution

Except for limited nesting and brood production on woodland beaver ponds, waterfowl use is restricted to the river valleys, salt-water marshes and bays, lowland lakes, and agricultural lands (Figure 5-2). The delta marsh and adjacent farmlands at the Skagit River mouth provide excellent feeding grounds for winter-migrant and winter-resident waterfowl which rest on Skagit, Padilla, and Samish Bays.

Many dabbling ducks which use this area in fall and early winter later move to other western Washington areas. To determine the duck movement pattern, the main concentration (resting) areas are counted periodically during the fall and winter. An 11-year average (1956 through 1966) of these periodic counts is shown in Table 5-17.

TABLE 5-17. Periodic census of mallard, pintail, green-winged teal, and widgeon on Skagit, Padilla, and Samish Bays, 1956-1966

Census Period	Skagit Bay	Padilla Bay	Samish Bay	Totals
Early October	40,155	24,500	8,100	72,755
Late October	46,050	45,612	13,400	105,062
Early November	47,832	52,809	25,027	125,668
Late November	32,200	36,371	18,300	86,871
Early December	23,786	23,357	16,514	63,657
Early January[1]	27,000	26,742	15,938	69,680

[1] Annual survey.

These counts reveal a steady buildup of the popular hunting species into early November, and then a steady decline as some of the ducks move on to other winter feeding areas. The turnover of ducks–birds arriving and others leaving–during this buildup and decline is undetermined.

January waterfowl counts reveal an annual average of 125,000 birds. The 1965 Skagit County survey is indicative of the species and their relative abundance: mallard (10,072); American widgeon (33,973); green-winged teal (2,781); pintail (5,935); redhead (107); canvasback (404); scaup (15,271); goldeneye (1,886); bufflehead (5,250); ruddy duck (1,048); harlequin (20); eider and scoter (12,810); oldsquaw (370); merganser (135); coot (546); snow goose (25,300); Canada goose (14); black brant (13,094); and whistling swan (28). An additional 286 miscellaneous ducks, including a few shoveler and ring-necked, were counted for a Basins' total of 129,330. Prior to the winter survey, waterfowl have been exposed to almost three months' hunting.

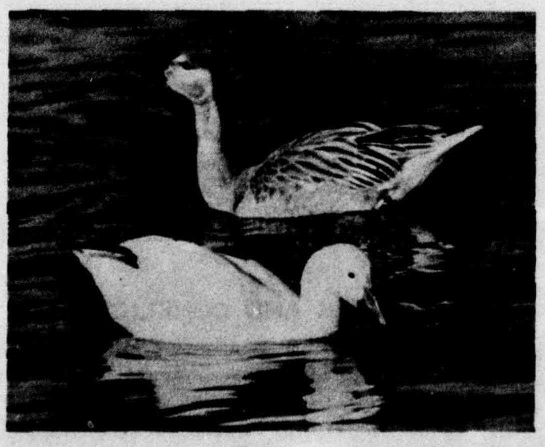


PHOTO 5-6. Skagit and Padilla Bays provide the major northwest winter concentration grounds for snow geese. (Bureau of Sport Fisheries and Wildlife photo)

The average mid-winter survey of 125,000 waterfowl and the average annual harvest exceeding 81,000 birds, coupled with the unknown number of ducks which stop over in fall and early winter for a limited period, emphasize the importance of the Skagit-Samish Basins as a waterfowl area.

Limiting Factors

Changes in farming practices, resulting in decreased cereal grain production, plus diking and drainage of marsh lands for agricultural use, have reduced waterfowl habitat. Present farming efforts are directed toward the production of peas, spinach, sweet corn, and pasture, resulting in little agricultural waste for waterfowl food. Adjacent large bay resting areas are numerous. Food availability, therefore, regulates winter waterfowl populations.

Production

As in the other drainages of the Puget Sound Area and, in fact, all of western Washington, the numbers of locally-raised ducks in comparison to winter migrants are small. A recent inventory revealed an average annual production of 9,000. The mallard is the predominant species raised, with wood duck and teal next in order of abundance.

Harvest

Duck hunting occurs throughout the lowland agricultural area, but is particularly concentrated on Skagit, Padilla, and Samish Bays and on adjacent tidal marshes.

Snow geese are hunted extensively along the tideflats and adjacent agricultural fields. An estimated 4,000 to 6,000 may separate from the main flock of 20,000 to 30,000 birds and use Port Susan and Padilla Bay periodically, providing hunting in and adjacent to these bays. Seldom do these birds venture any great distance inland.

Brant do not form large, highly concentrated flocks like snow geese, and, consequently, are more widely dispersed throughout much of northern Puget Sound. Eelgrass beds, prevalent around Samish Island and in Padilla and Samish Bays, attract considerable numbers of these small geese in mid-winter, and support outstanding hunting.

Recent years' harvest records indicate an average annual take of 76,700 ducks and 5,200 geese, which provides about 65,000 hunter-days.

Propagation

Waterfowl are not artificially propagated in the Basins.

Beneficial Developments

Control and management of 12,192 acres of estuarine habitat in Skagit Bay enhance winter carrying capacity and provide extensive public hunting. Management of the Skagit Game Range includes the retention of natural marsh and production of cereal grains on cultivated, diked land for duck food. Ducks fly from resting areas in Skagit Bay and Port Susan to feed in the marsh and unharvested grain fields of the range.

Conservation practices applied by private landowners to agricultural lands of direct benefit to waterfowl include 1,090 acres of wildlife wetland development, all in the western portion of the Basins.

OTHER WILDLIFE

The many and varied birds and animals in the Basins not classed as game or fur species are classified as other wildlife.

Williamson Rocks, small islands off Langley Point, are part of the San Juan National Wildlife Refuge and are used primarily as rookeries by colonial nongame birds.

Other members of this faunal group are discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

The Skagit-Samish Basins are expected to experience moderate industrial expansion; however, due to their scenic beauty and natural resources, outdoor recreation is expected to play an increasingly important role in the future development and economy.

The Basins are easily accessible from major urban areas to the south by an expanded freeway system and have long been one of the more popular recreation areas in the State. For this reason, much greater pressure is expected on the vast recreational potential than is indicated by the 1.3 to 1.6 percent predicted population increase.[1] Demand on wildlife resources will approximately double by the year 1980. To maintain the present level of hunting success, it will be necessary to provide an additional annual harvest of 2,200 deer; 800 bears; 65 mountain goats; 3,700 rabbits; 4,700 pheasants; 10,700 grouse; 9,000 band-tailed pigeons; and 76,200 waterfowl by 1980. As population, leisure time, and demand for outdoor recreation increase, the demand for wildlife resources will increase proportionately. This demand, expressed in hunter-days, is indicated in Table 5-18.

TABLE 5-18. Present and projected hunter use in Skagit-Samish Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	159.1
1980	148.0	307.1
2000	190.7	497.8
2020	116.5	614.3

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Skagit-Samish Basins is to be satisfied. Problems and conflicts discussed in the Area chapter apply to these Basins.

[1] Population forecasts shown in Future Needs—Fish.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basins during the target years (Photo 5-7).

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 5-19 shows projects and programs proposed for the Basins to satisfy 1980 needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include incidental recreation benefits that will accrue from public use of wildlife areas for swimming, boating, picnicking, hiking, and similar pursuits. Based on existing surveys, such nonconsumptive use more than equals hunting use.

TABLE 5-19. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Skagit-Samish Basins, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs 1/: Capital	Costs 1/: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	4,000	$ 16,000	$ 5,000	--
Develop educational program to stress renewable aspects and proper harvest of wildlife	37,100	196,400	--	$ 5,000
Develop new methods for wildlife population analysis, habitat improvement techniques, and compatible forest-wildlife management practices	2/	2/	35,000	10,000
Specific Programs and Projects				
Acquire and develop waterfowl and fur-animal habitat, 12,000 acres	84,500	422,000	6,150,000	30,000
Acquire access to band-tailed pigeon area, Samish Basin, 500 acres	4,000	16,000	35,000	--
Acquire salt-water access for waterfowl hunting	1,600	8,000	3/	3/
Enlarge game farm to produce additional 5,000 pheasants	6,800	27,200	50,000	15,000
Totals	138,000	$685,600	$6,275,000	$60,000

1/ Do not include survey and plan costs.

2/ Benefits would be widely distributed, but are partially included under other projects and programs in this table.

3/ Costs included in those shown in Table 5-12. These would be multiple-use areas.

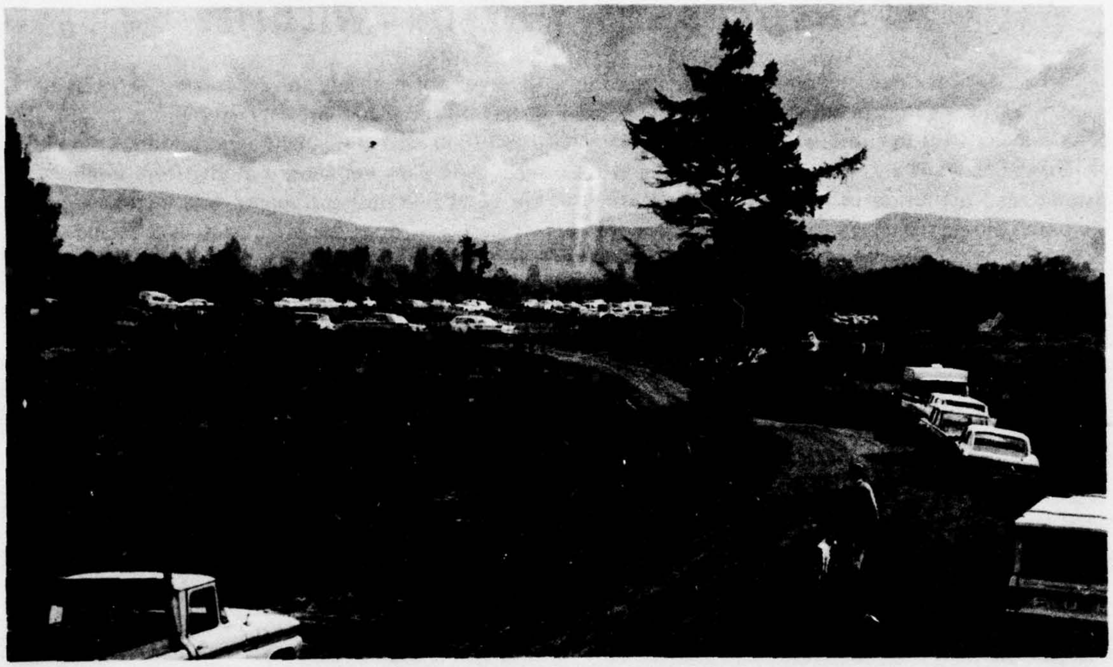


PHOTO 5-7. Growing sportsmen demand necessitates additional access to hunting areas. (Washington Department of Game photo)

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Continue wildlife management research.

(3) Complete programs and projects not completed prior to 1980.

(4) Develop new projects and programs as required.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Complete projects and programs not completed prior to 2000.

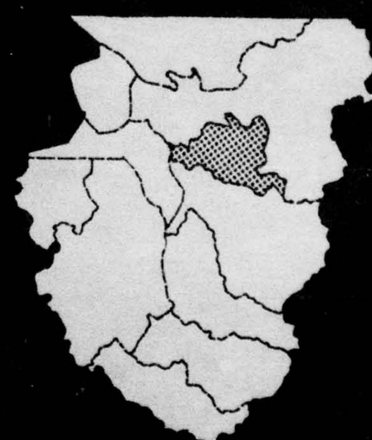
(3) Continue research for new techniques in wildlife management.

Table 5-20 indicates projects and programs for wildlife enhancement planned by the U.S. Forest Service in the pre-1980 period. Plans have not been developed beyond that point, but similar activities may be expected in subsequent periods. Hunter-day benefits from these projects and programs have not been determined, but they will help satisfy overall demand.

TABLE 5-20. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Skagit-Samish Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Surveys and Plans			
Conduct range analysis			
Deer	acre	34,980	$ 3,500
Mountain goat	acre	123,900	12,400
Conduct upland-game habitat surveys	acre	361,750	18,100
Develop habitat management plans	each	1	500
Create permanent openings for big game	acre	102	10,200
Construct shallow impoundments for waterfowl	acre	37	28,200
Total			$72,900

Stillaguamish Basin



STILLAGUAMISH BASIN

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Stillaguamish River and its tributaries is the only drainage system within the Basin boundary (Figure 6-1). Next to the Elwha-Dungeness and the island basins, this Basin has the smallest lake acreage. The nonstream fresh waters include 168 lakes (1,937 surface acres) and 33 farm ponds (17 surface acres). The river system affords excellent spawning and rearing conditions for anadromous and resident fishes. At its confluence with Puget Sound, the Stillaguamish significantly influences the estuarine and marine ecology of northern Port Susan. The estuarine and marine waters support important populations of shellfish and marine fishes.

The Stillaguamish River system consists of the North and South Forks, a relatively long mainstem, and numerous smaller tributaries. Both forks originate in heavily forested foothills of the Cascade Range. Emerging from a shallow canyon 3 miles northwest of Darrington, the North Fork turns west and flows through a mostly broad, gently sloping valley to its confluence with the South Fork at Arlington. The South Fork, which heads in the vicinity of Barlow Pass, flows west and northwest to merge with the North Fork. The headwaters of these forks are swift flowing, with numerous falls and few pools and riffles. Both streams, however, feature considerable pool and riffle area in their lower reaches.

Downstream from the junction, the Stillaguamish divides, with Cook Slough flowing along the south valley floor, and the smaller "Old Stillaguamish Channel" winding along the north valley perimeter. Cook Slough is predominantly a moderate flowing riffle section containing few pools, while the main Stillaguamish is mainly a pool and riffle type stream. The channels merge, but downstream divide again, with the smaller channel extending northwest to its confluence with the northern tip of Port Susan near Stanwood. Downstream from these forks, the main body of Stillaguamish water flows west down Hat Slough to its confluence with Port Susan. Each of these lower stream sections is subject to tidal influence, and represents an extremely important brackish water conversion area for anadromous fishes. The smaller channel is almost entirely a sluggish, extensively-channeled streamcourse receiving mainly overflow during high water periods. Hat Slough, when not under tidal influence, is characteristically a slow to moderate flowing river with numerous pool and riffle areas.

Lakes are relatively scarce in the lower valley. Those located in this zone have typically warmer, relatively shallow environment characteristics. Lake Cavanaugh is the largest, occupying 844 surface acres. Numerous small, cold alpine lakes are located along the Basin's southeastern border and on virtually all high elevation terrain. Many are ice free for only a few months.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in relatively low numbers, and with the exception of the trout, char, and whitefish, are not discussed here in detail.

Anadromous Fish—Anadromous fishes include chinook, coho, pink, and chum salmon; steelhead and searun cutthroat trout, and searun Dolly Varden. These fish migrate, spawn, and rear in 106.4 miles of river including both forks, plus an additional 109.8 miles of accessible tributaries (Figure 6-1). Distribution was increased considerably when fish-passage facilities were completed in 1954 at Granite Falls on the South Fork. Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

Upstream migration timing overlaps considerably, as shown on Table 6-1. Adults of one or more species enter the system every month. During the summer, May through August, the early running species remain in deep holes enroute to their spawning grounds.

The spring and fall races of chinook overlap in their distribution as do those of the other species.

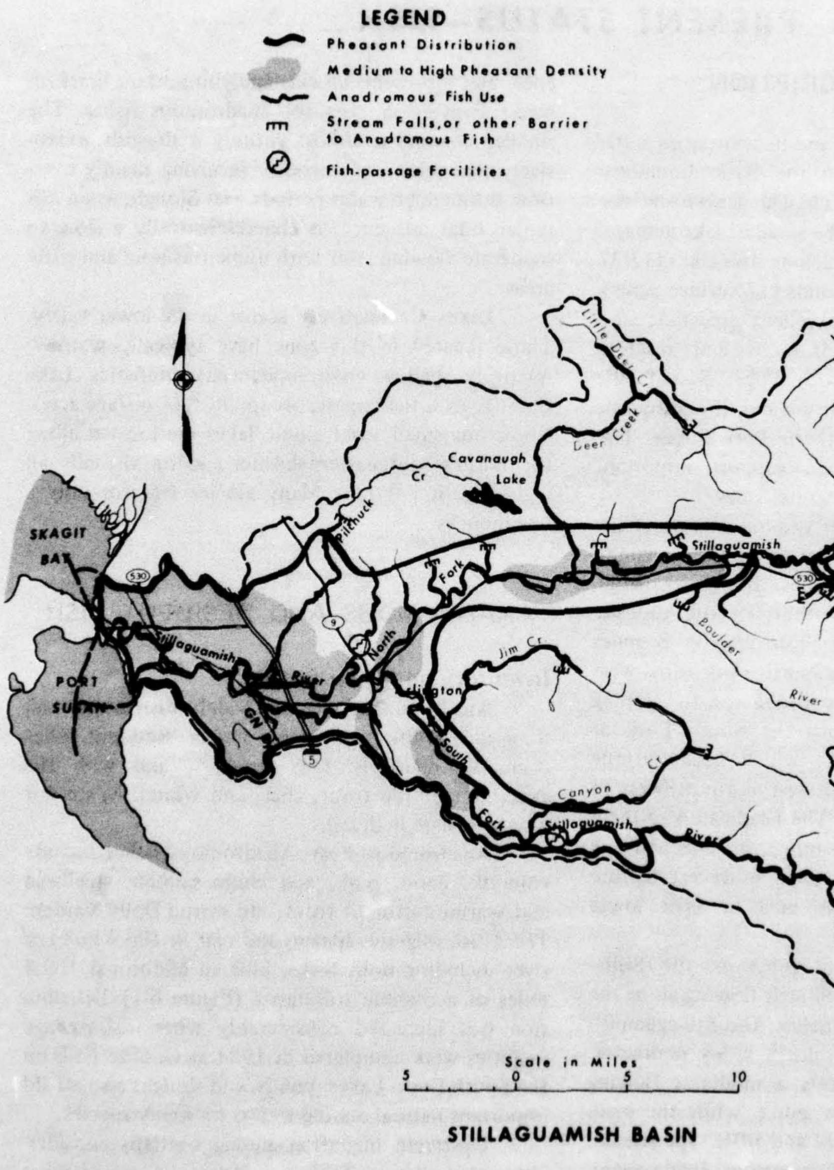


FIGURE 6-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

TABLE 6-1. Timing of salmon and searun trout fresh-water life phases in Stillaguamish Basin

Species	Fresh-water Life Phase	Month J	F	M	A	M	J	J	A	S	O	N	D
Spring chinook	Upstream migration				■	■	■	■	■				
	Spawning								■	■	■		
	Intragravel develop.	■							■	■	■	■	■
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Juv. out migration			■	■	■	■						
Summer-Fall chinook	Upstream migration							■	■	■	■		
	Spawning									■	■		
	Intragravel develop.	■	■							■	■	■	■
	Juvenile rearing	■	■	■	■	■	■						■
	Juv. out migration			■	■	■	■						
Coho	Upstream migration							■	■	■	■	■	■
	Spawning	■									■	■	■
	Intragravel develop.	■	■	■	■						■	■	■
	Juvenile rearing	■	■	■	■	■	■	■	■	■	■	■	■
	Juv. out migration			■	■	■	■						
Pink	Upstream migration							■	■	■			
	Spawning									■	■		
	Intragravel develop.	■	■	■						■	■	■	■
	Juvenile rearing		■	■	■	■							
	Juv. out migration		■	■	■	■							
Chum	Upstream migration									■	■	■	■
	Spawning	■										■	■
	Intragravel develop.	■	■	■	■							■	■
	Juvenile rearing		■	■	■	■							
	Juv. out migration		■	■	■	■							
Summer steelhead	Upstream migration				■	■	■	■	■	■	■		
	Spawning		■	■	■	■	■						
	Intragravel develop.		■	■	■	■	■	■					
	Juvenile rearing[1]	■	■	■	■	■	■	■	■	■	■	■	■
	Juv. out migration			■	■	■	■	■					
Winter steelhead	Upstream migration	■	■	■	■	■	■				■	■	■
	Spawning	■	■	■	■	■	■						
	Intragravel develop.	■	■	■	■	■	■	■					
	Juvenile rearing[1]	■	■	■	■	■	■	■	■	■	■	■	■
	Juv. out migration			■	■	■	■	■					
Searun cutthroat	Upstream migration	■	■					■	■	■	■	■	■
	Spawning	■	■	■	■								■
	Intragravel develop.	■	■	■	■	■							■
	Juvenile rearing[1]	■	■	■	■	■	■	■	■	■	■	■	■
	Juv. out migration			■	■	■	■	■					

[1] Normally extends over a two-year period.

Stream sections throughout the accessible length of the North and South Forks, plus portions of the Stillaguamish downstream from Arlington, receive chinook spawners. Tributaries supporting chinook populations include Boulder River and Squire, Deer, Canyon, Jim, and Pilchuck Creeks.

Nearly every accessible tributary receives coho spawners. In addition, coho spawning also occurs throughout sections of the North and South Forks and in a few areas of the lower Stillaguamish. Some of the more important spawning tributaries include Boulder River and Squire, French, and Deer Creeks on the North Fork; Boardman, Canyon, and Jim Creeks on the South Fork; and Portage and Pilchuck Creeks on the lower Stillaguamish. A number of these tributaries provide considerable spawning area.

Adult pink salmon spawn in virtually every tributary to the Stillaguamish River system. These fish also spawn in the riffles and side channels of the accessible length of the North Fork and in the extensive riffle areas of the lower South Fork upstream to Granite Falls. Some pinks spawn in the upper South Fork upstream from the falls, however, this species does not readily use the laddering system. Pink salmon also spawn in the riffles downstream from the confluence of the forks to within 5.1 miles of the Stillaguamish mouth.

Most streams tributary to the North Fork, South Fork, and to the Stillaguamish receive spawning chum salmon. Also, considerable spawning occurs in the North Fork, and in the South Fork upstream to Granite Falls. Few chum salmon have ever been recorded upstream from the falls. Chum salmon also spawn in the lower Stillaguamish downstream to within 5.1 miles from the mouth.

Steelhead have been observed in virtually every major or tributary stream downstream from anadromous fish barriers. Considerably improved spawning followed completion of the Granite Falls fishway. Spawning occurs in selected gravel areas and rearing takes place in all available sheltered sections.

Essentially, all accessible river segments and tributary drainages are utilized by searun cutthroat for spawning and/or rearing.

Significant spawning reaches in some streams are delineated in Table 6-2.

Intragravel egg development occurs over an 11-month period, because of the overlapping spawning time of various species.

"Out migration" for all species occurs mainly during the period February-June, corresponding with high runoff. Some intrariver migration of coho, chinook, and anadromous trout occurs throughout the year, but this is natural redistribution of juvenile salmonids within the stream systems. Various downstream migrants spend considerable time in the vital acclimation areas of Port Susan's estuarine waters. Extremely important to the survival of these tiny fragile fish is the environment in the lower Stillaguamish, in the estuaries, and in closely associated *marine* waters near the river's mouth. The juvenile salmonids, after adjusting to the salt-water environment, disperse into the Strait of Juan de Fuca and the ocean.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 6-3.

Resident Fish—Resident fish spawn and rear in most of the stream and lake waters (Table 6-2). Significant populations of rainbow trout inhabit all

TABLE 6-2. Significant spawning reaches for anadromous fish and resident game fish, Stillaguamish Basin[1]

Stream	Section	Stream Mileage	Type of Spawning Area
Stillaguamish R.	Hat Slough to Interstate Hwy. 5	2.0-9.0	Few broad riffles, many slow glides, some patch gravel
	Interstate Hwy. 5 to forks	9.0-16.0	Many broad riffles and beach gravel bars
North Fork	Mouth to Cicero	0.0-9.0	Few broad riffles, intermittent patch gravel area
	Cicero to Boulder R.	9.0-24.0	Numerous broad riffles, some patch and beach gravel
	Boulder R. to falls	24.0-34.0	Some broad riffles, some intermittent patch gravel
South Fork	Mouth to Canyon Cr.	0.0-15.0	Numerous broad riffles, some channel splitting
	Canyon Cr. to Robe	15.0-25.0	Few patch gravel sections only
	Robe to headwaters	25.0-45.0	Occasional broad riffles, mostly patch and beach gravel

[1] Additional spawning area is provided by virtually all tributaries entering within described reaches.

TABLE 6-3. Anadromous fish spawning escapement, natural and (artificial), in Stillaguamish Basin

Species	Range[1]	Average (Annual)
Chinook	160-10,880	4,940
	(0-650)	(340)
Coho	6,780-62,540	21,200
	(1,240-4,960)	(2,510)
Pink	125,000-640,000	268,750[2]
Chum	5,540-12,930	8,400
Summer steelhead[3]	900-2,350	1,500
Winter steelhead[3]	18,300-37,900	24,900
Searun cutthroat[3]	43,600-90,500	59,300
Searun Dolly Varden[4]		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

2/ Per odd-year escapement.

3/ Totals include natural and (artificial) escapement.

4/ No valid totals established.

large streams which afford adequate environment. They also are present to a lesser degree in smaller tributaries. Cutthroat trout are distributed throughout suitable waters, but favor the habitat in the lower river and its tributaries. Brook trout have been introduced in South Fork tributaries such as Jim and Deer Creeks and in smaller alpine lake outlets. Dolly Varden are common in the South and North Forks and Canyon and Deer Creeks.

Kokanee have been introduced only in Lake Cavanaugh and their ability to fill an ecological niche has been of major significance in those waters. Small tributaries to the lake provide limited spawning. Mountain whitefish, another stream-oriented species, are abundant. Largemouth bass, yellow perch, black crappie, pumpkinseed, and brown bullhead are introduced species and are distributed only in a few low-elevation lakes and ponds.

Other resident species occurring in relative abundance include threespine sticklebacks, sculpins, dace, redside shiners, suckers, and squawfish. Redside shiners and dace are established in Twin Lakes and throughout their outlet system to the South Fork Stillaguamish. Suckers, squawfish, and sculpins occur in nearly all of the lower elevation lakes and streams, and peamouth inhabit the Stillaguamish. Threespine sticklebacks are most common in Portage and Armstrong Creeks.

Production

Fish production is considerably lower in the South Fork drainage than in either the North Fork or main river drainages. Based on a 1966 stream survey, production varied from essentially zero to over 400 pounds of fish per surface acre. The average yield was 137.9 pounds. Salmonid populations equaled 83.9 pounds per surface acre, while other or undesirable species exclusive of lampreys comprised the remaining 54 pounds.

Anadromous Fish–Total salmonid production in the Basin depends greatly on levels of natural spawning and rearing success. The excellent quality and undisturbed character of much of the existing aquatic habitat promote a high degree of propagation from these streams. Exceedingly important areas include most of the North Fork, the lower South Fork, and the major tributaries.

Streams such as Deer and Canyon Creeks and both forks are noted for summer and winter steelhead runs, and production approaches the natural potential. During the period 1962-1966 the average annual natural production of steelhead approached 39,500 adults. Production of searun cutthroat trout is considered substantial; average annual natural production during that same period equaled 79,200 adults. Potential natural production of these species is anticipated to be somewhat greater.

Table 6-4 presents fish production data.

TABLE 6-4. Anadromous fish natural production (harvest plus escapement), Stillaguamish Basin

Species	Range[1]	Average (Annual)
Chinook	640-43,520	19,760
Coho	33,900-312,700	106,000
Pink	375,000-1,920,000	806,250
Chum	11,080-25,860	16,970
Summer steelhead	1,340-3,530	2,200
Winter steelhead	27,500-56,900	37,300
Searun cutthroat	58,200-120,700	79,200
Searun Dolly Varden[2]		

1/ Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965), searun cutthroat (1962-1966).

2/ Production limited and therefore not determined.

Resident Fish–Most Basin streams upstream from anadromous fish barriers are small, cold, and precipitous and are producing their natural potential. The instantaneous standing crop (excluding lampreys) in low flow periods, from streams sampled, was usually less than 38 pounds per surface acre; sculpin represented about 40 percent of this production. Fish recruitment comes primarily from headwater lakes or ponds (and occasionally from plants of hatchery-reared trout).

Stream reaches downstream from migratory barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The average standing crop yield (which does not include hatchery fish) varies between 70 and 170 pounds per surface acre.

Actual production of intermediate and low elevation lakes and ponds is shown in harvest data. The total harvest of certain standing waters varies from one season to another and may vary from less than 10 to nearly 100 pounds per surface acre annually. Potential production could be substantial.

Propagation

Although the State maintains no Basin hatcheries or other artificial propagation facilities for salmon (except for coho reared for lake planting), natural production is supplemented by perennial plants or stock from hatcheries in nearby basins. Chinook and coho juveniles are obtained from State salmon hatcheries located in the Skagit-Samish Basins. Salmon runs have been sustained in the Stillaguamish system at an adequate production level despite the lack of a hatchery and the heavy Indian fishery in Port Susan.

Preliminary commercial and sport catch statistics indicate that the salmon liberation program in the Basin contributes approximately 7,800 adult chinook and 9,000 adult coho to these fisheries annually.

Resident and anadromous game fish are produced at the Arlington Fish Hatchery near Cicero, and anadromous fish are reared at the Whitehorse Rearing Ponds near Fortson (Figure 6-2). Both facilities, located on tributaries of the North Fork Stillaguamish River, supplement planting activities in adjacent basins and in other waters of Washington.

Emphasis is placed on annual releases of resident and anadromous species in streams and lower elevation lakes. Many alpine lakes receive plants of resident trout every three to five years as needed. Plants of legal-size hatchery fish also supplement natural production in the most heavily fished lakes and streams, and in habitats which have been altered by barriers or polluted by nature or man and recently improved. Approximately 28 farm fish ponds receive plants of hatchery game fish every two to three years from privately-owned facilities.

Most of the fish reared at Whitehorse Ponds and approximately one-half of those produced at the Arlington facility are liberated in waters of this Basin. State facilities in other basins also contribute significantly to the overall trout stocking program.

Several privately-owned trout hatcheries in the Arlington and Granite Falls vicinities produce rainbow trout for commercial outlets, including private ponds.

It has been determined that nearly 50 percent of all North Fork steelhead caught in the winter of 1964-65 were artificially reared. This catch has increased about 20 percent since 1963 activation of the Whitehorse Ponds. Recent stream survey and catch data indicate that the Basin stocking program provides approximately 30 percent of all searun cutthroat trout, 50 percent of all steelhead trout, 90 percent of all resident trout, and 100 percent of all lake-reared coho salmon harvested in its waters annually.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 1,939,135 chinook; 430,702 coho; 134,968 steelhead; and 29,978[2] searun cutthroat. Resident fish propagation data are presented in the Area chapter.

Harvest

Existing Harvest–Salmon reared in the Stillaguamish River system contribute heavily to United States and Canadian ocean sport and commercial fisheries and to those in Puget Sound. Between 1956 and 1965, the average annual salmon catch was 401,670. The very limited marine segment of the Basin receives virtually no commercial or sport fishing effort for salmon.

Fresh-water angling for salmon is limited to the Stillaguamish River. The major portion of the catch is pink salmon. In 1965, the catch, representing 6,500 angler-days use, was estimated at 4,700 salmon. The reported take of coho and chinook in non-pink years 1964 and 1966 totaled only 415 fish. The estimated

[1] Anadromous trout data involve period 1962-1966.

[2] Annual stocking initiated in 1964, with most active program in 1966.

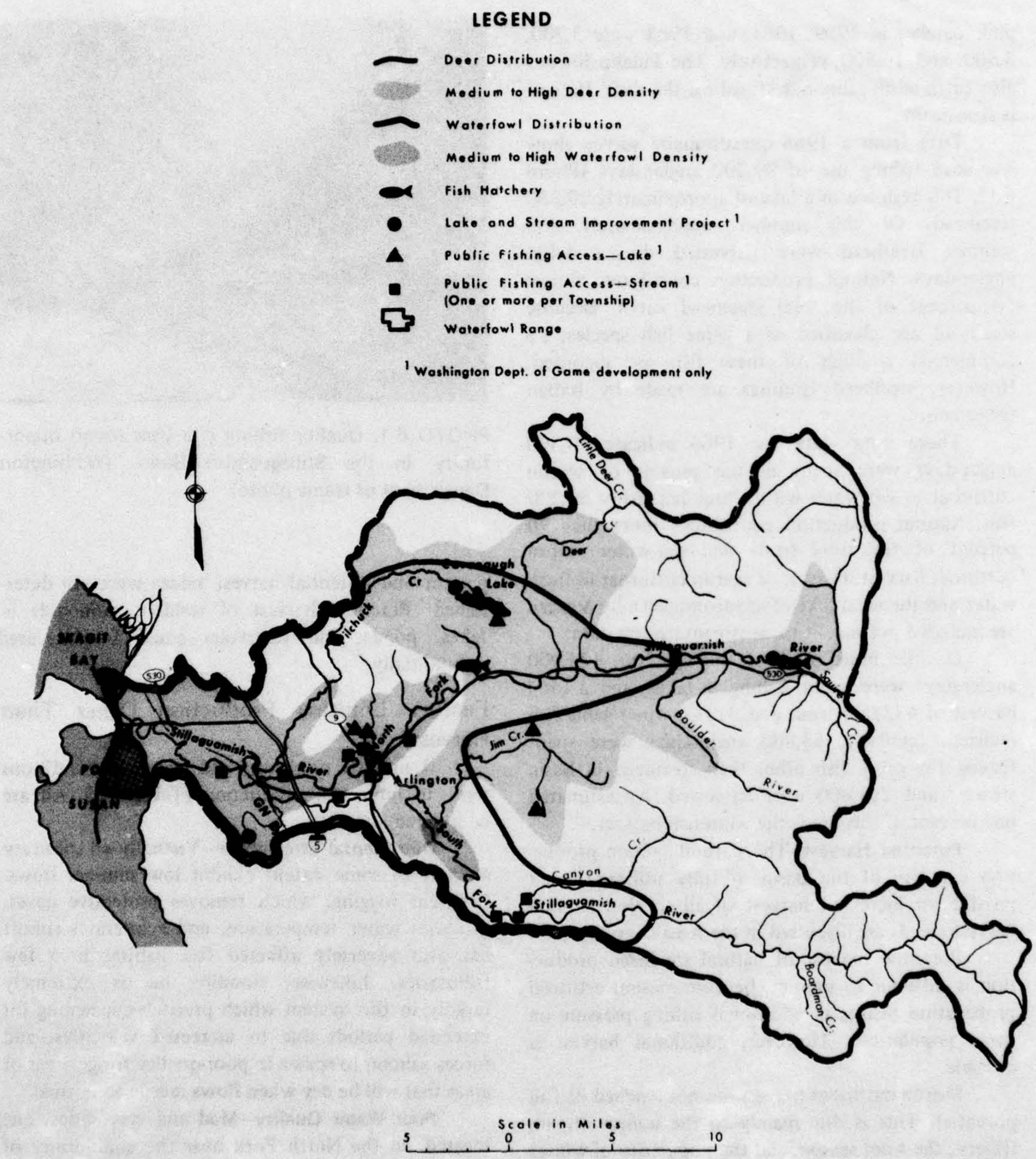


FIGURE 6-2. Wildlife distribution, and fish and wildlife developments (1965)

pink catches in 1959, 1961, and 1963 were 3,700, 3,500, and 16,500, respectively. The Tulalip Indians also catch adult salmon destined for the river. Harvest is significant.

Data from a 1966 questionnaire survey show steelhead fishing use of 99,200 angler-days (Photo 6-1). This resulted in a take of approximately 19,880 steelhead. Of this number, approximately 880 summer steelhead were harvested during 4,400 angler-days. Natural production contributes almost 50 percent of the total steelhead catch. Because steelhead are classified as a game fish species, no commercial landings of these fish are recorded. However, steelhead landings are made by Indian fishermen.

These same data for 1966 indicate 50,300 angler-days were spent in the pursuit of searun cutthroat in salt water with a total harvest of 30,200 fish. Natural production contributes more than 70 percent of the total fresh- and salt-water searun cutthroat harvest. Harvest of searun cutthroat in fresh water and the total take of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of 1966 survey data, 124,000 angler-days were spent fishing in lakes, and a total harvest of 433,000 trout and 31,000 other game fish realized. Similarly, 63,800 angler-days were spent fishing for game fish other than steelhead in Basin streams and 215,800 were harvested. An estimated one percent of this use is the whitefish harvest.

Potential Harvest—The natural salmon production capacity of the Basin, if fully utilized, could provide an increased harvest of all species. Salmon harvest trends are discussed in the Area chapter.

Potential harvest of natural steelhead production is difficult to predict, because present artificial propagation results in additional fishing pressure on these populations. However, additional harvest is possible.

Searun cutthroat harvest has not reached its full potential. This is due mainly to the unique stream fishery, the brief season, and the popularity of winter steelhead angling. Estimates indicate this population could support additional harvest.

The production and subsequent harvest of resident salmonids in streams are not expected to change, subject to the same exclusions noted for anadromous fish. An exception is the catch of mountain whitefish, which is estimated at less than one-fifth its potential. Because this total harvest is not separable from stream resident fish harvest data, present and potential harvest values were not determined. Potential harvest of resident salmonids in lakes, ponds, and reservoirs could be increased substantially.

PHOTO 6-1. Quality fishing is a year round opportunity in the Stillaguamish Basin. (Washington Department of Game photo)

Factors Limiting Production Other Than Harvest

A number of natural and manmade conditions serve to limit fish production (Table 6-5). All are considered alterable.

Detrimental Streamflow—Virtually all tributary streams to some extent exhibit low summer flows. Clear-cut logging, which removes protective cover, increases water temperature, and accelerates runoff has also adversely affected fish habitat in a few tributaries. Likewise, flooding occurs extremely rapidly in this system which precludes spawning for extended periods due to increased velocities, and forces salmon to spawn in poor-quality fringe areas or areas that will be dry when flows recede to normal.

Poor Water Quality—Mud and clay slides, one located on the North Fork near the community of Hazel, the other on the South Fork at Gold Basin, cause excessive water discoloration, heavy siltation of the downstream environment, and over-compaction of spawning gravels (Photo 6-2). In addition to limiting production capacity, the siltation adversely affects sport fishing downstream. Although pollution is not a serious problem, sewage and industrial wastes downstream from Arlington must be continuously monitored. More serious problems exist with water-

TABLE 6-5. Alterable factors limiting anadromous and resident fish production in Stillaguamish Basin

Stream	Limiting Factor[1]							Species Affected						
	Flooding	Low Flows	Unstable Soil (slide)	Falls-Cascades	Limited Spawning Area	Poor Water Quality	Profile Changes[2]	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Stillaguamish R.					X	X	X	X		X	X	X	X	X
North Fork			X	X	X	X		X		X				X
Squire Cr.	X	X						X	X	X		X		X
French Cr.		X			X				X	X		X		X
Boulder R.		X							X	X		X		X
Deer Cr.	X			X		X		X	X			X	X	X
South Fork			X		X	X		X		X	X	X	X	X
Canyon Cr.				X				X	X	X		X	X	
Jim Cr.		X						X		X			X	X
Pilchuck Cr.	X	X		X		X		X	X	X		X	X	X
Portage Cr.		X				X			X	X		X	X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

PHOTO 6-2. A clay slide on North Fork Stillaguamish damages stream environment. (Washington Department of Fisheries photo)

front cabin and homesite development particularly at lakes.

During summer low flows, the lower Stillaguamish sometimes experiences temperatures exceeding 70°F, which creates undesirable conditions for fish production.

Physical Barriers—There are few physical barriers that prevent fish access to suitable habitat upstream, although they do exist on streams including the upper North Fork, and Canyon and Little Pilchuck Creeks (Figure 6-1). Deer Creek has numerous cascades which may, during certain flow stages, hinder upstream migrating fish. The intermittent occurrence of small debris jams and beaver dams on some of the smaller tributaries, such as Grant and Fortson Mill Creeks, prevents access of adult fish during critical flow periods.

Conflicting Watershed Developments—The development of riverfront property for summer or permanent homes is just beginning. Detrimental effects on fish life is considered minor.

Limited Spawning and Rearing Areas—Stream gravels suitable for successful salmonid spawning are essential and invaluable. This is also true of the lowland lakes and their overall rearing potential.

Removal of gravel bars and alteration of natural streambed conditions seriously reduce the overall fish production.

Slides, cited under the Poor Water Quality section, cause severe gravel compaction of essential spawning and rearing areas downstream. Large boulders and rubble in steeper gradient streams limit some of the available spawning areas.

Competition and Predation–Populations of predator and competitor species, including suckers, squawfish, sculpins, and dace, are present throughout the Basin. Environmental changes favorable to these species cause them to overpopulate a particular area and reduce resident and anadromous fish populations.

Beneficial Developments

Accomplished and Continuing–Enhancement projects for anadromous fishes have involved extensive beaver dam and logjam removal, particularly on the North Fork and some of its larger tributaries, and the installation of fish-passage facilities at Granite Falls on the South Fork and on Armstrong Creek, a small tributary of the Stillaguamish near Arlington (Figure 6-2). Attempts have been made by State fishery agencies, through bank stabilization, to control the heavy siltation created by the North Fork slide. Heavy floods in 1966 and 1967 negated these efforts. Stream clearance, culvert repair, and channel maintenance are continuing programs. Various Federal land management agencies, in cooperation with the State, engage in similar activities.

Beneficial developments have also included increasing game fish production and increasing public access to game fishing waters. Approximately 21 miles of riverbank access are now under State administration.

All game fish liberations are intended to supplement natural production. To increase production of summer steelhead, a control structure to maintain lake level was installed at Trout Lake, a South Fork tributary, and lake waters were treated with fish toxicants. This lake is used only as a natural rearing pond. Both programs have resulted in fishery benefits and additional fishing opportunities downstream.

Lakes which have been chemically rehabilitated for trout management include Riley, Ki, Cavanaugh, Twin, and Armstrong. Ki and Armstrong Lakes required screening and Cavanaugh, Armstrong, and Twin Lakes required barriers. Figure 6-2 indicates the location of various lake and stream improvement projects.

Fishermen access developments exist at Armstrong, Riley, and Twin Lakes and Lake Cavanaugh (Figure 6-2). Stream access and boat launch areas include sites on the North and South Forks; Jim, Canyon, and Pilchuck Creeks; and the Stillaguamish River. Additional private and public developments supplement this program.

Under Development–Two fishery programs under development by the State involve: (1) experimental studies with rainbow-steelhead hybrids at Whitehorse Ponds and (2) preliminary design work in cooperation with the U.S. Forest Service to alleviate South Fork silting problems, and to increase total acreages on certain intermediate elevation lakes in conjunction with public use area development (e.g., Evan Lake in South Fork Stillaguamish drainage).

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters of the Stillaguamish Basin, as defined by arbitrary boundary placement, cover only estuarine environments that include small portions of northern Port Susan and southern Skagit Bay. These very limited areas are shallow mud flats extending 2 to 3 miles bayward from the mouth of the Stillaguamish River. The river's fresh-water influence is manifested throughout northern Port Susan.

Inventory and Distribution

Marine Fish–The marine waters are shallow, limited in area, and exhibit specific environmental characteristics. The marine fishes of importance known to inhabit those waters are flounders and soles. They are discussed in the Snohomish Basin, Present Status–Fish chapter. Direct biological interrelationships exist between these species and anadromous fishes.

Shellfish–Because of Stillaguamish River influence, the shellfish habitat boundaries extend from Stanwood to Tulalip Bay (Snohomish Basin).

Principal species of shellfish and other marine invertebrates are Dungeness and red crabs; Pacific oysters; littleneck, butter, horse, Manila, and softshell clams; blue mussels; pink scallops; spot and pink shrimp; squid; octopi; sea cucumbers; sea urchins; and ghost shrimp.

Significant numbers of Dungeness crabs inhabit the Stillaguamish Flats and dropoff areas in northern

Port Susan, and the water along the shores from Spee-bi-dah (Snohomish Basin) to Hermosa Point and south. Lesser numbers are found throughout the marine waters. The smaller red crabs are abundant on the Stillaguamish Flats and in scattered groups along the entire shoreline of the area.

Small populations of Pacific oysters inhabit Port Susan. Populations of littleneck, butter, cockle, and Manila clams utilize firm sand and coarse gravel beaches, while horse, geoduck, and softshell clams occur mainly on the Stillaguamish Flats where a suitable mixture of mud and sand predominate. Blue mussels are found in moderate abundance scattered throughout the intertidal sectors. The Port Susan area supports small populations of pink scallops.

Scattered groups of spot and pink shrimp occur in waters exceeding 30 fathoms.

The more gravelly and rock strewn areas support moderate numbers of octopus, particularly from Kayak Point to Hermosa Point, and the east shore of Port Susan. Seasonal migrations of squid occur in Port Susan. Scattered groups of sea cucumbers and sea urchins inhabit Port Susan and heavy concentrations of ghost shrimp form isolated groups on the Stillaguamish mud flats.

Production

Information is not available concerning numbers of marine fish and shellfish produced.

Propagation

Marine fishes are not propagated within the Basin.

Shellfish culture programs are limited. Certain tidelands, including those near the Snohomish Basin boundary, receive occasional oyster seedings. The spat is obtained from State controlled reserves in other basins.

Harvest

Marine Fish–The small marine water segment supports no commercial fishing and very limited sport fishing. Marine fish stocks produced contribute to commercial and sport fisheries of Port Susan and adjacent salt-water areas. Harvest is incorporated in the catch data presented in the Area chapter, Harvest section, Central Puget Sound. Average annual angler-day use devoted to sport angling for marine fish is 100.

Marine fish harvest potential was not determined.

Shellfish–Little commercial or sport fishing is expended on the limited shellfish stocks. Commercial harvest is presented in the Area chapter. Average annual man-days of use attributed to shellfish sport harvest are 200.

Harvest potential for shellfish was not determined.

Factors Limiting Production Other Than Harvest

Poor water quality is the principal limiting factor influencing marine fish and shellfish. Estuarine and marine waters, principally Port Susan, are greatly influenced by adverse physical and chemical conditions of the Stillaguamish River. Undesirable conditions include excessive siltation, deposition of dredged spoils, and presence of untreated municipal or industrial effluents. Fresh water discharged into Port Susan from the Stillaguamish and Snohomish Rivers, and from the Skagit River through Saratoga Passage, forms a shallow lens over the denser saline waters. This slows dilution of pollutants contained in such discharges. In addition, water quality in Port Susan is affected during certain tidal and climatological phases by the extensive industrial waste waters in Port Gardner (Snohomish Basin). Although such conditions may not be critical at present, future industrial expansion, uncoordinated with fish needs, could have devastating effects upon the estuarine and marine habitat of Port Susan.

The major limiting element affecting the tidelands and marine environment is pollution, both industrial and municipal. Waters of Port Gardner are considered low quality, particularly those containing pulp mill effluents which under prevailing southerly winds with incoming tides are spread into Port Susan and Saratoga Passage. Water temperatures are generally cold, typical of Puget Sound averages, except on the Stillaguamish Flats. Here, heavy silt and mud deposits reduce shellfish production by smothering beds and reducing spat growth.

Much of the Stillaguamish tideland is unsuitable for good oyster production and large sectors of the beach area are too narrow, steep, and exposed to wave action to be considered ideal clam grounds.

Shellfish predators causing significant mortality are starfish, native drills, moon snails, and red crabs that prey on oysters and clams; ghost shrimp, a pest that infests mud flats, making them too soft to support oysters; and octopi that feed upon Dungeness crabs.

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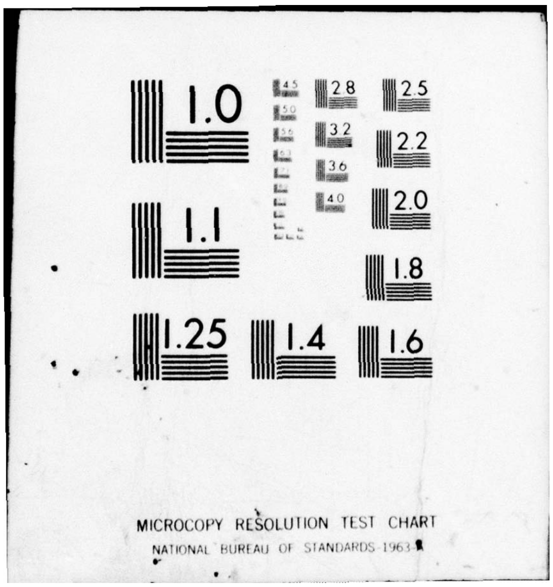
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Beneficial Developments

No beneficial development programs exist for marine fish enhancement. The only shellfish programs underway are those associated with commercial oyster production.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The most recent census ranks the Stillaguamish Basin as one of the smallest within the Puget Sound Area. The population is increasing at a moderate rate, but is expected to increase quite rapidly in the next few years. Projections forecast increases from the 17,600 people in 1963 to 30,200, 48,500, and 77,800 in 1980, 2000, and 2020, respectively. Although this is expected to remain one of the least populated Basins within the Area, its growth rate is expected to accelerate at a level approaching that of some of the larger ones. Major increases will be directly related to new industrial development planned for the Basin. This expansion, along with community and suburban developments, will be distributed principally throughout the lower Stillaguamish River valley, mainly west of Arlington. Local planning groups propose that much of the rich agricultural land in the lower Basin be maintained for farming. Unless zoning ordinances are enforced, considerable urban expansion is expected to occur over the entire lower valley floor and its surrounding hillsides. Summer home development and construction of year round residences will increase rapidly in areas adjacent to streams and rivers, especially in the upper watersheds. Future industrial development is expected to cover much of the lower valley in the vicinity of Stanwood.

The uncrowded and nearly undisturbed natural characteristics of the Basin and its location near heavily populated areas including Everett, Seattle, and Bellingham, make it valuable for outdoor recreation. The highway and road system provides generally good access to the river. With an expected upsurge in demand for more and more outdoor recreation associated with increased population and more leisure time, it is anticipated that sport fishing pressure within the Basin will accelerate at a rate much greater than that of population growth. Also, in salt-water areas, where Stillaguamish River-produced salmon are harvested, there will be a marked increase in demand for both commercial and sport fishing.

RESOURCE DEMANDS AND NEEDS

The Stillaguamish Basin, as defined by arbitrary boundary placement, supports virtually no commercial fishery for salmon, marine fish, or shellfish. However, the Basin's streams produce significant numbers of salmon that enter commercial and sport fisheries outside the Basin. The Tulalip Indian fishery operates in waters adjacent to the Basin, and harvests a considerable quantity of salmon destined for the Stillaguamish River. This fishery has remained relatively constant, and is expected to continue to do so, at least in the near future.

Sport fishing for salmon is confined principally to the Stillaguamish River downstream from the town of Arlington. Each year additional sport fishing pressure occurs in this popular reach, with particularly heavy effort during the high pink salmon years.

The Stillaguamish, its forks, and larger tributaries are popular and productive sport fishing areas, and in each of these, natural production potential is augmented by an artificial propagation program. In addition, related activities such as visiting the Granite Falls fishway, touring the Mountain Loop Highway, and stream, beaver pond, and lake fishing create considerable demand on the resources. Based on county use values, approximately 40 percent of all Basin harvest and utilization of game fish other than steelhead is by people from outside the Basin. It is estimated that, by 1980, Basin lakes must provide an additional 333,800 trout and 78,500 game fish of other species to the creel annually. This is an additional 212 fish per surface acre. Streams must produce an additional 177,100 resident trout and whitefish and 13,800 steelhead for harvest each year.

As sport and commercial demands continue to rise it will be necessary to develop projects and implement programs that will best utilize the available production potential within each Puget Sound basin. Table 6-6 indicates present and future projected demands and needs for game fish in this Basin in angler-days.

TABLE 6-6. Present and projected sport fishermen use (game fish) in Stillaguamish Basin

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	337.3
1980	226.0	563.3
2000	322.2	885.5
2020	531.3	1,416.8

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing fish and shellfish resources of the Stillaguamish Basin are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to this Basin.

Conflicting Land and Water Uses

(1) Clay slides on the North and South Forks Stillaguamish River create heavy silt loads in these streams, and in the main river downstream, causing serious gravel compaction and loss of essential spawning and rearing areas. The Canyon Creek slide limits fish production, spawning area, and harvest potential.

(2) Municipal and industrial water supply projects, which tap river headwaters, restrict the amount of fish production water remaining in the rivers downstream, and often inundate upstream production habitat. The storage reservoir being considered at Oso on the North Fork Stillaguamish would eliminate over 75 percent of the fish production in this stream.

Poor Water Quality

(1) Occasionally, intermittent seasonal pollution occurs in the lower river and in the estuarine waters of northern Port Susan. This may result in water quality inimical to fish life. Effluents from agricultural and industrial sources, as well as from domestic sewage, are particularly detrimental to aquatic life. The buildup of sludge and heavy waste in the estuary limits shellfish and marine fish production.

(2) Diversion of Sauk River water into the North Fork Stillaguamish River (being considered) could significantly alter natural water chemistry and temperature character, reduce production potential for salmonids, and cause serious problems with homing of anadromous fish.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Stillaguamish Basin. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential enhancement projects for anadromous fish include stabilizing slides on the North and South Forks, and curtailing erosion and slide conditions on Deer Creek. In conjunction with these projects the riverbed areas being subjected to excessive siltation from slides should be cleaned and the potential spawning gravel decompacted. Also, the channel at the river mouth should be periodically dredged (under controlled, approved methods) through the mud flats to improve transportation conditions for anadromous fish. Additional stream and streambed improvement projects are needed to ease adult fish passage and create better spawning and rearing conditions in the Stillaguamish and in many of the larger North and South Fork tributaries.

Streambed controls could be achieved through selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools and riffles where they are now unstable or lacking.

Enhancement projects should also include flood control and low flow augmentation on the North Fork and its tributaries—Boulder River, and Squire, French, and Deer Creeks; flood control and low flow augmentation on Jim Creek, South Fork tributary; and flood control and low flow augmentation on Pilchuck and Portage Creeks. Streamflow control might be achieved through the development of overflow channels, flood-flow diversions, or impoundments.

Modification of the Granite Falls fishway on the South Fork, and laddering of Canyon Creek falls would also be particularly beneficial.

Potential for artificial propagation in the Stillaguamish Basin includes development of hatcheries, eyed-egg incubation facilities or spawning channels, and creation of off-river rearing areas. Suitable land and water are available for such facilities along much of the upper North Fork and its tributaries–Boulder River, Squire and Deer Creeks; on the South Fork and its tributaries–Canyon and Jim Creeks; and on Pilchuck Creek.

One program to increase fish production would include the setting of rigid controls on the removal of water, for any purpose, from natural flowing streams. An extensive evaluation of new means for obtaining future municipal and industrial water supplies should be undertaken in conjunction with this. Areas deserving study include potential use of dual water systems (consumptive/irrigation and sewage) and possible use of desalted marine water as a byproduct of any proposed thermonuclear powerplants.

Other enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish populations, including control of forest and agricultural spraying, and curtailing the disposal of untreated municipal and industrial wastes; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to ensure protection of fish resources; (3) institute a permanent flood plain zoning plan to protect streambeds and adjacent land from unnecessary changes that would damage aquatic habitat; (4) promote maximum use of available fish stocks by securing information necessary for efficient regulation of harvest methods and fishing areas; and (5) perform studies and obtain information necessary to achieve the most efficient stream management possible. This would include: (a) securing basic water chemistry data for the South Fork Stillaguamish to determine feasibility of increasing production; (b) deriving techniques for removing silt and decompacting riverbed gravel in large streams; (c) obtaining river cross section measurements to ascertain flow levels necessary for fish; and (d) determining methods and techniques for altering streamflow and streambed conditions to increase fish production (Photo 6-3). Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, are shown in Table 6-7. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

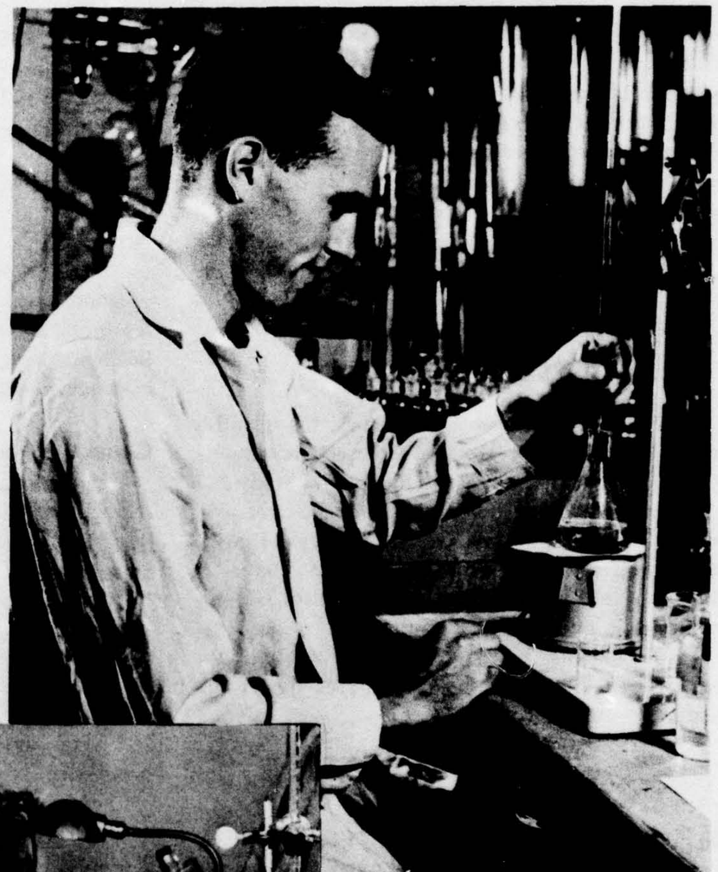
MARINE FISH

Enhancement projects for marine fishes could include creation of additional habitat and new fishing

TABLE 6-7. Tentative flow schedule required to maintain fish production levels, Stillaguamish Basin

Stream[1]	Flows (cfs) by Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Stillaguamish R.												
North Fork	1,200	1,800	2,000	2,000	1,900	1,700	1,800	1,800	1,500	800	800	800
Deer Cr.	300	400	500	500	500	400	500	600	300	100	100	100
Squire Cr.	200	250	250	200	200	100	200	200	200	100	65	65
South Fork	1,000	1,100	1,300	1,300	1,300	1,200	1,300	1,300	1,000	700	600	600
Jim Cr.	200	200	300	300	300	200	250	150	100	60	60	60
Pilchuck Cr.	250	400	450	450	450	350	300	200	150	50	50	75

[1] Locations are existing U.S. Geological Survey gaging stations.



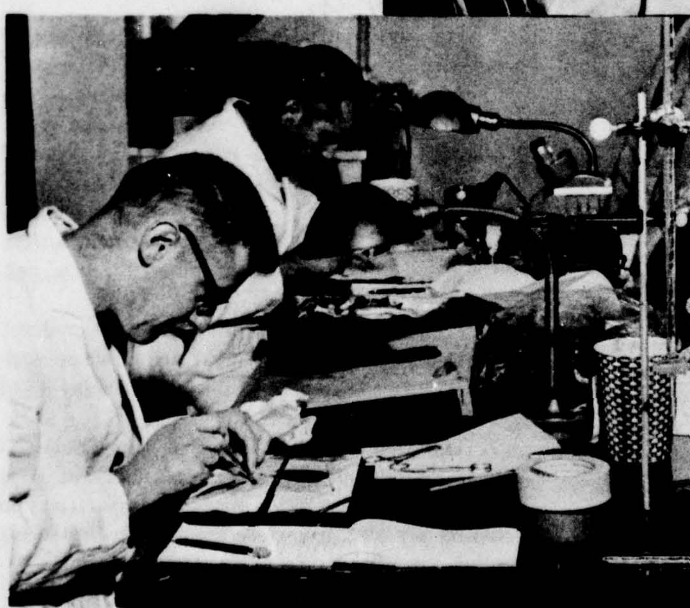


PHOTO 6-3. Water quality monitoring and fish production research are essential resource measures. (Washington Department of Game photos)

areas by selective placement of rock jetties or submerged automobile bodies. Another program benefiting these fishes is the present plan to establish and implement water quality controls on the lower river and the estuarine waters of Port Susan. Without such controls a drastic reduction in marine fish populations is foreseen.

At present, natural production is adequate, and artificial propagation will not be used until required.

SHELLFISH

Potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. The latter might be accomplished by heating controlled salt-water areas or by adding nutrients.

The marine waters hold some potential for expanded development of raft and rack oyster culture.

SUMMARY–ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Stillaguamish Basin offers many opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. Major potential developments, including an indication of priority, are categorized in Table 6-8 and defined by stream in Table 6-9.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the developments listed. Nearly all of the major proposals are goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of potential developments are included in a preliminary plan for increasing salmon production levels to meet overall Pacific Northwest demands for fish resources in the future. These proposals, and salmon production increases, are indicated by target years in Table 6-10.

Table 6-11 shows estimated annual benefits in terms of sport and commercial harvest for the same projects. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate, and needs are not so critical as for salmon.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Flood control should be accomplished by diking, and with as little lower river channel work as possible. Flood plain lands should be zoned for agriculture and outdoor recreation to prevent loss of homes and industrial plants during flood periods.

Thermal powerplants should be located in areas where water diversion is not detrimental to fish resources. Water cooling facilities must be included in the construction plans.

Logging practices should be carefully coordinated with all fish needs.

Outdoor recreation planning should be a high priority program. Emphasis must be placed upon programs to guarantee public access to all types of fresh- and salt-water areas. In addition, new management techniques must be developed through research in such areas as selective fish toxicants in waters managed for trout, lake and stream fertilization, and regulations.

Management emphasis must be placed on development of the searun cutthroat and summer steelhead fisheries and in better utilization of spiny-rayed and whitefish populations.

The overall attractiveness of this Basin will depend considerably upon the availability of good game fishing opportunities. Since outdoor recreation activities are assuming greater importance, planning for this type of demand must assume high priority.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubation, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study,

TABLE 6-8. Potential developments for production and use of salmon and shellfish, Stillaguamish Basin

Beneficial Development	Priority Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Control North and South Fork slides	X		
Clean and decompact gravel downstream from slide areas	X		
Improve Granite Falls fish-passage facility	X		
Improve public beaches for clam production		X	
Improve stream and streambed conditions	X	X	X
Dredge Stillaguamish River channel at mouth	X	X	X
(2) Acquisition			
Determine and evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop 2 salt-water public access sites	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Procure riverbank public access sites	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Promote conservation measures for Indian fishery	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Implement necessary fishery management regulation changes	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities on streams, i.e., gravel removal, flood control	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Gravel cleaning and decompaction techniques	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Basic productivity change in South Fork Stillaguamish		X	

TABLE 6-9. Potential beneficial developments for fish, Stillaguamish Basin

Stream	Enhancement Measure: Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Species Benefited: Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Stillaguamish R.		X	X							X		X	X	X	X	X
North Fork		$\boxed{X}$		X	X	X		X		X		X	X	X	X	X
Squire Cr.				X	X			X	X	X	X	X	X	X	X	X
French Cr.		X			X						X	X		X	X	X
Boulder R.		X			X		X	X	X	X	X	X		X	X	X
Deer Cr.		$\boxed{X}$		X			X	X		X	X			X	X	X
Montague Cr.		X									X			X	X	X
South Fork	$\boxed{X}$	X					X	X		X	X	X	X	X	X	X
Canyon Cr.	$\boxed{X}$	X						X	X	X	X	X		X		
Jim Cr.				X	X		X	X		X	X	X	X	X	X	X
Pilchuck Cr.	$\boxed{X}$	X		X	X		X	X	X	X	X	X	X	X	X	X
Portage Cr.					X						X	X	X	X	X	X

$\boxed{X}$ Priority project.

costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Public fishing access areas should be acquired and developed at Little, Sunday, Swartz, and Ki Lakes. Ultimately, all significant lakes and key portions of streams and salt-water areas should be provided with public fishing access.

(3) Streambank angler access on 50 miles of the Stillaguamish River and its tributaries should be acquired and developed, as funds become available.

(4) Two salt-water public access areas should be acquired and developed.

(5) Earthfill dams with control structures are needed at Little and Twin Lakes. The Twin Lakes project would be a cooperative effort between the State and the U.S. Navy. Each project would increase lake acreage and furnish outlet control.

(6) Halting and clearing the slide on the North Fork Stillaguamish River is recommended. Such a project would enhance spawning, rearing, and fishing in river segments downstream from the slide. Considerable streambed compaction has occurred on the South Fork Stillaguamish River. With slide correction and development and use of a large "riffle sifter" or other mechanical gravel cleaning device, the spawning, rearing, and fishing use of this river should be improved considerably.

(7) Two propagation sites are recommended for rearing of anadromous game fish before 1980. One would include further development of La Quee fish ponds on a South Fork tributary near Granite

TABLE 6-10. Estimated total salmon production increases in Stillaguamish Basin, by project or program, to satisfy needs[1/]

Project or Program, and Year	Chinook	Coho	Pink	Chum
	Species and Number			
Pre-1980				
Rebuild fish ladder, S. Fork	1,000	2,000	3,000	--
Stabilize slide and clean, S. Fork	6,000	1,500	247,500	4,200
Stabilize slide and clean, N. Fork	4,000	4,000	187,500	3,600
Subtotals	11,000	7,500	438,000	7,800
1980-2000				
Provide fish passage, Pilchuck Cr., 10 stream miles	400	1,500	200	--
Provide fish passage, Canyon Cr., 7 stream miles	200	1,000	200	--
Improve fish habitat, 4 streams, 21 stream miles	3,200	5,500	96,000	3,800
Supply flood control, N. Fork and 4 tributaries, 60 stream miles	1,200	4,400	9,300	2,900
Augment flows, N. Fork and Pilchuck Cr., 40 stream miles	2,600	10,200	18,000	--
Augment flows, 3 tributaries, 12 stream miles	1,700	5,200	5,400	--
Construct rearing ponds, 10 acres	--	8,500	--	--
Construct hatchery	--	51,000	--	--
Construct spawning channel, 1 mile	--	--	120,000	--
Subtotals	9,300	87,300	249,100	6,700
2000-2020				
Construct 3 hatcheries or equivalent	18,000	127,500	--	--
Develop rearing facilities, 15 acres	9,000	12,800	--	--
Develop spawning channel, 1 mile	--	--	120,000	--
Subtotals	27,000	140,300	120,000	--
Totals	47,300	235,100	807,100	14,500

[1/] Average annual production (catch plus escapement) at end of each period.

Falls. The other is a joint proposal between the State and the U.S. Navy on Jim Creek. At this site, springs on Navy property would be impounded for fish rearing purposes. Subsequent liberations and adult returns would provide fishing both on and off the military reservation where public use is assured.

(8) The Whitehorse rearing pond complex for steelhead and searun cutthroat should be expanded.

(9) A steelhead rearing pond should be developed on the South Fork in the Granite Falls area.

(10) Fish-passage facilities at Granite Falls should be modified.

(11) New fish toxicants that are effective, detoxify rapidly, and are selective as to species should be developed.

(12) Lake fertilization techniques should be developed.

(13) Hatcheries should be constructed to produce resident trout for lake and stream stocking as necessary to meet anticipated demand.

Table 6-12 indicates estimated annual benefits and costs of specific projects and programs proposed for the Stillaguamish Basin to satisfy needs for game fish prior to 1980. Subsequent proposals have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected. That is, benefits from constructing a hatchery may depend on first solving fertility, disease, and public access problems. In such cases, items showing costs will not necessarily show benefits because the latter are included under other projects and programs.

TABLE 6-11. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, Stillaguamish Basin

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Rebuild fish ladder, S. Fork	3,800	$ 8,800	$ 25,200	600	$ 3,600	$ 17,400	$ 15,000	$ 300
Stabilize slide and clean, S. Fork	163,400	136,700	632,300	9,400	56,500	263,200	1,400,000	51,500
Stabilize slide and clean, N. Fork	125,700	108,600	493,600	7,300	43,900	204,400	1,111,000	51,500
Subtotals	292,900	$ 254,100	$1,151,100	17,300	$104,000	$ 485,000	$2,526,000	$103,300
1980-2000								
Provide fish passage, Pilchuck Cr., 10 stream miles	1,300	$ 4,500	$ 9,700	300	$ 1,800	$ 8,200	$ 30,000	$ 600
Provide fish passage, Canyon Cr., 7 stream miles	1,000	2,700	6,400	200	1,100	5,100	9,000	200
Improve fish habitat, 4 streams, 21 stream miles	68,400	69,500	265,700	4,300	25,600	119.400	53,600	1,000
Supply flood control, N. Fork and 4 tributaries, 60 stream miles	10,900	21,300	62,700	1,200	6,500	32,300	2/	2/
Augment flows, N. Fork and Pilchuck Cr., 40 stream miles	19,700	38,300	115,200	2,400	14,100	67,800	2/	2/
Augment flows, 3 tributaries, 12 stream miles	7,900	19,100	51,300	1,300	7,400	35,200	2/	2/
Construct rearing ponds, 10 acres	6,200	19,600	37,900	1,100	6,400	29,700	55,000	10,000
Construct hatchery	37,400	118,400	228,200	6,400	38,300	178,800	1,020,000	60,000
Construct spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,400	700,000	14,000
Subtotals	248,500	$ 359,400	$1,102,500	21,500	$127,000	$ 596,900	–	–
2000-2020								
Construct 3 hatcheries or equivalent	103,100	$ 360,600	$ 725,600	21,600	$129,700	$ 605,200	$3,060,000	$180,000
Develop rearing facilities, 15 acres	14,200	62,000	134,800	4,400	26,600	124,200	82,500	15,000
Develop spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,400	700,000	14,000
Subtotals	213,000	$ 488,600	$1,185,800	30,300	$182,100	$ 849,800	$3,842,500	$209,000
Totals	754,400	$1,102,100	$3,439,400	69,100	$413,100	$1,931,700	–	–

1/ Anadromous trout benefits not included.

2/ Multipurpose project. Separable costs, if any, have not been determined.

Projects and Programs, 1980-2000

(1) Construct and manage additional rearing ponds for anadromous game fish on the North and South Forks Stillaguamish River.

(2) Complete programs and projects not completed by 1980.

(3) Develop additional projects and programs necessary to meet fish resource needs.

Projects and Programs, 2000-2020

(1) Complete programs and projects not completed by 2000.

(2) Develop necessary projects and programs to meet fish resource needs.

(3) Continue fisheries research.

TABLE 6-12. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Stillaguamish Basin, pre-1980

Project or Program	Annual Benefits		Costs	
	Angler-Days	Value	Capital	O&M (Annual)
Lakes				
Acquire and develop public access, 4 areas	29,600	$ 59,200	$ 68,000	$ 500
Enlarge Little and Twin Lakes	8,000	16,000	50,000	--
Develop new fish toxicants	117,200	234,400	10,000	10,000
Develop lake fertilization techniques	1/	--	10,000	10,000
Construct hatchery	2/	--	175,000	14,600
Subtotals	154,800	$309,600	$ 313,000	$ 35,100
Streams				
Control slides, North and South Forks	47,600	$238,200	3/	3/
Correct gravel compaction downstream from slides, N. and S. Fks.	6,300	31,300	3/	3/
Expand Whitehorse rearing complex for steelhead and searun cutthroat	25,900	114,700	$ 50,000	$ 27,000
Construct hatchery	43,000	129,000	1,000,000	87,500
Purchase streambank access on Stillaguamish R. and tribs., 50 stream miles	10,000	30,000	978,000	5,000
Subtotals	132,800	$543,200	$2,028,000	$119,500
Salt Water				
Acquire and develop public access, 2 areas	9,400	$ 28,200	$ 48,000	$ 500
Subtotals	9,400	$ 28,200	$ 48,000	$ 500
Totals	297,000	$881,000	$2,389,000	$155,100
Lakes (Alternate to above lake proposal)				
Acquire and develop public access and enlarge lakes as above	37,600	$ 75,200	$ 118,000	$ 500
Construct hatchery	45,500	91,000	672,000	56,000
Subtotals	83,100	$166,200	$ 790,000	$ 56,500

1/ Included with benefits from toxicant development.

2/ Included with other lake enhancement benefits.

3/ Joint project. Costs included under enhancement project and program costs for salmon (Table 6-11).

Approximately 172,000 acres of this Basin are under U.S. Forest Service administration. Projects and programs proposed by this agency for fish resource enhancement before 1980 are indicated in Table 6-13. Similar projects and programs probably will be initiated or continued during later time periods. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 6-13. Fishery enhancement projects and programs of U.S. Forest Service proposed for Stillaguamish Basin, pre-1980

Project or Program	Unit	Number	Capital Cost
Conduct stream surveys	mile	102	$ 3,100
Fertilize lakes	acre	67	46,100
Total			$49,200

PRESENT STATUS—WILDLIFE

INTRODUCTION

The Stillaguamish is one of the smallest basins, but ranks high in production of forest game species and, due to an abundance of natural water areas, produces significant numbers of fur animals and waterfowl. This watershed drains only the lower western slopes of the Cascade Range, as its upper extremity is partially encircled by the Sauk River drainage (Skagit-Samish Basins). The relatively low elevation contributes significantly to the Basin's wildlife value, as most species are limited in the areas they can inhabit by the depth and duration of winter snow.

BIG GAME

Big game is the most important group of wildlife inhabiting the Basin. Black-tailed deer are numerous and provide high hunter use. Black bear and mountain goat are abundant in areas of suitable environment and mountain lion occur in limited numbers.

Inventory and Distribution

Little of the Basin has been cleared for agricultural use. Consequently, forest game species inhabit virtually the entire area. Information concerning estimated deer population, production, and harvest is shown in Table 6-14.

TABLE 6-14. Deer population, production, and harvest, Stillaguamish Basin, 1961-1965

County	Population[1] (Total)	Production (Ave. Annual)	Harvest (Ave. Annual)
Skagit	2,000	620	250
Snohomish	4,400	1,350	550
Totals	6,400	1,970	800

[1] Game numbers vary throughout the year; therefore, figures designate late September-early October populations.

Areas of high deer density are north and east of Lake Cavanaugh; the Jim Creek area; and in the Boulder River drainage. Figure 6-2 indicates deer distribution and medium to high density areas. The current deer population exceeds 6,400 animals.

Several mountains in the eastern portion of the Basin, including Long, Dickerman, Whitehorse, and Meadow Mountains; Three Fingers; and Devils and Stillaguamish Peaks, provide the rugged, precipitous terrain required by mountain goats. Approximately 250 inhabit the Basin.

Black bears frequent the forested areas throughout the Stillaguamish watershed and a population of 750 is estimated.

Limiting Factors

Various factors limiting big-game populations are presented in the Area chapter, Present Status—Wildlife.

Production

Doe-fawn ratios determined just prior to the hunting season indicate an average annual increase of 1,970 deer over the spring population. Production estimates for the divisions within the Basin are shown in Table 6-14.

Late summer counts of mountain goat reveal 29 kids per 100 adults. This would indicate about 55 young annually.

Black bear studies indicate an annual reproductive rate of 25-30 percent, which would result in 150-200 cubs.

Harvest

Deer harvest data over a 5-year period (1961-1965) reveal an average annual harvest of 800 deer (Table 6-14). Of these, 250 were taken in the Skagit County portion and 550 in the Snohomish County portion.

Five to 10 goats are taken annually. The number of these animals harvested is not indicative of the population present.

Limited harvest data available indicate an average annual harvest of 150 bears.

The small population of mountain lion results in only an occasional animal taken annually.

Average annual hunter-days use devoted to big-game harvest in the Stillaguamish Basin is 16,000 (deer); 100 (mountain goat); 1,180 (black bear); and 100 (mountain lion).

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

Beneficial developments are described in the Area chapter, Big Game.

UPLAND GAME

One or more of the varied species of upland game inhabit virtually every habitat type. Native species utilize the remaining native habitat, and introduced exotics have been established in the area devoted to agriculture. The introduced species include ring-necked pheasant, California quail, gray partridge, and cottontail. Native upland game include blue and ruffed grouse, snowshoe rabbit, band-tailed pigeon, and mourning dove.

Inventory and Distribution

Grouse are the most numerous upland birds and both species are distributed throughout the Basin wherever suitable habitat exists. A ruffed grouse population of about 33,000 and a blue grouse population of about 22,000 are projected on the basis of density studies.

Ring-necked pheasant and limited numbers of California quail, as well as an occasional pair or small covey of gray partridge, occur throughout the agricultural land. There is a current wild population of about 9,000 ring-necks, with highest densities occurring in the area from Stanwood to Arlington (Figure 6-1). This wild population is supplemented annually by releases of game-farm-reared birds. California quail, like pheasant, use the agricultural area almost exclusively. The average fall quail population is estimated at 2,000.

Cottontail and snowshoe rabbit are perhaps the most numerous upland game species. The cottontail population is closely related to the degree of local agricultural activity. Population densities are influenced by the quantity of edge and fence row cover created by diversified farming. The snowshoe is confined to typical evergreen-hardwood forest area. Rabbit populations were not determined.

No population estimates were made for band-tailed pigeon or mourning dove.

Limiting Factors

The introduced species of upland game, all dependent on agricultural activity, are most seriously affected by changes in farming practices and crops raised. The change from cereal grain production to grazing and production of specialty crops such as sweet corn and peas, has reduced the productivity of the area for these species. Control of wildfire and reduced emphasis on slash burning after logging have reduced the productive potential of wooded areas for native upland game.

Residential development along Warm Beach (which extends into Snohomish Basin), a historical fall concentration area for band-tailed pigeon, has seriously reduced their numbers. Other limiting factors are discussed in the Area chapter, Upland Game.

Production

Wild pheasant production averages 6,000 annually. Average annual increments of 1,500 quail, 20,000 ruffed grouse, and 13,000 blue grouse are expected with the present populations.

Production estimates were not determined for rabbit, gray partridge, band-tailed pigeon, or mourning dove.

Harvest

Approximately 2,000 pheasants are harvested annually, resulting in 2,900 hunter-days. About 150 birds are a direct return of mature roosters released immediately prior to the hunting season. Hunters bag an annual average of 400 quail in slightly over 300 man-days of hunting. The average annual grouse harvest of 4,300 birds consists of about 3,200 ruffed and 1,100 blues. It represents about 7,200 hunter-days.

Cottontail are hunted extensively in and adjacent to agricultural lands throughout the lengthy season, resulting in about 850 hunter-days annually. Approximately 1,500 rabbits are harvested, most of which are cottontail.

Band-tailed pigeons congregate in the fall near the concentrated residential area of Warm Beach. Only by cooperative State-landowner agreement is limited hunting retained. Approximately 10,000 band-tailed pigeons and 500 mourning doves are harvested annually in the Basin, resulting in an estimated 8,500 days of shooting.

Upland-game hunting stimulates approximately 19,750 hunter-days annually.

Propagation

The wild pheasant population is supplemented annually by about 350 birds from State-operated game farms located within the Puget Sound Area. Approximately 250 of these birds are released as mature cocks prior to the hunting season. Small numbers of quail, and gray, red-legged, and bamboo partridge are propagated on State game farms and are released periodically. One private game farm raises a limited number of pheasant commercially.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game.

Conservation practices applied by private landowners to Basin agricultural lands of direct benefit to upland game include 20 acres of wildlife habitat development.

FUR ANIMALS

The Basin ranks high in fur-animal production. Snohomish County, which contains the bulk of the Basin, ranks third in the State in the harvest of mink, fifth in muskrat, and thirteenth in beaver. In addition, much of the prime beaver habitat of Skagit County lies in the Stillaguamish watershed. Other fur animals are marten, river otter, raccoon, red fox, skunk, weasel, bobcat, coyote, and opossum.

Inventory and Distribution

The fur-bearer group includes a wide variety of animals with varied habitat requirements, but those species most highly prized for their pelts are water oriented. The Basin is richly endowed with low-gradient creeks, lakes, and shallow water areas which contain an abundance of aquatic vegetation required by aquatic and semi-aquatic fur bearers. An inventory of such areas indicates the Basin contains 30 to 40 percent of Skagit and Snohomish Counties' beaver, muskrat, and mink habitat.

Individual population estimates are: 1,750-2,000 (beaver); 12,000-16,000 (muskrat); and 750 (mink) (Photo 6-4). Of the remaining species which occupy suitable habitat, raccoon and opossum occur most frequently in the trapper's catch.

PHOTO 6-4. Fur animals such as muskrat are numerous in the abundant marsh areas of the Basin. (Bureau of Sport Fisheries and Wildlife photo)

Limiting Factors

Most of the land and water areas are in near-natural condition. Little draining and diking of marsh areas for farming or industrial development have occurred. Natural predation is not serious when an abundance of optimum habitat is available.

Production

Annual production of the various fur animals, with the possible exception of beaver, is considered fairly stable. Readily accessible beaver areas have been trapped heavily during the 1963-64 through 1966-67 trapping seasons. Present population levels indicate that the average annual production of economically important fur bearers is as follows: 700-800 (beaver); 9,000-12,000 (muskrat); and 250-350 (mink).

Harvest

In relation to land area, fur harvest ranks very high. A large portion of the Skagit and Snohomish Counties' fur-animal harvest occurs in the Basin. Trapper records reveal the following average annual catches: 350-400 (beaver); 1,600 (muskrat); and 300 (mink). Significant catches of raccoon, opossum, marten, river otter, skunk, weasel, bobcat, and coyote also occur. Income derived from trapping during the 1965-1966 season was approximately $10,000.

Propagation

Four private mink farms are located in the Arlington-Stanwood area.

Beneficial Developments

Maintenance of native marsh and management of the Skagit Game Range (Skagit-Samish Basins) to enhance waterfowl populations also benefits fur animals.

Other beneficial developments are discussed in the Area chapter, Fur Animals.

WATERFOWL

The Stillaguamish Basin is an important production and winter concentration area for migratory waterfowl. The abundance of shallow fresh water with emergent vegetation provides ideal nesting and rearing habitat, and the proximity of agricultural land to salt-water resting area in Port Susan provides desirable fall and winter habitat.

Inventory and Distribution

High density spring and summer waterfowl use areas include shallow lakes, beaver ponds, and diked sloughs and ditches where considerable duck production occurs. Fall and winter concentrations occur primarily in Port Susan and the Stillaguamish River valley agricultural lands east to Arlington. Figure 6-2 designates waterfowl distribution and medium to high density areas. Resting areas are censused periodically during the fall and winter to establish migration trends. Most of the waterfowl remain in Port Susan during this period, with some exchange occurring between the Skagit-Samish, Stillaguamish, and Snohomish Basins. Eleven years of census data (1956-1966) reveal the following average annual use in the bay by the four leading species (mallard, pintail, widgeon, and green-winged teal): early October (12,727); late October (13,975); early November (9,027); late November (8,657); early December (10,267); and January (6,075).

The 1965 Snohomish County mid-winter survey is indicative of species use and relative abundance in the Basin (Table 6-15).

Snow geese seldom appear in the annual survey, but as noted under the Harvest section, are commonly hunted in the Port Susan area. Mid-winter waterfowl use (ducks) in the Basin equals about one-half this Snohomish County count.

TABLE 6-15. Waterfowl survey, Snohomish County, 1965

Species	Number	Species	Number
Mallard	3,038	Goldeneye	317
American widgeon	2,244	Scaup	177
Coot	1,815	Merganser	157
Pintail	1,681	Bufflehead	153
Eider and Scoter	983	Canvasback	142
Green-winged teal	350	Lesser Canada goose	250
Shoveler	333	Miscellaneous 1/	2,228
Ruddy duck	325		
		Total	14,193

1/ Includes wood duck and redhead.

Prior to the annual survey, waterfowl have been exposed to almost three months' hunting. In addition, an undetermined number of birds hold over in the Basin in fall and early winter for a limited period while enroute southward. The survey, therefore, is not indicative of the total number which use the area as a wintering station.

Limiting Factors

A change in agricultural practices has resulted in decreased cereal crop acreage. This has reduced the availability of food for migratory waterfowl use. Many of the waterfowl which use Port Susan as a resting area fly to the Skagit Delta (Skagit-Samish Basins) to feed.

Production

The Stillaguamish watershed is a good production area for waterfowl (Photo 6-5). Numerous shallow lakes, beaver ponds, and diked sloughs and ditches with abundant emergent vegetation provide the required habitat for successful duck production. A recent inventory disclosed an average annual production of 6,500 waterfowl. The following species are listed in order of their abundance: mallard, wood duck, coot, merganser, teal, and shoveler.

Harvest

Port Susan and adjacent agricultural lands are important duck and snow goose hunting areas. Hunting records for 1960-1966 indicate an average 23,000 ducks and 950 geese is harvested annually, providing more than 17,200 hunter-days.

PHOTO 6-5. River sloughs and natural marshes afford essential habitat for waterfowl and fur bearers. (Washington Department of Game photo)

Propagation

Waterfowl are not artificially propagated in the Basin.

Beneficial Developments

State administration of 12,192 acres of estuarine habitat in Skagit Bay (Skagit-Samish Basins) enhances winter carrying capacity of the lower Stillaguamish and the Skagit drainage for waterfowl. Management of the Skagit Game Range includes retention of natural marsh and production of cereal grains on cultivated, diked land for winter duck food. Ducks fly from resting areas in Port Susan to feed in the marsh and unharvested grain fields of the range. Their stay in the Stillaguamish Basin is extended by this additional food source.

Conservation practices applied by private landowners to Basin agricultural lands of direct benefit to waterfowl include 500 acres of wildlife wetland development.

OTHER WILDLIFE

The many and varied birds and animals in the Basin not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

No major problems in meeting the wildlife-oriented recreation demand from population growth[1] within the Stillaguamish Basin are anticipated. However, as population increases, the Basin must provide proportionately more hunting and related outdoor opportunity to meet the needs of the large metropolitan areas to the south. The Basin is easily accessible from the Everett-Seattle-Tacoma metropolitan complex and is one of the more popular waterfowl hunting areas in the State. Demand on the wildlife resource may more than double by the year 1980. Use in the form of family auto and hiking trips during which observation of wildlife plays an important role, are expected to increase considerably in popularity.

Interest in hunting is expected to parallel the population increase of the Puget Sound Area. To maintain the present level of hunting success, it will be necessary to provide an additional annual harvest of 750 deer; 150 bears; 4,000 grouse; 1,900 pheasants; 1,400 rabbits; 9,000 band-tailed pigeons; 21,000 ducks; and 900 geese by 1980. As population, leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately. Table 6-16 indicates present and projected demands for hunting in hunter-days.

[1] Population forecasts shown in Future Needs—Fish.

TABLE 6-16. Present and projected hunter use in Stillaguamish Basin

Year	Increase Over Previous Period (Need) (1000)	Total (Demand) (1000)
1965	--	54.2
1980	50.4	104.6
2000	65.0	169.6
2020	39.7	209.3

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Stillaguamish Basin is to be satisfied. Problems and conflicts discussed in the Area chapter apply to this Basin.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basin during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 6-17 shows projects and programs proposed for the Basin to satisfy 1980 needs. Similar data for subsequent periods are not available, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include incidental recreation benefits that will accrue from public use of wildlife areas for swimming, boating, picnicking, hiking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

TABLE 6-17. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Stillaguamish Basin, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs 1/: Capital	Costs 1/: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	2,100	$ 8,300	--	$ 2,500
Develop educational program to stress renewable aspects and value of proper utilization of wildlife resources	14,200	74,000	$ 5,000	--
Initiate studies to increase recreational potential of wildlife resources and develop compatible forest-wildlife management techniques	2/	2/	10,000	15,000
Specific Projects and Programs				
Acquire and develop waterfowl and fur-animal habitat, Hat Slough, 600 acres	13,400	64,300	300,000	3,000
Enlarge game farm to produce additional 2,500 pheasants	3,400	13,600	25,000	7,500
Totals	33,100	$160,200	$340,000	$28,000

1/ Do not include survey and plan costs.

2/ Included in other general program benefits.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Continue wildlife management research and develop new projects and programs as required.

(3) Construct a game farm to enhance hunting of exotic upland birds.

(4) Complete programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Develop studies to further intensify wildlife management to keep pace with increased demand.

(2) Continue acquisition and development of key wildlife habitat and hunting areas.

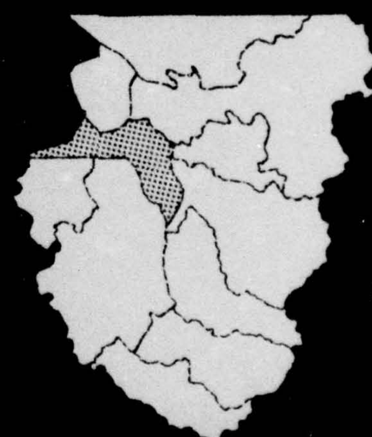
(3) Continue programs and projects not completed prior to 2000.

Table 6-18 indicates projects and programs for wildlife enhancement proposed by the U.S. Forest Service for the pre-1980 period. Plans have not been developed beyond that point, but similar activities may be expected in subsequent periods. Hunter-day benefits from these projects and programs have not been determined, but they will help satisfy overall demand.

TABLE 6-18. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Stillaguamish Basin, pre-1980

Project or Program	Unit	Number	Capital Cost
Surveys and Plans			
Conduct range analysis			
Deer	acre	29,700	$ 3,000
Mountain goat	acre	76,910	7,700
Conduct upland-game habitat surveys	acre	69,100	3,500
Develop habitat management plans	each	1	500
Construct shallow impoundments for waterfowl	acre	20	15,300
Total			$30,000

Whidbey-Camano Islands



WHIDBEY-CAMANO ISLANDS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

Whidbey and Camano Islands, with more than 220 miles of open beach and protected bays, provide excellent estuarine and marine habitat used extensively by anadromous and marine fish and shellfish (Figure 7-1).

The land areas contain mostly intermittent streams; however, two streams on Whidbey Island, including Maxwelton Creek and one on Camano, support anadromous fish runs. The Islands also have 47 lakes (747 surface acres) and 57 farm ponds (29 surface acres) which support mostly spiny-rayed species, but four lakes on Whidbey (Cranberry, Deer, Goss, and Lone) provide excellent habitat for trout.

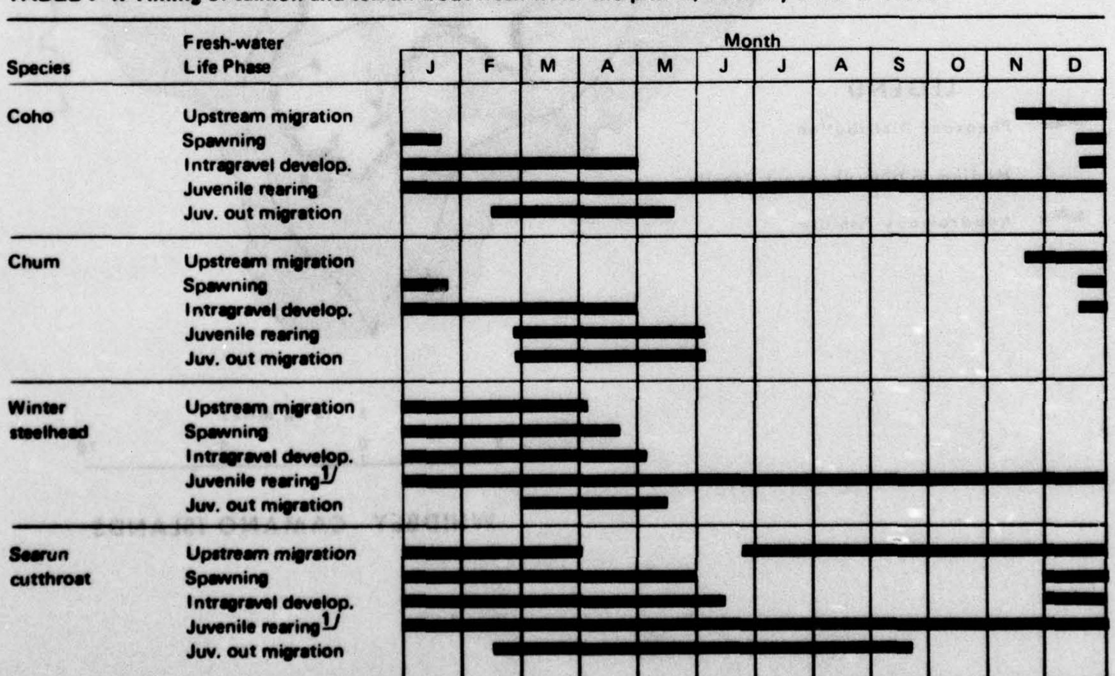
ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are distributed in various waters and their general life histories are similar. Resident fishes are numerous in the larger lakes.

Anadromous Fish—Anadromous fishes inhabiting the four permanent streams of the Whidbey-Camano Island group are coho and chum salmon, steelhead and searun cutthroat trout (Figure 7-1). Due to limited size, the streams support only a small population of steelhead and searun cutthroat trout. Upstream migration timing overlaps considerably, as shown in Table 7-1.

TABLE 7-1. Timing of salmon and searun trout fresh-water life phases, Whidbey-Camano Islands



1/ Normally extends over a two-year period.

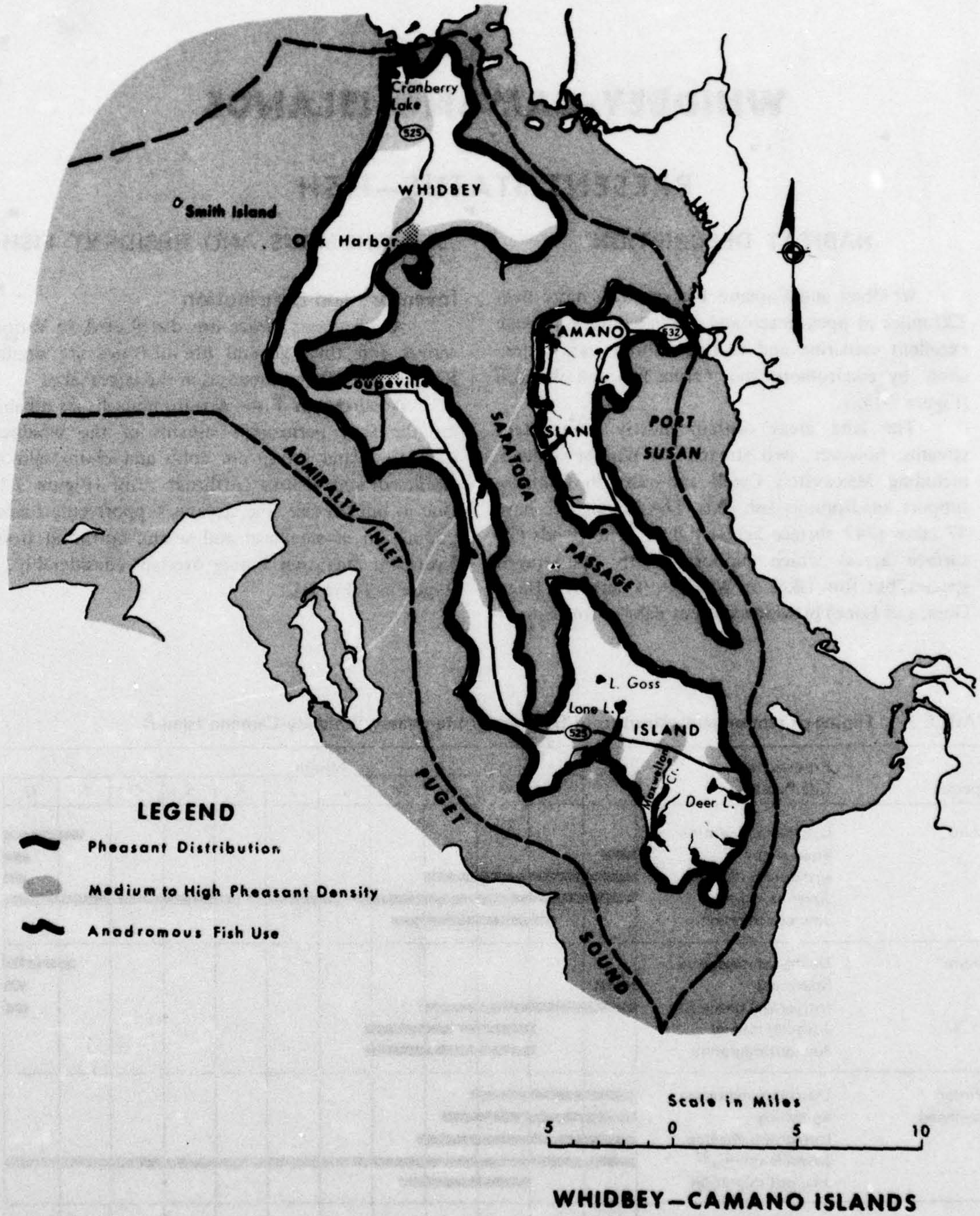


FIGURE 7-1. Anadromous fish and wildlife distribution (1965)

Estimated numbers of anadromous fish produced within basin waters and surviving to return as spawners are presented in Table 7-2.

