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THE BEHAVIOR AND ECOLOGY OF FALL PEREGRINE FALCONS AT LUMMI BAY AND VICINITY, WHATCOM COUNTY, WASHINGTON

By

Clifford M. Anderson
Randall K. Knapp
and
James K. Fackler

For
Seattle District
U.S. Army Corps of Engineers

Under Contract Number
DACW67-83-M-0996

January 1984

ABSTRACT

The behavior and ecology of Peregrine Falcons (Falco peregrinus) were studied at Lummi Bay, Whatcom County, Washington, from October through December, 1983. Peregrines were observed 207 times on 80% of the field days. We identified a minimum of 15 individual falcons during the study. The main peregrine activity was centered in and around Lummi Bay. Habitat preferred by the dominant adult female included a wooded ridge, tidal mudflats, and level agricultural fields. Combined observations yielded 154 hours and 46 minutes of direct study of peregrine behavior: falcons were perched 84% of that time, in flight 16%. Forty-two prey items, primarily ducks and shorebirds, were recovered. Peregrines were successful hunters 22% of the time; 153 hunting flights were witnessed. An adult female was radio-tagged on 1 December and followed over the next 30 days. She roosted in the San Juan Islands, 11 miles southwest of the main study area.

As a result of this study, the Lummi Bay region is now known to be one of the most important fall and winter peregrine use areas in Washington.

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Introduction

The Peregrine Falcon is one of thirty-eight species of falcons occurring throughout the world (Cade, 1982). It is the most widely distributed of the falcon species (White, 1968). It inhabits all continents except Antarctica, sharing this distinction with only two other birds, the Osprey and the Raven.

The peregrine has been the subject of wide attention during the last two decades, particularly since the discovery of its catastrophic population decline during the fifties and sixties, caused primarily by the pesticide DDT (Peakall, 1976).

In North America, the peregrine is considered to be a relatively uncommon species except in areas of high breeding density (e.g. the Queen Charlotte Islands in British Columbia) or at certain migration concentration points (South Padre Island, Texas).

In Washington State, studies on the peregrine have been few. The majority of research has focused on their winter ecology (Anderson et al., 1977, 1978, 1980; Anderson and DeBruyn, 1980; Dobler, 1982). More recently, studies on a newly-discovered spring migration of peregrines have taken place at Gray's Harbor (Herman and Bulger, 1981) and at the Cape Flattery Peninsula (Anderson et al., 1983).

The current study was commissioned by the U.S. Army Corps of Engineers, Seattle, Washington, in October, 1983. The primary objective of the project was to discover and document how the Peregrine Falcon utilized the Lummi Bay area of Whatcom County, Washington, during the fall months.

The study was initially formulated in response to the proposed development of the Lummi Aquaculture Pond from a salmon-rearing facility to a commercial marina. By mandate of the Endangered Species Act of 1973, the Corps is responsible for assessing the environmental impact on the peregrine from the proposed development.

The Study Area

The study area is located on the Lummi Indian Reservation in western Whatcom County, Washington. The Reservation (established in 1855) contains 19,000 acres and has a human population of 2,800.

The study was focused at Lummi Bay, including the 760 acre diked aquaculture pond. The study area expanded from this base as we followed individual peregrines to other locations. The final limits ultimately extended to the southeastern Straits of Georgia, Sandy Point, Onion Bay, Ferndale, I-5 Freeway, Marietta, Bellingham Bay, Brant Point, the Portage Hale Passage and Lummi Island (Map 1), an area of approximately 170 square miles.

Four main landscape components dominate the study area:

