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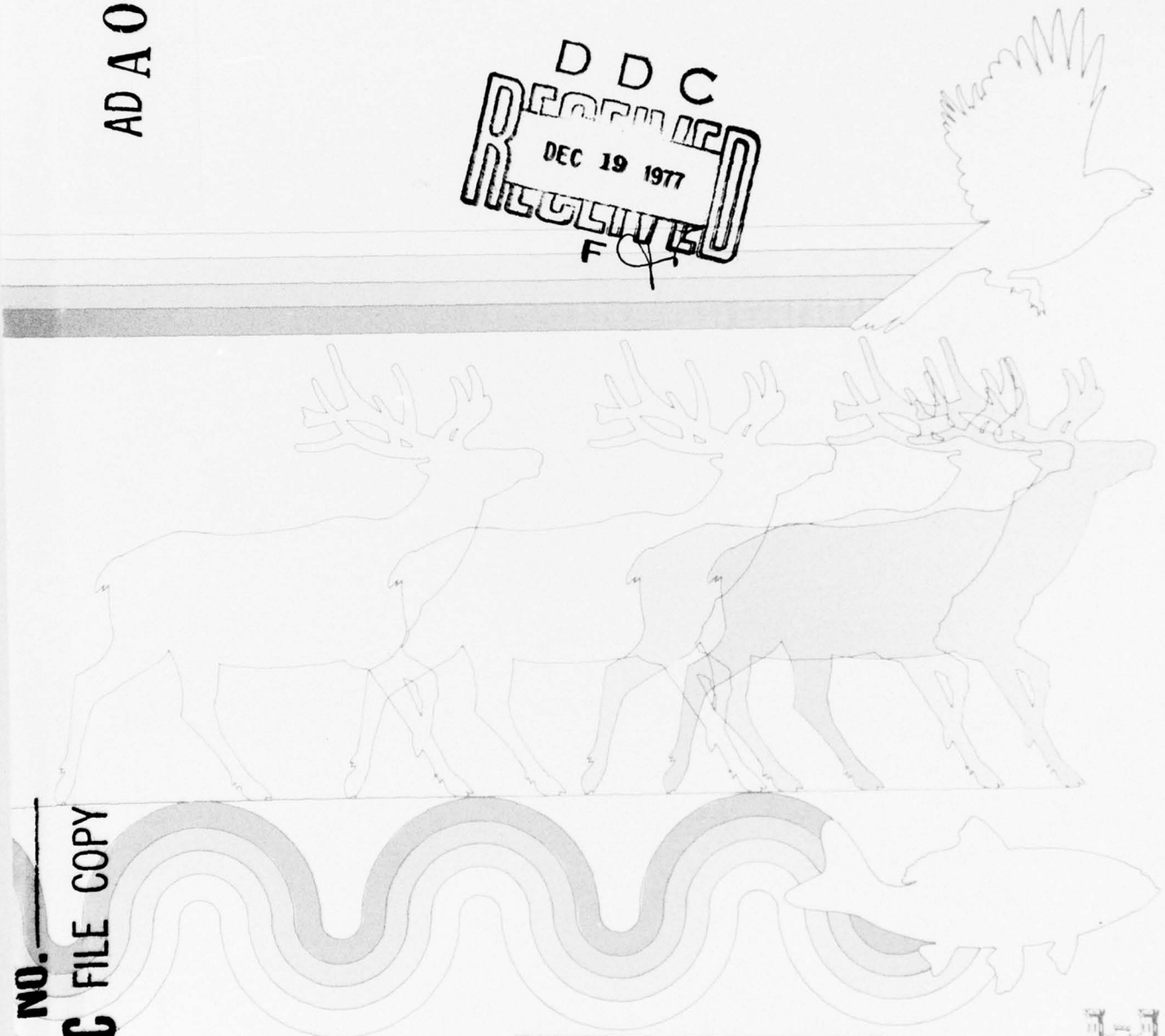
Evaluation of Planning for Fish & Wildlife

Ice Harbor
Lock and Dam Project
November 1977



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Fish and wildlife resources associated with the Ice Harbor Lock and Dam project have been the object of active planning at various times over a period of nearly 20 years. Original treatment of project-related impacts was based on limited data, which proved to be insufficient to enable adequate compensation recommendations. Over the years, the perceived importance of fish and wildlife

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resources has been upgraded dramatically. This evolution in the perception of fish and wildlife values is manifest in the recorded documentation of the Ice Harbor Lock and Dam project.

Early project-related planning recommendations to protect the project-associated fish and wildlife resources were presented in the Fish and Wildlife Coordination report of 1959. This particular report anticipated the severity of certain losses, with reasonable precision, such as those incurred by the big game population and a severe loss of goose nesting. On the other hand, other losses, particularly upland game, were substantially underestimated. Actions recommended to offset or lessen fish and wildlife losses were inadequate, being limited to provisions for fish passage facilities and acquisition of a 97 ha (240 ac) tract and associated 81 ha (200 ac) embayment referred to as the River Mile 25 (R.M. 25) tract. Fish passage facilities were constructed at a cost of $12,591,000 and the R.M. 25 tract was made available under license to the Washington Department of Game (WDG). Funding disagreements relating to operation and maintenance of the R.M. 25 tract precluded further habitat development by the WDG.

Considerably more detailed and comprehensive recommendations were presented by the affected federal fish and wildlife agencies (FWS and NMFS) in a special compensation report released in 1972. These currently proposed compensation actions relate to fish and wildlife resources associated with all four lock-and-dam projects constructed by the CE on the lower Snake River, including Ice Harbor. While vastly improved over the 1959 document, the current report contains significant errors pertaining to project-related hunting predictions and to the actions recommended to compensate for the lost resident fishery.

PREFACE

This document was prepared by staff of the Sport Fishing Institute for the U.S. Army Corps of Engineers (CE) under contract number DACW73-74-C-0040. The contract requires the compilation and comparison of pre- and post-construction data treating fish, wildlife, or both fish and wildlife (depending upon data availability) for twenty separate CE water development projects. This report presents the findings for one of the twenty individual project evaluations.

Upon completion of the full series of twenty separate studies, a final report will be prepared which will contain an analysis of the validity of the predictive procedures used in fish and wildlife planning, and will contain recommendations for improving the planning process.

This study of fish and wildlife planning at the Ice Harbor Lock and Dam project in Washington profited by the contributions of many interested local state and federal biologists. Particularly helpful comments and advice were provided by Messrs. Reade Brown, Cliff Millenbach, Wendell Oliver and James Stout, with the Washington Department of Game. Mr. Bill Rees and Mr. E. H. LeMier with the Washington Department of Fisheries also provided post-impoundment information. The federal involvement was discussed with Messrs. Norvell Brown and Charles Chambers with the Fish and Wildlife Service and with Mr. John McKern with the Army Corps of Engineers. Mr. William Morse, Western Field Representative, Wildlife Management Institute, visited the project and critically reviewed the manuscript.

Personnel in the environmental planning and recreation management elements of Corps agencies should review this report with view towards improvement of Corps activities.

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SPORT FISHING INSTITUTE

PROJECT PERSONNEL

Norville Prosser (Assistant Project Leader)

Robert Martin (Project Leader)

Richard Stroud (Contractor's Representative)

CONSULTANT'S REVIEW

Professional terrestrial wildlife consultative services were provided by the staff of the Wildlife Management Institute (WMI). Project personnel were accompanied by a WMI staff specialist during field reconnaissance and on on-site discussions. The terrestrial wildlife portion of the prepared evaluative manuscript was reviewed and evaluated by WMI. All pertinent suggestions offered by the consultant are reflected in this report.

INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

ICE HARBOR LOCK AND DAM PROJECT

INTRODUCTION

Location

Ice Harbor Lock and Dam and Lake Sacajawea are located on the Snake River, 9.7 miles from its confluence with the Columbia River. The project is in Walla Walla and Franklin Counties in southeastern Washington. The 1970 population of the two contiguous counties was 67,992. Within 50 miles of the Ice Harbor Dam are five communities in Washington and one in Oregon with 1970 populations over 5,000. The largest are Richland and Walla Walla, Washington, with 1970 populations of 26,290 and 23,619, respectively. The project is administered by the Walla Walla District of the North Pacific Division of the U.S. Army Corps of Engineers (CE). Lake Sacajawea is accessible at many points along both shores from secondary and tertiary roads. A map of the project site is presented in Figure 1.

Authorization

The Lower Snake River Project consisting of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Locks and Dams, was authorized by Public Law 14, 79th Congress, 1st Session, approved 2 March, 1945. The impoundments were authorized to provide slackwater navigation, irrigation, and hydroelectric power generation.

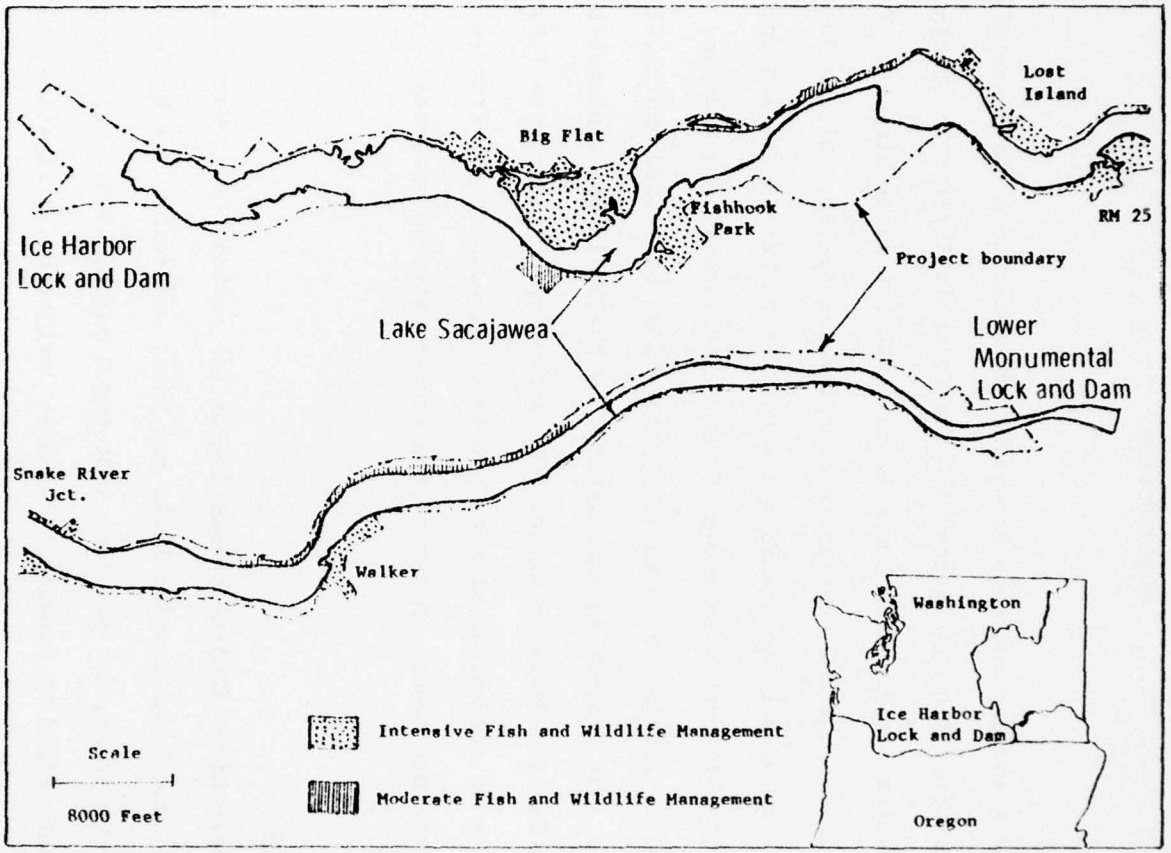

Figure 1. -- Map of Ice Harbor Lock and Dam project site.

Physical Features

Ice Harbor Dam is 860 m (2,822 ft) in length and impounds Lake Sacajawea at elevation 134 m (440 ft) mean sea level (msl) at normal pool. The lake inundates 3,723 ha (9,200 ac) and extends 51.5 km (32 mi) up the Snake River to the Lower Monumental Lock and Dam. At the 134 m msl elevation the pool has a shoreline of 129 km (80 mi) and stores 5.14 x $10^8 m^3$ (417,000 ac ft) of water. Daily and weekly fluctuation during low river flows depend upon power demand. A maximum drawdown of 0.9 m (3 ft) is provided for. Flood water flows of greater than 90,000 cfs increased water levels in the upstream portion of the reservoir(1).