TABLE 7-2. Anadromous fish spawning escapement, natural and (artificial), Whidbey-Camano Islands

Species	Range[1/]	Average (Annual)
Chinook	--	--
	(0-80)	(40)
Coho	50-250	100
	(0-650)	(280)
Chum	0-200	50
Summer steelhead[2/]	NA	NA
Winter steelhead[2/]	[3/]	> 500[3/]
Searun cutthroat[2/]	9,500-30,200	23,500
Searun Dolly Varden[3/]		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), trout (1962-1966).

2/ Totals include natural and (artificial) escapement.

3/ No valid totals established.

Resident Fish—Resident cutthroat trout populations are maintained in several small streams by natural propagation; however, the outstanding salmonid fishery in the lakes is maintained through an intensive rainbow planting program. Largemouth bass, yellow perch, black crappie, and brown bullhead are found in small ponds and lakes. Other resident species include sticklebacks and sculpins, which are abundant in the streams.

Production

Because of an almost complete lack of permanent streams in the Islands, standing crop estimates are based on sampling and comparison with similar streams in other nearby basins. Existing water diversion projects reduce fish production. The few independent drainages on these low elevation Islands are very productive. Based on a 1966 survey, production of an average stream section was 127.1 pounds of fish per surface acre. Production approached 116 pounds per surface acre for salmonids, while other or undesirable species comprised the remaining 11.1 pounds.

Anadromous Fish—Salmon production and the potential for this production are limited and therefore, were not determined.

The few streams producing winter steelhead and searun cutthroat trout are relatively free of limiting factors and production approaches the natural potential. Numbers produced are unknown, but comparative figures indicate the steelhead total to be between 500 and 1,000 adults, and the searun cutthroat production averages 31,300. It is believed that potential natural production could be increased slightly.

Resident Fish—For practical purposes, resident stream fish production has already been considered. There are so few stream areas that the present potential per-acre figures given above are correct for all stream areas and resident and anadromous fish production is inseparable.

Because lake and pond habitats are planted so frequently and managed for salmonids and/or spiny rays, actual production figures are shown in harvest data. Total harvest varies from one season to another and may vary from less than 10 to nearly 300 pounds per surface acre annually. Potential production could be substantial.

Propagation

Salmon production is supplemented by the Crockett Lake fish farm (salmon rearing pond), 4 miles south of Coupeville on Whidbey Island. The pond has been planted annually (except 1966) since 1962 with chinook fry. Prior to 1966, plants were also made in Maylor and Kennedy's Lagoons.

From 1961 through 1966, plants of fall chinook, coho, and chum were made from hatcheries outside the Islands. These fish were not reared to the usual release size before planting; therefore the contribution to fisheries is lower than plants from other basins. The estimated contribution to the fisheries is 1,300 chinook, 100 chum, and 6,700 coho.

No completely artificial propagation facilities for game fish are located on the Islands. Fish stocking requirements, especially in the large and productive lakes on Whidbey Island and the salt-water lagoons of both Islands, are fulfilled from production facilities in other nearby basins. Such fish stocks are also indispensable in stocking habitats which have been altered or recently improved. However, the State has utilized Kennedy and Camano Lagoons, located on Whidbey and Camano Islands, respectively, to experimentally rear steelhead and/or searun cutthroat. Only Camano Lagoon remains as an active facility designed to supplement planting activities of adjacent basins. Three farm fish ponds receive plants of hatchery game fish every two to three years from privately-owned facilities.

Approximately 98 percent of the annual resident trout harvest is contributed by State rearing facilities. Also, an undetermined amount of the anadromous game fish harvest is attributable to these same facilities.

During the period 1961-1965,[1] an average of 16,490[2] searun cutthroat were stocked in Island waters. Resident fish propagation data are presented in the Area chapter.

Harvest

Existing Harvest–Because of limited natural production, few salmon originating from the Islands contribute to commercial or sport harvest. However, fish farm operations on Whidbey Island, recently curtailed, have contributed as many as 2,820 adult salmon to the commercial and sport fishery in a single season. Extensive salmon harvest occurs within the marine sector. This is mainly due to the Islands' expanse of marine waters, their location at the head of Puget Sound and offshore from several major fish producing mainland streams, and their proximity to major fish landing ports. Popular commercial fishing grounds exist off West Beach, Lagoon Point, Brush Point, Double Bluff, Camano Head, Indian Point, in the west side of Possession Sound, and in the southern half of Skagit Bay.

Salmon sport fishing within the marine waters is also very intense, as indicated by the more than 120,000 angler-days logged in the vicinity in 1965. The yearlong abundance and availability of salmon in the semi-protected waters account for this heavy fishery. Also, throughout much of the year, the bays and inlets serve as a vacation paradise for numerous small boat enthusiasts. Salmon fishing, coupled with the scenic splendor of the Islands and waterways, serve as the principal attractions. Favorite sport angling sites include West Beach, Deception Pass, Possession Point, and virtually all of Admiralty Inlet. Because of the fishery, many resorts and tourist-oriented businesses thrive in the area, serving as a major source of revenue in some locations.

The salt-water trout fishery of the Islands is unique, because it is the only basin where both steelhead and searun cutthroat are taken in relatively large numbers (Photo 7-1). This fishery also occurs before the winter steelhead fishery in the mainland streams.

PHOTO 7-1. Steelhead angling in marine waters, a highly popular activity, is unique to this Basin. (Washington Department of Game photo)

A recent survey (1966) indicates 8,300 angler-days were spent in catching approximately 1,700 winter steelhead. The bulk of these fish are produced naturally in adjacent basins.

These same data indicate 16,800 angler-days were spent in the pursuit of searun cutthroat in salt water with a total harvest of 10,100 fish. The Islands' natural production is not considered to have provided more than 10 percent of the total fresh- and salt-water searun cutthroat harvest.

On the basis of available data (1962 through 1966), 44,100 angler-days annually were spent fishing in the lakes, ponds, and reservoirs, and a total harvest of 214,400 trout and 22,000 other game fish realized (Photo 7-2). Fishing effort in streams is negligible and was not determined.

Potential Harvest–Potential harvest of salmon and steelhead is most difficult to predict, since artificial propagation and natural production from adjoining basins provide the bulk of the fishery. Similar circumstances prevail for searun cutthroat and no estimates of increased production or harvest potential are shown.

Resident salmonid production, and therefore harvest in streams, is not expected to change. Potential harvest of such fish in lakes, ponds, and reservoirs could be increased significantly.

Factors Limiting Production Other Than Harvest

Nearly all the statements concerning alterable limiting factors for fish production and harvest in the West Sound Basins also apply to the Whidbey and

[1] Anadromous trout data involve period 1962-1966.

[2] Annual stocking initiated in 1964, with most active program in 1966.

PHOTO 7-2. Tomorrow's citizen expects that high angling opportunity will continue. (Washington Department of Game photo)

Camano Islands. The major exception is that many lakes, and particularly the largest ones on these Islands, are quite productive and support heavy fishing pressure. Streamflow and water temperatures are influenced primarily by natural phenomena, although logging and farming also have a pronounced effect on fish production.

Detrimental Streamflow–Within the limited stream reaches, the principal factor restricting both anadromous and resident fish populations is the lack of substantial flow. The majority of these streams are dry during the summer. Fish populations in streams maintaining a year round flow suffer extensively from reduced flows, which cause a loss in total available rearing area and limit the production capacity.

Intermittent streams have limited spawning potential. The reaches utilized principally by anadromous species do not require extended periods of streamflow. However, most of these streams exhibit seasonal flows too low for access by adult spawners.

Poor Water Quality–Many of the more permanent streams are slow moving, have shallow gradient, and during warmer periods, may exhibit unsuitable temperature and reduced oxygen conditions.

Physical Barriers–No physical barriers exist in the streams, other than low flow conditions cited above.

Conflicting Watershed Developments–Vacation cabin and permanent home construction is increasing. However, because the bulk of such development is oriented to and near the salt-water shoreline, it is less serious to fish resources than in other basins. Logging and farming have contributed to diminishing stream productivity.

Limited Spawning and Rearing Areas–Intermittent or low streamflows are primarily natural and afford limited spawning and rearing habitat.

Competition and Predation–All anadromous and resident salmonids are preyed upon by sculpins and sticklebacks. Mammals, birds, and marine fish are anadromous fish predators. Spiny rays and trout also prey to varying degrees upon other anadromous and resident salmonids.

Beneficial Developments

Accomplished and Continuing–Because natural stream areas are limited, very few salmonid enhancement projects have been developed. The State has tested the "fish farm" type of propagation in three natural impoundments on Whidbey Island. However, with available techniques, production costs are generally prohibitive in this area. Only Crockett Lake remains in production.

Whidbey-Camano Islands have a very limited inland game fish resource which has been suitably maintained by providing access to certain bodies of water and by a limited lake rehabilitation program. These management measures are concerned primarily with increasing game fish harvest and production.

Small streamflows common to the Islands, combined with tidal flows, have been used to rear searun cutthroat trout. Camano Lagoon, an estuarine area, is separated and screened from Port Susan, and these fish are reared here for release to salt water. A similar facility has been operated at Kennedy Lagoon in Penn Cove on Whidbey Island.

Waters which have been chemically rehabilitated for trout management include Deer, Lone, and Cranberry Lakes, and Lake Goss. Only Lone and Deer Lakes required screening. Figure 7-2 indicates various improvement projects.

The State's public fishing program is designed to guarantee fishermen access to lakes, streams, and salt-water areas. Land has been acquired and developed at Deer and Lone Lakes, and Lake Goss (Figure 7-2). Additional private and public land management agencies supplement this program.

Control structures for semi-natural salt-water rearing areas are continually being modified. The goal is to have self-maintained areas providing returns of anadromous fish to this Basin while supplementing the returns of such fish passing but destined for adjoining basins.

Other continuing programs involve the effort to obtain guaranteed public fishing access to lakes and certain salt-water areas and the construction and maintenance of lake inlet and outlet control structures accompanying specific lake rehabilitation work.

Under Development–A project to enlarge the public use area at Lone Lake is currently being developed.

MARINE FISH AND SHELLFISH

Habitat Description

The Whidbey-Camano Islands, located in proximity to the mainland, the numerous bays and coves, and the related open waters of the western boundary, offer a variety of ecological niches occupied by many fish species. Relatively deep water surrounds the Islands.

Inventory and Distribution

Marine Fish–Marine fish population is discussed in the Area section covering marine fish production.

Shellfish–The irregular shorelines with extensive sheltered bays and beaches provide excellent habitat for shellfish and other marine invertebrates. The reduced salinity resulting from Skagit, Stillaguamish, and Snohomish Rivers' inflow benefits these resources.

Dungeness crabs are distributed along the shorelines with the most productive waters located in the southern portion adjacent to the deeper channels. Excellent populations also occur in Saratoga Passage, Port Susan-Possession Sound, and Cultus, Useless, and Mutiny Bays on the southern end of Whidbey Island.

Pacific oysters flourish in scattered concentrations on gravelly beaches in protected bays where oyster clutch and seed have been introduced. Also, natural setting is responsible for small concentrations of oysters throughout most of the protected marine waters. Native Olympia and Kumamoto oysters occur in very minor numbers. The sheltered bays and sand-gravel beaches provide excellent habitat for littleneck and butter clams. Softshell clams, and lesser numbers of horse clams and geoducks, occur along the shore opposite the Skagit Flats (Skagit-Samish Basins). Other clam species are evenly distributed throughout the Island habitat. Extensive populations of mussels occur in the protected bays and on rocky points. A few scallops are found in the deeper channels.

Pink and spot shrimp are abundant in Saratoga Passage as far north as Oak Harbor; however, they also populate Possession Sound and Admiralty Inlet.

Large concentrations of squid are found in Saratoga Passage and Holmes Harbor during fall and winter; lesser numbers populate the Islands' protected marine waters during most of the year. Octopi are abundant throughout the area. Other marine invertebrates, such as sea cucumbers and sea urchins, are common.

Production

Information is not available concerning numbers of marine fish and shellfish produced.

Propagation

Holmes Harbor, on the east side of Whidbey Island, represents the only area in Puget Sound where the propagation of a marine fish species is enhanced on a major scale. The facilities used, the procedures followed, and the care and protection given to spawning adult herring and the developing young somewhat resemble those of a hatchery operation. A trapping and rearing operation is conducted in conjunction with a private commercial fishery (Photo 7-3).

PHOTO 7-3. Holmes Harbor herring trap provides mature fish for salmon sport fishing bait. (Washington Department of Fisheries photo)

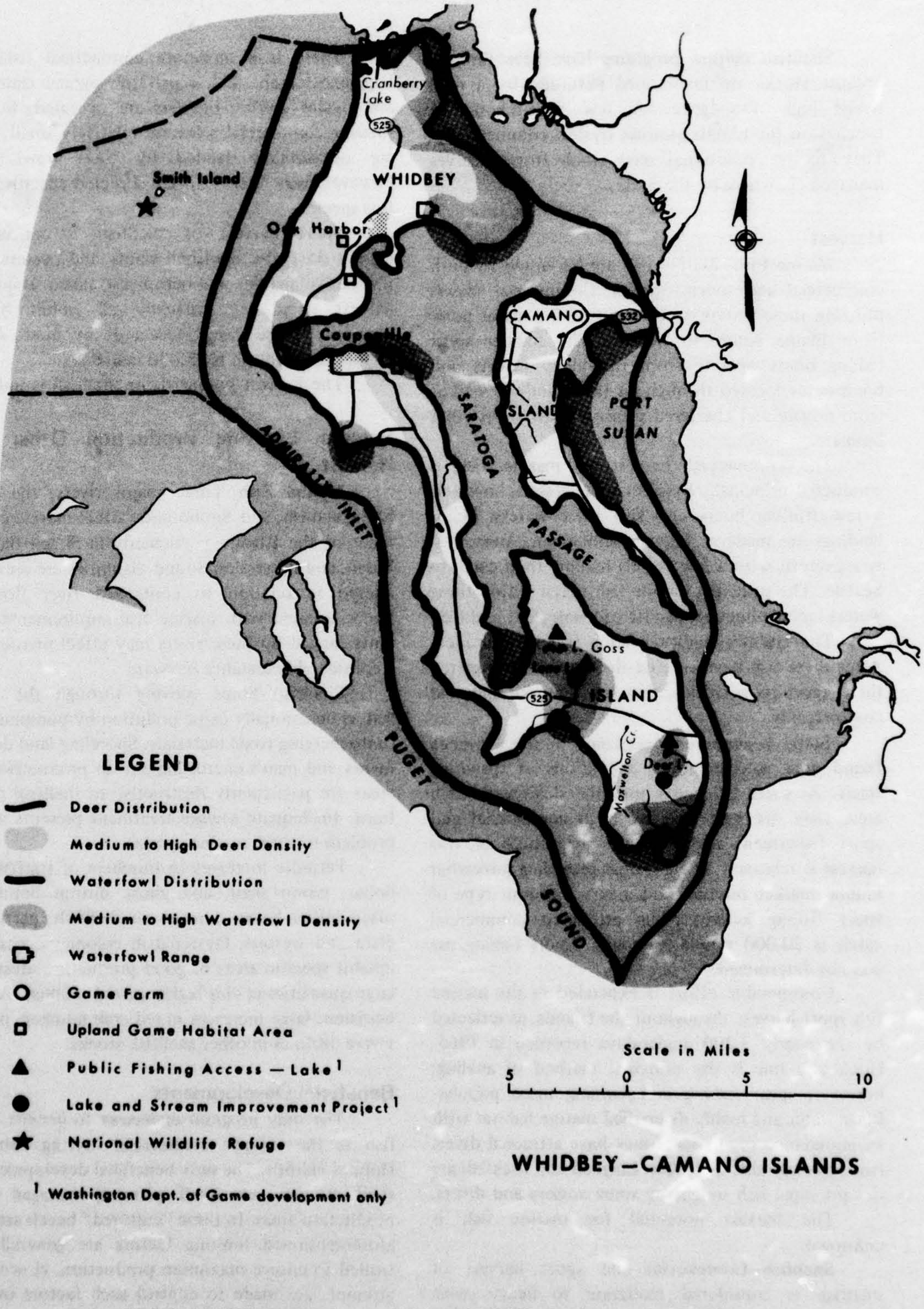


FIGURE 7-2. Wildlife distribution, and fish and wildlife developments (1965)

Shellfish culture programs have been limited, because stocks are maintained naturally by a relatively high abundance. A few privately-owned beaches on the Islands produce oysters commercially. They receive occasional seed stock from reserves managed elsewhere by the State.

Harvest

Marine Fish–Marine fish are harvested by both commercial and sport fisheries. Commercial vessels utilizing these waters operate out of the major ports from Blaine south to Seattle. The smaller sport fishing boats operate from the many resorts and boathouses located throughout the Islands as well as from private and chartered pleasure craft from other basins.

The commercial harvest of marine fish is conducted principally by otter trawl vessels; however, a few trolling boats also fish these waters. Major landings are made at Blaine, Bellingham, Anacortes, and Everett, with a few vessels hauling their catch to Seattle. The principal marine fish taken within these waters include lingcod, Pacific cod, sole, and rockfish.

The Holmes Harbor herring fishery is unique. After these fish have entered the trap and completed their spawning activities, they are removed and sold commercially.

Some beaches and tidelands in the Whidbey Island area receive annual migrations of spawning smelt. As these fish move into the shallower beach area, they are harvested by both commercial and sport fishermen. Although the magnitude of this harvest is relatively small, it does provide a somewhat unique market product and a very different type of sport fishing activity. The estimated commercial catch is 20,000 pounds annually. Sport fishing use was not determined.

Considerable effort is expended in the marine fish sport harvest throughout the Islands, as reflected by the nearly 3,200 angler-days recorded in 1965. Hook and line is the principal method of angling; however, spear fishing is becoming more popular. Clear water and highly diversified marine habitat with an abundance of marine fishes have attracted divers from considerable distances. Lingcod and rockfish are the principal fish sought by sport anglers and divers.

The harvest potential for marine fish is unknown.

Shellfish–Commercial and sport harvest of shellfish is considered moderate to heavy, with principal emphasis on crabs, oysters, and hardshell clams.

There is a moderate commercial fishery for Dungeness crab. A few privately-owned clam farms and oyster culture beaches are operated, but their present commercial sales are relatively small. Octopi are occasionally landed by otter trawl vessels; however, very little effort is directed specifically for this species.

Sport harvest of shellfish is concentrated mainly on crabs, hardshell clams, and oysters with a few native abalone and octopi also taken. Major sport harvest occurs on virtually all public beaches, especially those easily accessible by boat. Average annual use involved is 15,000 man-days.

The harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish–Three major rivers, the Skagit, Stillaguamish, and Snohomish, affect marine environment of the Islands, particularly in Skagit Bay, Port Susan, and Possession Sound. Salinities are reduced or altered in relation to controlled river flows but uncoordinated with marine fish requirements. Pollutants carried by these rivers may affect marine life at a considerable distance bayward.

Shellfish–Ships moving through the marine waters occasionally cause pollution by pumping bilges or discharging toxic materials. Shoreline land developments and man's encroachment on productive beach areas are particularly destructive to shellfish populations. Inadequate sewage treatment presents another problem to these marine species.

Periodic increases in numbers of starfish, sand dollar, moon snail, and ghost shrimp populations often inflict heavy damage on shellfish, particularly clam and oysters. Oyster drill colonies occasionally inhabit specific areas of good production, destroying large quantities of this highly prized mollusc. Also, on occasion, large increases in red crab numbers produce severe declines in other shellfish stocks.

Beneficial Developments

The only program underway to benefit marine fish is the unique commercial herring fishery at Holmes Harbor. The only beneficial developments for shellfish are the small privately-managed oyster production areas. In these "cultured" beach areas, the aforementioned limiting factors are generally controlled to ensure maximum production. However, no attempts are made to control such factors over the many miles of natural beaches.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

A recent population census (1963) ranks the Whidbey-Camano Islands Basin, with 19,900 people, as third smallest in the Puget Sound Area. Population is increasing rapidly. Population projections indicate increases to 26,900, 36,200, and 49,500 by 1980, 2000, and 2020, respectively, and this trend is expected to continue for some time. Although this Island basin will remain one of the least populated within the Area, its growth rate is expected to exceed that of some of the other moderate to large basins. Major increases will be related indirectly to industrial expansion on the adjacent mainland, particularly in the Seattle-Everett vicinity. Much of the growth on Whidbey and Camano Islands will result from private residence construction for commuters to the metropolitan areas. Considerable development will also be associated with summer-recreation home construction, which is expected to increase rapidly in areas adjacent to lakes, streams, and salt-water beaches.

The Islands' location near heavily populated areas, plus relatively good access provided by highway and ferry systems, promotes this area for outdoor recreation. Sport fishing for salmon and marine fishes has always been extremely popular, and such activities are expected to increase in the future. With the expected upsurge in demand for outdoor recreation associated with increased population and more leisure time, it is anticipated that sport fishing pressure within the Basin will accelerate at a rate even greater than that of population growth.

RESOURCE DEMANDS AND NEEDS

The Basin's marine waters support heavy commercial fisheries for salmon, marine fish, and shellfish. Its streams produce few salmon. However, the closely associated marine waters form part of the migration routes of salmon destined to spawn in the major Puget Sound drainages. This strategic positioning makes these waters a favorite of both commercial and sport salmon fishermen.

Sport fishing for salmon, marine fish, and shellfish is heavy throughout most of the Basin. Each year additional sport fishing pressure occurs, particularly during high pink salmon years.

Large numbers of marine fish and shellfish, particularly crabs, are harvested by both commercial and sport fishermen. It is anticipated that demands for marine fish and shellfish will increase rapidly, with especially heavy demands from sport fishermen.

The future demand for game fishing will occur on lakes, salt-water beaches, and the very limited number of streams and beaver ponds. Based on county use values, approximately 55 percent of all Basin harvest and utilization of game fish other than steelhead is by people from outside the Islands. It is estimated that, by 1980, Island lakes must provide an additional 143,600 trout and 14,800 game fish of other species to the creel each year. This is an additional 212 fish per surface acre. Salt-water game fishing beaches must support an additional yearly harvest of 1,200 steelhead by 1980.

As population, leisure time, and outdoor recreation demands increase in this and adjacent basins between 1980 and 2020, the need for game fishing opportunity will increase proportionately. This increase, in angler-days, is indicated in Table 7-3.

TABLE 7-3. Present and projected sport fishermen use (game fish) on Whidbey-Camano Islands

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	69.2
1980	46.4	115.6
2000	66.1	181.7
2020	109.0	290.7

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish of the Whidbey-Camano Islands are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to this Basin.

Conflicting Land and Water Uses

(1) Low flow conditions in various stream sectors are aggravated by water diversions, which

reduce the effectiveness of many of these streams as fish production areas. Such flow alterations further alter downstream recreation potential.

Poor Water Quality

(1) Occasionally, intermittent pollution occurs in certain more southerly Island areas. This is associated with poor quality water transported to the area from the Snohomish Basin.

(2) Although pollution conditions are quite limited within Basin waters, increased population will result in a domestic sewage problem.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of potential developments on Whidbey-Camano Islands. The relatively few such developments should be designed primarily to meet the rapidly increasing demands associated with sport harvest of fish and shellfish.

ANADROMOUS FISH

A major program to benefit anadromous fish, particularly those utilizing the Basin's marine waters for rearing and transportation, should be the implementation of water quality controls throughout the area. Salmon production could be enhanced somewhat through developments such as eyed-egg incubation facilities or controlled rearing impoundments. There are numerous small bays, salt-water lagoons, and some small lakes with outlets to salt water that have a potential for anadromous fish rearing.

To meet increased recreation demands for sport fishing will require development of new salt-water access areas, small boat moorages, recreation equipment, and tourist facilities. There is opportunity for such development in many areas.

The Whidbey-Camano Islands may be classified as a very limited production area for anadromous fish, because of the small size and limited number of spawning streams. Streamflows are primarily dependent upon surface runoff from rainfall, which results in greatly reduced summer flows. Therefore, significant spawning reaches were not determined. Low summer flows, in turn, greatly reduce production capacity for species whose life history dictates extended fresh-water rearing. The largest stream on the Islands is Maxwelton Creek (Whidbey Island), which contains a two-mile reach of spawning area from the mouth upstream. Two additional unnamed streams on Whidbey Island and one on Camano Island also contain some spawning habitat.

An average annual flow of not less than 3 cfs should be maintained in Maxwelton Creek. This flow should be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish. To sustain fish production in the various lakes and ponds, existing levels should be maintained.

MARINE FISH

Most beneficial developments for anadromous fish would also assure benefits for the extensive marine fish populations. Creating new marine fish habitat and new fishing areas through the placement of rock jetties or submerged "reefs" in selected areas would also be highly beneficial.

The Holmes Harbor commercial herring fishery, utilizing brush weirs to collect herring spawn, could be considered a propagation facility. Other marine fish can be artificially propagated effectively. This Basin will provide numerous highly suitable sites for such production when demand warrants.

SHELLFISH

Future programs to implement water quality controls will conserve and enhance shellfish production. Also, shellfish would be benefited by the establishment of measures guarding against tideland attrition, thus protecting against losses of valuable beach areas.

Potential projects for increasing shellfish populations include installation of beach breakwaters, and study and implementation of techniques to control natural predators. Expanded use of raft and rack culture methods would increase oyster production in these mostly clean and productive marine waters.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Whidbey-Camano Islands offer opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. In addition, a number of opportunities exist for development of facilities to meet increased recreation demands for fish resources. Major proposals, with a general indication of priority, are categorized in Table 7-4. They have not been evaluated, nor have costs been assigned. When demand for salmon, marine fish, and shellfish dictates, and effective, economical techniques for enhancing these resources in Whidbey-Camano Islands' habitat are developed, these projects and programs will be initiated.

TABLE 7-4. Potential developments for production and use of fish and shellfish, Whidbey-Camano Islands

Beneficial Development	Priority: Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Develop clam hatchery for restocking public clam beaches	X		
Develop artificial salmon propagation facilities	X	X	
Improve public beaches for clam production		X	
Create marine fish production and fishing areas	X	X	X
(2) Acquisition			
Determine and evaluate potential salmon propagation sites	X		
Acquire and develop 5 salt-water public access sites	X		
Purchase suitable land for propagation sites and procure water	X	X	
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Acquire 5 miles of additional tideland for public use		X	
Procure land for public access development	X	X	X
(3) Management and Administration			
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Develop subtidal park for skin divers		X	
Implement controls against excessive removal of stream water	X	X	X
Promote conservation measures for all fisheries	X	X	X
Implement fishery management regulation changes	X	X	X
Promote fish and shellfish culture programs	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities affecting streams and salt-water areas	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
Shellfish predator control	X	X	
Continue inventory of shellfish stocks and recreational use of tidelands		X	
Marine fish propagation and rearing		X	X

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Thermal powerplant sites should be carefully selected to minimize damage to the fish production potential. Water cooling facilities should be an integral part of construction plans.

Water diverted from the mainland for domestic and irrigation use will eliminate the need for lake water for this purpose.

Outdoor recreation and homesite developments will probably be the major future uses of land in this Basin. Planning should provide adequate consideration for all uses including sport fishing as a major recreation activity.

Public access to salt-water beaches and lakes must be assured.

Additional trout stocking in lakes and lake fertilization will increase the potential for game fish harvest.

Projects and Programs Proposed for Completion by 1980

Since only relatively minor stream fishing areas exist, only lake and salt-water developments are proposed.

(1) Public access and boat launching areas are proposed for Silver Lake, Greenbank Beach, Brush Point, Lagoon Point, and Land Point Manor. Ultimately, all significant lakes and key portions of salt-water areas should have assured public fishing access.

(2) Construction of estuarine ponds is possible, but must be judged critically. Sites worthy of consideration exist on the northeast and southwest sectors of Whidbey Island. Another potential lies in development of the creek system and intertidal area at Cultus Bay.

(3) The enlargement of Miller Lake on Maxwelton Creek is recommended; however, the release of flows to sustain this stream is a necessary requirement of the project development.

(4) A salt-water lagoon rearing area for searun cutthroat should be constructed.

(5) Fish disease and parasite control programs which permit increased survival of game-fish populations should be developed for lakes.

(6) New fertilizers and piscicides should be developed to improve fish production in lakes without developing undesirable side effects.

(7) Semi-artificial estuarine rearing areas should be constructed to enhance anadromous game fish resources.

Table 7-5 indicates estimated annual benefits and costs of specific projects and programs proposed

TABLE 7-5. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish on Whidbey-Camano Islands, pre-1980

Project or Program	Annual Benefits: Angler-Days	Annual Benefits: Value	Costs: Capital	Costs: O&M (Annual)
Lakes				
Acquire and develop public access, Silver Lake	9,000	$ 18,000	$ 12,000	$ 200
Enlarge Miller Lake	9,000	18,000	200,000	--
Conduct lake fertilization studies	40,000	80,000	10,000	1,000
Subtotals	58,000	$116,000	$222,000	$1,200
Salt Water				
Acquire and develop public access, 4 areas	24,000	$120,000	$235,000	$5,000
Develop salt-water rearing area	3,000	9,000	50,000	--
Subtotals	27,000	$129,000	$285,000	$5,000
Totals	85,000	$245,000	$507,000	$6,200

for Whidbey-Camano Islands to satisfy needs for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Subsequent developments, which now include some of those listed above, have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table.

Projects and Programs, 1980-2000

(1) Continue pertinent fisheries research.

(2) Develop new projects and programs as required.

(3) Investigate methods for control of spiny-rayed species overproduction.

(4) Increase public enthusiasm for spiny-rayed species by education and public relations.

(5) Complete programs and projects not completed by 1980.

Projects and Programs, 2000-2020

(1) Complete prior programs and projects not completed.

(2) Develop new projects and programs as required.

(3) Continue practical fisheries research.

PRESENT STATUS—WILDLIFE

INTRODUCTION

Whidbey-Camano Islands' weather is mild with no marked temperature extremes. Rainfall, particularly on the southern half of Whidbey Island, is affected by the rain shadow of the Olympic Mountains. This, combined with the low elevations, results in low precipitation for a western Washington area.

The area around Oak Harbor and Coupeville on Whidbey Island and the northeastern tip of Camano Island are farmed more intensively than the remainder of the two Islands. However, with a few exceptions, the agriculture of these areas is of low intensity and well dispersed throughout the predominant forest cover, creating a high percentage of "edge" which is favorable for wildlife production.

BIG GAME

Inventory and Distribution

The only big game, and by far the most important game species, are black-tailed deer. The diversified habitat, created by small ownerships and varied timber management and agricultural practices, produces high populations of these animals (Figure 7-2). Studies reveal that black-tailed deer may spend their entire life within an area of one square mile. Consequently, the amount and distribution of "edge" is an important factor in their density. In addition, mild weather conditions add to the productivity of the Islands' deer habitat.

The present deer harvest on Whidbey Island indicates a pre-hunting population of approximately 5,200 animals. An estimated 800 deer inhabit Camano Island. The Islands, therefore, have a total deer population of approximately 6,000 animals.

Limiting Factors

Deer are limited by availability of food. Agricultural development to date, in most instances, has increased the Islands' potential for deer production, but their scenic beauty has been "discovered" and shorelands and hillsides, which provide a view of the Sound, are being developed rapidly for housing. This will eventually decrease the amount of deer habitat; although, on Camano Island, some additional land clearing may be beneficial. Continued encroachment is inevitable as the Islands are within commuting distance of the large population centers of Everett and Seattle and have much to offer in the realm of outdoor recreation, scenery, and climate.

Production

The diverse habitat, adequate cover conditions, and mild winter climate of Whidbey and Camano Islands are ideal for deer. Productivity is high due to these environmental conditions and because a high percentage of the increase is harvested annually. Doe-fawn ratios determined just prior to the hunting season indicate an average annual increase of 1,800 deer over the late spring-early summer population.

Harvest

Deer on Whidbey Island have not only maintained their numbers, but have increased considerably over the years while being subjected to the most liberal seasons in the State. Serious deer damage to strawberry production in the early 1930's caused the State Game Commission to question the desirability of maintaining deer on the Island. A lengthy either-sex season was set in 1937, during which over 400 animals were taken. The following year a similar season was established with elimination of the herd the objective. Another 400 deer were harvested. Each year thereafter either-sex hunting has been permitted. The harvest trend has revealed a steady increase to about 950 animals taken annually, and has been cited nationally as an example of deer harvest potential through either-sex seasons. Hunting seasons on Camano Island, while not as liberal as those on Whidbey, have included several either-sex hunting days. The harvest here averages 175 deer annually. The total hunting effort represents approximately 22,500 hunter-days annually.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

Beneficial developments are described in the Area chapter, Big Game.

UPLAND GAME

The low rainfall and mild climate are particularly beneficial to the production and survival of upland game. Native species include snowshoe rabbit, ruffed and blue grouse, band-tailed pigeon, and mourning dove. Introduced species include ring-necked pheasant, California quail, red-legged and gray partridge, and eastern cottontail.

Inventory and Distribution

The cottontail is the most numerous game species. In fact, the foraging of these animals has at times been a serious problem in the production of certain agricultural crops. Rabbits are found throughout both Whidbey and Camano Islands, but are far more numerous in and adjacent to extensive agricultural developments. Greatest concentrations of cottontail occur around San de Fuca (on Penn Cove), Coupeville, and south to Keystone in the northern half of Whidbey Island. A population of 300,000 to 400,000 cottontails is estimated for the Islands. Numbers of snowshoe rabbit are insignificant.

Ring-necked pheasant, like cottontail, are associated with agriculture, and concentration areas more or less correspond with those of cottontail (Figure 7-1). Significant numbers of pheasant inhabit lands of the Oak Harbor Naval Air Station, attracted by waterfowl management grain fields. A current wild population of 10,000 pheasant, supplemented by artificially-reared birds, is present at the beginning of the fall hunting season.

A moderate population of California quail inhabits Whidbey Island's agricultural areas. An estimated 5,000 of these birds may be present on the Islands. Red-legged partridge have been reared and released from the State's Whidbey Island Game Farm into several areas on the Island and are commonly observed in a rather restricted area surrounding the farm. Gray partridge are few in number. Whidbey and Camano Islands support an estimated 1,200 ruffed grouse.

The populations of band-tailed pigeon and a limited number of mourning dove have not been estimated.

Limiting Factors

A change in agricultural practices on the Islands has resulted in reduction and alteration of the habitat used by introduced upland game. Early farming efforts were oriented toward production of cereal grains and hay which provided cover and food for these exotic species. Rapid housing development has eliminated increasing acreages of the woodland habitat used by limited numbers of grouse and band-tailed pigeon. The Area chapter, Upland Game, discusses factors limiting band-tailed pigeon density and residence period.

Production

There is an average annual production of 7,500 wild pheasants, 2,500 to 4,000 quail, and 700 ruffed grouse. Production of rabbit, mourning dove, band-tailed pigeon, blue grouse, and gray and red-legged partridge was not determined.

Harvest

Island County is one of the few areas of the State where rabbits may be hunted yearlong. This lengthy season for cottontail, in addition to above-average pheasant and quail hunting opportunities, contributes significantly to overall hunter recreation in the Puget Sound Area (Photo 7-4). An average of 20,000 rabbit and 3,900 pheasant is harvested annually. The pheasant harvest consists of 3,200 wild cocks and 700 fall-released artificially-reared roosters. Approximately 1,000 quail, 150 grouse, 2,000 band-tailed pigeon, and 370 mourning dove are also taken each year.

Average annual hunter-days use devoted to harvest of upland game on the Islands is 11,100 (rabbit); 5,600 (pheasant); 770 (quail); 250 (grouse); and 1,750 (band-tailed pigeon and mourning dove).

Propagation

Whidbey Island is the site of one of the eight game farms operated by the Washington Department of Game to supplement wild stocks of exotic game throughout the State. This farm produces 11,000 to 12,000 ring-necked pheasants and 1,000 to 2,000 red-legged partridges annually. Virtually all of these birds are released within the Puget Sound Area.

PHOTO 7-4. Introduced cottontail provide excitement and experience for beginning hunters. (Washington Department of Game photo)

The Island allotment of pheasant from the Whidbey Island Game Farm exceeds 2,000 birds, of which 1,200 are mature cocks and 800 to 1,000 are hens. The cocks are planted in September or October to supplement hunting, and the hens are released in early spring to augment wild broodstock.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual pheasant releases.

Through cooperative agreement with the Washington Department of Game, over 400 acres at the Oak Harbor Naval Air Station are managed to provide winter food for wildlife and public hunting. This area is used as a planting site for fall pheasant releases.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 243 acres of wildlife habitat development and 8,000 acres of wildlife habitat preservation, located throughout the Islands.

FUR ANIMALS

Fur-animal populations are somewhat limited; however, beaver, muskrat, mink, raccoon, red fox, weasel, and skunk are present in varying numbers. Some fur animals are dependent on water and water areas for their life requirements, and others require shoreland vegetation and animal life as food.

Inventory and Distribution

Beaver activity is evident in the permanent streams, numerous ponds, and lakes of Whidbey Island. Beaver numbers have declined slightly; the current population is estimated at 200.

Muskrat are widespread throughout the marshes, ponds, lakes, streams, and ditches on Whidbey and Camano Islands, and are the most numerous fur animals. A conservative estimate of their population is 1,500 to 2,000.

Mink, in addition to muskrat and beaver, are one of the three most important fur animals of the area. Water areas are nearly as important to mink as to muskrat and beaver, as most of their prey live in or near water. Mink are widespread, utilizing all fresh-water areas and the salt-water shoreline. Their population is estimated at 500 to 700.

Raccoon, red fox, weasel, and skunk occupy a variety of habitat. Actual numbers of each species are unknown, but populations are believed to be stable.

Limiting Factors

The most important fur-animal species–beaver, mink, and muskrat–are water-oriented, requiring primarily marsh-type habitat in which to live or find food. For this reason, the amount and quality of shallow water areas are the principal regulating factors governing numbers of these animals.

Man's encroachment on fur-animal habitat is the primary limiting factor on these animals. Draining and diking of marsh areas to create industrial areas or additional farmlands reduce fur-bearer food and cover areas. Homesite developments are concentrated along shorelands and, consequently, also tend to reduce fur-animal habitat.

Carnivorous fur animals such as minks and weasels depend in part on the muskrat for food; consequently, a loss of muskrat habitat is also reflected in a reduction of these predators.

Production

Population levels of the most valuable fur animals indicate the following average annual production available for the fall trapping season: 75 (beaver); 1,200-1,500 (muskrat); and 350 (mink). Varying numbers of the other species are produced.

Harvest

The number of beavers taken has decreased during the past four seasons (1963-64 through 1966-67). This decreased harvest may be the result of a loss of interest in beaver trapping, but is more likely a combination of this and overcropping of accessible concentrations. Sixty-three beavers were taken during 1963, the first year of beaver trapping by licensed trappers. The take had dropped to 10 by the 1965-1966 season.

It is doubtful if either mink or muskrat are harvested to the full extent of their potential. Mink which inhabit the salt-water shoreline are believed to produce poor quality fur and, consequently, are not trapped intensively. The trapper take of muskrat has declined during the last few years. This could indicate a lower population or a lack of interest in trapping this species. Muskrat appear most often in the catch of the casual trapper and, consequently, the take may vary more by area than for any other fur-animal species. The average annual take of mink is 140, of muskrat, 200.

Raccoon, red fox, skunk, and weasel occur only as incidental species in the trapper catch.

Income derived from trapping during the 1965-1966 season was approximately $2,300.

Propagation

There are at least two private beaver farms on Whidbey Island primarily raising breeding stock. This is a new enterprise and shows some promise of development; however, pelt values have not yet been established for these ranch-raised fur bearers.

Beneficial Developments

The Area chapter, Fur Animals, describes beneficial developments.

WATERFOWL

The numerous sheltered bays and extensive salt-water shoreline provide ideal resting areas for wintering waterfowl. Some food is provided by the cereal grain production on Whidbey Island, and many birds fly to the agricultural areas at the mouth of the Skagit to feed. The many duck species predominate, but black brant, lesser Canada geese, and snow geese are also present.

Inventory and Distribution

Areas of high waterfowl density include: Dugualla and Cultus Bays, Long Point east of Coupeville, and Skagit and Livingston Bays (Figure 7-2). Other areas which attract medium-high numbers of waterfowl are the fresh-water lakes; the eastern shoreline of Whidbey Island from Deception Pass to Polnell Point; the head of Penn Cove and the area north around the community of San de Fuca; the Fort Casey area; the heads of Holmes Harbor and Useless Bay; and the southern tip of Whidbey Island.

An undetermined number of ducks use the protected bays in fall and early winter prior to moving farther south or to inland flooded valleys to winter. Wintering populations of migratory waterfowl, determined by a January survey, show an annual average of 25,000 waterfowl after the early winter dispersal and a significant hunter harvest.

Limiting Factors

Waterfowl production is limited due to a lack of natural breeding habitat. Very few fresh-water areas exist and neither Whidbey nor Camano Islands have much salt-water marshland. The chief factor limiting migrant waterfowl numbers is availability of food. Reduction in cereal grain production on Whidbey Island, as well as in the Skagit delta, has reduced the potential of the Islands for wintering waterfowl.

Increasing numbers of home and outdoor recreation sites are being developed due to the accessibility of Whidbey and Camano Islands to the large population centers of Everett and Seattle, plus a unique low rainfall climate and scenic salt-water surroundings. These developments tend to reduce waterfowl habitat and use.

Production

Waterfowl production is limited on the Islands. A recent inventory disclosed an average annual production of 1,160 birds, the majority of which are mallards.

Harvest

Hunter harvest indicates the value of the area as an early winter waterfowl concentration site. Harvest records for 1960-1966 show that an average of 17,200 ducks and 420 geese is harvested annually, providing about 12,600 hunter-days. Mallard are the most numerous of the ducks bagged and goose harvest consists of snow geese, lesser Canada geese, and black brant. Island County ranked thirteenth in State waterfowl harvest during the 1966 season.

Propagation

Waterfowl are not artificially propagated on the Islands.

Beneficial Developments

Presence of the Skagit Game Range (Skagit-Samish Basins) also increases winter carrying capacity of the Islands. Ducks and geese fly from the numerous protected bays off Whidbey and Camano Islands to feed in the marsh and unharvested grain fields of the range.

Through cooperative agreement with the naval air station on Whidbey Island, limited access public hunting is provided and the State plants nearly 400 acres of grain annually for winter duck food.

Conservation practices applied to agricultural lands of direct benefit to waterfowl include 206 acres of wildlife wetland development and 200 acres of wildlife wetland preservation, located throughout the major Islands.

OTHER WILDLIFE

All Island fauna not classed as game or fur species are classified as other wildlife.

The Bureau of Sport Fisheries and Wildlife maintains Smith Island as a national wildlife refuge. This rookery island provides undisturbed nesting for colonial nongame birds.

Other members of this group are discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

The Basin, although composed primarily of two large Islands, Whidbey and Camano, is readily accessible to the heavily populated eastern shore of Puget Sound. The Islands are very attractive as living sites and outdoor recreation areas due to their extensive salt-water shoreline and favorable climate. People working in the industrial complex of Everett and Seattle seek housing in the more scenic area of Whidbey-Camano Islands and in the future such demand will increase.

Little industrial expansion is predicted for the Islands. However, due to their scenic beauty and natural resources, outdoor recreation is expected to play an increasing role in their future development and economy.

Large populations of deer, pheasant, rabbit, band-tailed pigeon, and waterfowl attract numerous hunters from mainland population centers. Recreational demand from the nearby heavily populated basins is expected to increase at an accelerated rate. To maintain the current level of hunting success it will be necessary to provide an additional annual harvest of 1,000 deer; 3,600 pheasants; 20,000 rabbits; 16,000 ducks; 400 geese; and 2,000 band-tailed pigeons by the year 1980. As population,[1]

[1] Population forecasts shown in Future Needs—Fish.

leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately. This increase, in hunter-days, is indicated in Table 7-6.

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand on the Whidbey-Camano Islands is to be satisfied. Problems and conflicts discussed in the Area chapter apply to this Basin.

TABLE 7-6. Present and projected hunter use on Whidbey-Camano Islands

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	54.6
1980	50.8	105.4
2000	65.5	170.9
2020	39.9	210.8

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the *Area* chapter, and activation of various developments on the Islands during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 7-7 shows projects and programs proposed for the Islands to satisfy 1980 needs. With this level of development hunter success must be decreased by 9 percent to meet projected needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from non-hunting use of wildlife such as trapping, wildlife photography, viewing, and dog training; nor does it include incidental benefits that will accrue from public use of wildlife areas for swimming, boating, picnicking, hiking, or other outdoor recreation activities. Based on existing surveys, such non-consumptive use more than equals hunting use.

TABLE 7-7. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife on Whidbey-Camano Islands, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs[1]: Capital	Costs[1]: O&M (Annual)
General Programs				
Develop educational program stressing renewable aspects and proper utilization of wildlife resources	20,000	$102,700	$ 5,000	--
Specific Programs and Projects				
Acquire title or easements to land for wildlife habitat development and hunter access	8,000[2]	32,000	50,000	$ 3,000
Acquire and develop salt-water public access areas	19,000	96,000	[3]	--
Enlarge Whidbey Island Game Farm to produce additional 3,000 pheasants	5,000	20,000	30,000	9,000
Totals	52,000	$250,700	$85,000	$12,000

[1] Do not include survey and plan costs.

[2] Includes off-project benefits.

[3] Costs included in salt-water fishing access area cost, Table 7-5.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Continue research in wildlife techniques and develop new projects and programs as required.

(3) Complete programs and projects not completed prior to 1980.

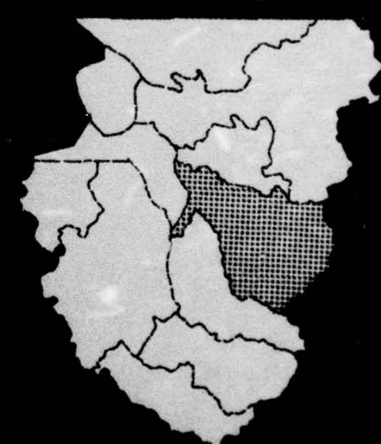
PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Complete programs and projects not completed prior to 2000.

(3) Continue research for new techniques in wildlife management.

Snohomish Basin



SNOHOMISH BASIN

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Snohomish Basin contains rivers, streams, lakes, and estuarine and marine waters, all important to the abundant and diverse fish and shellfish populations of the area (Figure 8-1). The nonstream fresh waters include 702 lakes (15,625 surface acres) and approximately 73 farm ponds (37 surface acres).

The Snohomish River system is the largest drainage system in the Basin. More than a dozen small independent streams enter Puget Sound. Most of these small drainages provide spawning and rearing area for anadromous and resident fishes, and each contributes to the specific environment of Puget Sound. Marine waters support shellfish and marine fishes.

The Snohomish River system consists of a relatively short mainstem, two principal tributary rivers, the Skykomish and the Snoqualmie, and numerous smaller tributaries. The principal tributaries head on the heavily-forested slopes of the Cascade Range. Their headwaters are swift, with extensive cascades and falls, while the lower reaches contain considerable pool and riffle areas. Snoqualmie Falls is a major barrier feature of the upper Snoqualmie River.

Downstream from the Skykomish-Snoqualmie confluence, the Snohomish assumes a meandering course as it flows to the Sound. Along this reach are numerous pools, deep slow moving glides, and riffles.

The independent drainages are all relatively short, but various sectors contain fairly sizeable pools and riffles.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in moderate to high numbers throughout the Basin.

Anadromous Fish—Anadromous fishes are chinook, coho, pink, and chum salmon; steelhead and searun cutthroat trout, and searun Dolly Varden. These fish migrate, spawn, and rear in 214.1 miles of accessible rivers, including 135.4 miles of accessible tributaries and 20 miles of independent drainages (Figure 8-1). Limited use occurs within the smaller independent drainages. Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

The majority of the Basin's spring chinook salmon utilize the upper Skykomish River system for spawning and rearing. This includes the North and South Forks Skykomish, and the Beckler, Foss, and Miller Rivers. Smaller runs occur in the Wallace and Sultan Rivers, upper reaches of the Snoqualmie and Tolt Rivers, and possibly in the upper Pilchuck River. Summer-fall chinook spawn throughout the entire accessible length of the Skykomish and Snoqualmie Rivers, and within a short reach of the Snohomish River upstream from the town of Snohomish. In addition, many larger tributaries to these major rivers, including the Beckler, Foss, Miller, Wallace, Sultan, Raging, Tolt, and Pilchuck Rivers, South and North Forks Skykomish, and portions of Woods, Elwell, Proctor, Tokul, and Griffin Creeks support summer-fall chinook spawners.

Coho spawn in a number of the same areas frequented by summer-fall chinook, particularly in watercourses formed by channel splitting. The more important Skykomish tributaries receiving spawners are the North and South Forks Skykomish, Wallace, Sultan, Raging, Tolt, and Pilchuck Rivers; and Elwell, Howard (Barr), Proctor, Woods, Tokul, Griffin, Harris, Patterson, Peoples, Cherry, and French Creeks (Photo 8-1). The majority of pink salmon spawning occurs in the Skykomish and Snoqualmie Rivers. Favored tributaries include the Wallace, Sultan, and Tolt Rivers; plus Elwell, Howard, Proctor, Woods, and Griffin Creeks. Chum salmon spawn principally in main river reaches utilized by summer-fall chinook and coho. Major tributaries receiving

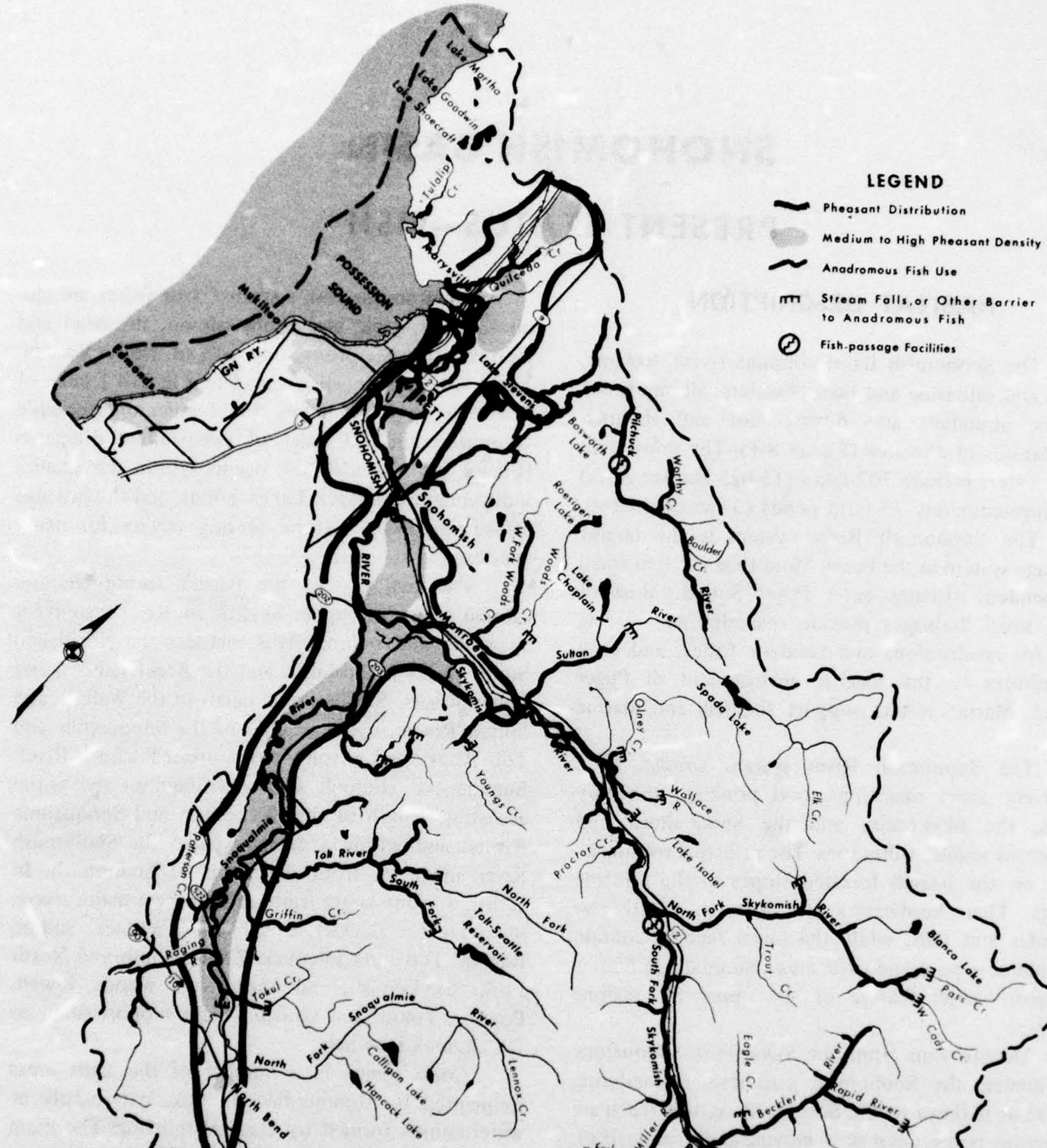


FIGURE 8-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

PHOTO 8-1. Coho spawning area on the Pilchuck River. (Washington Department of Fisheries photo)

spawners include the Wallace, Sultan, and Pilchuck Rivers. Spawning runs of summer and winter steelhead and searun cutthroat trout, and searun Dolly Varden occur principally in accessible tributaries and most particularly in the Pilchuck, Wallace, North and South Forks Skykomish, Raging, Tolt, and Sultan Rivers. In addition, the Skykomish River is a favored spawning area as is the Snoqualmie between Carnation and Fall City.

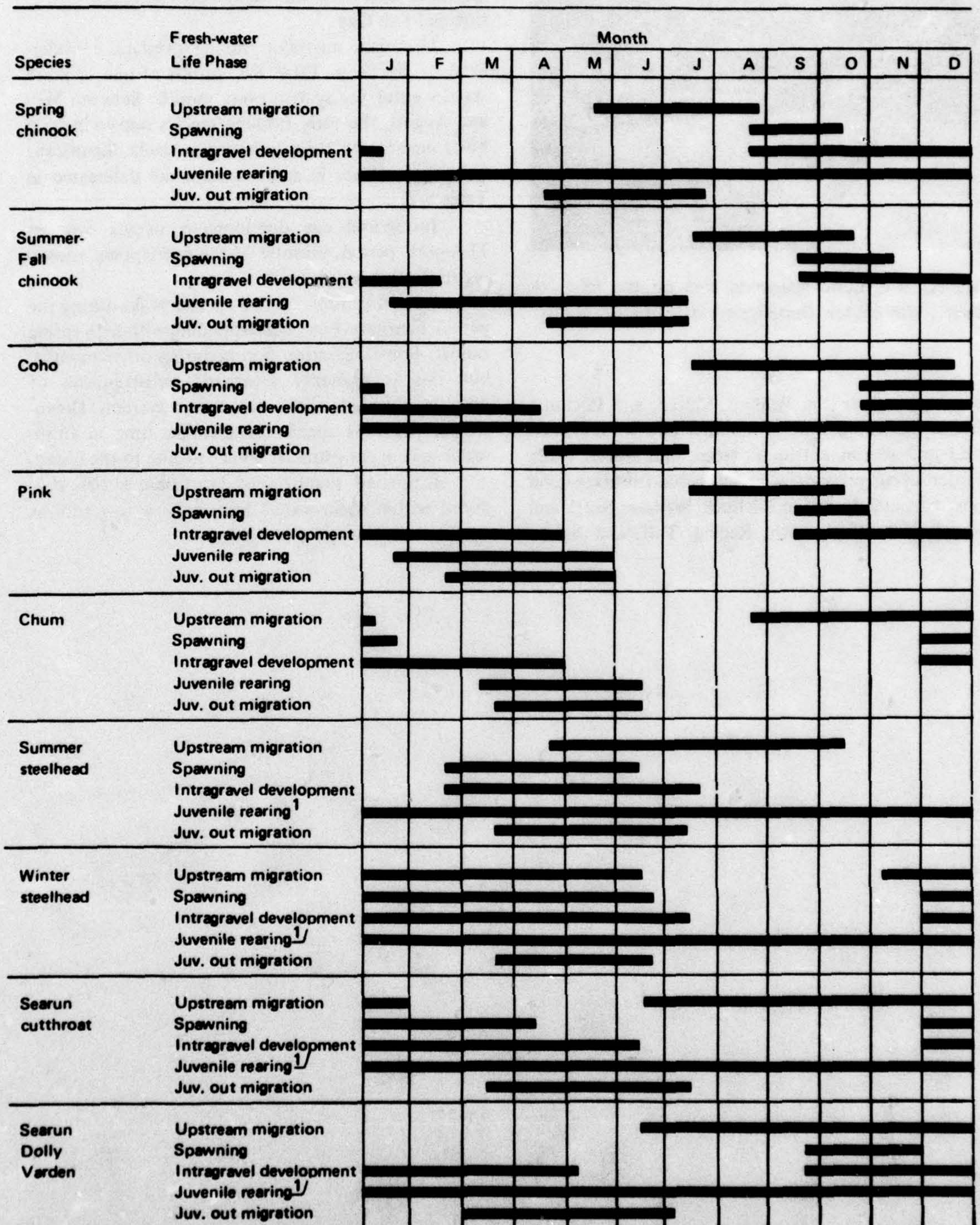
Upstream migration timing overlaps considerably, as shown in Table 8-1. Adults of one or more species enter the system every month. Between May and August, the early running species remain in deep holes enroute to their spawning grounds. Significant spawning reaches in some streams are delineated in Table 8-2.

Intragravel egg development occurs over an 11-month period, because of the overlapping spawning time of various species.

"Out migration" for all species peaks during the period February-June, corresponding with high spring runoff. Some migration occurs during other months, but this is primarily a natural redistribution of juvenile salmonids within the stream systems. Downstream migrants spend considerable time in fresh water and in the estuaries while enroute to the ocean.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 8-3.

TABLE 8-1. Timing of salmon and searun trout fresh-water life phases in Snohomish Basin



1/ Normally extends over a two-year period.

TABLE 8-2. Significant spawning reaches for anadromous fish and resident game fish, Snohomish Basin[1]

Stream	Section	Stream Mileage	Type of Spawning Area
Snohomish R.	Snohomish to Snoqualmie R.	13.0-21.0	Occasional broad riffles, long slow glides
Skykomish R.	Snoqualmie R. (forks) to Gold Bar	0.0-19.0	Many broad riffles, some long glides, some channel splits
	Gold Bar to North Fork	19.0-27.0	Some riffles and short glides, mostly patch gravel
N.F. Skykomish	Mouth to point upstream from Troublesome Cr.	0.0-12.0	Many riffles and short glides, some patch gravel
S.F. Skykomish	Baring to Tye R.	6.0-16.0	Few riffles, considerable patch gravel
Wallace R.	Mouth to May Cr.	0.0-4.1	Broad riffles and long glides, some channel splitting
	May Cr. to N. Fork	4.1-8.4	Short riffles and long glides, some patch gravel
Sultan R.	Mouth to diversion dam	0.0-9.6	Broad riffles, long glides, and some channel splitting to canyon, patch gravel and small bars through canyon
Snoqualmie R.	Carnation Farm to Tolt R.	20.0-22.5	Many broad riffles, considerable long glides
	Tolt R. to Falls City	22.5-33.5	Intermittent broad riffles, some patch gravel
	Falls City to Snoqualmie Falls	33.5-37.5	Some riffles, much patch gravel
Tokul Cr.	Mouth to diversion dam	0.0-1.4	Many riffles and short glides, some patch gravel
Raging R.	Mouth to forks	0.0-9.3	Many riffles and short glides, some patch gravel
Tolt R.	Mouth to forks	0.0-8.5	Many riffles and patch gravel, short glides
Pilchuck R.	Mouth to valley upstream from Worthy Cr.	0.0-30.0	Numerous riffles and short glides.

[1] Additional spawning reaches are provided by virtually all tributaries entering within described reaches.

TABLE 8-3. Anadromous fish spawning escapement, natural and (artificial), in Snohomish Basin

Species	Range[1]	Average (Annual)
Chinook	1,380-18,120	7,680
	(1,670-4,170)	(2,710)
Coho	11,300-80,900	36,440
	(9,620-22,380)	(13,200)
Pink	50,000-275,000	148,750[2]
Chum	9,030-32,990	21,150
Summer steelhead[3]	970-2,700	1,700
Winter steelhead[3]	45,900-67,000	53,800
Searun cutthroat[3]	41,500-60,400	48,500
Searun Dolly Varden[4]		

[1] Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

[2] Per odd-year escapement.

[3] Totals include natural and (artificial) escapement.

[4] No valid totals established.

Resident Fish—Resident fish spawn and rear throughout the Basin (Table 8-2). Rainbow trout and Dolly Varden occur primarily in the Snohomish River and its larger tributaries. Many headwater streams, lakes, or beaver ponds afford suitable habitat for cutthroat and brook trout (Photo 8-2). A few specific waters contain less numerous species, including lake, golden, and brown trout. Because these latter species are liberated only occasionally, their abundance is not discussed.

Kokanee are found only in Lake Stevens, tributary to the Pilchuck River. Spawning occurs in the inlet and outlet streams. Mountain whitefish are abundant in many waters. Largemouth bass, yellow perch, black crappie, brown bullhead, and pumpkinseed are introduced species distributed throughout numerous low-elevation lakes and ponds.

Other fresh-water fishes found in inland waters are suckers, sculpins, dace, squawfish, redside shiners, carp, and threespine sticklebacks. Peamouth are also evident, but less numerous. Suckers and sculpins are the most widely distributed and even

PHOTO 8-2. Beaver ponds are excellent headwater storage areas and provide high quality trout fisheries. (Washington Department of Game photo)

occur within the large drainage area upstream from Snoqualmie Falls. Squawfish inhabit lakes as well as the Snohomish River with peamouth. Shiners are distributed in greater numbers in the Pilchuck River tributaries, while dace are most evident in small tributaries and Snohomish reaches at lower elevations. Carp occur principally in lakes and in the Snohomish River and its sloughs. Sticklebacks are common in lower river or near estuarine environments in addition to several lakes of the Marysville and Lake Stevens areas.

Production

Anadromous Fish—Certain reaches of the Sultan and South Fork Skykomish Rivers have been significantly altered. Sultan River production and utilization are affected by a major water storage and diversion project. Stream production within the Skykomish River drainage is greater than that of the Snoqualmie. Independent drainages and lower elevation tributaries of these rivers as well as the Pilchuck and Snohomish Rivers are considerably more productive. Based on a 1966 stream survey, production varied from essentially zero to over 950 pounds of fish per surface acre. The average yield was 366 pounds. Salmonid populations equaled 245 pounds per surface acre, while other or undesirable species comprised the remaining 121 pounds.

This Basin is a very productive winter and summer steelhead area. With the exception of the limiting factors noted and the impassable Snoqualmie Falls, such production approaches the natural potential. During 1962-1966, the average annual natural steelhead production approached 83,300 adults. Estimates indicate that summer steelhead contributed approximately 10 percent of this total. Production of searun cutthroat trout is substantial; average annual natural production is 64,600 adults. These values exclude natural production on the South Fork Skykomish River upstream from Sunset Falls. Dolly Varden production estimates approach 50,000. Realization of potential natural production would result in a significant increase in numbers of these fish.

Fish production data are presented in Table 8-4.

TABLE 8-4. Anadromous fish natural production (harvest plus escapement), Snohomish Basin

Species	Range1/	Average (Annual)
Chinook	5,520-72,480	30,720
Coho	56,500-404,500	182,200
Pink	150,000-825,000	446,250
Chum	18,060-65,980	42,290
Summer steelhead	1,460-4,050	2,600
Winter steelhead	68,900-100,400	80,700
Searun cutthroat	55,200-80,500	64,600
Searun Dolly Varden2/		

1/Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

2/Production limited and therefore not determined.

Resident Fish—Most streams upstream from anadromous fish barriers are cold, small, and precipitous. Except for the mainstem Snoqualmie and its three major forks upstream from Snoqualmie Falls, these streams are producing their natural potential. Often their recruitment comes from headwater lakes or ponds (and occasionally from plants of hatchery-reared trout). The instantaneous standing crop (excluding lampreys) in these streams was usually less than 100 pounds per surface acre. Approximately 47 percent of this production consists of undesirable species—primarily sculpin.

Stream reaches downstream from barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The area standing crop varies between 98 and 950 pounds per surface acre. Hatchery-reared resident and anadromous trout are also planted in these areas. This is particularly true of the portion upstream from Sunset Falls.

All lakes, ponds, and reservoirs are included in a regular fishery management program, which includes trout planting. Because lake waters are managed for salmonids and/or spiny rays, actual production figures are shown in harvest data. Some lake harvest varies from one fishing season to the next, and may range from less than 10 to nearly 100 pounds of fish per surface acre annually. Under ideal conditions, production could be substantial.

Propagation

The State maintains and operates the Skykomish Salmon Hatchery on May Creek, a tributary to the Wallace River near Startup (Figure 8-2). Fall chinook and coho are the principal species produced. Currently, about 800,000 yearling and 2,000,000

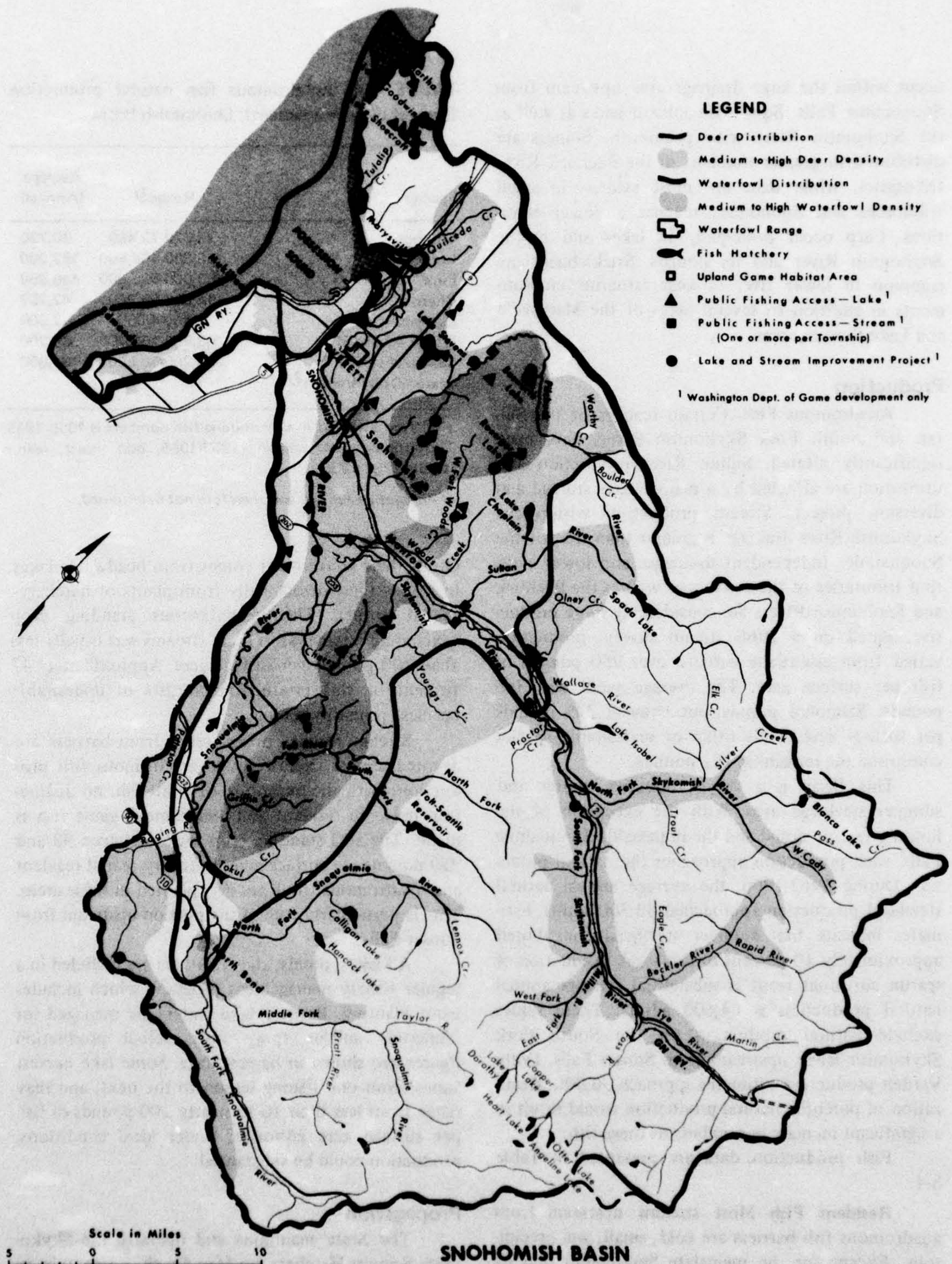


FIGURE 8-2. Wildlife distribution, and fish and wildlife developments (1965)

fingerlings are reared there each year. The bulk of these fish are planted in Basin waters.

Occasionally, some juvenile salmon are transplanted into the Snohomish from facilities located in other basins. However, total plantings of this type have been limited.

Preliminary commercial and sport catch statistics indicate that the present planting program in the Basin contributes approximately 12,800 chinook and 27,700 coho to these fisheries annually.

Artificial propagation is a game fish management tool used extensively in the Snohomish Basin. Most important is the release of hatchery-reared migrants into streams supporting anadromous fish, fingerling, and legal-size trout into popular lowland waters, and fry into alpine lakes. Suitable lakes also receive plants of kokanee. These same facilities are sources of fish for stocking habitats altered by nature or man and recently improved. Thirty-three farm fish ponds receive plants of hatchery game fish every two to three years from private facilities.

Natural game fish production is supplemented through operation of a State hatchery and semi-natural rearing pond complex. The Tokul Creek Fish Hatchery is situated near the town of Fall City and obtains its water from springs and Tokul Creek (Figure 8-2). This facility augments fish stocking in other waters of the Puget Sound Area and State, as well as holding the only native cutthroat broodstock which is the primary source of all Area egg requirements for this species. In addition, this station periodically operates trapping, spawning, and incubating facilities in Bear Creek, tributary of the Sammamish River (Cedar-Green Basins), for taking and eyeing of kokanee eggs for release in this and other basins. Occasionally, trout reared in other basins' facilities are liberated here.

Recent survey and catch data (1966) reveal that the Basin planting program contributes approximately 70 percent of all summer and winter steelhead, 85 percent of all resident trout, and 70 percent of all land-locked coho salmon and kokanee harvested in its waters annually.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 3,187,794 chinook; 1,316,643 coho; and 212,990 steelhead. Resident fish propagation data are presented in the Area chapter.

[1] Anadromous trout data involve period 1962-1966.

Harvest

Existing Harvest—Salmon produced in Basin waters contribute to United States and Canadian ocean sport and commercial fisheries, and to those in the Strait of Juan de Fuca, northern Puget Sound, and the Snohomish River. Average annual contribution (all species) to these fisheries between 1956 and 1965 was 476,280 salmon.

The marine waters support a moderate to heavy commercial fishery for salmon. Gill netters operate in the eastern Port Susan and Port Gardner areas, and favorite locations include Kayak Point, Tulalip Point, Hat Island, Mukilteo, and Meadowdale. The majority of salmon caught are landed in Everett; however, many fish are shipped to ports from Bellingham south to Seattle. Each of these ports also serves as a fleet base for numerous gill net vessels that fish in this Basin.

The Tulalip Indians, fishing the waters of southern Port Susan, harvest significant numbers of adult salmon migrating to the Snohomish and Stillaguamish Rivers. This is principally a beach or drag seine fishery. No net fishery is allowed in the Snohomish River. No commercial steelhead landings are recorded even though Indians are known to harvest these fish.

Salt-water sport fishing for salmon is considered light to moderate in Port Gardner. In 1965, more than 40,000 angler-days were recorded in the surrounding waters. Numerous small boat rental and moorage facilities in and around Everett Harbor flourish on sport fishermens' trade; however, the majority of sport boats operating out of this area fish the more productive marine waters of the San Juan, Whidbey-Camano, and West Sound Basins.

Fresh-water angling for salmon is permitted in portions of the Snohomish, Skykomish, Snoqualmie, and Tolt Rivers. Catch data indicate that an annual average of 210 salmon was taken from the Snohomish River system for the period 1964 through 1966. This sport catch, representing 880 angler-days each year, consisted of jack and adult coho and chinook salmon, and adult pink salmon.

Data from an angler survey (1966) indicate 172,600 angler-days were spent in catching 34,500 steelhead. Of this number, approximately 5,250 angler-days were expended in taking 1,000 summer steelhead. Natural production contributes almost 30 percent of the total steelhead catch.

These same data indicate 33,500 angler-days were spent in pursuit of searun cutthroat in salt-water with a total harvest of 20,100 fish. Natural production contributes 100 percent of the total searun cutthroat harvest. Harvest of searun cutthroat in fresh water and the take of anadromous Dolly Varden are included in resident trout stream harvest data.

A 1966 survey shows 389,300 angler-days were expended on lakes, ponds, and reservoirs, with a total harvest of 1,143,700 trout and 414,800 other game fish. Similarly, 293,000 angler-days were spent fishing for game fish other than steelhead in the streams and 955,600 were harvested. An estimated one percent of this total is the whitefish harvest.

Potential Harvest–If natural salmon production is increased, as indicated in the Production section, there would be a corresponding annual increase in the harvest of all species. Salmon harvest trends are discussed in the Area chapter.

Potential harvest of natural steelhead production is difficult to predict since present artificial propagation results in additional fishing pressure on these populations. However, a small increase in production would be possible.

Searun cutthroat trout harvest has not reached its full potential, because of the unique stream fishery, brief season, and the highly popular winter steelhead season. Estimates indicate that additional production and harvest of searun cutthroat could be realized.

Resident salmonid production and subsequent harvest in streams are not expected to change. This, or course, considers the same exclusions noted for anadromous fish. An exception would be the harvest of mountain whitefish, which is presently estimated at 10 percent its potential. Because this total harvest is not separable from stream resident harvest data, present and potential harvest values are not given. Potential harvest of resident salmonids in lakes and ponds could undergo a substantial increase.

Factors Limiting Production Other Than Harvest

Table 8-5 describes various limiting factors considered alterable.

Detrimental Streamflow–Seasonal flooding occurs in virtually all major streams and is particularly damaging in the Snohomish, Skykomish, Snoqualmie, Tolt, Raging, and Sultan Rivers. Excessive intermittent runoff results in flooding conditions on local tributaries where extensive logging or land clearing have occurred. Such land cover removal has occurred intermittently on forested watersheds of the Skykomish and Snoqualmie Rivers, as well as over many of the smaller lowland drainages where natural stream areas are rapidly becoming enveloped by suburban and industrial expansion.

Seasonal low flows are common in most of the small to medium-sized streams, and again the condition is more critical where excessive land clearing has occurred. In recent years, low water conditions have been particularly limiting in the Pilchuck, Raging, Sultan, Tolt, and Wallace Rivers, as well as in the numerous smaller tributaries to the Skykomish and Snoqualmie Rivers.

In the Sultan River a distinct limiting factor is imposed by the unregulated operation of the river flow by the city of Everett. Unnatural erratic flow fluctuation is not compatible with fish needs and is nearly always extremely damaging to fish populations.

Poor Water Quality–Stream areas with poor water quality conditions are located principally in the lower Snohomish River valley. In the upper watershed, water quality is relatively good except where excessive siltation occurs, usually from logging or road construction practices uncoordinated with basic fish needs. Along the lower river reaches, where expanding population and industry are closely associated with the watercourses, pollution is a distinct problem. The lower Snohomish River and the lower Pilchuck River are particularly affected, because they receive a variety of municipal, industrial, and agricultural wastes. Expected large scale population and industrial expansion will present a definite potential for extreme pollution throughout the lower river area.

The estuarine waters of Everett Harbor contain areas of extremely poor water quality caused by industrial waste disposal. Studies have shown that low dissolved oxygen, decomposition of sludge deposits, and pulp mill wastes have caused numerous fish kills in the area. This area is considered marginal for habitation by anadromous fish as well as other aquatic organisms. Both adult and juvenile salmonids must pass through these waters on their spawning or seaward migrations. The transition from fresh to salt water requires from a few days to several weeks within estuarine waters for juvenile salmonids and, as this is a critical period in their lives, they are vulnerable to heavy mortalities from poor water quality in the harbor. Industrial pollution also affects fish life in Port Susan.

In the upper watersheds, the Tolt and Taylor Rivers are most seriously effected by heavy siltation.

TABLE 8-5. Alterable factors limiting anadromous and resident fish production in Snohomish Basin

Stream	Limiting Factor 1/											Species Affected						
	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Unstable Streambed	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes 2/	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Snohomish R.	X							X		X	X	X	X	X	X	X	X	X
Pilchuck R.		X		X						X	X	X	X	X	X	X	X	X
Dubuque Cr.		X											X			X	X	X
Little Pilchuck Cr.		X									X		X			X	X	X
Worthy Cr.		X											X			X	X	X
French Cr.		X								X			X			X	X	X
Snoqualmie R.	X					X		X			X	X	X	X	X	X	X	X
Cherry Cr.		X					X			X	X		X	X	X	X	X	X
Harris Cr.		X					X						X		X	X	X	X
Tolt R.	X			X	X			X			X	X	X	X	X	X	X	X
Stossel Cr.		X					X						X			X	X	X
So. Fork Tolt				X					X			X	X			X	X	X
No. Fork Tolt				X					X			X	X			X	X	X
Griffin Cr.		X		X	X						X		X	X	X	X	X	X
Patterson Cr.		X						X		X	X		X	X	X	X	X	X
Raging R.	X	X							X		X	X	X	X	X	X	X	X
Tokul Cr.	X		X	X		X			X		X	X	X	X	X	X	X	X
So. Fk. Snoqualmie						X	X				X							X
Mid. Fk. Snoqualmie						X					X							X
No. Fk. Snoqualmie						X					X							X
Skykomish R.	X										X	X	X	X	X	X	X	X
Woods Cr.		X										X	X	X		X	X	X
East Fork		X				X						X	X	X		X	X	X
West Fork		X					X					X	X	X		X	X	X
Barr Cr.		X		X					X				X	X	X	X	X	X
Elwell Cr.		X		X					X				X	X	X	X	X	X
Sultan R.	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
Wallace R.		X				X			X			X	X	X	X	X	X	X
Bear Cr.		X					X		X				X	X	X	X	X	X
Olney Cr.		X				X							X	X	X	X	X	X
Proctor Cr.		X		X	X				X				X	X		X	X	X
Anderson Cr.		X		X	X				X				X	X		X	X	X
No. Fk. Skykomish	X	X				X						X	X	X		X		X
So. Fk. Skykomish																		
Money Cr.						X			X				X			X		
Miller R.						X						X	X			X		
Beckler R.									X			X	X			X		
Rapid R.				X	X	X			X			X	X			X		
Tye R.						X						X	X			X		
Foss R.						X						X	X			X		
Independent Drainages (all streams)		X						X	X				X		X		X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

This condition is primarily due to man-caused and natural earth slides located in their respective upper watersheds.

The lower Snohomish River valley watercourses often experience high temperatures during the low flow summer months. Although lethal temperature levels are seldom reached, the combination of excessively warm water with other poor water quality factors creates highly undesirable habitat for aquatic organisms including fish. Such conditions exist over various periods in the lower Snohomish River, Pilchuck River, and in French, Cherry, and Patterson Creeks. In the Sultan River, severe flow reductions are imposed during the summer and water temperatures in the lower river have reached lethal levels.

Physical Barriers–Most physical barriers to anadromous fish are of natural origin. The most prominent is Snoqualmie Falls, 268 feet high, which is located on the Snoqualmie River, downstream from its three major forks. Extensive fish production area exists upstream from this falls. The Wallace River, major Skykomish tributary, is blocked by falls 8 miles upstream from its mouth, and the Tolt River's North and South Forks are also blocked by falls 3.5 and 7.5 miles, respectively, upstream from their junction. Numerous falls and cascades are located on many of the small to moderate-sized tributary streams, however, individually they block considerably smaller fish use area. Also, log debris jams, and occasional beaver dams, create intermittent blocks on many of the smaller streams throughout the Basin, however, the total loss of stream lengths is relatively small.

The major manmade barrier is the Snohomish County Public Utility District No. 1 storage and diversion dam complex on the Sultan River. The diversion dam blocks all upstream migrating fish at river mile 12 and the operation of these facilities often creates low flow barriers downstream, depending upon the month (Photo 8-3). Another manmade obstruction to anadromous fish is the French Creek Flood Control District's French Creek project near the town of Snohomish.

Conflicting Watershed Developments–Logging remains one of the major activities. Improper cutting in certain areas of the watershed has influenced water quality conditions, and, to some extent, flow runoff patterns, generally degrading the stream quality with respect to capacity for producing anadromous fish.

Industrial development is expanding, particularly in the lower Snohomish River valley. Such expansion will tend to increase river pollution and result in alterations in the river banks and channels. Such alterations are seldom compatible with basic fish needs.

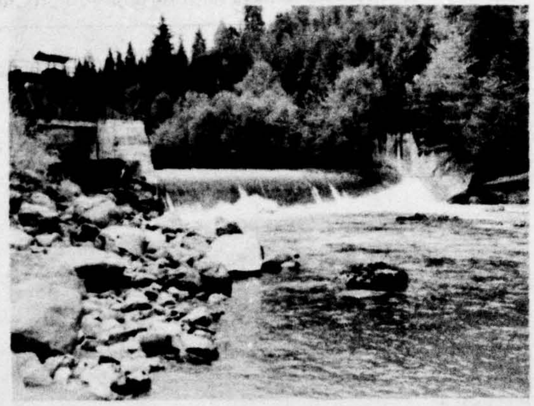


PHOTO 8-3. The Sultan River diversion dam prevents fish passage. (Bureau of Sport Fisheries and Wildlife photo)

Permanent and summer home development is accelerating throughout the Basin, particularly on land immediately adjacent to the streams, rivers, and lakes. This will result in demands for stream channeling and diking, and such stream and flow alterations seldom incorporate measures to protect fish life. On lakes such developments alter water chemistry to the extent that eutrophication could result.

Gravel removal from natural streambeds by Federal, State, county, and private agencies for construction and flood control purposes is seriously depleting and reducing the available spawning areas. Much of this activity is presently confined to lower river areas.

Water removal for municipal, agricultural, or industrial purposes presents a limiting factor on only a few streams, principally the Sultan, Pilchuck, and Tolt Rivers.

Limited Spawning and Rearing Areas–Streams experiencing very low summer flows or extreme flow fluctuation have limited rearing area. Such streams include the Pilchuck, Raging, Tolt, and Sultan Rivers. Some of the higher elevation mountain streams with steep gradients also have limited rearing potentials. Limited spawning conditions also occur in some of these streams and in streams where excess siltation has caused gravel compaction, such as the Tolt River.

Competition and Predation–Competition and predation pressure on anadromous and resident species is moderate in Basin waters. A variety of fish species are abundant in these waters and somewhat limit anadromous and resident fishes. They include suckers, dace, sculpins, squawfish, and sticklebacks. At the same time, however, many of these less desirable fishes are more susceptible to active predators, thus relieving pressure on salmon and trout species. In lakes with spiny rays, overpopulations usually exist. These spiny-rayed species also prey upon and compete successfully with trout, and in waters with mixed species, trout production is minimal. Certain birds and mammals also prey on salmonids.

Beneficial Developments

Accomplished and Continuing–Projects for anadromous fish enhancement have involved extensive beaver dam and logjam removal, road culvert repair, and installation and operation of fish-passage facilities. Attempts are made to clear major barriers as they occur. Both the State fishery and various Federal land management agencies engage in this activity. The major fish-passage facilities are the trap and hauling operation at Sunset Falls on the South *Fork Skykomish River (Photo 8-4) and a fish ladder* at the French Creek pumping station on the Snohomish River at the mouth of the creek (Figure 8-1).

PHOTO 8-4. Entrance flow at Sunset Falls fishway attracts fish from turbulent water. (Washington Department of Fisheries photo).

During 1961, a plant of juvenile coho was made in the watershed upstream from Snoqualmie Falls to determine the feasibility of future production increases from this area. Then in 1966 a similar test plant of 1/2 million juvenile chinook was made in this same area.

Anadromous and resident fish liberations, described in the Propagation section, augment natural production.

Developments beneficial for game fish consist primarily of lake and stream improvements and land acquisition. These include artificial propagation, research, rehabilitation, fish passage, and public fishing access areas on lakes and streams.

Research into controls of parasitic worm infections in trout in lakes has also been beneficial. Selected fish species, their liberation time, and size and number controls, are the present practices applied on a control basis. Companion projects include closing certain lakes to fishing, while parasite studies are being conducted and fishing closures on streams or stream reaches effected to provide additional natural spawning and rearing area for unique populations of summer and winter steelhead, and resident cutthroat trout. Such closures in force on Tokul and Pilchuck Creeks, the North Fork Skykomish, and North and South Fork Tolt Rivers, have developed additional fishing in areas upstream or downstream from these closure areas.

Lakes which have been chemically rehabilitated for trout management include: Alice, Ames, Connor, Howard, Flowing, Langlois, Margaret, Storm, Bosworth, Joy, Serene, Wagner, Martha, Crabapple, Devils, Loma, Lynch, Goodwin, McLeod, Marie, Shoecraft, Hannan, Fontal, Roesiger, Kings, Cochran, and Blackmans. While only 15 of these lakes required screening, five required screening and barrier dams. Figure 8-2 indicates the location of various fishery improvement projects.

Fishermen access sites exist on Alice, Ames, Bosworth, Blackmans, Chain, Connor, Crabapple, Cochran, Devils, Flowing, Goodwin, Howard, Loma, Langlois, Martha, Margaret, Panther, Roesiger, Shoecraft, and Storm Lakes, and Lakes Serene, Joy, Stevens, Cassidy, Hannan, and Fontal (Figure 8-2). *Stream access and boat launch areas include sites on* Tokul Creek plus the Snoqualmie, Raging, Tolt, Skykomish, Wallace, Pilchuck, and Snohomish Rivers. Additional private and public developments supplement this program.

Under Development–Efforts are presently underway to alleviate the anadromous fish obstruction resulting from the French Creek flood control facility.

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters provide considerable diversified environment. The more prominent waters include Port Susan, Port Gardner, and Possession Sound. Throughout these areas, depths principally range between 60 and 90 fathoms.

Inventory and Distribution

Marine Fish—The marine and estuarine environment and the influence of two major river systems, the Snohomish and Stillaguamish (affects Port Susan), make the marine waters highly suitable for varied and abundant populations of marine fishes. Species include cod, hake, lingcod, greenling, flounder, sole, surfperch, rockfish, herring, dogfish, and ratfish. Marine fish populations are discussed in the Area section concerning production of these species.

Shellfish—The estuarine and marine waters extending from Tulalip Bay on the north, southward through Port Gardner to Edwards Point on the south is the Basin habitat for shellfish. Although the fresh-water discharge from the Snohomish River influences the marine environment of the Stillaguamish Basin and Whidbey-Camano Islands, the major mixing and dilution occur in Port Gardner and Possession Sound.

Prinicipal species of shellfish and other marine invertebrates are Dungeness crabs; Pacific and native oysters; littleneck, butter, horse, and Manila clams; cockles; geoducks; blue mussels; pink scallops; spot and pink shrimp; squid; octopi; sea cucumbers; and ghost shrimp.

Significant populations of Dungeness crabs prevail along the outer edge of the Snohomish Flats from Mission Beach to Port Gardner, along the shoreline from the Everett boat basin south past Mukilteo to Edmonds, and in the shallow waters around Gedney Island. Red crabs occur in the same general areas.

Few oysters exist in the Basin. The hardshell clams such as the native littleneck, butter, Manila, and cockle occur on all beaches consisting of large rocks and gravel. The area from Mission Beach to Priest Point has significant populations of littlenecks and butter clams. Lesser numbers inhabit Edgewater Beach, northeast of Mukilteo, and from Elliott Point south to Edwards Point. Small scattered concentrations of geoducks are also found in this area. Blue mussels are prevalent throughout the dock areas and waterways in Everett Harbor and on submerged pilings and breakwaters in the area. Scattered concentrations of pink scallops inhabit the deeper waters of Possession Sound and Port Gardner below the 70-foot depth.

Only two species of shrimp, the spot and smaller pink, are known to inhabit Possession Sound and Port Gardner.

Small numbers of squid migrate through the marine waters, which also support moderate populations of octopi. Sea cucumbers are present along the shoreline from Everett to Edwards Point, and ghost shrimp occur in scattered concentrations along the Snohomish Flats in the heavy silt-mud bottom.

Production

Information is not available concerning numbers of marine fish or shellfish produced.

Propagation

Marine fishes are not propagated within Basin waters. Shellfish culture programs are limited to a few privately-owned oyster beds.

Harvest

Marine Fish—Marine fishes are harvested by both commercial and sport fisheries. Fishing effort is primarily from Everett, however, some vessels operating out of other nearby ports fish these waters.

The commercial marine fish harvest is conducted principally in eastern Port Susan and Port Gardner by trawl vessels. Major fish landing sites are located at Everett, with dealers receiving fish not only from the smaller vessels fishing locally, but also from the larger trawlers fishing ocean waters from the Columbia River north to Alaska. Principal marine fishes taken from Basin waters include a variety of sole, flounder, and rockfish, as well as numerous scrap fishes.

The commercial landings of herring also represent a highly significant fishery. Those landed at Everett are composed primarily of fish harvested from nearby basins.

Sport fishing for marine fishes includes angling in many locations throughout the marine waters and skin diving and spear fishing mainly in the clear semi-protected waters adjacent to mainland and island shorelines. Light to moderate angling effort is reflected by the 4,300 angler-days recorded in 1965. Prinicipal species sought by sportsmen include lingcod, sole, flounder, and rockfish.

Marine fish harvest potential is unknown.

Shellfish—Commercial and sport harvest of shellfish is very light. Some crabs, oysters, and hardshell clams are taken, however, the magnitude of this harvest is relatively small. Sportsmen expend an estimated 3,000 man-days of effort on shellfish each year.

Shellfish harvest potential is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish—Poor water quality and tideland development are the principal factors influencing marine fish production.

1. Poor Water Quality—Industrial and domestic effluents, plus introduction of other foreign materials from local shipping and barge traffic, each alters the natural water quality in the estuarine and marine waters. Such conditions are very prevalent in Everett Harbor, particularly adjacent to the highly industrialized waterfront area. Movement of this poor quality water is reflected in the relatively confined Port Susan area and westward into more open marine waters near the Whidbey-Camano Islands. The combined effects of all existing pollutants are undetermined. In some areas of Everett Harbor, and along some of the more heavily populated beaches, the elimination of certain fish populations is apparent. Untreated industrial pollutants and domestic sewage are believed to be the direct cause of such losses. Such conditions will undoubtedly become more acute as population and industrial expansion continues.

2. Tideland Development—In addition to contributing to poor water quality, rapid urbanization and expanded industrial development limit marine fish populations through attrition of natural production areas. Deposition of land excavation and dredged spoils and construction of extensive landfills are seldom compatible with fish needs and are particularly detrimental to juvenile marine fishes.

Shellfish—Principal factors influencing shellfish production include poor water quality, tideland development, and competition and predation.

1. Poor Water Quality—Fresh-water discharges from the Stillaguamish and Snohomish Rivers, with some contribution through Saratoga Passage from the Skagit River, form a shallow lens effect over the denser saline waters of the Port Susan, Port Gardner, and Possession Sound areas. This condition enhances algal blooms and food production of hardshell mollusks.

The major limiting factor affecting the tideland and marine environment is pollution, both industrial and domestic. The water quality is considered very poor, particularly from pulp mill effluents, which spread throughout much of Port Gardner. Under prevailing southerly winds with incoming tides, the effluents spread to Port Susan and Saratoga Passage. Water temperatures are generally cold, typical of Puget Sound averages, except on the mud flats at the river mouths. This results in poor spat growth. Heavy silt and mud deposits accumulated on the Stillaguamish and Snohomish Flats are detrimental to growth and survival of shellfish.

2. Tideland Development—Much of the Stillaguamish-Snohomish tidelands are unsuitable for good oyster production and large portions of beach area are too short and steep, and exposed to wind and wave action, to be considered ideal clam grounds. Rapid urbanization and expanded industrial development are further limiting this much restricted shellfish production area. The deposition of land excavation and dredged spoils, and construction of extensive landfills, large dikes, and breakwaters encroach on the limited production areas. Protective measures for shellfish stocks are seldom incorporated.

3. Competition and Predation—Shellfish predators causing significant mortalities are ghost shrimp and burrowing worms on the mud flats and soft beaches and sand dollar beds in beach areas that could produce clams. Also, starfish, native drills, moon snails, and red crabs prey upon oysters and clams. Octopi feed on the highly valuable Dungeness crabs.

Beneficial Developments

There are no specific projects or programs for the beneficial development of marine fish or shellfish within this Basin.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The Snohomish Basin with a 1963 population of 178,200 people, ranks among the top four basins in population density in the Puget Sound Area. Populations of 302,700, 485,800, and 780,300 are projected for the years 1980, 2000, and 2020, respectively. Large portions of the Basin, particularly between Seattle and Everett, are directly in the path of industrial and urban development. Developments around the smaller towns in the Snohomish, Skykomish, and Snoqualmie River valleys will also expand. Much of the rich farmland in the lower river basin could be lost to other causes. Summer recreation home development, plus construction of year round residences, will increase rapidly in areas adjacent to rivers and streams, especially in the upper watersheds.

The Snohomish, Skykomish, Snoqualmie, Tolt, Sultan, Wallace, Pilchuck, and Raging Rivers are located near heavily populated areas including Everett, Seattle, and surrounding communities. This makes these watersheds important outdoor recreation resources. The highway and road systems provide generally good access for sport fishermen. The nearly undisturbed natural environment in the watersheds of the upper Snoqualmie and Skykomish Rivers and their tributaries attracts much year round recreational activity, particularly hiking and fishing. More leisure time and greater outdoor recreational demands, in association with increased population in this area, will accelerate sport fishing pressure at a rate much greater than the population growth. Also, in the popular salt-water areas in and adjacent to the Snohomish Basin there will be a marked increase in demand for anadromous fish by both commercial and sport fishermen.

RESOURCE DEMANDS AND NEEDS

The extensive marine area bordering the Snohomish Basin supports an intensive commercial fishery for salmon and a moderate to light fishery for marine fish and shellfish. The Basin's rivers and streams produce significant numbers of salmon that are harvested by commercial and sport fisheries outside the Basin. The Tulalip Indian fishery operates within Basin waters and harvests a considerable quantity of salmon destined for the Snohomish River system. This fishery has remained relatively constant, and is expected to continue at the same intensity in future years.

Sport fishing for salmon is extensive throughout the marine waters and in 77.5 miles of the Snohomish, Skykomish, Snoqualmie, and Tolt Rivers open to salmon angling. Each year there is increased sport fishing pressure in these popular river reaches.

Lakes containing trout and spiny-rayed fish, and streams with anadromous game fish, attract large numbers of sportsmen. Alpine lakes, and streams upstream from anadromous fish barriers, also play highly significant roles in fishing recreation. Even in this densely populated Basin, based on county use values, approximately 40 percent of all Basin harvest and utilization of game fish other than steelhead is by people from outside the Basin. It is estimated that, by 1980, Basin lakes must provide an additional 729,700 trout and 216,100 game fish of other species to the creel each year. This is an increase of 61 fish per surface acre. Similarly, streams must supply an additional yearly harvest of 420,500 resident trout and whitefish and 25,400 steelhead.

As population, leisure time, and outdoor recreation demand increase in this and adjacent basins between 1980 and 2020, the demand for game fishing recreation will increase proportionately. Table 8-6 illustrates expected demands and needs for game fish in angler-days.