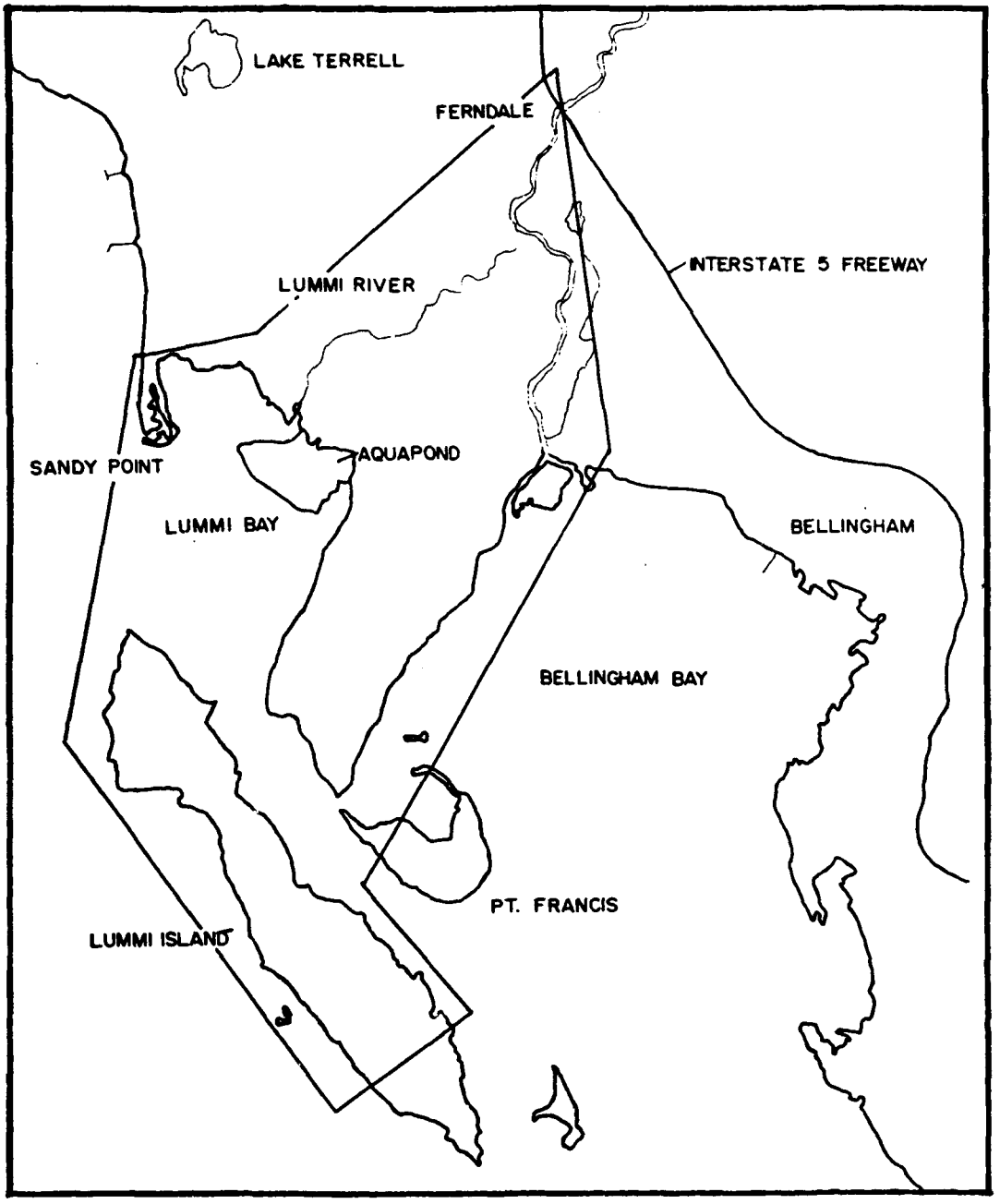
1. A flat, alluvial plain trending northeast/southwest, formed historically by the Lummi and Nooksack Rivers and now converted to agricultural use.

2. Three low, forested hills (maximum elevation 200 feet) bordering or containing the alluvial plain on the north, east and south.

3. A shallow protected salt-water bay located adjacent to the Straits of Georgia. The bay is approximately 5 square miles in extent and has an extensive intertidal mudflat area.

4. An open expanse of salt-water to the west (Straits of Georgia).

Within this area exist most of the characteristic Puget trough habitats; open salt-water, mudflat, gravel beach, salt-marsh, rocky shores, cultivated fields, mixed forest, freshwater lakes and rivers. The climate is predominantly maritime with cool summers and mild winters. Annual precipitation is 25-35 inches. Dominant winds are from the southwest. During winter, arctic air masses sometimes move south and produce extended freezing periods atypical of western Washington.