The total project area of 5,019 ha (12,401 ac) includes 2,073 ha (5,122 ac) of the original river bed plus a contiguous area of 2,946 ha (7,279 ac) of which 91 percent was acquired in fee.

Area Description

Topography of the project area is characterized by a basalt plain through which the Snake River has cut a canyon 200 to 1,000 feet deep and up to 5,000 feet in width. Lake Sacajawea is confined entirely within this gorge. The canyon is bounded by terraced bluffs covered with soils of loess origin. This upland terrain is used primarily for dryland wheat production and livestock production, which largely support the region's economy. Railroad lines extend along much of the lake's shoreline.

The climate is characterized by mild winters and hot, dry summers. Mean annual precipitation is approximately 10 inches, occurring mostly during winter and spring.

Descriptive Reports

The Ice Harbor Lock and Dam project has been the subject of discussion and study for twenty years. One reason for this attention is that the project is not a single, isolated dam and impoundment; rather it is a component of a vast system of major water developments on the Columbia and Snake River systems. The second major reason is that the Snake River is one of the most important fish production systems in the United States. Anadromous fish from the Snake River contribute substantially to commercial and sport fisheries in the Pacific Ocean, from California to Alaska (2).

To acquire pertinent reports and unpublished data basic to the evaluation of fish and wildlife resources, project personnel visited the project and knowledgeable state and federal personnel, both in Olympia and Walla Walla, Washington. In the course of these activities, 18 individuals provided information and assistance. Specific offices visited included the Washington Department of Game (WDG), the Washington Department of Fisheries (WDF), and the U.S. Fish and Wildlife Service's Ecological Services office, all of which are located in Olympia, Washington; and the District office of the CE located in Walla Walla, Washington. The project site was visited in company with CE personnel. Under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) two reports, separated by 13 years, have been prepared to assist fish and wildlife planning and development at the Ice Harbor Lock and Dam project. The initial report, prepared by the FWS, was submitted to the construction agency on May 1, 1959 (3). This re-

port was obtained from the Portland FWS Regional Office. The basic data files for the wildlife portion of the report were located in the Olympia field office of the FWS (4).

Around 1966, the piecemeal approach to evaluation of the projects on the Snake River was changed. Instead of considering the fish and wildlife impacts of individual projects, the agencies decided to analyze the four projects as one integral unit. Subsequently, a special report on all four projects was prepared in 1972 (2). This report was authored jointly by the FWS and the National Marine Fisheries Service (NMFS). The support documentation (basic data files) were located in the Olympia field office of the FWS (5).

The CE's plan and appended support documentation for compensating the fish and wildlife-related losses associated with the four lower Snake River projects was completed in 1975 (6).

WILDLIFE RESULTS AND DISCUSSION

General Discussion

The Lake Sacajawea site (area of permanent inundation) contained 2,506 ha (6,191 ac) of land and 1,214 ha (3,000 ac) of permanent water. The terrestrial habitat was comprised of 362 ha (895 ac) of irrigated alfalfa, 11 ha (27 ac) of dry-farmed crops, 1,192 ha (2,946 ac) of irrigable land, 761 ha (1,881 ac) of grazing land and 179 ha (442 ac) of railroad and rights-of-way (3).

The Ice Harbor site was the least valuable of all the Snake River projects, in terms of wildlife resources, except for waterfowl (Wendell Oliver, pers. comm., 1976). Still, many species of wildlife were expected to be adversely impacted by construction of the project. Each group of wildlife has been treated separately beginning with discussions of the expected impacts and derivation of these predictions, followed by a presentation of actual post-impoundment conditions, and, finally, an evaluation of the adequacy and accuracy of the pre-construction comments and recommendations.

Big Game Resources -- Pre-impoundment Predictions

Conditions for deer were not of sufficient quality to attract and support significant populations. The without-project discussion of the 1959 report indicated that mule deer occasionally utilized the riparian habitat. The section specifically addressing the question is as follows:

> Mule deer occasionally inhabit brush and tree areas within the reservoir site. During severe winters small numbers of deer utilize the reservoir area when they are forced from adjacent

> slopes and canyons by inclement weather. The population varies annually, depending upon weather conditions and forage availability. Hunting for deer is of minor importance in the project area.

The basic data report discussed the use of the project area by mule deer more specifically, viz:

> In the fall and winter of 1956-57 five deer were known to be utilizing the breaks along the Snake River within the project area. It appears reasonable to assume that about 20 deer could normally be expected to inhabit the Ice Harbor impoundment site during an average winter. Such deer are generally from adjacent slopes and canyons and are forced to the river bottoms by inclement weather. Wintering populations vary in number from year to year depending upon the severity of winter conditions.
>
> In 1958 ten deer were reported harvested on nearby uplands. However, deer inhabiting the reservoir area are seldom hunted and the annual harvest within areas affected by the project is minor.

The 1959 report related post-impoundment conditions for big game in this single sentence:

> The impoundment will flood a small area of valuable deer winter range.

The basic data contains nothing to amplify this statement. Big game was not mentioned further in either the discussion or recommendation sections of the 1959 report.

Updated pre-impoundment deer population estimates were derived from the comprehensive four-dam impact surveys conducted from 1964 to 1966. As a result of these studies, the probable pre-impoundment deer population within an 8,337 ha (20,600 ac) corridor extending 0.8 km (0.5 mi) along either side of the Ice Harbor site was estimated at 100 animals (7).

Upland Game Resources -- Pre-impoundment Predictions

As with big game, the Ice Harbor site did not constitute prime upland game habitat. Quail were considered, among the six species involved, to be the most important upland game. The 1959 FWS report covered the pre-impoundment upland game discussion in one paragraph:

> Valley quail are the principal upland-game species occupying the impoundment site. They are not abundant. Small populations of mourning doves, ring-necked pheasants, Hungarian partridges, chukar partridges, and cottontails are also present. Annual harvest of these species is small.

Upland game data of much greater detail was contained in the basic data report. It was noted that a significant factor affecting the upland game community associated with the Snake River was the "edge effect" of the vegetated riparian habitat. This cover and nesting habitat also facilitated utilization of the adjacent food producing agricultural lands.

Mourning doves utilized the riverside habitat to a limited extent for nesting. Based on an estimated average breeding population of 600 doves, annual production was estimated at 900 young for a total population of 1,500 birds. Between April and October an estimated 188,625 dove-days were spent on project lands.

Quail coveys were found along the vegetated shoreline as well as on the grass covered islands. Field observations established a fall population of about 700 valley quails. Annual harvest was not high, estimated at 10 percent, approximately 70 birds.

Pheasant habitat was of poor quality and limited to the scattered irrigated tracts within the project area. Brush habitat adjoining irrigated farm lands provided nesting and escape cover. Pheasants moved from the uplands to the flats along the river during the colder months. Field censuses, supplemented by interviews with local residents, indicated a fall pheasant population of about 200 birds in the impoundment area. The potential kill was estimated by assuming a 1:2 cock-hen ratio and a 60 percent harvest of the cock population. This provided an average annual potential pheasant harvest of 40 birds.

Hungarian partridges were also present along the Snake River in areas adjacent to cultivated lands. The total population was small, estimated at about 50 birds. A potential harvest of about 10 birds was noted.

A few chukar partridges inhabited the canyon, and the general area had been recently stocked with chukars by the WGD. The average fall population was estimated at 100 birds and the annual harvest was placed at 20 birds.

Cottontail rabbits, while listed as being present, were described as providing negligible potential harvest.

A summary of the potential harvest of upland game within the area to be impounded by the Ice Harbor project is presented in Table 1.

Construction of Ice Harbor dam and the subsequent loss of 2,505 ha (6,191 ac) of terrestrial habitat was expected to greatly reduce the populations of most of the upland game species found in the project

Table 1. -- Summary of upland game populations and potential harvests for the Ice Harbor Lock and Dam project area prior to project construction

Species	Pre-construction population	Pre-construction potential harvest
Doves*	1,500	--
Valley quail	700	70
Pheasants	200	40
Hungarian partridges	50	10
Chukars	100	20
Cottontail rabbits	negligible	negligible

* Estimated 188,625 annual dove-days use.

area. The exact description of project impact on upland game, presented in the fish and wildlife report, was:

> Elimination of marginal brush tracts adjacent to Snake River in the project area will significantly reduce quail populations. Most ring-necked pheasant and Hungarian partridge habitat will be inundated. Chukar partridge habitat will remain virtually unaltered. Trees and shrubs, important as nesting sites for mourning doves, will be eliminated by the project.

No quantitative estimates of these damages were presented to the construction agency. The damages incurred were simply described verbally in the narrative. Again, data of much greater detail was contained in the basic data report (4).

In this latter document, it was noted that doves were highly versatile with regard to nesting requirements. Still, the better nesting habitat was expected to be inundated and a reduction in dove production was predicted. The number of breeding doves expected to utilize the project area following lake construction was projected to be about 150 birds. A 50 percent loss in production of doves within the project area was expected.

Use of the project area by migrating doves was not expected to be impacted to any appreciable extent. As a result, the total use of the area after completion of Ice Harbor was expected to be around 100,775 dove-days. This represented a projected loss of 87,850 dove-days.

An estimated 80 percent decrease in the quail population was considered probable. However, as growth of some cover along the lake margin was considered likely, the initial loss was expected to be lessened slightly.

As a result, an average annual loss of 60 percent was predicted. The post-project quail population was predicted to approximate 280 birds, and to yield an annual harvest of 28 birds.

Loss of irrigated farm land and brushy escape and nesting cover was expected to adversely impact pheasants and Hungarian partridges. An 80 percent loss was projected for pheasants and a 60 percent loss was expected for partridges. The resulting potential harvest of 8 pheasants and 4 partridges was predicted.

Although not stated, applying the estimated harvest percentages to population levels would have provided population estimates of 160 pheasants (fall population) and 20 Hungarian partridges on Ice Harbor project lands following construction of the lake.

The chukar population was expected to remain stable, with post-project harvest equal to the pre-project level (20 birds). It was predicted that cottontail rabbit habitat would be destroyed, but the pre-construction population was considered to be very small. No post-construction rabbit harvest was expected.

A summary of the post-construction upland game community at the Ice Harbor Lock and Dam project is provided in Table 2.

Fur Animal Resources -- Pre-impoundment Predictions

The 1959 planning document did not present quantitative information regarding fur animal density or harvest. Pre-impoundment conditions were described as follows:

> Beavers, muskrats, and minks are the fur animals of principal

Table 2. -- Summary of upland game populations and potential harvests predicted for the Ice Harbor Lock and Dam project area after project construction

Species	Post-construction population	Post-construction potential harvest
Doves*	750	--
Valley quail	280	28
Pheasants	40	8
Hungarian partridges	20	4
Chukars	100	20
Cottontail rabbits	negligible	negligible

* Estimated 100,775 annual dove-days use.

> economic importance along Snake River within the project area. Raccoons, skunks, weasels, and badgers inhabit project lands, but are seldom trapped because of low pelt values.

Actual estimates of harvest were contained in the basic data report. According to a WDG Habitat Biologist and a Game Protector, the sustained harvests for several fur animal species were estimated as: beaver, 100; muskrats, 10; minks, 20; raccoons, 20; weasels, 10; and skunks, 10.

The furbearer resource was expected to be adversely impacted by construction of the project. The magnitude of the expected damage was not defined but was described briefly in the narrative:

> Ice Harbor Reservoir will destroy fur-animal habitat of value for beavers, minks, and muskrats. Occasional use of the pool area by these species may continue. Habitat for skunks, weasels, raccoons, and badgers will be eliminated by inundation, but these species will inhabit reservoir shore zones to some extent.

According to the basic data report, beavers were expected to suffer the greatest damage with only a remnant population remaining after project construction. A sustained annual harvest of only 10 animals was predicted. Mink were expected to be benefited, with a doubling of the potential harvest to 20 animals anticipated. All other furbearer were expected to be eliminated following habitat inundation.

Waterfowl Resources -- Pre-impoundment Predictions

Most of the wildlife section of the 1959 planning report focused on waterfowl resources. As this informative discussion contained quantitative data throughout, it is reproduced in its entirety below:

Waterfowl is the most important wildlife group in the Ice Harbor Reservoir site. Islands and adjacent shore zones furnish valuable nesting, resting, and feeding habitat for Canada geese and ducks. An estimated 95 percent of the area goose nesting occurs on the islands. Vegetated shore zones along the project section of Snake River are important brooding sites for young geese produced upstream. These goose broods migrate downstream through the project area and congregate on and in the vicinity of McNary Game Range and McNary National Wildlife Management Area.