TABLE 8-6. Present and projected sport fishermen use (game fish) in Snohomish Basin

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	888.4
1980	595.2	1,483.6
2000	848.6	2,332.2
2020	1,399.3	3,731.5

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish resources of the Snohomish Basin are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to this Basin.

Conflicting Land and Water Uses

(1) The lack of sufficient fish-passage facilities at French Creek and Marshland pumping stations on the lower Snohomish River is limiting anadromous fish production. A Denil ladder to pass adult fish at French Creek was completed in 1968; however, a downstream collection and bypass system is needed to provide passage of fingerlings back to the river.

(2) Releases of water from Snohomish County Public Utility District No. 1's Culmback Dam on the Sultan River are periodically below requirements for sustained fish life. Development of additional water storage on this river without establishing adequate downstream flows would eliminate it as a significant fish production stream.

(3) Municipal and industrial water supply projects, which tap river headwaters, restrict the amount of fish production water remaining in the rivers downstream and often inundate upstream production habitat. They also may pose problems with homing instincts of anadromous fish, particularly if water is diverted to the Cedar-Green Basins.

(4) Some aspects of projects being considered, such as the Snoqualmie River Middle Fork Dam and North Fork Dam and Reservoirs, Beckler River Dam and Reservoir, Tolt River North Fork Diversion Dam, and Snohomish River Floodway as well as the streambank stabilization and drainage and flood prevention projects may conflict with fish needs and harvest potential.

Poor Water Quality

(1) Intermittent and seasonal pollution in the smaller tributaries, lower river, and estuary result in water quality inimical to fish life. Effluents from agricultural, industrial, and sewage disposal sources are particularly detrimental to aquatic life.

(2) The buildup of industrial sludge, mud, and detritus in Port Gardner seriously reduces the shellfish, marine fish, and anadromous fish environment.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Snohomish Basin. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential enhancement projects for anadromous fish include fish-passage facilities at the natural barriers on Tokul and Olney Creeks, and trap and haul facilities at Snoqualmie Falls. The latter project would also require screening of diversions in order to pass downstream migrants safely at the falls.

Other potential enhancement projects include improvement of stream and streambed conditions in many of the smaller tributaries of the Snoqualmie, Pilchuck, and North and South Fork Skykomish Rivers. Stream sections along the Snohomish, Pilchuck, Snoqualmie, Tolt, Skykomish, and Wallace Rivers should also be improved and small clay slides stabilized or removed.

Streamflow controls might be achieved through the development of overflow channels, flood flow diversions, or impoundments on the main river or in potential off-river areas. Controls for streambed improvement could be achieved through selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools or riffles where they are now unstable or lacking.

The water supply and storage reservoirs being considered on the upper North Fork and Middle Forks Snoqualmie River may relieve much of the Snoqualmie-Snohomish valley flooding and, with cooperative agreements and proper safeguards, be beneficial to fish.

Reforestation projects should be continued on the heavily-logged hillsides of the upper watershed to help reduce excessive runoff.

Many sites throughout the Basin are suitable for development of hatcheries, eyed-egg incubation channels, spawning channels, or controlled impoundments for off-river rearing. Suitable land and water for such facilities are located along much of the Skykomish, North and South Forks Skykomish, Pilchuck, Raging, and Wallace Rivers as well as on many of the moderate-sized tributaries to these rivers. Further investigation will be needed to determine the most feasible sites for these projects.

Implementation of water quality controls in the lower Snohomish River estuary and Port Gardner will be necessary before any major production increases are inaugurated.

Certain enhancement programs, if implemented in the Snohomish Basin, would also lead to increased fish production. One such program would include the setting of rigid controls on the removal of water, for any purpose, from natural flowing streams. An extensive evaluation of new means for obtaining municipal and industrial water supplies should be undertaken in conjunction with this. Areas deserving study include potential use of dual water systems (consumptive/irrigation and sewage) and possible procurement of desalted marine water from any proposed thermonuclear powerplants.

Additional enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish, including control of forest and agricultural spraying, as well as curtailing the disposal of untreated municipal and industrial waste; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to ensure protection of fish resources; (3) institute a permanent flood plain zoning plan that would protect streambeds and land immediately adjacent to streams from unnecessary changes damaging to aquatic habitat; (4) promote effective regulation for all fisheries, and provide changes in fishing areas and harvest methods to yield greater maximum benefit from available stocks; (5) perform studies and obtain information necessary to achieve the most efficient management possible, including basic water chemistry data to determine the feasibility of increasing fish production, and determination of techniques for removing silt and decompacting riverbed gravel over large stream sections; and (6) determine specific streamflows (from river cross-section measurements) to ascertain flow levels necessary for fish, and to provide methods and techniques for altering streamflow and streambed conditions to increase the production capacity of the habitat. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, appear in Table 8-7. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

MARINE FISH

Enhancement projects for marine fishes could include creation of additional habitat and new fishing areas by selective placement of rock jetties or submerged automobile bodies. Another program benefiting these fishes is to continue monitoring of water quality controls on the lower Snohomish River sloughs, and the estuarine waters, including Port Gardner. Without such controls a drastic reduction in marine fish populations is foreseen. Restrictions should be imposed on disposal of garbage and dredged spoils in the outer harbor.

Natural production is adequate for the present, but when demand increases enough to warrant artificial propagation it will be instituted. The development of fishing piers and facilities for marine fish angling along the Everett waterfront should be stressed. Such facilities could be incorporated into boat storage and marinas as well as shipping piers.

SHELLFISH

Potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. Special emphasis should be directed toward providing more public salt-water beach areas and access; and increasing shellfish stocks that have been depleted or are being over-exploited.

Dredging of industrial sludge, mud, and detritus from Port Gardner and waterway would substantially enhance shellfish production.

TABLE 8-7. Tentative flow schedule required to maintain fish production levels, Snohomish Basin

Stream[1]	Flows (cfs) by Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Snohomish R.												
Skykomish R. (Gold Bar)	2,700	3,500	4,000	3,300	3,300	2,700	4,500	6,000	4,500	3,200	1,100	1,100
North Fork (Index)	850	1,000	1,050	950	950	850	1,400	1,800	2,000	950	425	400
South Fork (Index)	1,700	2,000	2,000	2,000	1,800	1,700	2,500	3,000	3,500	1,800	890	875
Beckler R.	300	450	450	430	400	430	650	900	700	450	110	100
Sultan R.[2]	200	200	200	200	200	200	200	165	165	165	165	200
Wallace R.	160	200	200	170	170	130	190	225	220	80	40	60
Snoqualmie R. (Snoqualmie)	2,000	3,000	3,000	3,000	2,500	2,300	3,000	3,500	3,000	1,500	1,500	1,500
Snoqualmie R. (Carnation)	3,000	4,500	5,000	5,000	4,200	3,700	4,500	5,000	4,500	2,100	2,000	2,000
Tokul Cr.	45	130	135	175	155	125	90	80	50	35	25	30
Raging R.	100	300	300	280	290	230	160	95	75	40	40	40
Tolt R.	500	800	800	800	710	600	700	800	600	300	300	300
Pilchuck R.	350	500	520	520	520	390	400	320	250	140	90	130

1/ Locations are existing U.S. Geological Survey gaging stations.

2/ *Sultan minimum flows established 1967 by State cross section study.*

SUMMARY–ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Snohomish Basin offers numerous opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. Major potential developments, including an indication of priority, are categorized in Table 8-8 and defined by stream in Table 8-9.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the developments listed. Nearly all of the major proposals are goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of these potential developments are included in a preliminary plan for increasing salmon production levels to meet overall Pacific Northwest demands for fish resources in the future. These proposals, and salmon production increases, are indicated by target years in Table 8-10.

Table 8-11 shows estimated annual benefits in terms of sport and commercial harvest for the same projects. Projects and programs for marine fish and shellfish have not been analyzed in this manner, because use data are inadequate, and needs are not so critical as for salmon.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Thermal powerplants should be located where cooling water requirements can be satisfied without having deleterious effects on game fish resources.

Undoubtedly some reservoir storage projects will be necessary for municipal, industrial, and irrigation water supplies. These projects should be located in areas which would cause minimal losses to fish, yet their waters should remain open for fishing. Flows downstream from such projects must be adequate to maintain existing fish populations and permit enhancement. Industrial water supplies should be separated from municipal supplies; they may then draw from lower river reaches which would reduce the impact on fish life. Irrigation needs should be carefully evaluated to determine if agricultural demand cannot be better met in other areas of the State where lands are more fertile and growing seasons longer.

Municipal watersheds should be opened for public use to permit meeting a portion of the demands for fishing.

Flood control measures should be more compatible with game fish needs if the Basin is to develop and meet future fish requirements. Damage from flooding can, however, be minimized with flood plain zoning. Channel enlargement projects, except overflow channels, should be minimized.

Industrial development (under consideration) should be confined to port areas and uplands not needed for other uses.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

Public fishing access should be required in watercourse and lake residential developments.

Outdoor recreation needs, including fishing, must be given equal status with other water uses. Extensive industrial development results in extensive urbanization and ultimate destruction of the outdoor recreation potential. A balance must be established by good planning.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Acquisition and/or development of additional public fishing access sites at Rattlesnake, Black, Boyle, Bridges, Calligan, Echo (near North Bend), Francis, Klaus, Mud (near Snoqualmie), Lynch, Swartz, Beecher, Blackmans, Dagger, Kellogg, Meadow, Menzel, Tomtit, Wallace, Wagner, Winters, Woods, Hanson, Hughes, King, and Mary Shelton Lakes, and Lakes Joy, Hannan, and Hancock, is needed, but probably cannot be completed during the

TABLE 8-8. Potential developments for production and use of salmon, marine fish, and shellfish, Snohomish Basin

Beneficial Development	Priority		
	Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Clean and decompact gravel in problem areas	X		
Improve public beaches for clam production		X	
Improve stream and streambed conditions	X	X	X
Plant salmon in stream areas upstream from partial or complete blocks	X	X	X
Create marine fish production and fishing areas		X	X
(2) Acquisition			
Evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Procure riverbank and salt-water public access sites	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Establish rigid control on removal of stream bottom material	X		
Promote conservation measures for Indian fishery	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Implement more effective controls against excessive removal of surface water	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities on streams, i.e., gravel removal, flood control, logging	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Gravel cleaning and decompaction techniques	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Basic productivity change to enhance rearing potential		X	

TABLE 8-9. Potential beneficial developments for fish, Snohomish Basin

Stream	Enhancement Measure									Species Benefited						
	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Snohomish R.		X		X						X	X	X	X	X	X	X
Pilchuck R.		X				X				X	X	X	X	X	X	X
Dubuque Cr.		X									X			X	X	X
Little Pilchuck Cr.		X									X			X	X	X
Worthy Cr.		X									X			X	X	X
French Cr.	X	X									X			X	X	X
Snoqualmie R.	$\boxed{X}$			X			X	X	X	X	X	X	X	X	X	X
Cherry Cr.		X									X	X	X	X	X	X
Harris Cr.		X	X								X	X	X	X	X	X
Tolt R.		X		X			X	X	X	X	X	X	X	X	X	X
Stossel Cr.		X	X					X	X		X			X	X	X
S. Fork Tolt		X								X	X	X	X	X	X	X
N. Fork Tolt		X								X	X			X	X	X
Griffin Cr.		$\boxed{X}$					X	X	X		X	X	X	X	X	X
Patterson Cr.		X									X	X	X	X	X	X
Raging R.		X		X	X	X	X	X	X	X	X	X	X	X	X	X
Tokul Cr.	$\boxed{X}$			X			X	X		X	X	X	X	X	X	X
Skykomish R.				X			X	X	X	X	X	X	X	X	X	X
Woods Cr.		X					X	X		X	X	X	X	X	X	X
E. Fork		X					X	X		X	X	X	X	X	X	X
W. Fork		X								X	X	X	X	X	X	X
Barr Cr.		X									X	X	X	X	X	X
Elwell Cr.		X			X					X	X	X	X	X	X	X
Sultan R.	X			X	$\boxed{X}$					X	X	X	X	X	X	X
Wallace R.		X			X		X	X		X	X	X	X	X	X	X
Olney Cr.	$\boxed{X}$	X									X	X	X	X	X	X
Proctor Cr.		X		X							X	X		X	X	X
Anderson Cr.		X		X							X	X		X	X	X
N. Fk. Skykomish	X			X				X	X	X	X	X		X	X	X
S. Fk. Skykomish	X				X	X	X	X	X	X	X			X	X	X
Money Cr.								X	X	X	X					X
Miller R.								X	X	X	X					
Beckler R.				X				X	X					X		X
Tye R.								X	X	X	X					
Foss R.								X	X	X	X					
Independent Drainages (all streams)		X									X		X		X	X

$\boxed{X}$ Priority project.

TABLE 8-10. Estimated total salmon production increases in Snohomish Basin, by project or program, to satisfy needs[1]

Project or Program, and Year	Species and Number			
	Chinook	Coho	Pink	Chum
Pre-1980				
Augment flows, Sultan R. ːr	400	1,200	2,200	--
Supply flood control, Snoqualmie R.	200	1,000	3,000	1,200
Supply flood control, Snohomish R.	100	1,200	1,500	1,600
Trap and haul past Snoqualmie Falls	16,400	60,000	--	--
Construct spawning channel, 1 mile	--	--	120,000	--
Construct spawning channel, 1 mile	--	--	--	120,000
Subtotals	17,100	63,400	126,700	122,800
1980-2000				
Provide fish passage, Olney Cr., 7 stream miles	200	2,000	--	--
Provide fish passage, 4 tributaries, 27 stream miles	1,800	18,400	--	--
Improve fish habitat, 24 streams, 45 stream miles	2,600	13,500	16,100	5,700
Clear channels, 2 streams, 6 stream miles	--	400	--	--
Supply flood control, 9 streams, 85 stream miles	600	4,500	4,500	5,000
Augment flows, 5 streams, 49 stream miles	2,600	6,500	6,400	--
Construct hatchery	--	51,000	--	--
Subtotals	7,800	96,300	27,000	10,700
2000-2020				
Construct 4 hatcheries or equivalent	18,000	178,500	--	--
Develop rearing facilities, 80 acres	24,000	68,000	--	--
Develop spawning channel, 1 mile	--	--	--	120,000
Subtotals	42,000	246,500	--	120,000
Totals	66,900	406,200	129,400	253,500

[1] Average annual production (catch plus escapement) at end of each period.

TABLE 8-11. **Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, Snohomish Basin**

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Augment flows, Sultan R.	2,500	$ 4,900	$ 14,900	300	$ 1,900	$ 9,500	[2]	[2]
Supply flood control, Snoqualmie R.	3,300	5,700	17,700	200	1,500	6,200	[2]	[2]
Supply flood control, Snohomish R.	2,600	5,800	15,100	300	1,300	7,100	[2]	[2]
Trap and haul past Snoqualmie Falls	48,200	178,100	366,100	11,300	67,600	315,500	$1,400,000	$60,000
Construct spawning channel, 1 mile	95,700	66,100	325,400	4,300	25,800	120,400	700,000	14,000
Construct spawning channel, 1 mile	100,000	281,000	562,000	--	--	--	700,000	14,000
Subtotals	252,300	$ 541,600	$ 1,301,200	16,400	$98,100	$ 458,700	--	--
1980-2000								
Provide fish passage, Olney Creek, 7 stream miles	1,500	$ 5,000	$ 9,900	300	$ 1,700	$ 8,100	$ 35,000	$ 400
Provide fish passage, 4 tributaries, 27 stream miles	13,400	45,400	90,200	2,600	15,800	73,900	367,000	37,000
Improve fish habitat, 24 streams, 45 stream miles	23,600	52,700	142,800	2,800	16,400	77,600	150,000	3,000
Clear channels, 2 streams, 6 stream miles	300	1,000	1,900	100	300	1,500	1,500	300
Supply flood control, 9 streams, 85 stream miles	8,700	20,700	52,100	900	5,000	24,600	[2]	[2]
Augment flows, 5 streams, 49 stream miles	9,700	25,000	66,500	1,700	9,900	26,700	[2]	[2]
Construct hatchery	37,300	118,400	228,200	6,400	38,300	178,800	1,020,000	60,000
Subtotals	94,500	$268,200	$591,600	14,800	$87,400	$391,200	--	--
2000-2020								
Construct 4 hatcheries or equivalent	140,400	$ 478,900	$ 953,600	28,000	$ 166,000	$ 784,000	$4,080,000	$ 240,000
Develop rearing facilities, 80 acres	62,700	244,100	511,300	16,100	96,400	449,700	440,000	80,000
Develop spawning channel, 1 mile	100,000	281,000	562,000	--	--	--	700,000	14,000
Subtotals	303,100	$1,004,000	$2,026,900	44,100	$264,400	$1,233,700	$5,220,000	$334,000
Totals	649,900	$1,813,800	$3,919,700	75,300	$449,900	$2,083,600	--	--

[1] Anadromous trout benefits not included.

[2] Multipurpose project. Separable costs, if any, have not been determined.

initial period. Ultimately, all significant lakes and key portions of streams, estuaries, and salt-water areas should have assured public fishing access.

(3) Streambank angler access on 50 miles of main rivers and tributaries (of a total of 400 miles) should be acquired and developed, as funds become available.

(4) A salt-water public fishing area is proposed at Smith Island near Warm Beach.

(5) Lake improvement projects are recommended at Elizabeth Lake, near Skykomish, where a dam could enlarge the lake significantly and at Meadow Lake, near Monroe, where the lake could be purchased for management and enlargement.

(6) Research in the field of hybridization of anadromous and resident trout species has resulted in game fish with more desirable growth rates. Use of these races under certain stress conditions could prove most productive.

(7) A system of screening or diking of fish past hydroelectric and municipal water intakes is recommended.

(8) Considerable streambed compaction has occurred on certain Basin streams. Development of a large "riffle sifter" or other streambed loosening and cleaning device should be scheduled for areas where necessary. This is particularly true where over-restrictive flood control work is involved and on streams where recent construction projects (e.g., Tolt River) have compounded the problem.

(9) Investigation into completion of anadromous fish passage upstream from falls and cascades should be undertaken. However, impact on the resident game fish populations as well as the potential introduction of undesirable species must also be considered.

(10) There are no completely artificial propagation sites known in the Snohomish Basin, but some undoubtedly exist. Several semi-natural rearing pond areas are proposed for the Skykomish River Basin. These areas are on Bear, McCoy, Wagley, Crystal, Duffy, Hogarty, and Austin Creeks.

(11) Steelhead rearing ponds should be constructed on the Sultan and Skykomish Rivers to produce 750,000 downstream migrants annually.

(12) Water storage on the Sultan River to augment low flows should be provided.

(13) Hatchery facilities to provide an additional catch of 1,000,000 trout annually in lakes and streams should be developed (Photo 8-5).

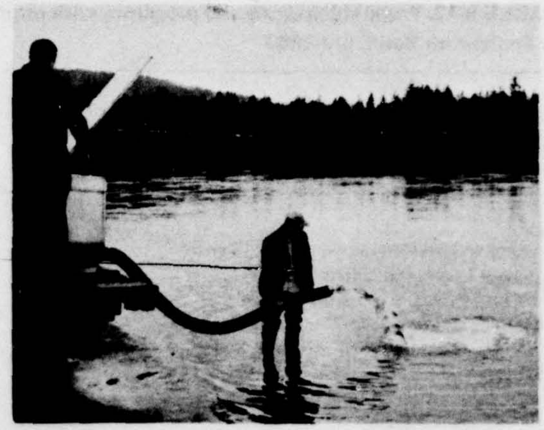


PHOTO 8-5. Increased fish planting will help maintain optimum fisheries on heavily-used waters. (Washington Department of Game photo)

(14) Clay slide problems on the Taylor River and Middle Fork Snoqualmie River should be corrected.

(15) Fertilization and management techniques should be developed for lakes and streams to increase fish food production and sport fishing without undesirable side effects.

(16) New fish toxicants that are effective, detoxify rapidly, and are also specific as to species should be developed.

(17) Streambank protection techniques compatible with fish production should be developed.

(18) Projects to provide maximum production and harvest from stabilized or augmented streamflows should be developed and implemented.

(19) Fish disease and parasite control programs should be developed for lakes to permit increased survival of game fish populations.

Table 8-12 indicates estimated annual benefits and costs of specific projects and programs proposed for the Snohomish Basin to satisfy needs for game fish prior to 1980. Proposals for subsequent years have not been evaluated nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected. That is, benefits from constructing a hatchery may depend on first solving fertility, disease, and public access problems. In such cases, items showing costs will not necessarily show benefits because the latter may be included under other projects and programs.

TABLE 8-12. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Snohomish Basin, pre-1980

Project or Program	Annual Benefits: Angler-Days	Annual Benefits: Value	Costs: Capital	Costs: O&M (Annual)
Lakes				
Acquire and develop public access, 13 areas	107,500	$ 215,000	$ 490,000	$ 3,000
Purchase 1 lake, and enlarge 2 lakes	10,600	21,200	150,000	--
Develop fish disease control program	67,000	134,000	30,000	--
Construct trout hatchery	75,600	151,200	827,000	68,900
Subtotals	260,700	$521,400	$1,056,000	$71,900
Alternatives to Above				
A.				
Acquire and develop public access, 13 areas	107,500	$ 215,000	$ 490,000	$ 3,000
Purchase 1 lake, and enlarge 2 lakes	10,600	21,200	150,000	--
Develop fish disease and parasite control program	67,000	134,000	30,000	--
Construct trout hatchery	195,100	390,000	437,000	36,400
Develop new fish toxicants	1/	--	10,000	10,000
Develop lake fertilization techniques	1/	--	10,000	10,000
Subtotals	380,200	$760,200	$1,127,000	$59,400
B.				
Acquire and develop public access, 13 areas	107,500	$ 215,000	$ 490,000	$ 3,000
Purchase 1 lake, and enlarge 2 lakes	10,600	21,200	150,000	--
Construct trout hatchery	142,600	285,200	1,500,000	125,500
Subtotals	260,700	$521,400	$2,140,000	$128,500
C.				
Construct trout hatchery	260,700	$ 521,400	$ 3,900,000	$ 325,000
Subtotals	260,700	$521,400	$3,900,000	$325,000
Streams				
Correct gravel compaction problems	5,000	$ 25,000	$ 10,000	$ 1,000
Develop steelhead rearing ponds	125,000	625,000	500,000	90,000
Correct clay slides, Taylor R. and Snoqualmie R.	10,000	50,000	500,000	--
Acquire streambank access, 50 stream miles	27,400	82,200	800,000	3,800
Construct trout hatchery	173,300	519,900	3,000,000	250,000
Subtotals	340,700	$1,302,100	$4,810,000	$344,800
Salt Water				
Acquire and develop public access area	4,700	$ 9,400	$ 25,000	$ 300
Subtotals	4,700	$9,400	$25,000	$300
Totals (with Alternative A.)	725,800	$2,071,700	$5,962,000	$404,500

1/ Included with benefits from hatchery.

Projects and Programs, 1980-2000

(1) Construct and manage additional steelhead rearing ponds and acquire trout hatchery lands.

(2) Construct and manage a searun cutthroat rearing pond.

(3) Complete programs and projects not completed prior to 1980.

(4) Investigate biological controls for spiny-rayed game fish and stimulate public interest in their harvest.

(5) Develop new projects and programs as required.

Projects and Programs, 2000-2020

(1) Continue fisheries research.

(2) Complete programs and projects not completed prior to 2000.

(3) Develop new projects and programs as required.

Approximately 420,000 acres of this Basin are under U.S. Forest Service administration. Projects and programs proposed by this agency for fishery enhancement are indicated in Table 8-13. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 8-13. Fishery enhancement projects and programs of U.S. Forest Service proposed for Snohomish Basin, 1980-2020

Project or Program	Unit	1980 Number	1980 Cost	2000 Number	2000 Cost	2020 Number	2020 Cost
Conduct stream surveys	mile	157	$4,700	1/	--	1/	--
Conduct lake surveys	acre	2,400	19,100	1/	--	1/	--
Clear stream channels	mile	35	70,000	70	$140,000	69	$138,000
Remove debris from lakes	acre	314	314,000	--	--	--	--
Fertilize lakes	acre	430	295,900	860	591,600	860	591,600
Total			$703,700				

1/ Not yet scheduled for these time periods.

PRESENT STATUS—WILDLIFE

INTRODUCTION

Wildlife in the Snohomish watershed is important to residents of the urban centers, as 62 percent of the Area's population resides in this drainage and adjacent Cedar-Green Basins. Hunting in the Cedar-Green Basins is extremely restricted due to urban development and municipal watershed closures. Consequently, the majority of the people in the three basins turn to the open space of the Snohomish drainage to hunt, photograph, or otherwise enjoy wildlife in its natural surroundings.

The Snohomish extends from the rugged Cascade mountain crest westerly through vast timber-covered foothills and river flood plain farmlands to tidal marsh at the river's mouth near Everett.

Wildlife habitat varies with elevation and land form. Although the watershed narrows considerably at its mouth, it contains a vast medium-low elevation foothill area where winters are mild and native wildlife species thrive during all but the most severe winters.

BIG GAME

Big game is an important wildlife category as a large part of the Basin is in some form of woodland cover. From a harvest viewpoint, the black-tailed deer is most important, but other big-game species of the Area—black bear, mountain goat, and mountain lion—occur in significant numbers. Elk are present but only as isolated individuals—no resident herd inhabits the Basin.

Inventory and Distribution

Black-tailed deer are found throughout the Basin except in the highly developed urban area of Everett. Highest concentrations occur in the medium-low elevation foothills of the Tolt and North Fork Snoqualmie River drainages north of North Bend and east of Carnation and Duvall and in the Skykomish River watershed near Monroe, Sultan, and Gold Bar (Figure 8-2).

The deer population slightly exceeds 14,000 animals. Deer population, production, and harvest by county are shown in Table 8-14.

TABLE 8-14. Deer population, production, and harvest, Snohomish Basin, 1961-1965

County	Population[1] (Total)	Production (Ave. Annual)	Harvest (Ave. Annual)
Snohomish	7,280	2,080	880
King	6,720	1,920	910
Totals	14,000	4,000	1,790

[1] Game numbers vary throughout the year; therefore, figures designate late September-early October populations.

Several mountains in the eastern portion of the Basin feature the rugged, precipitous terrain required by mountain goats. Census data indicate that a population of approximately 700 of these unique animals inhabits that area.

Black bear frequent the forested areas throughout the Basin, and a population of 1,800 to 2,200 animals is estimated.

The upper reaches of this Basin include considerable remote area which mountain lion inhabit. An estimated 10 to 20 of these animals range primarily within such areas.

Limiting Factors

Urban and industrial expansion, highway construction, and other activities of man have destroyed habitat of value to big game. Various other factors limiting big-game populations are discussed in the Area chapter, Present Status—Wildlife.

Production

Doe-fawn ratios determined just prior to the hunting season indicate an average annual increase of 4,000 deer over the spring population. Production estimates for the counties within the Basin are shown in Table 8-14.

Late summer counts of mountain goats show 29 kids per 100 adults, which indicates a production of about 150 annually.

Studies of black bear indicate an annual reproductive rate of 25-30 percent, which in the Snohomish watershed, would be 450-550 cubs.

Annual production of mountain lion is sufficient to sustain current populations.

Harvest

Five years of harvest data (1961-1965) reveal an average annual deer take of 1,790 animals, stimulating 35,800 hunter-days (Table 8-14). Of the total kill, 880 were harvested in the Snohomish County portion and 910 in the King County portion.

Part of the high roadless area in the upper South Fork Skykomish and Middle Fork Snoqualmie River drainages is included in a September buck season. Grouse, bear, and mountain goat are also legal game during this period. These high elevation areas display their full array of fall colors in September, creating the ultimate in outdoor enjoyment for the individuals who appreciate nature and prime hunting. Severe weather often renders these areas inaccessible during the regular October hunting season.

Closure of the Tolt River municipal watershed by metropolitan Seattle restricts recreational use, including hunting. This results in unsatisfied demand in an area adjacent to the most concentrated urban development in the State.

Management of mountain goat emphasizes the trophy features of this highly prized but limited big-game species and authorizes only 140 hunter permits annually within the Basin. Forty-five to 50 goats are taken, resulting in more than 450 man-days of unique hunting.

Limited harvest data available indicate an average annual harvest of 450 bear and a hunting effort of 3,600 hunter-days.

Only an occasional mountain lion is taken from the limited population within the watershed. Hunter pressure involved provides 100 man-days annually.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

The Area chapter, Big Game, contains a discussion of beneficial developments.

UPLAND GAME

One or more of the varied species of upland game inhabit virtually every habitat type. Native species utilize the remaining native habitat and introduced exotics have been established in the agricultural area. The introduced species include ring-necked pheasant, California quail, mountain quail, gray partridge, and cottontail. Native upland game are blue and ruffed grouse, band-tailed pigeon, snowshoe rabbit, and mourning dove.

Inventory and Distribution

The most numerous upland birds are ruffed and blue grouse; both are distributed throughout the Basin wherever suitable habitat exists. A ruffed grouse population of 55,000 and a blue grouse population of 43,000 are projected on the basis of existing density studies.

A current wild population of about 13,500 pheasant inhabit the Basin, with highest densities occurring along the Skykomish and Snoqualmie Rivers from their confluence at Snohomish, upriver along the Skykomish to Sultan, and upriver along the Snoqualmie River to Snoqualmie Falls (Figure 8-1). This wild population is supplemented annually by releases of game-farm-reared birds.

Mountain quail were introduced in the late 1800's and became numerous in lowland, logged, and burned-over areas, but as such areas were diverted to agricultural use or matured to dense second growth timber, numbers diminished. Both California and mountain quail persist and respond with good production during very dry summers. A population of 8,000 quail is estimated.

Rabbit are found in every type of vegetative habitat and rival grouse in overall abundance. The cottontail is prevalent in and near agricultural areas, and the snowshoe inhabits virtually all forested areas. The current rabbit population was not determined.

No population estimate of band-tailed pigeon or mourning dove was made.

Limiting Factors

Very effective control of wildfire, reduced emphasis on slash burning, and progressively less logging at low elevations have reduced the carrying capacity of wooded areas for native upland game and mountain quail. Current clean farming and emphasis on pasture, rather than on diversified crops, have reduced the potential of the area for introduced upland game. Pheasant, California quail, gray partridge, and cottontail require diversified farm crops and attendant fence row cover. Only about 10 percent of the Basin has been diverted to agricultural use and the bulk of this is devoted to pasture.

Band-tailed pigeon limiting factors appear in the Area chapter, Upland Game.

Production

Annual production of upland game includes 33,000 ruffed grouse; 26,000 blue grouse; 10,000 wild pheasant; and 4,000-6,000 quail. Production estimates were not determined for rabbit, band-tailed pigeon, mourning dove, or gray partridge.

Harvest

The grouse harvest of 7,700 consists of 5,500 ruffed and 2,200 blues. Grouse hunting produces an estimated 12,800 hunter-days annually (Photo 8-6). An average of 5,000 pheasants is harvested annually, resulting in 7,200 hunter-days. About 1,500 of these birds are a direct return of mature roosters released immediately prior to and during the hunting season. Sportsmen bag about 1,500 quail each year in approximately 1,150 hunter-days. Hunter questionnaires indicate about 2,000 rabbit annually may be taken, representing 1,100 hunter-days. Over 19,500 band-tailed pigeon and 1,900 mourning dove are bagged each year, involving an additional hunter-day use of 16,250 and 450, respectively. Upland-game hunting accounts for approximately 38,950 hunter-days annually.

PHOTO 8-6. Ruffed grouse, the most abundant and widespread game bird in the Area, affords quality hunting. (Washington Department of Game photo)

Propagation

The wild pheasant population is supplemented annually by about 2,200 birds from State-operated game farms within the Puget Sound Area. Approximately 2,000 of these birds are released as mature cocks immediately prior to and during the hunting season. Small numbers of bobwhite, California and mountain quail, and gray, red-legged, and bamboo partridge are propagated on various State game farms and are released periodically within the Basin.

Two private game breeders raise limited numbers of pheasant and quail commercially.

Beneficial Developments

Beneficial developments include liberalizing hunting seasons and annual pheasant releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game.

Through cooperative agreement with landowners, two large hunting areas managed by the State receive mature pheasant plants during the season to supplement upland-bird hunting.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 200 acres of wildlife habitat development, located in the western third of the Basin.

FUR ANIMALS

Various fur animals present in the Snohomish Basin include beaver, muskrat, mink, river otter, marten, weasel, skunk, raccoon, opossum, bobcat, lynx, red fox, and coyote.

Inventory and Distribution

Fur-animal distribution is oriented with three basic habitat types. Beaver, muskrat, mink, raccoon, and river otter occur in and along water areas throughout the Basin. Red fox, opossum, and skunk are found in lowland areas and bobcat and coyote are inhabitants of the foothill and mountainous regions. Marten are numerous at high elevations where lynx may also occur.

Individual fur-animal population estimates are: 2,400 (beaver); 23,000 (muskrat); 900 (mink); and 50-75 (river otter). All the other fur animals, with the exception of lynx, occur commonly in the trapper's catch.

Limiting Factors

The economically important fur bearers require marsh and riparian habitat in which to live. Such areas are limited in nature and it is in these areas that the most intensive manmade developments have occurred. Conflicting interests, which include waterfront homesite and industrial development, flood control measures, and drainage for agricultural production, all reduce fur-animal habitat. Because the State's major population centers are nearby, urban and industrial encroachment is seriously reducing fur-animal habitat and is expected to increase as the population centers expand.

Production

Beaver populations in the fall consist of 30 to 40 percent young, indicating an annual production of 700-900. Estimated annual production of muskrat and mink is 18,000 and 400-600, respectively. Other members of the fur-animal group have reproduction rates comparable to that of mink.

Harvest

Trapper records of the five leading species reveal the following average annual catches: 475

(beaver); 2,300 (muskrat); 175 (mink); 20 (marten); and 15 (river otter). Other fur animals are taken incidentally. It is doubtful if any of the fur bearers, except beaver, are cropped to the full extent of their potential. Income derived from trapping the five leading species exceeded $13,000 during the 1965-1966 season.

Propagation

Twenty-one ranchers in the Basin engage in the commercial production of mink pelts.

Beneficial Developments

Beneficial developments are discussed in the Area chapter, Fur Animals.

WATERFOWL

The Snohomish flood plain is an important waterfowl wintering area. Birds from Port Susan, and Skagit and Padilla Bays move into the Snohomish River valley as heavy fall rains increase the standing water in pastures and fields.

Inventory and Distribution

Except for limited nesting and brood production on woodland beaver ponds, waterfowl use is restricted to the river valleys, salt-water marshes and bays, lowland lakes, and agricultural lands. The flood plain of the Snohomish and Snoqualmie Rivers from Everett and Marysville to Carnation is heavily used by winter resident ducks. Figure 8-2 designates waterfowl distribution and density areas.

January waterfowl counts reveal an annual average of 41,800 birds. The most popular hunting species—mallard, pintail, widgeon, and teal—are predominant. Prior to the survey, waterfowl have been exposed to almost three months' hunting. In addition, an undetermined number of birds hold over in the Basin in fall and early winter for a limited period while enroute southward. The survey, therefore, is not indicative of the total number which use the area as a wintering station.

Limiting Factors

Availability of food and adequate water resting areas are the prime factors governing migratory waterfowl abundance. Native habitat is lost through marsh drainage for agricultural use, residential and industrial development of waterfront property, and flood control measures which remove shoreline vegetation and reduce shoal water areas. Due to the Basin's proximity to the major population center of the State, urban and industrial encroachment is seriously reducing waterfowl habitat and is expected to increase.

Production

As in other Area drainages and, in fact, all of western Washington, the number of locally raised ducks is comparatively low. A recent inventory revealed an average annual production of 12,800. Mallard and wood duck are the predominant species.

Harvest

About 45 percent of the Snohomish County waterfowl harvest and 35 percent of the King County harvest occur in the Snohomish Basin. Recent years' harvest records indicate an average annual harvest of 27,600 ducks and 1,100 geese, which provides about 20,500 hunter-days.

Propagation

One private game breeder lists wood duck among the variety of birds raised. This is a commercial operation and does not contribute to the wild duck population or waterfowl hunting.

Beneficial Developments

Lake Stevens is maintained as a State game reserve (closed to hunting) to provide necessary resting area for ducks using the agricultural lands in the Snohomish and Snoqualmie River valleys.

Two regulated hunting areas are managed by the Washington Department of Game through cooperative agreement with the private landowners primarily to enhance pheasant hunting; however, under certain conditions, limited waterfowl shooting is also provided.

Conservation practices applied by private landowners to agricultural lands of direct benefit to waterfowl include 175 acres of wildlife wetland development and 15 acres of wildlife wetland preservation, located near Snohomish and Lake Stevens.

OTHER WILDLIFE

The many and varied birds and animals in the Basin not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

The current demand for wildlife-oriented recreation exceeds the supply. Many people from the adjoining Cedar-Green Basins hunt in the Snohomish Basin, but the total harvest by Basin residents alone exceeds the Basin's natural production. Many resident hunters go elsewhere, either to the north in the Puget Sound Area or to other areas in the State to enjoy the sport of hunting. Demand on the Basin wildlife resource, however, is expected to increase nearly commensurate with the growth in population as close-in recreational areas are always in demand.[1]

Considerable industrial development is concentrated along the salt-water shoreline and lower reaches of the Snohomish River. Increases in industrial, urban, and residential development in these and surrounding forest and agricultural lands are anticipated. Open space and opportunity to enjoy nature near large centers of population will be in increasing demand. Outdoor recreation will play an increasing role in the future development of rural areas.

To maintain the present level of hunting success, it will be necessary to provide an additional annual harvest of 1,700 deer; 400 bears; 50 mountain goats; 7,000 grouse; 5,000 pheasants; 18,000 band-tailed pigeons; 26,000 ducks; and 1,000 geese by the year 1980. As population, leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately. Table 8-15 indicates present and projected demands and needs for hunting in hunter-days.

[1] Population forecasts shown in Future Needs—Fish.

TABLE 8-15. Present and projected hunter-use in Snohomish Basin

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	99.3
1980	92.3	191.6
2000	119.0	310.6
2020	72.7	383.3

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Snohomish Basin is to be satisfied. Problems and conflicts discussed in the Area chapter apply to this Basin.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basin during the target years (Photo 8-7).

PHOTO 8-7. Coordinated timber-wildlife management enhances deer production. (Washington Department of Game photo)

PROGRAMS AND PROJECTS REQUIRED BY 1980

Table 8-16 indicates projects and programs proposed for the Basin to satisfy 1980 needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography,

TABLE 8-16. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Snohomish Basin, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs[1]: Capital	Costs[1]: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	12,800	$ 51,000	--	$2,500
Develop and continue wildlife population analysis and means to provide compatible forest-wildlife management practices to increase recreational potential of wildlife resources	[2]	[2]	$ 10,000	15,000
Develop educational program to stress renewable aspects and value of use of wildlife	25,700	138,600	5,000	--
Specific Programs				
Acquire and develop waterfowl and fur-animal habitat at Ebey Island, 600 acres	9,600	48,000	450,000	5,000
Acquire and develop band-tailed pigeon habitat, Pilchuck River area, 640 acres	11,200	56,000	500,000	5,000
Acquire and develop upland-bird habitat for hunting and release sites, 1,000 acres	8,000	32,000	315,000	2,000
Construct game farm to rear additional 8,000 pheasants	8,000	32,000	300,000	24,000
Totals	75,300	$357,600	$1,580,000	$53,500

[1] Do not include survey and plan costs.

[2] Included in benefits from other projects and programs.

viewing, and dog training, nor does it include recreation benefits that will accrue from public use of wildlife areas for swimming, boating, picnicking, hiking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

PROJECTS AND PROGRAMS, 1980-2000

(1) Apply intensive management techniques to key big-game habitat.

(2) Continue acquisition and development of key ecological and hunting areas.

(3) Continue wildlife management research and develop new projects and programs as required.

(4) Complete programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

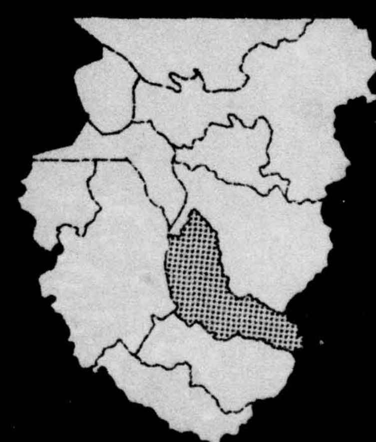
(2) Complete programs and projects not completed prior to 2000.

Table 8-17 indicates projects and programs for wildlife enhancement proposed by the U.S. Forest Service. Hunter-day benefits from these projects and programs have not been determined, but they will help satisfy overall demand.

TABLE 8-17. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Snohomish Basin, 1980-2020

Project or Program	Unit	1980 Number	1980 Cost	2000 Number	2000 Cost	2020 Number	2020 Cost
Surveys and Plans							
Conduct range analysis							
Deer	acre	296,760	$ 29,700	Survey and planning work is not carried forward to these time periods. Similar work here is probable.			
Elk	acre	27,390	2,700				
Mountain goat	acre	134,330	13,400				
Special	acre	10,540	1,100				
Conduct upland-game habitat surveys	acre	168,350	8,400				
Develop habitat management plans	each	35	17,500				
Big-Game Habitat Improvement							
Seed and plant forage	acre	3,768	376,800	3,760	$ 376,000	3,760	$ 376,000
Release forage	acre	803	20,100	1,580	39,500	790	19,700
Create permanent openings	acre	964	96,400	4,820	482,000	3,855	385,500
Develop waterfowl nesting facilities	each	150	7,500	150	7,500	--	--
Total			$573,600				

Cedar-Green Basins



CEDAR—GREEN BASINS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Cedar-Green Basins contain two major drainages: the Cedar River entering Puget Sound at Salmon Bay and the Green River, referred to as the Duwamish River in its lower (10-mile) reach, entering the Sound at Elliott Bay (Figure 9-1). Five independent streams also enter the Sound. Nonstream fresh waters include 236 lakes and reservoirs (33,887 surface acres) and 66 farm ponds (33 surface acres). Virtually all drainages afford suitable spawning and rearing habitat for anadromous and resident fishes, and each contributes to the ecological makeup of estuarine and marine habitat at its confluence with salt water. This habitat also supports shellfish and marine fishes.

The drainage system of the Cedar Basin is comprised of all waters funneling into Lake Washington, which then move through Lake Union and the Salmon Bay waterway to the Sound. The Cedar River originates in relatively high mountain country of the Cascade Range. It flows generally west-northwest to its confluence with the southern end of Lake Washington at Renton. The upper reaches, which contain two water-use developments, exhibit numerous rapids and cascades and few pool-riffle sections. Lower reaches afford spawning areas highly suitable for anadromous and resident fishes. The Sammamish River complex includes Sammamish Lake and the Sammamish River and their tributaries. Of the Sammamish Lake tributaries, Issaquah Creek provides the greatest amount of pool-riffle stream area, highly suitable for fish spawning and rearing. It heads in the foothill slopes near Hobart and meanders generally north to the lake. The Sammamish River runs north and west from the north end of the lake to the north end of Lake Washington, with predominant characteristics of sluggish flow with heavy bottom siltation. It affords transportation water for anadromous fishes.

The Green River originates in the high Cascades northeast of Mount Rainier. It flows generally west and northwest through a narrow valley, receiving tributary flow from several creeks and the North Fork. Downstream from the latter junction, the river supports two water-use developments. Further downstream the gradient is moderately steep as the river winds its way through a narrow valley, and then meanders northwesterly over a broad valley floor. Near Kent the gradient diminishes considerably, with the remainder of the Green-Duwamish exhibiting slow flows.

The five independent drainages are all relatively short and each experiences considerable periods of low or intermittent flow. Although they provide only limited spawning and rearing area for anadromous or resident fish, their runoff is important, contributing to the specific ecological makeup of the estuarine and marine habitats.

Of the 236 lakes and reservoirs, 119 (31,481 surface acres) lie within the Cedar Basin. The largest of these lakes is also the second largest natural body of water in the State—Lake Washington (22,138 surface acres). Lake Sammamish exceeds 4,897 surface acres in size. A 700-surface acre reservoir, Lake Youngs, is used exclusively for water storage and is chemically treated for domestic water quality control for the city of Seattle. It, therefore, has no present fishery value.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in large numbers throughout the Basins.

Anadromous Fish—Four Pacific salmon and three anadromous trout species populate various drainages. These include chinook, coho, sockeye, and chum salmon and steelhead and searun cutthroat trout, and some searun Dolly Varden. These fish migrate, spawn, and rear in 28.6 miles of the Cedar River and its tributaries, 105.2 miles of the Green River and its tributaries, and 8.8 miles of accessible

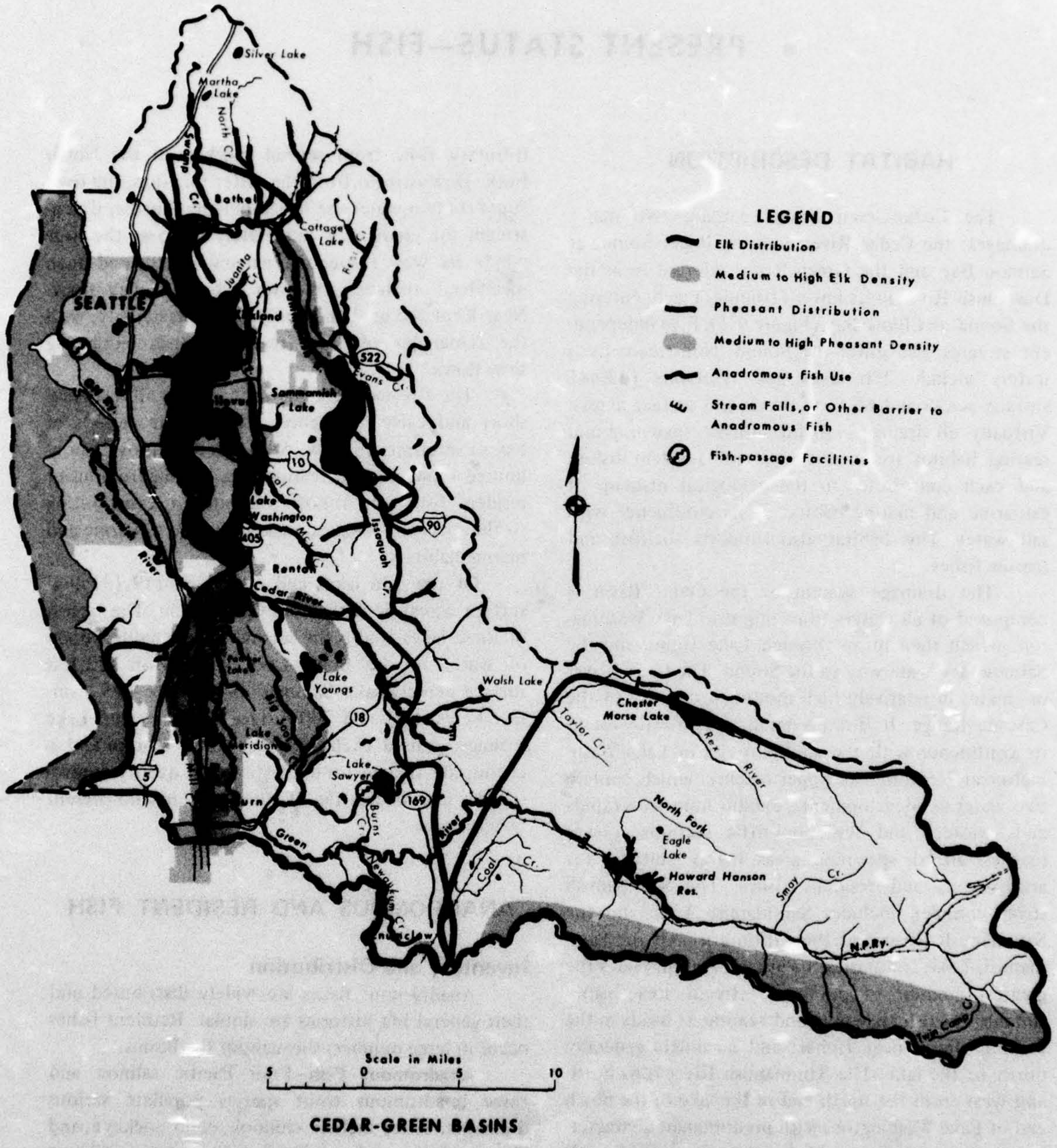


FIGURE 9-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

independent drainages (Figure 9-1). Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

Upstream migration timing overlaps considerably, as shown in Tables 9-1 and 9-2. Adults of one or more species enter the stream systems every month. The early running species remain in deep holes enroute to their spawning grounds for extended periods up to two months. Adult sockeye salmon remain in Lake Washington and Sammamish Lake for periods up to four months before ascending the Cedar River and other tributaries of the lakes.

Generally, spawning chinook utilize much of the Cedar River mainstem and the larger tributaries of the Sammamish River system, including Issaquah and Big Bear Creeks. In addition, important rearing occurs within Sammamish Lake, the Sammamish River, and Lake Washington. Lake Union, Salmon Bay, and Shilshole Bay are critical areas for all juveniles migrating from the Lake Washington system to the Sound.

Chinook spawners primarily utilize the Green River from Tacoma City Light's diversion structure near Kanaskat, downstream to the vicinity of Kent, and Newaukum and Big Soos Creeks. Juveniles rear in the entire accessible length of the Green River, in the above tributaries, and in the estuarine waters.

Coho salmon utilize virtually all accessible streams in the Cedar-Green Basins. Principal spawning areas include portions of the Cedar River and its tributaries, Rock Creek, Downs Creek, and one unnamed stream, all in the vicinity of Maple Valley; Sammamish River drainages including Sammamish Lake's Issaquah, Tibbetts, and Laughing Jacobs Creeks; the Sammamish River's Evans, Big Bear, Bear, North, and Swamp Creeks; and each of the eight independent Lake Washington drainages. Rearing coho occur in nearly every accessible tributary in Sammamish Lake and Lake Washington. Particularly vital waters for the immature fish are Lake Union and the Salmon Bay waterway and estuary.

Coho spawning occurs in some areas of the Green River. Tributaries maintaining coho runs include Newaukum, Crisp, Burns, and Big Soos Creeks, all upstream from Auburn; and Spring Brook and Hill Creeks near Kent. Certain independent drainages support small numbers of coho spawners. Juveniles rear in all waters utilized by the adults and in estuarine and marine waters.

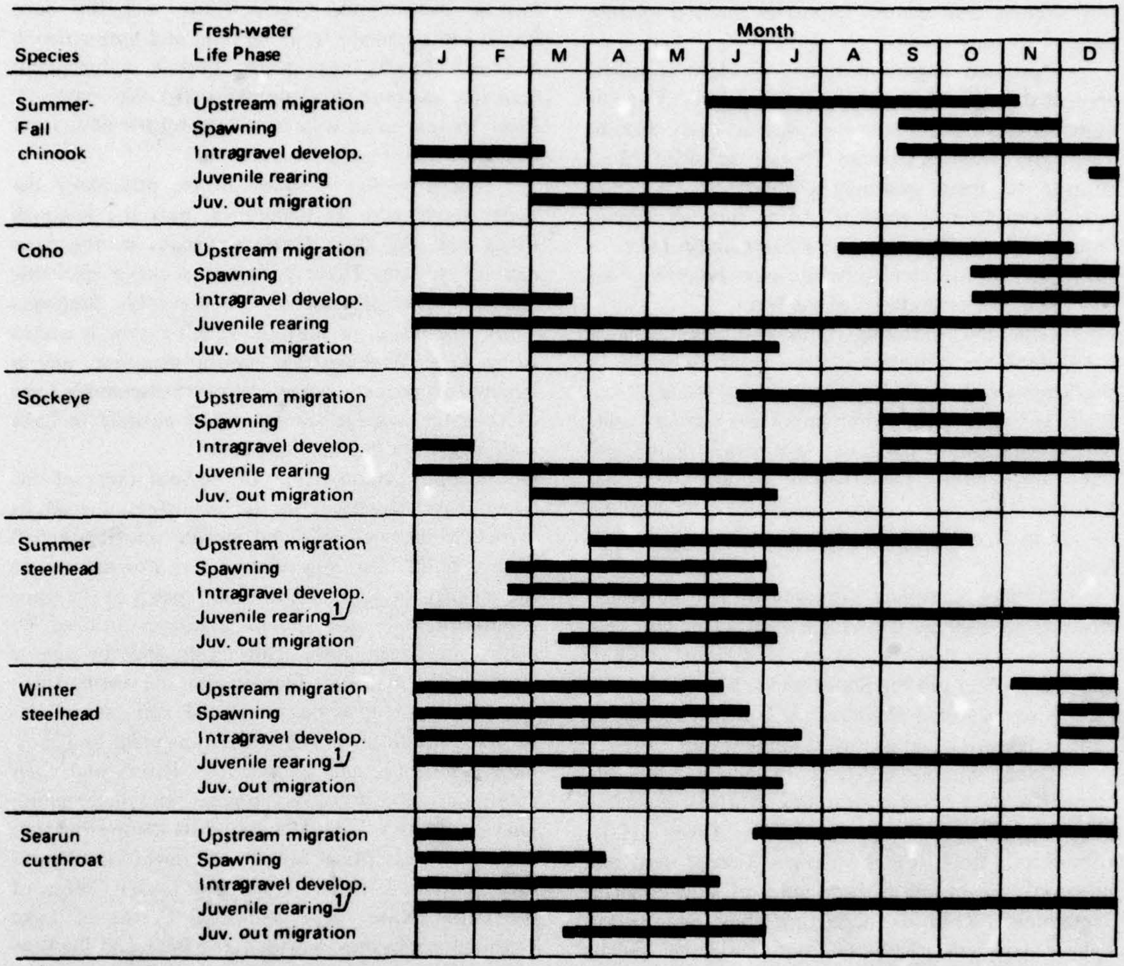
Adult sockeye salmon utilize principally the Cedar River and its tributaries, plus the Issaquah Creek and Big Bear Creek drainages in the Sammamish system. However, some sockeye spawning occurs in virtually all of the accessible drainages within the Basin. In addition, beach spawning occurs along Lake Washington's eastern shoreline, and is believed to occur in some areas of Sammamish Lake. Fresh-water juvenile rearing occurs entirely in Lake Washington and Sammamish Lake.

Chum salmon occur throughout most of the Green River drainage. In the mainstem, the adults favor the channel split and slower velocity sectors from a point near Newaukum Creek downstream to the vicinity of Kent. Chums also spawn in the same tributaries and independent drainages utilized by coho. The Green, lower Duwamish, and the marine environment of Elliott Bay are essential rearing areas.

Runs of spawning steelhead and searun cutthroat trout occur in the Cedar (upstream to Landsburg diversion), and Sammamish Rivers and their tributaries, and Lake Washington and Sammamish Lake tributaries. Lake Union and its connecting ship canal are most critical for juvenile migration. Significant tributaries include Rock and Taylor Creeks of the Cedar River; May and Coal Creeks of Lake Washington; Swamp, North, Little Bear, and Big Bear Creeks of the Sammamish River; and Issaquah Creek of Sammamish Lake. The independent streams are also utilized.

Larger runs of spawning steelhead and searun cutthroat favor the Green River and its tributaries downstream from Tacoma City Light's diversion, especially the Big Soos Creek and Newaukum Creek drainages.

TABLE 9-1. Timing of salmon and searun trout fresh-water life phases in Cedar Basin



1/ Normally extends over a two-year period.

TABLE 9-2. Timing of salmon and searun trout fresh-water life phases in Green-Duwamish Basin

Species	Fresh-water Life Phase	J	F	M	A	M	J	J	A	S	O	N	D
Summer-Fall chinook	Upstream migration						X	X	X	X	X	X	
	Spawning									X	X	X	
	Intragravel develop.	X	X							X	X	X	X
	Juvenile rearing	X	X	X	X	X	X	X					
	Juv. out migration				X	X	X	X					
Coho	Upstream migration	X							X	X	X	X	X
	Spawning	X										X	X
	Intragravel develop.	X	X	X	X							X	X
	Juvenile rearing	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration				X	X	X	X					
Chum	Upstream migration	X								X	X	X	X
	Spawning	X										X	X
	Intragravel develop.	X	X	X	X							X	X
	Juvenile rearing		X	X	X	X	X	X					
	Juv. out migration		X	X	X	X	X	X					
Summer steelhead	Upstream migration				X	X	X	X	X	X	X		
	Spawning		X	X	X	X	X						
	Intragravel develop.		X	X	X	X	X	X					
	Juvenile rearing[1]	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration			X	X	X	X	X					
Winter steelhead	Upstream migration	X	X	X	X	X	X					X	X
	Spawning	X	X	X	X	X	X						X
	Intragravel develop.	X	X	X	X	X	X	X	X				X
	Juvenile rearing[1]	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration			X	X	X	X	X					
Searun cutthroat	Upstream migration	X						X	X	X	X	X	X
	Spawning	X	X	X	X								
	Intragravel develop.	X	X	X	X	X	X						
	Juvenile rearing[1]	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration			X	X	X	X						

[1] Normally extends over a two-year period.

Significant spawning reaches in some streams are delineated in Table 9-3.

Intragravel egg development occurs over an 11-month period because of the overlapping spawning period of various species.

"Out migration" for all species peaks during the period March-June, corresponding with high flows during spring runoff. Some migration of coho and chinook as well as trout occurs throughout the year, but this is a natural redistribution of juvenile salmonids within the stream systems. Downstream migrants spend considerable time in fresh water and the estuarine environment. The Green-Duwamish River is exceedingly important to the early fresh-water rearing of chum salmon. The lower 6 to 8 miles of the Duwamish River serve as the transition zone where the fry acclimate to salt water. Extremely vital to the young are the brackish estuarine waters of the Duwamish waterway and the marine environment of Elliott Bay. The juvenile salmonids, after adjusting to the salt-water environment, disperse into Puget Sound, the straits, and the ocean.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 9-4.

Resident Fish—Resident fish species are distributed and spawn throughout the Cedar-Green Basins (Table 9-3). The upper Cedar and Green Rivers support significant populations of rainbow trout. They also occur in many lakes and ponds and, to a lesser degree, in tributaries. Cutthroat trout are more common in lower river tributaries and ponds, but are distributed throughout most of the lakes and streams. Brook trout have been introduced into lowland and alpine lakes in addition to tributaries and connecting ponds. Dolly Varden, least common of the native species, occur in upper sections of the Cedar and Green Rivers.

Significant populations of kokanee inhabit Lakes Washington and Sawyer, and Sammamish Lake. Their inlet tributaries as well as Sammamish River tributaries provide essential spawning habitat. These fish also occur in smaller lakes tributary to the Green River. Mountain whitefish are abundant in various streams, especially the Green River, and a few specific waters contain lake and brown trout. Populations of largemouth bass, yellow perch, black crappie, brown bullhead, pumpkinseed, and other spiny-rayed fishes are distributed throughout many of the lower elevation lakes and ponds.

TABLE 9-3. Significant spawning reaches for anadromous fish and resident game fish, Cedar-Green Basins[1/]

Stream	Section	Stream Mileage	Type of Spawning Area
Lake Washington drainage	Lake areas	--	Numerous lake areas having gravel bottom suitable for sockeye "beach" spawning
(Other than Sammamish or Cedar R. system)	Lake Washington tribs.	Totals over 15 mi.	Smaller drainages containing both riffle and patch type gravel
Sammamish R. drainage	Sammamish Lake and Sammamish R. tribs.	Totals over 50 mi.	Mostly small drainages containing both riffle and patch type gravel
Cedar R. drainage	Mouth to Maple Valley	0.0-13.0	Numerous broad riffles, some patch gravel areas
	Maple Valley to Landsburg Dam	13.0-19.0	Few large riffles, considerable patch gravel
Green R.	Kent area to gorge	22.0-38.0	Numerous broad riffles, some beach and patch gravel
	Gorge to Tacoma diversion	38.0-52.0	Occasional riffles, mostly patch gravel sections
Newaukum Cr.	Mouth to point near headwaters	0.0-11.0	Many short riffles, some patch gravel areas
Big Soos Cr.	Mouth to point near headwaters	0.0-9.0	Numerous riffles, many patch gravel sections

[1/]Additional spawning area is provided by virtually all tributaries entering within described reaches.

TABLE 9-4. Anadromous fish spawning escapement, natural and (artificial), in Cedar-Green Basins

Species	Range1/	Average (Annual)
Chinook	1,050-7,810	3,490
	(16,720-22,220)	(19,370)
Coho	11,380-59,390	32,480
	(30,530-78,290)	(50,890)
Chum	3,720-43,210	16,6802/
Sockeye	45,400-190,000	90,0003/
Summer steelhead4/	20-180	905/
Winter steelhead4/	28,400-52,700	39,4005/
Searun cutthroat4/	32,900-60,400	45,800
Searun Dolly Varden6/		

1/Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), sockeye salmon (1964-1967), trout (1962-1966).

2/Green Basin only.

3/Cedar Basin only.

4/Totals include natural and (artificial) escapement.

5/Does not include those fish utilizing independent drainages.

6/No valid totals established.

Other fresh-water species are also scattered throughout the Basins in both lake and stream environment. The most common are suckers, sculpins, peamouth, carp, redside shiners, sticklebacks, dace, and squawfish.

The two largest lakes–Washington and Sammamish–are connected by the Sammamish River. Surrounded by metropolitan areas, these lakes receive unlawful releases of display or household fish pets, resulting in the most varied species composition of any in the State. Unfortunately, the most common fishes are also the least desirable.

Production

The Cedar-Green Basins are very highly developed industrially, which has damaged streams and greatly reduced natural production. Major diversions occur on both the Cedar and Green Rivers, and water storage projects exist upstream from each of these diversion points. Stream production is also limited by high elevation headwaters contributing cold water during much of the summer growing season. Weedicide application also restricts production in some waters. The independent drainages and low elevation streams, as well as Lake Washington and Sammamish Lake, are most productive. Based upon samples obtained on representative streams during low flow periods, production varied from only a few to nearly 450 pounds of fish per surface acre. The average was 245.5 pounds. Salmonid populations equaled 225 pounds per surface acre, while other or undesirable species comprised the remaining 20.7 pounds.

Anadromous Fish–Intense artificial propagation programs, coupled with considerable high quality natural production habitat, produce exceptional numbers of salmonids. The Cedar (Lake Washington–Sammamish Lake) drainage affords good to excellent spawning and rearing conditions (Photo 9-1). This system annually supports large numbers of spawning chinook, coho, and sockeye salmon.

PHOTO 9-1. A section of prime spawning riffles on the Cedar River. (Washington Department of Fisheries photo)

The Green River drainage supports good to excellent runs of chinook, coho, and chum salmon. Intense spawning and rearing occur throughout much of the river and in nearly every accessible tributary.

Both Basins are productive winter steelhead areas. Most of the production originates in the Green, but the Cedar and its associated drainages of Lake Washington and Sammamish Lake are significant. During 1962-1966, average annual steelhead production approached 59,230 adults in the Basins. Summer steelhead, found mostly in the Green Basin, contributed one percent of this total. Potential natural production is estimated to be considerably larger than the present population.

Searun cutthroat trout utilize marine, estuarine, lake, and lower elevation stream environments. The average annual production is calculated at 61,000 adults with a three-to-one contribution ratio for the Cedar Basin over the Green. It is believed that cutthroat production could be increased. Because so few anadromous Dolly Varden occur, their production is included with that of resident trout.

Fish production data are presented in Table 9-5.

TABLE 9-5. Anadromous fish natural production (harvest plus escapement), Cedar-Green Basins

Species	Range[1]	Average (Annual)
Chinook	4,200-31,240	13,960
Coho	56,900-296,900	162,400
Chum	7,440-86,410	33,360
Sockeye	48,000-190,000	90,000
Summer steelhead	40-280	130
Winter steelhead	42,600-79,100	59,100
Searun cutthroat	43,800-80,500	61,000
Searun Dolly Varden[2]		

[1] Period involved in determining fish numbers is 1956-1965. Exceptions: sockeye salmon (1964-1967), searun trout (1962-1966).

[2] Production limited and therefore not determined.

Resident Fish–Portions of the major rivers, some tributaries, and most independent drainages lie upstream from anadromous fish barriers. The main rivers in this category are largely in closed watersheds, in addition to being cooler and more precipitous. Observations following forebay flushing at the city of Seattle's Cedar River diversion dam indicate a standing crop in these Basins' streams that approaches 100 pounds per surface acre.

Stream reaches downstream from migratory barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The instantaneous low flow standing crop (which did not include hatchery fish or lampreys) varied between 107 and 448 pounds per surface acre.

Because many of the lakes, ponds, and reservoirs are planted frequently and managed for salmonids and/or spiny rays, actual production is shown in harvest data. Certain lakes' total harvest varies from one season to another and may vary from less than 10 to nearly 200 pounds per surface acre annually. Potential production could be substantial.

Propagation

The State maintains and operates the Issaquah Salmon Hatchery on Issaquah Creek near the town of Issaquah and the Green River Salmon Hatchery on Big Soos Creek near Auburn (Figure 9-2). The principal species reared at the Issaquah station are chinook and coho. They are released in Lake Washington tributaries. Fall chinook and coho salmon and some chum are propagated at the Green River facility. The majority of fish produced here are released in the Green; however, large numbers of juvenile fish are released in other drainages to supplement existing runs or introduce new populations to a particular river reach.

Occasionally salmon and trout reared at facilities in other basins are liberated here.

Preliminary commercial and sport catch statistics indicate that the planting program in the Green and Cedar River systems contributes approximately 17,600 chinook and 22,700 coho to these fisheries annually.

Emphasis is placed on annual liberations of resident and anadromous game fish in low elevation lakes and streams. Alpine lakes are stocked with small trout every three to five years or as needed.

Because many of the lakes lie within watersheds closed completely or partially to public access, regular planting programs have not been the policy. Only where public access is available, such as in the lower Green River watershed or on public domain, is an active program pursued. Plantings of legal-size hatchery fish are also being used to supplement natural production in lakes and streams supporting heavy trout fishing pressure. As an indication of high use, which does not include the closed area, game-fish propagation requirements in the Basins are the fourth highest in the Area, with annual plantings of 1.5 million trout, kokanee, and landlocked coho salmon. Facilities are also indispensable in providing fish for habitats which have been altered by barricades or polluted by nature or man and recently improved.

A salmon and trout hatchery is operated by the University of Washington, College of Fisheries, on the campus adjacent to the Lake Washington Ship Canal (Figure 9-2). Here, major emphasis is on research; however, salmon and trout propagation is supplemented by releases from this station.

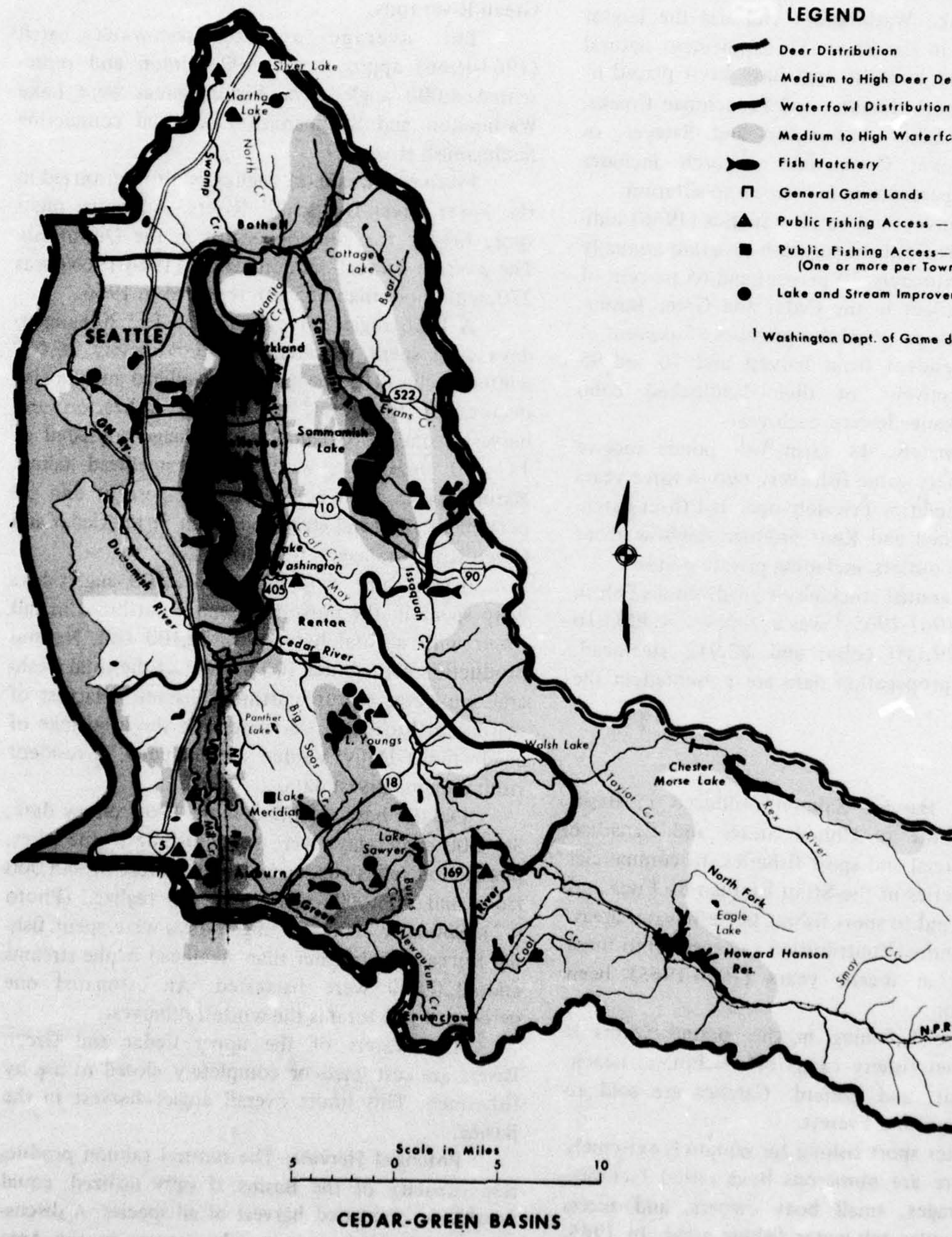


FIGURE 9-2. Wildlife distribution, and fish and wildlife developments (1965)

The State also administers the Seward Park Hatchery within the city of Seattle where rainbow and steelhead are produced (Figure 9-2). It utilizes water from Lake Washington, and has the largest visitor-day use in the State. To supplement natural production, eyed kokanee eggs have been placed in Rock, Bear, Seidel, Juanita, and Frenchman Creeks, tributaries to Lakes Washington and Sawyer, or Sammamish Lake. Companion research includes study of gravel percolation in relation to siltation.

Recent survey and catch statistics (1966) indicate that the artificial propagation program annually provides approximately 20 percent and 65 percent of all steelhead caught in the Cedar and Green Basins, respectively. This program also provides 95 percent of both Basins' resident trout harvest and 10 and 95 percent, respectively, of their landlocked coho salmon and kokanee harvest each year.

Approximately 48 farm fish ponds receive plants of hatchery game fish every two to three years from private facilities. Privately-operated trout hatcheries near Bothell and Kent produce rainbow trout for commercial outlets, including private ponds.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 4,406,616 chinook; 1,079,110 coho; and 82,912 steelhead. Resident fish propagation data are presented in the Area chapter.

Harvest

Existing Harvest–Salmon produced in Basin waters contribute to United States and Canadian ocean commercial and sport fisheries, to commercial and sport fisheries in the Strait of Juan de Fuca and Puget Sound, and to sport fishing in fresh-water areas. The average annual contribution (all species) to these fisheries has in recent years (1956-1965) been 603,040 salmon.

Commercial fishing in the marine waters is light. A gill net fishery exists off Richmond Beach, Meadow Point, and Ballard. Catches are sold to dealers in Seattle and Everett.

Salt-water sport fishing for salmon is extremely popular. There are numerous boat rental facilities, private moorages, small boat owners, and access points to popular salt-water fishing areas. In 1965, nearly 100,000 angler-days were recorded in the Cedar Basin area. The most popular fishing sites include waters from Richmond Beach to Meadow Point, Ballard, and outer Shilshole Bay. Elliott Bay, which supports over 60,000 angler-days annually, is a favorite salmon sport fishing area associated with the Green River runs.

The average annual fresh-water catch (1964-1966) approached 1,600 salmon and represented 8,000 angler-days. Fishing areas were Lake Washington and Sammamish Lake, and connecting Sammamish River.

Fresh-water salmon angling is also permitted in the lower Green-Duwamish Rivers. A unique night sport fishery for chinook occurs in the Duwamish. The average annual salmon catch (1964-1966) was 270, with more than 655 fish reported in 1966.

A 1966 angler survey indicated 132,200 angler-days were spent in catching approximately 26,400 winter steelhead. Some summer steelhead angling also occurs. Of the total, the annual utilization and harvest from the Green River drainage consisted of 111,450 angler-days with 22,550 steelhead taken. Natural production contributes 80 percent and 35 percent of the total steelhead catch in the Cedar and Green River drainages, respectively.

These same data indicate 33,500 angler-days were spent in the pursuit of searun cutthroat in salt water with a total harvest of 20,100 fish. Natural production contributes 100 percent of the total fresh- and salt-water searun cutthroat harvest. Harvest of searun cutthroat in fresh water and the total take of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of these same 1966 survey data, 368,800 angler-days were spent fishing in the lakes, ponds, and reservoirs; and a total harvest of 985,000 trout and 405,600 other game fish realized (Photo 9-2). Similarly, 100,200 angler-days were spent fishing for game fish other than steelhead in the streams and 320,800 were harvested. An estimated one percent of this total is the whitefish harvest.

The waters of the upper Cedar and Green Rivers are restricted or completely closed to use by fishermen. This limits overall angler harvest in the Basins.

Potential Harvest–The natural salmon production capacity of the Basins, if fully utilized, could provide an increased harvest of all species. A discussion of salmon harvest trends appears in the Area chapter.

Potential harvest of natural steelhead production is difficult to predict, since artificial propagation

[1] Anadromous trout data involve period 1962-1966.

PHOTO 9-2. In addition to trout, numerous spiny-rayed species provide angler enjoyment. (Washington Department of Game photo)

presently results in additional fishing pressure on these populations. However, additional harvest is possible.

The harvest of searun cutthroat has not reached its full potential. This is due mainly to the widely varied salt-water fishery, the unique stream fishery, and the popularity of winter steelhead angling. Estimates indicated this population could support additional harvest.

The production and subsequent harvest of resident salmonids in streams are not expected to change, subject to the same exclusions noted for anadromous fish. An exception is the harvest of mountain whitefish, which is estimated at less than 20 percent its potential. Most of the existing harvest occurs in the Green River. Because this total harvest is not separable from stream resident harvest data, present and potential harvest values were not determined. Potential harvest of resident salmonids in ponds, reservoirs, and lakes could be increased substantially.

Factors Limiting Production Other Than Harvest

Natural and manmade limiting factors appear in Table 9-6. All are considered alterable.

Detrimental Streamflow–Low summer flows curtail fish production in the Cedar Basin. Flows are further reduced by the city of Seattle's water diversion dam near Landsburg on the Cedar River (river mile 19).

Seasonal flooding is common in all the independent drainages due in part to logging and extensive land clearing associated with urban developments. This trend is common on all the smaller, but extremely important, fish producing streams located within commuting radius of the larger metropolitan areas.

Low summer flows occur on most tributary streams in the Green Basin. Particularly affected are tributaries in the vicinity of Auburn and Kent, where some stream sections become dry during August or September. Low flows also occur in the lower Green River. This factor, combined with high water temperatures, has created a water quality problem.

Seasonal flooding occurs in the Green Basin, particularly between Auburn and the Green River Canyon upstream, and at times shifts streambed material and destroys spawning nests.

Poor Water Quality–There are numerous sources of domestic, agricultural, and industrial effluents from outlying independent drainages and new population centers. Major contamination occurs through use of DDT, weed and brush control herbicides, and chemicals used for cleaning and deicing.

Increased traffic through the Hiram M. Chittenden Locks is causing salt-water intrusion into the Lake Washington Ship Canal and Lake Union. This is adversely affecting the fresh-water environment of these areas.

During summer low flow periods, high water temperatures and reduced oxygen occur in the lower Green River, particularly in tidal areas, and extend into the estuarine and marine waters. Industrial and domestic waste spillage occurs in the lower tributary streams and along the lower 20 miles of the Green River, an area of expanding industrial development.

Physical Barriers–The city of Seattle's diversion dam on the Cedar River blocks 12 miles of upper

TABLE 9-6. Alterable factors limiting anadromous and resident fish production in Cedar-Green Basins

Streams	Limiting Factor[1]										Species Affected						
	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Unstable Streambed	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes[2]	Chinook	Coho	Sockeye	Chum	Steelhead	Searun Cutthroat	Resident Trout
Lake Washington																	
Drainages			X						X		X	X	X		X	X	X
Mercer Slough Cr.		X		X						X	X	X	X		X	X	X
Coal Cr.		X		X						X		X			X	X	X
May Cr.		X		X						X		X			X	X	X
Juanita Cr.		X		X						X		X			X	X	X
Sammamish R.		X					X	X	X	X		X	X		X	X	X
Swamp Cr.		X		X						X		X	X		X	X	X
North Cr.		X								X		X			X	X	X
Bear Cr.		X								X		X			X	X	X
Big Bear Cr.		X								X	X	X			X	X	X
Sammamish Lake																	
Tibbetts Cr.		X								X		X			X	X	X
Issaquah Cr.	X	X								X	X	X	X		X	X	X
Cedar R.	X	X	X		X			X		X		X	X		X	X	X
Downs Cr.		X										X			X	X	X
Rock Cr.		X										X			X	X	X
Duwamish R.	X	X							X		X	X		X	X	X	X
Black R.		X							X	X		X		X	X	X	X
Spring Brook Cr.		X					X		X	X		X			X	X	X
Hill Cr.		X							X			X		X	X	X	X
Green R.	X	X	X								X	X		X	X	X	X
Big Soos Cr.		X								X		X			X	X	X
Burns Cr.		X				X	X					X		X	X	X	X
Crisp Cr.		X	X			X	X					X		X	X	X	X
Newaukum Cr.		X							X			X			X	X	X
Independent																	
Drainages																	
Miller Cr.		X	X	X	X			X	X	X		X			X	X	X
Bow Lake Cr.		X	X	X	X			X	X	X		X			X	X	X
Joes Cr.		X										X			X	X	X

1/ *Competition and predation generally affect all waters and are most serious in lake environments.*

2/ Includes watershed development.

watershed suitable for use by anadromous fishes. Low summer flows downstream from Landsburg are directly associated with municipal and industrial water supply demands from this source.

The Lake Washington Ship Canal locks are equipped with passage facilities to facilitate upstream migration of anadromous fishes. Salmon and trout can also ascend into the lake through the boat locks when they are in operation. Often, however, serious migration delays occur at this point due to poor fish attraction waters near the fish ladder and the location of the outfall releasing "drawdown" waters pumped from the locks, which distracts migrants away from the access points.

Virtually all of the small-to-moderate sized streams experience intermittent blocks or barriers to anadromous fish migration created by debris buildup, manmade impoundments, or culvert washouts. Such barriers make adult fish vulnerable to harassment or poaching by man or predators, as well as delay migration to spawning grounds.

A water storage and diversion complex on the upper Green River is a total block to anadromous fish migration. Tacoma City Light operates a diversion dam (barrier to fish) at river mile 50 near Kanaskat, while the Corps of Engineers maintains and operates Howard A. Hanson Dam and Reservoir for water storage purposes approximately 3 miles upstream. A total of 25 miles of valuable river spawning area exists upstream from the reservoir.

Some of the smaller tributary streams are occasionally affected by natural barriers. These blocks are generally formed through prolonged build-up of debris or by beaver activity.

Conflicting Watershed Developments—Man's encroachment in the Cedar Basin has substantially reduced fish production. Many of the upper watershed flows course through farmland interspersed with small communities while lower stream areas, particularly around Lake Washington and Sammamish Lake, are confined and altered by urbanization. Riprapping, channeling, and diking are common flood protection measures for such development. Storm drainage waters are frequently piped directly into stream channels, thus increasing the natural runoff rate. Some streams are no longer capable of producing fish, others are marginal. Flood control measures in Issaquah Creek and the Cedar River downstream from Maple Valley have changed the streambed profile in several sections and eliminated pool and riffle areas vital to anadromous fish production (Photo 9-3).

Industrial and urban development of the lower Green-Duwamish River area is the most significant factor affecting the fish resources. Water quality and environment for fish production have been and are being degraded. Pollution, removal of natural cover, and changes in the streams' natural pool-riffle character are the principal factors associated with such development.

Many of the small fish-producing tributaries of the Green, as well as the independent streams, are being altered by suburban developments which include channel changes, destruction of pool-riffle areas, removal of streambank cover, and deterioration of water quality.

Probably the second most significant development affecting fish populations is control of Green River flows through the operation of Howard A. Hanson Dam and Tacoma City Light's diversion dam. The flow regimen is designed to abate pollution in the lower Green-Duwamish Rivers. Flow releases downstream, however, are often insufficient to alleviate poor water quality conditions existing in the lower Duwamish, and to provide adequate adult salmonid transportation water and juvenile rearing area.

PHOTO 9-3. Flood control projects cause loss of fish habitat and fish life. (Washington Department of Fisheries photo)

Indiscriminate removal of streambed gravel occurs within the Green River drainage. This activity, which is associated with flood control or with gravel stock piling for construction purposes, often destroys natural spawning riffles and reduces good quality rearing areas.

Limited Spawning and Rearing Areas—Floods in the Green Basin cause silting of spawning gravel and downstream gravel movement. The shifting of gravel bars and channels reduces the natural pool-riffle conditions necessary to achieve a proper balance of fish spawning and rearing areas. Flood control projects that have also reduced and altered natural spawning and rearing areas include the Sammamish River channeling project, and the Cedar River channeling and bank stabilizing projects. In the smaller streams, logjams and debris frequently choke channels and cause formation of new channels of inferior gravel quality, and increase stream siltation. Some spawning reaches in the lower Green River valley tributaries are affected by natural siltation and weed choking; however, the condition is not considered extremely serious.

Competition and Predation–Throughout early rearing, juvenile salmonids are preyed upon by a variety of other fishes, as well as mammals and birds. One important predator and competitor is the dogfish, which is abundant in certain estuarine and marine waters. Spiny-rayed and undesirable fishes common to Lake Washington and Sammamish Lake deplete available food or prey directly on most salmonids. Except where open water plankton feeders are involved, the salmonid populations are severely curtailed in these and other large lakes.

Beneficial Developments

Accomplished and Continuing–Enhancement projects for anadromous fishes have involved extensive beaver dam and logjam removal, road culvert repair, and installation and operation of fish-passage facilities at the Government locks in the Lake Washington Ship Canal.

Downstream discharges at Howard A. Hanson Dam on the Green River are augmented during low flow periods so that approximately 110 cfs remains in the lower reaches for fishery enhancement.

Beneficial developments also include artificial propagation facilities, lake rehabilitation, access area development, stream and lake improvement, and fisheries research.

The Bureau of Commercial Fisheries Research Center, Seattle, engages in oceanographic and biological research to support programs of the Bureau and certain international commissions. The College of Fisheries, University of Washington, maintains an undergraduate and graduate school in fisheries science.

Lakes which have been chemically rehabilitated and stocked with single or mixed species of resident trout or with specific spiny-rayed species include: Boren, Beaver (near Black Diamond), Black Diamond, Desire, Echo (Highway 99), Echo (near Maltby), Fenwick, Geneva, Cinder, Green, Haller, Holm, Leota, Martha, Meridian, Morton, Pine, Silver, Star, Shadow, Shady, Twelve, Wilderness, and Walker. While only 18 of these lakes required screening, six also required barrier dams. Figure 9-2 indicates the location of various fishery improvement projects.

Fishermen access developments exist at Boren, Beaver (near Black Diamond), Dolloff, Echo (Highway 99), Echo (near Maltby), Fenwick, Fish (near Cumberland), Geneva, Holm, Morton, Pine, Phantom, Shadow, Shady, Spring, Twelve, Walker, and Wilderness Lakes, and Lakes Washington, Desire, and Meridian (Figure 9-2). Streambank fishing and boat launching access are available at points along the Cedar, Green, and Sammamish Rivers. Additional private and public developments augment this program.

Effort to obtain guaranteed public fishing access to lakes, streams, and certain salt-water areas is a continuous process–likewise, the construction of inlet and outlet control structures accompanying specific lake rehabilitations.

Under Development–The sewage collection and treatment system owned and operated by the Municipality of Metropolitan Seattle (Metro) is implementing water quality controls for the Lake Washington system. The "Studies of Relation Between Nutrient Supply and Productivity in Lake Washington," being conducted by the University of Washington, will provide information on the effectiveness of the Metro Plan in relation to other biological features.

Experimental studies involving release of rainbow-steelhead hybrids into the Lake Washington complex and other production and broodstock experiments are being conducted by the University of Washington.

A large semi-natural rearing pond complex is being developed on a water source adjacent and tributary to the upper Green River in the vicinity of Kanaskat. These facilities are being completed primarily to rear steelhead smolts for the Green.

Concerning the opening of the Cedar River watershed to public use, preliminary proposals have been submitted by the State for a fisheries management program, including liberation of trout into Rattlesnake Lake near Cedar Falls.

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters of the Cedar and Green Basins possess similar characteristics, and, therefore, are considered jointly. Aside from its nearly uniform beach characteristics, a unique feature of this body of water is the deep (100-155 fathoms) mid-Sound trench, running north and south paralleling the shoreline. This contributes to a highly diversified marine environment. Elliott Bay, terminus of the

Duwamish River outflow, is the largest semi-protected body of water within the marine water sector.

The combined marine and estuarine shoreline extends from Edwards Point near Edmonds (in Snohomish Basin) southerly to Point Pulley near Burien. Except for Elliott Bay, beach topography throughout this sector is similar in gradient, expanse, and composition. The tidelands are narrow, have a moderate gradient, and the beaches are primarily gravel interspersed with large rocks and boulders. Spring and North Beaches, north of Seattle, and Seaola Beach, south of Fauntleroy, are the only tidelands containing mixed sand and gravel in the upper portion of beach, and hard compact sand in the middle and lower portions, with a shallow gradient.

Tidal currents are generally weak and variable in central Puget Sound, however, frequent wind and wave actions cause considerable water mixing and movement. Depths exceed 100 fathoms throughout the length of the main channel, which maintains salinities approaching typical ocean conditions.

Inventory and Distribution

Marine Fish—The diversity of marine environment, plus the introduction of fresh water from the Lake Washington and Green-Duwamish drainages, affords a highly suitable habitat for an extensive variety and abundance of marine fishes. They include species of cod, lingcod, greenling, flounder, sole, rockfish, surfperch, herring, dogfish, and ratfish. Population is discussed in the Area section concerning production of these species.

Shellfish—Concerning shellfish, the Cedar River-Lake Washington system and the Green-Duwamish River system must necessarily be considered as one common drainage estuary. The proximity of the two river outlets results in intermixing of their fresh-water discharges with the heavier salt water of Puget Sound. Therefore, influence of these discharges upon shellfish distribution cannot be independently determined.

Principal species of shellfish and other marine invertebrates are Dungeness crabs; littleneck, butter, horse, and Manila clams; geoducks; cockles; blue mussels; pink scallops; pink shrimp; squid; octopi; sea cucumbers; and sea urchins.

Dungeness crabs inhabit the entire intertidal zone. Littleneck clams occur in moderate abundance in the gravelly intertidal beach areas from Edmonds to Meadow Point, north of Seattle, and from Alki Point to Point Pulley, south of Seattle. Only scattered quantities of butter, horse, and Manila clams and cockles are present in these same areas. Occasional small numbers of geoducks inhabit the sandy reaches below the zero tidemark. Small populations of the common blue mussel occur within the intertidal reaches, particularly on waterfront docks, pilings, and jetties of the boat harbors in Shilshole and Elliott Bays. Small pink scallops occur in small numbers in Elliott Bay. In addition, small scattered "beds" exist along the Shilshole breakwater and throughout the marine sector near the 50- to 70-foot depth where the bottom is relatively sandy.

Spot shrimp were abundant in many parts of Elliott Bay. The smaller pink shrimp, in lesser numbers, inhabit these waters.

Scattered groups of squid occur in various marine waters. Significant numbers of octopi inhabit the rocky shorelines, particularly adjacent to the large rock breakwaters and rocky points. Sea cucumbers occur only in isolated groups, particularly along the more sandy beaches. Small populations of sea urchins favor areas of large rocks and boulders where currents are stronger.

Production

Production of marine fish and shellfish was not determined.

Propagation

Marine fish and shellfish are not propagated in the Basins.

Harvest

Marine Fish—Marine fish harvest is principally by sport fishermen with only limited effort by commercial vessels. Occasionally, otter trawl vessels "drag" the deeper waters for lingcod, English sole, or some species of rockfish. Fishing from piers in Elliott Bay is a popular sport. Spear fishing by skin divers is also growing in importance. This activity occurs mainly along the Puget Sound shoreline south of Seattle. Average annual angler-day use devoted to sport angling for marine fish is 12,400.

Little is known regarding harvest potential of marine fish.

Shellfish—Shellfish harvest is almost entirely by sportsmen. Occasional crab fishing and some small privately-operated oyster culture beaches contribute to commercial landings. Local dealers and processors in the metropolitan Seattle area handle large quantities of fresh shellfish, most of which have been taken in waters outside the Basins.

Sport harvest of shellfish is concentrated on hardshell clams with occasional crabs also taken. Harvest has been intense on all public beaches, and now totals only 7,500 man-days annually. The heavy pressure has not affected private beaches, which are protected.

Harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish and Shellfish—Poor water quality, tideland development, and competition and predation are principal factors influencing production.

(1) Poor Water Quality—Water quality in estuarine and marine waters is measurably altered by the introduction of domestic and industrial effluents, and other foreign materials from extensive shipping traffic. Such conditions are prevalent within Shilshole Bay. With the completion of Metro's trunk line and the treatment plant in this area, the marine water quality should be significantly improved. The occasional disposal of dredged spoils in adjacent waters and the pumping of oil and bilge liquids, or spillage of other toxic materials from local ship and barge traffic also create degrading and harmful water conditions for aquatic life. In addition, shellfish production is impaired by cold marine waters.

(2) Tideland Development—The extension of piers and landfills for marine and commercial enterprises limits marine fishes through attrition of some natural production beach areas. Construction of extensive dikes and breakwaters often reduces the living habitat of many marine species, particularly juveniles. Residential developments are extensive along the marine waterfront of Shilshole Bay and have altered the beach area to some degree. Natural beaches north of Golden Gardens exhibit minimum encroachment or alterations.

(3) Competition and Predation—Dogfish are abundant throughout the marine waters and are considered heavy predators on most food fishes. Less desirable species of marine fishes periodically occur in heavy concentrations and occupy the ecological niche normally used by more desirable fish.

Prevalent shellfish predators include red crabs, starfish, moon snails, and native drills which prey on clams and oysters, and octopi that particularly seek out crabs.

Beneficial Developments

No beneficial development projects exist for marine fish or shellfish enhancement.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The Cedar-Green Basins contain the largest metropolitan center in the Puget Sound Area and form the hub of industrial and shipping activity. The adjacent urban, suburban, rural, and farm lands are directly in the path of current expansion. The 1963 population was about 976,700, and projections indicate that 1,479,000, 2,375,700, and 3,816,300 people will reside in the Basins by 1980, 2000, and 2020, respectively. Major increases will be directly related to new industrial development planned for the Basins. This expansion (Photo 9-4), along with community and suburban developments, will be distributed throughout the Duwamish and Green River valleys to above the Kent-Auburn areas. Expansion will also occur east of Lake Washington and Sammamish Lake throughout the Cedar River valley and the many drainages of the Basins. Summer recreation home developments, plus year round residential construction, will increase rapidly in areas adjacent to streams and rivers, especially over the upper watersheds. The Tacoma-Seattle-Everett metropolitan area will meld into one continuous complex encroaching on all of the streams and tributary drainages.

The proximity of the Cedar and Green Rivers, plus the Lake Washington-Sammamish Lake complex and the larger independent streams, to the large Seattle metropolitan area promotes these waters for extensive outdoor recreation and related facilities. Associated with increased population and more leisure time, it is anticipated that sport fishing pressure within the Basins will accelerate at a rate much greater than that of the population growth. In the

PHOTO 9-4. As residential expansion moves to the lakeshore the future of general public access is at stake. (Washington Department of Game photo)

salt-water areas, particularly Shilshole and Elliott Bays, there will be a marked increase in demand by sport fishermen. Salmon stocks from the Green River, Cedar River, and Lake Washington will be intensively sought by commercial fishermen in adjacent waters open to such a fishery.

RESOURCE DEMANDS AND NEEDS

Marine waters of the Basins support a relatively light commercial fishery for salmon. A large portion of the salmon originating from the Green River-Lake Washington complex is harvested by sport and commercial fisheries outside of the Basins. Sport fishing for salmon is very popular, with Elliott and Shilshole Bays the most productive marine areas. Fresh-water angling for salmon is permitted in Lake Washington, Sammamish Lake, and the Sammamish River, as well as the Duwamish River and the Green River downstream from the East Valley Highway Bridge. Each year there is additional sport fishing pressure in these areas.

Exceptional sockeye salmon runs have developed in the Cedar River-Lake Washington system in the past few years and approximately 190,000 adults returned to these spawning grounds in 1967. There will be additional commercial net fishing pressures by both Canadian and Washington fishermen to harvest this particular stock of salmon. Such catches represent a highly significant contribution toward meeting overall demands for fish resources. As these demands continue to increase, it will be necessary to develop projects and implement programs that will best utilize the production potential within these Basins.

Commercial harvest of marine fish and shellfish is restricted primarily to heavy shipping and boat traffic. The sport fishery for these species also is curtailed considerably. Sport harvest has increased sharply in the past few years and there are increasingly strong demands for better facilities, such as fishing piers and beach access. There is also an immediate need to increase shellfish production on the available public beaches to meet the intensive sport pressure.

People of the Basins exert great demands on the game fish recreation potential of the vast water resources. Additional pressure is exerted on these resources by residents of adjacent basins. Based on county use values, approximately 10 percent of all Basin harvest and utilization of game fish other than steelhead is by people from outside these Basins. Resident game fish in lowland lakes attract large numbers of sportsmen. Alpine lakes also play a vital role in fishing recreation. In addition, one very large steelhead stream, Green River, offers excellent game fish recreation. It is estimated that, by 1980, Basin lakes must support an additional annual harvest of 786,250 trout and 241,600 game fish of other species. This is an increase of 30 fish per surface acre. Similarly, streams must provide an additional 415,200 resident trout and whitefish and 2,750 steelhead to the creel annually. Table 9-7 indicates present and projected demands and needs for game fish in angler-days.

TABLE 9-7. Present and projected sport fishermen use (game fish) in Cedar-Green Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	634.7
1980	425.2	1,059.9
2000	606.3	1,666.2
2020	999.7	2,665.9

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish resources of the Cedar-Green Basins are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to these Basins.

Conflicting Land and Water Uses

(1) Releases of water from Howard A. Hanson and Cedar Falls Dams for low flow augmentation and flood control storage are not synchronized and coordinated with fish needs.

(2) Indiscriminate building of industrial plants and private residences in the flood plain zone requires special flood control protection. This frequently leads to emergency measures which alter the river channel or encroach on the river boundaries and reduce the area for fish production (i.e., all Cedar River, Green River, and Lake Washington-Sammamish Lake tributary streams). Such development also limits public access to these fishing waters and increases water quality deterioration potential.

(3) Removal of gravel and streambed materials reduces spawning areas and causes continuous bedload movement during high-water periods. Egg mortalities are extreme in areas where shifting gravel conditions are created by gravel removal. The loss of suitable gravel from bars forces superimposition of eggs on the remaining areas. This is a particularly serious situation in the Cedar River and small Lake Washington-Sammamish Lake tributaries. Significant numbers of fry and fingerlings invariably are trapped in the pits and pockets left by gravel excavations on the riverbanks and are lost when rivers recede.

(4) The development of residential areas on farmlands along Lake Washington-Sammamish Lake tributary streams encroaches upon, and degrades the stream environment. New roads and dikes associated with these developments destroy the protective trees, brush, and streambank cover. Access to lakes is restricted by residential developments.