MAP I. STUDY AREA

Lummi Bay is recognized as an extremely important area for many species of birds. Wahl et al. (1981) classified the Bay as one of eleven "significantly important areas" for birds in the northern Puget Sound region. They write:

"This productive shallow bay with extensive eelgrass beds supported very important wintering bird populations, particularly of diving and surface-feeding ducks, gulls, and shorebirds. Sizeable flocks of Black Brant stopped and foraged at Lummi Bay during spring and additional shorebird flocks were important migrants using the flats in spring and fall."

They also established that 10,000-20,000 ducks use Lummi Bay each winter. In 1983, we counted approximately 8,000 dunlin inhabiting the study area in November and December. Both ducks and shorebirds are the main prey of peregrines wintering in western Washington (Anderson and DeBruyn, 1979).

Habitat surrounding Lummi Bay supports what we believe to be the highest density of wintering raptors in western Washington. In a two-mile distance along Hillaire Road during the study period, we counted 26 Short-eared Owls (18 December), 15 Roughlegged Hawks (19 November), 30 Northern Harriers (October), 10 Red-tailed Hawks (2 November), 6 Bald Eagles (17 November) and 10 accipitrine hawks (11 November).

In addition to peregrines and merlins, which are regularly encountered on the study area, three other falcon species occur during winter, the American Kestrel, the Prairie Falcon, and the Gyrfalcon.

A list of all species of birds that we observed during the study period is included in Appendix 1.

Methods

In order to locate and study peregrines, we relied primarily on automobile travel. We drove through the study area, stopping regularly at approximately quarter-mile intervals to search for raptors with binoculars and spotting scopes. Peregrines were observed for varying lengths of time when we encountered them. All areas suitable for peregrines (e.g. open fields, mudflats, conspicuous trees) were

scrutinized closely and were often examined several times each day.

We also monitored concentrations of prey species, and by this means were able to observe peregrines hunting as they, too, sought out prey birds.

Whenever a peregrine was sighted, we attempted to keep it under observation for as long as possible. We recorded the date, time, location, age-class, sex, activity, perch type, and perch location of each sighting. All daily peregrine data were transcribed to specially prepared forms each night. In addition, all individual falcon movements were plotted on study area maps.

When a peregrine was observed capturing or eating prey, we recorded the time, location, and duration of the feeding. After the falcon finished and left the feeding site, we collected, identified and froze the prey remains whenever possible.

The contract study period extended from 2 October through 31 December, 1983. During that period, we worked in the field on 92 days. In addition, Knapp independently surveyed the Lummi flats area on 11 of 30 days in September. Data collected during that period are included in this report. During October we surveyed the study area from dawn to dark on 21 of 31 days. From 1 November through 31 December, we expanded our coverage to include every day during both months with the exception of 25 December.

The age of peregrines (adults/immature) was established by plumage pattern and color. Sex was determined by size, wingbeat, head configuration and behavior. Individual peregrines were identified by their topographic characteristics. Such features included the extent of the black cap, the configuration of the malar/auricular area, the ventral background coloration, molt pattern, presence or absence of spotting in the upper breast of adults, broken feathers, overall coloration of juveniles, nuchal collar pattern of immatures and sex/age class.

One of the goals of this study was to describe the activities of Peregrine Falcons at Lummi Bay. Therefore, during each peregrine sighting, we noted what activity each peregrine was engaged in and how long it performed that activity.

All of the various activities (and we recognized 29) were categorized under two broad headings, perching and flying. Descriptions of these activities and the frequency of their occurrence are included in the behavior section of this paper.

We used a one-minute minimum resolution in defining behavior types. For example, if a peregrine made an unsuccessful hunt lasting for 45 seconds, we counted it as a one minute activity. Intervals were always rounded to the next higher value. While this method skewed the behavioral data somewhat, we considered it to be sufficient for outlining general behavior during the study. More precise resolution was not possible under our particular field conditions.

During November, we identified the dominant adult female peregrine on the study area. We defined "dominant peregrine" as the adult female observed holding a "best" area and driving all other females from the vicinity. She was never observed being driven from this area herself.

On 1 December we trapped the female and attached an AVM single-stage radio transmitter (SM-1) to the base of her left center tail feather. A United States Fish and Wildlife Service aluminum lock-on band (No. 987-38105) was placed on her right leg.