Situated near the confluence of Columbia and Snake Rivers, the project area is within a major waterfowl migration route of the Pacific Flyway. This region serves as a concentration point for large numbers of ducks and geese. Many migrants rest on islands and shoreline areas that will be affected by the reservoir. These birds feed on nearby grain fields and grasslands. Nearly all species of ducks and geese common to the Pacific Flyway frequent the study area.

Total migratory waterfowl movement through the area involves several hundred thousand ducks and geese. The bulk of the fall migration occurs from September into December. The highest numbers of migrant ducks and geese counted within the project area during any aerial survey were 29,100 ducks and 10,200 Canada geese. These transient populations are continuously replaced by other migrants and by wintering birds as the season progresses. Weather conditions and food availability are key factors in determining local abundance of wintering waterfowl. Maximum winter population counts in the project area were in excess of 75,000 ducks and 24,000 Canada geese. Use of the area by spring migrants is comparatively minor.

Canada geese account for most of the waterfowl broods produced in the project area. Nesting requirements of these birds are furnished by river islands which provide isolation and protection. Since 1951, an annual waterfowl nesting census of 13 Snake River islands within the project areas has been made by personnel of Washington Department of Game and Bureau of Sport Fisheries and Wildlife. Eight years accumulated nesting data show an average total of 66 located goose nests, with the highest year's total being 86 nests in 1958. These data show a yearly average of 95 observed pairs of geese and 100 unclassified geese. Thus, during the nesting season the annual average number of geese in the project area is 290 adult birds and an estimated 264 young are reared. Duck nesting is limited to a few mallards and teals.

In the project area, it is unlawful to hunt migratory waterfowl within one-half mile of Snake River (other game hunting

> permitted). However, grainlands adjacent to this sanctuary provide good goose hunting. As hunting pressure on these outlying areas increases, there is a tendency for the birds to concentrate in the sanctuary area. Waterfowl depredations on croplands are minor due to nature and location of crops grown. Stubble and green vegetation on dry-farmed grainlands provide abundant food for waterfowl with negligible crop damage.

More complete aerial count records were presented in the basic data. Counts of ducks and geese using the 33 mile stretch of Snake River within the Ice Harbor impoundment site are presented in Table 3.

The estimated average annual waterfowl use for the project site was determined to be 3,232,225 duck-days and 2,161,800 goose-days (Table 4).

Goose production information as summarized in the 1959 report was derived by expansion of nest-count data by means of nesting-success ratios derived from literature and from studies on the Columbia River. The FWS staff considered 20 pairs of ducks as the probable nesting population within the proposed lake site.

It was anticipated that construction of Ice Harbor Lock and Dam would drastically impact the waterfowl resources of the project area. The impact on both nesting and migratory use by ducks and geese was described in the 1959 report to the CE as follows:

> Canada goose nesting will be drastically curtailed by loss of important Snake River islands (figure 1). Shore and cliff nesting by geese is not expected to increase appreciably with the project. Project interference with the ancestral movement of goose broods from upstream islands to McNary Game Range and McNary National Wildlife Management Area may have serious effects upon local and upriver goose populations.
>
> Waterfowl use during migration and winter periods will be reduced since habitat which presently attracts ducks and geese

Table 3. -- Results of aerial waterfowl counts conducted on Ice Harbor Lock and Dam project area (33 mi) prior to project construction

Date (counts made on this date ± 2 days)	Number of geese counted				Number of ducks counted			
	1956-57	1957-58	1958-59	Average	1956-57	1957-58	1958-59	Average
October 6	-	-	2,332	2,332	-	-	1,217	1,217
October 22	7,850	-	30,737	19,294	1,530	-	15,700	8,615
November 4	6,250	16,210	21,399	14,620	11,310	15,550	9,637	12,166
November 18	10,200	8,900	10,770	9,957	11,795	29,100	63,775	34,890
December 2	-	15,965	14,300	15,133	-	29,700	70,530	50,115
December 7	2,350	-	-	2,350	16,158	-	-	16,158
December 17	24,250	-	5,914	15,082	18,525	-	55,840	37,183
January 4	21,820	16,425	16,953	18,399	75,170	37,958	40,275	51,134
January 19	-	1,132	4,840	2,986	-	817	18,280	9,549
February 2	-	-	5,290	5,290	-	-	20,650	20,650
February 10	12,580	-	-	12,580	12,890	-	-	12,890
February 19	-	727	3,815	2,271	-	464	7,170	3,817
March 17	500	370	338	403	615	375	1,315	768
Average	10,725	8,533	10,608	9,284	18,499	16,281	27,672	19,935

Table 4. -- Estimated average annual waterfowl use calendar for Ice Harbor Project areas, Snake River, Washington prior to lake construction (from FWS's 1959 basic data)

Month	No. days use	Ducks	Total days use	Geese	Total days use
January	31	32,000	992,000	18,000	558,000
February	28	5,000	140,000	5,000	140,000
March	31	1,000	31,000	2,000	62,000
April	30	100	3,000	400	12,000
May	31	50	1,550	600	18,600
June	30	50	1,500	600	18,000
July	31	50	1,550	600	18,600
August	31	375	11,625	600	18,600
September	30	2,000	60,000	2,000	60,000
October	31	10,000	310,000	8,000	248,000
November	30	25,000	750,000	15,000	450,000
December	31	30,000	930,000	18,000	558,000
Total			3,232,225		2,161,800

> in this reach of Snake River will be destroyed. Furthermore, observations on nearby McNary Reservoir indicate that the impoundment may be frequently ice-covered and this would further decrease utilization by wintering waterfowl. Ducks and geese may be benefited by the few sheltered embayments which will be created.

Wildlife mitigation recommendations contained in the 1959 FWS report related primarily to the waterfowl resource. A 97 ha (240 ac) area surrounding an 81 ha (200 ac) embayment, which was located on the south bank approximately mid-way on the lake, was proposed as a wildlife management area. This area was referred to as the River Mile 25 Site. The report indicated that development of this area would provide limited nesting habitat. The primary uses expected were resting and feeding by migrant waterfowl and wintering use during ice-free periods. In addition, the tract was expected to serve as a brooding area for waterfowl produced nearby and upstream.

The 1959 report contained two development recommendations which were proposed to mitigate a portion of the wildlife resource losses. These recommendations related to the River Mile 25 site, viz:

> 1. All of the area designated in Exhibit A as River Mile 25 be purchased in fee simple and made available for administration as a wildlife management area.
>
> 2. The General Plan appended to this report be executed to provide that the area designated in Exhibit A as River Mile 25 be made available to Washington Department of Game in accordance with Section 4 of the Fish and Wildlife Coordination Act, 48 Stat. 401 as amended; 16 U.S.C. 661 et seq.

Post-impoundment Studies -- General Comments

Following submission of the Ice Harbor fish and wildlife report, the FWS

completed separate studies on the two upriver lock and dam projects. The Lower Monumental report was submitted in 1960 and the Little Goose report was completed in 1963. Rather than continuing their piece meal project-by-project evaluations, the affected agencies decided in 1964 to treat the four Lower Snake River dams as one project and develop a comprehensive mitigation plan for the total project.

The WDG's position relative to this change in philosophy was discussed by Oliver in a 1970 publication (8). This discussion is presented below:

> Detailed reports were released by the U.S. Fish and Wildlife Service on the fish and wildlife resources of Ice Harbor project in 1959, Lower Monumental project in 1960, and Little Goose project in 1963. Although much of the input of these reports was contributed by the Department of Game, it was subsequently found to be extremely conservative in appraisal of wildlife resource losses. Furthermore, the on-site mitigation proposals for wildlife were found to be ineffective, unworkable, and untenable.
>
> A re-evaluation of the effects of these projects on fish and wildlife was undertaken by Region 3 personnel, beginning in 1964. Using a combination of data obtained from periodic aerial overflights and strategically located checking stations and road counters, estimates of total hunters and fishermen using the Snake River project areas were obtained for the years 1964, 1965, and 1966. Additional information was obtained from special questionnaires sent to people contracted within the limited sphere of project influence. This yeilded additional information concerning amounts of game and fish taken, hours expended, number of people per vehicle, and hunting and fishing expenditures.
>
> The total harvest and use data obtained by Region 3 personnel is the foundation of a comprehensive report on fish and wildlife losses and mitigation measures in the lower Snake River four-dam complex, which will be submitted soon by the Bureau of Sport Fisheries and Wildlife.
>
> This regional data also provide the base for estimating wildlife population declines that have taken place in the Ice Har-

bor project perimeter following inundation, and the calculation of total pre-project population of wildlife publicly reported as affected by the Snake River dam complex.

The 1964, 1965, and 1966 survey results mentioned by Oliver (op. cit.) were reported by Stout and Garrison (9,10,11). The comprehensive report was submitted (2) and some additional information relating to wildlife populations on Ice Harbor project lands also was published (12).

A summary was included in the FWS's basic data files (5) describing the extent of wildlife habitat lost and the location of perimeter lands included in the FWS projections at each of the four Lower Snake River projects. The impact of Ice Harbor on wildlife resources within a 1-mile-wide corridor was evaluated by comparing wildlife harvests, etc., between Ice Harbor (constructed) and Lower Monumental project sites. These data have been reproduced as Table 5. The WDG considered the two sites, Ice Harbor and Lower Monumental, as being very similar in wildlife populations prior to Snake River development, even though it is evident that more river bank habitat was lost on the Ice Harbor project.

Each major group of wildlife which was evaluated in the 1964-1966 surveys is discussed in the following section.

Big Game Resources -- Post-impoundment Occurrences

The WDG utilized a direct comparison of wildlife harvests from the Lower Monumental site prior to project completion (flooded in 1969) to the harvests from an area around the Ice Harbor Lock and Dam and Lake Sacajawea in order to ascertain the impact of Ice Harbor project development on the

Table 5. -- Comparative acreages of wildlife habitat impacted by four lower Snake River projects

Project	Inundated	River bank 1/	1/2 mile 2/ extension	Total (inventory and extended areas)
Ice Harbor	9,200	4,520	22,400	26,920
Lower Monumental	6,590	2,345	18,560	20,905
Little Goose	10,025	4,012	23,800	27,812
Lower Granite	8,900	3,576	24,960	28,536
Totals	34,715	14,453	89,820	104,173

1/ Based on analysis of essential riverbank habitat inundated by project reservoirs.

2/ Area extending one-half mile out from either riverbank. This mile-wide band along the river encompasses habicat of wildlife considered to be directly influenced by the 4-dam project. Big game range covers an estimated 10 miles wide band along the river.

wildlife resources. The hunter surveys, upon which the comparisons were based, were conducted in 1964-1965 and 1965-1966 (9,10).

These WDG surveys indicated an average annual harvest of 17 deer from the unimpounded 7,511 ha (18,560 ac) study area encompassing the Lower Monumental site. However, no deer harvest was reported from the 9,065 ha (22,400 ac) study area encompassing Ice Harbor Lock and Dam and Lake Sacajawea.

The WDG developed deer population estimates by dividing the 1964-65 harvest estimates by an assumed kill rate of 17%. These calculations produced a deer population estimate of 100 head for the Lower Monumental site. It was assumed, because of the presumed similarities, that the Ice Harbor site had probably supported a herd of approximately 100 head. Because no deer were harvested in the Ice Harbor study area after impoundment (1964-65 survey) it was concluded that the pre-impoundment population of 100 head had been eliminated by the project.

The WDG applied this 100% loss concept in later project impact predictions for the total four-project area. Consequently, an eventual loss of 1,800 deer was projected following completion of all four projects 36,350 ha (89,820 ac) (13).

In the 1972 comprehensive FWS/NMFS report, the authors estimated a pre-impoundment harvest of 162 resident and 50 migratory deer from the one-mile wide periphery along the four projects (total of 212). Their subsequent population estimate was derived by applying an assumed 20% har-

vest rate to the total known kill, resulting in a population estimate of 1,060 deer (212 / 0.20). To develop an estimate of hunting effort, a 32 days-per-kill ratio was used and a pre-impoundment effort estimate of 6,784 hunter-days per year was computed for the four-project area. The hunting effort was expected to double to 13,568 man-days, within 30 years, correlated with increased human population. This level of use was expected to continue over the remainder of the project life of 100 years. These estimates, weighted for the project life, provided average without-project estimates of 12,550 average annual man-days of use and 392 harvested deer (rounded to 400 in the report), which are the statistics provided in the 1972 comprehensive report.