(5) Fish-passage facilities and attraction waters at the Lake Washington Ship Canal and Hiram M. Chittenden Locks should be improved to reduce delay of returning adult anadromous fish.

(6) The projects being considered for the Cedar-Green Basins such as levee construction on the lower Cedar River, bank protection projects on Lake Washington-Sammamish Lake tributaries, flood control and land drainage projects, and the waterway extension on the Green-Duwamish River may conflict with fish needs.

(7) Navigation requirements for channel straightening of the Duwamish River and changes inherent in road construction would reduce fish rearing and food production.

Poor Water Quality

(1) Intermittent and seasonal pollution in the lower Duwamish River results in water quality below that required for fish life. Effluents from agricultural, industrial, and domestic sources are particularly detrimental to aquatic life. The buildup of sludge in the estuary limits shellfish and marine fish. A dissolved oxygen deficiency barrier occurs in the lower river during the late summer-fall low flow period each year. Dissolved oxygen levels are well below those required to sustain fish life. Such conditions cause serious delays in upstream migrations and could conceivably eliminate an entire year class.

(2) Salt-water intrusion into the Lake Washington Ship Canal, including Salmon Bay and Lake Union, through the operation of the Hiram M. Chittenden Locks alters the fresh-water environment of the area and poses a potential threat to fish production.

(3) Summer low flow temperatures in the Sammamish and Duwamish Rivers often exceed the upper tolerance limits for salmonids and directly influence fish production.

(4) Thermal powerplants would require large amounts of cooling water and could destroy vital fish habitat.

Social and Psychological Considerations

(1) Closed watersheds for municipal water supply preclude realizing the fishery use potential for the Basins. All of the upper watersheds' streams and reservoirs are needed to meet demands. Enlargement of flood and municipal water storage projects would further compound the problem.

(2) Demand on the productive capacity of the lakes will increase with fishing pressure and result in lower success rates and increasingly crowded public access areas. Exceptions to this exist at Lake Washington and Sammamish Lake.

MEANS TO SATISFY NEEDS—FISH

To satisfy expected large increases in demand for fish and shellfish will require activation of various potential developments in the Cedar-Green Basins. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential enhancement projects for anadromous fish include using areas such as the Cedar River upstream from the diversion dam near Landsburg, and the Green River upstream from Tacoma City Light's diversion dam at Kanaskat for fish production. Also, the reservoirs and upper watersheds on the upper Cedar and Green could be utilized. Fish production from these waters could replace losses occurring on many of the lowland streams through man's encroachment.

Fish-passage facilities at the Chittenden Locks and Lake Washington Ship Canal should receive priority in order to safeguard and perpetuate the anadromous fishes of the Basins.

Summer and early fall low flow augmentation should be provided for the Cedar River in order to increase stream rearing during this period. Flow increases should be sufficient to insure maximum spawning area for chinook and sockeye salmon. Increased fish flows in the Green River from releases at Howard A. Hanson Dam are also desirable. This increase would provide better transportation conditions for returning adults, increase the available spawning area throughout the river, and reduce the low oxygen problem in the lower Duwamish River which is at a critical level during August and September. In addition, increased flow would enhance the rearing area of fingerling salmon.

Additional storage behind Howard A. Hanson Dam and controlled releases would provide fish flows during low flow periods and eliminate much flooding.

Potential artificial propagation in the Cedar-Green Basins includes development of hatcheries, eyed-egg incubation facilities or spawning channels, and creation of off-river rearing areas through the construction and operation of impoundments. Spawning channel development could bring about reestablishment of pink salmon in the Green River. Suitable land and water sources are available for such facilities along sections of the Cedar River and its Rock Creek tributary, and on Issaquah Creek, plus the Green River and its tributaries–Big Soos, Newaukum, Burns, and Crisp Creeks.

One enhancement program would include setting rigid controls on removal of water, for any purpose, from natural flowing streams upstream from major fish production habitat. Special attention should be accorded a study for the use of dual water systems for the large metropolitan areas. Such systems could also utilize water from Lake Washington or from the lower Duwamish River.

Streambed controls could be achieved through selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools and riffles where they are now unstable or absent. Priority areas for this type of development include the Sammamish River, and Burns and Crisp Creeks on the Green River.

Additional enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish, including control of forest and agricultural spraying; curtailing the disposal of untreated municipal and industrial wastes, and further control of salt-water intrusion in Lake Washington Ship Canal; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to insure protection of fish habitat; (3) institute a permanent flood plain zoning plan that would protect streambeds and adjacent lands from unnecessary changes damaging to aquatic habitat; (4) guide management to promote effective regulation of all fisheries, and provide necessary changes in fishing areas and harvest methods to yield greater maximum benefit from available stocks; (5) perform studies and obtain information necessary to achieve the most efficient management possible, including basic water chemistry data for the Cedar River-Lake Washington complex and the Green-Duwamish Rivers; (6) derive techniques for removing silt and decompacting riverbed gravel over large stream sections; and (7) determine specific streamflows (from river cross section measurements) to ascertain flow levels necessary for fish, and to provide methods and techniques for altering streamflow and streambed conditions to increase the productive capacity of the habitat. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, are listed in Table 9-8. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

MARINE FISH

Enhancement projects for marine fishes could include creation of additional production habitat

TABLE 9-8. Tentative flow schedule required to maintain fish production levels, Cedar-Green Basins

Stream[1]	Flows (cfs) by Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Cedar R. (Point near Renton)	350	700	1,000	1,000	1,000	900	900	900	700	350	250	250
Sammamish R. (Bothell)	150	250	500	600	700	600	500	300	200	125	100	110
Green R. (Point near Auburn)	800	1,300	2,000	2,000	1,800	1,600	1,900	1,900	1,500	800	500	500
Newaukum Cr.	30	80	125	125	110	90	75	50	40	25	20	20
Big Soos Cr.	35	80	150	200	200	180	150	100	65	40	30	30

[1] Locations are existing U.S. Geological Survey gaging stations.

through selective placement of rock jetties or submerged automobile bodies. Such a program would facilitate development of new fishing areas to meet the rapidly developing sport fishing demand. Another program benefiting these fishes is to continue monitoring of water quality controls on the lower river and the estuarine waters of the Duwamish River and Elliott Bay. Without such controls a drastic reduction in marine fish populations is foreseen.

Natural production is adequate at present, but when demand for these fish increases enough to warrant artificial propagation it will be instituted. The development of fishing piers and facilities for marine fish angling along the Seattle waterfront should be stressed. Such facilities could be incorporated into boat storage and marinas as well as shipping piers.

SHELLFISH

Potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. Special emphasis should be directed toward providing more salt-water public beach areas and access, and to increasing shellfish stocks that have been depleted or are being overexploited.

SUMMARY–ANADROMOUS FISH, MARINE FISH, AND SHELLFISH

The Cedar-Green Basins offer numerous opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of the habitat, and provide for increased angler use. In order to meet future demands a number of these potential developments must be undertaken. Major proposals, and an indication of priority, are categorized in Table 9-9, and defined by stream in Table 9-10.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the developments listed. Nearly all of the major proposals are goals of long-range planning programs, and are acted upon as monies, manpower, and time permit.

A number of these potential developments are included in a preliminary plan for increasing salmon production levels to meet overall Pacific Northwest demands for fish resources in future years. These proposals, and salmon production increases, are indicated by target years in Table 9-11.

Table 9-12 shows estimated annual benefits in terms of sport and commercial harvest for the same projects. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate, and needs are not so critical as for salmon.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Thermal powerplants should be located and operated to prevent destruction of fish and fish habitat.

Flood control should be coordinated with flood plain zoning on the two major rivers. Flood lands should be zoned for agriculture and outdoor recreation, not industrial or urban use. Urbanization and industrialization will undoubtedly destroy much lowland fish habitat. Control of development of these areas would help save fish habitat in lowland tributary streams.

Watersheds closed to public use must be opened to supply future demands for fish. Regulated angling should be a top priority program in any basin plan, particularly on waters designated for single purpose use.

Water storage must be developed so as not to destroy fish potential of major streams.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

Public access to streams and lakes must be assured. There appear to be adequate water areas to meet a large portion of the demand for game fishing, if access is assured and recreation areas are developed.

TABLE 9-9. Potential developments for production and use of salmon, marine fish, and shellfish, Cedar-Green Basins

Beneficial Development	Priority		
	Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Provide fish-passage facilities at SCS pumping stations	X		
Expand Green River, Issaquah hatchery facilities	X		
Revise Chittenden Locks fish-passage facilities	X		
Provide salt-water wedge control in Lake Washington	X		
Develop marine fish production habitat	X		
Plant salmon upstream from obstructions	X	X	
Improve stream and streambed conditions	X	X	X
(2) Acquisition			
Determine and evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop 3 salt-water public access sites	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Procure riverbank public access lands	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Develop subtidal park for skin divers		X	
Monitor Duwamish River water quality	X	X	X
Implement fishery management regulation changes	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities on streams, i.e., gravel removal, flood control	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Stream fertilization		X	
Gravel cleaning and decompaction techniques	X	X	

TABLE 9-10. Potential beneficial developments for fish, Cedar-Green Basins

Stream	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Sockeye	Steelhead	Searun Cutthroat	Resident Trout
	Enhancement Measure									Species Benefited							
Lake Washington																	
Drainages																	
Mercer Slough Cr.		X									X			X	X	X	X
Coal Cr.		X									X				X	X	X
May Cr.		X							X		X				X	X	X
Juanita Cr.		X									X				X	X	X
Sammamish R.		X	$\boxed{X}$		$\boxed{X}$				X		X			X	X	X	X
Swamp Cr.		X	X								X			X	X	X	X
North Cr.		X						X	X		X				X	X	X
Bear Cr.		X	X						X		X				X	X	X
Big Bear Cr.		X						X	X		X				X	X	X
Sammamish Lake																	
Tibbetts Cr.		X									X				X	X	X
Issaquah Cr.		$\boxed{X}$		X	X		X	X	X	X	X			X	X	X	X
Cedar R.	$\boxed{X}$	X		$\boxed{X}$	$\boxed{X}$		X	X	X	X	X			X	X	X	X
Downs Cr.		X									X				X	X	X
Rock Cr.		X				X	X	X	X		X				X	X	X
Duwamish R.					$\boxed{X}$					X	X		X		X	X	X
Black R.		X									X		X		X	X	X
Spring Brook Cr.		X									X				X	X	X
Hill Cr.		X									X		X		X	X	X
Green R.	X			$\boxed{X}$	$\boxed{X}$	X	X	X	X	X	X	X	X		X	X	X
Big Soos Cr.		X					X	X	X	X	X	X	X		X	X	X
Burns Cr.		$\boxed{X}$	$\boxed{X}$					X			X	X	X		X	X	X
Crisp Cr.		$\boxed{X}$	X					X			X	X	X		X	X	X
Newaukum Cr.		X				X	X	X	X		X	X	X		X	X	X
Independent																	
Drainages																	
Miller Cr.		X									X		X		X	X	X
Bow Lake Cr.		X									X		X		X	X	X
Joes Cr.		X					X	X			X		X		X	X	X

$\boxed{X}$ Priority project.

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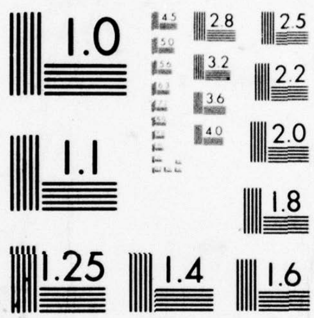


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 9-11. Estimated total salmon production increases in Cedar-Green Basins by project or program, to satisfy needs[1]

Project or Program, and Year	Species and Number				
	Chinook	Coho	Pink	Chum	Sockeye
Pre-1980					
Ladder barrier dam, Cedar R.	800	5,000	--	--	111,000
Supply flood control and augment flows, Green R.	2,200	3,500	--	1,200	--
Supply flood control and augment flows, Cedar R.	1,000	1,500	--	--	32,600
Subtotals	4,000	10,000	--	1,200	143,600
1980-2000					
Provide fish passage, Green R., 25 stream miles	2,800	11,000	--	--	--
Improve fish habitat, 22 streams, 51 stream miles	800	14,400	--	--	10,000
Clear and improve Burns and Crisp Crs., 2 stream miles	--	2,300	--	1,600	--
Clear channels, 3 streams, 6 stream miles	100	1,200	--	--	--
Construct spawning channel, 1 mile	--	--	60,000	90,000	--
Subtotals	3,700	28,900	60,000	91,600	10,000
2000-2020					
Construct 4 hatcheries or equivalent	18,000	178,500	--	--	--
Develop rearing facilities, 35 acres	12,000	29,800	--	--	--
Develop spawning channel, 1 mile	--	--	--	--	150,000
Subtotals	30,000	208,300	--	--	150,000
Totals	37,700	247,200	60,000	92,800	303,600

[1] Average annual production (catch plus escapement) at end of each period.

TABLE 9-12. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, Cedar-Green Basins

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Annual Benefits: Commercial Harvest: Value: To Fishermen	Annual Benefits: Commercial Harvest: Value: Retail	Annual Benefits: Sport Harvest: No. of Fish	Annual Benefits: Sport Harvest: Value: Federal	Annual Benefits: Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Ladder barrier dam, Cedar R. 2/	63,400	$170,500	$ 482,200	800	$ 4,800	$ 22,400	$ 48,000	$1,000
Supply flood control and augment flows, Green R.	4,000	16,200	34,600	1,000	6,100	28,400	3/	3/
Supply flood control and augment flows, Cedar R.	25,300	52,500	147,400	500	2,700	12,600	3/	3/
Subtotals	92,700	$ 239,200	$ 664,200	2,300	$13,600	$ 63,400	--	--
1980-2000								
Provide fish passage, Green R., 25 stream miles	8,800	$ 32,600	$ 67,100	2,100	$ 12,300	$ 57,600	$ 700,000	$ 30,000
Improve fish habitat, 22 streams, 51 stream miles	17,500	47,600	106,600	1,900	11,300	52,800	151,500	3,000
Clear and improve Burns and Crisp Crs., 2 stream miles	2,400	7,200	14,100	300	1,600	7,500	7,600	300
Clear channels, 3 streams, 6 stream miles	900	2,900	5,600	200	1,000	4,500	1,100	1,100
Construct spawning channel, 1 mile	92,700	243,700	657,300	2,200	12,900	60,200	700,000	14,000
Subtotals	122,300	$334,000	$850,700	6,700	$39,100	$182,600	$1,560,200	$48,400
2000-2020								
Construct 4 hatcheries or equivalent	140,400	$478,900	$ 953,600	28,000	$ 168,000	$ 783,900	$ 4,080,000	$ 240,000
Develop rearing facilities, 35 acres	28,300	112,100	236,400	7,000	44,900	209,700	192,500	35,000
Develop spawning channel, 1 mile	125,000	242,500	702,500	--	--	--	700,000	14,000
Subtotals	293,700	$833,500	$1,892,500	35,000	$212,900	$993,600	$4,972,500	$289,000
Totals	508,700	$1,406,700	$3,407,400	44,000	$265,600	$1,239,600	--	--

1/ Anadromous trout benefits not included.

2/ Joint project with Washington Department of Game. Part of costs included in those shown in Table 9-13.

3/ Multipurpose project. Separable costs, if any, have not been determined.

It will be extremely difficult to meet all these Basins' future outdoor recreation needs due to their tremendous population and land requirements. Therefore, other basins and areas of the State must absorb any slack.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Public fishing access areas are proposed for Sammamish, Cottage, Echo (Highway 99), Bass, Deep, Kathleen, Lucerne, Pipe, Panther, Paradise, Ravensdale, Retreat, Star, Tradition, Webster, Jones, Moneysmith, Ballinger, Crystal, and Ruggs Lakes and Lake McDonald. Ultimately, all significant lakes and key portions of streams, estuaries, and salt-water areas should have assured public fishing access.

(3) Streambank angler access on 60 miles of major rivers and tributaries (of a total of 275 miles) should be acquired and developed, as funds become available.

(4) Municipal watersheds should be opened for public use to permit meeting a portion of the demands for fishing.

(5) Boat launch or fishing access areas are proposed for the Lake Washington Ship Canal immediately downstream from the Hiram M. Chittenden Locks and for one other selected salt-water area.

(6) The Sammamish River could be developed to provide better pool and riffle habitat for resident and anadromous game fishes. Water withdrawal restrictions to protect the existing fishery should be enforced on Issaquah and Newaukum Creeks, and fish passage and screening should be provided between the Landsburg and Cedar Falls Dams on the Cedar River.

(7) Spawning channel and propagation sites are recommended for Rock and Madsen Creeks in the Cedar Basin.

(8) Storage at Howard A. Hanson Reservoir should be manipulated to further increase summer flows on the Green River. Redistribution of mean monthly flows on the Cedar River should also be accomplished.

(9) Spawning and rearing facilities to provide an additional 1,125,000 trout annually in lakes and streams should be developed.

(10) A steelhead rearing pond complex should be constructed on the Green River.

(11) New fish toxicants that are effective, detoxify rapidly, and are specific as to species should be developed.

(12) New techniques for lake and stream fertilization to increase fish production should be developed.

(13) Interest in spiny-ray fishing should be stimulated by education and public relations.

(14) Fish population analyses should be continued on main rivers and tributary streams to determine areas where management practices should be implemented.

(15) Fish disease and parasite control programs should be developed for lakes, permitting increased survival of game fish.

(16) Programs involving the return of all diverted water, surplus to pipeline needs, to the stream of origin rather than to an adjoining drainage should be implemented.

(17) Municipal watersheds should be opened for public use to permit meeting a portion of the demands for fishing.

Table 9-13 shows estimated annual benefits and costs of specific projects and programs proposed for the Cedar-Green Basins to satisfy needs for game fish prior to 1980. These are, in a sense, alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Subsequent proposals have not been evaluated nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table.

TABLE 9-13. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Cedar-Green Basins, pre-1980

Project or Program	Annual Benefits: Angler-Days	Annual Benefits: Value	Costs: Capital	Costs: O&M (Annual)
Lakes				
Acquire and develop public access, 21 lakes	40,000	$ 80,000	$ 357,000	$ 4,800
Develop new fish toxicants and lake fertilization techniques	109,000	218,000	20,000	20,000
Stimulate interest in spiny-ray fishing	100,000	200,000	5,000	--
Develop fish disease and parasite control program	50,000	100,000	50,000	--
Open closed watersheds for fishing	20,000	40,000	--	--
Construct fish hatchery	1/	1/	180,000	15,000
Subtotals	319,000	$638,000	$612,000	$39,800
Streams				
Install fish passage and diversion screening, Landsburg Dam	2,000	$ 10,000	$ 27,000 2/	$ 3,000
Construct propagation developments, including spawning channel in Cedar R.	4,000	20,000	170,000	7,500
Construct steelhead rearing pond complex, Green R.	75,000	375,000	215,000	37,500
Acquire and develop public access, main river (50 stream miles), tribs. (10 stream miles)	10,000	30,000	1,535,000	5,000
Construct fish hatchery	67,100	201,300	1,900,000	87,500
Subtotals	158,100	$636,300	$3,847,000	$140,500
Salt Water				
Acquire and develop public access, 2 areas	23,000	$ 69,000	$ 60,000	$ 2,000
Subtotals	23,000	$69,000	$60,000	$2,000
Totals	500,100	$1,343,300	$4,519,000	$182,300
Lakes (Alternate to above lake proposal)				
Acquire and develop public access, 21 lakes	40,000	$ 80,000	$ 357,000	$ 4,800
Stimulate interest in spiny-ray fishing	100,000	200,000	5,000	--
Open closed watersheds for fishing	20,000	40,000	--	--
Construct fish hatchery	90,000	180,000	1,500,000	125,000
Subtotals	250,000	$500,000	$1,862,000	$129,800

1/ Included with benefits from other projects and programs.

2/ Joint project, $48,000 cost included in that shown under Salmon Enhancement Program (Table 9-12). Total capital cost $75,000.

Projects and Programs, 1980-2000

(1) Expand hatchery facilities.

(2) Construct and manage a searun cutthroat rearing pond.

(3) Install municipal water treatment facilities concurrently with provision of public fishing access to closed watersheds.

(4) Continue fisheries research.

(5) Complete programs and projects contemplated prior to 1980 but not completed.

(6) Investigate biological control of spiny-rayed game fish.

(7) Develop new projects and programs as required.

(8) Construct fishing piers at Lake Washington and Sammamish Lake.

Projects and Programs, 2000-2020

(1) Complete projects and programs not completed prior to 2000.

(2) Undertake research to develop and enhance the fishery for game fish in Lake Washington and Sammamish Lake.

(3) Develop new projects and programs as required.

Approximately 169,000 acres of the Cedar-Green Basins are under U.S. Forest Service administration. Projects and programs proposed by this agency are indicated in Table 9-14. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 9-14. Fishery enhancement projects and programs of U.S. Forest Service proposed for Cedar-Green Basins, 1980-2020

		1980		2000		2020	
Project or Program	Unit	Number	Capital Cost	Number	Capital Cost	Number	Capital Cost
Conduct stream surveys	mile	17	$ 500	1/	1/	1/	1/
Clear stream channels	mile	4	8,000	8	$16,000	8	$16,000
Remove debris from lakes	acre	19	19,000	--	--	--	--
Total			$27,500				

1/ Not scheduled as yet, but expected to be similar to 1980 data.

PRESENT STATUS—WILDLIFE

INTRODUCTION

The Cedar-Green Basins demonstrate the extreme effect of urban and industrial development on wildlife. The area in its natural state had a high wildlife potential due to an abundance of natural water areas and mild climate, but extensive home and industrial site development necessary to accommodate over a million people has greatly reduced wildlife habitat. Extensive municipal watershed closures on both the Cedar and Green Rivers seriously restrict utilization of the existing wildlife resource.

BIG GAME

Black-tailed deer, elk, bear, mountain lion, and a limited number of mountain goat inhabit the timbered area of the Basins. Deer are by far the most numerous and widespread of the big-game animals, but elk and black bear—although usually requiring slightly more remote areas—are also common.

Inventory and Distribution

Black-tailed deer are distributed throughout the remaining forest land but are most prevalent on the medium-low elevation foothills. Areas of highest density extend generally south from Tiger Mountain, including the vicinity of Hobart, Maple Valley, Black Diamond, and Enumclaw (Figure 9-2). The current deer population is estimated at 7,000[1]; however, evidence indicates numbers may be declining.

The elk are descendents of 80 animals introduced from Montana in 1912. These animals were released in the vicinity of Enumclaw and were the nucleus of the present White (Puyallup Basin), Green, and Cedar Rivers' herds. Within the Cedar-Green Basins, the bulk of the herd of about 400 ranges primarily in the watershed of the Green River, but increasing reports of elk in the Cedar River drainage indicate a growing herd in that area (Figure 9-2).

Although the Cedar and Green River drainages head in the rugged Cascade Range, rocky, precipitous slopes required by mountain goat are very limited. Small numbers of these animals occur there, but may not be year round residents.

Black bear inhabit the more secluded sections of the Basins' woodlands, yet are widespread, ranging in distribution from the low rolling foothills to high alpine meadows. A population of 600 to 700 is estimated.

Up to ten mountain lion may occur within the Basins. These animals are restricted to remote areas and are never numerous in comparison with other big game.

Limiting Factors

Big-game numbers are regulated by the amount and quality of their lowland winter habitat. A major portion of the land area below 2,000 feet has been diverted to urban and industrial use, which precludes big-game use.

Logging and other forest management practices also influence big-game populations such as deer, elk, and bear. Most current logging occurs above the 2,000-foot level, and previously logged areas are growing beyond the stage of optimum forage production, resulting in a gradual decline in big-game carrying capacity. Various other factors limiting big-game populations are discussed in the Area chapter, Present Status-Wildlife.

[1] Game numbers vary throughout the year; therefore, figures designate late September-early October populations.

Production

Doe-fawn ratios determined just prior to the hunting season indicate an increase of 1,800 deer over the spring population.

Elk are scattered over a large area, much of which is closed to hunting. Based upon a near-constant harvest in the open hunting area and indicated increases within the Cedar River municipal watershed closure area, an annual production of 80 to 100 young is indicated.

Studies of black bear indicate an annual reproduction rate of 25 to 30 percent, which would be 125 to 180 young.

Harvest

Five years of harvest data (1961-1965) reveal an average annual deer harvest of 900 animals, providing approximately 18,000 hunter-days.

The elk herd in the upper Green River drainage has provided a harvest of approximately 60 animals each year. Elk hunting stimulates over 2,300 hunter-days annually.

Limited harvest data available indicate an average annual harvest of 75 to 80 bear. Bear hunting provides about 600 hunter-days each year.

Records of mountain lion hunting within the Basins show only an occasional animal taken, indicating a rather limited population. An estimated 100 man-days annually are spent hunting them.

Deer, elk, bear, and mountain lion hunting creates a total of 21,000 man-days of highly prized outdoor enjoyment in the Cedar-Green Basins annually.

Harvest of the big-game resource is seriously restricted by complete closure to recreational use of the upper Cedar River watershed by the city of Seattle and almost complete closure of the Tacoma municipal watershed on the upper Green River. Combined, these municipal closures amount to 242,000 acres, which is half of the remaining natural wildlife habitat in the two Basins.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

The present elk herd is the result of a transplant of 80 head from Montana in 1912.

Other beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

The varied species of upland game are the most widely distributed of the major game groups. Native species utilize the remaining native habitat and introduced exotics have been established in the area devoted to agricultural use. The introduced varieties include cottontail, ring-necked pheasant, California quail, and a few gray partridge and mountain quail. Native upland game are blue and ruffed grouse, band-tailed pigeon, mourning dove, and snowshoe rabbit (Photo 9-5). Both the native and exotic species have suffered from extensive habitat losses through urban and industrial expansion. The introduced species which require conditions created by man—agriculture or a variety of cultivated garden crops—are more tolerant of human activity and persist in numerous, relatively small, remaining cover areas throughout the perimeter of concentrated urban development.

PHOTO 9-5. Band-tailed pigeon—a migratory game bird which nests and remains through early fall. (Washington Department of Game photo)

Inventory and Distribution

Grouse are the most numerous upland-game birds and both species are distributed throughout the Basins wherever suitable habitat exists. A ruffed grouse population of 40,000 and a blue grouse population of 20,000 are projected on the basis of current density studies.

An estimated population of 12,000 pheasants inhabits the Basins, with highest densities occurring between Auburn and Tukwila (Figure 9-1). Pheasants persist throughout the agricultural land and in some areas occur near concentrated urban development.

California quail require slightly more diversified habitat than pheasant and are more inclined to populate fringes of intensively farmed land or the edge of residential communities. Although many urban residents encourage quail, these birds sometimes constitute a problem to those persons raising vegetable gardens. The Basins' quail population is estimated at 2,500 birds.

The populations of band-tailed pigeon and mourning dove were not determined.

One or both of the rabbit species inhabit nearly every vegetative habitat type present. The cottontail is directly associated with agricultural activity and numbers are influenced by the quantity of edge and fence row cover created by diversified farming. Snowshoe are confined to typical evergreen-hardwood forests. The rabbit population was not determined.

Limiting Factors

Continued habitat reduction is the prime factor limiting upland-game numbers. Urban and industrial development to accommodate the largest metropolitan center of the State has completely altered the vegetative environment over an extensive area.

Effective wildfire control and reduced emphasis on slash burning after logging adversely affect native upland game and mountain quail numbers.

Band-tailed pigeon limiting factors are discussed in the Area chapter, Upland Game.

Production

Grouse production is estimated at 21,000 ruffed and 12,000 blue each year. Wild pheasant production averages 7,500 annually, and an increment of 2,000 quail is expected from the present population.

Actual production of band-tailed pigeon, mourning dove, rabbit, and gray partridge is undetermined.

Harvest

The Basins' grouse harvest of about 5,000 birds consists of 4,000 ruffed and 800 blue grouse. This provides over 8,500 hunter-days. An average of 2,500 pheasant and 400 quail is harvested annually as a result of 4,000 hunter-days in the field. Rarely are the beautiful mountain quail taken by sportsmen. These birds frequent thick, brushy areas which hampers hunting. Over 7,700 band-tailed pigeon and 2,800 mourning dove are taken, providing an additional 7,000 hunter-days.

Harvest and recreational use of the resource are seriously restricted by the municipal watershed closures on the upper Cedar and upper Green Rivers.

Game harvest questionnaires indicate a harvest of 1,500 rabbit involving over 800 hunter-days. Most rabbit hunting is for cottontail–snowshoes are rarely taken. Upland-game hunting represents over 20,300 hunter-days annually.

Propagation

Game farm pheasant and other exotic game-bird releases common in other basins have been virtually discontinued in the Cedar-Green Basins due to increasing habitat losses.

Five private game breeders are licensed to commercially raise pheasant, chukar, and quail as well as various waterfowl species.

Beneficial Developments

Liberalization of hunting seasons to allow better utilization of the resource has been the principal change in management over the past several years.

Information concerning exotic species introduction appears in the Area chapter, Upland Game.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 232 acres of wildlife habitat development and 7,273 acres of wildlife habitat preservation, all located in agricultural areas of the western portion of the Basins.

FUR ANIMALS

Fur animals include a wide variety of species with varied habitat requirements. Those most highly prized for their pelt value–beaver, muskrat, mink, and river otter–require lowland water-associated vegetation in which to live and forage. The Cedar-Green Basins were richly endowed with lakes, low gradient streams, and shallow water areas containing an abundance of natural marsh and riparian habitat. Unfortunately, it is these areas which have been most highly developed for industry, resulting in a reduced fur-animal potential.

Inventory and Distribution

Beaver, muskrat, mink, river otter, raccoon, and nutria occur in and along lowland watercourses and sloughs. Red fox, opossum, weasel, and skunk inhabit valley lands primarily, and bobcat and coyote occur in the foothills. The high remote region of the Cascade Range is inhabited by lynx and marten. Individual fur-animal population estimates are: 700 (beaver); 25,000 (muskrat); 500-600 (mink); and 75-100 (river otter). Other fur-bearer populations were not determined.

Limiting Factors

Man's influence on fur-animal habitat is the foremost factor affecting population levels. Industrial and urban development and associated flood control, draining, and riprap projects effectively reduce the potential of land and water areas for fur bearers. The fur animals most highly prized by the fur industry–beaver, muskrat, mink, and river otter–are most seriously affected by such developments.

Production

Fall beaver populations consist of 30 to 40 percent young of the year, which indicates an average annual production of about 250 animals. Muskrat, like many other rodents, is a prey species–being the food of a wide variety of other animals. Thus, nature has provided it with a high reproductive rate. Basin production is estimated at 20,000. Annual mink production is estimated at 300 to 350. Other members of the fur-animal group have reproduction rates similar to that of mink.

Harvest

Annual beaver harvest has fluctuated subsequent to the 1963 legislative change, but no definite trend is indicated. The average catch over the past four seasons (1963-1964 through 1966-1967) has been 140.

In recent years, about 2,580 muskrat, 110 mink, and 10 river otter have been trapped each year. Other fur animals are taken only incidentally. It is doubtful if any of the fur bearers other than beaver and possibly river otter are being harvested to the full extent of their potential. Income derived from trapping during the 1965-1966 season totaled about $8,000.

Propagation

The Cedar-Green Basins, perhaps because of their proximity to the major market center, Seattle, contain a high percentage of privately operated fur farms. Within recent years, 36 private ranches have engaged in the commercial production of mink.

Beneficial Developments

Beneficial developments are described in the Area chapter, Fur Animals.

WATERFOWL

The Cedar-Green Basins have all the natural attributes that constitute a high waterfowl use area. However, many of these same features–protected salt-water shoreline, flat bottomland, and a wealth of low elevation lakes and meandering streams–encourage urban and industrial expansion, resulting in the development of the largest metropolitan center in the State. Waterfowl are affected more than any other major wildlife group by such concentrated urban development. Loss of native marsh and conversion of valley bottomland to industrial use have seriously reduced waterfowl use.

Inventory and Distribution

The Green River valley and surrounding area in the vicinity of Auburn and the Sammamish River valley between Sammamish Lake and Lake Washington are the major remaining high waterfowl concentration areas (Figure 9-2). The majority of the waterfowl using the Cedar-Green Basins are fall and winter migrants. January waterfowl counts reveal an annual average of 18,500 waterfowl. Prior to this mid-winter survey, waterfowl have been exposed to almost three months' hunting.

Limiting Factors

Vast urban and industrial development of the greater Seattle area, including the Kent-Auburn valley, has greatly reduced waterfowl habitat. Development of waterfront property, marsh drainage, and flood control measures eliminate native waterfowl vegetation and industrial expansion into the valley farmlands reduces feed resulting from agricultural crop production.

Production

As noted previously, production is not the most important use of the area by waterfowl. Numbers of locally raised ducks in comparison with winter migrants are small. A recent inventory reveals an average annual production of 6,700. Mallard predominate with wood duck and teal next in order of abundance.

Harvest

Although certain areas in the Green and Sammamish River valleys provide consistent duck hunting, the waterfowl harvest in the Cedar-Green Basins is more the result of the opportunist. Individuals "pot" birds on the various lakes–not closed to shooting due to concentrated residential development–and on numerous other water areas when the opportunity arises. Recent years' harvest records indicate an average annual harvest of 18,400 ducks and 350 geese, resulting in about 13,400 hunter-days.

Propagation

Four private game breeders list waterfowl among the variety of birds raised. These birds are domesticated wild strains raised for commercial purposes and do not contribute to the wild duck population or waterfowl hunting.

Beneficial Developments

No management areas or artificial facilities are maintained in the Basins to enhance wild waterfowl production or harvest.

Conservation practices applied by private landowners to agricultural lands of direct benefit to waterfowl include 31 acres of wildlife wetland development and 106 acres of wildlife wetland preservation, all located in agricultural areas of the western portion of the Basins.

OTHER WILDLIFE

The many and varied birds and animals in the Basins not classed as game or fur species are classified as other wildlife (Photo 9-6). This faunal group is discussed in the Area chapter.

PHOTO 9-6. The pine squirrel is a fascinating part of the outdoor experience. (Washington Department of Game photo)

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

The demand for wildlife-oriented recreation by Basin residents far exceeds the supply. Currently, less than 10 percent of the hunting by residents occurs within the Basins. As population pressures increase, the demand for remaining open space and outdoor recreation opportunity within a reasonable distance will increase at an accelerated rate.[1] Non-hunting use of the wildlife resource will experience a considerable rise in popularity and surpass hunting.

Although birds and game animals may not be taken from the wild for commercial purposes, sale of game birds and certain game animals produced domestically by authorized game breeders is permitted. An increase in such activity is anticipated.

The entire western portion of the Basins is almost completely enveloped in urban or industrial development. Some farming continues in the Kent-Auburn area of the Green River valley, although at present this lowland area is experiencing rapid industrial expansion resulting in a loss of waterfowl and fur-animal use of these lands.

To maintain the present level of hunting success in the Puget Sound Area, it will be necessary to provide an additional annual harvest of 900 deer; 50 elk; 75 bears; 4,700 grouse; 2,500 pheasants; 17,000 ducks; and 350 geese within the Cedar-Green Basins by the year 1980. As population, leisure time, and demand for outdoor recreation increase the demand for wildlife resources will increase proportionately. Table 9-15 illustrates this projected increase in hunter-days.

TABLE 9-15. Present and projected hunter use in Cedar-Green Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	54.6
1980	50.8	105.4
2000	65.5	170.9
2020	40.0	210.9

[1] Population forecasts shown in Future Needs—Fish.

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Cedar-Green Basins is to be satisfied. Problems and conflicts discussed in the Area chapter apply to these Basins.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basins during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 9-16 shows projects and programs proposed for the Basins to satisfy 1980 needs. Similar data for subsequent periods are not available, but a listing of probable projects for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include incidental recreation benefits that will accrue from public use of wildlife areas for swimming, boating, picnicking, hiking or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

TABLE 9-16. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Cedar-Green Basins, pre-1980

	Annual Benefits		Costs 1/	
Project or Program	Hunter-Days	Value	Capital	O&M (Annual)
General Programs				
Develop educational programs stressing renewable aspects and value of proper harvest of wildlife	17,000	$ 89,500	$ 5,000	--
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	4,000	16,000	--	$ 5,000
Develop compatible forest-wildlife management techniques, and study means of increasing recreational potential of wildlife	2/	2/	10,000	10,000
Specific Projects and Programs				
Develop program for recreation use of closed watersheds	12,000	70,000	--	--
Lease and develop 10 sites for pheasant releases and hunting	5,700	22,800	10,000	5,000
Acquire band-tailed pigeon concentration areas, 1,300 acres	10,400	41,600	15,000	1,000
Enlarge game farm to produce additional 5,000 pheasants	3/	3/	50,000	15,000
Totals	49,100	$239,900	$90,000	$36,000

1/ Do not include survey and plan costs.

2/ Benefits included under other projects and programs.

3/ Benefits included under leasing of pheasant release sites.

Projects and Programs, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Complete programs and projects not completed prior to 1980.

(3) Develop new projects and programs as required.

Projects and Programs, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

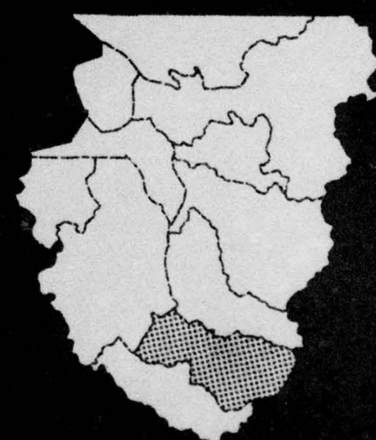
(2) Complete programs and projects not completed prior to 2000.

Table 9-17 indicates projects and programs for wildlife enhancement proposed by the U.S. Forest Service. Hunter-day benefits from these projects and programs have not been determined, but they will help satisfy overall demand.

TABLE 9-17. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Cedar-Green Basins, 1980-2020

		1980		2000		2020	
Project or Program	Unit	Number	Capital Cost	Number	Capital Cost	Number	Capital Cost
Surveys and Plans							
Conduct range analysis							
Deer	acre	74,800	$ 7,500	Survey and planning work is not carried forward to these time periods. Similar work here is probable.			
Elk	acre	74,800	7,500				
Mountain goat	acre	--	--				
Special	acre	--	--				
Conduct upland-game habitat surveys	acre	28,580	1,400				
Develop habitat management plans	each	8	4,000				
Big-Game Habitat Improvement							
Seed and plant forage	acre	370	37,000	360	$ 36,000	360	$ 36,000
Release forage	acre	432	10,800	840	21,000	420	10,500
Create permanent openings	acre	100	10,000	510	51,000	405	40,500
Develop waterfowl nesting facilities	each	12	600	10	500	--	--
Total			$78,800				

Puyallup Basin



PUYALLUP BASIN

PRESENT STATUS—FISH

HABITAT DESCRIPTION

Puyallup Basin has one major river system, four small independent drainages, 251 lakes and reservoirs (totaling 6,170 surface acres), and 48 farm ponds (24 surface acres) which support anadromous and/or resident fishes (Figure 10-1). Marine water influenced by the streams includes the heavily populated and industrialized area of Commencement Bay, Tacoma Narrows, and southern Puget Sound to Nisqually Flats. Shellfish and marine fishes are abundant in this environment, except in the industrial areas of Commencement Bay.

The Puyallup River originates on the southwest slopes of Mount Rainier. It moves northwest through a narrow valley before receiving the Mowich River from the east. The latter exhibits relatively steep gradient, numerous cascades, and few pool-riffle sections. A short distance downstream on the Puyallup is a major water-use development. The river then flows through a narrow canyon and exhibits numerous cascades and deep pools. Downstream from Electron to the Carbon River confluence, mountain type stream characteristics prevail for some distance, affording considerable pool-riffle area. The Carbon also originates on the rugged slopes of Mount Rainier and courses northwest to its junction with the Puyallup. Steep gradient, large rock, and numerous cascades characterize its upper reaches. The lower quarter offers spawning area highly suitable for fish use.

Downstream from the Carbon, the Puyallup meanders generally north to the confluence of the White River at Sumner. In this reach it contains numerous pools and riffles. The White also heads on Mount Rainier, flowing generally north to Greenwater and then generally west to Buckley. The upper reaches have steep gradient and considerable areas of large streambed rocks. Occasional pool-riffle sections exist near Buckley. Two water-use developments are located on the river in this reach. Downstream from Buckley, the river meanders northwesterly to Auburn then south to Sumner. This lower section provides considerable pool-riffle area.

Downstream from the White River, the Puyallup courses west-northwest to Commencement Bay. It offers numerous pool-riffle areas conducive to anadromous and resident fish production.

Each of the four independent drainages provides areas suitable for production of anadromous and resident fishes. The flows from each are important to the specific ecological makeup of the estuarine and marine environment in the vicinity of their confluence with salt water.

Four large lakes or reservoirs comprise over half the nonstream aquatic habitat. The largest of these—Lake Tapps (2,296 surface acres)—was formed by inundating several small lakes with water from a canal originating from a diversion dam on the White River. The lake is, in turn, used for storage for a hydroelectric powerplant at Dieringer. Lake Kapowsin, located adjacent to the town of Kapowsin, is a natural lake of 512 surface acres, and is drained by Kapowsin Creek into the Puyallup River. Steilacoom Lake at Steilacoom covers 313 surface acres and drains via Chambers Creek to Puget Sound, while 1,125-acre American Lake drains to Puget Sound via Sequallitchew Creek. Other lakes occur throughout the Basin. In addition, beaver ponds are situated in the headwaters of nearly all tributaries to the major drainages described above.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in good numbers throughout the Basin.

Anadromous Fish—Anadromous fishes are chinook, coho, pink, and chum salmon; steelhead and searun cutthroat trout; and searun Dolly Varden. On the White River, anadromous fish are trapped at the Buckley diversion, and trucked to a point near Greenwater. Here they are returned to the river to continue upstream migration and natural spawning. Approximately 238.6 miles of the Puyallup drainage and 27.4 miles of the independent drainages are used

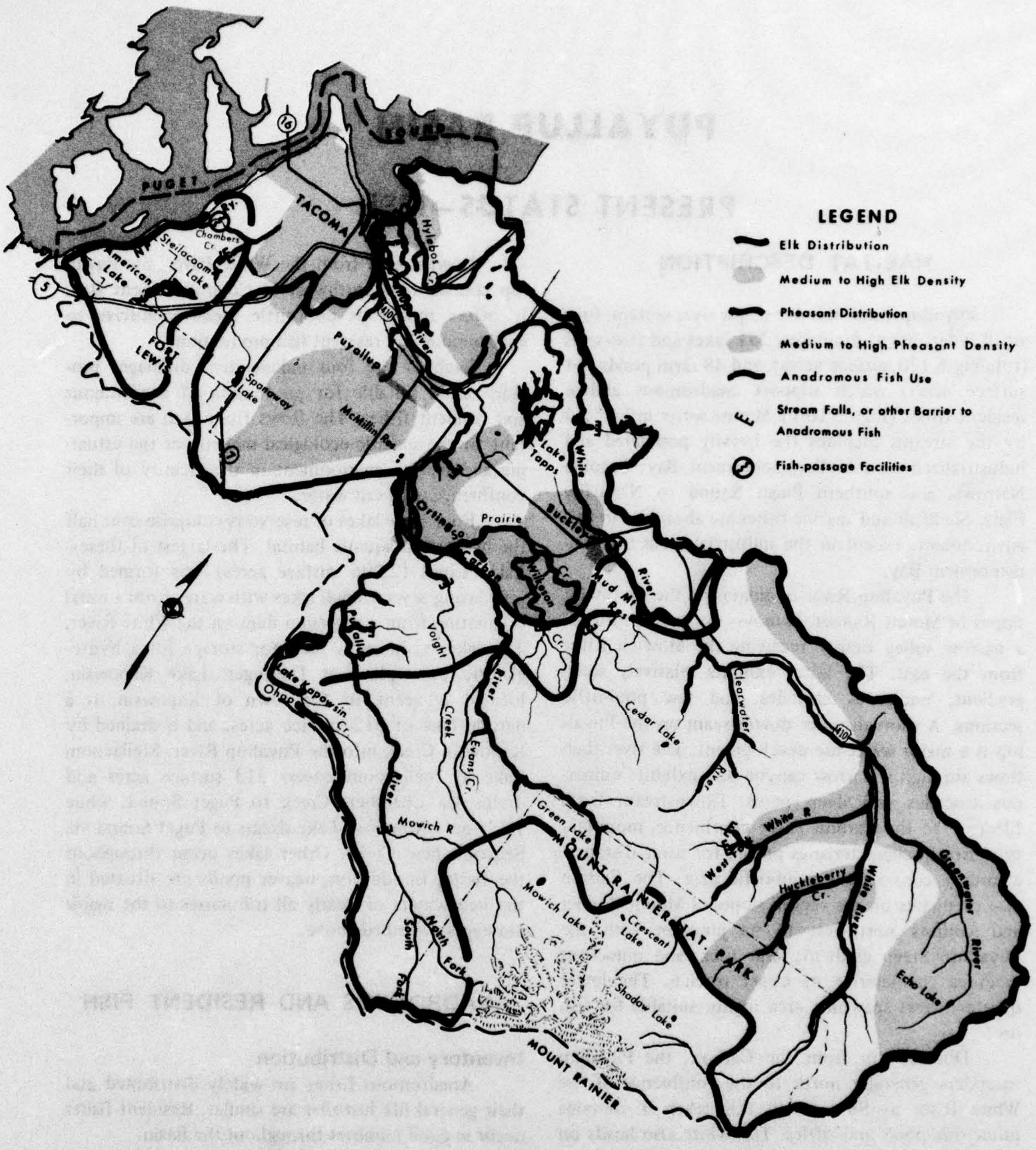


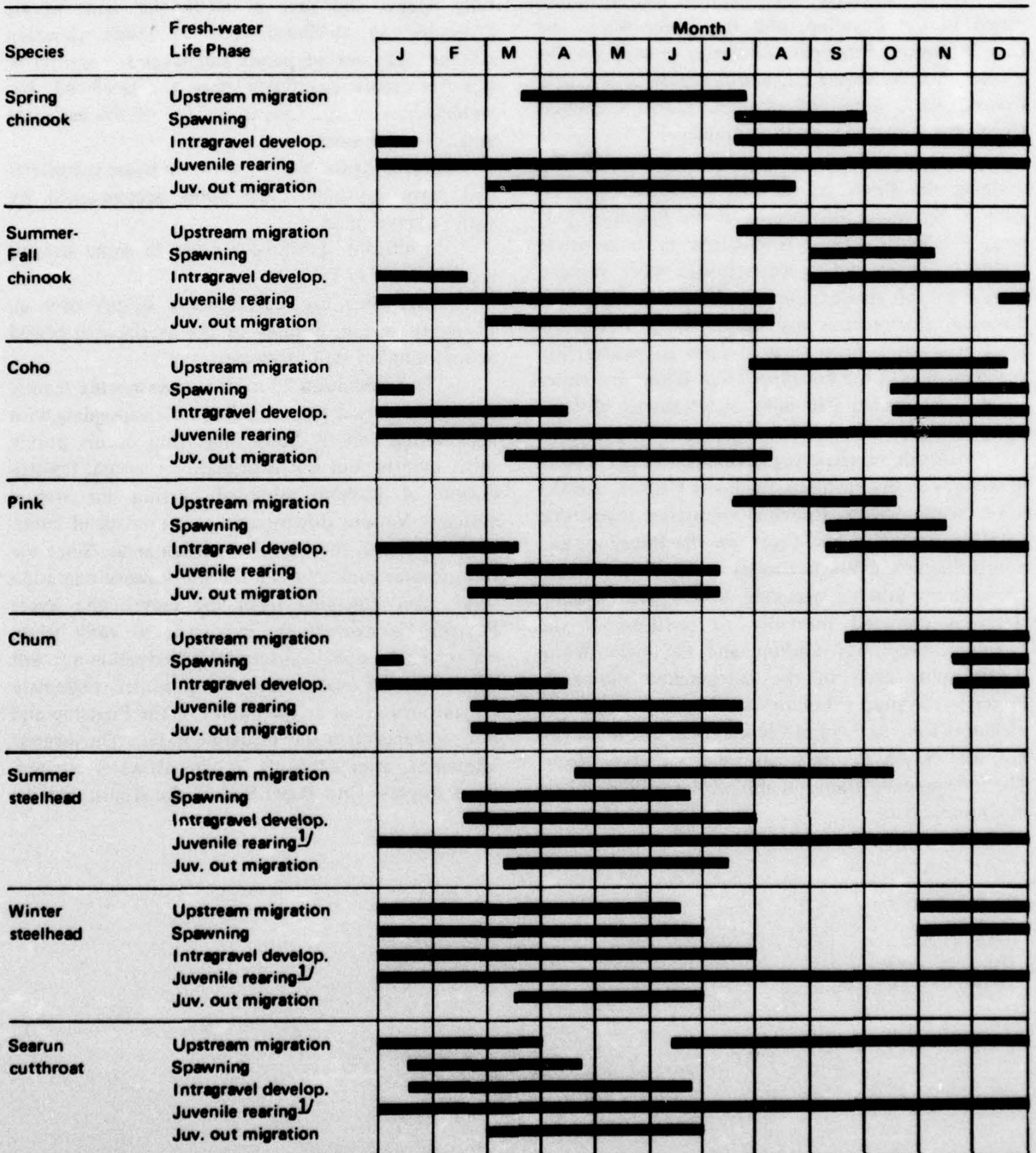
FIGURE 10-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

for migration, spawning, and rearing (Figure 10-1). Other important natural rearing waters for many species are the lakes, sloughs, and ponds.

Upstream migration of the various races and species of anadromous fish overlaps considerably, as shown on Table 10-1. Adults of one or more species enter the system every month. During the summer, May through August, the early running species remain in deep holes enroute to their spawning grounds.

Adult spring chinook utilize principally the high mountain streams of the upper White River system for spawning. These include Huckleberry

TABLE 10-1. Timing of salmon and searun trout fresh-water life phases in Puyallup Basin



1/ Normally extends over a two-year period.

Creek, and the West Fork White, Greenwater, and Clearwater Rivers. Also, limited numbers of spring chinook are believed to use the upper reaches of the Puyallup and the upper Carbon Rivers. It is estimated that within the Puyallup system approximately 93 miles of stream are utilized by spawning spring chinooks. Fall chinook spawning occurs throughout the Puyallup drainage, with heaviest concentrations noted in the Puyallup, and the lower White and Carbon Rivers. Principal tributaries utilized by this species include Kapowsin, South Prairie, and Voight Creeks. Also, some fall chinook utilize Chambers Creek, the largest independent drainage.

Virtually all accessible streams and tributaries draining the Basin are utilized by spawning coho salmon. Spawning also occurs in the Puyallup, Carbon, and White Rivers, particularly in areas where divided channels create watercourses more suitable for use by this species. Each of the four independent drainages also receives spawning coho, however, the total production from these streams is considerably less than that of the Puyallup River. Within the entire Basin, an estimated 230 miles of stream are utilized by spawning coho.

Pink salmon spawning occurs almost exclusively in sections of the Puyallup, the lower Carbon, and the lower White Rivers. Principal tributaries supporting spawners include Kelly Creek on the Puyallup, and South Prairie and Voight Creeks on the Carbon River.

Chum salmon spawning within the Puyallup Basin is confined primarily to portions of the Puyallup, the lower Carbon, and the lower White Rivers, plus each of the independent drainages. Principal Puyallup tributaries known to receive chum include Clear, Kelly, and Clark Creeks on the Puyallup; and South Prairie Creek on the Carbon River. The independent drainages also receive good numbers of chum salmon.

Adult steelhead have been recorded in all accessible waters in the Basin where selected gravel areas are used for spawning. These same areas complement the rearing in adjacent upstream and downstream sections, particularly where no other anadromous fish occur.

Searun cutthroat trout frequent and successfully spawn and rear in much the same waters accessible to steelhead, but in lower elevation systems. The use of ponds and lakes for rearing is, however, more significant than for steelhead. Extremely important, too, is the use of the estuarine and salt-water areas.

Searun Dolly Varden spawn in larger tributaries that have typically deep pools accompanied by shallow gravel areas.

Significant spawning reaches in some streams are delineated in Table 10-2.

Intragravel egg development occurs over an 11-month period, because of the overlapping period of spawning for various species.

"Out migration" for all species occurs mainly during the period February-June, corresponding with high spring runoff. Some migration occurs during other months, but this is primarily a natural redistribution of juvenile salmonids within the stream systems. Various downstream migrants spend considerable time in the vital acclimation areas. Since the frail juvenile pink and chum begin seaward migration soon after emerging from the gravel, the lower Puyallup is exceedingly important to early freshwater rearing, and to successful introduction into salt water. For all anadromous fish juveniles, extremely critical areas exist at the mouth of the Puyallup and in Commencement Bay estuarine waters. The juvenile salmonids, after adjusting to the salt-water environment disperse into Puget Sound, the straits, and the ocean.

TABLE 10-2. Significant spawning reaches for anadromous fish and resident game fish, Puyallup Basin[1]

Stream	Section	Stream Mileage	Type of Spawning Area
Puyallup R.	White R. mouth to Electron	10.0-30.0	Occasional broad riffles, some beach and patch gravel
	Electron to diversion (upstream from gage)	30.0-39.0	Few riffles, mostly patch gravel
	Diversion to headwaters	39.0-46.0	Some broad riffles, mostly patch gravel
Mowich R.	Mouth to point near headwaters	0.0-6.0	Some riffles, mostly beach and patch gravel
Carbon R.	Mouth to point near Carbonado	0.0-12.0	Occasional broad riffles, some beach and patch gravel
	Fairfax to point near headwaters	18.0-28.0	Numerous riffles, channel splits, some beach gravel
S. Prairie Cr.	Mouth to point near headwaters	0.0-14.0	Many riffles, occasional patch gravel sections
White R.	Point near Sumner to Buckley Diversion	3.0-21.0	Few riffles, some beach and patch gravel areas
	Mud Mountain Reservoir to point near headwaters	32.0-60.0	Few riffles, some beach and patch gravel areas
West Fork	Mouth to point near headwaters	0.0-12.0	Some riffles and channel splits, occasional patch areas
Greenwater R.	Mouth to point near headwaters	0.0-10.0	Numerous riffles, some patch and beach gravel
Clearwater R.	Mouth to Lily Cr. area	0.0-6.0	Many riffles and channel splits, some patch gravel

[1] Additional spawning area is provided by virtually all tributaries entering within described reaches.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 10-3.

Resident Fish—Resident fish spawn throughout the inland waters (Table 10-2). Rainbow and cutthroat trout are found in significant numbers in most of the streams. In addition, cutthroat thrive in streams upstream from anadromous fish barriers where they are generally self-sustaining. Brook trout occur with resident cutthroat in many higher elevation streams and most beaver ponds. In addition, they have been stocked in many high lakes. Mountain whitefish are abundant. Dolly Varden occur mostly downstream from the anadromous fish barriers in the Puyallup, White, and Carbon Rivers. Lake trout are also found in some lake waters and kokanee are present in Steilacoom and American Lakes. Perch, crappie, bullhead, pumpkinseed, and bass are abundant in many of the lowland lakes. More common competitive and/or predator species resident to the Basin are squawfish, suckers, sculpins, dace, sticklebacks, and peamouth.

Production

As determined during a 1967 stream survey, fish production, including all anadromous salmonids which reside one or more years in fresh water (exclusive of lampreys), is varied. Instantaneous standing crop values ranged from practically zero in the glacial headwaters to more than 875 pounds of fish per surface acre in the rich lowland streams. The average was 334.3 pounds. Salmonid populations equaled 205.7 pounds per surface acre, while other or undesirable species comprised the remaining 128.6 pounds.

TABLE 10-3. Anadromous fish spawning escapement, natural and (artificial), in Puyallup Basin

Species	Range 1/	Average (Annual)
Chinook	150-3,650 (480-710)	2,030 (600)
Coho	830-28,770 (6,380-17,230)	7,570 (9,990)
Pink	10,000-25,000	14,750 2/
Chum	4,950-57,490	22,200
Summer steelhead 3/	4/	4/
Winter steelhead 3/	18,100-40,300	26,500
Searun cutthroat 3/	13,500-30,200	19,900
Searun Dolly Varden 4/		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

2/ Per odd-year escapement.

3/ Totals include natural and (artificial) escapement.

4/ No valid totals established.

Anadromous Fish–Total salmonid production from the Puyallup Basin depends largely on levels of natural spawning and rearing success. Each of the major streamcourses contains numerous sections suitable for spawning and rearing, and each offers high quality tributaries where excellent production is achieved. Of the independent drainages, Chambers Creek is by far the largest producer of salmon and steelhead.

The Basin is a very productive winter steelhead area and only moderately productive for summer steelhead. About 39,800 adult steelhead (5 to 10 percent are summer run) and 26,500 adult searun cutthroat trout are produced each year. Potential natural production of these species is anticipated to be somewhat greater than the current numbers produced.

Table 10-4 presents fish production data.

TABLE 10-4. Anadromous fish natural production (harvest plus escapement), Puyallup Basin

Species	Range 1/	Average (Annual)
Chinook	600-14,600	8,120
Coho	4,150-143,850	37,850
Pink	30,000-75,000	44,250
Chum	9,900-114,980	44,390
Summer steelhead	3/	3/
Winter steelhead	27,100-60,400	39,800
Searun cutthroat	18,000-40,200	26,500
Searun Dolly Varden 2/		

1/ Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

2/ Production limited and therefore not determined.

3/ No valid totals established.

Resident Fish–Streams upstream from anadromous fish barriers are, for the most part, producing their natural potential. With the exception of streams with glacial origin, fish recruitment comes mostly from headwater lakes or ponds; occasionally hatchery-reared trout are planted.

Stream reaches downstream from migration barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The instantaneous standing crop (excluding lampreys) produced during low flow periods varies between 206 and 378 pounds per surface acre. Hatchery-reared resident and anadromous trout are also planted in these areas.

All lakes, ponds, and reservoirs are included in a regular fishery management program, which includes trout planting. Because lake waters are managed for salmonids and/or spiny rays, actual production figures are shown in harvest data. Some lake harvest varies from one fishing season to the next, and may range from 10 to more than 100 pounds of fish per surface acre annually. Under ideal conditions, production could be substantial.

Propagation

The State maintains and operates the Puyallup Salmon Hatchery on Voight Creek near Orting (Figure 10-2). Fall chinook and coho are the principal

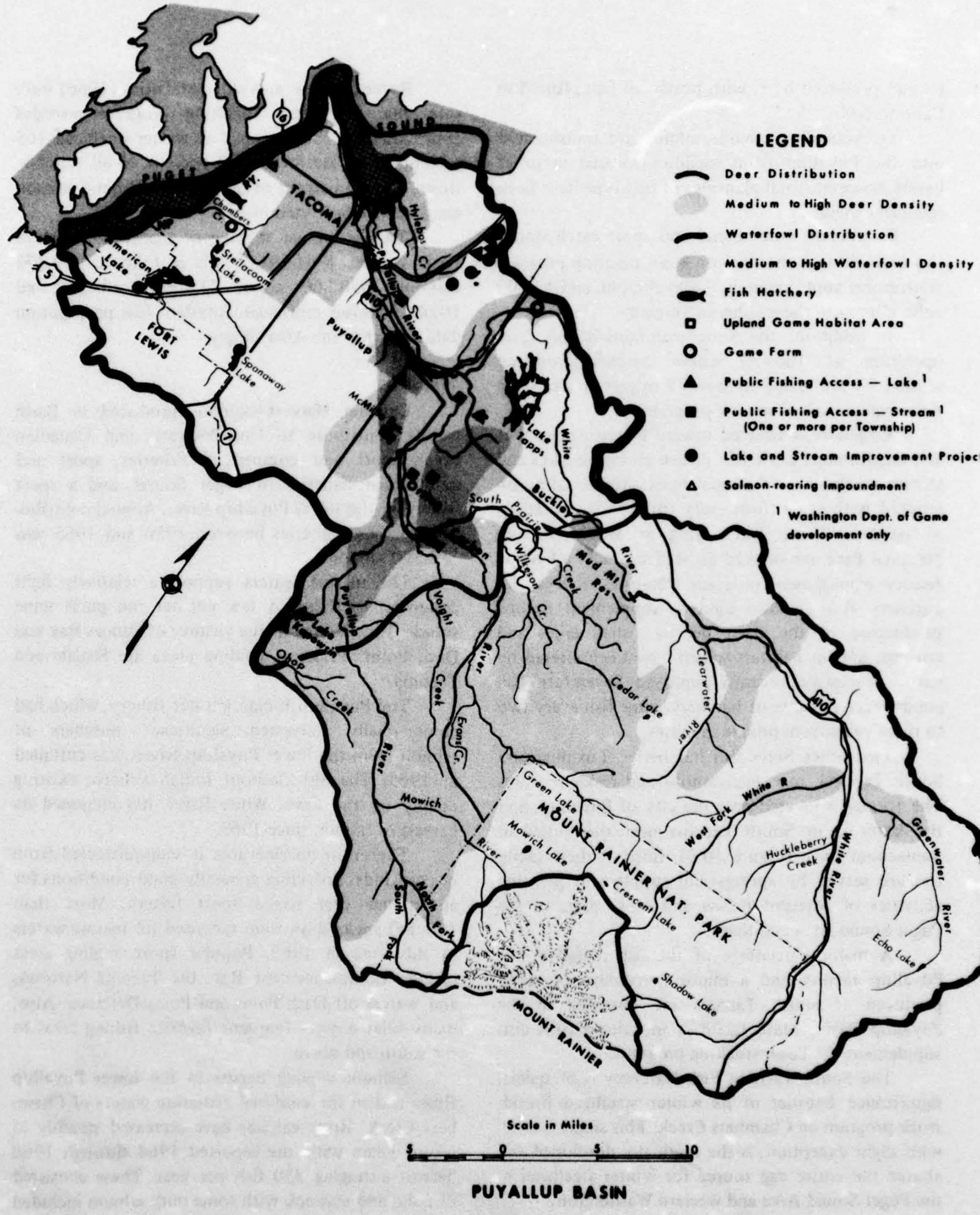


FIGURE 10-2. Wildlife distribution, and fish and wildlife developments (1965)

salmon produced here, with nearly all fish planted in Basin waters.

Occasionally, juvenile salmon are transplanted into the Puyallup from facilities located in other basins; however, total plantings of this type have been relatively small.

Preliminary commercial and sport catch statistics indicate that the present Basin planting program contributes approximately 3,800 chinook and 12,400 coho salmon to these fisheries annually.

In addition, the State maintains a fish farm operation at Tacoma where hatchery-produced salmon fry are reared to seaward migration size. This is basically an experimental program.

Emphasis is directed toward liberating resident and anadromous game fish in low elevation lakes and stream reaches on an annual basis. Alpine lakes are stocked with small trout every three to five years or as needed. Those lakes lying in Mount Rainier National Park are stocked as needed, under a Federal fishery management program. Plantings of legal-size hatchery fish are also used to supplement natural production in the most heavily fished lakes and streams, and in habitats which have been altered by nature or man and recently improved. Seven farm fish ponds receive plants of hatchery game fish every two to three years from private facilities.

Two other State fish hatcheries, Puyallup and South Tacoma, rear anadromous and resident trout. The former is located near the city of Puyallup, and the latter is in South Tacoma near the outlet of Steilacoom Lake (Figure 10-2). Both of these facilities are served by springs and supplement planting activities of adjacent basins and other parts of the Puget Sound Area and State.

A major percentage of the fish reared at the Puyallup facility and a minor percentage of those produced at South Tacoma are liberated in the Puyallup Basin. State facilities in other basins also supplement the Basin stocking program.

The South Tacoma Fish Hatchery is of special significance because of its winter steelhead broodstock program on Chambers Creek. This single source, with slight exception, is the originally developed and almost the entire egg source for winter steelhead in the Puget Sound Area and western Washington.

Five private trout hatcheries, near Tacoma and McMillan, produce rainbow trout for commercial outlets, including private ponds.

Recent survey and catch statistics (1966) indicate that the Basin planting program provides approximately 75 percent of all winter steelhead, (65 percent of all steelhead), 80 percent of all resident trout, and 90 percent of all lake-reared coho salmon and kokanee harvested in its waters annually.

Average annual sticking of anadromous fish in Basin waters, 1961-1965[1] was as follows: 959,375 chinook; 590,860 coho; 73,908 steelhead; and 10,000[2] searun cutthroat. Resident fish propagation data appear in the Area chapter.

Harvest

Existing Harvest–Salmon produced in Basin waters contribute to United States and Canadian ocean sport and commercial fisheries, sport and commercial fisheries in Puget Sound, and a sport fishery in the lower Puyallup River. Annual contribution to these fisheries between 1956 and 1965 was 152,590 salmon.

The marine waters support a relatively light commercial fishery. A few gill net and purse seine vessels fish the area in the vicinity of Dumas Bay and Dash Point. Principal landing areas are Seattle and Tacoma.

The Puyallup Indian gill net fishery, which had commercially harvested significant numbers of salmon from the lower Puyallup River, was curtailed in 1965. The Muckleshoot Indian fishery, existing mainly on the lower White River, has increased its harvest of salmon since 1965.

The entire marine area is semi-protected from heavy winds, providing generally good conditions for an intense year round sport fishery. More than 120,000 angler-days were recorded for marine waters in this area in 1965. Popular sport angling areas include Commencement Bay, the Tacoma Narrows, and waters off Dash Point and Point Defiance. Also, many boat anglers frequent favorite fishing areas to the south and north.

Salmon angling occurs in the lower Puyallup River and in the confined estuarine waters of Chambers Creek. River catches have increased steadily in recent years with the reported 1964 through 1966 harvest averaging 820 fish per year. These consisted of coho and chinook with some pink salmon included

[1] Anadromous trout data involve period 1962-1966.

[2] Annual stocking initiated in 1964, with most active program in 1966.

in the 1965 catch. Average annual use represented is 4,100 angler-days.

A 1966 questionnaire survey of anglers indicated an average use of 100,700 angler-days in catching nearly 20,100 winter steelhead. Because summer water conditions (glacial silt) do not permit main river angling, summer steelhead are included in the winter steelhead catch. Natural production contributes almost 35 percent of the total steelhead catch. No commercial steelhead landings are recorded; however, Indian fishermen have harvested this species in recent years.

These same data indicate 16,800 angler-days were spent fishing for searun cutthroat in salt water, with a total harvest of 10,100 fish. Natural production contributes 100 percent of the total fresh- and salt-water searun cutthroat harvest. Harvest of searun cutthroat in fresh water and that of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of 1966 survey data, 383,300 angler-days were expended on the lakes, ponds, and reservoirs and a total harvest of 1,109,100 trout and 610,000 other game fish realized. Similarly, 106,500 angler-days were spent fishing for game fish other than steelhead in the streams and 366,100 were harvested. The whitefish harvest was estimated to be less than one percent of this total.

Potential Harvest–If natural salmon production is increased, as indicated in the Production section, there would be a corresponding annual increase in the harvest of all species. The Area chapter presents a discussion of salmon harvest trends.

Potential harvest of natural steelhead production is difficult to predict since artificial propagation programs promote additional fishing pressure on these populations. However, an increased harvest would be possible.

Searun cutthroat trout harvest has not reached its full potential, because of the widely varied salt-water fishery, brief season, and highly popular winter steelhead season. Estimates indicate that additional production and harvest of searun cutthroat could be realized.

Resident salmonid production and subsequent harvest in streams are not expected to change. This, of course, considers the same exclusions noted for anadromous fish. An exception would be the harvest of mountain whitefish, which is estimated at less than one-tenth its potential. Because this total harvest is not separable from stream resident harvest data, present and potential harvest values were not determined. Potential harvest of resident salmonids in lakes and ponds could be increased substantially.

Factors Limiting Production Other Than Harvest

There are a number of alterable factors that limit fish production (Table 10-5).

Detrimental Streamflow–Fish production in nearly all smaller streams is curtailed by low summer flows. In the Puyallup River, upstream from the confluence of the Carbon, and in the White River between Puget Sound Power and Light Company's Buckley diversion dam and a point just upstream from Sumner, low flow conditions are aggravated by diversion of water to a hydroelectric plant. In addition, low flows and wide ranging flow fluctuations occur in the Puyallup from the company's diversion dam downstream to a powerhouse.

Seasonal flooding is common in all of the major drainages. Warm temperatures at glacial headwaters combined with heavy rains on steep, mountainous terrain, frequently cause violent runoff. Intermittent flooding also occurs in Chambers Creek as a direct result of storm drainage runoff associated with urbanization.

Poor Water Quality–There is considerable glacial silt in the White, Puyallup, and Carbon Rivers from late spring to early fall. Silting also occurs from intermittent flushing of the Electron power canal flume on the Puyallup and annual flushing of Mud Mountain Reservoir on the White River in September. All of these conditions are detrimental to egg survival and food production.

Domestic, agricultural, and industrial pollution occurs in the Puyallup drainage. Pollution becomes more acute during periods of low flow, and particularly near populated areas.

Pulp mill wastes are discharged directly into the Puyallup River at its confluence with Commencement Bay. Studies reveal that these effluents can be particularly damaging to juvenile salmonids, especially during slack tides or low river flow conditions. The bay also receives wastes from wood treatment plants, chemical refining, domestic sewage, smelter slag disposal, log booms, oil spills, and dredged spoil deposition. The estuarine waters off Chambers Creek mouth are used as a log dump and storage area by a paper plant. Waste material discharged by the plant further degrades natural water quality.

TABLE 10-5. Alterable factors limiting anadromous and resident fish production in Puyallup Basin

Stream	Limiting Factor[1]											Species Affected						
	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Unstable Streambed	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes[2]	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Puyallup R.	X	X	X	X	X					X	X	X	X	X	X	X	X	X
Kapowsin Cr.		X										X	X			X	X	X
Carbon R.	X	X				X				X	X	X		X	X	X		X
S. Prairie Cr.		X										X	X			X	X	X
Voight Cr.		X				X	X						X			X	X	X
Clear Cr.		X							X				X			X	X	X
Kelly Cr.		X					X						X			X	X	X
White R.	X	X	X	X				X		X		X	X			X	X	X
West Fork	X				X							X	X			X		X
Greenwater R.		X					X				X	X	X			X		X
Boise Cr.		X								X			X		X	X	X	X
Clark Cr.		X						X		X			X			X	X	X
Clear Cr.		X	X					X	X	X			X			X	X	X
Independent Drainages																		
Hylebos Cr.		X								X			X			X	X	X
Wapato Cr.		X								X			X			X	X	X
Chambers Cr.		X	X	X			X			X		X	X		X	X	X	X

1/ Competition and predation generally affect all waters (less so on glacial streams) and are most serious in lake environments.

2/ Includes watershed development.

Physical Barriers—About 11 miles upstream from Electron, a dam diverting major river flow for a hydroelectric powerplant blocks anadromous fish upstream migration. On the White River, a similar block exists at Buckley diversion dam; however, adult anadromous fish are trapped and transported around this structure and Mud Mountain Dam upstream.

Additional falls and barriers occur on less important tributary streams. These physical obstructions significantly diminish anadromous fish production.

Fish screens located in a flume operate in conjunction with the White River diversion. However, tests have shown that these screens are not effectively passing downstream migrants. As a result, the young fish are swept over the screens, into Lake Tapps, and through the power turbines. Mortalities here are extreme.

Cascades and intermittently-formed logjams prevent access to upstream spawning areas on the Greenwater River. Logjams and beaver dams occur on Kelly and Voight Creeks, and upstream migrants are hindered by cascades and falls on the Carbon River. A lake level control dam at Steilacoom Lake outlet blocks fish migration into the upper Chambers Creek drainage.

Conflicting Watershed Developments—Logging is one of the principal factors affecting the watershed. Extensive clear cutting over certain areas influences the magnitude of flood flows and low summer flows. This type of cutting also increases stream siltation and, in smaller streams, increases temperature.

Urbanization and industrial expansion occur in many of the lower drainages. There is considerable home development on the flood plains. This creates a need for flood protection for landowners, involving diking and channeling or stream straightening. Such activities are not compatible with fish needs.

Within the estuarine and marine waters of Commencement Bay, and in the Chambers Creek estuary, log storage, wood preservation plants, and pulp and chemical plants directly influence the anadromous fish production capacity of the entire Basin.

Flood control projects are located throughout much of the Puyallup drainage. Major emphasis is on channeling, straightening, and narrowing the natural stream channel, creating conditions which adversely affect fish populations. River profile changes generally associated with stream channeling projects have occurred in the Carbon, White, and Puyallup Rivers.

Hydroelectric power developments on the Puyallup and White Rivers are detrimental to fish production. Also, the operation of Mud Mountain Reservoir on the upper White River is often not coordinated with fish needs.

Limited Spawning and Rearing Areas–Floods have destroyed or shifted many spawning riffles and resting pools in the various stream systems. Channeling, channel realigning, or diking associated with flood control and land reclamation, have aggravated flooding effects on fish habitat.

Competition and Predation–Predator and competitor fishes such as peamouth, suckers, squawfish, sculpins, and dace inhabit the drainage. Mixed species fish populations of lowland lakes limit trout production. Predation of various species by marine fishes such as the dogfish and by certain mammals and birds is common in estuarine waters.

Beneficial Developments

Accomplished and Continuing–Enhancement projects for anadromous fishes have involved extensive beaver dam and logjam removal, culvert repair, bank stabilization, and the installation of fish-passage facilities on the White River and on Chambers Creek (Photo 10-1, Figure 10-1). The State attempts to clear all intermittent barriers as they occur. Various Federal land management agencies, in cooperation with the State, also engage in this activity. Such projects also benefit resident game fish.

Nearly all game fish stocks come from the South Tacoma and Puyallup facilities. Although the Puyallup facility is the smaller, its contribution to resident and anadromous trout production and fisheries research is extremely significant to this and adjoining basins. All liberations from the two facilities are intended to supplement natural production, which is insufficient to sustain present harvest.

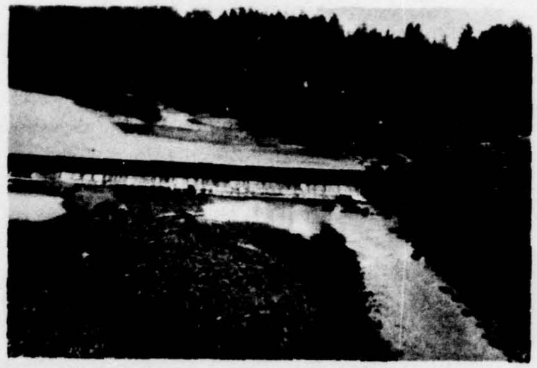


PHOTO 10-1. Fish trap and haul facilities (right) at the White River Diversion Dam. (Washington Department of Fisheries photo)

Waters which have been chemically rehabilitated for trout management include Fivemile, Steel, North, Bonney, Wapato, Orting, Louise, Spanaway, Tule, Sequallitchew, Killarney, and American Lakes. While only Sequallitchew Lake required screening, American and Spanaway Lakes required screens and barrier dams. Various improvement projects are noted on Figure 10-2.

Fishing access developments exist at Fivemile, North, Steel, American, Killarney, and Bonney Lakes (Figure 10-2). Stream access and boat launch areas include sites on the Puyallup, White, and Carbon Rivers. The Federal fishery management program on the Fort Lewis Military Reservation provides angler access to Sequallitchew and Chambers Lakes. The fishery projects on the reservation are under a cooperative plan involving the Fort Lewis Command, Bureau of Sport Fisheries and Wildlife, and the Washington Departments of Fisheries and Game. Additional public and private developments provide multiple use access to Basin waters.

Research and investigations at the South Tacoma Hatchery have had a most significant impact on steelhead management. This is the first facility in Washington where winter steelhead were reared and released in parent streams in numbers sufficient to justify the program which presently includes planting almost 2 million winter steelhead smolts within the State each year. Continued studies in pond rearing, timing of returning runs, and hybridizing have resulted in increased benefits annually.

Under Development–A research program in fish farm salmon production being conducted at

Titlow Pond in Tacoma is expected to benefit future development of artificial rearing projects.

Beneficial programs under development include experimental studies with rainbow-steelhead hybrid returns from plants in Steilacoom Lake and preliminary investigations of searun cutthroat trout liberations into South Prairie Creek. Investigations of continued eyed-egg kokanee plants in Murray Creek, tributary to American Lake, are underway. As many as 700,000 eggs are deposited in gravel of varied composition to determine maximum egg density and survival.

MARINE FISH AND SHELLFISH

Habitat Description

Marine waters provide considerable diversified environment. Numerous broad beaches provide extensive shallow water exposure, while some areas have depths approaching 90 fathoms. The principal marine waters are Commencement Bay, Tacoma Narrows, and that portion of south Puget Sound to the Nisqually Flats.

In Commencement Bay, Puyallup waters tend to stratify and form a thin layer over the heavier saline water. Thorough mixing and dilution occur in Dalco Passage off Port Defiance, where heavy tide rips and currents are encountered. Weak and variable currents exist through East Passage while strong currents move through Colvos Passage and the Tacoma Narrows.

The topography of the northernmost beach area, also the most productive shellfish grounds, consists generally of gradual gradient with upper and middle beach composed of mixed sand and small gravel becoming more sandy near the mean lower-low tidemark. The beaches in this section generally extend out 500 to 600 feet to the zero tidemark. The beach area around Port Defiance and southerly in the Narrows to the Tacoma Narrows Bridge consists of high steep banks and short, sharp gradient beaches composed of clay outcropping with occasional large rocks and gravel.

Inventory and Distribution

Marine Fish—The variety of ecological niches and the influence of the Puyallup River and other Basin drainages contribute to a highly suitable and productive habitat supporting a variety of abundant marine fish populations.

The principal marine fishes are cod, lingcod, greenling, flounder, sole, rockfish, herring, dogfish, and ratfish. Population is discussed in the Area section concerning species production.

Shellfish—The estuarine and marine waters and shoreline from Point Pulley near Burien (Cedar-Green Basins) south through Commencement Bay to the Tacoma Narrows Bridge comprise the Puyallup Basin's shellfish area. Except for Commencement Bay, this area affords excellent marine habitat for shellfish.

Principal species of shellfish and other marine invertebrates are Dungeness crabs; littleneck, butter, piddock, and Manila clams; blue mussels; pink scallops; spot shrimp; squid; octopi; and sea cucumbers.

Dungeness crabs inhabit the sandy intertidal zone, mostly north of Commencement Bay and particularly where eelgrass beds are prevalent.

Sizable numbers of littleneck, butter, and horse clams are present from Point Pulley to Dash Point, and geoducks are abundant in the sandy bottom areas below the mean-lower-low tidemark. Cockles are relatively scattered throughout the area. Piddock are concentrated in the blue clay deposits around Point Defiance. The log booms, pilings, docks, and heavy riprap along the waterfront and waterways in outer Commencement Bay support heavy clusters of blue mussels, and this shellfish is also abundant around Point Defiance where swift currents occur. The sandy bottom north of Commencement Bay provides ideal environment for pink scallops which are found in scattered beds in 70 to 100 feet of water.

Spot shrimp are predominant in scattered concentrations in the deep channel of East Passage and Dalco Passage.

Pacific oysters are limited to small private oyster beds. Prior to private ownership, extensive recreational use of these beaches had completely depleted the natural native oyster production.

The waters in the Tacoma Narrows and in Dalco Passage support large schools of squid and the steep rocky shoreline around Point Defiance and in the Narrows, with strong mixing currents, provides an ideal environment for octopi. Sea cucumbers are abundant along the sandy eelgrass bottom from Point Pulley to Dash Point, and sea urchins are prevalent in concentrated groups on the tidal shorelines around Point Defiance and in the Narrows.

Production

Information is not available concerning numbers of marine fish or shellfish produced.

Propagation

Marine fishes are not propagated in the Basin. Small privately-owned oyster beds are located south of the Tacoma Narrows.

Harvest

Marine Fish–Marine fish receive only light commercial fishing effort. Herring make up the bulk of the catch and most fish are taken with beach seines and round haul nets from the eastern Tacoma Narrows area. Most marine bottom fishing effort is conducted principally by otter trawl vessels, and is also confined to waters north of Point Defiance. Landings are made in the Tacoma area while some vessels travel to Seattle, Everett, and as far north as Blaine to sell their catch.

Sport angling plus spear fishing are becoming increasingly popular in these marine waters. Principal species sought by sportsmen are lingcod and rockfish. Popular areas include Dash Point, Brown's Point, Point Defiance, and the Tacoma Narrows. Average annual angler-day use devoted to sport angling for marine fishes is 3,800.

Little is known regarding harvest potential of marine fishes.

Shellfish–Shellfish harvest is principally by sportsmen. Squid are harvested commercially by otter trawl and herring gear mainly in the Tacoma Narrows area, and are landed at ports from Tacoma to Blaine.

Popular sport digging areas, populated mainly with hardshell clams, include beaches and tidelands east of Dash Point and the east shoreline of the Tacoma Narrows south of Day Island. These areas receive heavy pressure due to numerous access areas and proximity to metropolitan centers. Average annual man-days of use attributed to shellfish harvest are 4,700.

Harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish and Shellfish–Poor water quality, tideland development, and competition and predation are principal factors influencing production.

(1) Poor Water Quality–Domestic and industrial effluents and introduction of other foreign materials from local shipping traffic alter the natural water quality in estuarine and marine waters. Such conditions are prevalent in Commencement Bay, particularly along its southern shore and off the mouth of Chambers Creek. Rapid expansion of the metropolitan and industrial waterfront of Tacoma as well as urban developments cause increasing problems of sewage disposal and pollution. Pollution has become so acute that some fish populations have been eliminated. Also, shrimp and scallop habitat in Commencement Bay and Dalco Passage has been reduced or fouled by disposal of sludge and dredged materials.

(2) Tideland Development–Tideland destruction through industrial development and urbanization is detrimental to juvenile fishes and has curtailed or depleted native clam populations. Dredged spoil deposition, extensive landfills, and dike and breakwater construction are not compatible with species needs. In general, the tidal areas are not conducive to good oyster culture because of narrow beach configuration. Beach attrition and alterations resulting from residential development have also reduced much of the intertidal shellfish area.

(3) Competition and Predation–Dogfish, abundant in some areas, prey upon juvenile marine fishes and compete with more desirable species, such as rockfish or cod. Shellfish predators include red crabs, starfish, moon snails, sand dollars, and native drills which prey on clams and oysters; and octopi that feed upon crabs.

Beneficial Developments

No beneficial development projects exist for the enhancement of marine fish or shellfish.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The 1963 census ranked the Puyallup Basin second in the Puget Sound Area with 324,500 persons. Projections indicate Basin populations of 449,800, 721,000 and 1,157,700 in 1980, 2000, and 2020, respectively. Major increases will be directly related to new industrial development planned for the Basin. This expansion, along with community and suburban developments, will be distributed principally throughout the lower Puyallup River valley, especially around Tacoma, Puyallup, Sumner, and Orting. Unless zoning ordinances are enforced, considerable urban sprawl is expected to occur throughout the surrounding areas, and to some extent over many sections of the surrounding lowland hillsides. Year round residence construction, plus summer-recreation home development, will increase rapidly in areas adjacent to streams and rivers, especially over the upper watersheds. Industrial development is expected to cover much of the lower valley floor northwest of the town of Orting.

The size of the Puyallup River system and the variety of stream types afforded by its many drainages, associated closely with heavily populated areas, promote this area strongly for outdoor recreation. This is especially true for the upper watersheds. Highways and roads provide generally good access for sport fishermen desiring to use the rivers and streams. The expected increase in demand for more and more outdoor recreation, associated with increased population and more leisure time, will lead to acceleration of sport fishing pressure increases at a rate much greater than that of population growth. Also, in salt-water areas where salmon produced in the Puyallup Basin are harvested, there will be a marked increase in demand by both commercial and sport fishermen.

The proximity of good quality marine water, beach, and tidelands to the heavily populated sectors of the Basin will result in considerable pressures on both the marine fish and shellfish common to the area. Each will suffer from loss of natural production habitat by development of waterfront homesites and industrial facilities.

RESOURCE DEMANDS AND NEEDS

The Puyallup Basin supports limited commercial fisheries for salmon, marine fish, and shellfish within Basin boundaries. The streams produce significant numbers of salmon that enter commercial and sport fisheries both inside and outside the Basin. The Muckleshoot Indian fishery, operating mainly on the lower White River, harvests large numbers of salmon annually. This particular fishery has remained relatively constant, and is expected to continue to do so, at least in the near future. Some commercial landings of salmon, marine fish, and shellfish are made at the Port of Tacoma, supplying a number of licensed dealers who sell their product principally on the fresh fish market.

Sport fishing for salmon is quite heavy throughout the salt-water area, and light to moderate in the Puyallup River. Numerous boat rentals, including one of the largest publicly-owned boathouses on the West Coast (Point Defiance), serve thousands of sport fishermen. In addition, many private boat moorages and boat access areas are scattered along the marine shoreline. Each year additional sport fishing pressures occurs within the Basin, with particularly heavy effort during high pink salmon years.

It is anticipated that local demands for marine fish and shellfish will increase very rapidly, with particularly heavy demands from sportsmen. As these demands continue to rise it will be necessary to develop projects and implement programs that will best utilize the production potential within the Basin.

Resident game fish in lakes will play a most significant role in future fishing recreation. Based on county use values, approximately 25 percent of all Basin harvest and utilization of game fish other than steelhead is by people from outside the Basin. It is estimated that, by 1980, Basin lakes must annually provide an additional 742,500 trout and 409,100 game fish of other species to anglers' creels. This is an additional 148 fish per surface acre. Basin streams must support an additional yearly harvest of 264,700 resident trout and whitefish and 14,100 steelhead by 1980. Most of the increase in fishing pressure will have to be met by increased artificial propagation. As population, leisure time, and outdoor recreation demands increase in this and nearby basins between 1980 and 2020, the need for game fish angling will increase proportionately. Table 10-6 indicates present and projected demands and needs for game fish in angler-days.

TABLE 10-6. Present and projected sport fishermen use (game fish) in Puyallup Basin

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	607.4
1980	407.0	1,014.4
2000	580.2	1,594.6
2020	956.8	2,551.4

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish resources of the Puyallup Basin are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to this Basin.

Conflicting Land and Water Uses

(1) Downstream fish-passage facilities, associated with Puget Sound Power and Light Company's Buckley diversion, are inadequate and cause serious losses of juvenile salmonids.

(2) Late spring and summer flows downstream from the Buckley diversion are often not sufficient to pass upstream migrating anadromous fish. In addition, attraction flows to the ladder and trapping facilities are often insufficient to attract fish.

(3) Puget Sound Power and Light Company's Diversion Dam, located upstream from Electron, blocks about 24 miles of stream from use by anadromous fishes. It also restricts upstream passage between this point and Electron Powerhouse under certain flow conditions.

(4) Projects being considered, such as those for flood prevention and drainage of Puyallup River tributaries, White River tributaries, South Prairie Creek, and the Carbon River storage dam, may conflict with fish needs.

(5) Log boom storage in the eastern portion of Commencement Bay has had serious detrimental effects upon marine fish and shellfish production in this area.

(6) Dams and power diversions on the White and Puyallup Rivers limit fish production potential.

(7) Poor logging practices, stream channel alterations, and projects retaining glacial silt would also reduce fish production and harvest.

Poor Water Quality

(1) Occasionally, intermittent seasonal pollution occurs in the lower Puyallup River, in the estuarine waters of Commencement Bay, and in Chambers Creek drainage. This often results in water quality inimical to fish and shellfish. An almost constant pollution problem, caused by heated effluent and fly ash, exists on Boise Creek, White River tributary. Effluents from agricultural and industrial sources, as well as from sewage disposal, are particularly detrimental to aquatic life. Buildup of sludge and heavy wastes in the estuary limits shellfish and marine fish production.

(2) The annual drawdown and flushing of the Corps of Engineers' Mud Mountain Reservoir on the White River release excessive quantities of silt, mud, and debris into the lower river where such material settles out and deteriorates environment and restricts fish production.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Puyallup Basin. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential enhancement projects include the opening of new stream areas upstream from barriers for spawning and rearing of anadromous fishes. Passage facilities at Puget Sound Power and Light

Company's Electron Diversion, on the Puyallup River, would add 24 miles of stream area for these fish. Other barriers deserving attention include extensive cascades in the middle Carbon River and a lake level control dam on Chambers Creek, the major independent drainage.

Streams requiring streambed and fish passage improvement include the Puyallup, Carbon, and White Rivers, as well as many of the larger tributaries including the Greenwater and West Fork White Rivers, and Huckleberry and South Prairie Creeks. Streambed controls could be achieved through selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools and riffles where they are now unstable or lacking. Such measures will be particularly beneficial in stream sections where narrow diking and channel straightening have been performed.

Another major enhancement project would involve alteration of the upstream and downstream migrant fish-passage facilities associated with Puget Sound Power and Light Company's White River diversion dam and canal. Additional water and/or better attraction flows should be provided at the adult fish ladder-hauling facility located at the diversion dam upstream from Buckley. The diversion canal rotating-drum fish screens should be redesigned, or possibly relocated nearer the canal intake. Such projects on the White River could significantly increase fish production. Negotiations are being conducted between the State and Federal fishery agencies and the Puget Sound Power and Light Company concerning all of the company's projects in the Puyallup Basin drainages.

Flood control and low flow augmentation would be highly beneficial on a number of streams, particularly the Carbon and upper White Rivers. Streamflow controls might be achieved through the development of overflow channels, flood flow diversions, or impoundments either on the main river or in potential off-river areas. Potential propagation sites are somewhat limited in the Basin but some sites are available for development of hatcheries, eyed-egg incubation facilities, spawning channels, or controlled impoundments for off-river rearing areas. There are suitable land and water sources for such facilities along sections of the Puyallup, White, and Carbon Rivers as well as on Kapowsin Creek, West Fork White River, and the Greenwater River.

One enhancement program would include coordination and close liaison with the Corps of Engineers for removing accumulated silt from Mud Mountain Reservoir in order that little or no damage would result from flushing this material into the lower White and Puyallup Rivers. Another program to benefit fish production would include setting rigid controls on the removal of water, for any purpose, from natural flowing streams. An extensive evaluation of new means for obtaining future municipal and industrial water supplies should be conducted in conjunction with this. Subjects deserving study include potential use of dual water systems (consumptive/irrigation and sewage) and possible procurement of desalted marine water produced as a byproduct of any proposed thermonuclear powerplants. Other enhancement projects should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish populations, including control of forest and agricultural spraying, as well as curtailing the disposal of untreated municipal and industrial wastes; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to ensure protection of fish resources; (3) institute an effective permanent flood plain zoning plan to protect streambeds and adjacent land from unnecessary changes that would damage the aquatic habitat; (4) guide management to promote effective regulation of all fisheries, and provide changes in fishing areas and harvest methods to yield maximum benefits from available stocks; and (5) perform studies and obtain information necessary for achieving the most efficient management possible, including the development of new techniques for flood control channeling and accumulation of specific streamflow data (from river cross section measurements) to determine flow levels necessary for fish. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative streamflow schedule has been developed. Such flows, by month, are listed in Table 10-7. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

TABLE 10-7. Tentative flow schedule required to maintain fish production levels, Puyallup Basin

Stream[1]	Flows (cfs) by Month Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Puyallup R. (Puyallup)	1,800	2,500	3,000	3,000	3,000	2,750	3,000	3,500	3,000	2,500	2,000	1,600
Carbon R.	300	400	450	400	350	300	400	500	400	400	250	250
S. Prairie Cr.	150	250	350	350	350	250	300	250	150	100	60	55
White R.	600	800	1,200	1,200	1,200	1,100	1,200	1,400	1,200	1,000	750	600
Greenwater R.	70	150	200	200	200	150	250	300	250	100	60	60

[1] Locations are existing U.S. Geological Survey gaging stations.

MARINE FISH

Enhancement projects for marine fishes should include improvement of habitat and creation of new fishing areas through selective placement of rock jetties or submerged automobile bodies. Another program benefiting these fishes would involve establishing and implementing water quality controls in the estuarine and marine waters of Commencement Bay and Tacoma Narrows. Without such controls a drastic reduction in marine fish populations is foreseen.

Natural production is adequate at present, but artificial propagation will be instituted when required.

SHELLFISH

Potential enhancement projects for shellfish should include the installation of beach breakwaters where strong currents now limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. The latter might be accomplished by heating controlled salt-water areas or by adding nutrients.

The marine waters hold considerable potential for expanded development of raft and rack oyster culture. Also, the many beach areas receiving increasingly heavy use by sport diggers are well suited for put-and-take shellfish stocking programs.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Puyallup Basin offers numerous opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. Major potential developments, including an indication of priority, are categorized in Table 10-8 and defined by stream in Table 10-9.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the potential developments listed. Nearly all of the major proposals are goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of these potential developments are included in a preliminary plan for increasing production levels to meet overall Pacific Northwest demands for fish resources in the future. These proposals, and salmon production increases, are indicated by target years in Table 10-10.

Table 10-11 shows estimated annual benefits in terms of sport and commercial harvest for the same proposals. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate, and needs are not so critical as for salmon.

TABLE 10-8. Potential developments for production and use of salmon and shellfish, Puyallup Basin

Beneficial Development	Priority		
	Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Provide fish passage at Electron Diversion	X		
Improve White River fish-passage facilities	X		
Improve public beaches for clam production		X	
Improve stream and streambed conditions	X	X	X
(2) Acquisition			
Evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop 3 salt-water public access sites	X		
Acquire 2 miles of additional tideland for public use		X	
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Procure riverbank sites for public access development	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Promote Indian fishery conservation measures	X		
Develop subtidal park for skin divers		X	
Implement fishery management regulation changes	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities on streams, i.e., gravel removal, flood control	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
River diking and channeling techniques	X	X	

TABLE 10-9. Potential beneficial developments for fish, Puyallup Basin

Stream	Enhancement Measure								Species Benefited						
	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Puyallup R.	☒	X			X			X	X	X	X	X	X	X	X
Kapowsin Cr.					X	X		X	X	X	X	X	X	X	X
Carbon R.		X		X	X								X		X
S. Prairie Cr.					X				X	X	X		X	X	X
Voight Cr.			X					X		X	X		X	X	
Clear Cr.		X								X		X	X		X
White R.	☒	X		X	☒		X	X	X	X			X	X	X
West Fork		X		X			X	X	X	X			X		X
Greenwater R.			☒		X	X	X		X	X			X		X
Boise Cr.	X									X			X		X
Clark Cr.		X								X			X	X	X
Clear Cr.		X								X			X	X	X
Independent Drainages															
Chambers Cr.	X	X		X						X			X	X	

☒ Priority project.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Thermal powerplants should be located where cooling water requirements can be satisfied without harmful effects on fish resources.

Flood plain zoning should be enforced to prevent building construction in areas subject to flooding. Such areas should be zoned for agriculture and outdoor recreation. Flood water storage should be located in off-stream areas.

Logging practices should be designed to insure that harvesting methods are compatible with game fish production.

Low flow augmentation should be provided on the White River downstream from the Buckley diversion and downstream from the Electron diversion on the Puyallup River. Upstream and downstream fish passage should be provided at the Electron diversion and improved downstream fish passage should be furnished at the Buckley diversion canal.

Angling should be a high priority development program in any basin plan. This Basin is in a high density population area, and nearby outdoor recreation areas are essential. Public access to salt water, lakes, and streams must be made available if future demands are to be satisfied.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit a more proper perspective for water uses.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evalu-

TABLE 10-10. Estimated total salmon production increases in Puyallup Basin by project or program, to satisfy needs[1]

Project or Program, and Year	Species and Number			
	Chinook	Coho	Pink	Chum
Pre-1980				
Ladder and screen Electron diversion	2,200	8,800	--	--
Augment flows, White River	700	2,000	300	--
Alter diversion flume fish screens, White R.	2,000	2,200	--	--
Subtotals	4,900	13,000	300	--
1980-2000				
Improve fish passage, Chambers Cr., 8 stream miles	--	2,000	--	--
Improve fish habitat, 8 streams, 53 stream miles	7,400	25,200	13,500	13,600
Clear channel, Greenwater R., 4 stream miles	400	800	--	--
Supply flood control, 4 streams, 36 stream miles	1,700	4,000	800	1,300
Augment flows, Puyallup R., 18 stream miles	800	4,000	900	--
Augment flows, 4 tributaries, 34 stream miles	1,900	5,200	2,000	--
Construct spawning channel, 1 mile	--	--	120,000	--
Construct hatchery	42,000	--	--	--
Subtotals	54,200	41,200	137,200	14,900
2000-2020				
Construct 4 hatcheries or equivalent	18,000	178,500	--	--
Develop rearing facilities, 16 acres	6,000	13,600	--	--
Construct spawning channel, 1 mile	--	--	120,000	--
Subtotals	24,000	192,100	120,000	--
Totals	83,100	246,300	257,500	14,900

[1] Average annual production (catch plus escapement) at end of each period.

ate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Public fishing access areas are proposed at Fivemile, Morgan, Surprise, Spanaway, Steilacoom, and Gravelly Lakes and Lake Kapowsin. Ultimately, all significant lakes and key portions of streams and salt-water areas should have assured public fishing access.