According to the FWS, construction of the four projects would result in the immediate loss of 72% of the deer harvest, of which 60% would result from a reduced herd and the remaining 12% reduction would be due to reduced accessibility to hunters. Of the 1,060 deer existing within the four-project study area before project construction, the FWS estimated the loss of 636 head, leaving a post-project herd of 424 head. An additional 127 deer were assumed to be inaccessible to hunters, leaving some 297 head available to hunters. Using an initial 15% harvest rate, an assumed 30% harvest rate after 30 years, and a 32-days-per-kill factor, an average annual kill of 82 deer (27.6% harvest) in 2,700 hunter-days was projected. Therefore, according to the FWS, the estimated losses attributable to construction of the four projects would have been approximately 39% of the pre-construction harvest (82 / 212), 60% of the population (424 / 1,060), and 79% of the hunter-days (2,637 / 12,550).

To focus on the Ice Harbor project alone, requires making several assumptions. If the 1964-1965 hunter surveys did, indeed, reflect the pre-construction harvest and population size at the Lower Monumental site and the pre-construction deer resource at Ice Harbor (a kill of 17 from a population of 100); the impact of Ice Harbor Lock and Dam on big game resources, according to the FWS ratios, would have been a loss of 60 animals, 268 hunter-days and a harvest of 7 animals. The diminished harvest of 7 deer annually compares to the total harvest loss of 17 animals as estimated by the WDG.

In addition to the 1964-65 surveys, which indicated a harvest loss of 17 deer in the Ice Harbor perimeter lands, an indirect indication of the impact of the Snake River projects was available through evaluation of statistics from the five WDG Game Management Areas located near the project sites (Wendell Oliver, pers. comm., 1976). An annual average harvest loss of 177 deer (Table 6) since construction of the Lower Monumental and Little Goose projects is reflected by the statistics. Over the same period of evaluation, deer harvest reflected no demonstrable change within the counties bordering the Lower Monumental and Little Goose projects. The losses reflected in the deer harvest statistics from the management areas along the Snake River substantiate the harvest losses reflected from the earlier hunter surveys.

Upland Game Resources -- Post-impoundment Occurrences

The impact of inundation of the Snake River bottomland on upland game was determined by the WDG in their hunter surveys of 1964 and 1965. The ef-

Table 6 . -- Pre-impoundment and post-impoundment deer kill figures from five Washington Game Management Areas incorporating Lower Monumental and Little Goose Lock and Dams

Year	Harvest by individual Game Management Units					
	2-E	I-P	3-M	3-G	3-N	Total
1964	61	286	85	273	-	
1965	42	400	156	186	-	
1966	53	361	51	136	117	
1967	42	356	65	188	79	
1968	45	290	70	278	108	
Pre-impoundment averages	49	339	85	212	101	786
1969	35	278	33	182	54	
1970	43	212	26	178	85	
1971	18	379	36	173	111	
1972	10	292	53	145	90	
Post-impoundment averages	27	290	37	170	85	609

fects of habitat loss were assumed to be represented by the average difference between population and harvest information from the unimpounded Lower Monumental site and the same statistics from the Ice Harbor and Lake Sacajawea area.

According to these data (Table 7), the upland game community suffered the loss of 20,350 small game animals (including doves and chukars) as a direct result of Ice Harbor development. Although the loss to quail (-6,780 birds) was the largest component of the total damage, Hungarian partridges sustained the greatest population decline (-80%) among the listed species.

The FWS Special Report of 1972 also examined the extent of damages incurred by construction of the four-dam lower Snake River development project. These federally calculated (FWS) wildlife losses differed significantly from state data. The FWS's upland game loss estimates, which were reported to the construction agency primarily in hunter-day equivalents, were based upon game community loss estimates that were approximately one-half as large as the WDG statistics.

As the difference between the state and federal impact assessments represents a significant disagreement (state estimate approximately 100% greater than federal estimates), and the monetary benefits allocated to the lower Snake River fish and wildlife compensation plan reflected hunter-day losses based on full exploitation of the greatly reduced population estimates, a detailed discussion of the differences follows.

Table 7. -- Estimated impact of construction of Ice Harbor Lock and Dam project on upland game community as reflected by 1964 and 1965 WDG surveys

Species	Population size			Harvest		
	Pre-impoundment	Post-impoundment	Loss	Pre-impoundment	Post-impoundment	Loss
Pheasant	3,400	1,490	1,910	604	298	306
Quail	11,960	5,180	6,780	598	259	339
Hungarian partridge	3,500	700	2,800	175	34	141
Cottontail rabbit	1,900	420	1,480	95	21	74
Chukar	6,860	1,680	5,180	343	84	259
Mourning dove	17,900	15,700	2,200	197	157	40
Totals	45,520	25,170	20,350	2,012	853	1,159

The disagreements stemmed from "apparent" differences in assumptions of the two agencies regarding probable game population densities. The state population estimates were based upon the average of 1964 and 1965 kill records of hunters within a one-mile-wide strip of terrain extending 1/2 mile on either side of the 140-mile length of Snake River to be impacted by the four-dam project(9,10). Thus, the recorded harvests were representative of an 89,600-acre tract of habitat (140 mi^2 x 640 ac per mi^2)

To estimate population densities from the kill records, the state investigators divided the average number of each species harvested by an estimated kill-rate derived from statewide evaluations of wildlife harvests (14). For example, a 20% kill-rate was assumed for pheasants within the study area around the Ice Harbor project. When applied to the total kill-estimate of 293 birds, this harvest percentage produced a total population estimate of 1,465 birds.

As a result of these project-by-project calculations, a total pre-construction pheasant population estimate of 21,945 birds (corrected for Ice Harbor losses) was projected by the WDG for the total 89,600-acre, four-project study area. This works out to an average of 24.5 pheasants per 100 acres of habitat. The maximum density associated with any one project site, according to the state statistics, was around the Little Goose project. A pheasant population density of 35.4 pheasants per 100 acres was listed on that project.

Although provided with the WDG's data, as noted previously, the FWS used

significantly different population estimates in its mitigation report. These estimates appear to have been erroneously computed. The FWS's basic data files contained detailed developmental computations for their projections related to pheasants. Their (FWS) estimate was computed in the following manner. First (important to note), the FWS assumed that the four lock-and-dam projects would impact upland game habitat extending 1/2 mile beyond each river bank on either side of the river. It is on this point that they later made a serious computational error.

The basic data files clearly reflect that a one-mile wide corridor of influence, as used by the WDG, was also firmly accepted by the FWS personnel. Their introductory comments (basic data files) include the statement:

> The following estimates of project effects on game populations and human use of that resource are based upon habitat-related losses and reduced access to the project area of influence which includes those lands which extend out 1/2 mile on either side of the river for most wildlife and at least 5 miles for big game.

One page later this concept was repeated:

> For purposes of evaluation, the range of project-affected wildlife along Snake River is considered to extend 1/2 mile beyond the river banks. This perimeter includes most habitat lying within the topographic confines of the Snake River canyon -- a natural biological unit. All game and many nongame wildlife species living within that one mile wide band along the river are directly dependent on habitat destroyed or otherwise adversely affected by the four projects. At Wells project, Columbia River, studies by Washington Department of Game (Oliver and Barnett 1966) have demonstrated the dependence upon riparian vegetation of wildlife on adjoining lands. For example, pheasants dependent on streamback cover were found to range seasonably almost three miles from the river edge.

This discussion was followed by a tabular presentation of the affected habitat for each of the four projects. This table was reproduced and included, preceding, as Table 5 of this report. It should be noted that the FWS's 1/2-mile-wide extended habitat totaled some 89,820 acres, which compares favorably with the 89,600-acre figure used consistently by the WDG.

Next came the specific evaluation of pheasant losses, and the mistaken area computation that then became automatically incorporated into all subsequent upland game discussions. This critical page of the basic data is duplicated below.

Pheasants

Without the Project

The estimated pheasant population for the area of influence of the 4-dam complex is 10,448. This figure is about one half the State's estimate. An analysis of the State data indicated a density of about 100 birds per 100 habitat acres for Lower Granite and Little Goose. *This we could not accept* when compared to other areas such as Yakima and Walla Walla which ran about 35 birds/100 habitat acres. We believe that the State data reflects harvest over a much larger area and it appears that their data is about double the populations and harvest found in what we consider the area of influence. The data we used is shown in Table 1 as follows:

The referenced Table 1 above is duplicated following, as Table 8. The tabled area of influence, at variance with all previous discussions, reflected a zone of influence extending only one-quarter mile beyond each shoreline (one-half-mile wide corridor) rather than the intended one-mile wide corridor.

Contrary to the FWS's contention, the state's estimated pheasant populations of 8,432 and 6,713 in the Little Goose and Lower Granite project

Table 8.--Pheasant population estimates

Project	Flooded lands	(Acres) Area of influence	1/ Harvest percent	Estimated birds per 100 hab. acres	Estimated project affected pop.	Estimated harvested year 1 25%
Ice Harbor 35 mi.	4,490	11,200 2/	5	10	1,120	280
Lo. Monumental 29 mi.	2,340	9,280 2/	9	15	1,392	348
Little Goose 37 mi.	4,010	11,840 2/	54	40	4,736	1,184
Lo. Granite 39 mi.	3,575	8,000 3/	32	40	3,200	800
Totals	14,415	40,320	100		10,448	2,612

140 miles stream inundated

1/ Based on WDG 1965 hunter survey (approximately)
2/ One-half-mile area of influence
3/ Project take line

areas actually represented densities of 35.4 birds/100 acres, and 24.9 birds/100 acres, respectively (similar to densities at Yakima and Walla Walla), when calculated with the use of the proper one-mile-wide corridor areas of 23,808 and 26,944 acres. To summarize, the WDG projected an impacted pheasant population within a corridor 140 miles long and one-mile-wide containing 21,945 birds or 24.5 pheasants per 100 acres. The FWS computed an impacted pheasant population within a corridor 140 miles long but only one-half-mile-wide (slight modification of Lower Granite) containing 10,448 birds or 25.9 birds per acre.

Having mistakenly determined that the state figures were "inflated" for pheasants, the FWS arbitrarily halved the without-project harvest estimates for all other upland game species. In the case of quail, for example, the FWS used a total harvest estimate of 3,949 birds. The WDG survey had provided a harvest estimate of 6,806 quail (corrected for Ice Harbor).

To compound the error, the FWS misidentified the estimated harvest loss projections, which had been supplied by the WDG as pre-project harvest estimates. For example, the pre-project quail harvest, as indicated above, was placed at 6,806 birds by the WDG (9,10). The WDG assumed that completion of the project would result in a 57% reduction from the pre-impoundment (without-project) quail harvest, and projected a loss of 3,879 birds. This loss projection was mistakenly identified by the Service as the WDG's estimate of pre-project harvest.

The FWS treated these erroneous pre-construction population and/or har-

vest estimates by various modifiers, including increasing harvest rates over the 100-year project life (rates supplied by WDG), and calculated a weighted-average harvest of 27,400 small game animals per year without the project.

The hunter-day estimates were developed by the FWS from hunter-success rates supplied by the WDG. Harvest was simply divided by kill/day or days/kill to estimate total effort. As the beginning point of the equations (harvest) was too low, all hunting-effort values subsequently developed by FWS, based on these harvest figures, were equally underestimated. For example, the upland game hunting effort loss was projected at 57,187 hunter-days by the WDG, but at 28,500 (only one-half as great) by the FWS.

The WDG continued to press for acceptance of the greater wildlife losses which they believed to be associated with the project. Correspondence with the construction agency in 1974 (7) contained the same animal loss statistics developed from the 1964-65 surveys. The WDG wildlife loss estimates were eventually accepted and incorporated into the Corps' Compensation Plan for the Lower Snake River (6). Paradoxically, the upland game hunter-day projections incorporated in the lower Snake River Fish and Wildlife Compensation Plan were derived from the population densities erroneously developed by FWS rather than from the population densities developed by the WGD.

Fur Animal Resources -- Post-impoundment Occurrences

Evaluation of the project's impact on furbearers relied on the statis-

tics developed for the comprehensive four-dam project, as no specific furbearer data were presented for the Ice Harbor project, either background information or in subsequent formal reports. Table 9 presents the State's estimation of impacts on furbearer after inundation without implementation of compensation measures.