(3) Streambank angler access on 40 miles of the Puyallup River and its major tributaries, and smaller tributaries and independent drainages (of a total of 174 miles) should be acquired and developed, as funds become available.

(4) Public fishing access to salt-water areas is proposed at the mouth of Chambers Creek and in the Puyallup River estuary.

(5) Two stream improvement projects are proposed, one each on the Puyallup and White Rivers.

TABLE 10-11. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon [1] and other anadromous fish resources, Puyallup Basin

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Ladder and screen Electron diversion	7,000	$ 170,500	$ 482,200	800	$ 4,800	$ 22,400	$ 25,000 [2]	$ 1,000
Augment flows, White R.	1,900	16,200	34,600	1,000	6,100	28,400	[3]	[3]
Alter diversion canal fish screens, White R.	2,500	52,500	147,400	500	2,700	12,600	[4]	[4]
Subtotals	11,400	$239,200	$664,200	2,300	$13,600	$63,400	--	--
1980-2000								
Improve fish passage, Chambers Cr., 8 stream mi.	1,400	$ 4,300	$ 8,300	200	$ 1,400	$ 6,600	$ 30,000	$ 600
Improve fish habitat, 8 streams, 53 stream miles	20,700	92,300	191,000	4,700	26,200	132,700	160,500	3,200
Clear channel, Greenwater R., 4 stream miles	700	2,900	6,200	200	1,200	5,500	800	800
Supply flood control, 4 streams, 36 stream miles	4,700	16,300	35,900	1,000	5,700	27,400	[2]	[2]
Augment flows, Puyallup R., 18 stream miles	3,700	11,600	25,800	700	4,100	18,900	[2]	[2]
Augment flows, 4 tributaries, 34 stream miles	5,800	18,200	42,700	1,200	6,900	34,900	[2]	[2]
Construct spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,400	700,000	1,400
Construct hatchery	22,800	151,100	362,600	13,200	79,300	369,900	1,020,000	60,000
Subtotals	155,500	$362,700	$997,900	25,500	$150,600	$716,300	--	--
2000-2020								
Construct 4 hatcheries or equivalent	140,400	$ 478,900	$ 953,600	28,000	$168,000	$ 783,900	$ 4,080,000	$ 240,000
Develop rearing facilities, 16 acres	13,200	53,200	112,700	3,600	21,600	100,600	88,000	16,000
Construct spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,400	700,000	14,000
Subtotals	249,300	$598,100	$1,391,700	35,900	$215,400	$1,004,900	$4,868,000	$270,000
Totals	416,200	$1,200,000	$3,053,800	63,700	$379,600	$1,784,600	--	--

1/ Anadromous trout benefits not included.

2/ Joint project. Part of capital cost included in that shown in Table 10-12.

3/ Multipurpose project. Separable costs, if any, have not been determined.

4/ Project under study. Costs not yet determined.

Each project is associated with a hydroelectric project. The White River project involves recommendations to a Federally-licensed power company for improved power canal screening, and increased flows downstream from the Buckley Diversion point. These developments should be coordinated with the Mud Mountain flood control storage project upstream. The Puyallup project involves the same company and includes recommendations for increased flows, fish passage upstream from the power canal diversion point, and power canal screening. This diversion, known as the Electron Diversion, lies immediately downstream from the mouth of the Mowich River.

(6) Two propagation sites are recommended for development by the State. One would include acquisition and further development of the Phillips Trout Farm, a commercial trout rearing facility contiguous to the State's South Tacoma facilities. This development would include construction of large rearing ponds and additional experimental work to rear summer and winter steelhead as well as searun cutthroat trout. The other proposed development is a steelhead rearing pond on lower South Prairie Creek, Carbon River tributary. Liberations and adult returns from a pond here would provide fishing both in the Puyallup Basin and in other basins.

(7) The Puyallup hatchery should be expanded to rear an additional 300,000 steelhead smolts annually.

(8) Additional hatchery facilities to provide a catch of 650,000 trout annually in lakes and streams should be developed.

(9) A program should be developed for elimination of channel changes by development of an adequate streambank stabilization program.

(10) New and efficient fish toxicants which detoxify rapidly and are selective as to species should be developed.

(11) New lake and stream fertilization techniques to increase fish production should be developed.

(12) An education program to stress the value and increase the popularity of fishing for spiny-rayed species should be initiated.

Table 10-12 indicates estimated annual benefits and costs of specific projects and programs proposed for the Puyallup Basin to satisfy needs for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Proposals for subsequent years, which may include some projects and programs listed above, have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected; that is, benefits from constructing a hatchery may depend on first solving fertility, disease, and public access problems. In such cases, items showing costs will not necessarily show benefits because the latter are included under other projects and programs.

Projects and Programs, 1980-2000

(1) Construct and operate additional hatchery facilities.

(2) Complete programs and projects not completed prior to 1980.

(3) Develop new projects and programs as needed.

Projects and Programs, 2000-2020

(1) Complete uncompleted projects and programs.

(2) Institute new projects and programs as needed.

(3) Continue fisheries research.

TABLE 10-12. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Puyallup Basin, pre-1980

Project or Program	Annual Benefits: Angler-Days	Annual Benefits: Value	Costs: Capital	Costs: O&M (Annual)
Lakes				
Acquire and develop public access, 8 lakes	20,000	$ 40,000	$ 125,000	$ 1,000
Develop new fish toxicants and fertilization techniques	204,000	408,000	20,000	20,000
Expand Puyallup trout hatchery	1/	1/	280,000	28,000
Develop educational program to stress value of spiny-ray fishing	35,000	70,000	5,000	--
Subtotals	259,000	$518,000	$430,000	$49,000
Streams				
Acquire and develop steelhead rearing facilities	70,000	$ 350,000	$ 225,000	$ 50,000
Acquire and develop streambank access, 40 stream miles	1/	1/	556,000	4,000
Provide fish passage at Electron Dam and adequate fish flow required between dam and powerhouse	3,500	17,500	25,000 2/	--
Construct fish hatchery	71,400	214,200	1,200,000	100,000
Subtotals	144,900	$581,700	$2,006,000	$154,000
Salt Water				
Acquire and develop public access, 2 areas	11,300	$ 33,900	$ 34,000	$ 300
Subtotals	11,300	$33,900	$34,000	$300
Totals	415,200	$1,133,600	$2,470,000	$203,300
Lakes (alternate to above lake proposal)				
Acquire and develop public access, 8 lakes	20,000	$ 40,000	$ 125,000	$ 1,000
Develop educational program to stress value of spiny-ray fishing	35,000	70,000	5,000	--
Construct fish hatchery	210,000	420,000	3,000,000	250,000
Subtotals	265,000	$530,000	$3,130,000	$251,000

1/ Benefits included in other proposed projects and programs.
2/ Joint project. Part of costs included in those shown in Table 10-11.

Approximately 136,000 acres of this Basin are under U.S. Forest Service administration. Projects and programs proposed by this agency for fishery enhancement are indicated in Table 10-13. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 10-13. Fishery enhancement projects and programs of U.S. Forest Service proposed for Puyallup Basin, 1980-2020

		1980		2000		2020	
Project or Program	Unit	Number	Capital Cost	Number	Capital Cost	Number	Capital Cost
Conduct stream surveys	mile	72	$ 2,200	1/	--	1/	--
Conduct lake surveys	acre	273	2,200	1/	--	1/	--
Clear stream channels	mile	10	20,000	22	44,000	22	$ 44,000
Remove debris from lakes	acre	46	46,000	100	100,000	100	100,000
Total			$70,400				

1/ Not yet scheduled for these time periods.

PRESENT STATUS—WILDLIFE

INTRODUCTION

The Puyallup is the main drainage and is typical of the watersheds draining into Puget Sound from the east. A broad relatively level flood plain interspersed with low rolling hills is situated near the mouth of the river and extends eastward to meet the foothills of the Cascade Range. From this point, the terrain becomes more rugged and rises in elevation to terminate at majestic Mount Rainier. The varied climate greatly influences wildlife abundance and distribution.

BIG GAME

The black-tailed deer is the most numerous and widespread of the big-game species. Elk, black bear, and mountain lion inhabit the foothill areas surrounding Mount Rainier and mountain goat are found in the rugged mountainous areas near the Cascade crest.

Inventory and Distribution

Black-tailed deer inhabit nearly every part of the Basin. Areas of current high density are generally the timbered foothills adjacent to the broad flood plain. The areas surrounding McMillin, Carbonado, and Electron represent the major deer sectors (Figure 10-2). Deer population, production, and harvest data are shown in Table 10-14.

TABLE 10-14. Deer population, production, and harvest, Puyallup Basin, 1961-1965

County	Population 1/ (Total)	Production (Ave. Annual)	Harvest (Ave. Annual)
King	1,150	320	160
Pierce	10,250	3,160	1,350
Totals	11,400	3,480	1,510

1/ Game numbers vary throughout the year; therefore, figures designate late September— early October populations.

Elk occur on the foothills generally at a higher elevation than deer. There are three areas of moderate density: one approximately on the boundary of the Puyallup and the Cedar-Green Basins in the area of Grass Mountain (northeast of Mud Mountain Reservoir), and the other two in the upper reaches of the White River drainage in the West Fork White River watershed and in the Huckleberry Creek area (Figure 10-1). The total number of elk is estimated at 1,100.

The rugged mountainous terrain in and abutting Mount Rainier National Park is the home of the mountain goat. The park has an estimated population of 350 of these animals while another estimated 300 inhabit the area east of the Naches Pass highway on Mutton and Castle Mountains.

Slightly over 70 percent of the black bear habitat of Pierce County and 9.5 percent of the King County bear habitat are within the Basin. A population of 1,000 animals is estimated.

Only a few mountain lion are found within the Basin. During the period when bounties were paid on these animals, there were seldom more than one or two taken a year from either Pierce or King Counties. Perhaps 10 to 15 mountain lion range within the Basin with the majority of these in or near Mount Rainier National Park.

Limiting Factors

Deer populations in lowland areas are affected by diversion of land to agricultural use, industrial sites, and urban development. Various other factors limiting big-game populations are described in the Area chapter, Present Status–Wildlife.

Production

Doe-fawn ratios determined just prior to the hunting season indicate an average annual increase of 3,480 deer over the spring population. Production estimates for the divisions within the Basin are shown in Table 10-14.

Based on the current trend of increasing annual harvest resulting from comparable hunting seasons, the elk herd is expanding. This indicates the herd has not reached the carrying capacity of its habitat. Under such conditions, reproduction should be high and losses near minimum. A 25 percent annual production totaling 275 young is assumed under these conditions.

Late summer counts of mountain goat reveal 29 kids per 100 adults, resulting in 130 to 150 young annually.

Black bear studies indicate an annual reproductive rate of 25-30 percent, which would total 200 to 250 animals.

Annual production of mountain lion is adequate to sustain current populations.

Harvest

Deer harvest data covering a five-year period (1961-1965) reveal an average annual harvest of 1,510 animals (Table 10-14). Of these, 160 were taken in the King County portion and 1,350 in the Pierce County portion.

The Pierce County elk harvest has gradually increased from 15 in 1961 to 75 in 1965, indicating an upward trend in the population. Increase and spread of these animals into deer habitat, both within the Basin and adjacent drainages, have been partially controlled by liberal hunting seasons. Over half of the Pierce County take, approximately 100 animals, occurs in the Basin.

The mountain goat harvest, regulated by special permit, results in a total take of 5 to 10 animals annually.

Within Pierce County, bear are legal game year round and in King County a season from July to November outside the national forest and from September to November inside the national forest is normal. Limited harvest data available indicate an average annual harvest of 200 animals.

Mountain lions occur in small numbers and are not harvested with any regularity.

Average annual hunter-days use devoted to harvest of big game in the Basin is 30,200 (deer); 3,900 (elk); 100 (mountain goat); and 1,575 (black bear). Hunter-days involved in the pursuit of mountain lion are few and were not determined.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

The only significant incident of big-game stocking which has had an effect on present big-game numbers in the Basin was the initial stocking of 80 head of elk from Montana in 1912. Most of these animals were released in the vicinity of Enumclaw and were the nucleus of the present White and Green Rivers' elk herd.

Other beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

The varied species of upland game which inhabit the Basin include both native members and introduced exotics. The native species include blue and ruffed grouse, snowshoe rabbit, band-tailed pigeon, and mourning dove. Introduced varieties are ring-necked pheasant, California quail, mountain quail, gray partridge, and cottontail.

Inventory and Distribution

Both blue and ruffed grouse are numerous and distributed throughout the Basin in suitable habitat. Populations of 41,000 ruffed grouse and 35,000 blue grouse are projected on the basis of current density studies.

No estimate of the band-tailed pigeon and mourning dove populations was made.

Ring-necked pheasant, like all the introduced exotics except mountain quail, frequent the areas which have been diverted to agriculture. Nearly all the pheasant range in Pierce County and a small part of King County's pheasant habitat are within the Puyallup watershed. The two main high density locations are the Parkland-Spanaway area and the area south and west of Buckley (Figure 10-1). A fall population of 30,000 wild pheasant is estimated. This wild population is supplemented by annual releases of game-farm birds.

California quail utilize essentially the same area as pheasant, but the mountain quail is a bird of logged brushlands. Populations of both species persist at very low density, yet appear to respond to extremely dry summers. A population of 10,000 quail is estimated. Gray partridge are not numerous.

Rabbit may be found in every type of vegetative habitat and rival grouse in overall abundance. The cottontail is prevalent in and near agricultural areas, and the snowshoe inhabits virtually all forested areas. Populations were not determined.

Limiting Factors

Encroachment by industry and urban sprawl is reducing the agricultural land area and, consequently, the pheasant, California quail, and cottontail habitat. Current clean farming practices and emphasis on hay, pasture, silage, vegetables, and berries rather than cereal grains have also reduced the upland game potential. Wildfire control and reduced emphasis on slash burning after logging have reduced the carrying capacity of wooded areas for native upland game and mountain quail.

Commercial development of Hylebos Waterway, near Tacoma, has seriously reduced pigeon numbers in this historical fall concentration area. Other limiting factors are described in the Area chapter, Upland Game.

Production

The average annual production of various species is as follows: 25,000 (ruffed grouse); 21,000 (blue grouse); 18,000 (wild pheasant); and 7,500 (quail). Actual production of band-tailed pigeon, rabbit, mourning dove, and gray partridge is undetermined.

Harvest

The average annual harvest of grouse is about 6,100 birds, consisting of 4,200 ruffed and 1,900 blues. Such harvest stimulates over 10,200 hunter-days.

Band-tailed pigeon are hunted generally throughout forested lands, with the Electron-Carbonado-Fairfax triangle (northeast of Lake Kapowsin) a particularly popular area. The historical fall concentration area at the mouth of Hylebos Creek has been closed to shooting due to extensive commercial development. About 8,000 band-tails and 900 mourning doves are bagged within the Basin each year, resulting in a total of 7,000 hunter-days.

An average of 7,000 pheasant and 1,500 quail is harvested annually, resulting in about 10,000 and 1,150 hunter-days, respectively. Rarely are the beautiful mountain quail taken by hunters. These birds frequent thick, brushy areas which hampers hunting.

Hunter questionnaires indicate that the majority of the 2,800 rabbits harvested each year are cottontail. Snowshoe are seldom hunted. Rabbit hunting produces about 1,550 hunter-days each year. Upland-game hunting in the Basin totals about 29,900 hunter-days annually.

Propagation

Two of the eight game farms operated by the State to supplement wild stocks of exotic game birds throughout Washington are located in the Basin. The South Tacoma Game Farm produces about 10,000 ring-necked pheasants and 100 each of mountain quail, bobwhite, and Japanese green pheasant annually. The Auburn Game Farm has an average annual production of 7,000 ring-necked pheasants and 100 bamboo partridge. The majority of these birds are released within the Puget Sound Area. The annual allotment of ring-necked pheasant to the Puyallup Basin exceeds 2,400 birds, of which 1,900 are mature cocks and 500 are hens. The cocks are planted in September or October to supplement hunting, and the hens are released in the early spring to augment wild broodstock. Small numbers of bobwhite, California and mountain quail, and red-legged, bamboo, and gray partridge are propagated on State-administered game farms and are released periodically within the Basin.

Eleven private game breeders located within the Basin are licensed to raise pheasant, turkey, quail, gray partridge, chukar, dove, pigeon, waterfowl, and woodcock for sale. One of these farms maintains a licensed "shooting preserve" where birds are released and hunted on the premises for a fee.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 28 acres of wildlife habitat development and 350 acres of wildlife habitat preservation, all located in the western half of the Basin.

FUR ANIMALS

A wide variety of fur bearers inhabits the Basin. Beaver, muskrat, mink, river otter, raccoon, weasel, and skunk are represented as well as red fox, bobcat, and coyote.

The fur animals, as a group, are most prevalent in lowland areas. The animals which furnish the greatest monetary return to the trapper require shallow water areas with an abundance of aquatic vegetation. Nearly every stream exhibits some evidence of fur-animal activity.

Inventory and Distribution

Beaver activity is widespread with evidence of their presence in nearly every drainage. Lowland areas are most heavily populated, although beaver are also found in mountain valleys. Their numbers are estimated at 1,200 to 1,500.

Mink and muskrat are found primarily in the lowland areas where preferred marshes, swamps, and slow-moving sloughs and streams occur. An average annual population of 8,000 muskrat and 500 or more mink is estimated.

River otter, raccoon, weasel, skunk, bobcat, red fox, and coyote occur incidentally in the trappers' catch (Photo 10-2). Their actual numbers are unknown.

Limiting Factors

Man's encroachment on fur-animal habitat is the primary limiting factor on these mammals. The fur bearers which provide the greatest monetary return to the trapper are water oriented, requiring primarily marsh-type habitat in which to live or feed. The amount and quality of shallow water areas are the principal regulating factors governing numbers. Draining and diking of marshes to create industrial area and additional farmland as well as straightening and lining of lowland streams have reduced fur-animal food, cover, and potential.

Carnivorous animal species such as mink and weasel depend, in part, on the muskrat for food. Consequently, a loss of muskrat habitat is also reflected in a reduction of these predators.

Production

The beaver population is believed to be stable and reproducing at a rate of 30 to 40 percent annually. This reproduction rate results in about 400 to 600 young beaver each year. The average annual production of muskrat is believed to be about 6,500.

PHOTO 10-2. Successfully resistant to human pressures, the coyote remains common throughout the Area. (Washington Department of Game photo)

Annual mink production is estimated at 300. Other fur bearers have reproduction rates which closely approximate that of mink.

Harvest

The annual beaver harvest has fluctuated, but no definite trend is indicated. The average annual catch during the period 1963-1966 was 260 beaver.

In recent years, about 800 muskrat, 50 mink, and 10 river otter have been taken by trappers annually. It is doubtful if either mink or muskrat are harvested to the full extent of their potential. Muskrat are trapped by the casual trapper, and consequently, the annual harvest has fluctuated. The remaining fur bearers are taken only incidentally. Trappers receive over $6,000 annually from the sale of wild-trapped fur-animal pelts.

Propagation

Sixteen private mink farms are located within the Basin.

Beneficial Developments

Beneficial developments are discussed in the Area chapter, Fur Animals.

WATERFOWL

The Puyallup Basin is a significant winter concentration area for migratory waterfowl. Suitable habitat attracts a variety of species.

Inventory and Distribution

Highest waterfowl densities occur in early winter along the shores of Puget Sound from Tacoma southwest to Dupont and in the flat lower elevation portions of the Puyallup and White River valleys (Figure 10-2).

January waterfowl counts reveal an annual average of 20,000 waterfowl. The more popular hunting species–mallard, pintail, widgeon, and teal–feed through the area during migration, but find insufficient food to remain as winter residents. The 1965 Pierce County survey is indicative of the species and relative abundance of birds using the Basin in mid-winter (Table 10-15).

Prior to the annual survey, waterfowl have been exposed to almost three months' hunting. In addition, an undisclosed number of birds hold over here in fall and early winter for a limited stay while enroute southward. The survey does not indicate the total number which use the Basin as a winter feeding station.

TABLE 10-15. January waterfowl inventory, Pierce County, 1965

Species	Number	Species	Number
Scaup	5,131	Green-winged teal	92
Eider and Scoter	4,385	Ruddy duck	89
Goldeneye	1,190	Canvasback	64
Coot	1,153	Merganser	57
Mallard	838	Pintail	4
Shoveler	605	Gadwall	2
American widgeon	465	Unidentified	75
Bufflehead	191		
		Total	14,341

Limiting Factors

Shortage of winter food is perhaps the greatest limiting factor. The entire estuarine area at the mouth of the Puyallup has been developed as an industrial complex. This had been a high production and wintering area for dabbling ducks. Draining and diking of marshes to create industrial areas and additional farmland have reduced waterfowl food and cover. Channeling and lining of lower stream reaches to reduce flood hazards also seriously reduced the riparian habitat. Agricultural production devoted to hay, vegetables, and berries have little value as waterfowl food.

Production

Waterfowl production is limited. A recent inventory disclosed an average annual production of 3,000 birds. Mallard and wood duck are the predominant species reared in the area.

Harvest

Pierce County ranks relatively high in the State in waterfowl harvest, and the Puyallup watershed includes a large part of the primary hunting area of the county.

Waterfowl hunting is generally dispersed throughout the lowlands and salt-water shoreline. An annual average of 12,300 ducks and 115 geese is harvested in 9,000 hunter-days.

Propagation

Three private game breeders list waterfowl among the variety of birds raised. These are domesticated wild strains which are never released for hunting. Otherwise, waterfowl are not artificially propagated in the Basin.

Beneficial Developments

Conservation practices applied by private landowners to agricultural lands of direct benefit to waterfowl include 250 acres of wildlife wetland preservation, located in the western half of the Basin.

OTHER WILDLIFE

The many and varied birds and animals in the Basin not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

The demand for wildlife-oriented recreation by Basin residents far exceeds the supply. Currently, less than 25 percent of the hunting by residents occurs within the Basin; however, as population pressures increase, the demand for open space and outdoor recreation opportunity within a reasonable distance will increase at an accelerated rate.[1] Non-hunting use of the wildlife resource will experience a considerable increase in popularity and surpass hunting. To maintain the present level of hunting success in the Puget Sound Area, it will be necessary for this Basin to provide an additional annual harvest of 1,400 deer; 100 elk; 160 bears; 5,600 grous; 6,700 pheasants; 11,500 ducks; 100 geese; 7,000 band-tailed pigeons; and 2,500 rabbits by 1980. As population, leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately. Table 10-16 indicates present and projected demands and needs in hunter-days.

Although birds and game animals may not be taken from the wild for commercial purposes, sale of game birds and certain game animals produced domestically by authorized game breeders is permitted. An increase in such activity in areas of high demand is anticipated.

TABLE 10-16. Present and projected hunter use in Puyallup Basin

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	74.7
1980	69.5	144.2
2000	89.5	233.7
2020	54.7	288.4

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Puyallup Basin is to be satisfied. Problems and conflicts discussed in the Area chapter apply to this Basin.

[1] Population forecasts shown in Future Needs—Fish.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basin during the target years (Photo 10-3).

PHOTO 10-3. Increased elk production is dependent upon meeting basic environmental needs. (Washington Department of Game photo)

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 10-17 indicates projects and programs proposed for the Basin to satisfy 1980 needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include recreation benefits that will accrue from public use of wildlife areas for swimming, boating, hiking, picnicking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Continue to develop cooperative programs with private landowners to assure retention of habitat and access for wildlife observation and hunting.

(3) Apply intensive management techniques to key big-game habitat.

(4) Continue research in wildlife techniques and develop new projects and programs as required.

(5) Continue programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Continue programs and projects not completed prior to 2000.

(3) Continue research for new techniques in wildlife management and harvest.

Table 10-18 indicates projects and programs for wildlife enhancement proposed by the U.S. Forest Service. Hunter-day benefits from these proposals have not been determined, but they will help satisfy overall demand.

TABLE 10-17. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Puyallup Basin, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs[1]: Capital	Costs[1]: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	4,000	$ 16,000	--	$ 5,000
Develop educational program to stress renewable aspects and value of proper use of wildlife resources	39,300	152,800	$ 5,000	--
Develop new techniques for population analysis, habitat improvement, and forest-wildlife management	[2]	[2]	20,000	10,000
Specific Programs and Projects				
Acquire title or easement to upland-bird habitat and hunting area, White River valley, 600 acres	4,800	19,200	432,000	5,400
Enlarge game farm to produce additional 3,000 pheasants	5,100	20,400	30,000	9,000
Totals	53,200	$208,400	$487,000	$29,400

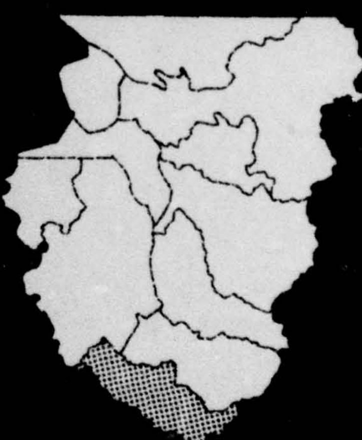
1/ Do not include survey and plan costs.

2/ Included with benefits from other projects and programs.

TABLE 10-18. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Puyallup Basin, 1980-2020

Project or Program	Unit	1980 Number	1980 Capital Cost	2000 Number	2000 Capital Cost	2020 Number	2020 Capital Cost
Surveys and plans							
Conduct range analysis							
Deer	acre	70,590	$ 7,100	Survey and planning work is not carried forward to these planning periods. Similar work here is probable.			
Elk	acre	70,590	7,100				
Mountain goat	acre	3,480	400				
Conduct upland-game habitat surveys	acre	54,410	2,700				
Develop habitat management plans	each	23	11,500				
Big-Game Habitat Improvement							
Seed and plant forage	acre	565	56,500	690	$69,000	565	$56,500
Release forage	acre	796	19,900	1,620	40,500	810	20,200
Create permanent openings	acre	315	31,500	1,570	157,000	1,260	126,000
Total			$136,700				

Nisqually-Deschutes Basins



NISQUALLY—DESCHUTES BASINS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Basins contain two principal drainages, the Nisqually River system and the Deschutes River system (Figure 11-1). Three independent streams also enter the Sound. Nonstream fresh waters include 194 lakes and reservoirs (8,936 surface acres) and 32 farm ponds (16 surface acres). Various drainages provide suitable spawning and rearing area for anadromous and resident fishes, and each contributes to the ecological makeup of estuarine and marine habitat at its confluence with salt water. This habitat supports shellfish and marine fishes.

The Nisqually River heads in the high Cascades in Mount Rainier National Park. It flows generally west to the Alder-La Grande Dam complex, exhibiting many high-quality pool and riffle sections. Downstream, it courses generally northwest, receiving the Mashel River from the north and moving across a broad valley to merge with the Sound at Nisqually Reach. In this sector, it features extensive, moderately deep riffles and long glides, and occasional deep pools. There is a water-use development in the lower reach.

The Deschutes River heads in the foothill slopes of the Cascades southwest of Eatonville. Flowing through a narrow valley, the river courses generally northwest across a broad prairie-type valley floor to its confluence with the Sound at Budd Inlet. Upper reaches of this stream have moderately steep gradient, numerous small cascades and rapids, with few good-quality pools and riffles. The remaining river downstream contains considerable high-quality pool-riffle areas interspersed with occasional rapids. At Tumwater, the river flows over a series of falls into Capitol Lake and then into Budd Inlet.

The three independent drainages exhibit a gentle gradient and contain sections of good quality spawning gravels and considerable rearing area.

Several large lakes and a large reservoir are located in the Basins. Lake Lawrence lies about 7 miles southeast of Yelm and covers about 339 surface acres. Mineral Lake, 277 surface acres, is located at the town of Mineral. Ohop Lake is about 1 mile northwest of Eatonville and covers over 235 surface acres. Tanwax (173 surface acres) and Clear (155 surface acres) Lakes are adjacent to each other—approximately 5 miles north of Eatonville. The largest reservoir, Alder Lake, lies about 5 miles south of Eatonville and is 2,931 surface acres in area. There are many other significant lakes as well as important scattered beaver ponds.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in good numbers in the Basin.

Anadromous Fish—Anadromous fishes are chinook, coho, pink (Nisqually only), and chum salmon, and steelhead and searun cutthroat trout. These fish migrate, spawn, and rear in 135.8 miles of the Nisqually River and tributaries, 49 miles of the Deschutes River and tributaries, and 10.8 miles of accessible independent drainages (Photo 11-1, Figure 11-1). Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

PHOTO 11-1. A typical spawning riffle section on the Nisqually River. (Washington Department of Fisheries photo)

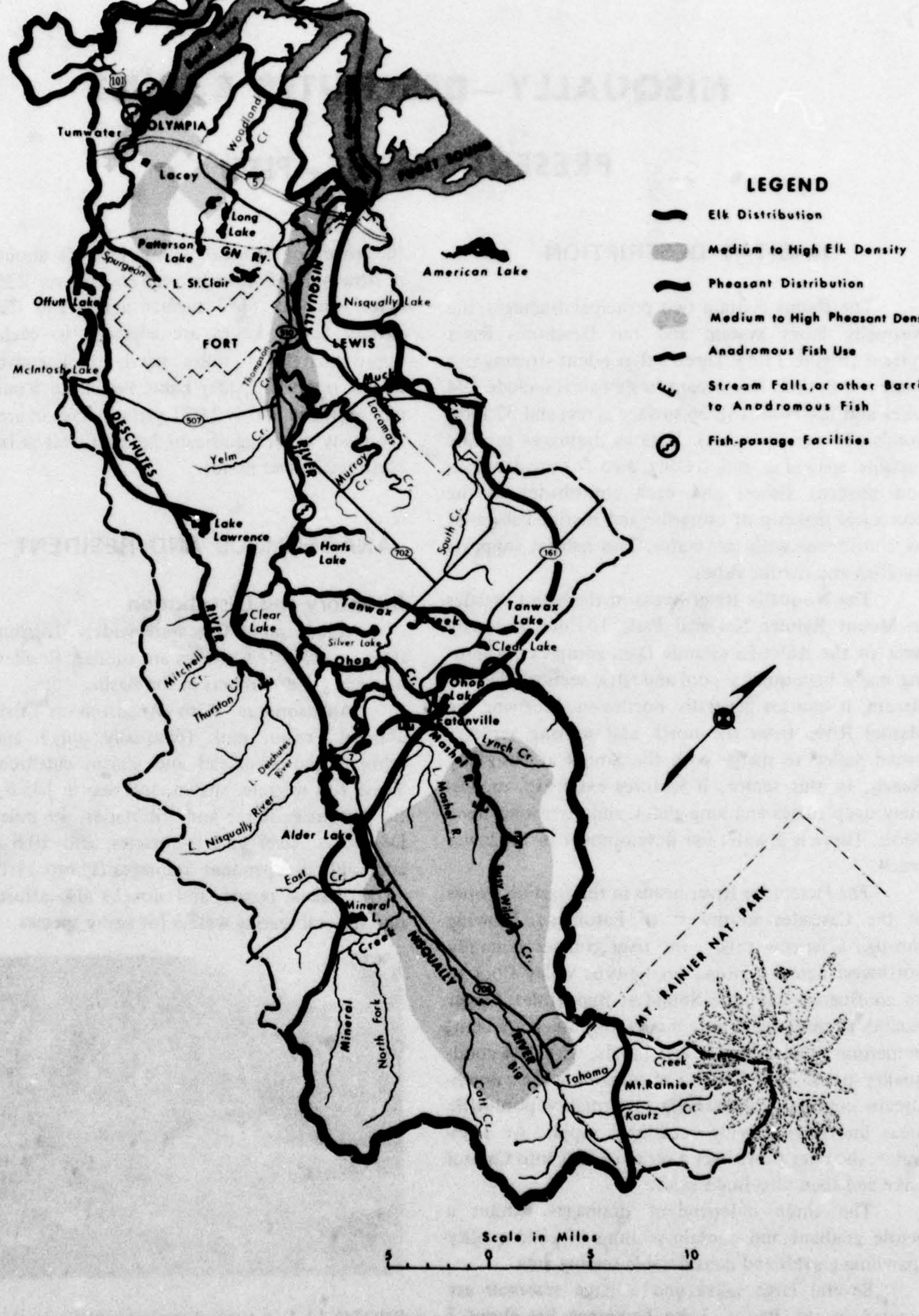


FIGURE 11-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

Upstream migration timing overlaps considerably, as shown in Tables 11-1 and 11-2. Adults of one or more species enter the stream systems every month. During the summer, May through August, the early running species remain in deep holes enroute to their spawning grounds.

Chinook salmon populate the Nisqually Basin and are generally considered to be the summer-fall segment. These fish spawn in various sections throughout the river's accessible length and in some portions of the larger tributaries, principally the Mashel River, and Ohop, Yelm, and Muck Creeks. The occurrence of chinook spawning in other Nisqually tributaries or in McAllister Creek is considered minimal. In the Deschutes, the chinook are principally fall run fish. Spawners use river sections throughout the accessible length of the Deschutes, with major spawning occurring between Tumwater and Vail, a distance of nearly 23 miles. Of the Deschutes tributaries, only Percival Creek and one of its tributaries, Little Percival, support spawning chinook. Use of independent drainages by this species is minimal.

Nearly every accessible stream draining the Nisqually-Deschutes Basins is utilized by coho salmon. The tributaries of the Nisqually serve as the principal spawning grounds. Some spawning occurs in the main river, particularly in areas where divided channels create smaller courses affording more suitable spawning conditions. Such areas are common downstream from the diversion canal for the city of Centralia's Yelm powerplant. Some of the more important tributaries receiving coho include the Mashel River, and Ohop, Tanwax, Horn, Yelm, and Muck Creeks. McAllister Creek also maintains significant coho populations. In the Deschutes system, coho spawning occurs in almost every stream area with suitable conditions, including many sections of the main river. Important tributaries include Spurgeon and Percival Creeks. The independent drainages, McLane, Woodward, and Woodland Creeks, also receive relatively good runs of coho.

Adult pink salmon spawn principally in the Nisqually. These fish utilize the broad shallow riffle areas, particularly where channel splitting creates more suitable spawning conditions. They also spawn in the Mashel River, Yelm Creek, and to a lesser extent, in McAllister Creek.

Chum salmon spawn extensively in the Nisqually downstream from the Yelm Powerplant Diversion Canal and in Muck and Yelm Creeks. The number of adult chum successfully negotiating the ladder system at the diversion is unknown. Large numbers of chum have also been reported in McAllister Creek and in the other independent drainages, McLane, Woodward, and Woodland Creeks. Some chum utilize Percival Creek, however, they do not readily ascend fishways and thus do not reach available spawning ground in the Deschutes River.

Steelhead and searun cutthroat spawn and rear in all accessible reaches of the main rivers and small tributaries. Exceptions are the more restricted use limits of searun cutthroat. The independent drainages such as McLane, Woodward, Woodland, and McAllister Creeks, are also important spawning and rearing areas. A few searun Dolly Varden occur in larger tributaries and the Nisqually River.

Significant spawning reaches in some streams are delineated in Table 11-3.

Intragravel egg development occurs over an 11-month period, because of the overlapping period of spawning for various species.

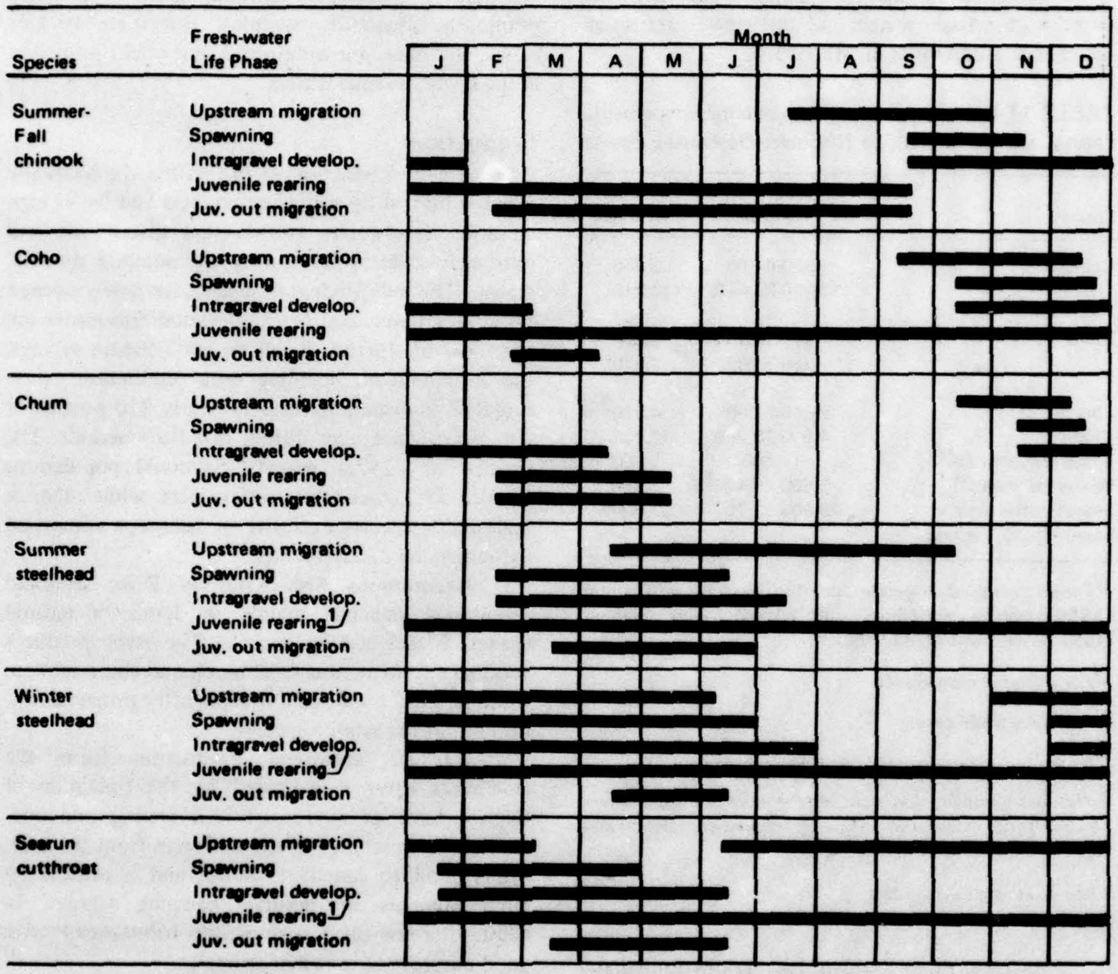
"Out migration" for all species peaks during the period March-June, corresponding with high spring runoff. Some migration occurs throughout the year, but this is natural redistribution of juvenile salmonids within the stream systems. Various downstream migrants spend considerable time in fresh water and the estuarine acclimation environment. The estuarine and marine waters are of prime importance to their successful early rearing and survival. After adjusting to the salt-water environment, they disperse into Puget Sound and the ocean.

TABLE 11-1. Timing of salmon and searun trout fresh-water life phases in Nisqually Basin

Species	Fresh-water Life Phase	J	F	M	A	M	J	J	A	S	O	N	D
		Month											
Summer-Fall chinook	Upstream migration							X	X	X	X		
	Spawning									X	X	X	
	Intragravel develop.	X	X							X	X	X	X
	Juvenile rearing	X	X	X	X	X	X						X
	Juv. out migration		X	X	X	X	X						
Coho	Upstream migration							X	X	X	X	X	X
	Spawning	X	X									X	X
	Intragravel develop.	X	X	X	X							X	X
	Juvenile rearing	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration		X	X	X	X	X						
Pink	Upstream migration								X	X	X		
	Spawning									X	X	X	
	Intragravel develop.	X	X	X						X	X	X	X
	Juvenile rearing		X	X	X	X	X						
	Juv. out migration		X	X	X	X	X						
Chum	Upstream migration								X	X	X	X	X
	Spawning	X	X	X								X	X
	Intragravel develop.	X	X	X	X	X						X	X
	Juvenile rearing		X	X	X	X	X						
	Juv. out migration		X	X	X	X	X						
Summer steelhead	Upstream migration				X	X	X	X	X	X	X		
	Spawning		X	X	X	X	X						
	Intragravel develop.		X	X	X	X	X	X					
	Juvenile rearing[1]	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration			X	X	X	X						
Winter steelhead	Upstream migration	X	X	X	X	X	X					X	X
	Spawning	X	X	X	X	X	X						X
	Intragravel develop.	X	X	X	X	X	X	X					X
	Juvenile rearing[1]	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration				X	X	X						
Searun cutthroat	Upstream migration	X	X	X			X	X	X	X	X	X	X
	Spawning	X	X	X	X								
	Intragravel develop.	X	X	X	X	X	X						
	Juvenile rearing[1]	X	X	X	X	X	X	X	X	X	X	X	X
	Juv. out migration			X	X	X	X						

[1] Normally extends over a two-year period.

TABLE 11-2. Timing of salmon and searun trout fresh-water life phases in Deschutes Basin



1/ Normally extends over a two-year period.

TABLE 11-3. Significant spawning reaches for anadromous fish and resident game fish, Nisqually-Deschutes Basins1/

Stream	Section	Stream Mileage	Type of Spawning Area
Nisqually R.	Nisqually to La Grande area	3.0-42.0	Some broad riffle sections, extensive patch gravel
Mashel R.	Mouth to Eatonville	0.0-6.0	Occasional riffles, mostly patch gravel
	Eatonville to point near headwaters	6.0-14.0	Few riffles, considerable patch gravel
Ohop Cr.	Mouth to Ohop Lake area	0.0-6.0	Occasional riffles, mostly patch gravel
Deschutes R.	Falls to Rainier area	2.0-18.0	Numerous riffles, occasional patch gravel sections
	Rainier area to point near headwaters	18.0-33.0	Some riffles, mostly patch gravel

1/ Additional spawning area is provided by virtually all tributaries entering within described reaches.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 11-4.

TABLE 11-4. Anadromous fish spawning escapement, natural and (artificial), in Nisqually-Deschutes Basins

Species	Range 1/	Average (Annual)
Chinook	950-8,600	3,850
	(12,350-25,050)	(18,710)
Coho	1,040-12,150	4,890
	(230-5,380)	(3,870)
Pink	3,650-6,000	4,510 2,3/
Chum	4,030-18,890	10,730
Summer steelhead 4/	10-400	80
Winter steelhead 4/	5,500-10,400 5/	7,300 5/
Searun cutthroat 4/	22,600-33,700 5/	27,600 5/
Searun Dolly Varden 6/		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

2/ Per odd-year escapement.

3/ Nisqually Basin only.

4/ Totals include natural and (artificial) escapement.

5/ Includes Nisqually Basin and independent drainages only—no valid totals established following fishway completion and stocking on Deschutes River.

6/ No valid totals established.

Resident Fish—Resident fish are distributed and spawn throughout the inland waters (Table 11-3). Rainbow trout inhabit the major rivers and a number of the larger tributaries. Cutthroat and brook trout occur primarily in the smaller tributaries at higher elevations. Numerous small lakes and ponds also support these two species. The major occurrence of Dolly Varden, an entirely self-sustaining species, is in the Nisqually River and its larger tributaries.

Kokanee are most common in Alder Lake and Lake St. Clair in the Nisqually Basin. Populations are stable and self-sustaining. Mountain whitefish occur in various streams, but are most abundant in the Nisqually River. Populations of largemouth bass, yellow perch, pumpkinseed, brown bullhead, and white and black crappie, all introduced species, frequent lowland lakes and Alder Lake. Rock bass and warmouth are also found in these Basins.

Other fresh-water species, such as suckers, peamouth, squawfish, sculpins, threespine sticklebacks, and dace, are widespread, but occur primarily in the lower, warmer waters.

Production

Stream production of fish within the Nisqually River is limited by water-use projects and by its high elevation headwaters contributing glacial silt and extremely cold water during the summer growing season. The independent drainages, the newly opened Deschutes River, and lower elevation tributaries are the most productive. Based on 1967 stream surveys, the instantaneous standing crop production values varied from essentially zero to nearly 310 pounds of fish per surface acre during low flow periods. The average was 252.7 pounds. Salmonid populations equaled 28.8 pounds per surface acre, while other or undesirable species exclusive of lampreys comprised the remaining 223.8 pounds.

Anadromous Fish—Nisqually River salmonid production depends mainly on levels of natural spawning and rearing success. The river produces good to excellent runs of chinook and chum salmon, while Nisqually tributary streams offer prime habitat for each of the salmon species.

Overall salmonid production from the Deschutes River is increased by the operation of Capitol Lake as a semi-artificial rearing impoundment. The Deschutes River, upstream from the lake, offers good to excellent habitat and is utilized by large numbers of natural spawning salmon. In addition, a few small, high quality tributaries receive good numbers of spawners annually.

The Nisqually Basin is a productive summer and winter steelhead area. The Deschutes Basin was opened in 1954 and received stocks of winter steelhead. During 1962-1966, the average annual natural production of steelhead in the Nisqually Basin approached 11,130 adults. Estimates indicate that summer steelhead contributed approximately 5 percent of this total. Marking experiments are underway to determine the existing natural steelhead production potential and resultant harvest in the Deschutes Basin with establishment of stocks following completion of the Deschutes River fish-passage facilities. The average annual natural production of searun cutthroat trout is calculated at 36,700 adults. This considers an incomplete establishing of these fish within the Deschutes Basin. Realization of potential natural production would result in a significant increase in numbers of both species.

Fish production data are shown in Table 11-5.

TABLE 11-5. Anadromous fish natural production (harvest plus escapement), Nisqually-Deschutes Basins

Species	Range 1/	Average (Annual)
Chinook	3,800-34,400	15,400
Coho	5,200-60,750	24,450
Pink	10,950-18,000	13,530
Chum	8,070-37,770	21,460
Summer steelhead	10-600 3/	130 3/
Winter steelhead	8,200-15,700 3/	11,000 3/
Searun cutthroat	30,100-45,000 3/	36,700 3/
Searun Dolly Varden 2/		

1/ Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

2/ Production limited and therefore not determined.

3/ Figures include Nisqually Basin and independent drainages only—no valid totals established following fishway completion and stocking on Deschutes River.

Resident Fish—Portions of the major rivers, some tributaries, and independent drainages lie upstream from anadromous fish barriers. In the Nisqually Basin they are often small, cold, and precipitous, and are producing their natural potential. Streams not originating from glaciers often receive fish recruitment from headwater lakes or ponds. Planted hatchery trout supplement natural production. The instantaneous standing crop (excluding lampreys) in Basin streams also varies between little or no production to about 300 pounds of fish per surface acre.

Stream reaches downstream from migration barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The instantaneous standing crop of fish produced varies between 200 and 310 pounds per surface acre. Hatchery-reared resident and anadromous trout are also planted in these areas. This is particularly true of the Deschutes River.

Actual production of lakes, ponds, and reservoirs is shown in harvest data. The total harvest of certain standing waters varies from one season to another and may vary from less than 10 to more than 300 pounds per surface acre annually. Potential production could be substantial.

Propagation

Although no salmon propagation facilities are maintained in the Basins, juvenile salmon are introduced into the Nisqually River system from State hatcheries located in other basins. In general, both chinook and coho juveniles are planted annually, principally from the Puyallup Salmon Hatchery.

Commercial and sport catch statistics indicate that the salmon stocking program in the Nisqually Basin contributes approximately 1,400 chinook and 4,400 coho to these fisheries annually.

Salmon eggs are obtained annually at the Tumwater Falls fishway on the Deschutes River (Figure 11-2) with incubation and early rearing occurring at State hatcheries outside this Basin. The extensive chinook and coho populations inhabiting the Deschutes were originally introduced via planting programs. Chinook are now supplemented through intensive plants made in Capitol Lake, a 300-acre managed rearing area located between the falls and Puget Sound. Occasional coho plants are also made in the system.

Preliminary commercial and sport catch statistics indicate that the salmon planting program in the Deschutes Basin contributes approximately 63,480 chinook and 7,100 coho to these fisheries annually.

There are no public hatchery facilities for game fish within the Basins. Fish-stocking requirements are fulfilled from the production of facilities in other generally adjacent basins and from hatcheries outside the Puget Sound Area. These facilities provide rainbow, steelhead, cutthroat, brook, and searun cutthroat trout in addition to kokanee, for Basin waters. A total of 14 farm fish ponds receives plants of hatchery fish every two to three years from private facilities. Several privately-owned hatcheries near Olympia and Nisqually produce rainbow trout for commercial outlets, including private ponds.

Surveys and catch statistics indicate that the planting program annually provides approximately 30 percent of all sport-caught steelhead in the independent drainages of the Deschutes Basin and in the Nisqually River, exclusive of the Indian fishery. They also indicate that 10 percent of searun cutthroat trout, 95 percent of all resident trout, and 98 percent of all kokanee caught in both Basins annually are contributed by this program.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 3,403,798

[1] Anadromous trout data involve period 1962-1966.

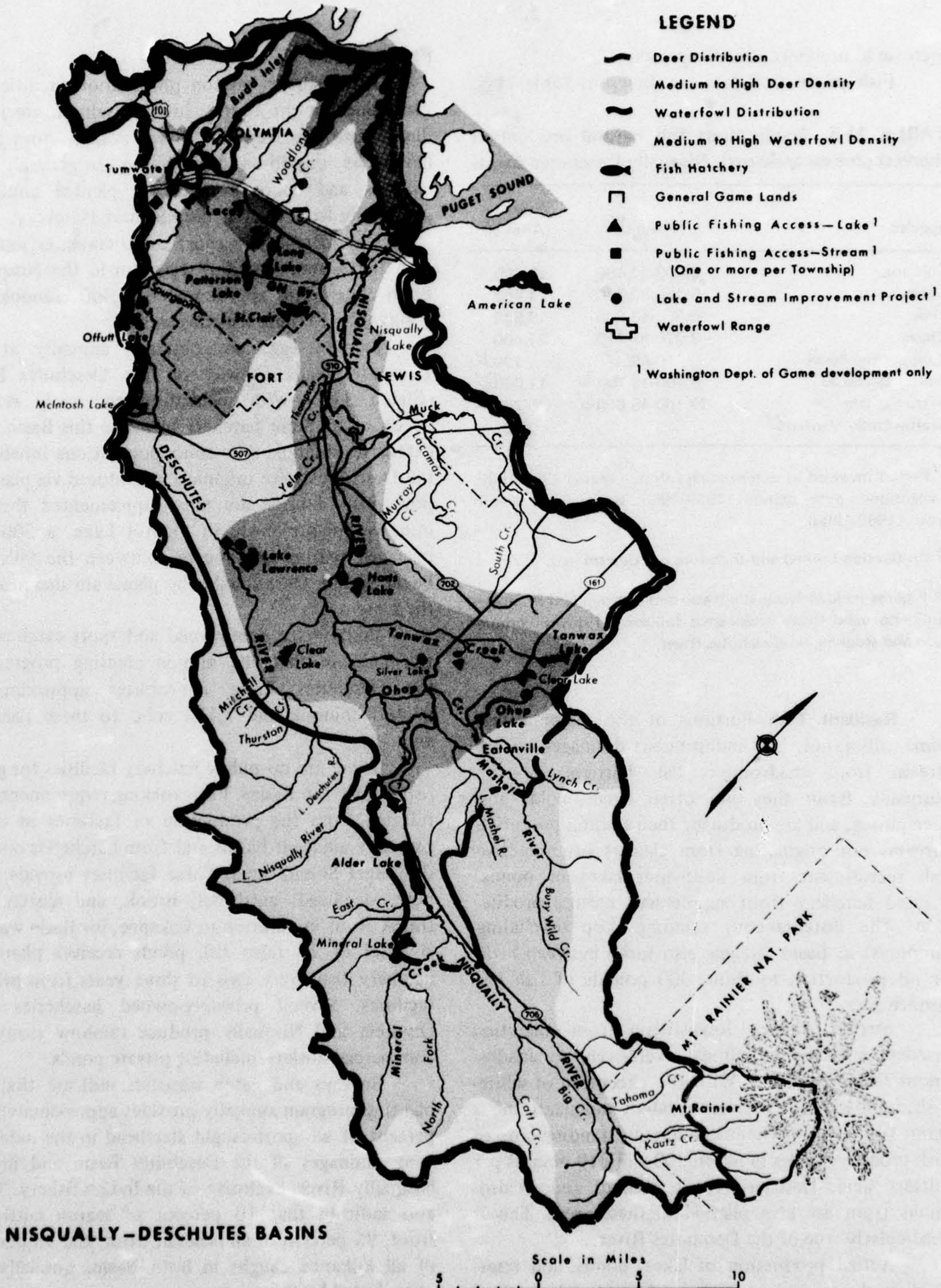


FIGURE 11-2. Wildlife distribution, and fish and wildlife developments (1965)

chinook; 544,048 coho; 43,753 chum; 39,431 steelhead; and 3,760[1] searun cutthroat. Resident fish propagation data appear in the Area chapter.

Harvest

Existing Harvest—Salmon produced or reared within Basin waters contribute to United States and Canadian ocean sport and commercial fisheries, and to those in the Strait of Juan de Fuca and Puget Sound. Some sport harvest also occurs within the Nisqually and lower Deschutes Rivers. The average annual contribution to these various fisheries, during the period 1956-1965, was 143,200 salmon.

The marine waters are closed to commercial salmon fishing. In the Nisqually Indian fishery, operating in the lower Nisqually River, significant numbers of salmon are caught and marketed through licensed fish dealers.

Sport angling for salmon is very popular in the marine waters, with fishermen utilizing the area from the river mouths to Johnson Point, Cooper Point, and waters off southwestern Anderson Island. Relatively large numbers of immature fish are attracted to excellent feeding grounds within these waters year round. This fact, combined with significant returns of adult salmon through the area to southern Puget Sound streams, relatively good access for fishermen to their favorite fishing areas, and the fishing areas' semi-protection from winds and turbulent water, tend to make this fishery an important yearlong activity. The angling sites here are among the most popular in southern Puget Sound where, in 1965, nearly 100,000 angler-days were recorded.

From 1964 through 1966, the average annual sport catch of salmon from the lower Nisqually River was 90 fish, representing 550 angler-days. Most of these were jack chinook or coho, although pinks were harvested in 1965.

Sport salmon angling is permitted in Capitol Lake, the impounded lower reach of the Deschutes River, and in the river upstream from the old Highway 99 bridge.

A recent survey (1966) indicated that 25,000 angler-days were spent in catching nearly 5,000 steelhead. Of this number, approximately 1,000 angler-days were expended in the harvest of 200 summer steelhead. The harvest from the Nisqually River drainage constitutes 77 percent of this total and its natural production contributes almost 70 percent of the total. Angler access is becoming a problem on the lower Deschutes River. The problem will continue with the ever-increasing vacation cabin and homesite development along the river. Because steelhead are classified as a game species, no commercial landings of these fish are recorded. However, steelhead landings are made by Indian fishermen. This unrestricted fishery limits game fish escapement and subsequent production.

Survey data (1966) also indicate 16,800 angler-days were spent in the pursuit of searun cutthroat in salt water with a total harvest of 10,100 fish. Natural production contributes over 90 percent of the total fresh- and salt-water searun cutthroat harvest. Harvest of searun cutthroat in fresh water and the take of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of 1966 survey data, 358,700 angler-days were spent fishing in the lakes, ponds, and reservoirs, and a total harvest of 1,224,400 trout and 550,600 other game fish realized. A total of 83,800 angler-days was spent fishing for game fish other than steelhead in streams and 313,600 were harvested. The whitefish harvest was estimated to be less than one percent of this total.

Potential Harvest—Potential salmon harvest in the Basins would be significantly greater than that which presently occurs. The Area chapter presents a discussion of salmon harvest trends.

Potential harvest of natural steelhead production is difficult to predict, because artificial propagation currently results in added fishing pressure on these populations. However, an increase in harvest would be possible.

The harvest of searun cutthroat has not reached its full potential. This is due mainly to the widely varied salt-water fishery, brief season, and popularity of winter steelhead angling. Increased harvest estimates are not available for the Deschutes River. However, indications are that greater numbers of these fish could be harvested.

Resident salmonid production and harvest in streams are not expected to change, even though undesirable species composition in the Deschutes River is similar to that in the areas harboring anadromous fish. In the Nisqually River drainage, reservoirs and glacial silt restrict the potential for control of undesirable fishes and a potential increase is not calculated. All values consider that the exclusions noted for anadromous fish apply to areas both

[1] Annual stocking initiated in 1964, with most active program in 1966.

upstream and downstream from migration barriers. An exception is the catch of mountain whitefish, which is estimated at less than one-twentieth its potential. Because this total harvest is not separable from stream resident fish harvest data, present and potential harvest values are not given. Potentially, harvest of resident salmonids in lakes, ponds, and reservoirs could undergo a substantial increase.

Factors Limiting Production Other Than Harvest

Table 11-6 presents various alterable factors limiting Basin production of fish.

Detrimental Streamflow—Fish production in nearly all of the Nisqually's smaller tributaries suffers to some extent from low summer flows. In the Nisqually, low flow conditions are aggravated by restricted water releases from Tacoma City Light's Alder Dam during summer months, and by the diversion of water into the Yelm Powerplant Diversion Canal upstream from Yelm. These two projects are not coordinated with fish needs, and the result is extreme low flow conditions in the main river. The two major tributaries to the Nisqually downstream from Alder Dam, Muck Creek and the Mashel River, both experience annual low flow problems. Portions of Muck Creek, because of its location in a glacial outwash plain, are dry for a month or more each year. The natural summer low flow problem in the Mashel River has been aggravated by extensive logging.

In the Nisqually River, flooding has only a limited effect on the fish producing environment. The Mashel River experiences flooding problems because of rapid runoff from steep mountainous terrain. This in turn causes rapid movement of streambed materials and stream stability is affected.

Seasonal flooding occurs throughout the Deschutes River drainage; however, within the smaller streams the effect is usually less damaging. In the Deschutes, occasional floods destroy salmonid spawn or drastically alter spawning and rearing habitat. Extensive logging in the upper Deschutes watershed has intensified intermittent runoff and consequently has increased the magnitude of short duration floods.

Seasonal low flows are common in virtually every stream, but are especially critical where excessive land clearing has occurred.

Poor Water Quality—Glacial silt occurs in many Nisqually Basin drainages from late spring to early fall, and from November to March. This condition is detrimental to fish production from the standpoint of egg survival and fish food production. It also hampers angler success. The nonseasonal siltation between November and March, downstream from Alder Dam, is caused by reservoir flushing operations. The accumulated silt in this impoundment has increased the duration and degree of stream coloration considerably over the past decade.

Within the marine and estuarine waters of the Nisqually Basin, the problem of maintaining water quality has been minor. However, future industrial and domestic expansion within the Basin may degrade water quality.

Rapidly expanding urban and highway developments are expected to influence water quality and silt loading of streams in the relatively near future. Highway construction landfill has created excessive leaching of mud and silt in Woodland Creek, which has destroyed good coho and chum salmon spawning area.

Uncoordinated flow releases have resulted in nearly nonexistent flows with resultant high water temperatures and low dissolved oxygen in the lower Nisqually River. In addition, the smaller lowland drainages experience warm temperatures which may be limiting to fish production. Examples of these are McAllister, Muck, and Yelm Creeks.

The Deschutes River exhibits warm temperatures, particularly during the summer low flow period. This results in near optimum conditions for competitive and undesirable species and could limit future fish production.

In addition, resident game fish have been subjected to unscheduled diversions of water into the Yelm Powerplant Diversion Canal. These diversions often cause a temperature rise with resulting drop in dissolved oxygen in the Nisqually River for 12 miles downstream. This has resulted in fish kills of both anadromous fish and resident game fish on several occasions.

Physical Barriers—Tacoma City Light's Alder-La Grande Dam complex located at river miles 41.2 and 39.7, respectively, blocks 30 additional miles of the upper Nisqually River watershed suitable for use by anadromous fishes. The combination of river control at the dam, which diverts all summer flow to the La Grande Powerhouse, and an impassable barrier in the canyon upstream from the powerhouse, essentially restricts anadromous and/or resident fish production on the Nisqually River to the La Grande Powerhouse and downstream. Another power diversion, the Yelm

Powerplant Diversion Canal, exists downstream. Even though this diversion point is screened and provides fish passage, water withdrawal sometimes exceeds the combined natural flow and La Grande Powerhouse release with a resultant dewatering of much of the Nisqually River from this diversion to the Yelm Powerplant discharge several miles downstream from Yelm. Minimum releases of 50 cfs for fish life have been established from the diversion, but since upstream flows are often not coordinated with diversion at the Yelm Powerplant Diversion Canal, minimal benefits are realized.

There are several waterfall-cascade type barriers which have considerable production area upstream. They are located on the Mashel River and its upper tributaries (Table 11-6).

A serious problem in this drainage is the formation of intermittent logjams and beaver dams on many of the smaller tributaries such as Tanwax and 25 Mile Creeks. These sometimes become complete blocks, or at least, hinder upstream migrating fish, particularly during extreme low or high water conditions.

A falls at river mile 35 on the upper Deschutes River blocks anadromous fish migrations. Some spawning and rearing potential exists upstream from these falls. Intermittent barriers created by debris buildup, or by beaver activity, occur on all of the smaller streams within the Basin. Attempts are made by State fishery agencies to remove such barriers whenever they are reported.

Conflicting Watershed Developments—Logging is, and will probably continue to be, the most significant development factor in the upper water-

TABLE 11-6. Alterable factors limiting anadromous and resident fish production in Nisqually-Deschutes Basins

	Limiting Factor[1]										Species Affected						
Stream	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes[2]	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Nisqually R.		X	X	X							X	X	X	X	X	X	X
Muck Cr.		X		X				X				X	X	X	X	X	X
Horn Cr.		X				X						X	X	X	X	X	X
Tanwax Cr.		X				X	X					X	X	X	X	X	X
Ohop Cr.		X					X			X	X	X	X	X	X	X	X
Lynch Cr.		X		X	X					X	X	X			X		X
25 Mile Cr.						X						X			X		X
Mashel R.	X	X			X				X	X	X	X	X		X		X
Little Mashel R.		X			X							X			X		X
Beaver Cr.					X	X						X			X		X
Busy Wild Cr.						X						X			X		X
Deschutes R.	X	X			X					X	X	X			X	X	X
Percival Cr.		X									X	X			X	X	X
Spurgeon Cr.		X				X	X					X			X	X	X
Independent Drainages																	
McAllister Cr.						X			X	X		X		X	X	X	X
Woodward Cr.			X			X						X	X		X	X	X
McLane Cr.			X			X						X		X	X	X	X
Woodland Cr.			X			X			X			X		X	X	X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

sheds. Excluding Mount Rainier National Park, timber harvesting occurs throughout the upper watersheds, particularly those of the Mashel and Nisqually Rivers. These operations accelerate flow runoff patterns and degrade water quality in downstream waters.

Minor industrial development occurs in the Deschutes drainage. Such development is seldom compatible with fish needs.

Home development adjacent to the Deschutes River and the smaller drainages is accelerating. Associated with such development will be demands for stream channeling and diking, and such alterations seldom incorporate measures that promote or protect fish life.

Gravel removal from natural streambeds by public and private agencies for construction and flood control purposes is depleting available spawning areas. Most operations of this type are occurring in the Deschutes River.

Water withdrawal from Deschutes drainages for municipal, agricultural, or industrial purposes is a limiting factor on virtually all streams involved.

Limited Spawning and Rearing Areas–Spawning area in the Nisqually Basin is limited mainly by physical blocks, profile changes, and by destruction of suitable streambed by construction and/or erosion control projects. The loss of gravel associated with profile changes in the Mashel River is a serious problem which reduces available salmon spawning area. Construction has had only a limited effect on the environment, but it is expected to become an increasing problem as population and industrial expansion continues. Rearing area is naturally limited by the low summer flows in the Basin. Also, considerable potential rearing area is unavailable because it is located upstream from manmade and natural barriers.

Some watercourses within the Deschutes Basin do not provide a good balance of spawning and rearing area; extreme low summer flows in certain streams limit the rearing capacity. Such conditions are prevalent in Woodward and McLane Creeks, and in the Deschutes River during particularly low water years.

Competition and Predation–Considerable predation upon juvenile salmonids occurs in the estuarine and marine areas. These small fish are consumed by larger anadromous fishes and by certain marine fishes and birds. Also, the spiny dogfish, abundant in some areas, feeds on juvenile fish as well as on herring, a principal food of adult salmon. Seals are predators on adult salmonids.

Competition and predation pressure on anadromous fishes is moderately intense in the Deschutes drainage. Large populations of resident and anadromous fishes inhabit these waters, and their behavioral and feeding habits limit total populations. During the summer, spiny rays cause predation in the lower Deschutes River.

Production of desirable game fish in lowland lakes is limited by serious competition and stunting in spiny-rayed populations. In many lakes, spiny rays compete with and prey upon trout. Other undesirable species are also prevalent.

Trout production is minimized in mixed-species lakes. Spiny-ray reproduction and inadequate harvest cause serious competition among these species which results in stunted undesirable populations. This is the most important factor limiting management attempts to provide a maximum sustained yield of single or combinations of species most desired by anglers.

Beneficial Developments

Accomplished and Continuing–Enhancement projects for anadromous fishes in the Nisqually Basin have involved stream clearance of beaver dams and logjams and installation and improvement of facilities to facilitate upstream fish migration (Figure 11-1). Most of these operations were performed on small Nisqually tributaries downstream from La Grande.

Enhancement projects for anadromous fish in the Deschutes drainage have included beaver dam and logjam removal on small tributaries, plus installation and annual clearing of the major fishway at Tumwater Falls (Photo 11-2).

PHOTO 11-2. Deschutes River fishway (right) provides passage of adult fish at Tumwater Falls and canyon. (Washington Department of Fisheries photo)

Beneficial management developments in the Nisqually-Deschutes Basins are primarily concerned with increasing game fish production and public fishing access in lowland lakes, and in stream reaches of importance to anadromous game fish. This entails artificial propagation, fish ladders, screening of managed waters, experimental liberation of hybrid stocks, lake rehabilitation, stream and lake improvement, and public fishing access area development. Lake rehabilitation is especially important in the productive lowland lakes.

Rivers in Mount Rainier National Park originate from active glaciers and carry glacial silt during the summer. No fish are planted in them. Only three lakes in the national park portion of the Nisqually Basin support fish. These lakes, comprising an important segment of all park lake acreage, are included in the fisheries management program of the park, administered under a cooperative agreement between the Bureau of Sport Fisheries and Wildlife and the National Park Service. This program includes planting rainbow and cutthroat trout on a two-year cycle.

The Alder-La Grande hydroelectric project complex has produced reservoir-type fisheries. However, this was accomplished at the expense of natural stream production.

Waters which have been chemically rehabilitated for trout management include Clear, Nisqually, Tanwax, Trails End, Ward, Offutt, Hicks, McIntosh, Clear (Bald Hill), Fiander, Munn, and Mineral Lakes, Lake Lawrence, and Lake St. Clair. While only four of these lakes required screening, four also required barrier dams. Figure 11-2 indicates location of various stream and lake improvement projects.

Fishermen access developments exist at Clear, Harts, Ohop, Rapjohn, Tanwax, Chambers, Clear (Bald Hill), Long, McIntosh, Munn, Offutt, Patterson, Hicks, Ward, and Mineral Lakes, Lake Lawrence, Lake St. Clair (2), and Lake Whitman (Figure 11-2). Fishing and boat launch access areas exist on the Nisqually River and fishing access areas are located on the Deschutes River (Figure 11-2). The Federal fishery management program on the Fort Lewis Military Reservation provides angler access to Lewis, Nisqually, Chambers, and Fiander Lakes and Wright Marsh. The fishery projects on the reservation are under a cooperative plan involving the Fort Lewis Command, Bureau of Sport Fisheries and Wildlife, and the Washington Departments of Fisheries and Game. Private and public agencies augment these areas with other facilities along Basin streams and lakes.

Effort to obtain guaranteed public fishing access on lakes, streams, and certain salt-water areas is a continuous process—similarly, the maintenance and construction of inlet and outlet control structures accompanying specific lake rehabilitation.

Under Development—Hybrid stocks of cutthroat trout have been liberated in the Deschutes Basin. Based on preliminary recovery data, returns of resident and searun species have been encouraging.

Several fish bypass and water diversion projects are nearly completed in the Muck Creek drainage.

MARINE FISH AND SHELLFISH

Habitat Description

The saline waters encompassed within the Nisqually-Deschutes Basins possess similar characteristics and, therefore, are considered as a single unit. Within these waters depths are quite uniform, with few areas exceeding 30 fathoms. The area contains numerous bays, coves, and protected waters, and provides considerable shallow water habitat.

The southern Puget Sound waters include all inclosed waters and marine shorelines south of the Tacoma Narrows Bridge (in Puyallup Basin). Since this area is unique for shellfish, and production records include all the southern Sound inlets, it must necessarily be considered as one unit. Thus, southern Puget Sound includes the Nisqually-Deschutes Basins, and portions of the Puyallup and West Sound Basins.

The marine and estuarine waters and shoreline extending from the Tacoma Narrows Bridge to Shelton (in West Sound Basins) comprise the Basins' shellfish habitat. Included are Fox, Anderson, McNeil, Hartstine, and Squaxin Islands, and other smaller islands. In addition, there are numerous inlets, including Carr, Henderson, Case, Budd, Eld, Totten, Skookum, and Hammersley.

The salt water of southern Puget Sound is less saline than that of the central and northern portions, because mixing with denser marine waters is limited by the restricted channel of the Tacoma Narrows. Therefore, interchange is extemely limited within the long inlets. The extensive mud flats at the head of each inlet create water temperatures considerably above those of other Sound waters.

Inventory and Distribution

Marine Fish–The uniform ecological character of the area tends to limit the variety of marine fishes. These include species of cod, surfperch, flounder, sole, rockfish, herring, dogfish, and ratfish. Population is discussed in the Area chapter concerning species production.

Shellfish–Principal species of shellfish and other marine invertebrates are red crabs; Pacific, native, and Kumamoto oysters; Manila, littleneck, butter, horse, and softshell clams; geoducks; cockles; piddocks; blue mussels; spot and pink shrimp; squid; octopi; sea urchins; and sea cucumbers.

Dungeness crabs are few in number and occur on the Nisqually Flats and in Oro Bay at Anderson Island. The smaller red crabs, however, are extremely abundant throughout the oyster and clam habitat, as are other undesirable species such as the spider crab. Box crabs, few in number, frequent deep water areas.

Oyster Bay in Totten Inlet is considered the most productive area in Puget Sound for Pacific oysters. Carr, Eld, Case, Budd, Skookum, and Henderson Inlets; Pickering and Peale Passages; Squaxin and Hope Islands' vicinity; Oakland Bay in Hammersley Inlet; and the Nisqually Flats are also productive.

Although the native and Kumamoto oyster beds are not as extensive as those of Pacific oysters, they are generally found throughout this southern area, principally in north and south Case Inlet; in Vaughn, Rocky, and North Bays extending along the shoreline through Pickering Passage; in Oakland Bay; Skookum Inlet; Oyster Bay; from Rocky Point to Mud Bay in Eld Inlet; at Silver Spit and in Gull Harbor in Budd Inlet; and from Chapman Bay to South Bay in Henderson Inlet.

Manila clams, an introduced species, are the most numerous hardshell clam, occurring in Carr, Case, Skookum, Totten, and Budd Inlets, and Oakland Bay. Native littlenecks, somewhat less abundant, occur in the same areas as the Manila. Heavy concentrations of horse clams occur in sandy mud areas. Butter clams inhabit the same beaches as the Manila; they occur in significant numbers in Carr and Case Inlets. Softshells are abundant on most of the shallow mud flats in the coves, bays, and inlets. Geoducks are numerous on all sandy mud flats and tidelands below the lower-low water mark, especially on the Nisqually Flats, in north Carr, north Case, Totten, and Eld Inlets; and in Oakland Bay. Cockles are prevalent on all clam beaches in concentrations far exceeding those in other Sound areas. Piddocks occur in isolated concentrations where clay outcroppings extend into the tidelands. Blue mussels are abundant along all beach areas.

Pink shrimp are the predominant species of this shellfish, occurring in Carr Inlet, the McNeil Island vicinity, in Hale and Drayton Passages, in the Anderson Island-Nisqually Reach area, and off the east side of Hartstine Island in Case Inlet. Sizeable populations of spot shrimp favor deep channel areas with moderate currents.

The most abundant populations of squid in the Sound inhabit waters south of the Tacoma Narrows, especially Hale Passage and its arm, Wollochet Bay; Carr, Case, and Budd Inlets; and Oakland Bay. Octopi are numerous around Fox and Anderson Islands, and in Case and Carr Inlets and Dana Passage. Lesser numbers occur throughout other marine waters. Sea urchins favor narrow confined passages, mainly between the islands, where rocky shoals and heavy currents exist. Sea cucumbers are more abundant along the sand and gravel beaches where some protection is afforded from heavy currents.

Production

Information is not available concerning actual numbers of marine fish and shellfish produced.

Propagation

Marine fishes are not propagated within the Basins.

The Nisqually and Deschutes drainages contribute to the marine environment designated as southern Puget Sound waters. This entire area contains extensive oyster culture beaches, the majority of which are commercial operations. Many of these procure seed for propagation from State-owned reserves, also located in these waters. In addition, there is considerable seeding of foreign stock. However, extensive reseeding of "noncultured" beaches is usually unnecessary since the somewhat warmer waters characteristic of the area tend to promote sufficient natural setting of spat. Principal production areas include each of the bays and inlets, plus portions of island shorelines and the Nisqually Flats.

Harvest

Marine Fish–There is very little commercial harvest of marine fishes from Basin waters, and most of these species taken by sportsmen are caught incidentally while salmon fishing. A few otter trawl vessels occasionally fish these waters for some specific variety, usually one of the scrap fish species. Commercial fishing for herring occurs, with the majority of the catch marketed as bait fish, and sold locally or trucked to ocean fishing ports.

Sport harvest of marine fishes includes angling, plus the increasingly popular activity of spear fishing. Angling effort specifically for marine fishes is reflected by the more than 10,000 angler-days recorded for all southern Puget Sound in 1965. Spear fishing interest is growing rapidly, due mainly to the relatively clean marine waters and the variety of marine environment available. The principal species taken by sportsmen include lingcod, flounder, sole, and rockfish.

Little is known concerning harvest potential for marine fishes.

Shellfish—An intense commercial harvest of shellfish, mainly oysters and clams, occurs in the Basins. Sport harvest in the Nisqually Basin is considered light, due to the lack of sufficient public access and a somewhat limited variety of shellfish available. In the estuarine sector of the Deschutes Basin, shellfish sport harvest is moderate, with much of the potential harvest area under private ownership.

Privately-operated oyster culture beaches encompass much of the tideland area on the Nisqually Flats. In the Deschutes Basin, oyster culture operations are conducted throughout the estuarine areas, many of the beach areas, and over much of the Mud Bay tidelands.

Sport harvest of shellfish is conducted on a few public access areas on the Nisqually Flats and on beach areas west and north of this area. Species taken by sportsmen include hardshell clams, oysters, and some crabs. In the Deschutes Basin, sport harvest, primarily hardshell clams and some oysters, occurs in estuarine and beach areas at Johnson and Cooper Points. Man-days of use attributed to shellfish harvest are estimated at 18,600 annually.

Harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish—The principal factors influencing marine fish production are poor water quality, and competition and predation.

(1) Poor Water Quality—Poor quality water does not originate in the Nisqually Basin, however, some silting occurs from erosion upstream. This has little effect on marine fish populations. Pollutants from areas outside the Basin are introduced by tidal interchange and from foreign materials discharged by local shipping traffic. This condition will undoubtedly become more acute as population and industrial expansion continues.

Industrial and domestic effluents, plus introduction of other foreign materials from local shipping and barge traffic, each alters the natural water quality in the Deschutes Basin's estuarine and marine waters. Such conditions have occurred in Budd Inlet. During flooding periods on the Deschutes River, these pollutants are partially diluted and carried out of the inlet and into the marine and estuarine waters of the adjacent West Sound Basins. It is anticipated that with future increases in population and expanded industrial development, such conditions will become more acute.

(2) Tideland Development (Deschutes Basin only). In addition to contributing to poor water quality, rapid urbanization and expanded industrial development limit marine fish populations through attrition of natural production areas. Deposition of land excavation and dredged spoils, and construction of extensive landfills, large piers, and dikes are seldom compatible with fish needs, and are particularly detrimental to juvenile marine fishes.

(3) Competition and Predation (Nisqually Basin only). The spiny dogfish, abundant in certain waters, preys upon some marine fishes, particularly on the juveniles. In addition, heavy dogfish concentrations will compete for, often dominate completely, a particular niche in the environment, eliminating the more desirable species such as rockfish or cod.

Shellfish—Principal factors influencing shellfish production include poor water quality, tideland development, and competition and predation.

(1) Poor Water Quality—Poor water quality from industrial waste, sewage disposal, and disposal of toxic materials from local ship and barge traffic, is a prime limiting factor in Budd Inlet near Olympia.

(2) Tideland Development (Deschutes Basin only)—In addition to contributing to poor water waterfront summer home and residential developments are becoming evident throughout the area. Much of the southern Sound waters and beaches are restricted from recreation use due to the extensive private commercial oyster grounds and clam beaches.

(3) Competition and Predation (Nisqually Basin only)—The spiny dogfish, abundant in certain shrimp and burrowing worms on the mud flats and silt beaches; sand dollar beds in beach areas that could be producing clams; starfish; native drills; moon snails and red crabs that prey on oysters and clams; and octopi that seek out the available crabs.

Beneficial Developments

No programs for marine fish enhancement exist within the Basins. The only shellfish programs are those associated with commercial oyster production.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The Nisqually-Deschutes Basins are only moderately populated, with 69,600 people censused in 1963. Projections indicate populations of 74,900, 104,500, and 146,500 in 1980, 2000, and 2020, respectively. Any major increases would be directly related to new industrial development planned for the Basins. This expansion, along with community and suburban developments, would be distributed principally throughout the lower Nisqually River valley, and around the metropolitan area of Olympia. Some expansion is also expected in the vicinity of Yelm. Unless zoning ordinances are enforced, urban sprawl is expected to occur over much of the flatland and low hillsides bordering the Nisqually River. The proposed development of port facilities on the Nisqually Flats by the Ports of Tacoma or Olympia would have a damaging effect on fish (and wildlife). Land development would be somewhat restricted along the lower reaches of this river due to the presence of the Fort Lewis Miltiary Reservation and the Nisqually Indian Reservation. Summer and recreation home development, plus year round residence construction, will increase rapidly in other areas adjacent to streams and rivers, especially in the upper Deschutes and Nisqually watersheds.

The proximity of the Basins' streams and rivers to the more heavily populated areas of southern Puget Sound, along with the generally uncrowded and nearly undisturbed natural characteristics of the upper watershed streams, promote this area for outdoor recreation. The highway and road systems provide generally good access for sport fishermen desiring to fish the rivers. With an expected increase in demand for more and more outdoor recreation, associated with increased population and more leisure time, it is anticipated that sport fishing pressure within the Basins would accelerate at a rate much greater than that of population growth. Also, in all salt-water areas where Basin-produced salmon are harvested there would be a marked increase in demands for these fish by both commercial and sport fishermen.

RESOURCE DEMANDS AND NEEDS

The Nisqually-Deschutes Basins support no licensed commercial fishery for salmon and only a very limited commercial fishery for marine fishes. Commercial harvest of shellfish is moderate to heavy, particularly in the Nisqually Flats area. The Nisqually and Deschutes River systems produce significant numbers of salmon that enter commercial and sport fisheries in other portions of the Puget Sound Area and in the open ocean. The Nisqually Indian fishery operates in waters of the lower Nisqually River, and harvests a considerable quantity of salmon and steelhead annually. This fishery has remained relatively constant, and is expected to continue to do so, at least in the near future.

Sport fishing for salmon occurs throughout the salt-water areas as well as in the lower reaches of the Nisqually and Deschutes Rivers. This fishery supports numerous local boathouse and boat moorage operations located mainly in the Olympia, Johnson Point, and Boston Harbor areas. Each year additional sport fishing pressure occurs both in the salt-water areas and on the local rivers.

Along with increased population and associated demands for increased outdoor recreation opportunities, there will be more and more pressure exerted on marine fish and shellfish stocks of the Basins. Not only will these fishes suffer from loss of natural production habitat through attrition of beach, tideland, and marine habitat, but the increased demand, particularly from sport fishermen, will require new measures to provide the increased quantities of these highly valued stocks.

Anadromous game fish will attract large numbers of sportsmen, but lakes will also play a most significant role. Streams in the higher elevations also offer excellent resident game fish angling. Based on county use values, approximately 55 percent of all Basin harvest and 45 percent of all utilization of game fish other than steelhead is by people from outside the Basins. It is estimated that, by 1980, Basin lakes must provide an additional 854,800 trout and 417,850 game fish of other species. This is an additional 92 fish per surface acre. Similarly, streams of the Basins must supply an additional 231,350 resident trout and whitefish and 3,860 steelhead annually. Table 11-7 indicates present and projected demands and needs for game fish in angler-days.

TABLE 11-7. Present and projected sport fishermen use (game fish) in Nisqually-Deschutes Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	484.3
1980	324.5	808.8
2000	462.6	1,271.4
2020	762.8	2,034.2

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish resources of the Nisqually-Deschutes Basins are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to these Basins.

Conflicting Land and Water Uses

(1) Lack of coordination of river flow control between the Tacoma City Light's Alder-La Grande Dams and the city of Centralia's Yelm Powerplant Diversion downstream often results in the virtual removal of all water for a distance of 12 miles on the Nisqually River. Heavy mortalities of juvenile and adult anadromous fish have occurred because of this problem.

(2) Nisqually River tributary streams located on the Fort Lewis Military Reservation often suffer from physical alterations of the streambed associated with continuous military maneuvers, which reduce the fish production capabilities of these streams.

(3) Projects being considered, such as those involving flood prevention, drainage, irrigation, and bank stabilization in the Nisqually-Deschutes Basins and port development on the Nisqually Flats may conflict with basic fish needs.

(4) Log boom storage in Budd Inlet has serious detrimental effects on shellfish production in the immediate vicinity.

(5) Drastic alteration of streamflow by power-peaking operations reduces downstream fish rearing and recreation potential.

Poor Water Quality

(1) Occasionally, unseasonal heavy silt loads and excessive turbidity occur in the Nisqually River; this is caused by reservoir regulation at the Tacoma City Light's Alder-La Grande Dam complex. Whenever this occurs during low to moderate river flow periods, excessive siltation occurs in the lower mainstem, causing gravel compaction and generally deteriorating the environment and restricting fish production.

(2) Occasionally, intermittent and seasonal pollution conditions occur in the lower Nisqually and Deschutes Rivers and their immediate estuarine waters. Such conditions can result in water quality inimical to fish and shellfish. Effluents from agricultural and industrial sources, as well as from sewage disposal, are particularly detrimental to aquatic life. Also, the buildup of sludge and heavy waste in the estuaries severely limits marine fish and shellfish production.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Nisqually-Deschutes Basins. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Potential enhancement projects include the removal of natural barriers on the Mashel River, and on many of the Basins' small-to-moderate-sized tributary streams. Additional projects include the improvement of stream and streambed conditions to conserve natural flows and to enhance existing spawning and rearing potential. Stream areas particularly capable of such enhancement include Muck and Ohop Creeks, and portions of the Mashel River and tributaries in the Nisqually River system, the upper reaches of the Deschutes River, and some of its larger tributaries.

Streambed controls could be achieved through selective placement of rock weirs or submerged log or concrete barriers to retain spawning gravel and create suitable pools and riffles where they are now unstable or lacking.

Enhancement projects also include flood control and low flow augmentation on a number of streams within the Basins, particularly the Mashel, Nisqually, and Deschutes Rivers. Streamflow controls might be achieved through the development of overflow channels, flood-flow diversions, or impoundments located either on the main river channels or in suitable off-river areas.

Numerous sites appear suitable for development of hatcheries, eyed-egg incubation facilities or spawning channels, and creation of off-river rearing areas through impoundment construction and operation. There is suitable land and water for this purpose along the Nisqually and Deschutes Rivers as well as on a number of the moderate-sized tributary streams including the Mashel River, and Ohop, Muck, and McAllister Creeks.

One potential enhancement program closely associated with artificial propagation would be to use upriver areas, now blocked to anadromous fish migration, as natural rearing areas. This would involve fish planting programs in areas where it is not economically feasible to install fish-passage facilities.

A major program involves establishment of sufficient flows for the Nisqually River between the city of Centralia's Yelm Powerplant Diversion Canal and the city's powerplant downstream. This must be accomplished through cooperative water management involving flow regulation at Tacoma City Light's Alder-La Grande Dam complex and the city of Centralia's operation downstream; or by installation of facilities at the canal diversion that would allow sufficient water to be passed downstream at all times.

Another very important program directed toward protecting and enhancing fish production would include setting rigid controls on the removal of water, for any purpose, from natural flowing streams. An extensive evaluation of new means for obtaining future municipal and industrial water supplies should be conducted in conjunction with this. Subjects deserving study include potential use of dual water systems (consumptive/irrigation and sewage) and possible procurement of desalted marine water that may be a byproduct of any proposed thermonuclear powerplants.

Other enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish populations, including control of forest and agricultural spraying, as well as curtailing the disposal of untreated municipal and industrial wastes; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to insure protection of fish resources; (3) institute an effective permanent flood plain zoning plan to protect streambeds and land adjacent to streams from unnecessary changes that would damage aquatic habitat; (4) guide management to promote effective regulations for all fisheries, and provide necessary changes in fishing areas and harvest methods to yield greater maximum benefits from available stocks; (5) perform studies and obtain information necessary in achieving the most efficient management possible, including the determination of chemical means for increasing fish production; and (6) determine specific streamflows (from river cross section measurements) to ascertain flow levels necessary for fish, and to provide methods and techniques for altering streamflow and streambed conditions to increase the productive capacity of the environment. Optimum flows derived would be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, are listed in Table 11-8. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas would be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

Marine Fish

Enhancement projects for marine fishes in the Nisqually-Deschutes Basins could include creation of additional habitat and new fishing areas through selective placement of rock jetties or submerged automobile bodies. Another program benefiting these

TABLE 11-8. Tentative flow schedule required to maintain fish production levels, Nisqually-Deschutes Basins

Stream[1]	Flows (cfs) by Month											
	Oct.	Nov.	Dec	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Nisqually R. (Olympia)	1,000	1,400	1,800	1,800	1,700	1,600	1,500	1,500	1,200	800	600	600
Mashel R.	120	200	300	300	300	250	250	200	150	60	25	40
Ohop Cr.	40	90	100	100	100	90	90	60	40	20	10	10
Deschutes R. (Olympia)	150	300	600	600	600	500	450	275	200	130	100	100
Deschutes R. (Rainier)	100	250	400	400	400	350	250	160	90	50	40	40

[1] Locations are existing U.S. Geological Survey gaging stations.

fishes would be to establish and implement water quality controls in estuarine and marine waters. Without such controls a drastic reduction in marine fish populations is foreseen.

Natural production is adequate at present, but artificial propagation would be instituted when required.

Shellfish

Potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents now limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. The latter might be accomplished by heating controlled salt-water areas or by adding nutrients.

The marine waters hold considerable potential for expanded development of rack and raft oyster culture. Also, many of the accessible beach areas offer good potential for put-and-take clam stocking programs.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Nisqually-Deschutes Basins offer numerous opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. In order to meet demands, a number of these potential developments must be undertaken. Major proposals, including an indication of priority, are categorized in Table 11-9 and defined by stream in Table 11-10.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the developments listed. Nearly all of the major proposals are goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of these potential developments are included in a preliminary plan for increasing future salmon production to meet overall Pacific Northwest demands for fish resources. These proposals, and salmon production increases, are indicated by target years in Table 11-11.

Table 11-12 shows estimated annual benefits in terms of sport and commercial harvest for the same proposals. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate, and needs are not so critical as for salmon.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these proposals have not been evaluated.

General Programs

Thermal powerplants should be located in areas where water diversion is not detrimental to fish

TABLE 11-9. Potential developments for production and use of salmon and shellfish, Nisqually-Deschutes Basins

Beneficial Development	Priority: Prior to 1980	Priority: Prior to 2000	Priority: Prior to 2020
(1) Maintenance and Enhancement			
Provide fish passage on Mashel River	X		
Develop clam hatchery for stocking public beaches	X		
Improve stream and streambed conditions	X	X	
Improve public access on smaller streams	X	X	
Plant salmon in presently inaccessible stream areas	X	X	X
Improve public beaches for clam production		X	
Develop artificial salmon propagation facilities		X	X
(2) Acquisition			
Evaluate potential salmon propagation sites	X		
Acquire and develop 4 salt-water public access sites	X		
Procure riverbank and salt-water sites for public access development		X	
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Acquire 2 miles of additional public beach		X	
Initiate purchase of suitable land for propagation sites and procure water	X	X	
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specified circumstances	X		
Develop subtidal park for skin divers		X	
Control excessive removal of river water	X	X	X
Promote Indian fishery conservation	X	X	X
Implement fishery management regulation changes	X	X	X
Promote shellfish culture programs	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Institute stream conservation on Fort Lewis Military Reservation	X	X	X
Coordinate all operations and activities on streams and tidelands	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Shellfish predator control	X	X	
Basin productivity measures for upper Nisqually River		X	

TABLE 11-10. Potential beneficial developments for fish, Nisqually-Deschutes Basins

Stream	Enhancement Measure								Species Benefited						
	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Nisqually R.	X			X	$\boxed{\text{X}}$	X	X	X	X	X	X	X	X	X	X
Muck Cr.		$\boxed{\text{X}}$			X		X	X		X		X	X	X	X
Horn Cr.		X	X										X	X	X
Tanwax Cr.		X	X										X	X	X
Yelm Cr.		X								X	X	X	X	X	X
Ohop Cr.		X					X	X	X	X			X	X	X
Lynch Cr.	X	X					X	X		X			X	X	X
25 Mile Cr.			X										X	X	X
Mashel R.	X	X	$\boxed{\text{X}}$	X				X	X	X	X		X	X	X
L. Mashel R.	X	X											X	X	X
Beaver Cr.		X	X										X	X	X
Busy Wild Cr.		X	X					X	X				X	X	X
Deschutes R.		X		X	X	X	X	X	X	X		X	X	X	X
Percival Cr.		X						X		X			X	X	X
Spurgeon Cr.		X	$\boxed{\text{X}}$					X		X			X	X	X
Independent Drainages															
McAllister Cr.		X	X				X	X		X		X	X	X	X
Woodward Cr.		X	X							X		X	X	X	X
McLane Cr.		X	$\boxed{\text{X}}$				X	X		X		X	X	X	X

$\boxed{\text{X}}$ Priority project.

TABLE 11-11. Estimated total salmon production increases in Nisqually-Deschutes Basins, by project or program, to satisfy needs[1]

Project or Program, and Year	Chinook	Coho	Pink	Chum
	Species and Number			
Pre-1980				
Supply flood control and augment flows, 70 river miles	2,400	8,000	6,600	3,000
Subtotals	2,400	8,000	6,600	3,000
1980-2000				
Provide fish passage, 5 streams, 60 stream miles	4,000	43,500	--	--
Improve fish habitat, 16 streams, 38 stream miles	7,000	35,500	13,800	6,500
Clear channels, 10 streams, 54 stream miles	700	6,600	1,400	2,100
Construct rearing ponds, 10 acres	--	8,500	--	--
Supply flood control, 2 streams, 49 stream miles	900	1,800	300	--
Augment flows, 2 streams, 41 stream miles	1,100	5,000	300	1,200
Construct spawning channel, 1 mile	--	--	120,000	--
Construct hatchery	--	51,000	--	--
Subtotals	13,700	151,900	135,800	9,800
2000-2020				
Construct 2 hatcheries or equivalent	18,000	76,500	--	--
Develop rearing facilities, 45 acres	18,000	38,200	--	--
Develop spawning channel, 1 mile	--	--	120,000	--
Subtotals	36,000	114,700	120,000	--
Totals	52,100	274,600	262,400	12,800

[1] Average annual production (catch plus escapement) at end of each period.

TABLE 11-12. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, Nisqually-Deschutes Basins

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Supply flood control and augment flows, 70 river miles	12,300	$ 32,000	$ 80,600	1,800	$ 10,700	$ 51,000	2/	2/
Subtotals	12,300	$ 32,000	$ 80,600	1,800	$ 10,700	$ 51,000	--	--
1980-2000								
Provide fish passage, 5 streams	31,600	$106,800	$ 211,800	6,200	$ 37,100	$ 173,000	$ 365,000	$ 2,100
Improve fish habitat, 16 streams	35,200	111,000	241,400	6,300	36,600	176,800	118,000	2,300
Clear channels, 10 streams	6,300	19,600	405,700	1,000	5,800	27,500	3,500	3,500
Construct rearing ponds, 10 acres	6,200	19,700	37,900	1,100	6,400	29,700	55,000	10,000
Supply flood control, 2 streams	1,700	6,700	148,000	500	2,800	13,000	2/	2/
Augment flows, 2 streams	4,700	16,100	33,400	1,000	4,300	25,100	2/	2/
Construct spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,800	700,000	14,000
Construct hatchery	37,400	118,400	228,200	6,400	38,300	178,800	1,020,000	60,000
Subtotals	218,800	$464,300	$1,631,800	26,800	$157,100	$ 744,700	--	--
2000-2020								
Construct 2 hatcheries or equivalent	65,800	$242,300	$ 497,500	15,200	$ 91,400	$ 426,500	$2,040,000	$120,000
Develop rearing facilities, 45 acres	37,800	153,400	326,200	10,400	62,600	292,300	247,500	45,000
Develop spawning channel, 1 mile	95,700	66,000	325,500	4,300	25,800	120,400	700,000	14,000
Subtotals	199,300	$461,700	$1,149,200	29,900	$179,800	$ 839,200	$2,987,500	$179,000
Totals	419,330	$958,000	$2,861,600	58,500	$347,600	$1,634,900	--	--

[1] Anadromous trout benefits not included.

2/ Multipurpose project. Separable costs, if any, have not been determined.

resources. Alder Lake reservoir is a possible fresh-water site for such a project. However, satisfactory water cooling requirements must be included in the construction plans.

Flood problems could be minimized with flood plain zoning. Such areas should be reserved for agricultural and recreation uses.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

As in most Puget Sound basins, the Nisqually-Deschutes area lends itself ideally to development of outdoor recreational potential. These Basins have many excellent fishing lakes that are readily accessible. These lakes vary in size, so all of the many water-oriented uses are possible within a short distance from the population centers. Salt-water areas are also nearby. Public access to all water areas must be assured to permit fulfillment of the Basins' recreation potential. Summer temperatures are normally warmer than in other basins, so outdoor recreation is very popular. Any plans for development of these Basins should give adequate consideration to development of the sport fishing potential, including the construction of camp sites and picnic areas adjacent to water areas as well as the preservation and enhancement of fish habitat.

Overall Basin planning must consider all uses of water and related lands equally.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows would be considered jointly with water quality standards.

(2) Public fishing access acquisition and development is proposed at Muck, South Twin, North Twin, Bald Hill, Southwick, Hewitt, and Elbow Lakes. Ultimately, all significant lakes and key portions of streams, estuaries, and salt-water areas should have assured public fishing access.

(3) Streambank angler access on 50 miles of the Nisqually and Deschutes Rivers (of a total of 170 miles) should be acquired and developed, as funds become available.

(4) Salt-water boat launch sites and public access have been proposed for the Nisqually Flats at McAllister Creek and on Henderson Inlet.

(5) Installation of a mechanical revolving screen at the outlet of Tanwax Lake to prevent the escapement of planted trout is proposed.

(6) Complete coordination of flow releases is necessary between the reregulating dam downstream from Alder Dam and the La Grande Powerhouse; between the La Grande Powerhouse and city of Centralia's Yelm Powerplant Diversion Canal; and between this point of diversion and the city's powerplant. Management and rearing programs could be altered considerably, especially with cooperation from the Nisqually Indians, if a comprehensive plan were implemented.

(7) Development of a large "riffle sifter" or other streambed loosening and cleaning device should be scheduled for use in certain Basin streams where streambed compaction of essential spawning material has occurred.

(8) Investigations concerning the introduction of anadromous fish or completion of fish passage in areas upstream from existing barriers should be undertaken. Impact on the resident game fish populations as well as the potential introduction of undesirable fishes must also be considered.

(9) Several spring-fed semi-natural rearing pond areas are recommended for both the Nisqually and Deschutes Rivers, and potential hatching sites exist at several locations.

(10) New lake fertilization programs and management techniques that will assure increased fish production without undesirable side effects should be developed.

(11) New techniques and products for lake and stream rehabilitation should be developed. This would include development of fish toxicants that are selective by species.

(12) A program allocating flow releases from Nisqually River reservoir and power diversions for use in providing adequate fish flows in overdiverted stream sections should be developed.

(13) Fishery management programs to increase production of Basin reservoirs should be undertaken.

(14) Fish disease and parasite control programs for lakes should be developed to permit increased survival of game fishes.

(15) An educational program to stress the value and recreational aspects of fishing for spiny-rayed species should be developed.

Table 11-13 indicates estimated annual benefits and costs of specific projects and programs proposed for the Nisqually-Deschutes Basins to satisfy needs for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Proposals for subsequent years, which may include some projects and programs listed above, have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected. That is, benefits from constructing a hatchery may depend on first solving fertility, disease, and public access problems. In such cases items showing cost would not necessarily show benefits because the latter are included under other projects and programs.

TABLE 11-13. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Nisqually-Deschutes Basins, pre-1980

	Annual Benefits		Costs	
Project or Program	Angler-Days	Value	Capital	O&M (Annual)
Lakes				
Acquire and develop public access, 7 lakes	11,200	$ 22,400	$ 100,000	$ 1,100
Develop new fish toxicants and fertilization techniques	200,000	400,000	20,000	20,000
Develop effective fish management program for large lakes and reservoirs	52,000	104,000	25,000	--
Develop fish disease and parasite control program	10,000	20,000	20,000	--
Construct fish hatchery	1/	1/	600,000	50,000
Initiate educational program to stress value of spiny-ray fishing	67,000	134,000	5,000	--
Subtotals	340,200	$ 680,400	$ 770,000	$ 71,100
Streams				
Acquire and develop streambank access, 50 stream miles	1/	1/	$ 550,000	$ 2,500
Conduct stream cross-section surveys	1/	1/	20,000	--
Develop steelhead and searun cutthroat rearing ponds	47,600	$ 235,400	100,000	35,000
Construct fish hatchery	36,500	109,500	750,000	75,000
Subtotals	84,100	$ 344,900	$1,420,000	$112,500
Salt Water				
Acquire and develop public access, 2 areas	16,800	$ 50,400	$ 36,000	$ 1,000
Subtotals	16,800	$ 50,400	$ 36,000	$ 1,000
Totals	441,100	$1,075,700	$2,226,000	$184,600
Lakes (Alternate to above lake proposal)				
Acquire and develop public access, 7 lakes	11,200	$ 22,400	$ 100,000	$ 1,100
Construct fish hatchery	162,100	324,200	3,000,000	250,000
Initiate educational program to stress value of spiny-ray fishing	67,000	134,000	5,000	--
Subtotals	240,300	$ 480,600	$3,105,000	$251,000

1/ Benefits included in other projects and programs.

Projects and Programs, 1980-2000

1. Complete programs and projects not completed prior to 1980.
2. Construct and manage a game fish hatchery
3. Develop stream fertilization programs to increase fish production.
4. Continue research in game fisheries management.

5. Develop new projects and programs as required.

Projects and Programs, 2000-2020

1. Complete programs and projects not completed prior to 2000.
2. Develop new projects and programs as required.
3. Continue fisheries research.

About 44,000 acres of these Basins are under U.S. Forest Service administration. Projects and programs proposed by this agency for fishery enhancement are indicated in Table 11-14. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 11-14. Fishery enhancement projects and programs of U.S. Forest Service proposed for Nisqually-Deschutes Basins, 1980-2020

		1980		2000		2020	
Project or Program	Unit	Number	Capital Cost	Number	Capital Cost	Number	Capital Cost
Conduct stream surveys	mile	32	$ 1,000	1/	--	1/	--
Conduct lake surveys	acre	153	1,200	1/	--	1/	--
Clear stream channels	mile	9	18,000	14	$28,000	14	$28,000
Fertilize lakes	acre	33	22,600	62	42,700	62	42,700
Total			$42,800				

1/ Anticipated to be approximately the same as planned for 1980 period.

PRESENT STATUS—WILDLIFE

INTRODUCTION

The lower elevation portion of the Nisqually-Deschutes Basins was formed by terminal drift of the Puget Glacier and is characterized by low rolling hills and interspersed prairie dotted with numerous lakes and ponds. The glacial moraine, consisting of gravelly porous soil with low moisture retention qualities, produces a semi-prairie type native vegetation with rather low nutritive content. The flood plain at the mouth of the Nisqually contains the most fertile agricultural land. Eastward the drainages are typical of other watersheds draining into Puget Sound from the Cascade Range. Although the Deschutes is of somewhat lesser proportions, the Nisqually River originates from the active Nisqually glacier on majestic Mount Rainier and traverses all the typical life zones of western Washington on its route to salt water. The climate pattern is varied and determines wildlife distribution and abundance.

Outdoor recreational use, including hunting, fishing, and trapping, is somewhat restricted by the presence of the Fort Lewis Military Reservation which encompasses a large portion of the lower Nisqually Basin.

BIG GAME

Approximately 75 percent of the combined Basins' land area is in some form of woodland cover. Consequently, much habitat is available for big game. Black-tailed deer are widespread, and elk, bear, and mountain lion inhabit the somewhat more remote foothills and mountainous regions. Mountain goat occur in the extreme eastern portion in and adjacent to Mount Rainier National Park.

Inventory and Distribution

Although deer are found throughout the two Basins, highest densities occur on the lower foothills and wooded sections along the river valleys (Figure

11-2). In the Nisqually watershed, deer are most prevalent in the Tanwax Lake, Eatonville, and La Grande sections and along the river from Alder Lake reservoir to Longmire. The Vail-Lake Lawrence-Clear Lake vicinity is the major concentration area within the Deschutes drainage. Data concerning estimated deer population, production, and harvest by Basin and county, for a five-year period, are presented in Table 11-15.

TABLE 11-15. Deer population, production, and harvest, Nisqually-Deschutes Basins, 1961-1965

Drainage and (County)	Population[1] (Total)	Production (Ave. Annual)	Harvest (Ave. Annual)
Nisqually R.			
(Pierce)	5,000	1,500	690
(Thurston)	1,650	500	190
(Lewis)	1,600	480	185
Deschutes R.			
(Thurston)	2,900	870	335
(Lewis)	150	50	30
Totals	11,300	3,400	1,430

[1] Game numbers vary throughout the year; therefore, figures designate late September-early October populations.

An estimated 850 elk inhabit the Nisqually Basin. A few elk also occur in the Deschutes River drainage. Greatest numbers occur south of the Nisqually River from Elbe almost to Longmire and in the area east of Eatonville (Figure 11-1). Elk appear to be increasing and expanding their range.

Mountain goat occur only in the upper reaches of the Nisqually Basin. Approximately 100 of these magnificent animals occupy the rugged divide between the Nisqually and Cowlitz River drainages.

A population of 600 to 700 black bear is estimated to inhabit the Basins.

It is estimated that 10 mountain lion may range within the combined Basins of the Nisqually and Deschutes Rivers.

Limiting Factors

A condition peculiar to these Basins is the semi-prairie type lowland habitat. The "new" glacial moraine soils, besides being low in nutritive content, retain little summer moisture and, consequently, produce forage of low palatability and wildlife value.

Logging and other forest management practices influence big-game populations such as deer, elk, and bear. Most current logging occurs above the 2,000-foot level and previously logged areas are growing beyond the stage of optimum forage production resulting in a gradual decline in big-game carrying capacity. Less slash burning after logging also reduces production of desirable forage plants.

Production

Late summer doe/fawn ratios reveal an increase of 3,400 deer over the spring population. Production estimates for divisions within the Basins are shown in Table 11-15.

Elk normally reproduce at a rate of about 20 percent in a stable herd. The Nisqually Basin herd, however, appears to be increasing. Under such conditions, an annual production of nearly 25 percent might be expected which would result in approximately 200 calves.

Late summer mountain goat populations show 29 kids per 100 adults, which for the Nisqually Basin would indicate an annual production of 25 to 30 young.

Black bear studies indicate an annual reproductive rate of 25 to 30 percent, which would be 140 to 160 cubs.

Harvest

Five years of harvest data (1961-1965) reveal an average annual deer harvest of 1,430 animals, creating 28,600 hunter-days. The harvest by division is shown in Table 11-15.

The elk harvest in the Nisqually Basin has been increasing in recent years. This is due primarily to the rapid growth of the herd. The current herd supports an average annual harvest of about 150 animals, resulting from 5,500 man-days of highly prized hunting experience (Photo 11-3). Elk are not harvested in the Deschutes Basin.

Special hunter permits are authorized by lot drawing for each mountain goat management unit. However, no kill has been recorded from the Basins. This reflects the inaccessibility of these animals to hunters.

Bear are legal game year round in the Basins without restriction as to numbers taken per hunter. Limited harvest data indicate an average annual take of 120 to 140 bears. This represents 1,100 hunter-days.

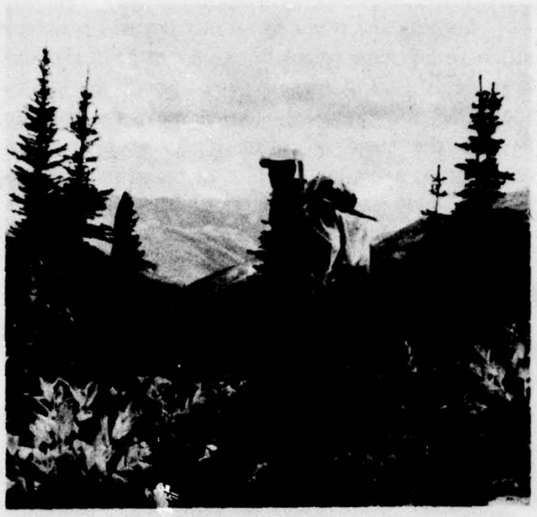


PHOTO 11-3. Headwaters provide prime hunting area, as well as big-game summer range. (Washington Department of Game photo)

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

The present elk herd in the Eatonville area is the result of a transplant of 30 head from Montana in 1932.

Other beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

The varied species of upland game are the most widely distributed of the major wildlife groups. Native species utilize the native woodland habitat and introduced exotics have been established in the area devoted to agriculture. Introduced varieties include ring-necked pheasant, California quail, mountain quail, gray partridge, and cottontail. The native species include blue and ruffed grouse, and snowshoe rabbit.

Native species are abundant and widely distributed throughout the native vegetation areas. Pheasant and quail, however, which depend on diversified farming activity, are not particularly numerous since the lower reaches of the Basins are not heavily used for agriculture.

Inventory and Distribution

Grouse are the most numerous of the upland-game birds. Both species are distributed throughout the Basins wherever suitable habitat exists. A ruffed grouse population of 56,000 and a blue grouse population of 36,000 birds are projected on the basis of existing density studies.

Grass hay and pasture, which are not conducive to high pheasant and quail populations, are the principal agricultural crops. An estimated wild population of 12,000 ring-necked pheasant inhabits the Basins. Distribution and density of pheasant are indicated in Figure 11-1. This wild stock is supplemented annually by game-farm-reared birds. An estimated 3,000 California quail and a remnant population of gray partridge and mountain quail inhabit the area.

Snowshoe rabbit are numerous throughout the Nisqually-Deschutes watersheds and cottontail have been successfully introduced in restricted locations. Populations were not estimated.

Band-tailed pigeon and mourning dove numbers were not estimated.

Limiting Factors

Rigid and effective control of wildfire and reduced emphasis on slash burning after logging have reduced the carrying capacity of wooded areas for native upland game and mountain quail. Limited agricultural acreage and emphasis on hay and pasture production restrict the area's potential for introduced exotics.

Factors limiting band-tail density and residence period are treated in the Area chapter, Upland Game.

Production

An annual production of 34,000 ruffed grouse and 22,000 blue grouse was estimated. Wild pheasant production averages 7,000 annually and an annual average production exceeding 2,000 quail is expected from the present population. Production of band-tailed pigeon, rabbit, gray partridge, and mourning dove was not determined.

Harvest

The average annual grouse harvest of 7,400 birds consists of about 5,600 ruffed grouse and 1,800 blues. Grouse hunters spend over 12,000 man-days hunting annually.

An annual average of 2,500 pheasant and 350 quail are harvested as a result of 3,700 and 300 hunter-days, respectively. Rarely are the beautiful mountain quail taken by hunters. These birds frequent thick, brushy areas which makes hunting difficult.

An estimated 600 man-days are spent each year hunting rabbits. Average annual harvest is about 1,000. Although snowshoes are numerous, the majority of rabbits taken are cottontail. During an estimated 6,300 hunter-days annually, 7,300 band-tailed pigeon and 900 mourning dove are bagged.

Upland-game hunting totals 22,900 hunter-days annually.

Propagation

The wild pheasant population is supplemented annually by an average of 1,500 birds from State-operated game farms. Approximately 1,200 are released as mature cocks prior to the hunting season, and the remaining 300 are liberated in the spring and early summer as additional broodstock. Small numbers of quail and gray, red-legged, and bamboo partridge are propagated on various State game farms and released periodically within the Basins. One private game farm raises limited numbers of pheasant, quail, and partridge commercially.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game.

An upland game habitat plot of eight acres is maintained primarily as a release site for game-farm-reared birds. Such plots are retained in near natural grass-shrub cover which provides limited undisturbed nesting cover.

Conservation practices applied to agricultural lands of direct benefit to upland game include 1,100 acres of wildlife habitat development and 875 acres of wildlife habitat preservation, all located in the western two-thirds of the Basins.

FUR ANIMALS

The fur-animal group includes a wide variety of animals with varied habitat requirements. Those species most highly prized for their pelt value–beaver, muskrat, mink, and river otter–require low-land water-associated vegetation in which to live and forage. The land formed by melting ice of the Puget Glacier contains numerous pockets in which lakes and ponds have formed, constituting an inherent potential for fur animals and waterfowl. The low nutritive content of these "new" soils, however, may limit the productivity of these natural water areas.

Inventory and Distribution

All the various fur animals found in the Puget Sound Area inhabit the Nisqually-Deschutes Basins. Beaver, muskrat, mink, river otter, raccoon, and nutria occur in and near lowland water areas. Red fox, opossum, weasel, and skunk inhabit valley land primarily, and bobcat and coyote occur in foothill and mountainous areas. The high, remote areas of the Cascade Range are inhabited by marten and may support lynx.

Individual fur-animal population estimates are: 3,500 (beaver); 20,000 (muskrat); 400 (mink); and 100 (river otter). Estimates of other fur-bearer populations were not determined.

Limiting Factors

Homesite development around the numerous natural lakes and on the extensive salt-water shoreline restricts the fur-animal potential. Urban and industrial development, a limiting factor, is primarily confined to Budd Inlet and the Olympia-Tumwater-Lacey area.

Production

Beaver populations in the fall consist of 30 to 40 percent young of the year, which indicates an average annual production of 1,200 animals. Muskrat production totals approximately 16,000 animals each year. Average annual mink production is 300. Other members of the fur-animal group have reproduction rates similar to that of mink.

Harvest

Subsequent to 1963, when beaver became legal game for licensed trappers, an average of 650 pelts was marketed annually. During the period 1963-1966 about 2,100 muskrat, 70 mink, and 25 river otter were taken each year. Other fur animals are trapped only incidentally.

It is doubtful if any of the fur bearers other than beaver and possibly river otter are being harvested to the full extent of their potential. Income derived from trapping during the 1965-1966 season totaled about $15,000.

Propagation

Three private farms raise mink commercially.

Beneficial Developments

Beneficial developments are discussed in the Area chapter, Fur Animals.

WATERFOWL

The numerous lakes and ponds formed in the glacial moraine of southern Puget Sound indicate a high waterfowl potential. This potential is not fully realized, however, due to a lack of fertile soil and accompanying diversified farming activity. In contrast, the Nisqually flood plain, which contains the richest soils of the Basins, has heavy waterfowl use.

Inventory and Distribution

Except for limited nesting and brood production on the numerous lakes and ponds, the Basins are used primarily by winter resident waterfowl. Figure 11-2 presents the medium to high density waterfowl areas. Widgeon and mallard are the principal species with lesser numbers of pintail, teal, scaup, goldeneye, bufflehead, scoter, and other miscellaneous varieties. During September, October, and November, waterfowl concentrate off the mouth of the Nisqually River and feed inland–primarily on the Nisqually flood plain (Photo 11-4). As winter progresses and standing water in pastures and fields increases, feeding becomes more general throughout lowland areas.

January counts reveal an annual average of 16,000 waterfowl.

Prior to the survey, waterfowl have been exposed to almost three months' hunting. An undetermined number of birds pass through during fall and early winter while enroute southward. The survey does not indicate the total number using the area as a winter feeding station.

Limiting Factors

Recent trends in agriculture have resulted in a decrease in total acreage devoted to cereal crops. This has reduced the availability of food for waterfowl in the Basins. Homesite development around the numerous natural lakes and along the extensive salt-water shoreline also restricts waterfowl potential.

PHOTO 11-4. The Nisqually Delta tidelands provide vital winter habitat for waterfowl in southern Puget Sound. (Washington Department of Game photo)

Production

As in other drainages of the Puget Sound Area and western Washington, the number of locally raised ducks is small compared to that of winter migrants. Nesting is general throughout the numerous lowland lakes and ponds, however, and in comparison with other basins, waterfowl production in the Nisqually-Deschutes Basins is high. A recent inventory revealed an average annual production of 8,800 ducks. Mallard and wood duck predominate.

Harvest

Several established duck clubs on the Nisqually delta and associated high hunter success ratio are evidence of the value of the area for duck hunting. Recent years' harvest records indicate an average annual harvest of 19,500 ducks and 160 geese, as a result of over 14,000 hunter-days.

Propagation

Waterfowl are not artificially propagated in the Basins.

Beneficial Developments

In 1966, the State initiated purchase of certain Nisqually delta lands for concentrated waterfowl management. Development of the site will parallel that of other waterfowl management areas and include public hunting and production of cereal grain for winter duck food.

Conservation practices applied to agricultural lands of direct benefit to waterfowl include 22 acres of wildlife wetland development and 200 acres of wildlife wetland preservation, located in the eastern portion of the Basins south of the Fort Lewis Military Reservation.

OTHER WILDLIFE

The many and varied birds and animals in the Basins not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

No major problems in meeting the wildlife-oriented recreation demands from population growth within the Basins are anticipated.[1] However, as the Area population increases, the Nisqually-Deschutes Basins must provide proportionately more hunting, fishing, and related outdoor activity to meet the needs of the large metropolitan areas to the north. The Basins are easily accessible from the major Tacoma-Seattle metropolitan complex and are one of the more popular recreation areas. Demand on wildlife resources is expected to nearly double by the year 1980. Nonconsumptive uses such as family auto and hiking trips to observe or photograph wildlife will increase in popularity and exceed the hunting use. To maintain hunting at the present level of success, it will be necessary to provide an additional annual harvest of 1,300 deer; 150 elk; 140 bears; 7,000 grouse; 2,300 pheasants; 18,000 ducks; and 150 geese by the year 1980. As population, leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately. Table 11-16 indicates present and projected demands and needs in hunter-days.

[1] Population forecasts shown in Future Needs–Fish.

TABLE 11-16. Present and projected hunter use in Nisqually-Deschutes Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	72.1
1980	67.1	139.2
2000	86.4	225.6
2020	52.8	278.4

Although birds and game animals may not be taken from the wilds for commercial purposes, sale of game birds and certain game animals produced domestically by authorized game breeders is permitted. An increase in such activity in areas of high demand is anticipated.

PROBLEMS AND CONFLICTS

A number of problems must be resolved if future wildlife-oriented recreation demand in the Nisqually-Deschutes Basins is to be satisfied. Problems and conflicts discussed in the Area chapter apply to these Basins.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basins during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 11-17 indicates projects and programs proposed for the Basins to satisfy 1980 needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include recreation benefits that will accrue from public use of wildlife areas for swimming, boating, hiking, picnicking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

TABLE 11-17. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Nisqually-Deschutes Basins, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs 1/: Capital	Costs 1/: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter success	7,500	$ 30,000	--	$ 8,500
Develop educational program to stress renewable aspects and value of proper use of wildlife resources	25,900	138,800	$ 5,000	--
Develop new techniques for population analysis, habitat improvement, and forest-wildlife management	2/	2/	20,000	5,000
Specific Projects and Programs				
Acquire and develop waterfowl and fur-animal habitat, 3,000 acres	28,800 3/	144,000 3/	2,500,000	20,000
Acquire and develop upland-bird habitat, 1,000 acres	6,000	24,000	215,000	12,500
Acquire and develop salt-water public access areas	1,000	5,000	4/	4/
Construct game farm to produce 5,500 pheasants	2/	2/	200,000	16,500
Totals	69,200	$341,800	$2,940,000	$62,500

1/ Do not include survey and plan costs.

2/ Benefits included under other projects and programs.

3/ Includes off-project benefits.

4/ Costs included in those associated with fish development program.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Continue wildlife management research and develop new projects and programs as required.

(3) Continue programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Develop studies to further intensify wildlife management to keep pace with increased demand.

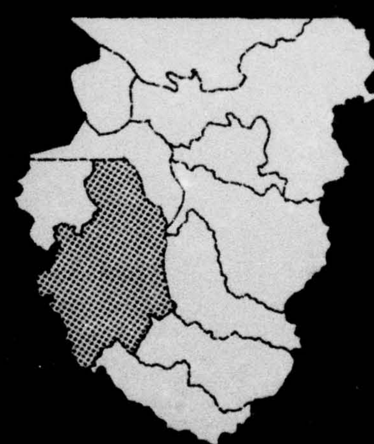
(3) Continue programs and projects not completed prior to 2000.

Table 11-18 indicates projects and programs for wildlife enhancement proposed by the U.S. Forest Service. Hunter-day benefits from these proposals have not been determined, but they will help satisfy overall demand.

TABLE 11-18. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Nisqually-Deschutes Basins, 1980-2020

Project or Program	Unit	1980 Number	1980 Capital Cost	2000 Number	2000 Capital Cost	2020 Number	2020 Capital Cost
Surveys and Plans							
Conduct range analysis							
Deer	acre	79,020	$ 7,900	Survey and planning work is not carried forward to these time periods. Similar work here is probable.			
Elk	acre	2,110	200				
Mountain goat	acre	1,050	100				
Conduct upland-game habitat surveys	acre	17,580	900				
Develop habitat management plans	each	6	3,000				
Big-Game Habitat Improvement							
Seed and plant forage	acre	1,020	102,000	1,025	$102,500	1,025	$102,500
Release forage	acre	857	21,400	1,710	42,800	860	21,500
Create permanent openings	acre	269	26,900	1,370	137,000	1,100	110,000
Total			$162,400				

West Sound Basins



WEST SOUND BASINS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The West Sound Basins have 16 moderate to large river systems, over 100 smaller drainages, 430 lakes and reservoirs (totaling 12,895 surface acres), and 114 farm ponds (57 surface acres) which support anadromous and/or resident fishes (Figure 12-1). Marine waters influenced by the streams include the southeastern portion of the Strait of Juan de Fuca, Admiralty Inlet, Central and South Puget Sound, and Hood Canal. Shellfish and marine fishes inhabit the estuarine and marine waters of this extensive area.

For ease of description, three separate geographical segments are considered. The South Puget Sound segment includes drainages entering the Sound south of the Tacoma Narrows, mainly along the southeastern shores of the Kitsap Peninsula. These drainages are typically lowland streams with generally moderate gradients. Many originate from lakes or swamp-like basins. Their stream profile characteristics are primarily pool and riffle in nature.

The West Puget Sound segment includes the streams draining east from the Kitsap Peninsula and those draining north and west entering Admiralty Inlet and the southeastern portion of the Strait of Juan de Fuca. These streams can also be characterized as generally moderate gradient lowland waters. Channel profiles are also similar to those of South Puget Sound streams, with principally pool-riffle character. A significant difference between West and South Puget Sound segments is that West Puget Sound drainages join salt water that is cooler and more highly saline. Thus the estuarine and marine environment is quite different than that in South Puget Sound.

The third segment, distinctly separate, includes streams draining into Hood Canal proper. The canal is a relatively long body of marine water with unique physical and chemical characteristics. Its drainages include many moderate gradient, lowland streams and a number of swift flowing, cold water mountain streams originating on the high slopes of the Olympic Mountains. The majority of streams originating on Kitsap Peninsula and flowing generally to the east side of Hood Canal are lowland, characterized by moderate gradients and alternating pools and riffles. Most of them head in small lakes, marshes, and beaver ponds. A few drainages originating on the east slopes of the Olympic Peninsula also have basically lowland streams, similar in profile and structure.

The larger of the Hood Canal drainages originate high in the Olympic Mountains, the majority within Olympic National Park. These include the Skokomish, Hamma Hamma, Duckabush, Dosewallips, and Big Quilcene Rivers. They are primarily steep gradient swift flowing streams, with numerous cascades and falls, and large rock bottoms. Only the upper South Fork Skokomish, upper Hamma Hamma, and upper Dosewallips Rivers offer significant pool-riffle reaches. Two hydroelectric power dams are located on the North Fork Skokomish River and a municipal water storage dam is situated on the Union River. All are migrant fish barriers.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in fair to good numbers throughout the Basins.

Anadromous Fish—Anadromous fishes are chinook, coho, pink, and chum salmon; steelhead and searun cutthroat trout; and searun Dolly Varden. Various species migrate, spawn, and rear in 202.3 miles of the larger streams in the South Puget Sound segment (Figure 12-1).

Drainages in the West Puget Sound (Kitsap Peninsula) segment offer approximately 60 miles of accessible stream area to anadromous fishes (Figure 12-1). An estimated 352 miles of accessible stream area in the Hood Canal segment are utilized by these fish (Figure 12-1). Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

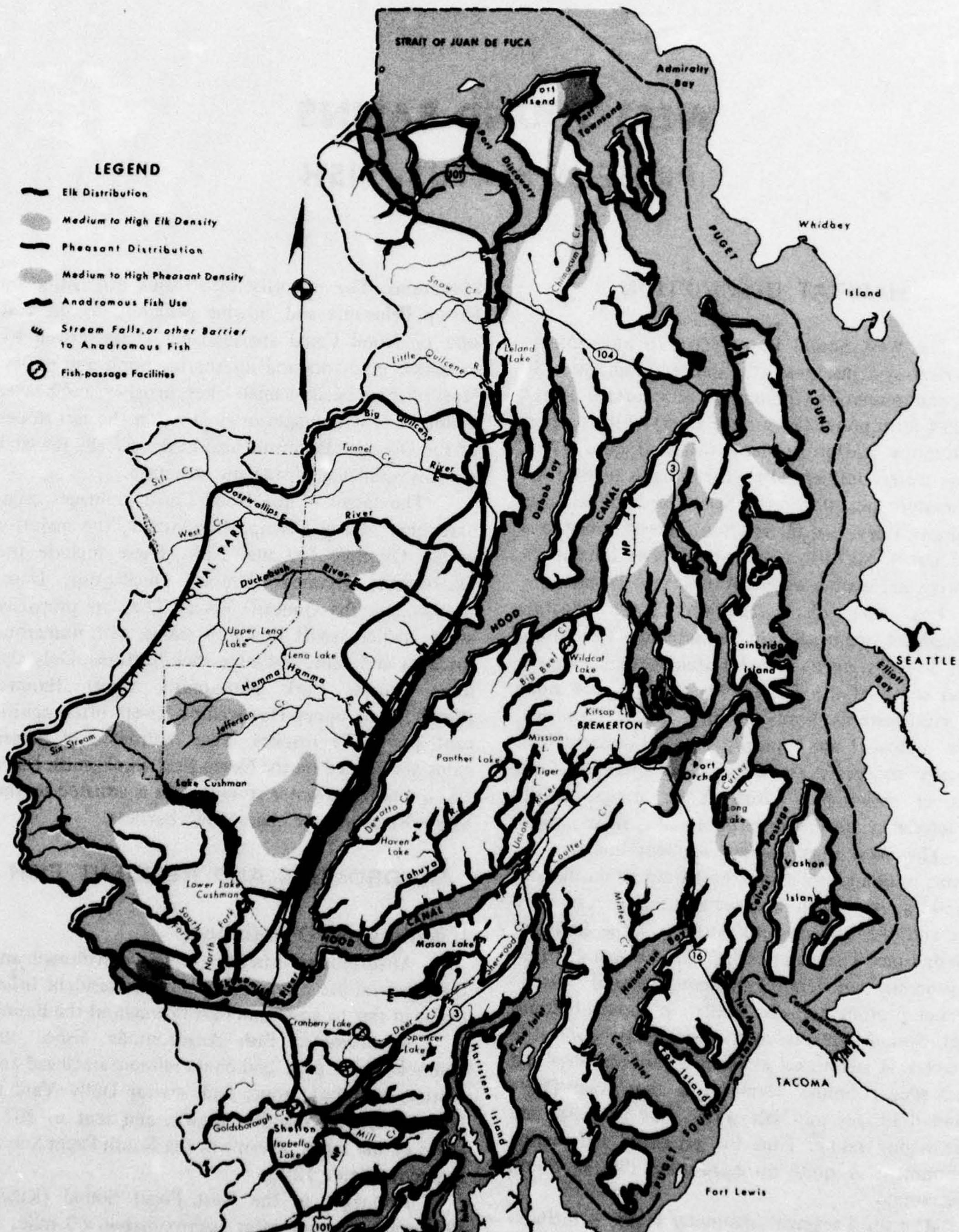


FIGURE 12-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

Chinook, principally the fall race, and other migratory species, overlap in their distribution. Generally, the chinook spawners utilize the larger streams and rivers and the other species spawn in the tributaries and specific sectors of the larger streams. Principal chinook waters include Burley, Minter, Rock, Mill, Chico, and Dogfish Creeks. Pink salmon utilize the larger rivers in the Hood Canal segment such as the Hamma Hamma, Duckabush, and Dosewallips.

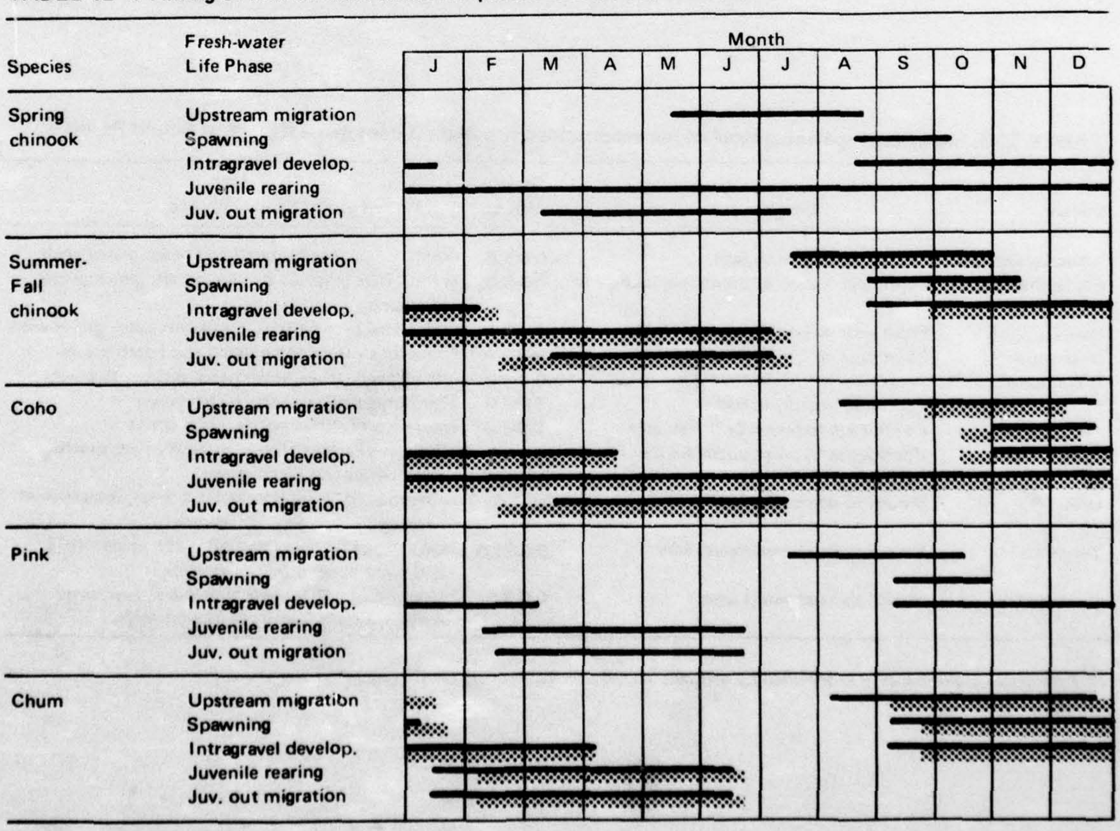
Coho and chum salmon and winter and summer steelhead and searun cutthroat trout are produced in nearly every accessible stream. Some of the more important ones include Sherwood, Coulter, McLane, and Perry Creeks in the South Puget Sound segment; Chico, Curley, and Crescent Creeks in the West Puget Sound segment; and Dosewallips, Duckabush, Tahuya, and Hamma Hamma Rivers, and Dewatto Creek in the Hood Canal segment. Searun Dolly Varden are restricted to the larger streams and particularly those in the Hood Canal segment.

Upstream migration timing overlaps considerably, as shown on Tables 12-1 and 12-2. Adults of one or more species enter the systems every month. Between May and August, the early running species remain in deep holes enroute to their spawning grounds. Significant spawning reaches in some streams are delineated in Table 12-3.

Due to the extended spawning time of most species, intragravel egg development occurs over an 11-month period.

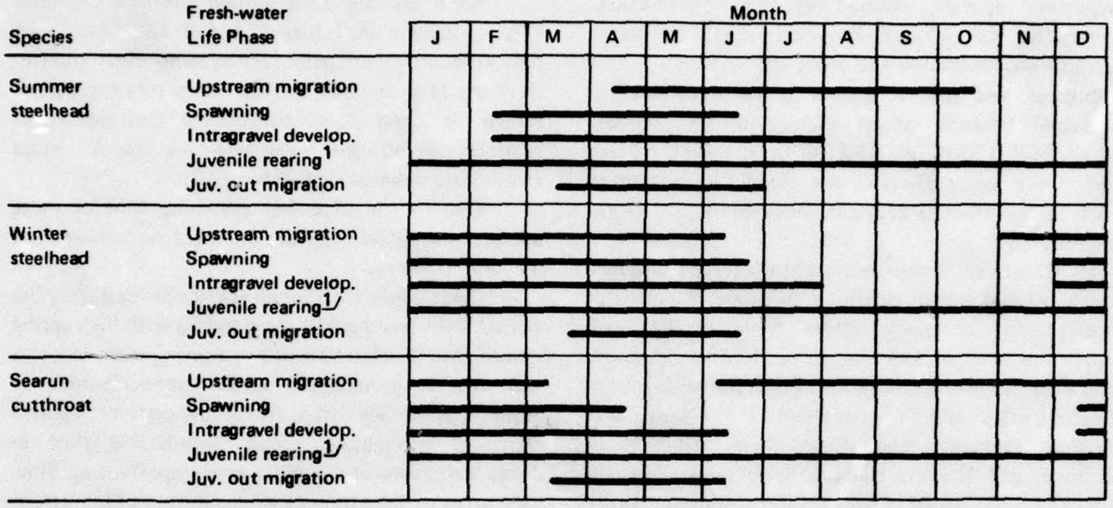
"Out migration" for all species peaks during the period February-June, corresponding with high spring runoff. Some migration occurs during other months, but this is primarily a natural redistribution of juvenile salmonids within the stream systems. Various downstream migrants spend considerable time in fresh water and in the extremely important acclimation areas of the estuaries while enroute to the ocean.

TABLE 12-1. Timing of salmon fresh-water life phases in West Sound Basins[1/]



1/ Symbol ▬ indicates Hood Canal segment; symbol ░ indicates South and West Puget Sound segments.

TABLE 12-2. Timing of searun trout fresh-water life phases in West Sound Basins



1/ Normally extends over a two-year period.

TABLE 12-3. Significant spawning reaches for anadromous fish and resident game fish, West Sound Basins1/

Stream	Section	Stream Mileage	Type of Spawning Area
Little Quilcene R.	Point near mouth to falls	0.0-5.0	Some riffles, mostly patch and beach gravel areas
Big Quilcene R.	Point near mouth to point near Tunnel Cr.	0.0-9.0	Some riffles in lower 2 miles, mostly patch gravel upstream
Dosewallips R.	Point near mouth to Jumpoff Falls	0.0-14.0	Occasional broad riffles, numerous patch gravel areas
Duckabush R.	Point near mouth to falls	0.0-3.0	Numerous riffles, some patch and beach gravel
Hamma Hamma R.	Point near mouth to falls	0.0-3.0	Many broad riffles, some patch and beach gravel
Skokomish R.	Point near mouth to forks	1.0-8.0	Many broad riffles, some beach gravel
North Fork	Confluence to lower Cushman area	0.0-8.0	Intermittent riffles, much patch gravel
South Fork	Confluence to point upstream from Church Cr.	0.0-20.0	Numerous broad riffles in lower 4 miles, mostly small riffles and patch gravel
Union R.	Mouth to point near headwaters	0.0-7.0	Numerous riffle areas in lower 3 miles, intermittent riffle and patch gravel upstream
Tahuya R.	Near mouth to headwaters area	0.0-21.0	Many broad riffles in lower 8 miles, small riffles and some patch gravel upstream
Dewatto Cr.	Mouth to headwaters area	0.0-9.0	Intermittent riffles and patch gravel over lower 3 miles, mostly patch gravel upstream

1/ Additional spawning area is provided by virtually all tributaries entering within described reaches.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 12-4.

TABLE 12-4. Anadromous fish spawning escapement, natural and (artificial), in West Sound Basins

Species	Range 1/	Average (Annual)
Chinook	780-9,580	3,760
	(7,010-13,480)	(9,980)
Coho	38,300-174,540	74,460
	(13,050-38,380)	(25,330)
Pink	33,050-513,000	187,010 2/
Chum	56,460-238,000	129,340
Summer steelhead 3/	420-1,180	750
Winter steelhead 3/	8,800-17,300	11,600
Searun cutthroat 3/	101,400-198,500	133,000
Searun Dolly Varden 4/		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

2/ Per odd-year escapement.

3/ Totals include natural and (artificial) escapement.

4/ No valid totals established.

Resident Fish—Resident fishes spawn and rear throughout the Basins, and are in competition with anadromous fishes downstream from migration barriers (Table 12-3). Rainbow trout and Dolly Varden occur more frequently in the major rivers and larger tributaries. Typical rainbow waters include the Hamma Hamma, Skokomish, Duckabush, Dosewallips, Big Quilcene, and Little Quilcene Rivers, and their larger tributaries. All headwaters provide suitable habitat for cutthroat and brook trout rearing. Mountain whitefish are common and frequent typically rainbow trout habitat. Kokanee inhabit suitable lacustrine environment such as Mason Lake and Lake Cushman. A few select waters contain more exotic salmonids such as the landlocked chinook salmon or Montana black-spotted cutthroat trout in limited numbers. Largemouth bass, pumpkinseed, yellow perch, black crappie, and brown bullhead are introduced species distributed throughout many of the lower elevation lakes and ponds. Less desirable species, including peamouth, suckers, squawfish, sculpins, sticklebacks, shiners, and dace, are abundant in the lowland waters.

Production

As determined during a 1967 stream survey, fish production, including all anadromous salmonids which reside one or more years in fresh water (exclusive of lampreys), is varied. Such production (measured as instantaneous standing crops at low flows), ranged from practically zero in the glacial headwaters to more than 415 pounds of fish per surface acre in the very productive lowland streams. The average was 250 pounds. Salmonid populations equaled 172.2 pounds per surface acre, while other or undesirable species comprised the remaining 77.4 pounds. Per surface acre production data are not separable by species.

Anadromous Fish—The Basins are an important winter steelhead area and are moderately productive for summer steelhead. Nearly 19,450 adult steelhead (approximately 5 percent are summer run) and 174,000 adult searun cutthroat trout are produced each year. Potential natural production of these species is anticipated to be somewhat greater than the current numbers produced.

Fish production data are shown in Table 12-5.

TABLE 12-5. Anadromous fish natural production (harvest plus escapement), West Sound Basins

Species	Range 1/	Average (Annual)
Chinook	3,120-38,320	15,040
Coho	191,500-872,700	372,300
Pink	99,150-1,539,000	561,030
Chum	110,920-475,990	258,670
Summer steelhead	100-1,800	650
Winter steelhead	12,200-26,000	18,800
Searun cutthroat	92,700-201,200	174,000
Searun Dolly Varden 2/		

1/ Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

2/ Production limited and therefore not determined.

Resident Fish—Most large streams upstream from anadromous fish barriers are producing their natural potential. Smaller streams, particularly those in the southern portion and on the Kitsap Peninsula, are producing near their natural potential. With the exception of glacial streams originating in Olympic National Park, fish recruitment comes mostly from headwater lakes or ponds; occasionally hatchery-reared trout are planted. With few exceptions, the instantaneous standing crop values were nearly equal to the production occurring downstream from anadromous fish barriers.

Stream reaches downstream from migratory fish barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fish is made. The measured standing crop values (excluding lampreys) vary between 144 and 353 pounds per surface acre. Hatchery-reared resident and anadromous trout are also planted in these areas.

All lakes, ponds, and reservoirs are included in a regular fishery management program, which includes trout planting. Because lake waters are managed for salmonids and/or spiny rays, actual production figures are shown in harvest data. Some lake harvest varies from one fishing season to the next, and may range from less than 10 to nearly 300 pounds of fish per surface acre annually. Under ideal conditions, production could be substantial.

Twenty farm ponds managed for trout produce enough natural food annually for about 100 pounds of trout per surface acre. Increased production is possible.

Propagation

The State maintains and operates three salmon hatcheries within the Basins (Figure 12-2). The Minter Creek Salmon Hatchery is situated on Minter Creek near Purdy. Fall chinook and coho are the principal salmon produced here, although chum and pink are often propagated also. The majority of plantings from this hatchery are made within the Basins. The George Adams Salmon Hatchery is located on the Skokomish River at the south end of Hood Canal. It utilizes the waters of the Skokomish River and Purdy Creek. The principal species reared are fall chinook and coho, and nearly all juveniles are introduced into Basin waters. At Hoodsport is the Hood Canal Salmon Hatchery, located on Finch Creek. Principal species reared are fall chinook, coho, and pink salmon, with smaller numbers of chum occasionally produced. Nearly all of the juveniles produced are released into Basin streams.

For years attempts have been made to develop an even-year returning adult pink salmon. Through selective breeding a chum-pink hybrid (the "chumpy") has been successfully produced at the Hoodsport station. Returns of this fish have been encouraging.

The Quilcene National Fish Hatchery is situated on the Big Quilcene River near Quilcene (Figure 12-2). It utilizes waters from the river and Penny Creek. Principal species reared are chum, coho, and fall chinook salmon, and rainbow trout. Smaller numbers of Kamloops, cutthroat, brook, and steelhead trout are also produced. This hatchery meets commitments for fish required on Indian reservations, military bases, national parks, and other Federal areas and those involving State cooperative programs. The majority of fish reared are released in Basin waters.

Numerous commercial fish farms are operated within the Basins. Active fresh-water areas include Erdman, West, Melbourne, and Alexander Lakes. Three salt-water fish farms, Little Clam Bay, Whiteman's Cove, and Keyport and Kingston Lagoons, are located on the Kitsap Peninsula. Annual plants of juvenile salmon have been made into these areas.

Occasionally, salmon reared at facilities in other basins are liberated here.

Preliminary commercial and sport catch statistics indicate that the present planting program in the West Sound Basins contributes approximately 41,100 chinook, 73,400 coho, 9,600 pinks (on odd years), and a few chums to these fisheries annually.

Game fish production is supplemented through operation of a State hatchery and the Quilcene National Fish Hatchery which rear both resident and anadromous species. The State facility, Shelton Fish Hatchery, is situated on a spring-fed tributary of the lower Skokomish River (Figure 12-2). It supplements planting activities of adjacent areas and the State.

Emphasis is directed toward liberating resident and anadromous game fish in low elevation lakes and stream reaches on an annual basis. Alpine lakes also rely heavily on these same facilities, and are stocked with small trout every three to five years or as necessary. Sixteen alpine lakes in Olympic National Park are stocked on a three-year rotation plan. Liberation of legal-size hatchery fish is also used to supplement natural production in the most heavily fished lower elevation lakes and streams, and in habitats which have been altered by nature or man and recently improved.

An estimated 90 percent of the fish reared at the Shelton facility are liberated in the West Sound Basins. State game fish facilities in other basins also supplement the overall trout stocking program.

Survey and harvest data indicate that the planting program provides approximately 35 percent of all steelhead caught within the 22 independent drainages annually. These data also reveal that the program contributes approximately 70 percent of all

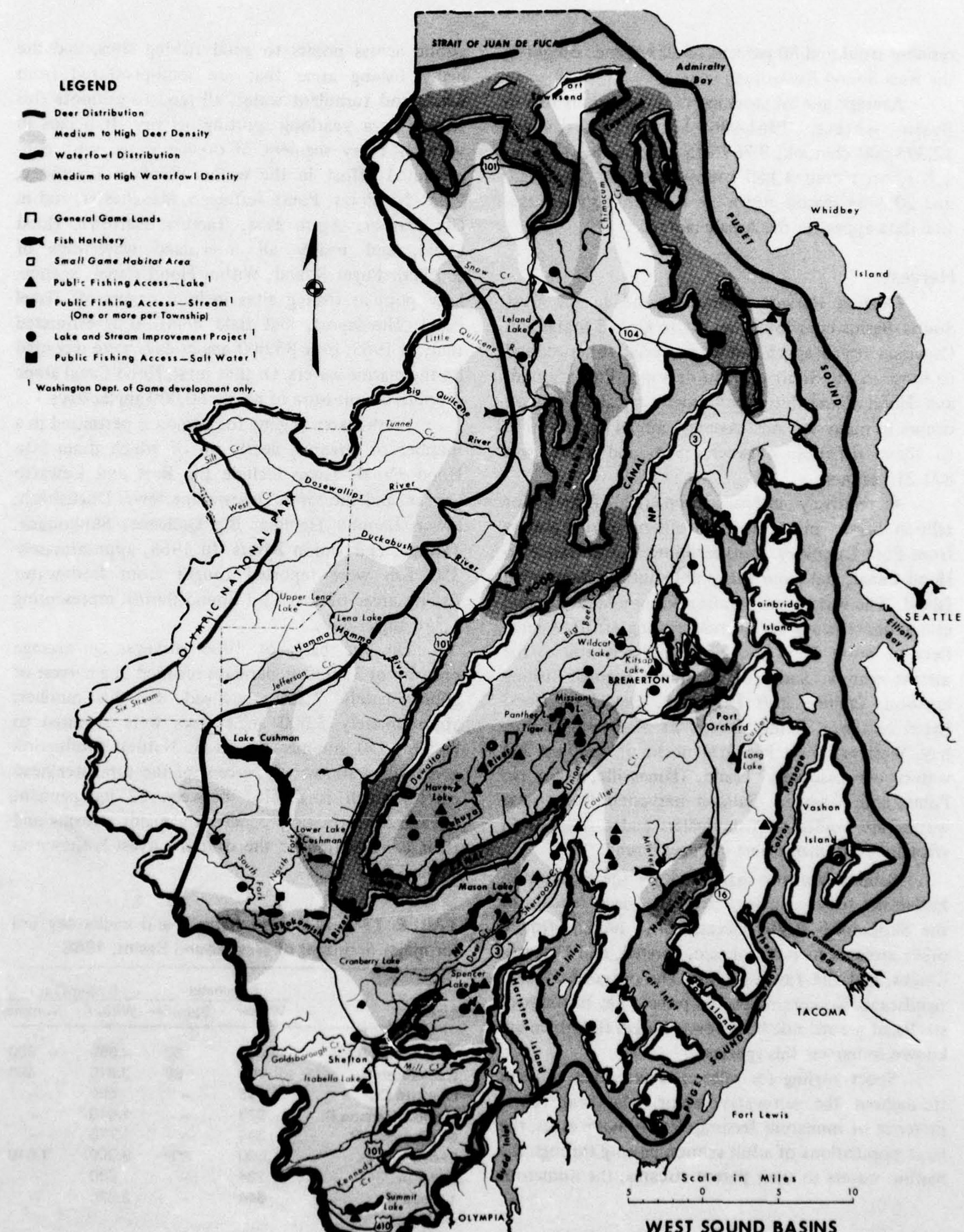


FIGURE 12-2. Wildlife distribution, and fish and wildlife developments (1965)

resident trout and 80 percent of all kokanee caught in the West Sound Basins each year.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 12,398,000 chinook; 3,769,315 coho; 915,132 pink; 2,701,588 chum; 4,140 sockeye; 84,938 steelhead; and 20,246[2] searun cutthroat. Resident fish propagation data appear in the Area chapter.

Harvest

Existing Harvest–Salmon reared in the West Sound Basins contribute heavily to United States and Canadian ocean sport and commercial fisheries, and to those in the Strait of Juan de Fuca, Puget Sound, and Hood Canal. Excellent sport harvest of salmon occurs in many streams. Average annual contribution to these fisheries, between 1956 and 1965, was 871,210 salmon.

A relatively intense commercial fishery for salmon occurs in the more northern marine waters from Port Discovery southeast into the entrance to Hood Canal, and from this point south to Bainbridge Island. The waters surrounding Vashon-Maury Island also support heavy commercial fishing effort. A large fleet of purse seine and gill net vessels utilizes the marine waters. Some of the more popular fishing locations include Port Discovery, Oak Bay, Hood Canal entrance, Skunk Bay, Port Madison, Rollingbay, West and East Pass just north of Tacoma, and waters off Discovery Island, Hainesville, Point No Point, and Kingston. Salmon harvested from these waters are landed at fish dealers and processors in virtually every major port in Puget Sound.

Salmon are also harvested by the Skokomish Indian net fishery, mainly from the lower reaches of the Skokomish River. Occasionally, Indians fish in other streams including Eagle, Jorsted, and Dewatto Creeks, and the Tahuya River. The overall harvest is significant. No commercial or private net landings of steelhead are recorded, however, Indian fishermen are known to harvest this species.

Sport angling for salmon is extremely popular throughout the salt-water sector. The year round presence of immature feeding fish in many areas, the large populations of adult salmon passing through the marine waters to their parent streams, the numerous public access points to good fishing sites, and the many fishing areas that are semi-protected from winds and turbulent water, all tend to promote this fishery as a yearlong sporting activity. It occurs in virtually every segment of marine water, with concentrated effort in the waters off Port Discovery, Point No Point, Point Jefferson, Manchester, and in Gig Harbor, Agate Pass, Tacoma Narrows, Hood Canal, and nearly all interisland waterways of southern Puget Sound. Within Hood Canal, particularly popular fishing sites include waters off Hazel Point, Hoodsport, and Bald Point. It is estimated that, in 1965, over 83,000 angler-days were recorded on the marine waters. Of that total, Hood Canal alone supported a pressure of nearly 50,000 angler-days.

Fresh-water angling for salmon is permitted in a number of streams, nearly all of which drain into Hood Canal. These include Big Beef and Dewatto Creeks, and the lower Dosewallips, lower Duckabush, lower Hamma Hamma, Big Quilcene, Skokomish, Tahuya, and Union Rivers. In 1965, approximately 350 fish were reported caught from fresh-water fishing areas of the West Sound Basins, representing 1,750 angler-days.

On the basis of 1966 surveys, an average pressure of 35,900 angler-days resulted in a harvest of approximately 7,200 steelhead. Of this number, approximately 3,000 angler-days were required to harvest 590 summer steelhead. Natural production contributes almost 65 percent of the total steelhead catch, which is divided between 22 independent streams. Information concerning major streams and their contribution to the overall harvest is shown in Table 12-6.

TABLE 12-6. Steelhead harvest and angler-day use for major drainages of West Sound Basins, 1966

	Steelhead		Angler-Days	
Stream	Winter	Summer	Winter	Summer
Dosewallips R.	931	60	4,655	300
Duckabush R.	783	98	3,915	490
Dewatto Cr.	118	--	590	--
Hamma Hamma R.	328	--	1,640	--
Big Quilcene R.	344	--	1,720	--
Skokomish R.	1,860	302	9,300	1,510
Snow Cr.	124	--	620	--
Tahuya R.	644	--	3,220	--
All Other (Including salt water)	1,384	133	7,135	665

[1] Anadromous trout data involve period 1962-1966.

[2] Annual stocking initiated in 1964, with most active program in 1966.

Survey data (1966) also indicate 83,800 angler-days were spent in the pursuit of searun cutthroat in salt water with a total harvest of 50,200 fish. Natural production contributes all of the total fresh- and salt-water searun cutthroat harvest. Harvest of searun cutthroat in fresh water and the total take of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of 1966 survey data, 335,300 angler-days were expended on the lakes, ponds, and reservoirs, and a total harvest of 1,338,800 trout and 242,200 other game fish realized (Photo 12-1). Similarly, 74,500 angler-days were spent fishing for game fish other than steelhead in the streams and 193,400 were harvested. The whitefish harvest was estimated to be less than one percent of this total.

Potential Harvest–If natural salmon production is increased as indicated in the Production section, there would be a corresponding increase in the harvest of all species. Salmon harvest trends are discussed in the Area chapter.

Potential harvest of natural steelhead production is difficult to predict, because present artificial propagation results in additional fishing pressure on these populations. However, an increase in production would be possible.

Searun cutthroat harvest has not reached its full potential. This is due primarily to the unique stream fishery, the brief season, and the popularity of winter steelhead angling. Estimates indicate that additional production and harvest of searun cutthroat could be realized.

PHOTO 12-1. Small high country lakes provide angling and other recreation benefits. (Washington Department of Game photo)

The production and subsequent harvest of resident salmonids in streams are not expected to change, subject to the same exclusions noted for anadromous fish. An exception is the harvest of mountain whitefish, which is estimated at less than one-tenth its potential. Because this total harvest is not separable from stream resident fish harvest data, present and potential harvest values were not determined. Potential harvest of resident salmonids in lakes, ponds, and reservoirs could undergo a substantial increase.

Factors Limiting Production Other Than Harvest

Limiting factors are shown on Table 12-7. All are alterable.

Detrimental Streamflow—Seasonal flooding occurs in virtually every major drainage, as well as on many of the small to moderate-sized streams. It is particularly severe on the Little Quilcene, Big Quilcene, Dosewallips, Duckabush, Hamma Hamma, and Skokomish Rivers. The intensity of intermittent flood runoff is increased in areas where extensive logging has occurred over the upper steep-sloped watersheds. Excessive short duration runoff also occurs on many of the smaller streams where urbanization and summer home development have resulted in extensive clearing of natural land cover.

Seasonal low flows are common in most streams, but are especially damaging to fish life in the small to medium-sized tributaries to the larger rivers as well as in the smaller independent drainages. Low flow conditions are more critical where excessive logging or land clearing have occurred. Also, the numerous impoundments in the small to moderate-sized drainages further reduce streamflow during the dryer summer months. This problem is accelerating rapidly in many of the Kitsap Peninsula and southern Puget Sound drainages.

Poor Water Quality—Concerning water quality, only a very few streams are polluted to any extent by man's activities, and hence exist in their near natural state. Some estuarine waters used by adult and juvenile salmonids have questionable water quality, caused by chemical sprays and agricultural wastes. However, the overall effect is considered negligible.

Streams in some of the smaller lowland drainages are believed to reach excessive temperature ranges during the warmer summer months, particularly those draining the Kitsap Peninsula.

Physical Barriers—Falls and steep gradient cascades on many of the streams and rivers limit possible upstream migration by anadromous fish. Streams having considerable potential upstream from such barriers include the Dosewallips, Duckabush, Big Quilcene, Little Quilcene, and Hamma Hamma Rivers on Hood Canal, and Kennedy Creek in southern Puget Sound. Although permanent barriers exist on many other streams, they tend to block considerably less spawning area than do the falls or cascades existing on the aforementioned streams. Totally, some 67 stream miles, suitable for use by anadromous species, are presently blocked.

Virtually all of the small to moderate-sized streams experience intermittent barriers to anadromous fish migration, such as those created by debris buildup and beaver dam construction. Although sometimes detrimental to adult fish migration, such barriers often impound water on streams which undergo extensive low summer flow conditions, thus creating natural, additional rearing area for juvenile salmonids.

Conflicting Watershed Developments—Logging is one of the major activities and the Skokomish and Hamma Hamma River watersheds are the most heavily logged. Smaller stream drainages on the Kitsap Peninsula and in southern Puget Sound are experiencing some logging as well as considerable land development clearing. Extensive removal of watershed cover, particularly in land clearing operations, affects flow runoff patterns and water quality conditions, generally limiting the associated streams' capacity for producing anadromous fish.

Tacoma City Light's hydroelectric dam complex on the North Fork Skokomish River effectively limits migrating fish to that point. It also restricts rearing downstream, because water is shunted to a powerhouse on Hood Canal rather than being returned to the North Fork.

Industrial development is considered moderate. Residential permanent and summer home development is accelerating throughout the Basins, particularly on lands immediately adjacent to the streams, rivers, and lakes. Associated with this development are alterations of natural and environmental conditions including water withdrawals, stream channel changes, and diking. Such alterations seldom incorporate measures to protect fish life.

Gravel removal from natural streambeds by Federal, State, county, and private agencies for construction and/or flood control purposes is seriously depleting available spawning material. Much

TABLE 12-7. Alterable factors limiting anadromous and resident fish production in West Sound Basins, by segment

	Limiting Factor[1]											Species Affected						
Basin Segment and Stream	Flooding	Low Flows	Dams-Diversions	Unstable Streamflow	Unstable Streambed	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Limited Rearing Area	Poor Water Quality	Profile Changes[2]	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
South Puget Sound																		
Kennedy Cr.		X			X	X	X		X		X		X		X	X	X	X
Mill Cr.								X							X	X	X	X
Goldsborough Cr.			X										X		X	X	X	X
Cranberry Cr.			X				X			X	X		X			X	X	X
Rocky Cr.		X					X		X			X	X		X	X	X	X
Burley Cr.		X							X		X	X	X		X	X	X	X
West Puget Sound																		
Snow Cr.		X							X				X			X	X	X
Dogfish Cr.		X								X			X		X	X	X	X
Chico Cr.							X		X				X		X	X	X	X
Gorst Cr.			X									X	X		X	X	X	X
Olalla Cr.		X						X					X		X	X	X	X
Crescent Cr.		X						X	X		X		X		X	X	X	X
Hood Canal																		
Little Quilcene R.	X	X	X	X					X				X		X	X	X	X
Big Quilcene R.	X	X			X	X		X				X	X		X	X	X	X
Dosewallips R.	X	X				X		X			X	X	X	X	X	X	X	X
Duckabush R.	X	X		X	X	X					X	X	X	X	X	X	X	X
Hamma Hamma R.	X	X				X						X	X	X	X	X	X	X
Lilliwaup Cr.						X							X			X	X	X
Skokomish R.	X	X	X	X	X	X					X	X	X	X	X	X	X	X
Union R.		X				X		X				X	X		X	X	X	X
Big Mission Cr.		X					X		X				X		X	X	X	X
Tahuya R.		X					X				X	X	X		X	X	X	X
Rendsland Cr.		X						X	X				X		X	X	X	X
Dewatto Cr.							X	X				X	X		X	X	X	X
Big Beef Cr.	X		X							X	X		X		X	X	X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

of this material is presently being removed from lower river areas.

Water withdrawal for municipal, agricultural, or industrial purposes is a limiting factor on only a few streams.

Limited Spawning and Rearing Areas—Associated with flooding in the major drainages is the loss of gravel that constitutes vital spawning material for salmon. Also absent are the natural pool-riffle conditions necessary to achieve a proper balance between fish spawning and rearing areas. This indiscriminate removal of riverbed gravel also reduces total fish production habitat. Virtually all streams exhibiting extensive low flows are limited in total effective rearing area. Some of the higher elevation streams in the Olympic Mountains have steep gradients and are thus limited in rearing as well as spawning potential.

Competition and Predation—Competition and predation range from moderate to heavy in the streams. Many of these streams are inhabited by large populations of fish, comprised of numerous species. This in itself creates excessive competition for feed, and thus reduces the ultimate production capacity. However, many of the less desirable species, such as suckers, squawfish, sculpins, peamouth, dace, and sticklebacks, are more readily available to active predators, thus relieving some of the predation pressure on young salmon and trout.

Considerable predation occurs on juvenile salmonids in the estuarine and marine areas, particularly in southern Puget Sound waters. These fish are consumed by larger anadromous species, birds, and by certain marine fishes, such as the dogfish. The latter, abundant in some areas, also feeds on herring, a principal food of adult salmon. Seals and killer whales occasionally utilize these waters, and prey on adult salmon.

Beneficial Developments

Accomplished and Continuing–Enhancement projects for anadromous fishes have involved extensive beaver dam and logjam removal, road culvert repair, and installation and operation of fish-passage facilities on the Tahuya River, and Johns, Goldsborough, and Big Beef Creeks (Figure 12-1). The State fishery agencies attempt to remove all intermittent barriers as they occur. Various Federal land management agencies, in cooperation with the State, also engage in this activity. Such projects may also benefit resident game fish.

Beneficial developments have also included increasing game fish production and increasing public access to lowland lakes and in stream reaches of importance to anadromous game fish. This entails artificial propagation, lake rehabilitation, stream and lake improvement, and public fishing access area development.

All streams in Olympic National Park, including much of the upper North Fork Skokomish, Duckabush, and Dosewallips Rivers, are managed primarily in their natural state. Sixteen alpine lakes in the park are included in a rainbow trout planting program, administered under a cooperative agreement between the Bureau of Sport Fisheries and Wildlife and the National Park Service.

Research, including the use of radioactive isotopes of certain chemicals, has been conducted at Fern Lake on the Kitsap Peninsula, as part of a continuing program to increase natural production of inherently poor lake habitats. The first findings of this work, which is a joint effort of the College of Fisheries, University of Washington and the Washington Department of Game, are being analyzed.

Several lakes and streams are closed to fishing in order to protect existing fish populations and the use of these varied habitats. These are usually unique situations or populations involving control structures and/or research projects.

Waters which have been chemically rehabilitated for trout management include Horseshoe, Ludlow, Peterson, Tarboo, Cresent, Pheasant, Silent, Mission, Wildcat, Buck, Panther, Kitsap, Tiger, Fern, Wye, Deep, Island, Aldrich, Spencer, Panhandle, Haven, Tee, Benson, Phillips, Robbins, Twin (Big and Little), "U", Devereaux, Bennettsen, Clara, Hanks, Lost, Deer, Old Hatchery, Osborne, Stetson, Standstill, and Bay Lakes, Lake Maggie, and Lake Wooten. While only 19 of these lakes required screening, nine also required barrier dams. Figure 12-2 indicates the location of various lake and stream improvement projects.

The State's public fishing program is designed to guarantee fishermen access to both lakes and streams. Access area developments exist at Crocker, Leland, Tarboo, Buck, Horseshoe, Kitsap, Long, Mission, Tiger, Wildcat, Wye, Aldrich, Benson, Cady, Clara, Devereaux, Haven (2), Isabella, Island, Lost, Mason, Panther, Phillips, Prickett, Spencer, Tee, Twin, Cresent, Bay, Carney, and Jackson Lakes, Lake Maggie, and Lake Wooten (Figure 12-2). Stream access and/or boat launch areas include sites on the Skokomish, Tahuya, and Union Rivers. Salt-water launching areas also exist near the mouths of Union and Skokomish Rivers, at Misery Point (Hood Canal), and at Retsil (Bremerton). Additional private and public developments supplement this program, and where developments have been completed for salmon, anadromous and resident game fish may also benefit.

Effort to obtain guaranteed public fishing access on lakes, streams, and certain salt-water areas is a continuous process–likewise, the maintenance and construction of inlet and outlet control structures accompanying specific lake rehabilitation programs.

Under agreement between the city of Tacoma and the State, funds were supplied for construction and annual maintenance of the George Adams Salmon Hatchery in lieu of the loss of fish resources caused by the North Fork Skokomish River diversion.

Under Development–A 1.8-acre semi-natural steelhead rearing facility on a Skokomish River tributary is nearing completion. This type facility is a vital adjunct to the quality and quantity of steelhead and searun cutthroat production programs.

Research concerning the quantity of specific chemical additives required to augment fish production of nutrient-deficient lakes is being continued. Knowledge gained will be useful in increasing natural production by fertilization.

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters of the West Sound Basins are the most extensive, and contain the most highly diversified ecological environment types of all basins. These waters can be separated into several geographical segments. The open and semi-open waters of the Strait of Juan de Fuca, Admiralty Inlet, and northern Puget Sound contain relatively few areas having depths exceeding 50 fathoms. These waters exhibit ocean-like characteristics, being cooler, more dense, and having higher salinities than the more southerly Puget Sound waters. The more prominent protected waters in this segment include Sequim Bay, Port Discovery, and Port Townsend.

Paralleling the Basins' eastern boundary, from the northern end of the Kitsap Peninsula south to a point near Gig Harbor, is the mid-Sound trench, with depths exceeding 100 fathoms. Between the Kitsap Peninsula and Vashon Island, depths often exceed 60 fathoms. With these depths, and somewhat open and unrestricted waters prevailing, the marine water remains generally cool, dense, and highly saline. The Basins' eastern boundary also contains much protected water, including Dyes, Sinclair, and Liberty Inlets, plus Port Madison and Gig Harbor.

South and west of Gig Harbor, through the Tacoma Narrows and into the many inlets and arms of South Puget Sound, only a few areas exceed the 50-fathom depth. This South Sound segment contains many islands, bays, coves, and interisland watercourses, and offers a great expanse of shallow water exposure and diverse marine environment. The principal watercourses include Carr, Case, Totten, and Hammersley Inlets, and Pickering Passage. Because of the tidal interchange restriction at the Tacoma Narrows, the marine waters of this South Sound segment are characteristically warmer, less dense, and less saline than most other marine waters within the Puget Sound Area.

In the Hood Canal segment, depths often exceed 50 fathoms, with large areas in the 70-fathom and above range. Dabob Bay is the canal's principal arm or extension and has depths exceeding 100 fathoms. A unique characteristic of the canal is the relatively large volume of fresh water which forms a layer on the salt-water surface, or which stratifies at different depths depending upon the temperature differences between the drainage runoff and the salt water. Thus the environmental characteristics experienced by the marine fish and shellfish inhabiting these waters may be altered by the magnitude and dispersion characteristics of the fresh-salt water balance.

Inventory and Distribution

Marine Fish—The highly diversified environment types and ecological niches afforded by the marine waters provide suitable habitat for a great variety of marine fishes. Also, the extensive marine area associated with the large number of streams and rivers entering salt water provides living space and productivity to support abundant populations. Those fishes contributing to local commercial and sport catches include species of the cod family, lingcod, greenling, flounder, sole, surfperch, rockfish, herring, smelt, dogfish, and ratfish. The cods, lingcod, greenling, surfperch, flounder, and sole occur in significant numbers, particularly in the central and southern marine waters and in some sectors of Hood Canal. Dogfish, ratfish, and herring are also common throughout the marine sector, with especially large concentrations in the southern Sound waters. Population is discussed in the Area chapter concerning species production.

Shellfish—For ease of description of shellfish inventory, distribution, and production, the Basins are basically divided into two segments: Hood Canal proper and Central Puget Sound-Kitsap Peninsula. The estuarine and marine waters and shoreline from Kala Point on the west side of the mouth of Hood Canal southerly through the canal proper and then northerly back through the canal to Foulweather Bluff opposite Port Ludlow comprise the Hood Canal segment. The Central Puget Sound-Kitsap Peninsula segment extends from Foulweather Bluff southeasterly through Port Madison, Port Orchard, Dyes Inlet, Sinclair Inlet, southerly through Colvos Passage, and Gig Harbor as far south as the Tacoma Narrows Bridge (Puyallup Basin). Three islands, Bainbridge, Blake, and Vashon-Maury, are also included in this segment.

The mouth of Hood Canal is subject to tidal interchange from Admiralty Inlet. The canal contains water with depths approaching 100 fathoms with shallow flats at the river mouths and enclosed bays. Two sills, at the mouth of Dabob Bay and in southern Hood Canal, restrict the movement of deep saline waters. Entrapped bottom waters behind these sills tend to warm above average during the annual warming cycle. Surface temperatures in bays and in the canal periphery are higher than those in mid-channel and provide ideal spawning and "setting" conditions for clams and oysters. There is relatively little flushing action in the canal. The greatest temperature gradients occur within the upper 50 feet, with relatively little change at greater depths. Salinities follow a similar pattern. Fresh-water discharges from the larger drainages directly influence the salinities in their immediate vicinities as well as overall dilution of the deeper waters throughout the canal.

The mixed sand and mud tidal flats near the river mouths provide prime areas for clam and oyster production (Photo 12-2). Aside from these areas, the bulk of Hood Canal contains short, relatively steep gravel beaches composed of medium to small gravel on the upper beach area and coarse to large gravel with scattered boulders on the middle and lower tidal areas. Prevailing winds cause wave action in the long reach of the canal, which tends to remove the silt and mud from the unprotected beaches.

Principal species of shellfish and other marine invertebrates in the Hood Canal segment are Dungeness and red crabs; Pacific, native, and Kumamoto oysters; littleneck, butter, horse, Manila, geoduck, softshell, cockle, and piddock clams; blue mussels; pink and rock scallops; spot, coon stripe, and pink shrimp; squid; octopi, and sea cucumbers.

PHOTO 12-2. Tidelands associated with river mouths promote shellfish production. (Washington Department of Fisheries photo)

Dungeness crabs occur in the shallow bottoms throughout the canal, but are not present in significant numbers. Scattered concentrations inhabit the tidal flat dropoffs and more sandy protected areas where eelgrass flourishes. The smaller red crabs are moderately abundant from the shorelines to 60-foot deep waters.

The large Pacific oysters are abundant throughout the canal. The native Olympia oysters are only found in limited quantities in the northern end of Dabob and Quilcene Bays, along the Dosewallips Flats, and in Lunch Cove at the toe of the canal. Scattered small populations occur throughout the canal. Kumamoto oysters are found on a few planted beds.

Littleneck, butter, Manila, and horse clams occur in Hood Canal. These species and cockles occur primarily on the gravel beaches throughout the canal, while the geoduck and softshell prefer the sandy mud flats near the river mouths and sand flats in protected bays. Geoducks occur below the mean low tidemark to depths exceeding 60 feet. Piddocks inhabit solid clay banks and outcroppings that extend into the intertidal zone. The common blue mussels are found in moderate abundance and are more concentrated north of Oak Head in the main canal where tidal effects are strongest. Pink scallops occur in waters exceeding 40 feet in depth on sandy bottoms where currents are active. Rock scallops are present wherever rock outcroppings or large boulders exist below low tide.

Four species of shrimp inhabit Hood Canal. Spot shrimp occur in greatest abundance and lesser numbers of pink, coon stripe, and side stripe shrimp inhabit these waters. Dabob Bay, Quilcene Bay, and waters off Dewatto, Dosewallips River, Duckabush River, and Hoodsport are the most productive shrimp grounds; however, beds occur throughout the canal in waters from 30 to 60 fathoms in depth.

Squid are present year round in large concentrations throughout the canal and large octopi occur in most marine areas, particularly where crabs are present and there are rock outcroppings and large boulders for protection. Sea cucumbers are abundant, but sea urchins are present only where moderately strong tidal currents exist.

The Central Puget Sound-Kitsap Peninsula segment, unlike Hood Canal, has excellent currents and water interchange except for Dyes Inlet near Bremerton. Here the tide moves through Port Washington Narrows which is restricted and freshening requires many tidal changes. Cold, saline water conditions prevail through the influence of the deep intermixing central Sound currents. The tidelands throughout this area feature excellent gravel and sand composition for clam production. Good oyster production is somewhat restricted.

Principal species of shellfish and other marine invertebrates in the Central Puget Sound-Kitsap Peninsula segment are Dungeness and red crabs; Pacific and native oysters; littleneck, butter, horse, Manila, geoduck, softshell, and cockle clams; blue mussels; pink and rock scallops; spot and pink shrimp; squid; octopi; and sea cucumbers.

Moderate numbers of both Dungeness and red crabs are found in this area. Pacific oysters are grown in commercial abundance in Liberty Inlet near Poulsbo, in Dyes Inlet near Silverdale, in Ostrich, Oyster, and Mud Bays, and in the enclosed portion of Sinclair Inlet. The small native Olympia oysters occur in limited numbers near Poulsbo and in Sinclair Inlet near Bremerton. Private beaches with small seedings are scattered throughout this area.

Native littleneck, butter, and Manila clams occur in commercially significant numbers in the Bremerton area, Rollingbay, Quartermaster Harbor; near Vashon Island and Poulsbo; in Port Madison; and in Fletcher Bay on Bainbridge Island. Horse clams and geoducks occur in moderate abundance on tidelands and in the mud and sand bays to depths exceeding 60 feet. Blue mussel populations are moderate to heavy, particularly in the channels and entrances to inlets where strong currents exist. Scallops occur in waters over 40 feet deep on sandy bottoms where currents are active. The commercial harvest of pink scallops was heavy in Kitsap Peninsula waters prior to 1952. There have been no landings, however, since 1953.

Pink shrimp and a few spot shrimp beds exist in this area. Shrimp catches have always been minor in these waters with no significant exploitation of this species since 1942.

The squid catch from 1933 to 1941 in the Kitsap Peninsula area was commercially significant. However, this fishery ceased after 1942 and failed to materialize again. Herring fishermen in this area frequently capture large schools of squid during their night operations. Octopi are numerous in the fast current reaches, especially in the Bainbridge and Vashon Islands area. The sporadic commercial landings do not reveal their true abundance. Moderate numbers of sea cucumbers and sea urchins inhabit marine waters. Urchins prefer the rocky areas with swift currents and the sea cucumbers are scattered over the more protected sandy bottoms.

Production

Information is not available concerning marine fish or shellfish production.

Propagation

Marine fishes are not propagated within Basin waters.

The entire segment designated as South Puget Sound contains extensive oyster culture beaches, the majority of which are private commercial ventures. Many of these procure "seed" for propagation from State-owned reserves also located in these waters. In addition, occasional seedings of foreign stock are also introduced. However, extensive beach "reseeding" is usually unnecessary in the South Sound since the somewhat warmer waters tend to promote sufficent natural "setting" of spat. Principal production areas include the bays and inlets, plus portions of the island shorelines.

In the Hood Canal segment, private oyster beds, many of which are commercial operations, occupy extensive beach area particularly in the southern reaches and in the bays and inlets along the canal's length. Here, as in South Puget Sound, commercial beds are heavily seeded, using State-produced seed and foreign import stock.

Along the shorelines bordering eastern Kitsap Peninsula mostly small private oyster beds exist, with few commercial operations.

Harvest

Marine Fish—Generally, the marine fishes support light to moderate commercial and sport fishing effort. Fishing effort and catch magnitude and composition vary considerably in the different marine segments. This is due principally to species distribution and abundance levels and to the proximity of the fishing grounds to major fish landing ports or metropolitan areas.

The commercial harvest of marine fish is conducted principally by otter trawl vessels; however, some hook and line fishermen also utilize these waters. The more popular fishing grounds utilized by trawlers include the southeast portion of the Strait of Juan de Fuca just off Sequim and Port Discovery; portions of Admiralty Inlet, including the entrance to Hood Canal; the Kingston-Port Madison area; and Case and Carr Inlets in southern Puget Sound. The principal species harvested include lingcod, flounder, and sole, and a variety of rockfish from the northern and eastern portions, as well as sole and various scrap fish species from the more southern waters. Marine fishes harvested from Basin waters are landed and marketed at virtually every major port in the Puget Sound Area.

A moderate to intense commercial herring fishery occurs at numerous locations, but is particularly intense in the waters south of the Tacoma Narrows and in Hood Canal. The bulk of this harvest is marketed as "bait fish" and sold locally to resorts or boathouses, or is trucked to major ocean fishing ports along the Washington coast. Surf smelt are also harvested in small quantities both commercially and by sport fishermen within Basin waters.

Sport fishing specifically for marine fishes is performed in virtually the entire marine environment. Sport angling from boats, piers, or beach areas, is especially heavy in Sequim Bay and Port Discovery, in certain areas in Admiralty Inlet, in the waters surrounding Bainbridge and Vashon-Maury Islands, in the Tacoma Narrows and the interisland waterways of southern Puget Sound, and in virtually all of Hood Canal. Sport diving and spear fishing are increasing rapidly in popularity, and the marine waters of the West Sound Basins support the bulk of this activity. The clear waters of Hood Canal and the many bays and inlets throughout the Basins, along with highly diversified marine environment types providing an extensive variety of marine fishes, support spear fishing. The major marine fishes sought by sport anglers and spear fishing enthusiasts are lingcod, flounder, sole, and a variety of rockfish. Because of the extent of area and extremely wide distribution of sport fishing effort, it is difficult to accurately determine the total sport harvest of marine fishes. Preliminary data indicate that, in 1965, a minimum of 9,000 angler-days was expended within the marine waters. This did not include pressure from spear fishing or angling from piers or from small boats not utilizing boathouses or public access points.

Harvest potential for marine fishes was not determined.

Shellfish–The commercial and sport harvest of shellfish is considered relatively intense, with emphasis on oysters, hardshell clams, crabs, and shrimp. Major commercial shellfish landings for the Puget Sound Area come from these waters, and the great expanse of relatively undisturbed and highly diversified shoreline provides outdoor sporting enthusiasts one of the finest and most easily accessible shellfish production areas in the Pacific Northwest.

Major commercial harvest occurs in southern Puget Sound and Hood Canal waters, and in Sequim Bay and Port Discovery. The commercial harvest of crab and shrimp is extensive in Hood Canal and large numbers of crab are also taken by commercial fishermen in the Sequim-Port Discovery area. A small commercial fishery for sea cucumbers exists in Rich Passage and Port Washington Narrows.

Sport harvest of shellfish occurs over virtually every section of beach or tideland. In many areas, commercial type "pots" are used to harvest crab and shrimp. This fishing method is especially productive in portions of Hood Canal, in the Sequim-Port Discovery area, and in some sections of southern Puget Sound. Swimmers, including free and SCUBA divers, are becoming significant harvesters of shellfish. Their catches add considerably to the total sport harvest, and because new and previously untouched production grounds are the principal areas being fished, this form of harvest creates little or no additional pressure on the already heavily utilized beaches. In general, the majority of shellfish are taken by digging or by merely "picking" the desired species from beaches or tidelands. Receiving especially heavy use by sportsmen are those areas where extensive public beach and relatively easy access are readily available. Much of the highly productive beach and tideland is accessible only by boat, and receives only moderate sport harvest effort. Average annual man-days of use attributed to shellfish harvest are 28,000.

Harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish–The principal factors influencing marine fish production are poor water quality, tideland development, and competition and predation.

(1) Poor Water Quality–A few marine areas present minor pollution conditions which influence the abundance of local marine fish populations. Domestic and industrial effluents, plus introduced foreign materials from local shipping traffic, alter the natural water quality in the estuarine and marine waters. Such conditions are prevalent in areas near cities and port facilities including Shelton, Bremerton, Poulsbo, and Port Townsend. The combined effects of all pollutants entering marine waters are undetermined. Domestic sewage and detergents, in addition to industrial pollutants, are believed to be a direct cause of reduced marine fish populations in certain areas, particularly where extensive beach home development has occurred. Problem areas are Port Orchard, Liberty Bay, and southern Hood Canal. Such conditions will become more acute as population and industrial expansion continues.

A unique character of Hood Canal is the relatively large volume of fresh water forming a layer over the salt-water surface, or stratifying at varying depths within the salt-water environment. This tends to influence the distribution and availability of living space for the marine fishes common to the area. Thus the environmental conditions experienced by both the fish and shellfish inhabiting these waters may be altered simply by the magnitude and dispersion characteristics of the fresh-salt water balance.

(2) Tideland Development—In addition to contributing to poor water quality, rapid urbanization and expanded industrial development limit marine fish populations through attrition of natural production areas. The disposal of excavation and dredged spoils, and construction of extensive landfills, large dikes, and breakwaters are seldom compatible with fish needs, and are particularly detrimental to juvenile marine fishes. Such conditions are prevalent only in certain sections, particularly where the larger metropolitan areas have developed. The construction of beach bulkheads and clearing of overhanging trees for private beach developments have destroyed many of the spawning areas for surf smelt, which require fresh-water seepage, shade, and fine gravel.

(3) Competition and Predation—The dogfish, abundant in some waters, preys upon some marine fish species, particularly juveniles. In addition, heavy concentrations of these fish will compete for, and often dominate, a particular niche within the environment, eliminating the more desirable species such as rockfish or cod. Dogfish are considered in moderate to heavy abundance throughout most waters, with sizable numbers in the southern Puget Sound marine environment.

Shellfish—Principal factors influencing shellfish production include poor water quality, adverse physical conditions, tideland development, and competition and predation.

(1) Poor Water Quality—The river systems entering Hood Canal produce a two-layer stratification near the river mouths, which influences the adjacent beaches. This thin fresh-water lens over the denser saline water appears to have little or no deleterious effect on shellfish populations. Since no major rivers are located in the Kitsap Peninsula section, the marine waters of this area are typical of the central Puget Sound cold-deep salt water, with minor fresh-water stratification. Small creeks discharge into each of the many shallow bays and inlets, contributing fresh-water surface layering to these respective areas. The more southern Puget Sound bays and inlets also receive waters from numerous small creeks, which influence both the salinity and overall water quality conditions. These more southern Puget Sound waters have restricted tidal interchange and consequently tend to exhibit certain temperature and nutrient characteristics. Consequently, many of the bays and inlets experience warmer temperatures and often more productive conditions for the natural propagation of certain shellfish, while other segments of the Basins are quite limited in this regard.

Some limited pollution effect occurs in the more metropolitan and industrialized areas near Shelton, Bremerton, Poulsbo, and Port Townsend. Within Hood Canal, pollution is practically nonexistent as a limiting factor; however, the growing development of private beaches and summer homes along the entire shoreline poses a serious sewage disposal threat in specific areas. Although somewhat minor in total effect, some 10 log dump and log boom sites within Hood Canal have to some degree fouled and damaged the beaches for shellfish culture. In the Port Townsend, Bremerton, and Shelton areas, effluents from municipal and industrial wastes create pollution conditions, which at certain times of the year, are quite extensive. To a lesser degree, the spillage of oils, paints, and other toxicants from ships and barges serving these larger ports creates somewhat localized poor water quality conditions. It is anticipated that future expansion of industrial development, particularly at these major port areas, will create additional pollution problems and limit local shellfish production.

(2) Adverse Physical Conditions—In some of the southern Puget Sound bays, as well as in many of the inlets along the eastern shore of the Kitsap

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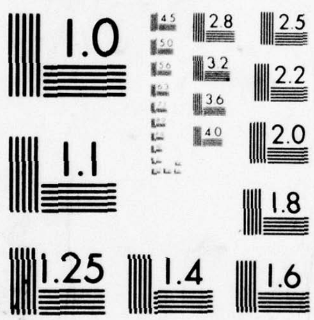


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Peninsula, oyster culture is limited by the nature of the mud covering the bottom material. There is insufficient tidal action to remove it and make the beaches suitable for production of this valuable shellfish. Throughout the marine sector other physical factors limiting shellfish production include periodic heavy wind and wave action over the beaches, and freezing conditions over considerable periods which tend to destroy large quantities of clams and oysters. Also, the low normal summer temperatures prevent adequate spawning and setting of these shellfish species, except in certain areas of southern Puget Sound's bays and inlets.

(3) Tideland Development—The log dump and log boom sites within the Hood Canal area have degraded certain beach areas for shellfish culture. Beach alterations associated with residential developments have also reduced the area available for shellfish. The largest portion of beach and waterfront property has been developed in the vicinity of Bremerton. Continued industrial and urban expansion will further limit available shellfish production area within the Basins.

(4) Competition and Predation—Throughout the marine sector natural predators causing shellfish mortalities include ghost shrimp and burrowing worms on the mud flats and soft beaches; sand dollar beds in beach areas that could be producing clams; starfish, native drills, large moon snails, and red crabs that prey on oyster and clams; and octopi that prefer crabs to other available foods. Blooms of green sea moss during June and July smother seed oyster beds.

Beneficial Developments

Specific marine waters, including some bays and inlets, are established preserves restricting the commercial harvest of marine fishes. These preserves are undoubtedly one of the most important beneficial factors for sustaining high natural production in these waters. No specific projects exist for the beneficial development of marine fishes.

Many beneficial development programs for shellfish have been undertaken and are currently being conducted. Some of the more extensive programs concern methods for eliminating natural predators of oysters and clams, particularly starfish, oyster drills, and red crabs. Also, economical means and methods of eliminating ghost shrimp infestations from beach areas that could be utilized for clam and/or oyster production are presently under study. Other programs include studies of oyster fattening and condition factors; water temperature relationship to oyster and hardshell clam spawning; annual assessment and prediction of timing and setting of Pacific oyster larvae for commercial production; effects of water movement and currents on oyster larvae; and transplanting of Pacific oyster and Japanese littleneck clam seed stock to barren areas.

Approximately 1,192 acres of tideland comprise the State oyster preserve areas in Oakland Bay near Shelton, in Totten Inlet, Eld Inlet, and upper Case Inlet. The State also maintains a shellfish laboratory near Brinnon on Hood Canal where research projects, including water quality studies, are centered.

Research is underway to determine the feasibility of placing (seasonally) a floating surface barrier across the northern end of Dabob Bay in Hood Canal to prevent loss of water mass which contains heavy concentrations of oyster larvae.

The largest proportion of privately-owned commercial clam and oyster lands is located in the West Sound Basins. Propagation of Pacific seed oysters in Hood Canal has been expanding in direct proportion to availability and cost of seed from other sources. There is an increased trend in transporting seed and partially grown Pacific oysters from Hood Canal to other basins. The clam and oyster preserves provide many thousands of bushels of seed stock for transplanting in commercial and public tidelands.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The West Sound Basins are geographically the largest in the Puget Sound Area. Their total population, 124,200 in 1963, is among the largest of all the basins, but density is well below that of the Everett-Seattle-Tacoma area. In the Bremerton and Kitsap Peninsula area the projected average annual growth rate is 2.5 percent through the year 2020. Increases in the more remote areas such as southern Puget Sound, Hood Canal, and northern Olympic Peninsula will be more moderate. A forecasted population of 175,000, 274,100, and 432,700 for 1980, 2000, and 2020, respectively, is shown.

As important as any factor in influencing the Basins' growth rate is transportation and the probable eventual construction of a cross-Sound bridge. Recreational property developments are rapidly appearing along many marine and fresh-water areas, and the rate of this growth will continue to increase with demands for outdoor recreation. These Basins contain numerous small streams that will feel the impact of this form of development. Both recreational and permanent home development will accelerate sharply when the bridge is constructed.

RESOURCE DEMANDS AND NEEDS

Much of the commercial salmon fishing by Puget Sound-based fleets occurs in the West Sound Basins. Intense fisheries for chinook, coho, and chum salmon are centered in Port Discovery, Hood Canal, Admiralty Inlet, and central Puget Sound south to Tacoma. During odd-numbered years there are important pink salmon fisheries in Port Discovery, Hood Canal, and Admiralty Inlet. An efficient Indian fishery on the Skokomish River contributes to the economy of Skokomish Reservation residents. Anadromous fish are also vital to the major sport fishing and recreational industries throughout these Basins. Angling is popular in all salt-water areas and several streams, although effort is concentrated at relatively few localized areas where fishing success is consistently high.

Since public access to virtually all salt-water areas is readily possible, and the price of boats and necessary equipment is within the reach of a majority of the people, the popularity of salmon fishing is increasing at a rate faster than population growth. These increasing demands, plus requirements for commercially caught fish to feed a rapidly expanding population, make the salmon producing capacity of these Basins extremely important.

Salmon production occurs in several major Olympic Peninsula streams, however, the numerous small streams throughout the West Sound collectively are the heaviest contributors. While this production has satisfied past fishery requirements with reasonable success, the rate of production must increase to meet future demands. This will require programs and projects to fully develop and efficiently utilize all potential production areas.

A number of marine areas within the West Sound Basins support valuable marine fish stocks that are harvested by otter trawl vessels. The increase in importance of these species as a food source will provide the impetus for rapid future fisheries development. Programs involving product research, animal ecology, and resource conservation will provide for more complete utilization of marine fishes, many of which are not presently sought by fishermen. Although salt-water sport fishermens' appetite has historically been whetted only by salmon, increased emphasis on angling for other marine species is assured in future years. Spear fishing for marine fishes has developed from an uncommon hobby to a popular recreational activity during recent years. This trend will continue and will add to the demand for these fish.

West Sound shellfish production exceeds that of any other Puget Sound basin. It is unsurpassed in the production of oysters, Washington's most valuable shellfish resource. Oyster farming on privately-owned tidelands in southern Puget Sound and Hood Canal is of great importance to several local economies. Oyster culture in other bays throughout this area, as well as clam farming and shrimp and crab fisheries, make these Basins a vital area in fulfilling shellfish needs. As with virtually all other resources, the commercial demand for shellfish will increase at least in proportion to human population.

The demand for shellfish on easily accessible public beaches has already surpassed the production. Most readily reached beach areas are being over-exploited. However, a number of edible shellfish, such as softshell clams, mussels, and sea cucumbers, are being ignored by fishermen. Eventually the demand will become so great that these varieties will enter the fishery.

Much of the future demand for fishing will come from urban areas and from adjacent basins. Based on county use values, approximately 80 percent of all use of Basin game fish, other than steelhead, is by people from outside the Basins. Much of Kitsap County is urban and is completely different in character from the rural mountainous portion in the west. In this county only 30 percent of all game fish harvest exclusive of steelhead is by people living outside. This compares with adjoining basin counties where fully 65 percent of use is by people living outside. In addition to the population of the Puget Sound Area, people from other parts of the State travel to the West Sound Basins primarily for outdoor recreation, including fishing. A large number of streams and lakes provide excellent fishing for resident game fish. Alpine lakes in the Basins are generally less intensively managed than in other basins; consequently, success rates and demand are lower. It is estimated that, by 1980, Basin lakes must provide an additional 933,400 trout and 153,600 game fish of other species to the creel annually (Photo 12-3). This is an additional 85 fish per surface acre. Similarly, streams must supply an additional harvest of 210,100 resident trout and whitefish and 6,900 steelhead each year. Table 12-8 indicates present and projected demands and needs for game fish in angler-days.

TABLE 12-8. Present and projected sport fishermen use (game fish) in West Sound Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	529.5
1980	354.8	884.3
2000	505.8	1,390.1
2020	834.1	2,224.2

PROBLEMS AND CONFLICTS

Some major problems and conflicts specific to the West Sound Basins are described below. These are among the limiting factors for conservation of the existing fish and shellfish resources, and for their future enhancement. In addition, general problems and conflicts discussed in the Area chapter apply to these Basins.

Conflicting Land and Water Uses

(1) Demands for dam construction on rivers and streams by land developers to create artificial lakes or reservoirs for summer home and/or permanent residential communities benefit only the developers. Fisheries problems arising from such developments include spawning area destruction and possible deterioration of water quality. Such developments also limit public access to fishing waters.

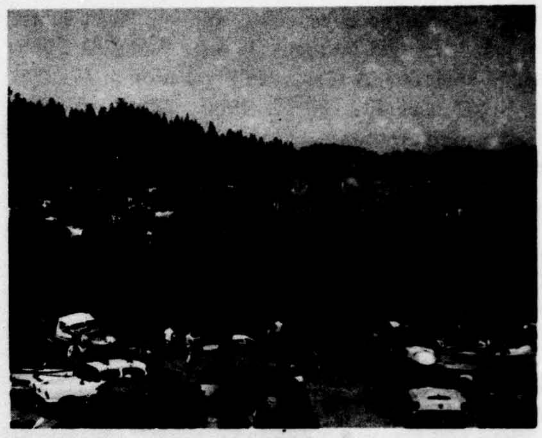


PHOTO 12-3. Demands for sportsmen access to lakes are high and growing. (Washington Department of Game photo)

(2) The development of farmlands adjacent to rivers and streams on the Hood Canal and Kitsap Peninsula areas into residential communities is gradually encroaching and inflicting degrading environmental changes in the river and stream ecology. New roads and dikes associated with these developments result in the destruction of the protective trees, brush, and stream cover. Numerous requests for creating ponds, small lakes, and stream alterations are associated with these rural changes.

(3) Projects being considered, such as those involving flood prevention and drainage on the North Fork and South Fork Skokomish River, the Dosewallips and Duckabush Rivers, and Goldsborough Creek, as well as municipal and industrial storage reservoir projects (i.e., Dewatto Creek, and Tahuya, Union, Duckabush, Dosewallips, Big Quilcene, and Little Quilcene Rivers) may pose conflicts with fish needs. Flood control structures would destroy fish habitat and the impoundments would have no fishing value due to heavy drawdown and increased retention of silt-laden water.

(4) Undesirable fishes could compete with and prey upon game fishes to an increasing degree in lacustrine areas such as Mason Lake. Stunting of spiny-rayed species would contribute to decreasing quantity and quality of harvest.

Poor Water Quality

(1) Intermittent and seasonal pollution in certain streams and estuaries results in water quality inimical to fish. Effluents from agricultural, industrial, and sewage disposal sources are particularly detrimental to aquatic life. The buildup of sludge and heavy waste in the estuaries limits shellfish and marine fish production.

(2) Conversion of second growth tree farm areas in Mason and Kitsap Counties into Christmas tree farms has resulted in large scale canopy removal with accompanying increased water temperatures and lower summer streamflow.

Social and Psychological Considerations

(1) Conflict over water use will continue between oyster growers and industries that contribute potentially damaging effluents to estuaries.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the West Sound Basins. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

Fish production can be increased by removing barriers that block natural stream areas. One such potential project is the falls at about stream mile 2 on the Hamma Hamma River. Upstream from this barrier lies approximately 13 miles of accessible spawning and rearing area that could accommodate large numbers of anadromous fish. The Duckabush River is heavily utilized by pink salmon downstream from the cascades, which forms a partial barrier to fish migration. Additional production in more than 10 miles of upstream area would occur if this barrier were removed. Investigations are needed to determine the most feasible and economical methods for passing fish over the above mentioned barriers, and over barriers on other streams.

Growing populations invariably alter streamflows from their natural pattern. Causes may include diversions, deforestation or canopy removal, and storage for hydroelectric power facilities, irrigation, or flood control projects. Historically, most flow changes have been detrimental to fish populations. It is essential that future multiple-use stream projects fill flow regulation needs of fish. Specific streamflows for fish production must be established.

Rigid controls should be set on the removal of water, for any purpose, from natural flowing streams. An extensive evaluation of new means for obtaining future municipal and industrial water supplies should be conducted in conjunction with this. Areas deserving study include potential use of dual water systems (consumptive/irrigation and sewage) and possible procurement of desalted marine water, a byproduct of any proposed thermonuclear powerplants.

Flood control projects have a great potential for enhancing fisheries benefits by eliminating severe flooding and supplementing summer runoff. Projects should include such control on the Skokomish River, where erosion and scouring during winter freshets and extreme low summer flows limit fish production. Elimination of peak floods and maintenance of summer flow would contribute tremendously to needed production increases for the future.