Beaver was considered to be the most adversely impacted species, and was assigned a harvest loss of 92 percent. The population loss was placed at 80 percent. This species played an important role in focusing attention upon the adverse impacts on the animal communtiy which resulted from the inundation of riparian habitat. The situation which arose was described by Oliver (8) as follows:

> Furbearers are harvested at fluctuating rates, which generally correspond to current market values of furs. In recent years, there has been an upswing in value of long-haired furs (coon, cats, coyote) as well as in "recreational" trapping for the more popular furbearing species (mink, muskrat, beaver). The latter will be affected most by the impact of Snake River projects. Beaver, in particular, have recently called public attention to their plight as starving colonies were prominently displayed following the creation of Little Goose backwater. This revelation caused the Corps of Engineers to hurriedly request particular measures for the alleviation of a too-obvious barometer of dam-caused ecological disaster.
>
> An optimistic estimate that 20 percent of original beaver populations survive the drastic habitat changes caused by impounding Snake River habitat concludes that 848 beaver (80 percent of 1,060; see Table 1) will ultimately be lost with the four-dam complex. Losses of muskrat, mink, otter, and raccoon are similarly manifest.

Similar losses were assumed for each of the four reservoir projects and thus an 80% loss of the beaver population which inhabited Snake River habitat within the Ice Harbor pool has been assumed.

Table 9 . -- Impact of lower Snake River development (four dam complex) on fur animals, as compiled by WDG

Species	Without project harvest	With project harvest	Projected losses	
			Number	%
Beaver	212	17	195	92
Muskrat	2,685	1,610	1,075	40
Mink	230	140	90	40
Otter	23	0	23	100
Raccoon	52	26	26	50
Total	3,202	1,793	1,409	44

Waterfowl Resources -- Post-impoundment Occurrences

Studies of waterfowl nesting activity have shown steadily declining use of the Ice Harbor project area since impoundment of Lake Sacajawea (15). When Lake Sacajawea was flooded, 12 of the 13 existing river islands used by waterfowl for nesting and brooding areas were covered by water. Pre-and post-impoundment Canada goose nest counts and nesting pairs information for the Snake River area are presented in Table 10. The information shows that nesting was reduced to only one active nest in the Ice Harbor project three years after impoundment. Goose nesting activity has remained at minimal levels with a total reservoir gosling production of 6 and 5 during 1974 and 1975, respectively (16).

No data are available regarding the intensity of cliff nesting activity along the Ice Harbor pool. This form of nesting is not believed to constitute a significant source of goose production, however (*op. cit.*). Little information is available with regard to duck nesting on the project.

Use of the Ice Harbor project area by waterfowl during the fall migratory season has possibly increased since project construction; however, no studies of this use have been conducted. The close proximity of agricultural lands, especially dry land wheat, provides excellent feeding opportunity for the migratory waterfowl that rest on the Ice Harbor pool.

Mid-winter waterfowl counts have been obtained by WDG staff. The results of these counts, which are obtained during late December or early January, are presented in Table 11. Making accurate counts of migratory waterfowl presents a difficult task. The count data presented reflects

Table 10. -- Number of pairs of Canada Geese and/or nests on Snake River hydro-water development project areas from 1952-1971 (from Bowhay, 1972)

Year	Ice Harbor		Upper Snake River [1]	
	Pairs	Nests	Pairs	Nests
1952	91			
1953	99			
1954	110		48	
1955	88		40	
1956	91			
1957	109			
1958	105	91	41	35
1959	99			30
1960	97		43	27
1961	100 (Pool) [2]	78	74	
1962	110	7	109	
1963	75		78	
1964	32		80	
1965	17		52	
1966	15		78	
1967	14	1		27
1968		1		30
			(Pool)	(Lower Monumental)
1969		1		21
			(Pool)	(Little Goose)
1970		1		8
1971		2		17

1. Includes Lower Monumental, Little Goose, and Lower Granite project areas.

2. (Pool) indicates year of inundation.

Table 11. -- Mid-winter waterfowl counts from Ice Harbor project (Lake Sacajawea) before and after project construction (data provided by Washington Department of Game)

Date	Number of birds counted		
	Ducks	Geese	Total birds
Pre-impoundment			
1/5&6/1954	28,581	6,254	34,835
1/3/1956	1,235	375	1,610
1/2/1957	11,046	4,051	15,097
1/3/1960	10,615	11,520	22,135
1/5/1961	18,915	24,384	43,299
Average	14,078	9,317	23,395
Post-impoundment			
12/27/1962	711	4,432	5,143
1/8/1969	1,148	6,325	7,473
1/5/1970	2,920	2,770	5,690
1/5/1971	15,631	1,317	16,948
1/6/1972	961	3,479	4,440
1/9/1973	2,642	4,011	6,653
1/18/1974	73*	210*	283*
1/9/1975	3,743	5,837	9,580
1/13/1976	8,685	6,600	15,285
1/10/1977	1,037	810	1,847
Average**	3,755	3,579	7,334

* 1974 waterfowl counts below Ice Harbor were up and apparently included birds normally found on Lake Sacajawea.

** Post-impoundment averages computed without the 1974 counts: ducks-4,164, geese-3,953, total birds-8,117.

the highly variable results of such counts. Although Lake Sacajawea provides one of the better mid-winter resting areas for migratory waterfowl on the lower Snake River (Jim Stout, pers. comm., 1977), available count information indicates less use of the project area by waterfowl since impoundment of Lake Sacajawea.

According to the hunting surveys conducted by the WDG during the 1964-65 and 1965-66 hunting seasons, 71% more ducks and 7 times as many geese were harvested from the Lake Sacajawea study area than from the unimpounded Lower Monumental study area (9,10). The actual project-related harvests reported (hunting prohibited within 1/2 mi of either project site) were 356 ducks and 292 geese from Ice Harbor, and 208 ducks and 41 geese from the Lower Monumental study area.

Wildlife Resources -- Evaluation of Planning Input

Planning activities for fish and wildlife resources associated with the four Lower Snake River projects have been under way since the mid-1950's. Consideration of the fish and wildlife aspects of the projects have occurred in two distinctively different phases. The initial fish and wildlife planning input pertained specifically to the Ice Harbor Lock and Dam project and was contained in the pre-construction (post-authorization) Fish and Wildlife Coordination Act report of 1959. Subsequent reports prepared in the early 1960's dealt individually with the Lower Monumental and Little Goose lock-and-dam projects.

The approach to fish and wildlife planning for the projects on the Snake River was altered significantly in the mid-1960's when a comprehensive multi-project study of all four projects (including the Lower Granite

Lock and Dam project) replaced the piece meal, project-by-project approach used previously. Unfortunately, none of the reservoirs received specific evaluation of both pre- and post-construction aspects of fish and wildlife resources.

Studies conducted by the WDG facilitated preparation of the comprehensive evaluation and to a large degree comprised the data base used to evaluate the efficacy of the 1959 Fish and Wildlife Coordination Act report.

These investigations by the WDG were conducted after the Ice Harbor project had been completed. Pre-impoundment characteristics of the Ice Harbor project were assumed to be similar to those of the Lower Monumental project site which had not yet been flooded at the time of the investigation.

The 1959 planning document provided no quantitative big game data either to reflect pre-impoundment conditions or to assess the probable impacts of project construction. In the report, deer populations were described as "small" and hunting as "minor." Impact projections were confined to a single sentence which related to expected loss of "a small area of valuable deer winter range." The unpublished basic support files spelled out the expected big game losses more carefully and noted an assumed loss of winter habitat for about 20 deer. An average of ten deer were believed harvested annually on the surrounding uplands.

The WDG's hunter surveys in 1964-65 and 1965-66 indicated no deer harvest from the study area surrounding the project following construction of Ice

Harbor Lock and Dam. Thus, the entire herd supported by this habitat was assumed by WDG to have been lost as a result of project construction. Based on surrogate population and harvest rates extant at the Lower Monumental site, the Ice Harbor loss was estimated by the WDG to have been a population of 100 head and a harvest of 17 deer per year. This total loss theory was applied equally to all four projects by the WDG for purposes of the comprehensive report.

The state's projection of a total elimination of deer within a one-mile-wide, two-bank corridor along the river, as a result of development of the four projects, was not completely acceptable to the FWS. That agency developed another set of post-impoundment impact assumptions which, when applied to the Ice Harbor site, indicated a loss of 60 animals, 268 hunter-days and a harvest of 7 animals from that single project area.

The 1959 FWS pre-construction report contained a totally inadequate and inaccurate portrayal of the impact of the Ice Harbor Lock and Dam project upon upland game resources. The formal report contained no actual figures representing the number of animals residing within the area of impact, nor gave consideration to man's use of this upland game community. The construction agency was informed merely that upland game populations and harvest within the project area were "small," although actual numbers representing the upland game resource in the project area were available in the basic data files. The numerical estimates appear to have been extremely conservative, when compared to subsequent follow-up studies. Table 12 presents the loss estimates as contained in the unpublished basic data files pertinent to the FWS 1959 report and the act-

Table 12. -- Upland game losses expected by FWS prior to Ice Harbor Lock and Dam construction and actual loss estimates developed by WDG personnel from hunter surveys of 1964-65 and 1965-66

Species	FWS projected losses (1959)			WDG estimated losses (1972)		
	No/ha	(No/ac)	Total[1]	No/ha	(No/ac)	Total[2]
Pheasants	.06	(.03)	160	.23	(.09)	1,910
Quail	.17	(.07)	420	.82	(.33)	6,780
Hungarian partridge	.01	(.01)	30	.34	(.14)	2,800
Chukars	0	(0)	0	.63	(.25)	5,180
Cottontail rabbits	negligible	negligible	negligible	.18	(.07)	1,480
Doves	.30	(.12)	750	.27	(.11)	2,200
Totals	.54	(.23)	1,360	2.47	(.99)	20,350

(1) Investigators considered only the 2,505 ha (6,191 ac) of terrestrial habitat that was inundated.

(2) Investigators considered area of impact extending 0.8 km (0.5 mi) on either side of Snake River or 8,288 ha (20,480 ac).

ual losses as computed by the WDG from post-impoundment hunter surveys and estimated harvest success ratios. The observed discrepancies resulted from differences in estimating animal densities, compounded by the consideration of different zones of project influence by different agencies.

The pre-construction prediction (1959 report) of a total loss of 1,360 upland game birds compares poorly with the actual post-impoundment circumstances. Survey findings were that the actual loss was 20,350 animals following construction of the Ice Harbor project. The difference represents a 15-fold discrepancy.

The WDG's estimate of project-occasioned losses, which were stated in terms of animal populations, were accepted by the CE. Those game animal loss estimates are reflected in the current (1975) compensation plan for the lower Snake River (6). The FWS's impact assessments (1972) which were expressed as hunter-day losses, were based on animal population estimates mistakenly established at approximately one-half the number estimated by WDG biologists. These erroneously based hunter-day estimates, which were accepted by the CE, comprise the monetary benefits associated with the current plan to compensate the wildlife losses resulting from development of the lower Snake River.

Monetary values of the lost hunting opportunity predictions were not developed in any of the reports prepared by the conservation agencies. The CE applied a value of $9.00 per day to the FWS developed hunter-day figures to justify the funding requested for the comprehensive compensation

plan (6). This wildlife compensation plan was developed to achieve compensation for the project-caused losses of wildlife as delineated by the WDG. The tangible benefits listed for the plan were associated with the hunting and appreciative use of these recovered resources. If the WDG's estimated project-related upland game hunting loss (57,187 hunter-days) had been claimed as recovered benefits, instead of the erroneously computed FWS estimated recovery figure (28,500 hunter-days), the tangible benefits of the compensation plan would have been $710,678 annually, instead of the listed value of $452,495. Use of the higher value ($710,678) would have provided a tangible cost:benefit ratio of 1.47:1 instead of the reported value of 0.94:1.

The dire prediction of project impact on the beaver population (predicted annual harvest decline from 100 to only 10 animals) was apparently well founded. Based on WDG studies, a 92% decline in beaver harvest resulted from a loss of the riparian timber and brushy habitat. As had also been predicted, post-impoundment studies indicated a total loss of otters. A 40% to 50% decline in muskrat and raccoon populations was indicated by WDG studies while the prediction had been for nearly complete elimination of these animals. A 40% loss of mink was indicated by the WDG studies of the entire four-project area. A 100% increase, to 20 animals harvested annually, had been predicted.