Flood control and low flow augmentation projects should also be considered for the Little Quilcene, Big Quilcene, Dosewallips, Duckabush, Hamma Hamma, and Union Rivers, and for Jorsted and Rendsland Creeks, all Hood Canal tributaries. Other streams needing augmented flows are Cranberry, Rocky, and Burley Creeks in the southern Puget Sound area.

Potential for natural production of anadromous fish is limited, particularly in the face of competition with future water requirements for other uses. Therefore, artificial propagation will become increasingly important in satisfying the needs of both sport and commercial fishermen. Propagation facilities may consist of hatcheries, spawning channels, eyed-egg incubation channels, or rearing ponds. The rearing capacities of the Minter Creek, George Adams, and Hood Canal Salmon Hatcheries will be expanded to the limit of their water supplies to supplement the future demands for salmon production. A new salmon hatchery is planned for Stavis Creek (Hood Canal segment) to increase production of chinook, coho, and chum salmon. Other potential hatchery sites include Kennedy Creek (South Puget Sound segment) and the Dosewallips, Hamma Hamma, and Tahuya Rivers, and Big Beef Creek (Hood Canal segment). Numerous spawning channel, incubation channel, and rearing facility sites are available throughout the Basins. Collectively, these facilities could contribute substantially to fish resource needs.

Additional enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish populations, including control of forest and agricultural spraying, as well as curtailing the disposal of untreated municipal and industrial wastes; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to ensure protection of fish resources; (3) institute a permanent flood plain zoning plan that would protect streambeds and land immediately adjacent to streams from unnecessary changes that would damage aquatic habitat; (4) guide management to promote effective regulation for all fisheries, and provide necessary changes in fishing areas and harvest methods, thus yielding greater maximum benefit from available stocks; (5) perform studies and obtain information necessary to achieve the most efficient management possible, including basic water chemistry data needed to determine feasibility of increasing production, and deriving techniques for removing silt and decompacting riverbed gravel in large streams; and (6) determine specific streamflows (from river cross section measurements) to ascertain flow levels necessary for fish, and to provide methods and techniques for altering streamflow and streambed conditions to increase the production capacity of the environment. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, appear in Table 12-9. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

MARINE FISH

The importance of marine fishes to Washington's economy is certain to increase rapidly in future years, so projects to increase production of these species will become essential. Since natural production is capable of filling existing demands, less conservation effort and consideration has been accorded this resource. Studies will be needed to investigate the ecology of the important populations with regard to population size, reproduction, distribution, behavior, and ability to sustain a harvest. Specific enhancement projects will stem from these studies.

Goals of this work will be to maintain stocks at a level that will provide the highest sustained yield possible. This could include artificial propagation, physical manipulation of environment such as reef construction, and maintenance of suitable water quality for habitation and reproduction. An investigation could be made concerning the feasibility of increasing the naturally low dissolved oxygen concen-

TABLE 12-9. Tentative flow schedule required to maintain fish production levels, West Sound Basins

Stream[1]	Flows (cfs) by Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Little Quilcene R.	25	75	70	120	65	65	70	60	50	40	25	15
Dosewallips R.	250	350	450	400	400	300	450	600	500	400	250	175
Duckabush R.	250	400	500	450	450	300	400	550	450	300	125	100
Hamma Hamma R.	200	350	400	375	375	275	350	450	350	200	100	75
Skokomish R.	700	1,500	2,000	1,900	2,000	1,300	1,200	1,000	500	320	225	225
North Fork (Potlatch)	75	100	200	200	200	100	75	90	70	60	60	60
South Fork	450	800	1,200	1,100	1,100	800	800	550	350	175	125	125
Union R.	30	60	80	90	90	60	50	35	30	20	20	20
Tahuya R. (Belfair)	5	80	100	110	110	50	35	10	4	1.5	0.4	0.15
Dewatto Cr.	20	90	120	140	140	75	60	35	23	20	15	15
Goldsborough Cr.	40	100	200	200	200	150	110	65	45	25	23	23

[1] Locations are existing U.S. Geological Survey gaging stations.

tration that annually occurs in the Lynch Cove area of Hood Canal.

The development of salt-water public access and marine fish production and sport fishing habitat will be particularly beneficial in these Basins. Needs of both anglers and spear fishing enthusiasts must be satisfied through such projects.

SHELLFISH

The important oyster farming industry in the West Sound Basins is almost entirely private enterprise on private land. As demand for this shellfish increases, oystermen will undoubtedly respond with improved production techniques. The successful future of this industry, however, is dependent upon available water of high productivity and suitable quality to provide satisfactory growth and survival. Development of seed production will be required to fulfill future demands. This will be manifested in the form of expanded seed collection in Dabob Bay on Hood Canal, one of the few areas of Puget Sound where natural reproduction consistently occurs. Artificial spawning of oysters, as well as other shellfish, will become increasingly important.

Total shellfish needs will be satisfied to some extent by increased use of several species such as mussels, sea cucumbers, and softshell clams not now widely accepted. Efforts will also be made to control predator populations, physically manipulate environments, and introduce new species and varieties. These enhancement programs will require prior biological studies.

Development of new salt-water public access points and implementation of shellfish stocking programs would be highly beneficial.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The West Sound Basins offer numerous opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. In order to meet future demands, a number of these potential developments must be undertaken. Major proposals, including an indication of priority, are categorized in Table 12-10 and defined by stream in Table 12-11.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the management developments listed. Nearly all of the major proposals are goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of these potential developments are included in a preliminary plan for increasing future production of salmon to meet overall Pacific Northwest demands for fish resources. These proposals, and salmon production increases, are indicated by target years in Table 12-12.

Table 12-13 shows estimated annual benefits in terms of both sport and commercial harvest for the same proposals. Projects and programs for marine fish and shellfish have not been analyzed in this manner because use data are inadequate and needs are not so critical as for salmon.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

These Basins lend themselves to development as an outstanding recreation area. The Kitsap Peninsula has many lakes which provide excellent sport fishing. These lakes are being developed as vacation and permanent homesites. Mason and Jefferson Counties have both lakes and streams which provide good fishing and other outdoor recreation. Hood Canal is the greatest salt-water recreation area in the entire Puget Sound Area. All of these water areas must be protected from overdiversion or pollution and preserved for future generations. Public access programs for all water areas must be enlarged to insure such use.

The western portion of the Basins does not appear suitable for large industrial developments. Therefore, forest products and outdoor recreation will probably remain the major industries. Logging practices should be coordinated with fishery and outdoor recreation requirements.

Flood control should be accomplished by diking, and with little lower river channel work.

TABLE 12-10. Potential developments for production and use of salmon, marine fish, and shellfish, West Sound Basins

Beneficial Development	Priority: Prior to 1980	Prior to 2000	Prior to 2020
(1) Maintenance and Enhancement			
Perform barrier removal on Hamma Hamma River	X		
Perform removal of partial barriers on Duckabush and Skokomish Rivers	X		
Increase capacity of Minter Creek, George Adams, and Hood Canal hatcheries	X		
Place floating barrier across northern Dabob Bay to enhance oyster setting	X		
Develop clam hatchery for restocking public beaches	X		
Improve public beaches for clam production		X	
Perform barrier removal and improve streambeds on minor streams	X	X	X
(2) Acquisition			
Determine and evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop 10 salt-water public access sites	X		
Acquire and develop public access to and parking facilities at public beaches		X	
Acquire 5 miles of additional public beaches		X	
Procure riverbank and salt-water public access sites	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Promote conservation measures for Indian fishery	X		
Establish management program for public harvest of oysters	X		
Develop aquaculture program	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances (all such lands in Dabob Bay-Quilcene Bay systems are to be reserved for oyster spawning stock, under Washington Department of Fisheries management)	X		
Develop subtidal park for skin divers		X	
Investigate fishery management efficiency, with application to all phases of the resource	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities affecting streams, i.e., gravel removal, logging, flood control	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Gravel cleaning and decompaction techniques	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Develop use of shellfish and marine fish species not now harvested		X	
Shellfish predator control	X	X	
Introduction of new species of marine fish and shellfish	X	X	X
Marine fish artificial production		X	X

TABLE 12-11. Potential beneficial developments for fish, West Sound Basins (by segment)

	Enhancement Measure									Species Benefited						
Basin Segment and Stream	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
South Puget Sound																
Kennedy Cr.	X	X	X			X	X	X	X		X		X	X	X	X
Mill Cr.							X	X					X			
Goldsborough Cr.	X										X		X	X	X	X
Cranberry Cr.		X	X		X						X		X	X	X	X
Sherwood Cr.								X					X			
Rocky Cr.		X	X		X				X	X	X		X	X	X	X
Minter Cr.						X	X	X	X	X	X	X	X			
Burley Cr.		X			X		X	X	X	X	X		X	X	X	X
West Puget Sound																
Snow Cr.		X							X		X			X	X	X
Gorst Cr.	X										X			X	X	X
Olalla Cr.		X						X	X		X		X	X	X	X
Crescent Cr.		X							X		X		X	X	X	X
Hood Canal																
L. Quilcene R.		X		$\boxed{\text{X}}$					X		X		X	X	X	X
Big Quilcene R.		X		X	X		X	X	X	X			X	X	X	X
Dosewallips R.	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Duckabush R.	X	X		$\boxed{\text{X}}$	X		X	X	X	X	X	X	X	X	X	X
Hamma Hamma R.	X			$\boxed{\text{X}}$	X	X	X	X	X	X	X	X	X	X	X	X
Jorsted Cr.				X							X		X	X	X	X
Eagle Cr.			X				X	X	X		X			X	X	X
Lilliwaup Cr.									X		X					
Skokomish R.	$\boxed{\text{X}}$	X		$\boxed{\text{X}}$	$\boxed{\text{X}}$		X	X	X	X	X	X	X	X	X	X
Twanoh Cr.		X											X	X	X	X
Union R.		X			X			X		X	X		X	X	X	X
Stimson Cr.		X	X								X		X	X	X	X
Big Mission Cr.		X	X					X	X		X		X	X	X	X
Tahuya R.		X	X	X		X	X	X	X	X	X		X	X	X	X
Rendsland Cr.		X			X						X		X	X	X	X
Dewatto Cr.		X	X					X	X		X		X	X	X	X
Stavis Cr.						X				X	X					
Big Beef Cr.						X	X	X	X	X	X		X			

$\boxed{\text{X}}$ Priority project.

TABLE 12-12. Estimated total salmon production increases in West Sound Basins, by project or program, to satisfy needs[1]

Project or Program, and Year	Species and Number			
	Chinook	Coho	Pink	Chum
Pre-1980				
Provide fish passage, Hamma Hamma R.	1,400	11,000	--	--
Supply flood control and augment flows, Duckabush R.	300	800	7,800	5,800
Supply flood control and augment flows, Hamma Hamma R.	200	1,000	5,600	5,200
Supply flood control and augment flows, Skokomish R.	500	1,200	5,000	500
Subtotals	2,400	14,000	18,400	11,500
1980-2000				
Provide fish passage, 6 streams, 52 stream miles	1,800	12,800	3,000	300
Improve fish habitat, 19 streams, 31 stream miles	1,100	6,700	10,500	3,500
Clear channels, 8 streams, 14 stream miles	200	1,900	--	1,400
Supply flood control, 5 streams, 19 stream miles	200	1,300	1,400	1,900
Augment flows, 7 streams, 20 stream miles	400	4,500	4,200	7,000
Construct 4 hatcheries	18,000	178,500	--	--
Construct rearing ponds, 40 acres	6,000	34,000	--	--
Construct spawning channel, 3 miles	--	--	240,000	120,000
Subtotals	27,700	239,700	259,100	134,100
2000-2020				
Construct 5 hatcheries or equivalent	72,000	153,000	--	--
Develop rearing facilities, 150 acres	45,000	127,500	--	--
Develop spawning channel, 1 mile	--	--	120,000	--
Subtotals	117,000	280,500	120,000	--
Totals	147,100	534,200	397,500	145,600

[1] Average annual production (catch plus escapement) at end of each period.

TABLE 12-13. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon[1] and other anadromous fish resources, West Sound Basins

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Provide fish passage, Hamma Hamma R.	8,200	$ 28,200	$ 56,500	1,700	$ 10,000	$ 46,700	$ 80,000	$ 1,600
Supply flood control and augment flows, Duckabush R.	8,500	14,100	44,300	400	2,700	11,000	[2]	[2]
Supply flood control and augment flows, Hamma Hamma R.	6,900	12,500	37,300	400	2,000	9,900	[2]	[2]
Supply flood control and augment flows, Skokomish R.	4,500	7,200	24,300	500	2,600	13,100	[2]	[2]
Subtotals	28,100	$ 62,000	$ 162,400	3,000	$ 17,300	$ 80,700	–	–
1980-2000								
Provide fish passage, 6 streams	11,600	$ 34,900	$ 77,200	2,000	$ 12,000	$ 56,600	$ 164,000	$ 3,300
Improve fish habitat, 19 streams	13,600	27,700	78,100	1,400	7,000	39,800	128,000	2,600
Clear channels, 8 streams	2,100	6,800	13,700	300	1,700	8,100	3,000	3,000
Supply flood control, 5 streams	2,800	6,800	16,800	300	1,600	7,400	[2]	[2]
Augment flows, 7 streams	9,400	22,600	34,900	800	4,600	22,100	[2]	[2]
Construct 4 hatcheries	140,400	478,900	953,600	28,000	168,000	783,900	4,080,000	204 000
Construct rearing ponds, 40 acres	28,200	100,600	204,100	6,200	36,900	172,300	220,000	40,000
Construct spawning channels, 3 miles	291,400	413,000	1,397,600	3,600	51,600	240,800	2,100,000	42,000
Subtotals	499,500	$1,091,300	$2,776,000	42,600	$283,400	$1,331,000	–	–
2000-2020								
Construct 5 hatcheries or equivalent	151,100	$ 614,200	$1,306,200	41,800	$250,900	$1,170,700	$5,100,000	$300,000
Develop rearing facilities, 150 acres	117,700	457,700	958,600	30,100	180,700	843,100	825,000	150,000
Develop spawning channel, 1 mile	95,700	66,000	325,400	4,300	25,800	120,400	700,000	14,000
Subtotals	364,500	$1,137,900	$2,590,200	76,200	$457,400	$2,134,200	$6,625,000	$464,000
Totals	892,100	$2,291,200	$5,528,600	121,800	$758,100	$3,545,900	–	–

[1] Anadromous trout benefits not included.

[2] Multipurpose project. Separable costs, if any, have not been determined.

Flood plain lands should be zoned for agriculture and outdoor recreation to prevent loss of homes and industrial plants during flood periods.

Management emphasis must be placed on development of the searun cutthroat fishery and a more optimal use of spiny-rayed and whitefish populations. A moratorium should be placed on construction of in-channel impoundments until more complete evaluations of their impact on the ecology of small watersheds are available.

Thermal powerplants should be located in areas where water diversion is not detrimental to fish resources. Water cooling facilities must be included in the construction plans.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Development of public fishing access at Ludlow, Horseshoe, Sandy Shore, Silent, Anderson, Beausite, Stansberry, City, Delanty, Devils, Gibbs, Peterson, Island, and Miller Lakes is proposed. Ultimately, all significant lakes and key portions of streams, estuaries, and salt-water areas should have assured public fishing access.

(3) Streambank angler access–100 miles in Kitsap, Mason, and Jefferson Counties (of a total of 219 miles)–should be acquired and developed, as funds become available.

(4) Public fishing access to salt water is needed at Pleasant Harbor (near Duckabush River mouth), Hoodsport (Hood Canal), Bald Point (Hood Canal), Pickering Passage, Case Inlet, and Hammersley Inlet.

(5) Acquisition of from four to seven acres at the outlet of Bay Lake will be needed. A water control structure to raise the lake level two or three feet above the annual mean level will then be constructed. In conjunction with this, a screen would be constructed to prevent trout escapement to Puget Sound.

(6) Considerable streambed compaction has occurred on certain Basin streams. A large "riffle sifter" or other streambed loosening and cleaning device should be developed for use in specific areas, particularly where extensive logging and glacial silt conditions prevail.

(7) Investigation into completing anadromous fish passage at falls and cascades should be undertaken. However, impact on the resident game fish populations and the potential introduction of undesirable species must also be considered.

(8) Special investigations should be conducted to determine more satisfactory uses for newly-created in-channel impoundments.

(9) Hatchery facilities should be expanded or new facilities developed to increase trout catch to a total of 630,000 annually.

(10) Rearing ponds to produce an increased catch of steelhead and searun cutthroat should be developed.

(11) A timber management program that will be more compatible with good fish management programs should be developed for the smaller landowners.

(12) New fertilizers and fish disease and parasite control programs which will increase fish production in lakes and streams without undesirable side effects should be developed.

(13) New fish toxicants that detoxify rapidly and are selective as to species should be developed.

Table 12-14 indicates estimated annual benefits and costs of specific projects and programs proposed for the West Sound Basins to satisfy needs for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. Proposals for subsequent years, which may include projects and programs listed above, have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected. That is, benefits from constructing a hatchery may depend on first solving lake and stream fertility, disease, and public access problems. In such cases items showing costs will not necessarily show benefits because the latter are included under other projects and programs.

TABLE 12-14. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in West Sound Basins, pre-1980

Project or Program	Annual Benefits		Costs	
	Angler-Days	Value	Capital	O&M (Annual)
Lakes				
Acquire and develop public access, 13 areas	45,000	$ 90,000	$ 175,000	$ 1,500
Enlarge Bay Lake	12,500	25,000	50,000	--
Stimulate interest in spiny-ray fishing	48,500	97,000	5,000	--
Develop new fish toxicants	1/	1/	10,000	10,000
Develop new lake fertilization techniques	1/	1/	10,000	10,000
Construct trout hatchery	119,000	238,000	360,000	30,000
Subtotals	225,000	$450,000	$ 610,000	$ 51,500
Streams				
Acquire and develop streambank access, 100 stream miles	1/	1/	$1,630,000	$ 10,000
Develop steelhead rearing pond	34,500	$172,500	100,000	30,000
Develop searun cutthroat rearing pond	27,600	82,800	40,000	7,000
Construct trout hatchery	50,000	150,000	450,000	37,500
Subtotals	112,100	$405,300	$2,220,000	$ 84,500
Salt Water				
Acquire and develop public access, 6 areas	28,200	$ 84,600	$ 180,000	$ 1,000
Subtotals	28,200	$ 84,600	$ 180,000	$ 1,000
Totals	365,300	$939,900	$3,010,000	$137,000
Lakes (Alternate to above lake proposal)				
Acquire and develop public access, 13 areas	45,000	$ 90,000	$ 175,000	$ 1,500
Enlarge Bay Lake	12,500	25,000	50,000	--
Stimulate interest in spiny-ray fishing	48,500	97,000	5,000	--
Construct trout hatchery	119,000	238,000	2,250,000	187,500
Subtotals	225,000	$450,000	$2,480,000	$189,000

1/ Included under other projects or programs.

Projects and Programs, 1980-2000

(1) Complete programs and projects not completed by 1980 and develop new projects and programs as needed.

(2) Investigate use of biological control of spiny-rayed game fish.

(3) Increase public interest in spiny rays.

(4) Continue purchase of streambank and lake access areas.

Projects and Programs, 2000-2020

(1) Complete uncompleted projects and programs.

(2) Develop new projects and programs as required.

(3) Continue programs of fisheries research.

Approximately 230,000 acres of these Basins are under U.S. Forest Service administration. Projects and programs proposed by this agency for fishery enhancement before 2000 are indicated in Table 12-15. Angler-day benefits have not been calculated, but they will help satisfy overall demand. Schedules for surveys, channel clearance, and debris removal have not been completed beyond 1980, and for habitat improvement, beyond 2000.

TABLE 12-15. Fishery enhancement projects and programs of U.S. Forest Service proposed for West Sound Basins, 1980-2000

Project or Program	Unit	1980 No.	1980 Capital Cost	2000 No.	2000 Capital Cost
Conduct stream surveys	mile	50	$ 1,500	1/	1/
Conduct lake surveys	acre	239	1,900	1/	1/
Clear stream channels	mile	42	84,000	1/	1/
Remove debris from lakes	acre	37	37,000	1/	1/
Fertilize lakes	acre	24	16,500	50	$34,400
Total			$140,900		

1/ Planning has not progressed to this time period (or to 2020), but projects and programs similar to those proposed for the 1980 period are anticipated.

PRESENT STATUS—WILDLIFE

INTRODUCTION

The West Sound Basins include two distinct classes of wildlife habitat. The numerous small watersheds which drain the east slope of the Olympic Mountains include a wide elevational range and exhibit much of the same wildlife characteristics of the major East Sound Basins. However, the Kitsap Peninsula, bordered on the west by Hood Canal and on the east by Puget Sound, is low country with relatively mild climate.

BIG GAME

Big game is an important consideration in the wildlife inventory, as a large part of the Basins is in some form of woodland cover. Black-tailed deer, Roosevelt elk, black bear, mountain lion, and a limited number of mountain goat inhabit the timbered area.

The mild climate of the Kitsap Peninsula and management of forest land for Christmas tree production contribute to a high production of forest game species. The additional sunlight which reaches ground vegetation in a Christmas tree culture increases the nutritive content of plants growing in the shallow gravelly soil to a palatable level for game. Such plants are available to foraging animals all year, as snow is seldom a factor at these low elevations.

Inventory and Distribution

Black-tailed deer are much more abundant than other big-game species. Areas of relatively high abundance include the lower reaches of the valleys west of Hood Canal; Sequim; Miller, Quimper, and Toandos Peninsulas; and the Silverdale, Crosby, Port Orchard, and Mason Lake areas (Figure 12-2). Except for the area west of Hood Canal, local food conditions determine density. Migration does not occur in the low rolling terrain of the Kitsap Peninsula where snow is no problem. The Basins support an annual average of 23,000 deer.

The elk are located west of Hood Canal (Photo 12-4). The watersheds of the North and South Forks Skokomish River support high numbers of these animals and lesser numbers inhabit the Hamma Hamma, Duckabush, and Dosewallips drainages

PHOTO 12-4. Roosevelt elk—common to the Basins' western drainages. (Washington Department of Game photo)

(Figure 12-1). A total of 900 elk is estimated.

Mountain goat were introduced on the Olympic Peninsula in 1924 and 1929 and now thrive on several mountains in the northern and eastern sections of the peninsula. Mountains within and adjacent to the Basins which support goat include Mount Constance between the Dosewallips and Dungeness Rivers, and Mount Lincoln and Mount Skokomish near the origin of the Hamma Hamma and North Fork Skokomish Rivers. A population of 60 goat is estimated.

Black bear seek more seclusion than deer but are widespread, ranging in distribution from the low rolling foothills to high alpine meadows. There is an estimated population of 1,700.

An estimated 15 to 20 mountain lion inhabit the east slopes of the Olympic Mountains within the West Sound Basins. Olympic National Park serves as an inviolate sanctuary for these otherwise heavily-hunted animals, but they require a large feeding area, and often range outside the park borders in search of food.

Limiting Factors

Big-game numbers are regulated by the amount and quality of their winter habitat. The elevation at which winter snow persists for long periods on the Olympic Peninsula is somewhat lower than that along the west slope of the Cascades. Snow in sufficient quantity to cover deer and elk forage as well as restrict movement of these animals normally persists for extended periods above the 1,000 to 1,500-foot level. Animals which use higher areas in summer and fall must move down for survival as snow covers their food supply.

Production

Late summer doe/fawn ratios indicate an average annual increase of 6,900 deer over the spring population.

Poor calf elk survival resulting from inadequate harvest is indicated in the Basins' elk herd. An annual production of 160 to 180 calves is estimated.

Late summer counts of mountain goats show 29 kids pcr 100 adults which, for the Basins, would indicate about 15 young produced annually.

Studies of black bear indicate an annual reproductive rate of 25 to 30 percent, which would result in about 350 to 425 young.

Harvest

Five years of deer harvest data (1961-1965) reveal an average annual deer harvest of 3,600 animals, creating 72,000 hunter-days.

The elk herd in the Skokomish, Hamma Hamma, Duckabush, and Dosewallips drainages has provided a harvest of approximately 120 animals annually. Elk hunting stimulates over 4,700 hunter-days each year.

Resident and migratory big-game animals within Olympic National Park are forced out by severe weather and cause depredation problems on private lands. Special January and February hunting seasons necessary to control this damage have met with varied success and reaction by landowners, sportsmen, and the public in general. Animals which must be harvested after being concentrated by adverse weather furnish little desirable recreation and create aversion to hunting by the nonhunting public.

There was no open season on mountain goat in the Basins prior to 1967.

Black bear are classified as predators within the Basins and, consequently, may be hunted the year round with few restrictions. About 350 bear are taken annually, creating an estimated 2,800 hunter-days.

Only two or three mountain lion are taken within the Basins annually, during an estimated 100 hunter-days.

Deer, elk, mountain goat, bear, and mountain lion hunting create a total of 79,650 hunter-days of highly prized outdoor recreation in the West Sound Basins.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

Mountain goat presently inhabiting the Olympic Peninsula are the result of a transplant of 12 animals from Alberta, Canada, and Alaska during 1924 and 1929. Various mountainous areas of the West Sound Basins presently support small numbers of this unique species.

Increased logging of pulp wood at low elevations in eastern Jefferson County is increasing the area's current big-game potential.

Christmas tree culture on the Kitsap Peninsula and in eastern Mason County benefits big game. The additional sunlight which reaches ground vegetation in such areas increases the nutritive content of big-game forage and, consequently, big-game carrying capacity.

Other beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

The varied species of upland game are the most widely distributed of the major game groups. Native species utilize the remaining native habitat and introduced exotics have been established in the area devoted to agriculture. The introduced varieties include ring-necked pheasant, California quail, mountain quail, and gray partridge. Native species include blue and ruffed grouse, snowshoe rabbit, band-tailed pigeon, and mourning dove.

Inventory and Distribution

A large part of the Basins remain in near native vegetation; consequently snowshoe and both species of grouse are widespread. Blue grouse use the dry, open uplands and ruffed grouse occur adjacent to the numerous interspersed lakes, beaver ponds, and small streams which characterize eastern Mason County and the Kitsap Peninsula. West of Hood Canal, ruffed grouse are found principally on the valley bottoms along major streamcourses and blue grouse occupy the open ridges and sparsely timbered burns or cutover mountain slopes. An estimated 52,000 ruffed grouse and 38,000 blue grouse inhabit the Basins.

Population estimates are not available for band-tailed pigeon or mourning dove.

Introduced exotics which require vegetation associated with diversified farming are not abundant. Locations of medium pheasant density include several small agricultural areas on Vashon Island; the Rosedale-Gig Harbor area in western Pierce County; Port Gamble, Poulsbo, Keyport, Winslow, and Port Orchard areas on the Kitsap Peninsula; and the Chimacum and lower Skokomish River areas west of Hood Canal (Figure 12-1). An estimated wild population of 12,000 pheasant inhabits the Basins. This wild stock is supplemented annually by game-farm-reared birds. An estimated 5,000 California quail and a remnant population of gray partridge and mountain quail are also present.

The snowshoe rabbit is quite common, but its numbers were not determined.

Limiting Factors

The major limiting factor restricting grouse populations is lack of new habitat in the area west of Hood Canal. Effective wildfire control, both in and out of Olympic National Park, and reduced emphasis on slash burning after logging have reduced the productive potential of wooded areas for these native species. Limited agricultural acreage and emphasis on hay and pasture production control the area's potential for introduced exotics.

The Area chapter, Upland Game, describes band-tailed pigeon limiting factors.

Production

There is an average annual production of 31,000 ruffed grouse and 23,000 blue grouse. Wild pheasant production averages 7,000 annually and quail, 3,500.

No production estimate is available for rabbit, gray partridge, band-tailed pigeon, or mourning dove.

Harvest

The Basins' grouse harvest of 7,000 birds consists of about 5,000 ruffed and 2,000 blue grouse. Such harvest creates over 11,700 hunter-days annually. An average of 3,200 pheasants is harvested annually, resulting in about 4,600 hunter-days. About 800 of these birds are a direct return of mature roosters released immediately prior to and during the hunting season. Hunters take about 1,200 quail in approximately 900 man-days of hunting. Hunter questionnaires indicate about 1,400 rabbit are taken in the Basins, creating approximately 800 hunter-days.

Over 13,300 band-tailed pigeon and 500 mourning dove are bagged annually, which provides an additional 11,200 hunter-days. Upland-game hunting accounts for a total of approximately 29,200 hunter-days each year.

Propagation

The wild population of pheasant is supplemented annually by about 1,300 birds from State-operated game farms. Nearly all these birds are released as mature cocks immediately prior to the hunting season. Small numbers of quail, and gray, red-legged, and bamboo partridge are propagated on various State game farms and released periodically within the Basins.

Five private game breeders are licensed to commercially raise pheasant, chukar, gray partridge, quail, and turkey as well as various waterfowl species.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game-bird releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 302 acres of wildlife habitat development and 7,156 acres of wildlife habitat preservation, located throughout the Basins.

FUR ANIMALS

The fur animals most highly prized for their pelt value–beaver, muskrat, mink, and river otter–require lowland water-associated vegetation in which to live and forage. The West Sound Basins are largely lowland areas richly endowed with lakes, low gradient creeks, and shallow water areas. These areas, however, are not particularly rich in nutritive content and aquatic and semi-aquatic vegetation is limited.

Inventory and Distribution

A wide variety of native fur animals exists. Beaver, muskrat, mink, river otter, and raccoon occur in and along lowland water areas. Red fox, opossum, weasel, and skunk inhabit the extensive low rolling terrain of the Kitsap Peninsula as well as the foothill areas west of Hood Canal. High areas of the Olympic mountain range support marten.

Individual fur-animal population estimates based on trapper catch are: 6,000 (beaver); 10,000 (muskrat); 700 (mink); and 600 (river otter). This is undoubtedly an extremely conservative estimate of mink, as wild mink have not been in demand for a number of years, and those which inhabit the salt-water shoreline are not trapped extensively due to poor quality pelts.

The other fur bearers occur in suitable habitat. Actual numbers of each species are unknown.

Limiting Factors

The economically important fur animals require water-associated vegetation in which to live and forage. Although the Basins include numerous water areas, the nutritive content of many is low and, consequently, aquatic and semi-aquatic vegetation is limited. Muskrat are most directly affected by this condition.

Homesite development of natural lake areas and salt-water shoreline restricts fur-animal potential.

Production

Fur-animal production appears to be rather stable, with the possible exception of beaver. Readily accessible beaver colonies have been trapped heavily in the past four trapping seasons (1963-64 through 1966-67). Beaver populations in the fall consist of 30 to 40 percent young of the year which indicates an average production of 2,000 young annually. Average annual production of muskrat is 8,000. Annual mink production is estimated to exceed 500. Other fur bearers have reproduction rates similar to that of mink.

Harvest

The beaver take in these Basins has decreased considerably during the past several seasons (1963-64 through 1966-67). This decrease appears to be the result of two factors–a decline in interest in beaver trapping and overcropping of readily accessible colonies. The average annual catch during the period has been 1,180. In recent years, about 1,030 muskrat, 75 mink, and 125 river otter have been taken annually. Other fur animals are trapped only incidentally.

It is doubtful if any of the fur bearers other than beaver and possibly river otter are being harvested to the full extent of their potential. Income derived from trapping during the 1965-1966 season totaled about $15,200.

Propagation

Two ranchers within the Basins engage in the commercial production of mink.

Beneficial Developments

Beneficial developments are described in the Area chapter, Fur Animals.

WATERFOWL

Diving ducks are numerous in the West Sound Basins, which contain more salt-water shoreline than any other Puget Sound basin. The more popular hunting species, however, are less abundant. Black brant utilize many of the inland salt-water areas.

Inventory and Distribution

Waterfowl nesting occurs at the numerous fresh-water lakes and ponds. However, the greatest use of the area is by fall and winter migrants. Important winter concentration areas include Washington Harbor, Port Discovery, and the flood plain of the Skokomish River and adjacent Tahuya and Dewatto areas on Hood Canal (Figure 12-2). Other significant winter-use areas include the Shelton-Bayshore-Mason Lake vicinity and protected bays near Bremerton, Purdy, Seabeck, Kitsap, Poulsbo, and Port Gamble.

January waterfowl counts reveal an annual average of 70,000 ducks and 7,000 black brant. Prior to this mid-winter survey, waterfowl have been exposed to almost three months' hunting. An undetermined number of birds hold over in the Basins in fall and early winter for a limited stay while enroute southward. The survey, therefore, is not indicative of the total number which depend on the Basins as a wintering area.

Limiting Factors

Food availability and adequate water resting areas are the prime factors governing migratory waterfowl abundance. The extensive salt-water areas of Hood Canal and Puget Sound provide an abundance of resting area. However, lack of fertile soil and accompanying diversified farming activity seriously limit use of the Basins by the popular dabbling duck species, which have customarily fed on grain remaining from harvesting operations.

Production

Due to an abundance of fresh-water habitat, the Basins are one of the higher waterfowl production areas of the Puget Sound Area. Waterfowl nesting is general at the numerous lowland lakes and ponds. A recent inventory revealed an average annual production of 8,700 ducks. Mallard and wood duck predominate.

Harvest

Marsh areas and agricultural lands adjacent to Washington Harbor, Port Discovery, and the flood plain of the Skokomish River are the more concentrated waterfowl hunting areas (Photo 12-5). An analysis of recent years' harvest records indicates an average annual harvest of 27,000 ducks and 700 black brant, resulting in about 20,000 hunter-days.

Propagation

Four private game breeders list waterfowl among the variety of birds raised. These birds are domesticated wild strains raised for commercial purposes and do not contribute to the wild duck population or waterfowl hunting.

Beneficial Developments

Three small areas are controlled by the Washington Department of Game principally to provide public hunting. One is near Union, another is in the Skokomish River tidelands, and the third is on Marrowstone Island. The 16-acre Marrowstone Island area is under the primary jurisdiction of the Bureau of Sport Fisheries and Wildlife and is administered by the State under a cooperative agreement. Black brant and ducks utilize these areas.

Conservation practices applied by private landowners to agricultural lands and of direct benefit to waterfowl include 92 acres of wildlife wetland development and 900 acres of wildlife wetland preservation, located throughout the Basins.

OTHER WILDLIFE

The many and varied birds and animals in the Basins not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

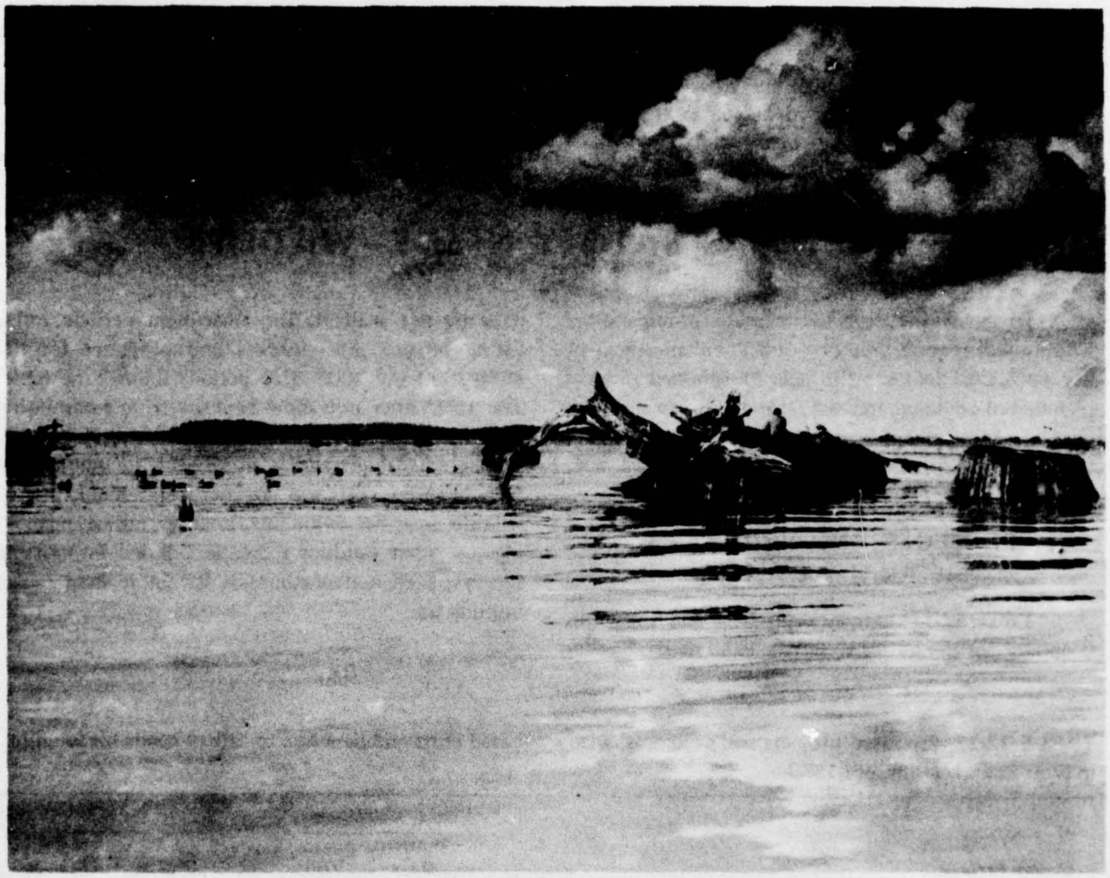


PHOTO 12-5. Estuarine areas along Hood Canal and western Puget Sound provide production, wintering, and hunting areas for migratory waterfowl. (Washington Department of Game photo)

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

Demands on the wildlife resource will not only increase from the rapid growth of Basins' population, but also from heavily populated areas east of the Sound.[1] To maintain the present level of hunting success, it will be necessary to provide an additional annual harvest of 3,000 deer; 120 elk; 330 bears; 6,000 grouse; 3,000 pheasants; 1,000 quail; 1,000 rabbits; 25,000 ducks; 600 geese; and 12,000 band-tailed pigeons by the year 1980. As population, leisure time, and demand for outdoor recreation increase the demand on wildlife resources will increase proportionately.

[1] Population forecasts shown in Future Needs—Fish.

Table 12-16 indicates present and projected demands and needs for hunting in hunter-days.

TABLE 12-16. Present and projected hunter use in West Sound Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	128.8
1980	119.8	248.6
2000	154.4	403.0
2020	94.3	497.3

PROBLEMS AND CONFLICTS

Certain problems must be resolved if future wildlife-oriented recreation demand in the West Sound Basins is to be satisfied. Problems and conflicts discussed in the Area chapter apply to these Basins.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basins during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 12-17 indicates projects and programs proposed for the Basins to satisfy 1980 needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include recreation benefits that will accrue from public use of wildlife areas for swimming, boating, hiking, picnicking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

TABLE 12-17. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in West Sound Basins, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs 1/: Capital	Costs 1/: O&M (Annual)
General Programs				
Develop educational program stressing renewable aspects and values of proper wildlife harvest	54,400	$308,400	$ 5,000	--
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	6,400	25,600	--	$10,000
Undertake population analysis, and research on habitat improvement and forest-wildlife management	2/	2/	35,000	10,000
Specific Projects and Programs				
Acquire and develop waterfowl and fur-animal habitat, 1,400 acres	16,000	80,000	1,000,000	25,000
Acquire title or easement to upland bird habitat and hunting area in Gorst-Dewatto-Tahuya area, 650 acres	4,800	19,200	155,000	5,000
Acquire and develop key elk winter range in Skokomish, Hamma Hamma, Dosewallips, or Duckabush River drainages	9,300	55,700	190,000	15,000
Acquire access to salt water for waterfowl hunting	3,000	15,000	3/	3/
Enlarge game farm to produce additional 5,000 pheasants	6,800	27,200	50,000	15,000
Totals	100,700	$531,100	$1,435,000	$80,000

1/ Do not include survey and plan costs.

2/ Included with benefits from other projects and programs.

3/ Costs included in those estimated under proposals for salt-water fishing areas. Benefit to wildlife is incidental.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological areas to provide maximum wildlife-oriented recreation.

(2) Continue research in wildlife techniques and develop new projects and programs as required.

(3) Continue programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Continue programs and projects not completed prior to 2000.

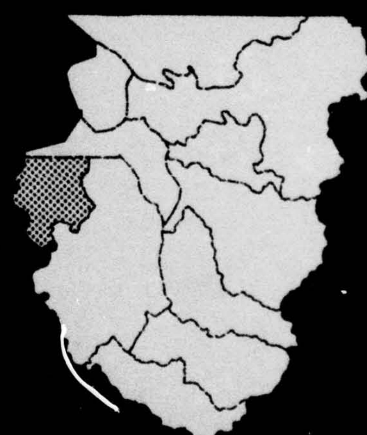
(3) Develop studies to further intensify wildlife management to keep pace with increased demand.

Table 12-18 indicates projects and programs for wildlife enhancement proposed by the U.S. Forest Service. Hunter-day benefits from these proposals have not been determined, but they will help satisfy overall demand. Planning has not progressed beyond 1980, but similar projects and programs are expected in subsequent periods.

TABLE 12-18. Wildlife enhancement projects and programs of U.S. Forest Service proposed for West Sound Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Surveys and Plans			
Conduct range analysis			
Deer	acre	60,050	$ 6,000
Elk	acre	60,050	6,000
Mountain goat	acre	22,440	2,200
Conduct upland-game habitat surveys	acre	92,180	4,600
Develop habitat management plans	each	12	6,000
Big-Game Habitat Improvement			
Seed and plant forage	acre	1,232	123,200
Release forage	acre	43	1,100
Creat permanent openings	acre	60	6,000
Waterfowl Habitat Improvement			
Construct shallow impoundments	acre	23	17,500
Develop food plantings	acre	20	2,000
Develop nesting facilities	each	58	2,900
Total			$177,500

Elwha-Dungeness Basins



ELWHA—DUNGENESS BASINS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The Elwha-Dungeness Basins contain two major drainages, the Elwha River entering the Strait of Juan de Fuca near Port Angeles, and the Dungeness River meeting the strait near Sequim (Figure 13-1). Also located between these major rivers are 10 smaller independent drainages. Each of the Basins' drainages provides suitable anadromous and resident fish habitat. Important nonstream fresh waters include 76 lakes and two reservoirs totaling 1,416 surface acres and 69 farm ponds (35 surface acres). The marine waters influenced by the rivers and streams are those of the eastern Strait of Juan de Fuca, south of the Canadian boundary. These open marine waters and intertidal zones provide suitable habitat for a large variety of marine fish and shellfish.

The Elwha River originates deep in Olympic National Park and winds generally north to its confluence with the strait west of Port Angeles. Despite the rugged headwater terrain, the river maintains a mostly moderate gradient throughout much of its length, providing numerous high-quality pools and riffles with occasional cascades and rapids. Two water-use developments are located on the lower reach.

Dungeness River headwaters also originate in the Olympic Mountains within national park boundaries. The river courses northeast, then north to merge with the strait near Sequim. Throughout its upper reaches to the Gray Wolf River confluence, the Dungeness flows through a narrow valley and is characterized by many cascades, falls, and rapids. The streambed is principally large rock material with gravel patches. The Gray Wolf flows northeast to its junction with the Dungeness. Its upper reaches present stream conditions similar to the upper Dungeness. The lower sector exhibits a more moderate gradient, resulting in an increase in stream and streambed area suitable for anadromous and resident fish use.

Downstream from the Gray Wolf, the Dungeness continues north over a much reduced gradient and across an increasingly broad valley floor. The character of the lower river is predominately pool-riffle with very few rapids—highly suitable for use by most anadromous and resident fishes.

The independent drainages located between the Dungeness and Elwha Rivers all extend generally north from the foothill slopes of the Olympic Mountains. Their lengths range from 3.8 to 14.2 miles, with McDonald, Seibert, and Morse Creeks being the largest. The upper reaches of all these streams flow mostly through moderately steep, densely forested terrain, with rapids and cascades predominating the stream character. Near their confluence with the strait, most streams encounter intermittent dense deciduous thickets and increasing amounts of open farmland and expanding urban areas. Dry, Tumwater, Valley, and Ennis Creeks all flow through residential and industrial areas of Port Angeles before entering the strait.

Lakes include two large reservoirs on the Elwha River totaling 722 surface acres. Fifteen lakes are located within Olympic National Park. Lake characteristics range from the normally warmer lowland variety to the cold high mountain type. Lake Sutherland, situated west of Port Angeles just north of the park, is the largest natural lake (over 360 surface acres) and is one of the most intensely fished.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are widely distributed and their general life histories are similar. Resident fishes occur in relatively low numbers, and with the exception of the trout, char, and whitefish, are not discussed here in detail.

Anadromous Fish—Four Pacific salmon species, chinook, coho, pink, and chum, populate drainage systems. Anadromous game fish utilizing the streams include steelhead, searun cutthroat trout, and searun Dolly Varden. These fish migrate, spawn, and rear in 36.1 miles of the Dungeness River and tributaries, in the 4 miles of the Elwha River downstream from

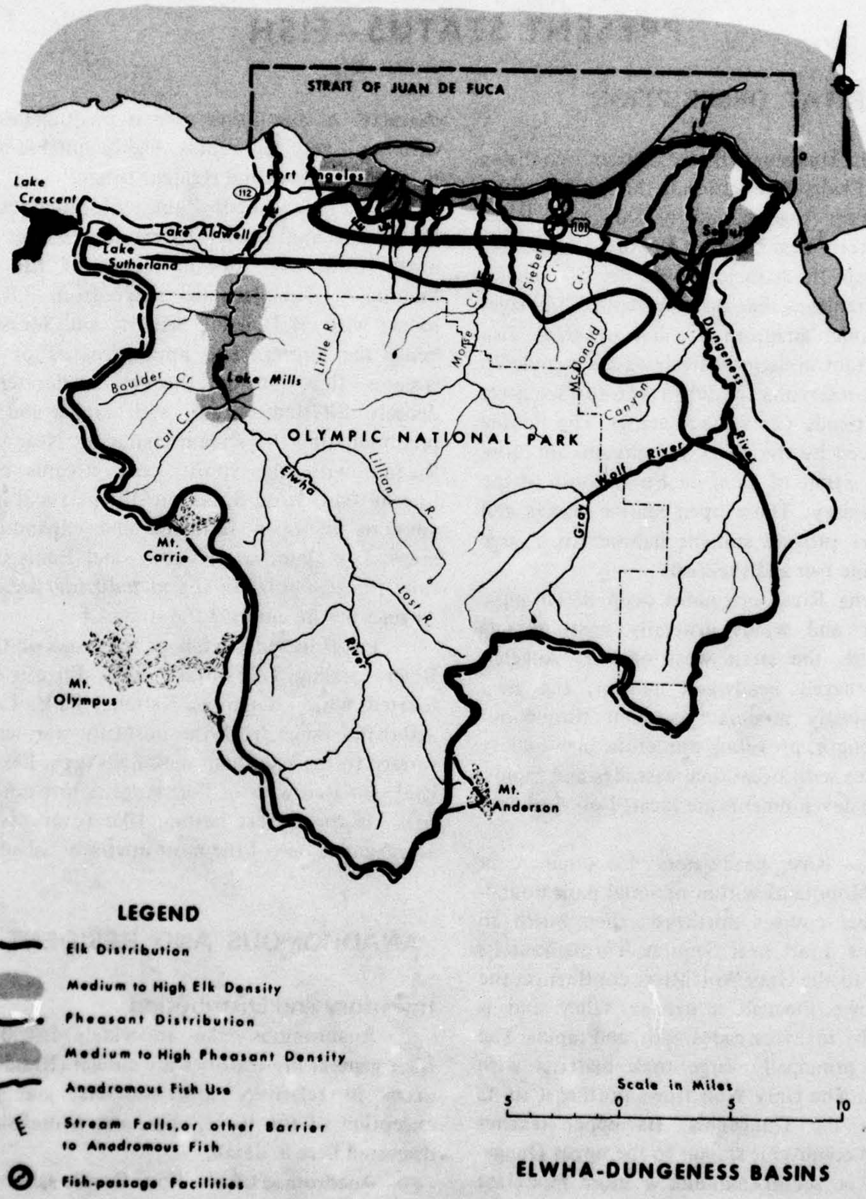


FIGURE 13-1. Anadromous fish and wildlife distribution, and fish facilities (1965)

Crown Zellerbach Corporation's Elwha Dam, and in 39.2 miles of accessible independent drainages (Figure 13-1). Lakes, ponds, and sloughs also afford important natural rearing waters for many species.

Upstream migration timing overlaps considerably as indicated on Table 13-1. Adults of one or more species enter the major systems every month. During the summer, May through August, the early-running species remain in deep holes enroute to their spawning grounds.

The majority of spring chinook spawning occurs in the accessible reaches of the upper Dungeness and Gray Wolf Rivers. Some adult springs seek the Elwha River, utilizing the riffle areas immediately downstream from Elwha Dam. The summer-fall race utilizes spawning areas throughout much of the accessible length of the Dungeness River, including the Gray Wolf River and portions of the upper Dungeness upstream from the Gray Wolf confluence. However, principal summer-fall chinook spawning occurs downstream from the Gray Wolf in the Dungeness. The Elwha River receives summer-fall chinook throughout its accessible lower reach.

Independent drainages, because of their relatively small size and characteristically reduced summer and fall flow patterns, receive only limited numbers of chinook salmon.

Virtually every accessible tributary stream of the Elwha and Dungeness Rivers receives coho spawners. Spawning also occurs throughout mainstem sections of these rivers. Adult coho spawn throughout the accessible length of each of the independent drainages.

Adult pink salmon spawn in the Dungeness, the Gray Wolf River, and the Elwha. Although the upper Dungeness and Gray Wolf Rivers are typical pink salmon spawning areas, they support exceptionally large runs in accessible reaches.

Chum salmon spawning occurs in the Dungeness and Elwha Rivers, and in suitable tributaries entering these rivers within their accessible limits. Chum spawning also occurs in the accessible lengths of the independent drainages.

Steelhead trout spawners utilize virtually every accessible stream area within the Basins. Selected gravel areas are used for spawning and most generally complement rearing in adjacent upstream and downstream areas.

All accessible streams and tributaries are used by searun cutthroat. Streams tributary to the lower Dungeness River and independent drainages serve as the principal spawning areas while segments of the Dungeness and Elwha Rivers serve as primary rearing and secondary spawning area.

Searun Dolly Varden spawn in large tributaries that have typically deep pools accompanied by shallow gravel areas.

Significant spawning reaches in some streams are delineated in Table 13-2.

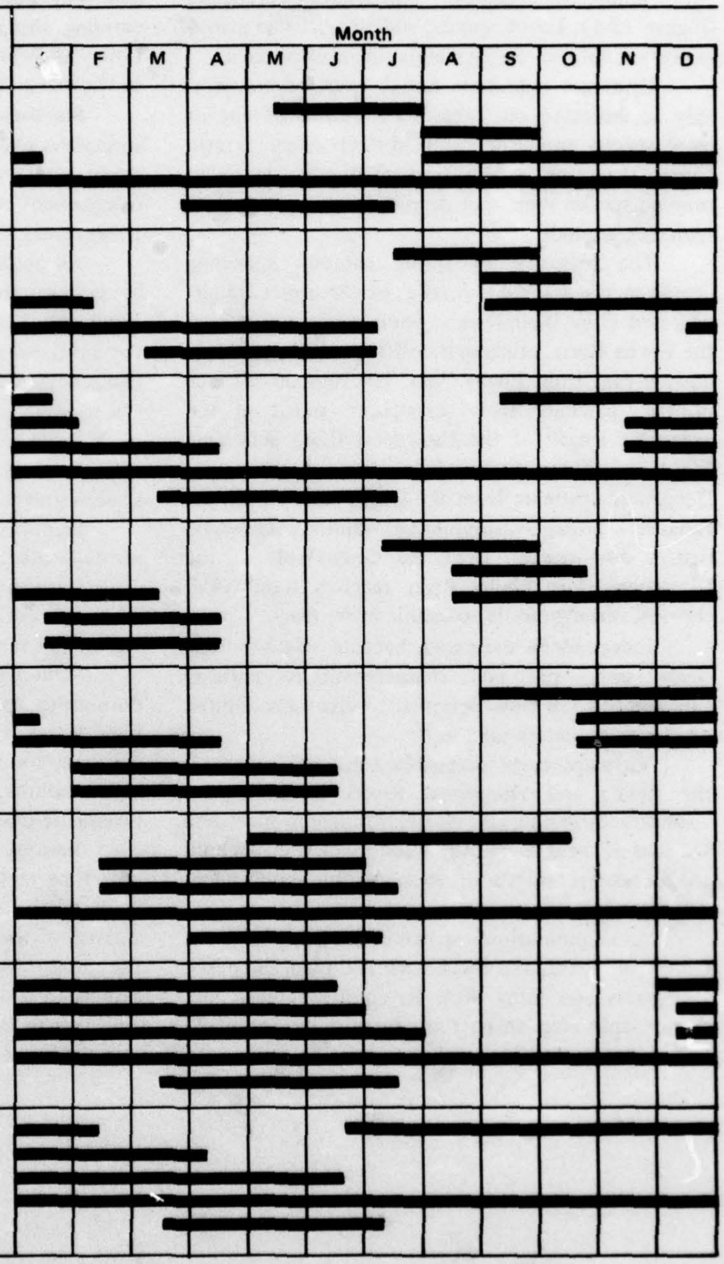
Intragravel egg development occurs over an 11-month period, because of the overlapping spawning time of various species.

"Out migration" for all species occurs mainly during the period February-June, corresponding with high spring runoff. Some intrariver migration of chinook, coho, and anadromous trout occurs during other months, but this is a natural redistribution of juvenile salmonids within the stream systems.

Various downstream migrants spend considerable time in fresh water and in the vital acclimation areas of the estuaries. Extremely important to the survival of these tiny fragile fish are the conditions in the lower rivers, in the estuary, and in closely associated marine waters near the river mouths. After adjusting to the salt-water environment, they disperse into the Strait of Juan de Fuca and the ocean.

TABLE 13-1. Timing of salmon and searun trout fresh-water life phases in Elwha-Dungeness Basins

Species	Fresh-water Life Phase
Spring chinook	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing
	Juv. out migration
Summer-Fall chinook	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing
	Juv. out migration
Coho	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing
	Juv. out migration
Pink	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing
	Juv. out migration
Chum	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing
	Juv. out migration
Summer steelhead	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing[1/]
	Juv. out migration
Winter steelhead	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing[1/]
	Juv. out migration
Searun cutthroat	Upstream migration
	Spawning
	Intragravel develop.
	Juvenile rearing[1/]
	Juv. out migration



[1/] Normally extends over a two-year period.

TABLE 13-2. Significant spawning reaches for anadromous fish and resident game fish, Elwha-Dungeness Basins[1]

Stream	Section	Stream Mileage	Type of Spawning Area
Elwha R.	Mouth to Lake Aldwell	0.0-4.0	Some broad riffles and patch gravel, short glides
Dungeness R.	Mouth to Burlinggame Br.	0.0-3.0	Many riffles, short glides
	Burlinggame Br. to hatchery	3.0-9.0	Many riffles, numerous channel splits, few pools
	Hatchery to Gold Cr.	9.0-16.0	Riffles and patch gravel, some pools
Gray Wolf R.	Mouth to Cameron Cr.	0.0-8.0	Some riffles and considerable patch gravel

[1] Additional spawning area is provided by virtually all tributaries entering within described reaches.

Estimated numbers of anadromous fish produced within Basin waters and surviving to return as spawners are presented in Table 13-3.

TABLE 13-3. Anadromous fish spawning escapement, natural and (artificial), in Elwha-Dungeness Basins

Species	Range[1]	Average (Annual)
Chinook	100-3,420	1,140
	(440-1,050)	(710)
Coho	990-6,780	2,540
	(530-1,910)	(1,200)
Pink	50,000-440,000	164,500[2]
Chum	1,890-3,560	2,560
Summer steelhead[3]	70-480	240
Winter steelhead[3]	6,400-15,400	9,200
Searun cutthroat[3]	21,700-53,800	29,500
Searun Dolly Varden[4]		

[1] Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), pink salmon (1959-1965), trout (1962-1966).

[2] Per odd-year escapement.

[3] Totals include natural and (artificial) escapement.

[4] No valid totals established.

Resident Fish—Resident fishes spawn and rear throughout the inland waters (Table 13-2). Rainbow trout are found in virtually all streams, sometimes coexisting with resident cutthroat trout, especially in smaller streams. They also occasionally share habitat with brook trout. Dolly Varden occur primarily in larger streams.

Kokanee have been introduced into Lake Aldwell, Lake Mills, and Lake Sutherland. Their ability to fill an ecological niche has been of major importance in Lakes Sutherland and Aldwell. The mountain whitefish is another stream-oriented species which is abundant. Relatively few largemouth bass, brown bullheads, and yellow perch occur within the Basins; they occur primarily in the few lakes situated at lower elevations.

Sculpins, threespine sticklebacks, redside shiners, and suckers are scattered throughout much of the two-Basin area. Sticklebacks and sculpins occur quite frequently in many of the low independent drainages, but suckers are less abundant. Shiners inhabit Lake Sutherland and its outlet, Indian Creek, and Lake Aldwell.

Production

The independent drainages and lower elevation tributaries are the most productive for fish. Based on samples obtained on representative streams and stream reaches during the 1967 low flow period, the instantaneous standing crop production values varied from essentially zero to approximately 110 pounds of fish per surface acre. The average was 99.4 pounds. Salmonid populations equaled 96.7 pounds per surface acre, while other undesirable species except lampreys comprised the remaining 2.7 pounds.

Anadromous Fish—Total salmonid production depends greatly on levels of natural spawning and rearing success. The good quality and as yet undisturbed character of much of the existing aquatic habitat promote a high degree of success, particularly from the upper Dungeness and Gray Wolf Rivers (Photo 13-1).

The Basins are productive for summer and winter steelhead and searun cutthroat. During the period 1962-1966 the average annual natural production of steelhead was 14,260 adults. Estimates indicate that summer steelhead contributed approximately 10 percent of this total. Potential natural production would be fairly substantial. The average annual natural production of searun cutthroat is calculated at 38,100 adults. Potential utilization and production of searun cutthroat could undergo a slight increase.

Potential utilization of the Elwha River between Lake Aldwell and the Glines Canyon Dam, and the entire river and tributary systems upstream from this dam and Lake Mills would provide a major increase in production, particularly for chinook, coho, and steelhead. Preliminary surveys indicate the upper Elwha River system might also produce large numbers of sockeye salmon.

Table 13-4 presents fish production data.

TABLE 13-4. Anadromous fish natural production (harvest plus escapement), Elwha-Dungeness Basins

Species	Range 1/	Average (Annual)
Chinook	400-13,680	4,560
Coho	4,950-33,900	12,700
Pink	150,000-1,320,000	493,500
Chum	3,790-7,110	5,120
Summer steelhead	110-720	360
Winter steelhead	10,300-24,300	13,900
Searun cutthroat	28,900-71,700	38,100
Searun Dolly Varden 2/		

1/ Period involved in determining fish numbers is 1956-1965. Exceptions: pink salmon (1959-1965, odd years), searun trout (1962-1966).

2/ Production limited and therefore not determined.

Resident Fish–Portions of the major rivers, many tributaries, and independent drainages lie upstream from anadromous fish barriers. Often they are cold, small, and precipitous, and are fulfilling their natural potential. Streams not originating from glaciers often receive fish recruitment from headwater lakes or ponds. Planted hatchery trout supplement natural production. The streams' instantaneous standing crop value in early summer is usually less than 30 pounds per surface acre. Often little or no production of salmonid or undesirable species occurs.

PHOTO 13-1. Typical pool and riffle section of the upper Elwha River. (Washington Department of Fisheries photo)

Stream reaches downstream from migration barriers are devoted almost exclusively to anadromous fish production. With the exception of whitefish, no distinction between resident and anadromous game fishes is made. The measured standing crop values (excluding lampreys) vary between 90 and 100 pounds per surface acre. Hatchery-reared resident and anadromous trout are also planted in these areas where necessary.

Because lake waters are planted so frequently and managed for salmonids and/or spiny rays, actual production is shown in harvest data. Certain lakes' total harvest varies from one season to another and may vary from less than 10 to more than 50 pounds per surface acre annually. Consistently higher production could be achieved.

Propagation

The State maintains the Dungeness Salmon Hatchery near Sequim and its associated station at Epperson Springs (Figure 13-2). These stations produce principally spring and fall chinook and coho, and occasionally chum and pink salmon. The majority of the fish produced are liberated in Basin waters. However, large numbers of fish from these facilities are planted in streams outside the Puget Sound Area.

Additional salmon liberations are sometimes made from State hatcheries located in the West

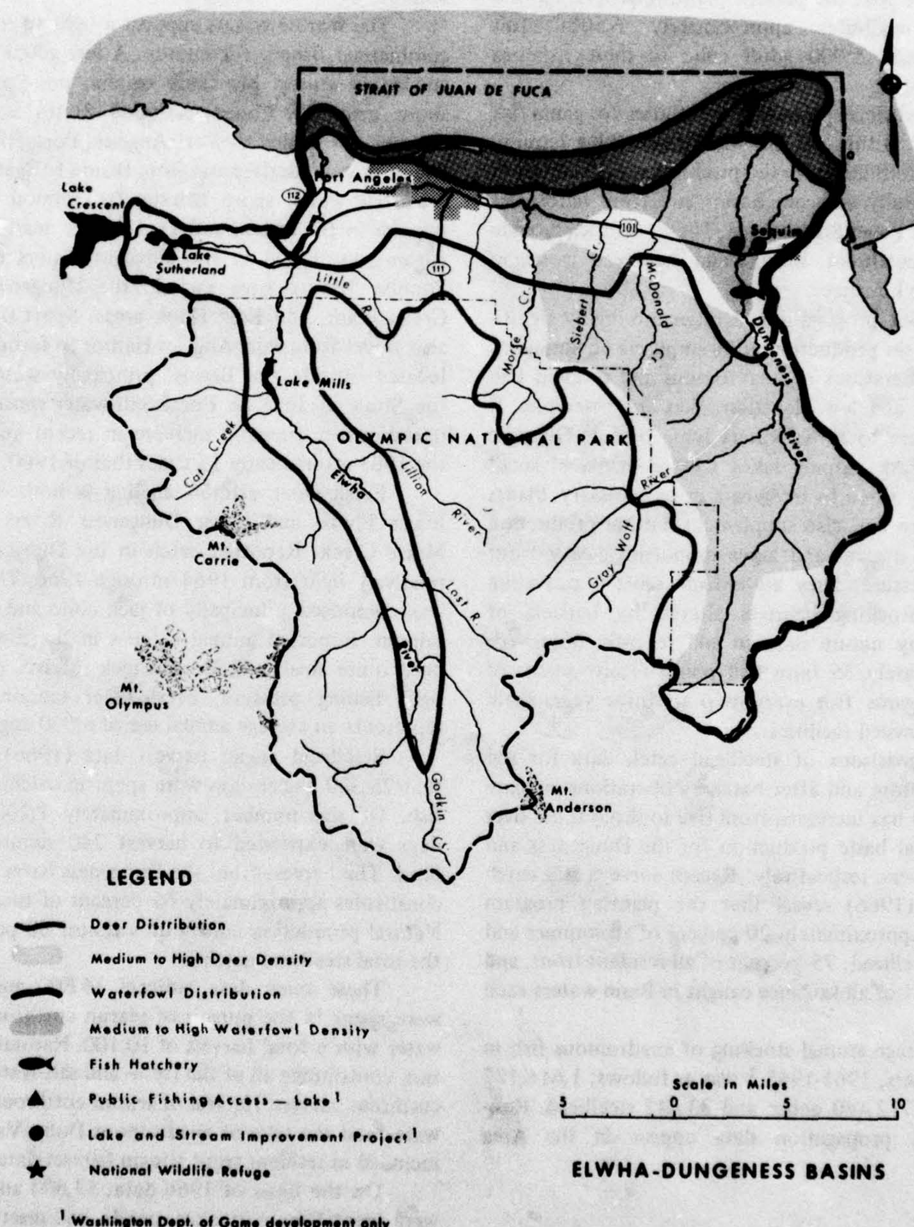


FIGURE 13-2. Wildlife distribution, and fish and wildlife developments (1965)

Sound Basins, specifically from the State's Hood Canal station.

Preliminary commercial and sport catch statistics indicate that the present planting program in the Basins contributes approximately 6,500 adult chinook and 15,000 adult coho to these fisheries annually.

No artificial propagation facilities for game fish are located within the Basins. Fish-stocking requirements are fulfilled from the production of facilities in other generally adjacent basins and from hatcheries outside the Puget Sound Area. These facilities provide rainbow, cutthroat, brook, and steelhead trout, in addition to kokanee.

Present propagation facilities are highly significant to Basin production with emphasis on annual or periodic liberations of anadromous and resident fish in streams and low elevation lakes and reservoirs. It applies more to those waters lying outside Olympic National Park. Alpine lakes receive plants of small trout every three to five years or as necessary. Plants of legal-size fish also supplement natural production in certain streams and lakes supporting heavy trout fishing pressure. They are indispensable in providing fish for stocking habitats altered by barriers or polluted by nature or man and recently improved. Approximately 35 farm fish ponds receive plants of hatchery game fish every two to three years from privately-owned facilities.

Comparisons of steelhead catch data for the periods before and after hatchery liberations indicate that catch has increased from five to seven times over the original basic production for the Dungeness and Elwha Rivers, respectively. Recent surveys and catch statistics (1966) reveal that the planting program provides approximately 20 percent of all summer and winter steelhead, 75 percent of all resident trout, and 95 percent of all kokanee caught in Basin waters each year.

Average annual stocking of anadromous fish in Basin waters, 1961-1965,[1] was as follows: 1,616,125 chinook; 712,440 coho; and 33,642 steelhead. Resident fish propagation data appear in the Area chapter.

Harvest

Existing Harvest–Salmon produced in Basin waters contribute to the United States and Canadian ocean sport and commercial fisheries, and to those in the Strait of Juan de Fuca and northern Puget Sound. The average annual contribution (all species) to these fisheries during the period 1956-1965, was 198,540 salmon.

The marine waters support a light to moderate commercial fishery for salmon. A few gill-net vessels and some seiners ply these waters, principally offshore near the Canadian-United States boundary. Catches are landed at Port Angeles, Port Townsend, and at more easterly ports from Blaine to Seattle.

Salt-water sport fishing for salmon is very popular in the area as reflected by the nearly 90,000 angler-days logged in the adjacent waters in 1965. Popular fishing sites include the Dungeness Spit, Green Point, and Ediz Hook areas. Sport fishermen also travel from Port Angeles Harbor to favorite areas located outside the Basins, principally westward in the Strait of Juan de Fuca. Salt-water sport angling has shown a dramatic increase in recent years with the 1965 effort nearly 13 times that of 1960.

Fresh-water salmon angling is limited to the lower Elwha and lower Dungeness Rivers and to Morse Creek. Reported catch in the Dungeness was relatively light from 1964 through 1966. This catch was comprised principally of jack coho and chinook salmon. Reported annual catches in the Elwha have been quite small and Morse Creek receives relatively light fishing pressure. Fresh-water salmon angling represents an average annual use of 8,000 angler-days.

Steelhead angler harvest data (1966) indicate that 25,300 angler-days were spent in catching 5,000 fish. Of this number, approximately 1,200 angler-days were expended to harvest 240 summer steelhead. The harvest from the Dungeness River drainage constitutes approximately 65 percent of these totals. Natural production contributes almost 80 percent of the total steelhead catch.

These same data indicate 16,800 angler-days were spent in the pursuit of searun cutthroat in salt water with a total harvest of 10,100. Natural production contributes all of the fresh- and salt-water searun cutthroat harvest. Harvest of searun cutthroat in fresh water and the take of anadromous Dolly Varden are included in resident trout stream harvest data.

On the basis of 1966 data, 53,600 angler-days were spent fishing in lakes, ponds, and reservoirs and a total harvest of 134,700 trout and 15,600 other game fish was realized. Similarly, 16,300 angler-days were spent fishing for game fish other than steelhead in the streams and 45,800 were harvested (Photo 13-2). The whitefish harvest was estimated to be less than one percent of this total.

[1] Anadromous trout data involve period 1962-1966.

PHOTO 13-2. Summer stream fishing in the Basins is productive and enjoyable. (Washington Department of Game photo)

Potential Harvest—The natural salmon production capacity of the Basins, now fully utilized, could provide an increased harvest of all species. Salmon harvest trends are discussed in the Area chapter.

Potential harvest of natural steelhead production could be increased, although it is difficult to estimate the degree of improvement, because artificial propagation encourages added fishing pressure on natural populations. However, the additional fish take would not adversely affect the population.

Searun cutthroat harvest has not reached its full potential, because of the unique stream fishery, brief season, and popularity of winter steelhead angling. Estimates indicate that this population could support additional harvest.

Resident salmonid production and therefore harvest in streams are not expected to change, subject to the same exclusions noted for anadromous fish. An exception is the mountain whitefish, which does not stimulate winter fishing interest. The present whitefish harvest is estimated to be less than one-tenth its potential. Because this total harvest is not separable from stream resident harvest data, present and potential harvest values are not given. Potential harvest of resident salmonids in lakes, ponds, and reservoirs could be increased substantially.

Factors Limiting Production Other Than Harvest

The major alterable factors limiting production of fish are shown on Table 13-5.

TABLE 13-5. Alterable factors limiting anadromous and resident fish production in Elwha-Dungeness Basins

	Limiting Factor 1/										Species Affected						
Stream	Flooding	Low Flows	Dam-Diversions	Unstable Streamflow	Unstable Streambed	Falls-Cascades	Log-Debris Barriers	Limited Spawning Area	Poor Water Quality	Profile Changes 2/	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Elwha R.	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
Dungeness R.	X	X	X			X			X	X	X	X	X		X	X	X
Gray Wolf R.	X										X	X	X		X	X	X
Bear Cr.		X						X	X			X		X	X	X	X
Matriotti Cr.		X						X	X			X		X	X	X	X
Independent Drainages																	
McDonald Cr.		X										X			X	X	X
Seibert Cr.		X					X					X		X	X	X	X
Bagley Cr.		X										X			X	X	X
Morse Cr.		X				X					X	X			X	X	X
Lees Cr.		X							X			X		X	X	X	X
Ennis Cr.		X					X		X			X		X	X	X	X
Valley Cr.		X							X			X		X	X	X	X
Tumwater Cr.		X										X			X	X	X
Dry Cr.		X										X			X	X	X

1/ Competition and predation generally affect all waters and are most serious in lake environments.

2/ Includes watershed development.

Detrimental Streamflow–Flooding conditions occur intermittently within the lower 4 miles of the Elwha River that are accessible to fish. This condition is often created by excessive water releases from Elwha Dam. In the Dungeness system the steep mountainous terrain and high stream gradients in the upper watershed compound the damaging effects of heavy runoff.

Low flows are prevalent throughout the Basins, particularly in the Dungeness system and in the independent drainages. Extensive water diversion for irrigation from the mainstem Dungeness and many of the smaller tributaries severely reduces the naturally low summer flows occurring in these streams. Low flows combined with a buildup of sand and mud bars at the river mouths often restrict access of upstream migrating salmon.

Poor Water Quality–Degraded water quality areas exist in the lower reaches of many of the smaller independent streams, and certain estuarine and marine waters in and near Port Angeles Harbor. Principal causes of inferior water quality result from domestic and agricultural pollutants in the streams, and domestic and industrial effluents in the estuarine and marine waters.

Excessive streambank erosion at one point on the lower Dungeness at times creates heavy silting in the river downstream. Silting also occurs in the Elwha River and Morse Creek and glacial debris and silt further degrade these three systems.

Water temperature problems are not considered severe. Occasionally, high temperatures occur in the lower reaches of the Dungeness River and in some of the smaller independent streams during the summer low flow period.

At certain times of the year extreme water fluctuations, resulting from operation of the Elwha hydroelectric power dams, create unnaturally wide temperature ranges in the river downstream. Such conditions adversely affect fish life and production of natural fish food, depending on the extent and rate of temperature change.

Physical Barriers–Known physical barriers limiting anadromous fish production include falls and cascades on the upper Dungeness near Gold Creek, steep cascades on Morse Creek, irrigation diversion dams[1] on the lower Dungeness and some of the smaller tributaries, occasional low flow conditions at the mouth of the Dungeness, and Elwha Dam on the lower Elwha River. Two natural barriers on the Dungeness River temporarily block anadromous fish migration during certain flow periods. Barriers are also created intermittently on smaller streams by the buildup of logs and debris. No major jams are known to exist. Extensive deposits of silt and mud at the mouth of the Dungeness River restrict fish migration.

Independent drainages are generally open, but barriers caused by undercutting of substrata by accelerated streams of water from road culverts sometimes block upstream migration of anadromous fish. Additional barriers exist, as a part of city development, on independent streams in and near Port Angeles.

Although these Basins are relatively undeveloped, irrigation practices in the lower Dungeness River valley limit fish production by streamflow diversion. On occasion, ditches are left unscreened or the screen sections are not adequately maintained. Under such conditions, salmonids are lost in side ditches and fields or may be diverted back to laterals which join small adjacent independent drainages.

Conflicting Watershed Developments–Hydroelectric power dam development on the Elwha River is considered the most significant factor limiting natural fish production. The two dams block many miles of highly suitable spawning and rearing area. Also, their operation, producing widely fluctuating flows, degrades the remaining spawning and rearing habitat in the lower 4 miles of river.

Depending upon its extent, clear-cut logging in the upper Dungeness watershed may prove to be a very definite limiting factor, creating flash runoff conditions and increasing siltation and turbidity downstream. Also, on the Dungeness, the extensive diversion of water for agricultural purposes severely reduces natural stream areas utilized by fish in the Dungeness Basin.

Expanding industrial operations in the Port Angeles area definitely influence water quality in adjacent estuarine and marine areas. Such conditions affect both adult and juvenile salmonids.

Minimal development of stream and lake frontages has occurred, primarily on independent streams, Lake Sutherland, and the relatively few smaller lakes. This will result in demands for channeling and diking, which present additional limiting factors on fish production. Such stream alterations are seldom compatible with basic fish needs.

[1] Certain of these structures are unscreened or improperly operated, and reduce main river flow during critical low flow periods.

Limited Spawning and Rearing Areas—Some of the flat gradient lowland streams in the Dungeness watershed lack spawning area. Also, there is some loss of spawning material in the mainstem Dungeness downstream from the confluence of the Gray Wolf, caused principally by a combination of high flows and gravel movement through artificially channeled areas.

In the Elwha River a major problem area exists in the lower 4 miles where sudden and excessive water releases have displaced most of the smaller-sized gravel, which destroys available spawning grounds, and in some instances, eggs and fish. This material, vital to the continuation of anadromous and resident fish life, is not naturally replaceable since the dams upstream halt its natural downstream movement.

Competition and Predation—Because resident game fishes compete with anadromous fishes downstream from migration barriers, they are less numerous there than in the higher areas. In the fresh waters, competition and predation on anadromous and resident fishes by other fish species, such as sculpins, sticklebacks, and suckers, appear to be minimal. Only in isolated instances are competitive spiny rays found in lakes, and their populations are stunted.

Throughout the early salt-water rearing period, juvenile salmonids are preyed upon by a variety of other fishes, and birds. One of the most undesirable of these predators is the spiny dogfish, inhabiting the estuarine and marine waters. Also in the marine environment, seal and blue shark are considered predators on adult salmon destined for spawning grounds.

Beneficial Developments

Accomplished and Continuing—State projects for anadromous fish enhancement have involved extensive beaver dam and logjam removal, road culvert repair, and installation of fish-passage facilities (Figure 13-1). Also, attempts have been made by State fishery agencies to maintain efficient adult fish-passage facilities at the diversion dams on the Dungeness River.

Beneficial developments have also been concerned primarily with providing public access to game fishing areas. Measures to increase game fish production have been limited to various combinations of stocking programs to offset competition from undesirable fishes.

With some exceptions, all streams in Olympic National Park, including much of the Elwha and Dungeness Rivers, exist primarily in their natural state. Reservoir fishing has been established at Lake Aldwell and Lake Mills. Park lakes are included in fish-planting programs, administered under a cooperative agreement between the Bureau of Sport Fisheries and Wildlife and the National Park Service.

Public fishing access areas have been developed at Lake Sutherland and streambank access has been provided on its outlet, Indian Creek. Additional access area development also occurs on Dungeness and Elwha Rivers (Figure 13-2). Private and public developments supplement this program, and where developments have been completed for salmon species, anadromous and resident game fishes also benefit.

Various projects to aid migratory fish have included fish passage at road crossings on streams (Photo 13-3).

Lake Sutherland has been scheduled for chemical rehabilitation but, to date, only the outlet structure portion is completed. In addition, quantities of select gravel have been deposited in the outlet immediately upstream from the screen section, to supplant and increase spawning potential of the

PHOTO 13-3. Fish passage at Siebert Creek highway crossing. (Washington Department of Game photo)

outlet stream. The location of various lake and stream improvement projects is presented on Figure 13-2.

Under Development–No beneficial developments, other than the undesirable fish control project at Lake Sutherland, are being constructed or programmed for game-fish production at this time.

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters, which include the southeastern portion of the inner Strait of Juan de Fuca, are nearly uniform in depths and beach topography. The area, with depths exceeding 100 fathoms, is more oceanlike in character than other Area marine waters.

The strait is the immediate source of deep salt water into Puget Sound from the open ocean. This water is somewhat diluted over the shoaling bottom in the vicinity of the Admiralty Inlet sill through effluents from the Strait of Georgia and to a lesser extent by those from the Sound itself. Cold, upwelling water prevails during the summer in the Strait of Juan de Fuca and attains its yearly maximum temperatures in winter. Salinities are greater in the summer and become somewhat less in the winter.

Fresh-water discharges from the Elwha River influence and dilute the marine environment of the strait. The much smaller Dungeness River has relatively little diluting effect. Washington Harbor has a narrow restricted entrance to the strait which reduces the tidal interchange. Port Discovery exhibits a warming trend near its head because of lack of mixing. Kilisut Harbor, formed by Marrowstone and Indian Islands, has a narrow confined entrance which maintains its shallow warm waters. Although the heads of Port Townsend and Oak Bay are connected by a very short, narrow channel, salt-water interchange is restricted.

The estuarine and marine waters and shoreline from Kala Point (West Sound Basins), on the west side of the mouth of Hood Canal, around Marrowstone Island to Port Townsend and west through Port Discovery, Washington Harbor, New Dungeness Bay, and Port Angeles Harbor to the Elwha River mouth comprise the Basins' marine habitat for shellfish.

The coastline is generally steep with narrow beaches of coarse gravel and large boulders, except in the more protected areas and bays where the gradient is gradual and the intertidal zone composition is mixed sand and gravel.

The shallow sandy-mud flats formed by Dungeness Spit also provide ideal shellfish habitat in conjunction with the surrounding broad shelf of gravelly shoreline extending from Port Angeles to Washington Harbors.

Inventory and Distribution

Marine Fish–Despite the lack of diversified salt-water environment, the marine waters support a large variety of marine fishes. Principal species include members of the cod family, lingcod, greenling, flounder, sole, surfperch, rockfish, dogfish, herring, and ratfish. Population is discussed in the Area section concerning species production.

Shellfish–Principal species of shellfish and other marine invertebrates are Dungeness and red crabs; Pacific oysters; littleneck, butter, Manila, horse, geoduck, cockle, and piddock clams; blue and California mussels; pink and rock scallops; spot, coon stripe, and pink shrimp; squid; octopi; sea cucumbers; and sea urchins. Several large protected bays and harbors–Washington Harbor, Port Discovery, Oak Bay, and Kilisut Harbor–are recognized as the best producers of hardshell clams in the State.

The Dungeness crab, an extremely prolific species, is indigenous to all of the marine waters. They are most abundant in the sandy estuaries in the Elwha-Dungeness-Port Townsend areas. The Dungeness crab, distributed along the entire Pacific Coast from California to Alaska, was named for this area because of its particular abundance in these waters. Red crabs occur along the shores and box crabs frequent the deep water channels.

Scattered plantings of Pacific oysters have been made near Dungeness and in Port Townsend and Kilisut Harbor. Clam populations are extensive throughout the shellfish habitat. Washington Harbor, Port Discovery, Oak Bay, Port Townsend, and Scow Bay are the prime areas for native littleneck, butter, and Manila clams, and lesser numbers of the other hardshell clams. Moderate numbers of the large California mussel occur from the Elwha River mouth to Port Townsend. Common blue mussels inhabit the shellfish environment in moderate abundance. Scattered groups of pink and rock scallops occur from Port Angeles to Port Townsend. Pinks inhabit dropoff areas in waters 50-80 feet in depth, while rock scallops are confined to the larger boulders and rock outcroppings below the mean low water line.

Small scattered beds of coon stripe shrimp are situated in deep water from Dungeness Spit to Port

Townsend. The Protection Island area supports small populations of spot and pink shrimp.

Seasonal migrations of squid occur in Port Discovery, Washington Harbor, Oak Bay, Port Townsend, and Scow Bay. The Port Angeles, Dungeness, Port Discovery, and Port Townsend areas support large octopus populations. Scattered groups of sea cucumbers and sea urchins are distributed throughout the marine waters.

Production

Specific information is not available concerning numbers of marine fish and shellfish produced.

Propagation

Marine fishes are not propagated within the marine waters.

Shellfish culture programs are conducted principally to enhance oyster production in the protected waters of Washington Harbor and New Dungeness Bay. These privately-managed beds are used to propagate occasional "seed" stock from State-owned oyster reserves located outside the Basins, and seed from foreign sources. Other shellfish stocks are maintained primarily through natural "settings".

Harvest

Marine Fish–Marine fishes receive moderate to heavy sport and commercial fishing effort. Commercial harvest is conducted principally by otter trawlers, which land their catches at Bellingham, Anacortes, Everett, and Seattle. Principal species include lingcod, Pacific cod, sole, and rockfish.

Sport fishing includes angling throughout the marine waters as well as spear fishing, which is performed mainly in semi-protected waters adjacent to the shoreline. In 1965, more than 2,000 angler-days were recorded in the area. Sport divers are limited by regulation to the taking of marine fishes only and lingcod and rockfish are the principal species sought. This sport is becoming increasingly popular in Basin waters as the entire Olympic Peninsula area becomes more and more recreation-oriented.

Harvest potential for marine fishes is unknown.

Shellfish–Sport and commercial harvest of shellfish is relatively light when compared to other Puget Sound areas. Commercial shellfish landings include principally clams, crabs, and octopi; some of the largest catches of octopus in Puget Sound occur in these marine waters.

Sport effort is concentrated mainly on crabs, hardshell clams, and geoducks. Major sport harvest occurs on virtually all public access beach areas from Angeles Point to Dungeness. Sportsmen harvesting shellfish average 12,500 man-days of use annually.

Potential for increasing shellfish harvest is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish–The principal factors known to limit marine fish production are poor water quality and competition and predation.

(1) Poor Water Quality–As noted in the Water Quality section for anadromous and resident fish, some of the estuarine and marine waters are influenced by pollution conditions created by industrial effluents stemming principally from Port Angeles Harbor. Additional factors affecting water quality include wastes introduced from beach property developments, disposal of dredged spoils, and occasional washing or discharge of oil or other toxic materials from ships or barges. The total compounded effects of poor water quality are unknown.

(2) Competition and Predation–Spiny dogfish and sculpin prey on some marine fish species, particularly on the immature individuals. Also, heavy concentrations of these fish compete for, and often completely dominate a particular environmental niche, eliminating the habitat for use by more desirable fishes such as rockfish, cod, or sole.

Shellfish–Concerning shellfish distribution, the stronger ocean tides within the strait readily dissipate the Elwha River discharge and tend to retain the colder ocean waters along the coastline. Ediz Hook at Port Angeles and Dungeness Spit form protective harbors that are less affected by the tides and prevailing westerly winds. Principal factors limiting shellfish production include poor water quality, tideland development, and competition and predation.

(1) Poor Water Quality–Pulp mill waste discharges in Port Angeles Harbor are a major limiting factor, the effects of which reach eastward along the shoreline to the Dungeness Spit. Studies reveal that these wastes are damaging to marine life, particularly in the Port Angeles area. Industrial wastes and sewage disposal are also pollution problems in the vicinity of Port Angeles and Port Townsend. Sludge beds in Port Angeles Harbor have gradually choked out the shellfish populations.

(2) Tideland Development—Log dumps and log boom areas within the protected bays are fouling the shellfish grounds and reducing the available growing areas for clams and oysters. Large portions of the prime clam beaches at Washington Harbor, Port Discovery, Scow Bay, and Oak Bay are private commercial areas and are posted against recreational use. Road systems restrict easy access to much of the marine area.

(3) Competition and Predation—Shellfish competitors causing significant mortality are ghost shrimp and burrowing worms on the mud flats and soft beaches, sand dollars in beach areas that could be producing clams; starfish, native drills, moon snails, and red crabs that prey on oysters and clams; and octopi that prefer the large Dungeness crabs.

Beneficial Developments

The natural production of marine fishes is considered adequate, and there are no beneficial development projects for the enhancement of the various species.

Beneficial development projects or programs for shellfish include those associated with privately-managed oyster culture operations and those concerning implementation of water quality standards.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The 1963 census ranked the Elwha-Dungeness Basins with 28,300 people as one of the least populated within the Puget Sound Area. Population growth is projected to be only 29,800 by 1980 and 41,000 and 56,600 by 2000 and 2020, respectively, considerably less than that of most other basins. It is expected that increases will be related to new industrial developments, particularly in the Sequim-Port Angeles area. Although urban and suburban developments will be few, there will be considerable summer-recreation home development, particularly near lakes, streams, and marine waters. Development of this type will occur outside Olympic National Park throughout the length of the independent drainages as well as along the lower reaches of the Dungeness and Elwha Rivers.

The lengths of the Elwha-Dungeness Rivers and the great variety of stream types afforded by their drainages make this area attractive for outdoor recreation. This is especially true of the upper watershed near and within Olympic National Park. Although access to many portions of the watersheds is poor, this lack of roads leaves rugged areas in their natural state, and provides a challenge for the more enthusiastic outdoor sportsmen. With an expected increase in demand for more and more outdoor recreation, associated with increased population and more and more leisure time for the outdoor enthusiasts, it is anticipated that sport fishing pressure within the Basins will accelerate at a rate much greater than population growth. Many individuals from the more heavily populated areas will travel across Puget Sound to enjoy this area's scenic splendor and utilize its numerous recreation facilities. Also, in salt-water areas where salmon produced within the Basins are harvested, there will be a marked increase in demand for these highly valued fish by both commercial and sport fishermen.

RESOURCE DEMANDS AND NEEDS

The marine waters of the Elwha-Dungeness Basins support a moderate to heavy commercial fishery for each of the three major commercial resources, salmon, marine fish, and shellfish. Basin streams produce significant numbers of salmon that enter commercial and sport fisheries outside as well as within Basin waters. Port Angeles serves as a principal fishing port, receives many commercial landings, and supports a very heavy sport fishing trade.

Sport fishing for salmon is heavy throughout the Basins' marine environment, and light to moderate in the lower reaches of the Dungeness and Elwha Rivers. Numerous boat rentals serve thousands of sport fishermen annually in the Port Angeles area. In addition, there are many private boat moorages and boat access points along the marine shoreline. Each year there is additional sport fishing pressure within the Basins, with particularly heavy effort during high pink salmon years.

Sport and commercial salmon catches represent a highly significant contribution toward meeting the overall Pacific Northwest demand for fish resources. As these demands continue to increase, it will be necessary to resolve a number of the problems and conflicts affecting the Basins' fish production capacity, as well as to develop projects and implement programs that will best utilize the production potential of Basin waters.

It is anticipated that local demand for marine fish and shellfish will increase very rapidly, with particularly heavy demands from those eager for outdoor recreation. Here too it will be necessary to resolve many of the present and anticipated problems, and implement projects and programs that will best meet the demands for these resources. Needs include additional land acquisition to provide public access to Dungeness National Wildlife Refuge. Such acquisition would help satisfy a portion of the overall demands, including that generated by salt-water anglers and shellfish harvesters.

Anadromous game fish attract large numbers of sportsmen, but only a limited number of streams and lakes provide fishing for resident species. Alpine lakes are less intensively managed than in other basins; consequently fisherman use of resident species is lower. Based on county use values, approximately 30 percent of all Basin harvest and utilization of game fish other than steelhead is by people from outside the Basins.

It is estimated that, by 1980, Basin lakes must provide an additional 147,500 trout and 9,800 game fish of other species to meet annual angler demands. This is an additional 26 pounds per surface acre. Similarly, streams must supply an additional harvest of 140,300 resident trout and whitefish and 5,600 steelhead annually. Table 13-6 indicates present and projected demands and needs for game fish in angler-days.

TABLE 13-6. Present and projected sport fishermen use (game fish) in Elwha-Dungeness Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	112.1
1980	75.1	187.2
2000	107.1	294.3
2020	176.6	470.9

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing fish and shellfish resources of the Elwha-Dungeness Basins are categorized below. In addition, general problems and conflicts discussed in the Area chapter apply to these Basins.

Conflicting Land and Water Uses

(1) More than 45 miles of the Elwha River and its tributary streams are blocked to anadromous fish by Crown Zellerbach Corporation's Elwha and Glines Canyon Dams and reservoirs.

(2) Power peaking flow releases downstream from Elwha Dam are not coordinated with fish requirements. This degrades stream environment and reduces the lower river's fish production capacity.

(3) In some areas of the Dungeness River watershed, logging practices conflict with fish requirements. Clear-cutting adjacent to streambanks eliminates some shade and cover, while faulty road construction has caused sloughing and siltation in adjacent streams.

(4) Projects being considered, such as those involving flood control and drainage for the Dungeness and Elwha Rivers, and a storage reservoir on the Dungeness River, may pose conflicts with fish needs.

(5) Extensive housing or land developments near rivers and lakes limit public access to such waters and create trespass problems. Large blocks of riverside lands are being subdivided and sold as summer cabin sites.

Poor Water Quality

(1) Occasionally, pollution in the estuarine and marine waters near Port Angeles creates water quality inimical to fish and shellfish. Effluents from agricultural and industrial sources, as well as from sewage disposal, are particularly detrimental to aquatic life.

(2) The accumulation of silt and sludge in New Dungeness Bay has gradually reached a level that is affecting shellfish production.

(3) A clay bank slide on the lower Dungeness River occasionally causes heavy siltation in the lower 3/4 mile of this stream.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of various potential developments in the Elwha-Dungeness Basins. These developments range from environmental enhancement projects to artificial propagation programs and facilities.

ANADROMOUS FISH

The Elwha River supports major enhancement potential in the form of possible development of adult fish-passage facilities at Elwha Dam and Glines Canyon Dam. Such facilities would provide an additional 45 miles of high quality natural spawning and rearing area. Required fish passage could be achieved by installing a combination ladder-trapping facility at Elwha Dam. Controlled numbers of adult salmonids could then be passed to utilize existing spawning area in the 5-mile reach of the Elwha River and 6 miles of tributaries lying between the two dams. The majority of adults arriving at the lower passage facility could be trucked upstream past Glines Canyon Dam and released into Lake Mills to use the excellent spawning areas throughout the upper Elwha River drainage. As an integral part of this operation it would be necessary to install downstream migrant collection facilities to safely bypass juvenile fish around the power intakes of each dam. It is expected that many adult chinook and coho salmon would use this presently inaccessible stream area. At least moderate use by sockeye salmon and steelhead could also be achieved if adequate passage facilities were constructed.

Creation of assured adult salmonid passage on the Dungeness River, would make available about 8 miles of natural spawning areas, now blocked by small falls and cascades. This project would mainly require selective blasting and rock placement rather than an extensive fish-passage facility.

Another potential enhancement project is adult fish-passage facilities at the falls and cascades of Morse Creek, the major independent drainage, and at the diversion dam upstream. The potential benefit from such an installation can be determined only after more extensive surveys are conducted.

Streambed improvement projects should include stabilizing stream gradients and controlling gravel movement in the Dungeness and Elwha Rivers. This might be accomplished through selective placement of permanent sills and weirs to create self-maintaining pool-riffle conditions. The design of such projects should incorporate methods of retaining as much flow as possible within the stream channel during low summer flow periods. Streambed improvement on the Dungeness River should also include dredging the silt and sand delta at the river mouth, and controlling erosion and slide conditions in the lower mile of river.

Some method of flood control would be beneficial for the Dungeness River and for its major tributary, the Gray Wolf. This might be achieved through high elevation impoundments, flood flow diversions, or strategically placed overflow channels. Flood control is also needed on the lower Elwha River. Some relief could be achieved here by reducing the suddenness and magnitude of hydroelectric dam flow releases associated with power peaking.

Augmentation of low summer flows would be highly beneficial for the Dungeness and lower Elwha Rivers. Development of impoundments in the upper Dungeness watershed could provide necessary flows in that river, however, loss of natural fish production habitat might negate any benefit. Existing impoundments on the Elwha River might be operated to increase summer flows for that stream.

There are a number of potential propagation sites in the Basins, particularly in the lower reaches of the Elwha and Dungeness Rivers. These would be suitable principally for eyed-egg incubation or spawning channels, or controlled rearing impoundments. One area on the Elwha River consists of a large spring-fed pond and tributary stream located just upstream from the river's mouth. This area, plus the relatively wide expanse of land adjacent to the lower two miles of river, appears suitable for controlled flow channels or rearing impoundments.

There is a potential for increased production in connection with irrigation channels and ditches throughout the lower Dungeness River area where controlled flows might be directed through eyed-egg incubation or rearing facilities.

Investigation is needed in order to establish more exactly the adequacy and the potential production from any proposed artificial propagation development.

Additional enhancement programs should be directed to: (1) implement water quality controls necessary to sustain fish and shellfish populations, including control of forest and agricultural spraying, as well as curtailing the disposal of untreated municipal and industrial wastes; (2) develop cooperative measures with Federal, State, county, and private agencies involved in flood control, logging, and gravel operations to ensure protection of fish resources; (3) institute a permanent flood plain zoning plan to protect streambeds and land immediately adjacent to streams from unnecessary changes that damage aquatic habitat; (4) guide management to promote effective regulation of all fisheries, and provide necessary changes in fishing areas and harvest methods, to yield greatest maximum benefit from available stocks; (5) perform studies and obtain information necessary to achieve the most efficient management possible, including basic water chemistry data needed to determine feasibility of increasing production and deriving techniques for removing silt and decompacting riverbed gravel in large streams; and (6) determine specific streamflows (from river cross section measurements) to ascertain flow levels necessary for fish, and to provide methods and techniques for altering streamflow and streambed conditions to increase the productive capacity of the environment. Optimum flows derived will be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish production.

A tentative flow schedule has been determined for some streams. Such flows, by month, are listed in Table 13-7. It is assumed that the amounts of water necessary to maintain fish production in the major fish use areas will be available if the recommended flow regimen is achieved. Much expansion and refinement of these figures will be necessary to determine optimum flows. Lakes and ponds should be maintained at existing levels.

MARINE FISH

Enhancement projects for marine fishes could include creation of additional habitat and new fishing areas through selective placement of rock jetties or submerged automobile bodies. Another program benefiting these fishes would be to establish and implement water quality controls on the Dungeness River and the estuarine waters.

Natural production is adequate at this time, but artificial propagation will be instituted as required.

SHELLFISH

Potential enhancement projects for shellfish might include the installation of beach breakwaters where strong currents limit production, the study and implementation of techniques to eliminate or control natural predators, and the alteration of environment to promote increased natural production. The latter might be accomplished by heating controlled saltwater areas or by adding nutrients. The marine waters hold some potential for expanded development of raft and rack oyster culture.

TABLE 13-7. Tentative flow schedule required to maintain fish production levels, Elwha-Dungeness Basins

	Flows (cfs) by Month											
Stream[1]	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Elwha R.	900	1,400	1,600	1,600	1,600	1,200	1,300	1,500	1,300	1,000	700	700
Dungeness R.	250	300	400	350	350	250	300	500	600	400	200	200

[1] Locations are existing U.S. Geological survey gaging stations.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The Elwha-Dungeness Basins offer numerous opportunities for projects and programs that could maintain and increase fish and shellfish production, promote better use of habitat, and provide for increased angler use. In order to meet future demands, a number of these potential developments must be undertaken. Major proposals, including a general indication of priority, are categorized in Table 13-8 and defined by stream in Table 13-9.

TABLE 13-8. Potential developments for production and use of salmon, marine fish, and shellfish, Elwha-Dungeness Basins

Beneficial Development	Priority: Prior to 1980	Priority: Prior to 2000	Priority: Prior to 2020
(1) Maintenance and Enhancement			
Provide fish-passage facilities on Elwha River	X		
Provide fish-passage facilities on Dungeness River	X		
Improve public beaches for clam production		X	
Develop marine fish production habitat	X	X	
Improve stream and streambed conditions	X	X	X
Dredge Dungeness River channel at mouth	X	X	X
(2) Acquisition			
Determine and evaluate potential salmon propagation sites	X		
Initiate purchase of suitable land for propagation sites and procure water	X		
Acquire and develop 10 salt-water public access sites	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Acquire 4 miles of additional beach for public use		X	
Procure riverbank public access sites	X	X	X
(3) Management and Administration			
Establish levels and implement controls for maintenance of fish production streamflow	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Develop subtidal park for skin divers		X	
Implement necessary fishery management regulation changes	X	X	X
(4) Coordination and Legislation			
Institute effective flood plain zoning codes	X		
Coordinate all operations and activities on streams, i.e., gravel removal, flood control	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
River cross section and profile measures	X		
Gravel cleaning and decompaction techniques	X		
Continue inventory of shellfish stocks and recreational use of tidelands	X		

TABLE 13-9. Potential beneficial developments for fish, Elwha-Dungeness Basins

Stream	Enhancement Measure									Species Benefited						
	Passage Facility	Streambed Improvement	Channel Clearance	Flood Control	Flow Augmentation	Hatchery	Incubation Channel	Spawning Channel	Rearing Pond	Chinook	Coho	Pink	Chum	Steelhead	Searun Cutthroat	Resident Trout
Elwha R.	[X]			[X]	X	X	X	X	X	X	X	X	X	X	X	X
Dungeness R.	[X]	X	X	X	[X]		X	X	X	X	X	X	X	X	X	X
Gray Wolf R.				X						X	X	X	X	X	X	X
Bear Cr.		X							X		X			X	X	X
Matriotti Cr.		X							X		X			X	X	X
Independent Drainages																
McDonald Cr.	X	X					X	X			X			X	X	X
Seibert Cr.		X									X			X	X	X
Bagley Cr.		X									X			X	X	X
Morse Cr.	X	X					X	X			X			X	X	X
Lees Cr.		X									X			X	X	X
Ennis Cr.		X									X			X	X	X
Valley Cr.		X									X			X	X	X
Tumwater Cr.		X									X			X	X	X
Dry Cr.		X									X			X	X	X

[X] Priority project.

The State fishery agencies and, to a lesser extent, various land management agencies are working on a number of the developments listed. Nearly all of the major proposals are goals of long range planning programs, and are acted upon as monies, manpower, and time permit.

A number of these potential developments are included in a preliminary plan for increasing salmon production levels to meet Pacific Northwest demands for fish resources in future years. These proposals, and salmon production increases, are indicated by target years in Table 13-10.

Table 13-11 shows estimated annual benefits in terms of sport and commercial harvest for the same proposals. Projects and programs for marine fish and shellfish have not been analyzed in this manner, because use data are inadequate, and needs are not so critical as for salmon.

Acquisition and development of a 33.3-acre tract, including headlands, at the base of Dungeness Spit, is planned before 1980 by the Bureau of Sport Fisheries and Wildlife. Benefits include: (1) blocking out the land ownership pattern to assure future public access to Dungeness National Wildlife Refuge and (2) fulfilling increasing demand for a nature-associated experience. Proposed development would provide for increased sport fisherman use associated with shellfish gathering and perimeter salt-water angling on the refuge. Angler-day benefits have not been determined, but such use would help satisfy overall demand. Estimated acquisition cost of the tract is $104,500, estimated annual cost, $4,000. Planning has not progressed beyond 1980.

TABLE 13-10. Estimated total salmon production increases in Elwha-Dungeness Basins, by project or program, to satisfy needs[1]

Project or Program, and Year	Chinook	Coho	Pink	Chum	Sockeye
	Species and Number				
Pre-1980					
Supply flood control and augment flows, Elwha R.	3,600	2,000	6,800	8,200	--
Supply flood control and augment flows, Dungeness R.	600	2,500	13,500	--	--
Trap and haul, Elwha R.	24,000	60,000	--	--	41,100
Subtotals	28,200	64,500	20,300	8,200	41,100
1980-2000					
Provide fish passage, 1 stream, 6 stream miles	100	1,500	--	--	--
Improve fish habitat, 12 streams, 18 stream miles	400	4,500	13,500	3,300	--
Clear channel, 1 stream, 8 stream miles	200	800	4,500	--	--
Construct rearing ponds, 10 acres	6,000	--	--	--	--
Construct hatchery	--	51,000	--	--	--
Subtotals	6,700	57,800	18,000	3,300	--
2000-2020					
Develop rearing facilities, 30 acres	17,000	25,500	--	--	--
Subtotals	17,000	25,500	--	--	--
Totals	51,900	147,800	38,300	11,500	41,100

[1] Average annual production (catch plus escapement) at end of each period.

TABLE 13-11. Proposed projects and programs, with estimated benefits and costs, for enhancement of salmon 1/ and other anadromous fish resources, Elwha-Dungeness Basins

Project or Program, and Year	Annual Benefits: Commercial Harvest: No. of Fish	Commercial Harvest: Value: To Fishermen	Commercial Harvest: Value: Retail	Sport Harvest: No. of Fish	Sport Harvest: Value: Federal	Sport Harvest: Value: State	Costs: Capital	Costs: O&M (Annual)
Pre-1980								
Supply flood control and augment flows, Elwha R.	11,500	$ 29,800	$ 79,100	1,400	$ 8,600	$ 39,800	2/	2/
Supply flood control and augment flows, Dungeness R.	10,600	13,300	50,900	900	5,300	26,300	2/	2/
Trap and haul, Elwha R.	82,400	263,700	666,900	13,600	81,700	381,200	$1,550,000	$60,000
Subtotals	104,500	$306,800	$ 796,900	15,900	$ 95,600	$447,300	--	--
1980-2000								
Provide fish passage, 1 stream	1,100	$ 3,500	$ 6,900	200	$ 1,200	$ 5,500	$ 12,000	$ 300
Improve fish habitat, 12 streams	13,500	21,500	69,900	1,000	6,300	29,100	57,000	1,200
Clear channel, 1 stream	3,400	4,100	16,100	300	1,600	7,800	20,000	600
Construct rearing ponds, 10 acres	4,400	29,200	70,100	800	4,500	21,100	55,000	10,000
Construct hatchery	37,400	118,400	228,200	6,400	38,300	178,800	1,020,000	60,000
Subtotals	59,800	$176,700	$ 391,200	8,700	$ 51,900	$242,300	$1,164,000	$72,100
2000-2020								
Develop rearing facilities, 30 acres	27,900	$120,300	$ 260,800	8,500	$ 51,200	$239,100	$ 165,000	$30,000
Subtotals	27,900	$120,300	$ 260,800	8,500	$ 51,200	$239,100	$ 165,000	$30,000
Totals	192,200	$603,800	$1,448,900	33,100	$198,700	$928,700	--	--

1/ Anadromous trout benefits not included.

2/ Multipurpose project. Separable costs, if any, have not been determined.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these proposals have not been estimated.

General Programs

Additional water storage on the Elwha River will be necessary if the forest products industry expands and population increases occur in the Port Angeles area. Without additional storage, river flows will be depleted to the detriment of fish resources.

Outdoor recreation planning, including fishing, should be a high priority program in any basins' plan. Emphasis must be placed on acquiring public access to lakes, streams, and salt water.

Industrial and municipal water supply should be separated. This would permit use of controlled quality water for industrial purposes and permit proper perspectives for water uses.

Thermal powerplants should be located in areas where water diversion is not detrimental to fish resources. Lake Aldwell reservoir is a possible site, and some warming of this impounded water could increase fish production. However, water cooling requirements must be included in the construction plans.

PHOTO 13-4. Public fishing access sites at strategic locations facilitate angler use. (Washington Department of Game photo)

Projects and Programs Proposed for Completion by 1980

(1) Basin-wide cross-sectional stream surveys should be conducted to determine the most beneficial flows for spawning, incubating, rearing, and fishing, and techniques should be developed to better evaluate such flows. This would be an Area-wide study, costs for which are indicated in the Area chapter. Flows will be considered jointly with water quality standards.

(2) Early acquisition and development of a public fishing access area at Lake Aldwell is recommended. Ultimately, all significant lakes and key portions of streams and salt-water areas should have assured public fishing access (Photo 13-4).

(3) Streambank angler access on 30 miles of the Elwha and Dungeness Rivers and independent drainages (of a total of 74 miles) should be acquired and developed, as funds become available.

(4) There is considerable potential for fishing impoundments in the northern portion of the Dungeness River valley. These and other areas not specifically located could be developed as rearing areas for steelhead and searun cutthroat and also provide fishing in an area with few low elevation lakes.

(5) A steelhead rearing pond should be developed in the Dungeness River drainage.

(6) A kokanee spawning channel should be developed at Lake Aldwell reservoir.

(7) Offstream storage projects to control flood flows and redistribute monthly flows should be developed.

(8) A late spring run of steelhead should be developed in the Elwha River.

(9) Irrigation diversions should be controlled to eliminate diversion during non-irrigation seasons.

(10) New techniques and products for lake and stream fertilization and rehabilitation should be developed.

(11) Fish population analysis of main rivers and tributary streams should be continued.

(12) Lake Sutherland should be rehabilitated and fertilized.

Table 13-12 indicates estimated annual benefits and costs of specific projects and programs proposed for the Elwha-Dungeness Basins to satisfy need for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed

TABLE 13-12. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish in Elwha-Dungeness Basins, pre-1980

	Annual Benefits		Costs	
Project or Program	Angler-Days	Value	Capital	O&M (Annual)
Lakes				
Develop kokanee spawning channel, Elwha R.	3,800	$ 7,500	$ 25,000	$ 1,000
Rehabilitate Lake Sutherland	10,000	20,000	10,000	2,500
Fertilize Lake Sutherland	20,000	40,000	--	5,000
Subtotals	33,800	$ 67,500	$ 35,000	$ 8,500
Streams				
Augment low flows, Elwha R.	1,700	$ 5,000	1/	1/
Augment low flows, Dungeness R.	3,300	10,000	1/	1/
Construct steelhead rearing pond	27,000	135,000	$ 50,000	$18,000
Acquire and develop streambank access, Elwha R. (5 stream miles), Dungeness R. (10 stream miles), independent drainages (20 stream miles)	19,100	57,300	562,600	3,000
Construct hatchery	11,000	33,000	250,000	21,100
Subtotals	62,100	$240,300	--	--
Totals	95,900	$307,800	--	--

1/ Multipurpose project. Separable costs, if any, have not been estimated.

above may be substituted as priorities for development shift. Proposals for subsequent years, which may include some projects and programs listed above, have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table. Some of these projects and programs are interconnected, that is, benefits from constructing a hatchery may depend on first solving fertility, disease, and public access problems. For such cases, items showing costs will not necessarily show benefits because the latter are included under other projects and programs.

Projects and Programs, 1980-2000

(1) Construct and manage lakes to meet increased demand for fishing.

(2) Construct and operate a hatchery to supply trout for lake and stream fishing.

(3) Complete programs and projects not completed prior to 1980.

(4) Construct and manage a searun cutthroat rearing pond.

(5) Develop new projects and programs as required.

Projects and Programs, 2000-2020

(1) Continue projects and programs not completed prior to 2000.

(2) Develop new projects and programs as needed.

(3) Continue fisheries research.

About 67,000 acres in these Basins are under U.S. Forest Service administration. Plans for fishery enhancement projects and programs have not advanced beyond 1980, but work similar to that listed in Table 13-13 is probable in subsequent years. Angler-day benefits have not been calculated, but they will help satisfy overall demand.

TABLE 13-13. Fishery enhancement projects and programs of U.S. Forest Service proposed for Elwha-Dungeness Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Conduct stream surveys	mile	21	$ 600
Conduct lake surveys	acre	12	100
Clear stream channels	mile	17	34,000
Total			$34,700

PRESENT STATUS—WILDLIFE

INTRODUCTION

The Elwha and Dungeness River watersheds are much smaller than the drainages on the west slopes of the Cascades. Although the smaller land area generally means less total wildlife, there is a wide variety present as these streams originate in the rugged Olympic Mountains and traverse all the life zones of western Washington on their route to the Strait of Juan de Fuca. The varied climate greatly influences wildlife abundance and distribution.

BIG GAME

Big game is an important consideration in the inventory of the wildlife resource, as much of the Basins are in some form of forest cover essential to various species. From a hunting viewpoint, the black-tailed deer is most important, but all other typical big-game species of the Puget Sound Area—Roosevelt elk, black bear, mountain goat, and mountain lion—are present in significant numbers.

Inventory and Distribution

Black-tailed deer inhabit the entire Basins' area, but are much more abundant in the lowland section, extending from Lake Sutherland to Sequim. The area south of Sequim has the highest density (Figure 13-2). The Basins support an annual average of 2,700 deer, 200 to 250 of which remain in Olympic National Park wintering at low elevation, primarily along the Elwha River.

Elk range exclusively within the Elwha drainage except for a small herd in the Morse Creek watershed (Figure 13-1). A majority of the 300 animals which inhabit the Basins remain within the boundary of Olympic National Park, except during severe weather.

Mountain goat were introduced on the Olympic Peninsula in 1924 and in 1929 near Storm King Mountain at the extreme westerly edge of the Basins. They now thrive on several mountains in the northern and eastern sections of the peninsula. Peaks which support these animals include Storm King; Mount Angeles, between the Elwha and Dungeness watersheds; and Mount Deception and Mount Constance at the head of the Dungeness River. A population of 100 mountain goat is estimated.

Black bear are common on forested lands of the Basins. A current population exceeding 300 animals is estimated.

An estimated 15 to 20 mountain lion inhabit the back country reaches of this section of the Olympic Peninsula. Olympic National Park serves as an inviolate sanctuary for these otherwise heavily-hunted animals. Their numbers, however, are comparable to those in other similarly remote areas.

Limiting Factors

Deer and elk numbers are regulated by the amount and quality of winter habitat. Logging and other forest management practices influence both quality and quantity of forage. National park preservation policy against harvest of timber limits production of wildlife forage. Wildfire control—a deviation from natural conditions—further limits game forage production.

The elevation at which winter snow persists for long periods on the Olympic Peninsula is somewhat lower than that along the west slope of the Cascades. Snow in sufficient quantity to cover deer and elk forage as well as restrict movement of these animals normally persists for extended periods above the 1,000- to 1,500-foot level in this northerly portion of the peninsula. Animals which use high areas in summer and fall must move down for survival as their food supply becomes covered by snow. This concentrating effect of weather is more pronounced during severe winters, emphasizing the value of low-lying areas.

Black bear numbers are limited by dense timber stands, which restrict food supplies.

Production

Doe-fawn ratios determined just prior to the hunting season indicate an average annual increase of 700 deer over the spring population.

The elk herd ranges almost exclusively within Olympic National Park where forage in the heavy forest is limited. The estimated annual production under such conditions is about 20 percent, or 50 elk.

Late summer counts of mountain goat show 29 kids per 100 adults. This would indicate that about 25 young are produced annually.

Black bear studies indicate an annual reproductive rate of 25 to 30 percent, which would result in 75 young.

Mountain lion production is believed to vary from 5 to 15 annually.

Harvest

The majority of the elk reside within Olympic National Park unless forced out by extreme weather. When such conditions occur, some of these animals cause damage to private property bordering the park. Special January and February hunting seasons, established to control this damage, have met with varied success and reaction by landowners, hunters, and the general public. During some years no elk are taken, and in others as many as 100 or more are killed in a brief period. Animals which must be harvested under such adverse weather conditions furnish little desirable recreation and the situation creates a certain aversion to hunting.

The average annual elk harvest within the Basins is 40 to 50 animals, creating about 1,500 hunter-days recreation.

The majority of the deer inhabit lowland areas and therefore, are available for harvest. Trophy bucks, however, tend to seek high, remote areas which, in these drainages, are generally within Olympic National Park.

Based on a five-year period (1961-1965), deer harvest averages 300 animals annually and the recreation created by this harvest approaches 6,000 hunter-days.

There was no open season on mountain goat in the Basins prior to 1967.

Black bear are classified as predators within the Basins and may be hunted the year round with few restrictions. About 60 bear are taken annually, creating an estimated 500 hunter-days.

Only two or three lion are taken within the Basins each year. Approximately 100 hunter-days annually are involved.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

The mountain goat present in the Basins were established by transplant from Canada and Alaska. This species is not native to the Olympic Peninsula. The Elwha elk herd has provided a number of animals for transplant to other sections of western Washington.

Other beneficial developments are discussed in the Area chapter, Big Game.

UPLAND GAME

One or more of the varied species of upland game inhabit virtually every habitat niche. Native species utilize the remaining native habitat, and introduced exotics have been established in the agricultural areas. The introduced species include ring-necked pheasant, California quail, and gray and red-legged partridge. Native upland game are blue and ruffed grouse, snowshoe rabbit, band-tailed pigeon, and mourning dove.

Inventory and Distribution

The most numerous upland birds are the native grouse. Both species are distributed throughout the Basins within suitable habitat. A ruffed grouse population of 12,000 and a minimum population of 7,000 blue grouse are estimated. The bulk of these grouse are found outside Olympic National Park, but limited numbers of blue grouse frequent natural open areas and ruffed grouse use the hardwood forest adjacent to watercourses within the park.

Population estimates are not available for band-tailed pigeon or mourning dove.

Introduced game birds, including ring-necked pheasant, California quail, and gray and red-legged partridge, are dependent on agricultural activities. The highest density of these birds occurs on agricultural lands near Sequim (Figure 13-1). This area has the lowest annual precipitation west of the Cascades, an ideal situation for these exotic species. There is a current fall population in excess of 8,000 wild pheasants. This wild population is supplemented annually by game-farm-reared birds. The quail population is quite small, numbering less than 3,000 birds. Gray and red-legged partridge are not numerous.

The snowshoe rabbit is common. Population estimates were not determined. Typical habitat for the snowshoe is evergreen-hardwood forest.

Limiting Factors

Limiting factors concerning band-tailed pigeon are described in the Area chapter, Upland Game.

Wildfire control and reduced emphasis on slash burning after logging have reduced the productive potential of forested areas for native grouse.

Lowland agriculture has changed somewhat from cereal grain production to greater acreage of pasture, and additional areas have been diverted to residential sites, adversely affecting exotic game-bird potential.

Production

Wild pheasant production averages 5,000; ruffed grouse, 7,000; blue grouse, 4,000; and quail, 2,000 annually.

No production estimate is available for rabbit, gray partridge, band-tailed pigeon, red-legged partridge, or mourning dove.

Harvest

Approximately 2,400 pheasants are harvested each year, many of which are the direct return of mature roosters released immediately prior to the hunting season. Pheasant hunting results in an estimated 4,000 hunter-days annually.

Each year, grouse hunters bag about 1,200 ruffed grouse and 250 blues–spending in excess of 2,400 days in the field. Only about 200 quail are harvested during an average season, representing more than 150 hunter-days. Over 2,000 band-tailed pigeon are bagged, which provides an additional 1,700 hunter-days. Hunter questionnaires indicate that approximately 225 hunter-days annually are spent hunting the snowshoe rabbit. The average number bagged each year is 400. Red-legged partridge may not be hunted. Upland-game hunting represents approximately 8,475 man-days of outdoor recreation each year.

Propagation

The wild pheasant population is supplemented annually by about 1,800 birds from State-administered game farms in the Puget Sound Area. Approximately 800 of these birds are released as mature cocks immediately prior to the hunting season, and the remaining 1,000 are planted in the spring and early summer as additional broodstock. Small numbers of quail, and gray and red-legged partridge are also propagated by the State and are released periodically within the Basins.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game.

Under a cooperative State-county agreement, 216 acres near Sequim are managed for maximum upland-game and waterfowl hunter recreation. Natural cover is maintained and approximately 70 acres of cereal grain are produced each year as supplemental food for both upland birds and waterfowl. Because food, cover, and unrestricted hunting are assured, the site is used extensively as a release site for game farm birds.

Conservation practices applied by private landowners to agricultural lands of direct benefit to upland game include 250 acres of wildlife habitat development and 1,500 acres of wildlife habitat preservation, located near Port Angeles.

FUR ANIMALS

The fur animals, as a group, are most prevalent in lowland areas. Those species which furnish the greatest monetary return to the trapper require shallow water areas with an abundance of aquatic vegetation. Such marsh habitat is limited in the Basins and occurs primarily on the lower Dungeness. Fur bearers present include beaver, muskrat, mink, marten, river otter, raccoon, weasel, skunk, bobcat, and coyote.

Inventory and Distribution

The beaver population is primarily limited to the major streams as few beaver ponds exist. The lower reaches of these streams are most heavily populated. Current beaver numbers are estimated at 300 to 400.

Muskrat and mink utilize marshes, ponds, shallow lakes, and low gradient streams and ditches which are widespread throughout the lower Dungeness. A population of 5,000 muskrat and over 250 mink was estimated.

River otter are numerous, frequenting salt-water estuaries and fresh-water streams. Approximately 100 of these animals inhabit the Basins.

Raccoon, weasel, bobcat, coyote, marten, skunk, and other fur animals occur in suitable habitat. Their actual populations are unknown.

Limiting Factors

Conflicting interests have reduced fur-animal habitat. The value of the lower Dungeness for agriculture has resulted in loss of swamp and marsh areas through drainage. Homesite development adjacent to water areas further reduces fur-animal habitat. The species most acutely affected by such development and by drainage projects are muskrat, beaver, and mink.

Production

The beaver population is believed to be stable and reproducing at a rate of 30 to 40 percent annually. This reproduction rate results in about 100 to 150 young beaver each year. The average annual muskrat production is estimated at 3,500. Approximately 150 mink are produced each year. Other members of the fur-animal group have reproduction rates similar to that of mink.

Harvest

Beaver habitat in the Basins is somewhat restricted in comparison with the remainder of Clallam County. It is estimated that only 15 to 20 percent of the county beaver take occurs within the Basins. An average annual trapper harvest of 70 to 100 beaver is calculated.

It is doubtful if either mink or muskrat are harvested to the full extent of their potential. Mink which inhabit the salt-water shoreline are believed to produce poor quality fur and consequently, are not trapped extensively. Trapper records reveal the following average annual catches: 500 (muskrat); 25 (mink); and 17 (river otter). Incidental catches of raccoon, bobcat, coyote, weasel, marten, and skunk complete the trapping harvest. Pelt value of major fur animals taken during the 1965-1966 season totaled approximately $2,700.

Propagation

Fur animals are not propagated in the Basins.

Beneficial Developments

Beneficial developments are described in the Area chapter, Fur Animals.

WATERFOWL

The Dungeness area, including the salt-water shoreline, brackish sloughs, marshes, and inland agricultural lands, is a concentration area for waterfowl. As evidence of this concentrated waterfowl use, many of the oldest and largest duck clubs of the State are located here, and a national wildlife refuge occupies much of Dungeness Spit.

Inventory and Distribution

Highest waterfowl populations occur along the salt-water shoreline and adjoining uplands between the eastern border of the Basins and a point several miles west of Dungeness Spit (Figure 13-2, Photo 13-5). The remaining salt-water shoreline supports lesser numbers.

January waterfowl counts in the Elwha and Dungeness watersheds reveal an annual average of 15,000 ducks and 3,150 geese. The following number and species of waterfowl were observed during the 1965 survey: 140 (eider and scoter); 92 (bufflehead); 750 (scaup); 200 (pintail); 100 (green-winged teal); 7,595 (widgeon); 1,212 (mallard); 1,500 (black brant); and 490 (coot).

Prior to the survey, waterfowl have been exposed to almost three months' hunting. In addition, an unknown number of birds hold over in the Basins in fall and early winter for a limited stay while enroute southward. The survey does not indicate the total number which use the Basins as a wintering area.

Limiting Factors

The limited feeding area in the Dungeness delta regulates the number of waterfowl that can be supported through the winter. Agriculture changes which have resulted in a decrease in the cereal grain acreage in other sections of western Washington are also in evidence in the Dungeness delta. Thus, waterfowl which have customarily fed on grain remaining from harvesting operations are forced to utilize other types of food.

PHOTO 13-5. Black brant—highly prized by hunters—find suitable fall and winter habitat in salt-water areas. (Bureau of Sport Fisheries and Wildlife photo)

Limited fresh-water marshes, lakes, and low-gradient streams restrict waterfowl numbers during the breeding season.

The unique climate plus salt-water shoreline and scenic surroundings have increased interest in the area for home and recreation sites, resulting in encroachment on natural waterfowl habitat.

Production

As noted previously, waterfowl production is very limited. A recent inventory disclosed an average annual production of 1,000 birds. Mallard, wood duck, and teal are the predominant species reared.

Harvest

Hunting is sufficiently productive in the Dungeness area to attract hunters from the Seattle, Tacoma, and Bremerton metropolitan areas. Harvest records (1960-1966) show that an average 12,000 ducks and 460 geese is harvested annually, providing about 9,100 hunter-days. This is one of the few areas in the State where black brant concentrate and provide considerable hunting.

Propagation

Production is enhanced by various management techniques on lands controlled by the large duck clubs, but artificial propagation such as that employed on upland birds is not practiced.

Beneficial Developments

Gun clubs preserve much of the waterfowl potential of the Dungeness delta by maintaining natural ponds and marshes just inland from the tidal shoreline. Without the interest of these groups, much of this favorable habitat may have been converted to real estate development and agriculture.

Part of Dungeness Spit and the adjoining water area, totaling 556.5 acres, is maintained as a national wildlife refuge by the Bureau of Sport Fisheries and Wildlife. It provides feed and sanctuary for various species of waterfowl, especially black brant, which contribute to local hunting opportunity. An important refuge objective is preservation of the beds of eelgrass, which is a primary food of black brant. Public access is limited to foot travel for nature-oriented pursuits such as photography and nature study, which are compatible with primary refuge aims.

Seventy acres of cereal grain are raised annually through management of the Voice of America site near Sequim to provide winter waterfowl food.

Conservation practices applied by private landowners to agricultural lands and of direct benefit to waterfowl include 125 acres of wildlife wetland development and 2,500 acres of wildlife wetland preservation located near Sequim.

OTHER WILDLIFE

The many and varied birds and animals in the Basins not classed as game or fur species are classified as other wildlife. This faunal group is discussed in the Area chapter.

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

Much of the future demands for wildlife-oriented recreation will originate from other more populated basins of the Puget Sound Area. Lowland sites offer excellent opportunities for upland-game and waterfowl hunting. Hunting opportunity for big game and grouse, however, is restricted. To maintain the present level of hunting success, it will be necessary to provide an additional annual harvest of 280 deer; 40 elk; 60 bears; 1,300 grouse; 2,200 pheasants; 11,000 ducks; 600 geese; and 2,000 band-tailed pigeons by the year 1980. As population,[1] leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately. This is indicated, in hunter-days, in Table 13-14.

[1] Population forecasts shown in Future Needs—Fish.

TABLE 13-14. Present and projected hunter use in Elwha-Dungeness Basins

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	25.7
1980	23.9	49.6
2000	30.8	80.4
2020	18.8	99.2

PROBLEMS AND CONFLICTS

Certain problems must be resolved if future wildlife-oriented recreation demand in the Elwha-Dungeness Basins is to be satisfied. Problems and conflicts discussed in the Area chapter apply to these Basins.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments in the Basins during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 13-15 indicates projects and programs proposed for the Basins to satisfy 1980 needs. Similar data are not available for subsequent periods, but a

TABLE 13-15. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife in Elwha-Dungeness Basins, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs 1/: Capital	Costs 1/: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	4,000	$ 16,000	--	$ 5,000
Develop educational program to stress renewable aspects and value of proper use of wildlife resources	12,000	60,800	$ 5,000	--
Develop studies to determine better wildlife population analysis techniques and compatible forest-wildlife management plans	2/	2/	10,000	10,000
Specific Projects and Programs				
Acquire and develop waterfowl and fur-animal habitat, 250 acres	6,700	33,600	190,000	800
Enlarge game farm to produce additional 3,300 pheasants	3,800	15,400	33,000	10,000
Totals	26,500	$125,800	$238,000	$25,800

1/ Do not include survey and plan costs.

2/ Benefits included under other projects and programs.

listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include recreation benefits that will accrue from public use of wildlife areas for swimming, boating, hiking, picnicking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological and hunting areas.

(2) Apply intensive management techniques to key big-game habitat.

(3) Continue research for new wildlife techniques and develop projects and programs as required.

(4) Continue programs and projects not completed prior to 1980.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

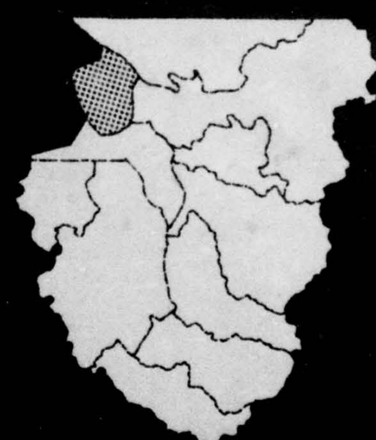
(2) Continue programs and projects not completed prior to 2000.

Table 13-16 indicates projects and programs proposed by the U.S. Forest Service for wildlife enhancement. Planning has not progressed beyond 1980 in these Basins, but similar projects and programs may be expected in subsequent periods. Hunter-day benefits from these proposals have not been determined, but they will help satisfy overall demand.

TABLE 13-16. Wildlife enhancement projects and programs of U.S. Forest Service proposed for Elwha-Dungeness Basins, pre-1980

Project or Program	Unit	Number	Capital Cost
Surveys and Plans			
Conduct range analysis			
Deer	acre	14,220	$1,500
Elk	acre	14,220	1,500
Mountain goat	acre	26,340	2,600
Conduct upland-game habitat surveys	acre	27,000	1,300
Develop habitat management plans	each	3	1,500
Total			$8,400

San Juan Islands



SAN JUAN ISLANDS

PRESENT STATUS—FISH

HABITAT DESCRIPTION

The more than 470 islands of the San Juan group with their open beaches, protected bays, and interisland courses afford highly suitable marine and estuarine environment used year round by anadromous and marine fishes and shellfish (Figure 14-1).

Streams are mostly intermittent and are of little value to anadromous fish, but afford some environment to resident species. There are, however, four small streams (unnamed) which support anadromous fish runs. Salmon occur only in one located on San Juan Island which drains the sparsely wooded San Juan valley and one located on Orcas Island which drains the south side of Mount Constitution, entering East Sound. There are also 46 lakes and reservoirs (908 surface acres) and 24 farm ponds (12 surface acres), most of which support a resident fishery.

ANADROMOUS AND RESIDENT FISH

Inventory and Distribution

Anadromous fishes are distributed in several stream systems and their general life histories are similar. Resident fishes occur in lakes and streams in fair to good numbers.

Anadromous Fish—Coho and chum salmon occur in the two permanent streams and steelhead and searun cutthroat are found in the intermittent as well as the permanent streams supporting anadromous fishes (Figure 14-1). The trout population is small, limited by stream size and reduced summer flow.

The many bays and coves provide highly suitable estuarine conditions for rearing juvenile salmon.

Estimated numbers of anadromous fish produced within basin waters and surviving to return as spawners are presented in Table 14-1.

TABLE 14-1. Anadromous fish spawning escapement, natural and (artificial), San Juan Islands

Species	Range1/	Average (Annual)
Coho	20-150	50
Chum	0-200	50
Summer steelhead2/	NA	NA
Winter steelhead2/	3/	<5003/
Searun cutthroat3/		
Searun Dolly Varden3/		

1/ Periods involved in determining fish numbers are: natural (1956-1965), artificial (1961-1965), trout (1962-1966).

2/ Totals include natural and (artificial) escapement.

3/ No valid totals established.

Resident Fish—The resident trout species, rainbow and cutthroat, spawn in suitable gravel areas of intermittent streams associated with lakes. The fishery, however, is sustained from an annual planting program. Kokanee occur in Cascade and Mountain Lakes on Orcas Island. This fishery also depends on systematic stocking rather than lake or tributary system spawning survival. Spiny-rayed species, such as pumpkinseed, perch, bullhead, crappie, and bass, are well established, self-sustaining, and utilized in several lakes, but most notably in Sportsmans Lake on San Juan Island. The populations of trout, kokanee, and spiny rays serve as a distinct addition to the already attractive recreation potential of the Islands. Carp, sculpins, and sticklebacks are the only undesirable fish species found within the fresh waters.

Production

There are few permanent streams and none of the water diverted by water-use projects returns to the streams. The few independent drainages are quite productive. However, because salmonid production is so restricted, numbers of salmonid spawners and total production estimates were not determined.

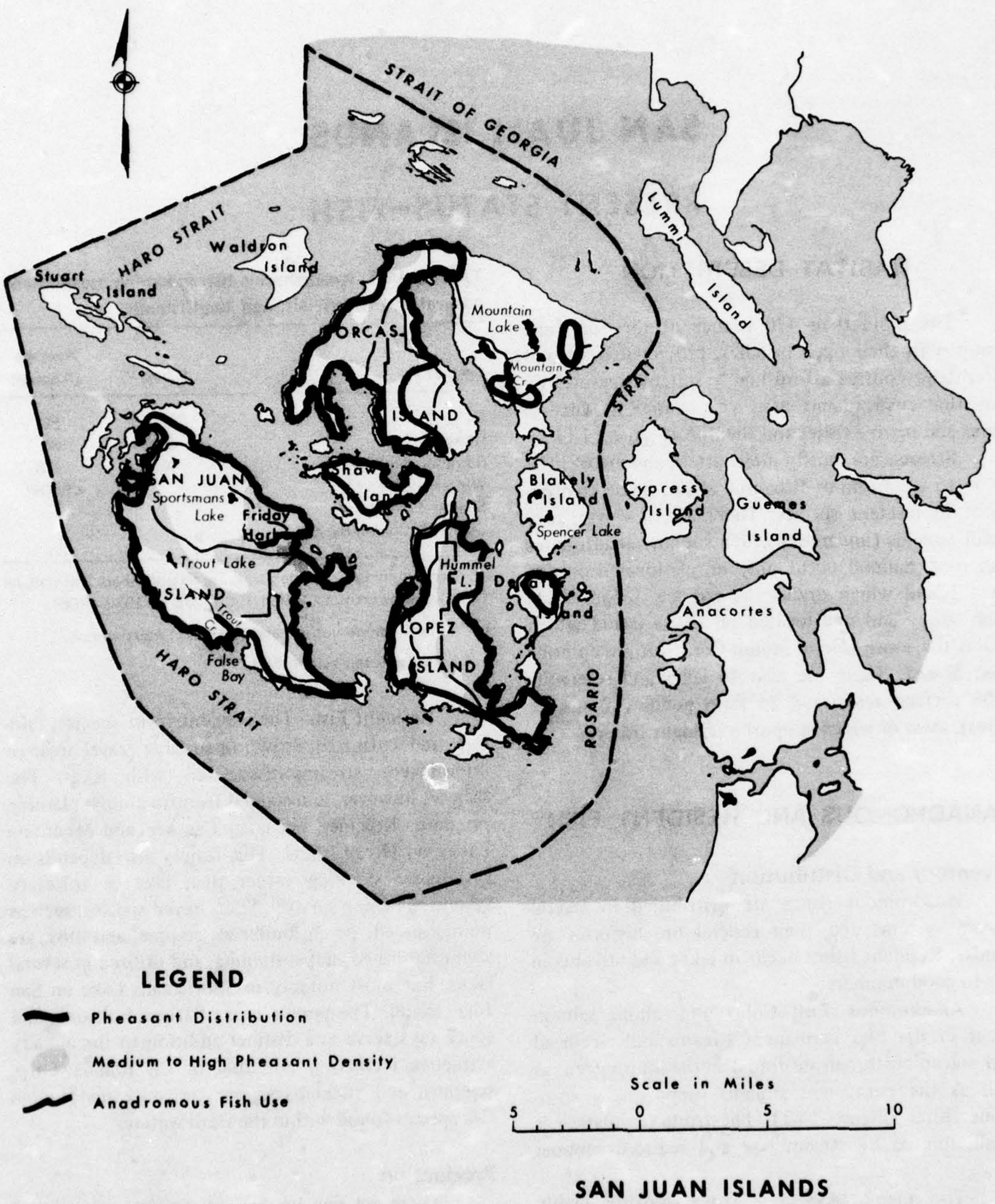


FIGURE 14-1. Anadromous fish and wildlife distribution (1965)

Anadromous Fish—Because salmonid production and potential are limited, no production data are presented.

The San Juan Islands Basin is not a productive winter steelhead or searun cutthroat trout area. The few streams producing these species are relatively free of limiting factors and actual production approaches the natural production potential. The most productive streams are limited by natural and manmade barriers. Although significant numbers of searun cutthroat are harvested in the salt-water area, the majority are produced in waters of adjacent basins and have been considered when calculating production for those habitats.

The actual number of steelhead and searun cutthroat produced is unknown, but comparative figures indicate their respective totals at approximately 500 adults. It is assumed that potential natural production could be increased slightly.

Resident Fish—For practical purposes, resident stream fish production has already been considered. The stream areas are so few that the present and potential resident and anadromous fish production is inseparable. Special consideration is given, including a restrictive fishing regulation, to protect those stream residents utilizing the waters flowing into or out of Cascade and Mountain Lakes.

Because lake, pond, and reservoir habitats are planted so frequently and managed for salmonids and/or spiny rays, actual production figures are indicated in harvest data. Certain lakes' total harvest varies from one season to another and may vary from less than 10 to nearly 100 pounds per surface acre annually. Potential production could be substantial.

Propagation

Anadromous and resident fish are not propagated within this Basin by State or Federal agencies. Game fish stocking requirements are fulfilled entirely from the production of facilities in other generally adjacent basins (data appear in Area chapter). Fingerling-sized rainbow and brook trout are stocked in suitable Island habitat; likewise, kokanee are planted as eyed eggs and swim-up fry.

Recent surveys and catch records indicate that artificial propagation provides approximately 98 percent of all resident trout and kokanee caught by sportsmen in Basin waters each year.

Twelve farm fish ponds receive plants of hatchery game fish every two to three years from private facilities.

Harvest

Existing Harvest—Because of limited natural production, few salmon originating from the San Juan Islands contribute to commercial or sport harvest. However, extensive salmon harvest does occur within Island waters. This is mainly due to the Islands' expanse of marine waters; their location at the head of Puget Sound and as a waterway to several major fish producing streams in Washington and British Columbia; and their proximity to major fish landing ports.

Popular commercial fishing grounds for gill netters and purse seiners are located off Lime Kiln Light, Cattle Point, Iceberg Point, and in the Salmon Banks, Upright Channel, President Channel, and west Rosario Strait.

Salmon sport fishing within the marine waters is also very intense, as indicated by the more than 79,000 angler-days logged in the vicinity in 1965. The yearlong abundance and availability of salmon in the semi-protected waters account for this heavy fishery. Also, throughout much of the year, the inlets and bays serve as a vacation paradise for small boat enthusiasts. Salmon fishing, coupled with the scenic splendor of the Islands and waterways, serve as the principal attractions. Favorite sport angling sites include William Point, Limestone Point, East Sound, Lopez Pass, Lawrence Point, Sares Head, Open Bay, North Bay, and Obstruction Pass. Because of the fishery, many resorts and tourist-oriented businesses thrive in the area, serving as a major source of revenue in some locations.

Surveys indicate that virtually no steelhead are caught within this basin and that natural production is not considered to have provided a significant part of this or any other basin's harvest.

These surveys also indicate that very little effort is spent in the pursuit of searun cutthroat in salt water.

On the basis of questionnaire survey data (1966), 9,600 angler-days were spent fishing in the lakes, ponds, and reservoirs, and a total harvest of 37,000 trout and 3,000 other game fish realized. The most significant stream environments are closed to fishing and all other stream environments have negligible production. Therefore, stream fishing effort was not determined.

From the standpoint of game fish harvest, angler pressure is not high in the San Juans. The cost and effort to reach them strictly for trout or spiny-ray fishing are considered excessive by nonresidents. Consequently, most of the harvest is by Island residents; spiny-rayed species are under-harvested.

Potential Harvest—Potential harvest of the various salmon species is unknown.

Potential harvest of natural steelhead production is difficult to predict, since artificial propagation and wild production from adjoining basins provide nearly all of the fish caught. Production from other basins includes nearly all of the existing harvest known to exist for this Basin. Similar circumstances prevail for searun cutthroat and no estimates of increased production or harvest potential are shown.

Resident salmonid production, and therefore harvest in streams, is not expected to change significantly. This, of course, considers the same exclusions noted for anadromous fish and applies to areas both upstream and downstream from migration barriers. Potential harvest of resident salmonids in lakes, ponds, and reservoirs could be increased substantially.

Factors Limiting Production Other Than Harvest

Since the stream reaches hold relatively limited value for fish production, most consideration of alterable limiting factors will be restricted to lakes supporting resident fish.

Detrimental Streamflow—Within the limited stream reaches, the principal factor restricting both anadromous and resident fish populations is the lack of substantial flow. The majority of these streams go dry during the summer. Fish populations in streams maintaining a year round flow suffer extensively from reduced flows, which reduces available rearing area and limits the production capacity. Many of the intermittent streams hold limited spawning potential, particularly for anadromous species not requiring extended rearing periods. However, most of these streams exhibit seasonal flows too low for access by spawners.

Poor Water Quality—Several of the more permanent streams have shallow gradient, slow-moving watercourses which exhibit unsuitable temperature and reduced oxygen conditions during warmer periods.

Physical Barriers—The two most important streamcourses are Cascade Creek and Gerrard Creek (Trout Lake outlet) on Orcas and San Juan Islands, respectively. Extensive water development for hydroelectric power resort operation or domestic use results in both streams going dry or nearly dry during the low flow periods.

Conflicting Watershed Developments—Vacation cabin and permanent home construction is increasing. However, because the bulk of such construction is oriented to and near the salt-water shoreline, this type of development is not as serious to fish resources as in other basins. Logging and farming in the past have contributed to diminishing stream productivity.

Limited Spawning and Rearing Areas—Intermittent or low streamflows, mostly a product of natural conditions, produce limited spawning and rearing habitat.

Competition and Predation—Anadromous and more abundant resident salmonids are preyed upon by sticklebacks. Trout and spiny-rayed species also prey to varying degrees upon these two groups. Of the undesirable fishes, the carp is most widely distributed. Under certain conditions, the spiny rays overrun a particular environment and drastically suppress other game-fish populations. Certain birds and mammals also prey on salmonids.

Beneficial Developments

Accomplished and Continuing—Enhancement projects for anadromous fish have been extremely limited, since most accessible streams support only very limited fish populations. This resource has been suitably maintained by providing access to certain bodies of water and by a limited lake rehabilitation program (Figure 14-2). These management measures are concerned primarily with increasing game fish harvest and production.

Because streamflows are so vital, restrictive fishing regulations have been implemented to protect populations of spawning fish in certain lake inlets and outlets. In addition, gravel spawning areas have been designated and eyed-egg plantings, plus supplemental water diversions into short-term fry rearing areas, are utilized. These situations are presently exclusive to the Cascade and Mountain Lakes drainages.

Under State law, the construction criteria for some 250 farm ponds on the Islands have been reviewed and altered when necessary to better serve the fish needs. State laws also provide additional protection to fish by requiring screen devices at each water diversion point; and by requiring review of water withdrawals which resulted in placing withdrawal restrictions on Sportsmans Lake.

Of the Island lakes, only Hummel and Egg have been chemically rehabilitated for trout management.

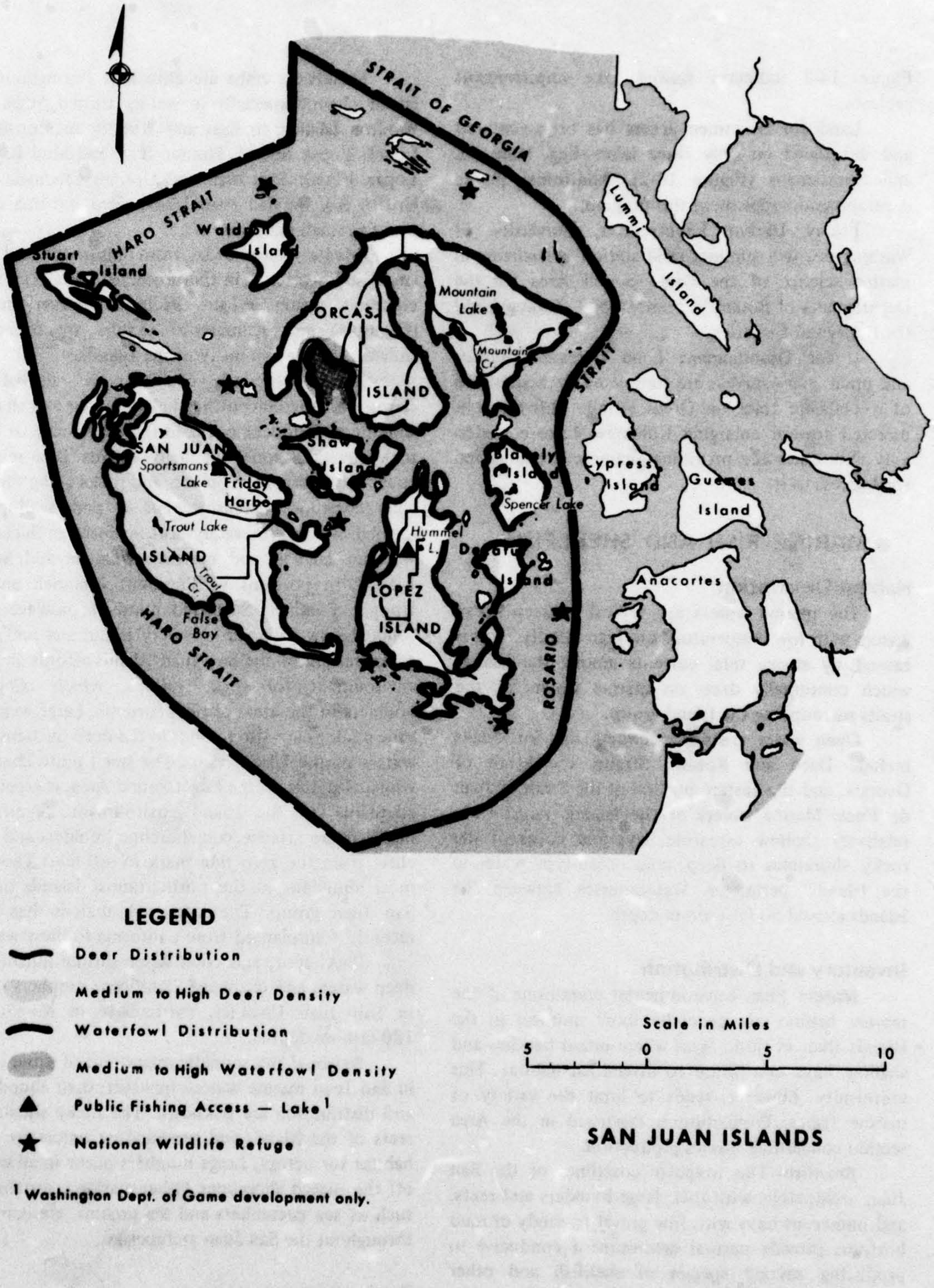


FIGURE 14-2. Wildlife distribution, and fish and wildlife developments (1965)

Figure 14-2 indicates various lake improvement projects.

Land for fishermen access has been acquired and developed on only three lakes–Egg, Hummel, and Sportsmans (Figure 14-2). Additional public developments supplement this program.

Friday Harbor Laboratories, University of Washington, is a summer field station specializing in marine science of the Puget Sound Area for the Departments of Botany, Oceanography, Zoology, and the College of Fisheries.

Under Development–Land purchase options and preliminary surveys are completed for acquisition of a 160-acre tract on Orcas Island. This effort is directed toward enlarging Killebrew Lake considerably with dikes and providing guaranteed fishing and road access to it.

MARINE FISH AND SHELLFISH

Habitat Description

The marine waters are typical of deep ocean waters with low temperature and high salinity. This is caused by strong tidal currents among the Islands which continually draw on marine waters of the straits surrounding the Island group.

Open water areas surrounding the San Juans include Haro and Rosario Straits, the Strait of Georgia, and the eastern portion of the Strait of Juan de Fuca. Marine waters of the Islands range from relatively shallow estuarine bays and coves of the rocky shorelines to deep, cold ocean-type water in the Islands' perimeter. Watercourses between the Islands exceed 50 fathoms in depth.

Inventory and Distribution

Marine Fish–Environmental conditions of the marine habitat are generally more uniform in the Islands than in those areas where broad beaches and shallow bays contribute to diversified habitat. This uniformity, however, tends to limit the variety of marine fishes. Population is discussed in the Area section concerning species production.

Shellfish–The irregular coastlines of the San Juan archipelago with their large boulders and reefs, and numerous bays with fine gravel to sandy or mud bottoms provide natural environment conducive to producing myriad species of shellfish and other marine invertebrates in vast abundance. The prime condition of the shellfish harvested from this area attests to the fertile waters in the straits.

Dungeness crabs are abundant throughout the Island chain, especially in waters around Sucia and Waldron Islands; in East and West Sounds on Orcas Island; Lopez Sound, Hunter Bay, and Mud Bay on Lopez Island; San Juan and Upright Channels; and Griffin Bay on San Juan Island. Red and box crabs occur in small numbers.

Private oyster beds, from imported seed, are small and scattered in the protected bays. The most common oyster is the Pacific, however, native (Olympia) and Kumamoto oysters are found in isolated colonies on many of the Islands.

Butter, littleneck, cockle, horse, and Manila clams are abundant in the sheltered bays and shallow shorelines. Piddocks occur in the heavy clay or solid rock intertidal zones on many Islands. Blue mussels cover the enormous boulders and rocks along the San Juan coastline. Extensive beds of pink scallop are located on the firm, sandy bottom between Sucia and Waldron Islands, and between Waldron and Stuart Islands; in portions of President Channel; and in Upright Channel. Scattered numbers, however, are found below low tide on every Island and reef. The rocky nature of the San Juan Islands affords an ideal environment for rock scallops, which cling to boulders in the areas of tidal currents. Large weathervane scallops are also present in the deep nutrient-rich waters of the Island chain. The small pinto abalone, which is native to the Puget Sound Area, is especially adaptable to the Island environment. Significant numbers are attached on shoreline boulders and rock cliffs from the zero tide mark to -60 feet. They are most abundant in the northernmost Islands of the San Juan group. The large red abalone has been recently transplanted from California to these waters.

Pink, spot, and coon stripe shrimp inhabit the deep waters and channels. Significant numbers occur in San Juan Channel, particularly in the 70- to 120-fathom depths.

Seasonal and sporadic migrations of squid occur in San Juan marine waters; however, their abundance and distribution are unknown. The rocky shoals and reefs of the Islands and surrounding waters are ideal habitat for octopi. Large numbers occur in all waters off the rugged shorelines. Other marine invertebrates, such as sea cucumbers and sea urchins, are common throughout the San Juan archipelago.

Production

Information is not available concerning production of marine fish and shellfish.

Propagation

Marine fishes are not propagated within Island waters.

Shellfish culture programs have been limited, mainly because existing stocks are maintained naturally at a high abundance level. The success of the red abalone introduction program, being conducted by the State, is undetermined. A few relatively small privately-operated oyster culture programs exist on San Juan and Orcas Islands; however, the beds occupy relatively little of the available tidelands.

Harvest

Marine Fish—Marine fishes are harvested by both commercial and sport fisheries. Commercial vessels utilizing these waters operate out of the major ports from Blaine south to Seattle. The smaller sport fishing boats operate from the many resorts and boathouses located throughout the Islands as well as from private and rental facilities in other basins.

The commercial harvest of marine fish is conducted principally by otter trawl vessels; however, a few trolling boats also fish these waters, particularly in the northern San Juan area. Popular sites utilized by the trawlers include western Rosario Strait, San Juan Channel, Saratoga Passage, and waters off Sucia Island and West Beach. Major landings are made at Blaine, Bellingham, Anacortes, and Everett, with a few vessels hauling their catch to Seattle. The principal marine fishes taken within these waters include lingcod, Pacific cod, sole, and rockfish.

The commercial herring fishery is highly significant. Large seiners, operating mainly out of Bellingham, fish select waters in the San Juan area. Catches are landed at Anacortes, Bellingham, or Blaine and are usually processed locally.

Considerable effort is expended in the sport harvest of marine fishes throughout the Islands, as reflected by the nearly 14,800 angler-days recorded in 1965. Hook and line is the principal method of angling; however, underwater spear fishing is becoming more popular. Clear water and highly diversified marine habitat with an abundance of marine fishes have attracted divers from considerable distances. Lingcod and rockfish are the principal fish sought by sport anglers and divers (Photo 14-1).

Harvest potential for marine fishes is unknown.

Shellfish—Commercial and sport harvest of shellfish is considered moderate to heavy, with principal emphasis on crabs, oysters, and hardshell clams.

PHOTO 14-1. Spear fishing, a fast growing and rewarding activity. (Washington Department of Commerce and Economic Development photo)

There is a moderate commercial fishery for Dungeness crab. A few privately-owned clam farms and oyster culture beaches are operated, but their commercial sales are relatively small. Octopi, which are abundant in the San Juan area, are occasionally landed by otter trawl vessels; however, very little effort is directed specifically for this species.

Sport harvest of shellfish is concentrated mainly on crabs, hardshell clams, and oysters, with a few native abalone and some octopi also taken. Major sport harvest occurs on virtually all public beach areas, especially those easily accessible by boat. Average annual man-days of use attributed to shellfish sport harvest are 11,000.

Harvest potential for shellfish is unknown.

Factors Limiting Production Other Than Harvest

Marine Fish—The extensive variety and large populations of marine fish inhabiting the San Juan Islands are influenced and regulated by natural environmental factors, such as bottom strata, depth, water temperature, tidal action, food, and salinity. Due to the distance of the Islands from the mainland, the Fraser, Nooksack, and Samish Rivers only slightly reduce the dense saline quality of their marine waters. Under certain wind and tide conditions, pollutants are carried by this fresh water and deposited in the San Juans area, thus adversely affecting marine environment of the Islands.

Shellfish–Ships or barges moving through the Islands' marine waters occasionally cause pollution by pumping bilges or discharging toxic materials. At present, shoreline land developments cause only minor damage to beach areas; however, increased developments can present a serious pollution problem to shellfish.

Periodic increases in numbers of starfish, sand dollar, moon snail, and ghost shrimp populations often inflict heavy damage upon shellfish, particularly on clams and oysters. Oyster drill colonies occasionally inhabit specific areas of good production, destroying large quantities of this highly prized mollusc. Also, large increases in the numbers of red crab occasionally produce severe declines in other shellfish stocks.

Beneficial Developments

There are no marine fish enhancement programs. The only beneficial shellfish developments are the small privately-managed oyster production areas, and the limited plantings of lobster and abalone by the State. In privately-managed "cultured" beach areas, the aforementioned limiting factors are generally controlled to ensure maximum production. However, no attempts are made to control such factors over the many miles of natural beaches.

FUTURE NEEDS—FISH

DEMOGRAPHIC AND RESOURCE ASPECTS

The 1963 population census ranks the San Juan Islands with only 2,600 people as the smallest Basin within the Puget Sound Area. Population projections indicate increases to 2,800, 3,700, and 5,100 in 1980, 2000, and 2020, respectively. Any increase in population of the Islands is expected to be associated with outdoor recreation development rather than with business or industrial expansion. Summer-recreation home building, plus some year round residence construction will occur on many of the larger Islands and will be concentrated adjacent to beaches and tidelands.

The proximity of the San Juan Islands to the heavily populated metropolitan centers, along with the natural beauty of the area, will continue to promote this Basin for outdoor recreation. The development of more and better boat facilities will draw increased numbers of sport fishermen to these already popular waters. With an expected upsurge in demand for outdoor recreation, associated with increased population and more leisure time, it is anticipated that sport fishing pressure will accelerate at a rate much greater than that of most other Puget Sound basins.

RESOURCE DEMANDS AND NEEDS

The marine waters surrounding this archipelago support a very heavy commercial fishery for both salmon and marine fishes. Only moderate quantities of shellfish are harvested commercially from local beaches. The Islands' streams produce virtually no anadromous fish.

Salt-water sport fishing for salmon and marine fishes occurs throughout the marine sector, but principally in and around the interisland watercourses. Many of these favorite fishing locations are protected from wind and turbulent water conditions so they are available to fishermen year round. The Islands are located in the path of salmon destined for most of the major Puget Sound drainages, as well as fish moving north toward the large Canadian river systems. The local waters are inhabited by an abundance of natural fish food organisms so the area is used by large numbers of feeding, but as yet immature, salmon. These particular fish are sought by increasingly large numbers of sport fishermen, particularly during the late fall and winter.

Based on county use values, approximately 75 percent of all Basin harvest and 65 percent of Basin utilization of game fish other than steelhead are by people from outside the Basin.

Future game fish demands will stem primarily from the Island residents. The game fish resources are located almost entirely in lakes. It is estimated that, by 1980, these lakes must provide an additional annual harvest of 24,800 trout and 2,100 game fish of other species, or an increase of 50 fish per surface acre. Table 14-2 indicates present and projected demands and needs for game fish in angler-days.

TABLE 14-2. Present and projected sport fishermen use (game fish) on San Juan Islands

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	9.6
1980	6.4	16.0
2000	9.2	25.2
2020	15.1	40.3

PROBLEMS AND CONFLICTS

Major problems and conflicts related to conserving, enhancing, and more effectively utilizing the fish and shellfish of the San Juan Islands are indicated below. In addition, general problems and conflicts discussed in the Area chapter apply to this Basin.

Conflicting Land and Water Uses

(1) Insufficient land area and boat facilities are available for public use. This type of development will undoubtedly conflict with private residents' use of the area.

(2) Withdrawal of additional surface waters will further reduce fish habitat. Fresh-water fish habitat is limited and further reduction in area or quality would preclude satisfaction of future fishing demands. Increased ground water withdrawal would also affect certain surface water areas.

(3) Alteration of existing streamflows will further alter downstream fish rearing and recreation potential.

(4) Development of residential areas could cause pollution of fresh- and salt-water areas. Such developments also restrict or eliminate public access to fishing lakes.

Poor Water Quality

(1) Although water pollution is not now a problem in the Basin, any increase in population without adoption of sufficient sewage collection and treatment facilities will create undesirable conditions.

Social and Psychological Considerations

(1) Opposition is expected to changes in management practices that would restrict such operations as pier and bulkhead development.

(2) Residential construction adjacent to the beach areas will continue to alter natural environments, and reduce available fish and shellfish habitat.

MEANS TO SATISFY NEEDS—FISH

To satisfy the expected large increase in demand for fish and shellfish will require activation of potential developments on the San Juan Islands. The relatively few such developments should be designed primarily to meet ever increasing demands for recreation opportunities associated with fish and shellfish harvest.

ANADROMOUS FISH

The San Juan Islands are an extremely marginal production area for anadromous fish. Only one unnamed stream near Olga on Orcas Island is definitely known to sustain anadromous salmonids. Other intermittent streams which may have supported small runs of chum salmon have been eliminated as production areas due to the need for domestic water supplies.

As in the Whidbey-Camano Islands, streamflows are insufficient to maintain anadromous fish populations. If present runs are to be maintained or improved, streamflows must be maintained at naturally occurring levels or must be augmented. Such flows should be considered jointly with associated intrastate water quality standards, being developed, to meet necessary requirements for fish. Lake and pond levels should be maintained at existing levels.

The implementation of water quality controls to maintain the good to excellent fish habitat would be a major program to benefit anadromous fish, particularly species using the Islands' marine waters for rearing and transportation. Salmon production could be enhanced through developments such as eyed-egg incubation facilities or controlled brackish or marine water rearing impoundments, but such facilities are not under consideration at this time.

To meet increased recreation demands for sport harvest of salmon will require development of marine water access, and small boat, recreation equipment, and tourist facilities. Considerable opportunity exists for such developments in many areas of the Islands.

MARINE FISH

Many of the beneficial developments required for anadromous fish would also assure benefits to extensive marine fish populations. Creation of new habitat for marine fishes through selective placement of rock jetties or submerged "reefs" could also be highly beneficial. These could be constructed in conjunction with development of new fishing areas.

SHELLFISH

Implementation of water quality controls would protect and enhance shellfish production. Also, shellfish would be benefited by measures to curtail tideland attrition through property development and spoil disposal, thus protecting against losses of valuable beach areas throughout the Islands. Potential projects for increasing shellfish populations might also include installation of beach breakwaters, and the study and implementation of techniques to control natural predators. Expanded use of raft and rack culture methods would increase oyster production in these nutrient-rich marine waters.

SUMMARY—ANADROMOUS FOOD FISH, MARINE FISH, AND SHELLFISH

The San Juan Islands offer few opportunities for projects and programs to maintain or increase anadromous fish, marine fish, and shellfish production. However, a number of opportunities exist for development of facilities to meet increased fish-associated recreation demands and promote better use of existing stocks and habitat. Major proposals, with a general indication of priority, are categorized in Table 14-3. They have not been evaluated, nor have costs been assigned. These projects and programs will be initiated when demand for salmon, marine fish, and shellfish dictates, and effective, economical techniques for enhancing these resources in San Juan Islands' habitat are developed.

GAME FISH

The following general and specific projects and programs will conserve and enhance game fish resources, and some will benefit other species as well. Incidental benefits from these projects and programs have not been evaluated.

General Programs

Stream spawning areas for resident game fish are extremely limited and of little value for sustaining these populations. This is due primarily to the use of lake outlet water for domestic and power generation purposes. Any additional diversion or withdrawal from Island lakes would reduce fish numbers proportionately. Lake fishing for trout is provided by annual liberations. Spiny-rayed species are lake spawners and are self-maintained.

The prime value of the San Juan Islands is for outdoor recreation. The Islands should be zoned against industrial development and planning should be developed to provide for the following: (1) a balanced development of homesites against need for salt-water, fresh-water, and land-based recreation; (2) preservation of water quality for public use; (3)

TABLE 14-3. Potential developments for production and use of fish and shellfish, San Juan Islands

Beneficial Development	Priority: Prior to 1980	Priority: Prior to 2000	Priority: Prior to 2020
(1) Maintenance and Enhancement			
Improve public beaches for clam production		X	
Create marine fish production and fishing areas	X	X	X
Develop artificial salmon production facilities		X	X
(2) Acquisition			
Determine and evaluate potential fish and shellfish propagation sites	X		
Acquire and develop 10 salt-water public access sites	X		
Acquire and develop public access to and parking facilities at State-owned beaches		X	
Acquire 5 miles of additional public beach		X	
Purchase suitable land for fish and shellfish propagation	X	X	
Procure land for public access development	X	X	
(3) Management and Administration			
Implement controls against excessive removal of stream water	X		
Promote conservation measures for all fisheries	X		
Locate, survey, and mark boundaries of State-owned tidelands outside corporate city limits and reserve such lands for public use except as required by specific circumstances	X		
Develop subtidal park for skin divers		X	
Implement fishery management regulation changes	X	X	X
Promote fish and shellfish culture programs	X	X	X
(4) Coordination and Legislation			
Coordinate all operations and activities affecting streams and salt-water areas	X	X	X
Implement necessary water quality controls	X	X	X
(5) Additional Studies			
Continue inventory of shellfish stocks and recreational use of tidelands	X		
Shellfish predator control	X	X	
Marine fish propagation and rearing		X	X

maintenance of lake environments against further water diversion; and (4) development of an irrigation and domestic water supply from the mainland or desalinated water from the Sound.

Salt- and fresh-water fishing should be improved to justify the protection of water quality.

Public access to salt- and all fresh-water recreation areas should be acquired to insure optimum use.

Projects and Programs Proposed for Completion by 1980

(1) Public access and boat launching areas are suggested for Orcas Island (2) and one each at Mitchell Bay, Deadman Bay, Turn Island, and Spencer Spit on Lopez Island. Ultimately, all significant lakes and key portions of streams, estuaries, and salt-water areas should have assured public fishing access.

(2) The lack of sustained flowing surface water precludes reservoir construction. Some farm ponds could be enlarged. Construction of estuarine ponds in bays is possible, but such installations must be accorded careful consideration. However, such construction, for rearing anadromous game fish, is suggested at Buck Bay and Deer Harbor on Orcas Island. On the Trout Lake outlet into False Bay on San Juan Island, a dam (Sec. 17, T35N, R3W, W.M.) could be constructed to impound 40 or more surface acres of water for game fish management.

(3) All lakes outside established State parks should be acquired, developed, and intensively managed for game fish production and fishermen use.

(4) Propagation sites are recommended with storage reservoir projects. These would be semi-artificial rearing areas in more or less estuarine environment. Development of such "fish-farm" lake facilities would significantly enhance the anadromous game fish resource of this Basin.

(5) New fertilization techniques to increase fish production in lakes should be developed.

(6) Fish disease and parasite control programs should be developed for lakes to permit increased survival of game fish populations.

Table 14-4 indicates estimated annual benefits and costs of specific projects and programs proposed for the San Juan Islands to satisfy needs for game fish prior to 1980. These, in a sense, are alternatives, and other projects and programs listed above may be substituted as priorities for development shift. The proposed salt-water access areas will also promote better use of salmon, marine fish, and shellfish, but this use has not been evaluated. Proposals for years subsequent to 1980, which may include some projects and programs listed above, also have not been evaluated, nor have costs been estimated; however, a listing of proposals for the 1980-2000 and 2000-2020 periods follows the table.

TABLE 14-4. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for game fish on San Juan Islands, pre-1980

	Annual Benefits		Costs	
Project or Program	Angler-Days	Value	Capital	O&M (Annual)
Lakes				
Acquire and develop 1 lake	3,000	$ 6,000	$120,000	$ 500
Develop lake fertilization techniques	1,900	3,800	10,000	1,000
Subtotals	4,900	$ 9,800	$130,000	$ 1,500
Streams				
Develop 3 estuarine rearing ponds for searun cutthroat	8,000	$24,000	$100,000	$15,000
Subtotals	8,000	$24,000	$100,000	$15,000
Salt Water				
Acquire and develop public access, 6 areas	1/	1/	$210,000	$ 1,000
Subtotals	--	--	$210,000	$ 1,000
Totals	12,900	$33,800	$440,000	$17,500

1/ Benefits widely distributed between marine fish, shellfish, salmon, hunting, boating, and general outdoor recreation.

Projects and Programs, 1980-2000

(1) Complete programs and projects not completed by 1980.

(2) Continue purchase of lake and salt-water public access and fish rearing areas.

(3) Develop new projects and programs as required.

(4) Continue research in fish rearing under estuarine conditions.

(5) Investigate production controls for spiny-rayed game fish and stimulate public interest in their harvest.

Projects and Programs, 2000-2020

(1) Complete programs and projects not completed by 2000.

(2) Develop new projects and programs as required.

(3) Continue fisheries research.

PRESENT STATUS—WILDLIFE

INTRODUCTION

The land areas of the San Juans are composed of 473 individual islands (Figure 14-1). These range in size from offshore rocks to Orcas Island, the largest of the group. Land forms among the Islands vary from glacial plains on Lopez Island to irregular, rocky nobs or mountain peaks on Orcas Island.

The climate is mild with little snow except, occasionally, on Mount Constitution on Orcas Island. Climatological variations influence wildlife abundance and distribution.

The Islands' vegetation varies from numerous natural grass-shrub clearings to near-typical stands of Douglas fir. Numerous small land ownerships and attendant land management practices increase the diversity of vegetative cover. This diverse habitat creates a desirable food and cover relationship for wildlife.

BIG GAME

Inventory and Distribution

The black-tailed deer is the only big-game species inhabiting the Islands. The mild climate and diversified habitat are conducive to production of very high deer numbers. Agricultural damage by these animals is a serious problem on the majority of the larger Islands.

Deer inhabit the majority of the San Juan Islands (Figure 14-2). Orcas, San Juan, and Lopez Islands have the bulk of the land area and the majority of the deer. The total population of these animals is estimated at 6,700.

Limiting Factors

Deer numbers on the Islands, as in all of the Puget Sound Area, are limited by availability of food. However, agricultural development to date has not seriously decreased the Islands' potential for production of these animals. Competition for food with domestic animals, such as sheep, restricts deer numbers. Feral goats also compete with deer on Orcas Island.

The Islands' scenic beauty and water-oriented recreation potential have been "discovered," and shorelands and hillsides, which provide access to or a view of the Sound, are being developed rapidly. This activity is reducing the deer habitat at an increasing rate.

Production

As indicated, diverse habitat providing essential browse species, and the mild climate of the San Juan Island group, are favorable for deer. Productivity is high due to these environmental conditions and because a high percentage of the increase is harvested annually. Individual animals in a heavily-cropped wildlife population produce more young which, in turn, have a high rate of survival. Present data indicate the annual deer production is approximately 2,000 animals.

Harvest

Liberal hunting seasons have been established in an effort to control deer damage to agricultural crops and ornamental shrubs. The annual harvest during the past five years (1961-1965) averaged 1,040 animals. In 1965, 1,520 deer were taken by hunters—the highest number ever recorded in San Juan County. The total hunting effort represents approximately 20,800 hunter-days annually. Lack of rapid, convenient, and inexpensive transportation to the rather remote San Juan Island group restricts hunter use of the resource. Most mainland hunters travel by ferry, while others use private boats or aircraft to reach this Island hunting area.

Propagation

Artificial propagation is not applicable to big-game management.

Beneficial Developments

Hunting seasons have been liberalized in recent years, allowing greater utilization of the resource.

UPLAND GAME

Ring-necked pheasant and two species of rabbits, the cottontail and the feral "San Juan" rabbit, are the principal upland game found on the Islands. Of lesser importance are quail, chukar, red-legged, gray, and bamboo partridge. All of these species were introduced. Band-tailed pigeon, a native species, also occur on the Islands.

Inventory and Distribution

Although the cottontail occurs on many of the Islands, the "San Juan" rabbit, a feral domestic, is far more numerous. San Juan Island, in particular Cattle Point, has the highest concentration of these animals, although all the large Islands have high populations. The "San Juan" rabbit originated from several domestic varieties which escaped or were purposely released during the earlier years of the century. This feral rabbit is a nongame animal, but is discussed here because it contributes significantly to the sport of hunting in San Juan County.

A wild population of 2,000 pheasants is estimated. This natural production (Figure 14-1) is supplemented annually by plants of game-farm-reared birds. The resident quail population is estimated at approximately 2,000 birds which inhabit primarily the three largest Islands: Orcas, San Juan, and Lopez. Chukar, and red-legged and bamboo partridge were introduced in recent years; however, the success of these introductions is unknown. The populations of band-tailed pigeon and rabbit were not determined.

Limiting Factors

All of the exotic upland-game species found on the Islands are dependent on and are influenced by agriculture. Pheasants, quail, and partridge, as well as cottontail and "San Juan" rabbits, are directly associated with edge and fence-row cover created by diversified farming. Much land, which has been farmed in the past, is being diverted to cabin and vacation home lots. This reduction in agricultural acreage has reduced the potential of the area for upland game. The Area chapter, Upland Game, describes band-tailed pigeon limiting factors.

The reduction in numbers of "San Juan" rabbits is apparently the result of a combination of factors which may also be influencing other upland game less dramatically. These factors include an unauthorized introduction of red fox in recent years, and reduction in farming intensity and farmland acreage. Prior to the introduction of fox, predation was negligible, as raccoon and mink were the only native ground predators. Rabbit populations have declined in areas which once were pasture land, but have now developed a rank growth of undesirable grass reducing the availability of required succulent forbs and grasses. Due to the magnitude of the population involved, an undetermined number of "San Juan" rabbits are poisoned annually by farmers to alleviate crop damage.

Production

During peak rabbit population years, the production of "San Juan" rabbits is phenomenal.

An average yearly production of 1,000 to 1,500 wild ring-necks is estimated. Quail produced each year total approximately 1,500. The wild production of the many newly-introduced species which include chukar, and red-legged and bamboo partridge was not determined. Production of gray partridge, band-tailed pigeon, and cottontail is undetermined.

Harvest

State studies in 1960 and 1961 revealed that the total number of rabbits taken annually by hunting and netting on the Islands at that time exceeded 100,000. "San Juan" rabbits comprised the bulk of this total. According to 1965 harvest data, 45,000 rabbits were bagged in San Juan County, indicating the decline in "San Juan" rabbits during this five-year period.

Pheasant harvest on the Islands tends to fluctuate, but has averaged slightly over 700 birds annually.

A total of 200 quail and 800 band-tailed pigeon is bagged each year. Two private game farms on San Juan Island maintain licensed shooting preserves where pheasant and quail are released and hunted on the premises for a fee.

Average annual hunter-days use devoted to harvest of upland game on San Juan Islands is 1,000 (pheasant); 150 (quail); 25,000 (rabbit); and 670 (band-tailed pigeon). Dove hunter effort was not determined.

Propagation

The wild pheasant stock established by releases in the 1930's has been supplemented by annual plants averaging 1,150 birds. The other exotic game birds of the Islands, with the exception of quail and gray partridge, have only recently been planted. Numbers of propagated upland-game birds released during the period 1961-1965 are shown in Table 14-5.

All of the game farm birds released in San Juan County are from facilities located elsewhere. The pheasants and red-legged partridges are usually produced at the Whidbey Island Game Farm (Whidbey-Camano Islands).

The two private game farms on San Juan Island raise pheasant and quail, and maintain licensed shooting preserves.

Beneficial Developments

Beneficial developments include liberalized hunting seasons and annual game bird releases. Information concerning exotic species introduction appears in the Area chapter, Upland Game. Private shooting reserves are considered beneficial as additional hunting is provided by private enterprise, which supplements the hunting wild game provides.

The Matia, Jones, and San Juan National Wildlife Refuges (within basin boundaries), administered by the Bureau of Sport Fisheries and Wildlife, provide Island habitat used by band-tailed pigeon.

Conservation practices applied by private landowners to Island agricultural lands of direct benefit to upland game include 50 acres of wildlife habitat development and 10,000 acres of wildlife habitat preservation.

FUR ANIMALS

Fresh-water areas are limited; therefore, those fur bearers which are dependent on this type of habitat, namely muskrat and beaver, are restricted in number. Mink, the other top-valued species, utilize salt-water shoreline. Other fur animals include river otter, weasel, raccoon, and red fox.

Inventory and Distribution

Most of the fur animals occur on the three largest Islands: San Juan, Lopez, and Orcas. Certain fur bearers inhabit the smaller Islands, but their populations are small.

Muskrat are among the most commonly trapped species, and a population of approximately 2,000 is indicated by trapper catch records. Most of the muskrat inhabit the poorly drained marsh areas on San Juan, Lopez, and Shaw Islands and occur in less concentrated numbers on Orcas Island. Some of the tidal marshes are not suitable for muskrat because of high salinity. Mink inhabit the same fresh-water areas as muskrat and also frequent the salt-water shoreline. A population of 500 to 700 mink is estimated.

River otter are numerous, frequenting primarily the salt-water areas. Since otter fur is quite valuable, this fur bearer is the object of considerable attention by trappers. Only a small number of beaver inhabit the San Juan Islands, primarily Orcas. Raccoon and fox are possibly the most widespread of the fur animals.

TABLE 14-5. Upland game bird releases, San Juan Islands, 1961-1965

Species	Year 1961	1962	1963	1964	1965	Totals
Ring-necked pheasant	1,524	1,250	900	850	1,260	5,764
Red-legged partridge	125	200	371	400	--	1,096
Bamboo partridge	--	--	--	105	--	105
Gray partridge	--	--	--	--	100	100

Limiting Factors

Habitat is limited for those species requiring fresh water. These areas are being further reduced by summer home development on the shores of lakes and ponds. Such developments often necessitate the removal of vegetation bordering water areas and drainage of marsh lands.

Production

Present population levels of the most valuable fur animals indicate that 1,500 muskrat and 300 mink are available for the fall trapping seasons. Beaver are few in number and the production of river otter is undetermined. Varying numbers of the other species are produced.

Harvest

Trapping intensity is uneven on the Islands. Some fur-animal populations are harvested at near maximum rate, while others are virtually untrapped due to difficult access. Many mink occur along salt-water areas, but produce poor quality fur and, consequently, are not trapped intensively. Harvest records indicate the presence of individual fur-animal species, but economics prohibit utilizing the resource on all Islands equally. Five years' trapping records (1961 through 1966) show the following average annual catches: 225 (muskrat); 125 (mink); 140 (raccoon); 15 (river otter); and 6 (red fox). Raccoon and fox are not trapped extensively due to low pelt prices. San Juan is one of the few counties of the State which reports no beaver harvested since 1963 legislation authorized trapping of this species by licensed trappers. The overall value of the fur take is estimated at $2,200 annually.

Propagation

Fur animals are not artificially propagated on the Islands.

Beneficial Developments

A number of landowners have constructed farm ponds to impound runoff, as fresh water is a limited resource on the Islands. These developments are a significant contribution for muskrat, mink, and in rare instances, beaver. Unfortunately, the loss of habitat through surface drainage, clearing, and diking of salt-water marsh areas and summer home development exceeds the addition of area provided by these artificial ponds.

Other beneficial developments are described in the Area chapter, Fur Animals.

WATERFOWL

The migratory waterfowl which inhabit the San Juan Islands are primarily transitory, using the numerous Islands and protected salt-water areas only seasonally. Migrants, primarily diving ducks, use the salt-water areas in fall, winter, and early spring as feeding and resting area. Some of the more popular hunting species, including mallard, pintail, widgeon, and teal, are also present.

Inventory and Distribution

Wintering populations of migratory waterfowl are determined during a January survey. The following number and species were observed in the Basin during the 1965 survey: 12,880 (eider and scoter); 5,600 (bufflehead); 3,060 (scaup); 1,654 (mallard); 1,360 (goldeneye); 200 (oldsquaw); and 130 (merganser). An additional 131 miscellaneous ducks, which included pintail, shoveler, and widgeon, were counted for an Island total of 25,015. During previous years, canvasback, wood duck, ruddy duck, and whistling swan have been observed in limited numbers. Geese are seldom observed during the annual survey; but as noted under Harvest, a few black brant are reported taken on the Islands each year. Figure 14-2 presents the medium to high waterfowl density area.

Limiting Factors

Limited breeding habitat such as fresh-water marshes, lakes, and streams restricts the number of waterfowl using the Islands during the breeding period. The limited amount of agriculture, particularly grain crops, and shortage of fresh-water areas, regulate the number of dabbling ducks such as mallard, pintail, teal, and widgeon which winter in the area.

Production

The San Juan Islands support only three types of nesting and brood habitat used by waterfowl. These are diked sloughs and ditches, shallow lakes, and meandering streams with the bulk of production occurring on the shallow lakes. Average annual production is 650 waterfowl.

Harvest

Because of the relative inaccessibility of the Islands and the small number of duck species favored by hunters, they support a minor annual harvest. They attract few nonlocal waterfowl hunters, because better and more accessible waterfowl hunting is available closer to the large metropolitan centers.

The average annual harvest of waterfowl in the Islands for the period 1960-1965[1] was 2,050 ducks and 230 geese (primarily black brant). Hunter-day use devoted to waterfowl harvest each year is 1,900.

[1] Overall period covered was 6 years, because 1963 harvest data are unknown.

Propagation

Waterfowl are not artificially propagated on the Islands.

Beneficial Developments

The Bureau of Sport Fisheries and Wildlife maintains national wildlife refuges on Jones Island, Matia Island, and in a small five-Island complex dotting the Basin area. Although some waterfowl use occurs, these are primarily "rookery" Islands used by colonial nongame birds.

Conservation practices applied to Island agricultural lands of direct benefit to waterfowl include 110 acres of wildlife wetland development and 2,400 acres of wildlife wetland preservation.

OTHER WILDLIFE

The many and varied birds and animals on the Islands not classed as game or fur species are classified as other wildlife (Photo 14-2). This faunal group is discussed in the Area chapter.

PHOTO 14-2. The bald eagle, the national symbol, is a common year round resident in the San Juan Islands. (Washington Department of Game photo)

FUTURE NEEDS—WILDLIFE

RESOURCE DEMANDS AND NEEDS

Most of the demand for wildlife-oriented recreation originates from the heavily populated areas of central Puget Sound and not from Island inhabitants. Local demand is expected to increase due to a loss of wildlife habitat in other more heavily developed basins. Demand on harvestable species of wildlife is expected to nearly double by the year 1980. To maintain the present level of hunting success it will be necessary to provide an additional annual harvest of 1,200 deer; 42,000 rabbits; 2,100 ducks; 200 geese; 500 pheasants; and 700 band-tailed pigeons by the year 1980. As population,[1] leisure time, and demand for outdoor recreation increase, the demand on wildlife resources will increase proportionately.

Table 14-6 indicates present and projected demands and needs for hunting in hunter-days.

[1] Population forecasts shown in Future Needs—Fish.

TABLE 14-6. Present and projected hunter use on San Juan Islands

Year	Increase Over Previous Period (Need) (1000)	Total Use (Demand) (1000)
1965	--	49.5
1980	46.0	95.5
2000	59.3	154.8
2020	36.2	191.0

The real value of the Islands lies in their natural beauty and scenic surroundings which promote recreation and recreation development. The area is experiencing no industrial expansion and agriculture is becoming less important. Wildlife-oriented recreation will continue to play an important role in the Islands' economy.

PROBLEMS AND CONFLICTS

Certain problems must be resolved if future wildlife-oriented recreation demand on the San Juan Islands is to be satisfied. Problems and conflicts discussed in the Area chapter apply to this Basin.

MEANS TO SATISFY NEEDS—WILDLIFE

To satisfy the expected increase in demand for wildlife will require preservation and enhancement of key ecological features through coordinated orderly planning of land and area use, as indicated in the Area chapter, and activation of various developments on the Islands during the target years.

PROJECTS AND PROGRAMS REQUIRED BY 1980

Table 14-7 indicates projects and programs proposed for the Basin to satisfy 1980 needs. Similar data are not available for subsequent periods, but a listing of probable projects and programs for the 1980-2000 and 2000-2020 periods follows the table. The table does not show benefits from nonhunting use of wildlife such as trapping, wildlife photography, viewing, and dog training, nor does it include recreation benefits that will accrue from public use of wildlife areas for swimming, boating, hiking, picnicking, or other outdoor recreation. Based on existing surveys, such nonconsumptive use more than equals hunting use.

TABLE 14-7. Proposed projects and programs, with estimated costs and benefits, to satisfy needs for wildlife on San Juan Islands, pre-1980

Project or Program	Annual Benefits: Hunter-Days	Annual Benefits: Value	Costs[1]: Capital	Costs[1]: O&M (Annual)
General Programs				
Develop cooperative programs with private landowners to preserve and improve wildlife habitat and assure hunter access	1,200[2]	$ 4,800[2]	--	$2,500
Develop educational program to stress renewable aspects and value of proper use of wildlife	23,400	119,600	$ 5,000	--
Specific Programs and Projects				
Acquire land for habitat improvement and hunter access	16,300[2]	65,300[2]	155,000	3,000
Acquire and develop salt-water public access areas	1,600	8,000	[3]	[3]
Totals	42,500	$197,700	$160,000	$5,500

1/ Do not include survey and plan costs.

2/ Includes off-project benefits.

3/ Costs included under fish development program.

PROJECTS AND PROGRAMS, 1980-2000

(1) Continue acquisition and development of key ecological areas to provide maximum wildlife-oriented recreation.

(2) Continue programs and projects not completed prior to 1980.

(3) Continue research for new wildlife techniques and develop projects and programs as required.

PROJECTS AND PROGRAMS, 2000-2020

(1) Continue acquisition and development of key wildlife habitat and hunting areas.

(2) Continue programs and projects not completed prior to 2000.

EXHIBITS

EXHIBIT 1. FISH AND WILDLIFE SPECIES, PUGET SOUND AREA [1]

FISH

Anadromous Fish

Chinook salmon (Oncorhynchus tshawytscha)
Coho salmon (Oncorhynchus kisutch)
Pink salmon (Oncorhynchus gorbuscha)
Chum salmon (Oncorhynchus keta)
Sockeye salmon (Oncorhynchus nerka)
Steelhead trout (Salmo gairdneri)
Searun cutthroat trout (Salmo clarki)
Searun Dolly Varden (Salvelinus malma)
White sturgeon (Acipenser transmontanus)
Lampreys (Lampetra spp.)
Eulachon (Thaleichthys pacificus)
American shad (Alosa sapidissima)

Resident Fish[2]

Kokanee (Oncorhynchus nerka kennerlyi)
Rainbow trout (Salmo gairdneri)
Cutthroat trout (Salmo clarki)
Brown trout (Salmo trutta)*
Golden trout (Salmo aquabonita)*
Dolly Varden (Salvelinus malma)
Brook trout (Salvelinus fontinalis)*
Lake trout (Salvelinus namaycush)*
Arctic grayling (Thymallus arcticus)*
Mountain whitefish (Prosopium williamsoni)
Suckers (Catastomus spp.)
Sculpins (Cottus spp.)
Dace (Rhinichthys spp.)
Redside shiner (Richardsonius balteatus)
Northern squawfish (Ptychocheilus oregonensis)
Peamouth (Mylocheilus caurinus)
Carp (Cyprinus carpio)*
Threespine stickleback (Gasterosteus aculeatus)
Largemouth bass (Micropterus salmoides)*
Smallmouth bass (Micropterus dolomieui)*
Black crappie (Pomoxis nigromaculatus)*
Rock bass (Ambloplites rupestris)*
Warmouth (Chaenobryttus gulosus)*
Yellow perch (Perca flavescens)*
Brown bullhead (Ictalurus nebulosus)*
Bluegill (Lepomis macrochirus)*
Pumpkinseed (Lepomis gibbosus)*

Marine Fish

Pacific cod (Gadus macrocephalus)
Other codfishes (Gadidae)[3,4]
Pacific hake (Merluccius productus)
Lingcod (Ophiodon elongatus)
Greenlings (Hexagrammidae)[3,4]
Flounders (Pleuronectidae)[3,4]
English sole (Parophrys vetulus)
Other soles (Pleuronectidae)[3,4]
Surfperches (Embiotocidae)[3,4]
Black rockfish (Sebastodes melanops)
Copper rockfish (Sebastodes caurinus)
Canary rockfish (Sebastodes pinniger)
Quillback rockfish (Sebastodes maliger)
Yellowtail rockfish (Sebastodes flavidus)
Other rockfishes (Scorpaenidae)[3]
Pacific herring (Clupea harengus pallasi)
Spiny dogfish (Squalus acanthias)
Sixgill shark (Hexanchus griseum)
Soupfin shark (Galeorhinus zyopterus)
Ratfish (Hydrolagus colliei)
Skates (Rajidae)[3,4]
Surf smelt (Hypomesus pretiosus)
Sablefish (Anoplopoma fimbria)
Albacore (Thunnus alalunga)
Skipjack tuna (Euthynnus pelamis)
Yellowfin tuna (Thunnus albacares)
Bluefin tuna (Thunnus thynnus)
Pacific halibut (Hippoglossus stenolepus)
Pacific Ocean perch (Sebastodes alutus)
Sculpins (Cottidae)[3,4]

[1] Not all-inclusive—primarily principal species—those important from utilization, esthetic, or predatory standpoint. Includes ocean caught marine fish landed at Area ports.

[2] Fresh water.

[3] Family name.

[4] Includes species landed at dockside.

*Introduced.

Shellfish[1]

Dungeness crab (Cancer magister)
Red crab (Cancer productus)
Box crab (Lopholithodes foraminatus)
Pacific oyster (Crassostrea gigas)*
Native oyster (Ostrea lurida)
Kumamoto oyster (Crassostrea gigas kumamoto)*
Littleneck or Rock clam (Protothaca staminea)
Butter clam (Saxidomus giganteus)
Horse clam (Schizothaerus nuttalli)
Manila or Japanese littleneck clam (Venerupis japonica)
Geoduck (Panope generosa)
Softshell or Mud clam (Mya arenaria)
Cockle (Clinocardium nuttalli)
Piddock or Boring clam (Zirphaea pilsbryi)
Jackknife clam (Solen sicarius)
Blue mussel (Mytilus edulis)
California mussel (Mytilus californianus)
Pink scallop (Chamlus hastata)
Rock scallop (Hinnites multirugosus)
Spot shrimp (Pandalus platyceros)
Coon stripe shrimp (Pandalus goniurus)
Side stripe shrimp (Pandalopsis dispar)
Pink shrimp (Pandalus borealis)
Pink shrimp (Pandalus jordani)
Kamchatka or Pinto abalone (Haliotis kamschatkana)
Red abalone (Haliotis rufescens)
Squid (Loligo opalescens)
Octopus (Octopus hongkongensis)
Sea cucumber (Stychopus californicus)
Sea urchin (Strongylocentrotus sp.)
Ghost shrimp (Callianassa affinis)
Burrowing worm (Nereis sp.)
Sand dollar (Echinarachnius parma)
Starfish (Asteroidea)[2]
Native drill (Urosalpinx cinereus)
Moon snail (Polinices spp.)

[1] Includes other marine invertebrates.

[2] Class name.

WILDLIFE

Big Game

Black-tailed deer (Dama hemionus)
Roosevelt elk (Cervus canadensis roosevelti)
Rocky Mountain elk (Cervus canadensis nelsoni)*
Mountain goat (Oreamnos americanus)
Black bear (Ursus americanus)
Mountain lion (Felis concolor)

Upland Game

Ring-necked pheasant (Phasianus colchicus)*
California quail (Lophortyx californicus)*
Mountain quail (Oreortyx pictus)*
Chukar (Alectoris graeca)*
Bobwhite (Colinus virginianus)*
Gray partridge (Perdix perdix)*
Band-tailed pigeon (Columba fasciata)
Mourning dove (Zenaidura macroura)
Blue grouse (Dendragapus obscurus)
Ruffed grouse (Bonasa umbellus)
Spruce grouse (Canachites canadensis)
White-crested kalij (Lophura leucomelana)*
Chilean tinamou (Nothoprocta perdicaria sanborni)*
Red-legged partridge (Alectoris rufa)*
Bamboo partridge (Bambusicola thoracica)
Japanese green pheasant (Phasianus colchicus versicolor)*
Eastern cottontail (Sylvilagus floridanus)*
Showshoe rabbit (Lepus americanus)
"San Juan rabbit[3] *

[3] A feral domestic.
* Introduced.

Fur Animals

Beaver (Castor canadensis)
Muskrat (Ondatra zibethicus)
Mink (Mustela vison)
Raccoon (Procyon lotor)
Red fox (Vulpes vulpes)
Long-tailed weasel (Mustela frenata)
Striped skunk (Mephitis mephitis)
Spotted skunk (Spilogale putorius)
River otter (Lutra canadensis)
Opossum (Didelphis marsupialis)
Bobcat (Lynx rufus)
Coyote (Canis latrans)
Marten (Martes americana)
Lynx (Lynx canadensis)
Nutria (Myocaster coypus)*
Fisher (Martes pennanti)

Waterfowl[1]

Mallard (Anas platyrhynchos)
Pintail (Anas acuta)
American widgeon (Mareca americana)
European widgeon (Mareca penelope)
Green-winged teal (Anas carolinensis)
Surf scoter (Melanitta perspicillata)
Common scoter (Oidemia nigra)
White-winged scoter (Melanitta deglandi)
Bufflehead (Bucephala albeola)
Common goldeneye (Bucephala clangula)
Barrow's goldeneye (Bucephala islandica)
Gadwall (Anas strepera)
Oldsquaw (Clangula hyemalis)
Eider (Somateria spp.)
Shoveler (Spatula clypeata)
Canvasback (Aythya valisineria)
Wood duck (Aix sponsa)
Ruddy duck (Oxyura jamaicensis)
Redhead (Aythya americana)
Harlequin duck (Histrionicus histrionicus)
Ring-necked duck (Aythya collaris)
Greater scaup (Aythya marila)
Lesser scaup (Aythya affinis)
Common merganser (Mergus merganser)
Hooded merganser (Lophodytes cucullatus)
Red-breasted merganser (Mergus serrator)
Canada goose (Branta canadensis)
Western Canada goose (Branta canadensis occidentalis)
Lesser Canada goose (Branta canadensis leucopareia)
Snow goose (Chen hyperborea)
Cackling goose (Branta canadensis minima)
White-fronted goose (Anser albifrons)
Black brant (Branta nigricans)
Whistling swan (Olor columbianus)
American coot (Fulica americana)
Common snipe (Capella gallinago)

Other Wildlife

The diverse number and type of other wild fauna preclude designation of all the species.

[1] Includes associated species.
* Introduced.

EXHIBIT 2. GLOSSARY

Anadromous fish—Species that are hatched in fresh water, mature in salt water, and return to fresh water to spawn.

Angler-day—A day or any part of a day spent fishing by an individual.

Demand (fish and wildlife)—The number of hunter-days, angler-days, non-hunting or fishing use, or commercial harvest that are expected at a given date.

Edge (edge effect)—The border between vegetative types. Most wildlife species tend to congregate near an edge.

Environment—The total of all external factors that affect an animal. Not to be confused with **Habitat**, which refers to the place where an animal is found.

Escapement—Number of anadromous fish that return from the ocean to fresh-water streams and spawn.

Estuary—Semi-enclosed body of water which has a free connection with the open sea and within which ocean water is measurably diluted with fresh water derived from land drainage.

Exotic—An animal which has been successfully introduced into a region, but which is not native to that region.

Fauna—The animals living in a particular region.

Feral—A domestic animal which has reverted to the wild state.

Fingerling—Young fish which are self-subsistent, but not yet mature.

Fish farm—A controlled natural rearing impoundment or relatively small pond for fish.

Food fish—In Washington, those species of fish which may be harvested and sold as a commercial venture.

Game fish—In Washington, those designated species of fish which may be taken by sporting means only.

Habitat—Area which supplies food, water, shelter, and space necessary for a particular animal's existence.

Harvest—Number of animals or fish taken from a population by man for sport or commercial purposes—usually refers to an annual period, and often expressed as a percentage of the total population.

Hunter-day—A day or any part of a day spent hunting by an individual.

Jack salmon—Any salmon not less than 10 inches or more than 24 inches in length, as interpreted by Washington State regulations.

Limiting factor—Anything which tends to hold an animal population at a certain level at a certain time. Lack of food and cover are the two most common limiting factors.

Man-day—Synonymous with angler-day and/or hunter-day.

Marine fish—All fish species that spend their entire life in salt water. Includes bottomfish such as flounder and sole.

Migration—The seasonal mass movement of fish or wildlife from one area to another. Waterfowl migrate north and south. Deer and elk migrate to high and low elevations. Fish migrate from fresh water to salt water and from salt water to fresh water.

Needs—Difference between base year (1965) demand, and future demand for angling and/or hunting; demand less supply.

Production (fish)—The total amount (either weight or number) of fish produced within all ecosystems. Expressed as instantaneous standing crops in mean elevation segments of representative streams, it is extremely varied.

Range—Land area used by an animal. Most common reference is to the seasonal ranges (winter, summer, fall/spring) used by big game animals.

Rehabilitation—Chemical treatment of a body of water to remove undesirable fish populations, followed by restocking with desired species. Term is also used to mean renovation of land.

Resident fish—Species that spend their entire life cycle in a fresh-water environment.

Salmon—A fish of the genus Oncorhynchus.

Salmonid—Refers to cold-water fishes of the family Salmonidae. Represented by the salmon, trout, whitefish, and chars (such as Dolly Varden and brook).

Scrap fish—Pertains to marine species. Includes all mixed fish purchased for reduction or animal feed which dealers have not separated as to species. Mostly dogfish, hake, and tomcod.

Spat—The spawn of the oyster or other bivalve shellfish.

Spiny ray—General term applied to fresh-water game fishes which have hard spines in their fins and usually inhabit relatively warm water. This group frequently includes the sunfish, perch, and catfish families, as opposed to cold water fishes such as trout.

Supply—Essentially that quantity (numbers) of fish and wildlife resources available to satisfy fishing and/or hunting demand at a given time. Man-day conversion is necessary for justification and evaluation purposes.

Use—Man-days of angling and/or hunting; expressed demand.

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