The 1959 fish and wildlife planning report contained only one development recommendation that related to compensation of wildlife losses. This recommendation was for the acquisition, development, and management of a

178 ha (440 ac) tract located at river mile 25. This parcel included 97 ha (240 ac) of land and was considered particularly beneficial to waterfowl resources if acquired and developed properly. The River-Mile-25 site was made available by the CE to the WDG on long-term license at no cost. To date no development or management work has been accomplished on this tract because a comprehensive development plan and funding arrangements satisfactory to the involved parties were never formulated.

Subsequent compensation recommendations made in the 1972 FWS/NMFS report were vastly improved and included funding of game studies, habitat development of both on-project lands and off-project lands, acquisition of perpetual access easements and construction of a game bird farm. The planned habitat development on project lands was expected to increase the wildlife populations to 70 to 80 percent of pre-project numbers. Acquisition of off-project lands and pheasant stocking on these lands was proposed as immediate replacement of wildlife losses pending development of on-project lands (6).

The project's adverse impact on goose reproduction, which accompanied loss of the Snake River islands, was clearly foreseen prior to construction of Ice Harbor Lock and Dam. The "drastic" reduction in nesting activity predicted certainly occurred, with only 1 or 2 active nests remaining out of an average of nearly 100 prior to project construction. No recommendations specifically designed to compensate for more than a minor portion of the loss of the nesting habitat were provided. Acquisition and development of the River-Mile-25 tract was expected to pro-

vide limited nesting habitat. Data reflecting actual nesting use of the River-Mile-25 area (though undeveloped) by nesting waterfowl is not available.

Subsequent planning recommendations relating to waterfowl (1972 FWS/NMFS report) included a request for a 5-year study of ways and means to offset the loss of Canada goose nesting and rearing habitat. The development of goose nesting and brooding areas was also recommended.

No conclusive data have been gathered to enable identification of the impact of the reservoir on use of the area by migratory waterfowl. Fall migrations are monitored by game and fish agencies on the Columbia River and up the Snake River to Ice Harbor Lock and Dam (Owen Vivian, pers. comm., 1977). No similar counts have been made of Lake Sacajawea proper. WDG personnel regularly conduct mid-winter counts, which indicate reductions in the level of such use since lake construction. Waterfowl harvest from the areas bordering Lake Sacajawea were significantly greater than harvest from the undeveloped Lower Monumental site, according to the WDG's hunting surveys of 1964-65 and 1965-66.

The agricultural lands located near the Snake River impoundments create desireable feeding habitat for migratory waterfowl. The extent of this use should be determined to as to enable evaluation of the full impact of project development on waterfowl resources.

FISHERIES RESULTS AND DISCUSSION

General Discussion

Fisheries resources of the Columbia River system, including the Snake River, have been dramatically altered by the development of these rivers for power, navigation and other purposes. Ice Harbor Lock and Dam contributes to the cumulative problems of fish passage and water quality degradation (nitrogen supersaturation) which have been identified as being associated with river development. Discussion of the probable impact on these fisheries of a single project (Ice Harbor) would produce a fragmentary and inadequate picture of the overall impact of river development on these valuable resources. Therefore, the following discussions assume a comprehensive multiple-project point-of-view with occasional specific references to the Ice Harbor Lock and Dam project, as appropriate.

As with terrestrial wildlife resources, the initial Ice Harbor-related fisheries planning began in the late 1950's, culminating with the Fish and Wildlife Coordination Act report of 1959 (3). Separate fish and wildlife reports were prepared for two additional lock-and-dam projects on the lower Snake River as they were planned and built. In 1966, the affected conservation and construction agencies agreed to consider the four lower Snake River dams (Ice Harbor, Lower Monumental, Little Goose and Lower Granite) as one project and prepare a comprehensive fish and wildlife compensation plan for the total project. This report was released in September, 1972 (2).

Anadromous Fish Resources -- Pre-impoundment Predictions

A brief description of the without-project Snake River fishery was included in the 1959 report, as follows:

> Chinook, blueback, and silver salmon, and steelhead trout, utilize the Snake River in the project area as a migration route to upstream spawning grounds. Runs in the Snake River system are of considerable magnitude and may, under certain conditions, be as high as 325,000 fish. An estimated 75 percent of the runs of chinook salmon and steelhead trout passing McNary Dam on Columbia River enter Snake River. Most of the salmon migrate to upstream segments of Snake River but some spawning occurs in the reservoir site. Aerial observations in November, 1957, revealed spawning chinook salmon and a total of 27 redds in the impoundment area. The total extent of spawning in the project area is not known.
>
> Snake River runs of anadromous fish are progenitors of a fishery which is valued at millions of dollars annually. Anadromous fish produced in Snake River are harvested in the ocean and Columbia River by commercial and sport fishermen and in Snake River and tributaries by sport fishermen. The contribution of these fisheries to the regional and national economy is of considerable importance.
>
> The sport catch of salmon and steelhead trout is not high in reaches of Snake River that flows through the Ice Harbor Reservoir site. It is known that a few steelhead trout are taken by anglers, although none were observed during periodic creel census checks of the area.
>
> There is an Indian dip-net fishery at Ash Siding, about 4.5 miles upstream from Ice Harbor Dam site. Historically this area was heavily fished by Indians, but at present there is only one dip netter fishing at this location.

Project construction effects and post-impoundment predicted impacts of the Ice Harbor Lock and Dam project, as contained in the pre-construction report of 1959, are presented below:

> Construction of Ice Harbor project was initiated in the fall of 1956. Development of the left bank coffer dam constricted the river to a narrow channel, with a resultant increase in velocity of river flow. During high water stages in May 1957, adult salmon and steelhead trout were unable to negotiate the channel. A

temporary fish ladder was incorporated in the coffer dam to aid passage of fish. After the fishway was put into operation it was utilized to some extent during the latter stages of high water.

Construction activity along the riverbed at Ice Harbor has caused Snake River below the dam to become extremely turbid at times. It is not known if the turbidity has detrimentally affected passage of fish and reproduction of salmon and resident game fish in the river below the damsite. It has apparently reduced angling efforts in this stream section.

Ice Harbor Dam will present an obstacle to upstream and downstream migrations of salmon and steelhead trout. The reservoir will eliminate stream habitat which served as salmon spawning and rearing areas. It is anticipated that there will be little sport fishing for salmon and steelhead trout in the reservoir. Angling pressure, mainly for steelhead, will probably increase downstream from Ice Harbor Dam due to improved access and angler preference for stream fishing.

A discussion of the possible mitigation or compensation measures deemed appropriate at that time for the anadromous fisheries was also presented in the 1959 report, viz:

Spawning habitat for salmon and steelhead will be lost. Stream improvement to develop natural spawning areas as compensation for that lost in Snake River is not possible due to the absence of tributary streams within the project area. Supplemental propagation facilities do not appear feasible because there is a lack of hatchery sites suitable for development. Artificial spawning channels are still in the experimental stage, and their value and need may be domonstrated. The probable number of fish to be handled by artificial propagation may not appear to warrant construction of facilities at this time. However, the need for such facilities may develop as a result of subsequent upstream river developments. Thus, further studies by appropriate State or Federal fishery agencies will probably become necessary when construction of other authorized Snake River projects is initiated. Plans for upstream passage are included in the project design, and consideration has been given to the protection of downstream migrating fingerlings in the design of the auxilary water system of the fishways.

The only measure recommended by the FWS, other than the features which

were already designed into the project to facilitate the passage of upstream and downstream migrants, was for temporary passage during construction and for further studies as additional Snake River projects were constructed.

The comprehensive lower Snake River compensation report was released ten years after Ice Harbor was completed. This report contained considerably more detailed discussions of the compensation features needed to replace the anadromous losses associated with development of the Snake River. Since these recommendations were provided after project construction, they will be considered in the following section on post-impoundment occurrences.

Anadromous Fish Resources -- Post-impoundment Occurrences

Most of the Snake River salmon and summer steelhead runs declined precipitously following completion of Ice Harbor Lock and Dam in 1962 and the other three projects in 1969, 1970, and 1975, respectively (Table 13). The initial steps taken to maintain these fisheries were obviously inadequate.

As noted in the 1959 FWS report, this subsequent construction on the lower Snake River necessitated further studies and a reevaluation of the compensatory measures necessitated by river development. In reference to the 1959 document, the subsequently prepared 1972 report stated:

> Initial proposals for offsetting some project-incurred fish and wildlife losses were based on very limited engineering and biological data. Subsequently, more intensive surveys of project-related fish and wildlife revealed much higher losses than originally estimated. Our analysis of more recent biological in-

Table 13. -- Ice Harbor Dam Counts 1962-76

Year	Spring Chinook	Summer Chinook	Fall Chinook	Steelhead
1962[1]	33,613	30,639	30,000	115,796
1963	26,778	20,875	13,500	74,539
1964	24,304	24,696	11,100	58,840
1965	12,178	14,701	12,400	62,873
1966	43,881	16,983	15,000	65,798
1967	35,593	30,315	19,000	44,205
1968[2]	44,773	29,531	24,400	82,383
1969[3]	52,090	30,917	16,900	63,889
1970	47,931	19,382	10,200	53,870
1971	32,638	26,606	11,000	67,029
1972	50,350	22,846	9,400	63,593
1973	60,639	12,829	8,400	38,311
1974[4]	19,361	10,269	2,800	12,473
1975	21,400	7,200	2,600	15,200
1976	25,056	10,026	1,469	23,230

Comparatively high Ice Harbor counts may not accurately reflect total run size or trend, particulary in recent years. All Indian and non-Indian sport and commercial fishing on Snake River runs has been steadily reduced to get more fish over Ice Harbor and into Snake Basin spawning areas.

1. Ice Harbor completed
2. Lower Monumental completed
3. Little Goose completed
4. Lower Granite completed

formation derived from limited project studies and other sources necessitates major changes in and additional to various earlier recommendations to significantly offset such losses.

Several adverse impacts on the fisheries of the Snake River have been identified as being associated with construction of the dams. Among these are additional obstructions to migratory populations, conversion of a riverine ecosystem to a series of slack-water pools, inundation of spawning grounds, and creation of adverse water quality conditions (nitrogen supersaturation).

Prior to completion of Ice Harbor Lock and Dam in 1962, the sizes of the salmon and steelhead runs into the Snake River were unknown. To back calculate the run sizes prior to river development, the FWS/NMFS investigators multiplied the highest count recorded at McNary Dam during the years 1954 to 1967 by the maximum percentage (second highest for fall Chinook) of the McNary counts that entered the Snake River (as reflected by the Ice Harbor counts) during the years 1962 to 1967. The Snake River proportion of the McNary counts for fall Chinook was reduced from the originally used maximum 68% to 33.5% as a result of continuing discussions among the various agencies after the 1972 FWS/NMFS report was released. A summary of the pre-construction fish run estimates (Table 14) shows that some 270,000 salmon and steelhead were estimated to have utilized the Snake River watershed prior to development on the river.

Losses associated with certain aspects of the projects have been quantified. Studies indicated that direct losses of salmonid smolts passing through turbines averages approximately 15 percent per dam. It is un-

Table 14. -- Estimated annual Snake River escapements before major dam construction began

Species	Maximum McNary count (year in parentheses)	Percent of McNary count passing Ice Harbor Dam	Computed Snake River escapements estimates
Fall Chinook	97,500 (1958)	33.5	32,660
Spring-Summer Chinook	222,100 (1957)	55.0	122,200
Steelhead	172,600 (1962-63)	66.5	114,800

likely that oceanic losses are density dependent; therefore, juvenile losses are reflected in reductions of similar magnitude in the subsequent adult runs. This loss (15 percent per dam or 48 percent cumulative loss over four lower Snake River dams) comprised the bulk of the compensation requested for spring and summer Chinook salmon and steelhead trout. In addition to the juvenile losses at each dam, the short-run fall Chinook salmon suffered the loss of spawning grounds within the 140-mile reach of inundated river. The FWS/NMFS report did not break this loss down by river sections, but only related a total loss equivalent to 5,000 adult fall Chinook salmon.

To compensate for the losses incurred by the anadromous fish runs, the affected state and federal agencies agreed that it would be necessary to construct hatcheries capable of producing juveniles in sufficient numbers to return 18,300 fall Chinooks, 58,700 spring and summer Chinooks and 55,100 steelheads. Table 15 presents the fish production capabilities considered necessary to compensate for the anadromous fish losses. These data reflect the reduction in fall Chinook compensation that was agreed to by all agencies after submission of the FWS/NMFS report of 1972.

Ascribing anadromous fish losses to individual dams (e.g., Ice Harbor) within the four-dam complex is a difficult task. Some adversities faced by the upstream and downstream migrants are cumulative and the deleterious impacts may be delayed and thus not readily assignable to a particular reservoir area.

Table 15. -- Hatchery requirements necessary to produce the required numbers of adult Chinook salmon and steelhead trout (reproduced from Table 8 in CE's Special report lower Snake River fish and wildlife compensation plan)

	Fall Chinook	Spring & summer Chinook	Summer steelhead
Adult loss level for basing hatchery size	18,300 1/	58,700	55,100
Percent survival, smolt to adult	0.20	0.87	0.50
Number of smolts	9,160,000	6,750,000	11,020,000
Smolts per pound	90	15	8
Pounds of smolts 2/	101,800	450,000	1,377,500
Percent survival, eggs to smolt	80	70	65
Number of eggs needed	11,450,000	9,650,000	16,950,000
Eggs per female	5,000	4,500	5,000
Number of females needed	2,290	2,145	3,390

1/ Reduced figure derived through negotiation between Corps and fish and wildlife agencies.

(The 66,300 and 34,400 figures are based on the highest percent of McNary count to enter Snake (some 68%). While this was an actual figure, it was twice as high as the next highest percent of McNary count to enter the Snake (33.5%). Thus, the second highest level was used as being more representative: [(97,500 x 33.5%) - 5,000] x 48% + 5,000 = 18,300.

2/ Pounds of smolts reared is the most significant item, both with respect to hatchery costs and eventual adult production. Size and numbers may be adjusted to hatchery practice.

Other more obvious losses can be directly attributed to certain project-related features. The Ice Harbor project inundated 51 km (32 mi) of the total 225 km (140 mi) flooded by all four dams, or 23 percent of the total. Assuming that 23 percent of the lost fall Chinook spawning grounds were within the Ice Harbor pool, the total loss (spawning ground loss plus migrant loss) of fall Chinook attributable to this project would have been approximately 2,836 fish. The loss of some 5,407 spring and summer Chinook and 5,067 steelhead also can be attributed to the Ice Harbor project.

Sport Fishery -- Pre-impoundment Predictions

Several cool-water and warm-water fish species supported a limited fishery in the Snake River prior to project construction. The 1959 report described this fishery as follows:

> White sturgeon, mountain whitefish, yellow perch, largemouth and smallmouth bass, white crappies, black crappies, and other sunfishes, channel catfish, and brown bullheads are resident game fish inhabiting the lower reaches of Snake River. Nongame fish include carp, suckers, squawfish, chiselmouth, chubs, red-sided shiners, and long-nosed dace.
>
> Creel census data indicated the light fishing pressure in the reservoir site is due principally to poor access and to the availability of more suitable fishing areas closer to population centers. It is estimated that approximately 1,300 angler days are expended annually in the reservoir area. Nearly all fishing is by local residents. About 61 percent of the anglers are bank and 39 percent boat fishermen. Approximately 75 percent of the total angling occurs during the months of April, May, June, July, and August. The majority of angler utilization occurs on weekends. Approximately 82 percent of the total fishing effort is expended near Page, Washington at river mile 19. Remaining fishing activity is rather evenly dispersed near other access points on Snake River in the project area.
>
> Sturgeon and steelhead trout are the most sought species in the area. There is some angling for warm-water species.

Reservoir construction was expected to adversely impact sturgeon and whitefish and to benefit nongame fishes such as carp, suckers, and squawfish. The entire predictive section is presented below:

> Ice Harbor Reservoir will eliminate stream habitat for resident game fish. Sturgeon and whitefish spawning grounds will be destroyed and food-producing areas eliminated. The reservoir site is in a narrow precipitous canyon. A small number of shallow bay and slough areas will be formed. These areas will be conducive to propagation of undesirable species, particularly carp, suckers, and squawfish. The ability of these species to prey on game fish and compete for food and space will limit populations of desirable game species.
>
> Certain areas of the reservoir may prove to be valuable for the production of certain game fish. The most important of these is located about three miles downstream from Sheffler, Washington at river mile 25. A small three-fingered bay about 50 acres in area will be created, thereby providing habitat suitable for the production and harvest of warm-water species.
>
> Angling pressure should increase with completion of the impoundment. Improved access will stimulate reservoir utilization even if fishing quality does not improve. Planned boat-launching facilities will permit anglers to traverse the reservoir in search of fishing areas. Interest of fishermen utilizing the reservoir probably will shift from sturgeon to warm-water species. Easy access and preference of some anglers for stream fishing will result in increased angling activity downstream from the dam. In addition, loss of stream habitat for sturgeon and whitefish will place emphasis on remaining Snake River areas which continue to support these species.

No recommended actions or facilities were provided to mitigate or compensate for the project-occasioned losses sustained by the resident fishery.

A more comprehensive review of the sport fishery problems was presented in the 1972 compensation report. The sport fishery for steelhead trout in the project area was expected to be totally destroyed as reflected in the following passage quoted from the 1972 report:

> The sport fishery for steelhead trout in this area will be virtually destroyed by inundation of 140 miles of freeflowing

> stream. Pre-project annual steelhead fishing use in the area was estimated at 52,000 angler-days. This would project to 130,000 angler-days annually during the 100-year project life. There is no known way to mitigate this loss other than by providing permanent public fishing areas along streams of known high use, such as Grande Ronde River in Washington and Oregon, Salmon and Clearwater River in Idaho, and Tucannon River in Washington.

The 1972 special report on compensation indicated that since Ice Harbor was completed, studies had shown much higher resident fishery losses that had been expected. The following is a direct quote from the report which formed the basis of the compensation requested:

> A fishery for warmwater species will develop in the impoundments with average annual use during the project life estimated at 205,000 angler-days. Such a fishery would not compensate for the 250,000 stream angler-days lost in the reservoir areas. The loss is actually greater than the 45,000 difference, because two stream angler-days are equivalent to three reservoir angler-days in value. Loss of the white sturgeon fishery in Snake River within the project area cannot be offset.

Since stream fishing was considered more valuable than reservoir fishing (3 days:2 days), state biologists increased the empirical difference in man-days (45,000) to attain equivalency with the stream fishing lost. These computations resulted in a compensation request for sufficient trout production to support 67,500 angler-days (17). Compensation requested in the compensation plan for this resident fishing loss was as follows:

> The estimated loss of 67,500 stream angler days for resident fish has been derived from creel census, population growth and fishing popularity data. This loss would be compensated by producing and planting 93,000 pounds of trout in southeastern Washington and western Idaho streams tributary or near to the Snake. The 93,000 pounds have been derived in the following manner on the basis of management experience in this area.

67,500 angler days x 2.52 trout/day = 170,000 trout harvested

170,000 trout harvest x $\frac{1.000}{0.729}$ (harvest rate) = 233,000 trout planted

233,000 trout planted ÷ 2.5 fish/pound = 93,000 pounds

Sport Fishery -- Post-impoundment Occurrences

Sport fishing on the Snake River involves anadromous as well as resident fish populations. Recreational angling for steelhead trout was studied by the WDG in 1964-1966 (Millenbach, pers. comm. 1974). The steelhead fishing statistics relating to the lower Snake River four-dam complex (including Ice Harbor impoundment and three other unimpounded project sites) are presented in Table 16. These data show that, although Ice Harbor (51.5 km) comprised 23 percent of the total river distance surveyed, less than 16 percent of the angling occurred on the lake and less than 5 percent of the steelhead harvest came from the Ice Harbor pool. A comparison of angling success for impounded (Ice Harbor) vs. free-flowing river sections (all other sites) shows, on the average, that angling for steelhead during 1964-1966 was 3.8 times more successful (per unit effort) on the unimpounded than the impounded reaches of river.

The Ice Harbor steelhead fishery was investigated during eight days of 1969 for the special purpose of discovering methods of increasing angling success for steelhead in slack water pools (18). Some 558 specially instructed anglers fished 3,422 hours and captured 22 steelhead in Lake Sacajawea during the eight-day survey. Average success was one fish harvested every 155.5 hours, or 25.4 angler-days. By comparison, persons

Table 16. -- Steelhead fishing statistics for the lower Snake River, 1964-1966* (Ice Harbor impounded, other sites free flowing)

Year	Ice Harbor		Lower Monumental		Little Goose		Lower Granite		Total	
	Steelhead caught	Angler-days	Steelhead caught	Angler-days	Steelhead caught	Angler-days	Steelhead caught	Angler-days	Steelhead caught	Angler-days
1964	287	2,359	1,662	6,547	3,208	11,914	3,320	15,807	8,477	36,627
1965	548	7,577	1,108	7,258	2,662	14,596	3,051	16,111	7,369	45,542
1966	282	10,279	816	4,061	1,794	9,035	5,324	23,706	8,216	47,081
Averages	372	6,738	1,195	5,955	2,555	11,848	3,899	18,542	8,021	43,083

* Statistics are not representative for calendar year, but rather those months in which steelheading effort was significant. April 1 through August 31 period not included.

fishing on the unimpounded river harvested an average of one steelhead every 25.7 hours or 4.2 angler-days.

Information in the same report indicated the number of steelhead in Lake Sacajawea during the angling survey period ranged from 1 fish per 4.9 ha (12 ac) to 1 fish per 7.3 ha (18 ac). The survey produced some evidence that development of an attraction flow within the lake might enhance fishing success for steelhead trout.

The FWS/NMFS special report (2) described the steelhead sport fishery for all four project sites as follows:

> The sport fishery for steelhead trout in this area will be virtually destroyed by inundation of 140 miles of free flowing stream. Pre-project annual steelhead fishing use in the area was estimated at 52,000 angler-days. This would project to 130,000 angler-days annually during the 100-year project life.

Unfortunately, for purposes of this investigation of Ice Harbor, the comprehensive total estimates were not associated with particular lakes.

In addition to the migratory steelhead trout, the Ice Harbor pool supports a diverse fishery for resident fishes. The warmwater resident fishes of the four-dam complex was expected to support an average (100-year project life) annual angling effort of 205,000 angler-days. No data were located which permitted allocation of this angling effort to individual reservoirs. The four lakes inundated 14,088 ha (34,810 ac) at normal power-pool elevation. Assuming, for purposes of rough estimation, a direct relationship between fishing pressure and surface area, Ice Harbor, with a surface area of 3,389 ha (8,375 ac), could be expected to attract some 49,200 angling trips annually over the life of the project.

This assumed acreage-related allocation does not consider differences in population densities or other modifying influences and is presented only to indicate the approximate magnitude of angler effort that might be expected for one of the four projects.

Based upon creel surveys of 1966 and 1967 (19,20), the Ice Harbor pool "spiny-ray" fishery was supporting approximately 20,000 trips annually. Table 17 summarized these early creel data. Largemouth and smallmouth bass contributed about 12 percent of the 1966 harvest, which was dominated by bullhead catfish at 57.4 percent. According to limited information, angling pressure declined in subsequent years to much lower levels. The WDG estimated that the resident fishery of the Ice Harbor pool attracted only 5,300 angler trips in 1970 (17).

The reservoir proper has not been stocked with fish although some small sub-impoundments located on project property receive annual plants of trout.

Water quality studies were conducted in 1970-1972 at several stations along the reach of river impacted by the lower Snake River development. Table 18 presents the results of the water sample analyses for the Ice Harbor pool station. The results reflect a well oxygenated lake with an intermediate temperature range, low fertility and near neutral pH. Thermal stratification does not occur (McKern, pers. comm., 1976) due to the current.

Fisheries Resources -- Evaluation of Planning Input

Fisheries planning for the Ice Harbor project passed through two dis-

Table 17. -- "Spiny-ray" fish catch and effort

Parameters	Year	
	1966	1967
Angling effort (trips)	18,564	21,274
Total Catch (no)	94,676	58,716
Success (no/trip)	5.10	2.76

Table 18. -- Water quality analyses from station located at R.M. 18 on Ice Harbor pool

Parameter	July 1970-* June 1971	July 1971- April 1972
Flow (10 day mean CFS x 1000)	18-118	21-142
Temperature	16.3-18.1	16.3-26.5
Vertical extinction coefficient	1.03	.78-.96
Oxygen (mg/L)	6.4-11.0	7.6-10.3
Oxygen (% saturation)	68-117	77.0-117.6
pH	6.0-8.1	7.21-7.92
Carbor dioxide (mg/L)	3-9.5	3-10
Bicarbonate alkalinity (mg/L)	77-135	10-82
Total dissolved solids (mg/L NaCl)	62-125	43-83
Total hardness (mg/L $CaCO_3$)	26-76	34-83
Ortho phosphate (mg/L P)	0.05-0.08	0.025-0.111
Nitrate-N (mg/L)	0.07-0.15	0.02-0.06
Sulphate (mg/L)	3.6-20.0	10.0-20.0
Iron (mg/L)	0.05-0.15	0.03-0.07
Chloride (mg/L)	3.5-8.2	-
Ammonia (mg/L NH_3)	0.04-0.19	-
Hydrogen sulphide (mg/L)	0.01	-
Biochemical oxygen demand-5 days (mg/L)	0.4-1.7	-
Chemical oxygen demand (mg/L)	4.4-11.4	-

* Ice Harbor sampled only during July, September, and November

tinctly different phases. The first phase, as detailed in the 1959 report, constituted only a minimal effort. Apparently handicapped by a nearly total lack of background information, only a few (but significant) mitigation recommendations were provided. The major FWS recommendation was for fish passage facilities at the Ice Harbor dam. These facilities subsequently were provided by the CE at a cost estimated as $12,591,000 (6). Also, temporary fish passage facilities were requested and provided for passing migrants through the construction site. Stream improvement to enhance natural spawning areas and development of artificial spawning channels and supplemental propagation facilities were considered but, for various reasons, deemed not warranted for the Ice Harbor project, alone.

Sport fishery considerations were all but overlooked during the earlier planning report period. Compensation was not requested for the losses of high quality sturgeon and steelhead trout fisheries later impacted by construction of Ice Harbor project. Also, no quantitative projections were provided as to the angling effort expected on the Ice Harbor pool, although "some" increase was anticipated over the estimated pre-construction level of 1,300 angler-days annually.

Several fisheries-related investigations have been carried out on the reservoir since project construction. Steelhead fishing in the reservoirs has proven to be poorer than in the free-flowing river. Creel surveys conducted in 1964-1966 indicated an average annual angling effort of 6,738 angler-days for steelhead. The "spiny-ray" fishery attracted ap-

proximately 20,000 angler trips annually in 1966 and 1967. Angling effort for the resident-fish fishery declined in subsequent years to only 5,300 angler-days in 1970.

Some unforeseen limited mitigation of these losses may, perhaps, be represented by the increased tailrace sport fisheries observed for steelheads and by some indications that angling success might perhaps be improved within the reservoir proper through application of improved management strategies, such as the use of attraction flows.

Although perhaps indicative of the frailties with which the authors perceived their 1959 report, the report's basic recommendation for a reevaluation of the overall fishery sitiation as additional impoundments were created was highly commendable. This proved to be a realistic recommendation as reflected in the much more comprehensive report submitted 13 years later. The comprehensive 1972 FWS/NMFS report accommodated planning for all four lock and dams, and addressed both anadromous and resident sport fisheries in a much more comprehensive manner than the earlier effort.

Reassessment of the river-related sport fishery, undertaken in the 1972 report, indicated an expected average annual fishing pressure of some 250,000 angling trips on the Snake River without the four projects. Only 205,000 angler-days were expected to be attracted to the slack-water pools with the projects in place. The 45,000 angler-day difference was to be compensated, in part, by stocking trout into streams tributary to the Snake River.

A major (and perhaps, debatable) premise by which the investigators computed the stocking requirement equates the value of two angler-days of stream fishing to three angler-days of reservoir angling. Therefore, rather than requesting compensation for the empirical one-for-one replacement difference of 45,000 angler-days, the recommendation called for sufficient hatchery production to support 67,500 angler-days (45,000 x 1.5). The FWS/NMFS report requested facilities capable of producing 85,000 pounds of rainbow trout at 3 fish per pound to compensate for the lost angler-days. This planning premise also implies equal values of the species assemblege which supported the pre-impounded river fishing and the stocked rainbow trout requested as compensation. This may also be a questionable assumption.

The compensation request also appears to contain a significant conceptual error. If river fishing was more valuable than reservoir fishing (2 days river fishing = 3 days reservoir fishing), an accepted philosophy reflected in later planning documents by all agencies (2, 6 ,17), the pre-construction river-related fishery of 250,000 angler-days should have been assigned a value equivalent to 375,000 reservoir-type angler-days (250,000 x 1.5). With an expected post-impoundment reservoir associated angling intensity projected at only 205,000 angler-days, compensation for the real difference of 170,000 angler-days annually should have been requested. The angling opportunity for which compensation was requested (67,000 angler-days) was only 40 percent of the real opportunity lost if the differential-value premise is accepted.

Additionally, the recommendation to acquire 150 linear miles of access corridors on off-site steelhead streams, requested in the FWS/NMFS report to compensate for project-incurred losses to the anadromous sport fishery, appeared to be well founded. Acquisition of 750 acres was considered necessary to accomplish this purpose, according to the CE. The construction agency agreed to seek authorization for $750,000 for acquisition of 750 acres and $300,000 for initial development, with the respective state agencies responsible for location (willing sellers only), purchase, and development.

The 1972 comprehensive FWS/NMFS report properly requested compensation for expected turbine-associated losses of anadromous downstream migrants (steelhead and spring, summer, and fall Chinook salmon) at all four reservoirs. Additional compensation was requested to offset the loss of fall Chinook salmon spawning grounds. However, a number of other sources of fish losses, such as losses between dams of adult upstream migrants, disorientation and predation losses of juveniles in slack water, and losses associated with nitrogen supersaturation, either were not anticipated or were not assessed quantitatively.

This recognition of the other unclaimed losses by the CE was one reason for acceptance by the construction agency of the maximum McNary counts and maximum (second highest for fall Chinook) percentages passing over Ice Harbor as reasonable project-incurred loss estimates. Some 18,300 adult fall Chinooks, 58,700 adult spring and summer Chinooks, and 55,100 summer steelheads were expected to be lost as a result of construction

of all four proposed projects. As compensation for the anticipated project-occasioned losses, artificial propagation facilities of sufficient productive capacity to supply 9.16 million fall Chinook salmon smolts, 6.75 million spring and summer Chinook salmon smolts and 11.02 million summer steelhead trout were requested for the total four-project area. These smolt stocking requirements were based on their anticipated return percentages as adults.

Pro-rating project-occasioned fish losses among the individual dams was not possible although the Ice Harbor-associated losses can be roughly estimated to approximate 2,836 fall Chinooks, 5,407 spring and summer Chinooks, and 5,067 steelhead adults.

SUMMARY

Fish and wildlife resources associated with the Ice Harbor Lock and Dam project have been the object of active planning at various times over a period of nearly 20 years. This documented record clearly illustrates the evolution of more meaningful wildlife-related priorities and the concurrent improvement of inter-agency cooperation which has occurred over this period.

Ice Harbor Lock and Dam was authorized in 1945 and completed in 1962. It is the first and lowermost of four lock-and-dam projects which have been built on the lower Snake River in Washington and Idaho. Lake Sacajawea, the 3,723 ha (9,200 ac) impoundment created, provides water for the navigation, power, and irrigation benefits for which the project was authorized.

Fish-and-wildlife-related planning has occurred at varying degrees of intensity since the mid-1950's. Two major planning reports have been submitted to the construction agency by the responsible fish and wildlife agencies. The first was released prior to project construction in 1959. The project-caused losses were also described as part of the comprehensive, four-project Lower Snake River compensation plan, released in 1972.

Plagued by inadequate information, the 1959 pre-construction report was largely deficient with respect to quantitative predictions and recommendations for mitigation or compensation. Sufficient data were gathered

during user surveys conducted by the WDG in 1964-1966 to enable some estimation of project impacts on terrestrial wildlife resources. At the time of these investigations, Ice Harbor Lock and Dam was already built, and planning was underway for the Lower Monumental Lock and Dam.

Differences between survey statistics from these two contiguous sections of the Snake River canyon were used to quantify the impacts of the Ice Harbor project on fish and wildlife.

Deer (predominantly mule deer) were the only big game animals affected by the Ice Harbor project. Probable deer population losses were described in the 1959 report as small, with little associated hunting effort. This assessment was supported by later surveys which indicated a loss of 60 big game animals and 268 big game hunter-days, and a harvest of 7 deer within the area of project influence.

On the other hand, the 1959 FWS pre-construction report greatly underestimated project influence on upland game populations. According to basic data files (1959 report), the predicted upland game animal loss was 1,360 animals. The 1964-1966 WDG surveys, in contrast, placed the actual post-construction loss at 20,350 animals. All later FWS planning documents prepared for the purpose of obtaining compensation for the project-occasioned upland game losses contained significant errors in hunter-day projections. The errors were caused by the authors' faulty reduction of the upland game population estimates upon which the hunter-day estimates were based. The hunter-day estimates presented in the 1959 report were approximately one-half of what they should have been. Both

ject-associated upland game animal losses are portrayed accurately in the CE compensation plan of 1975. These correct figures were taken from state statistics.

The 1959 report recommended development and management of a 97 ha (240 ac) tract of land as partial compensation for the terrestrial wildlife losses (in addition to waterfowl losses) caused by construction of Ice Harbor Lock and Dam. The site was licensed to the WDG, but was never managed due to the state's position that the construction agency should be responsible for funding both operation and management of the tract.

A drastic reduction in resident goose nesting activity, not quantified, was predicted as a result of the loss of nesting islands in the Snake River. This prediction proved to be well founded; the number of active goose nests within the Ice Harbor project site declined from around 100 each season to 1 or 2 in post-impoundment years. No compensation was requested in the 1959 pre-construction report for the expected waterfowl nesting losses. The 1972 FWS/NMFS report recommended a five-year study to formulate waterfowl habitat development plans. The construction agency at that time sought approximately $200,000 for habitat development, operation and maintenance. Few data were available to permit evaluation of the influence of Ice Harbor on migratory waterfowl use of the area.

The only development recommendation provided in 1959, to mitigate fisheries impacts of Ice Harbor, was for the construction of fish-passage facilities over the dam. This feature was provided subsequently by the CE at a cost of $12,591,000. The 1959 report also recommended that fur-

ther evaluation of the fisheries situation be undertaken as the upstream projects were built. For the most part, this recommendation was followed. Subsequent CE activities at the Ice Harbor project have dealt with improving passage of downstream juvenile migrants and attempts to ameliorate nitrogen supersaturation difficulties.

Compensation for project-incurred anadromous fish losses was recommended in the 1972 FWS/NMFS report based on historical fish-passage data from the McNary and the Ice Harbor projects. Though difficult to pro-rate precisely on a project-by-project basis, the adult loss due to the Ice Harbor project is estimated to include 2,836 fall Chinook salmon, 5,407 spring and summer Chinooks, and 5,067 steelhead trout. The spring and summer Chinook and steelhead losses were derived from juvenile mortalities (15 percent at each dam) anticipated from passage through turbines. The fall Chinook losses were based on juvenile losses from turbine passage plus the loss of spawning grounds. The 1972 FWS/NMFS report recommended construction of hatcheries with sufficient smolt production capacity to replace the predicted losses of some 18,300 fall Chinooks, 58,700 spring and summer Chinooks, and 55,100 summer steelhead adults.

The sport fishery was ignored or treated only superficially in the 1959 FWS report. The loss of high-quality river fishing for steelhead and sturgeon was identified, but not quantified. Reservoir fishing was expected to increase overall angling effort in the project area for resident fish by an unspecified amount over the pre-construction level, which was estimated at 1,300 angler-days annually. Later surveys indicated an

average angling pressure of approximately 20,000 angler-days for resident species in 1966-1967. Angling effort for reservoir-resident species declined to approximately 5,300 angler-days in 1970.

Post-impoundment studies suggested that steelhead fishing on the slack water (reservoir) pool was far less successful than in the formerly free-flowing river. The 1964-66 WDG study indicated that steelhead catch-per-unit-effort was 3.8 times more successful in unimpounded upstream stretches than in the reservoir. The Ice Harbor pool (comprising 26 percent of the total river miles in the study section) accounted for less than 16 percent of the angling pressure, and only 5 percent of the total steelhead harvest.

The 1972 FWS/NMFS report recommended acquisition of stream-bank access on nearby steelhead streams to compensate for losses to the steelhead sport fishery in the project area. Approximately 750 acres of stream-bank corridors were considered adequate for this purpose by the CE. Hatchery production of rainbow trout was requested to replace the lost river fishing opportunity for resident species. This request appeared to be only 40 percent of the true opportunity replacement necessary to compensate for the losses.

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