The transmitter was encapsulated in dental acrylic and coated with 5-minute epoxy. The entire unit weighed 6 grams. We attached it to the feather by means of epoxy and a hand-molded dental acrylic "saddle" tailclip devised by Jim Weaver of Cornell University, Ithaca, New York. The antenna consisted of .006 inch diameter, two-strand, brass-plated stainless steel wire cut to 17.92 inches in length (full 1/4 wavelength at 164 MHz). The distal tip of the antenna was

soldered to prevent unravelling. The basal portion of the antenna was tied by waxed thread at three points along the feather shaft and secured by 5 minute epoxy (Cochran, 1975). Although the antenna extended 11 inches beyond the tail-tip, we never observed the falcon biting or pulling at the wire at any time. The antenna was still intact and straight 73 days later in February 1984.

We used two receivers (AVM LA-12 and RB-4) in separate cars to monitor the movements of the radio-tagged falcon over the next 30 days. Receiving antennas included a 2-element directional Yagi (Telonics RA-2AK) and an omnidirectional whip (Kulrod). Headphones were essential to reduce ambient noise, particularly while driving. A full-rotation antenna mast system was employed effectively on one vehicle.

On all days (except 3 December) subsequent to capture, we received radio signals from the unit on the falcon. When the falcon entered the mainland study area, we immediately began our attempts to locate her visually to monitor her behavior. When she left the area, we continued to search for other peregrines on the study area.

To establish if peregrines used the Aquaculture Pond area of Lummi Bay, we conducted several dike-top surveys via automobile from 26 October through 30 December (Appendix 2). Duration of the surveys varied from a minimum of 40 minutes to several hours.

Scientific names of all species referred to in this paper are listed in Apendix 1.

Historic Records of the Peregrine Falcon in Whatcom County

The first record of the Peregrine Falcon in Whatcom County is that of J.M. Edson. In a letter dated 13 December 1919 (on file at the Thomas Burke Museum, Seattle), he states that he had observed a peregrine in a cage at Fairhaven (Bellingham) on 25 September, 1890. The falcon had been "taken near here", although the exact location was unspecified. Edson did not specify whether the bird was taken as a nestling,

juvenile or adult.

Edson (1939) later collected an immature female Peale's Falcon (F.p.pealei) on 28 October 1938 in Bellingham. The specimen was subsequently lost or misplaced.

S.G. Herman (personal communication) reports that a falconer took young peregrines from a nest in Whatcom County during the 1940's. Anderson and Fackler checked this site in 1976 and 1977 and found it to be inactive. In 1980, an adult male and an immature female frequented the site and in 1981 three young, all females, were fledged there. In 1982 one young was produced and in 1983, three young were fledged. The peregrines at this eyrie are identifiable as to F.p. anatum, the primary endangered species.

Fackler began recording fall and winter peregrine sightings in the Lummi Bay region in 1968. In that year, he repeatedly observed an adult male peregrine preying on Green-winged Teal. This falcon used the exact same hunting perches that we observed peregrines using in 1983. Peregrines have been observed using the Lummi Bay area each winter since 1968.

T. Wahl, J. Duemmel, P. DeBruyn, T. Ulm, J. Fackler, D. Leo, and R. Knapp have all reported peregrines on the Lummi flats during the last decade. Several Bellingham Christmas bird counts have listed peregrines within a 15-mile perimeter of the city, usually on the Lummi flats. On the 1982 count Fackler and Duemmel observed an apparent pair of adult peregrines near the Lummi Aquaculture Pond. We observed the same phenomenon in 1983 at the identical location. Knapp repeatedly observed peregrines on the Lummi flats during the 1982/83 winter season. His data are summarized in Table 1.

In summary, historic records demonstrate that the Peregrine Falcon has had a long association with the Lummi Bay area and occurs there commonly during at least the fall and winter.

Taxonomic Status of the Lummi Bay Peregrines

The Peregrine Falcon is a cosmopolitan species

TABLE 1

PEREGRINE OBSERVATIONS, LUMMI FLATS, 1982/83

by R. Knapp

DATE	AGE/SEX
16 December 1982	Adult Female
19 December 1982	Adult Female
20 December 1982	Adult Female
2 January 1983	Adult Female
5 January 1983	Adult Female
7 January 1983	Immature Female
8 January 1983	Adult Female
12 January 1983	Adult Female
17 January 1983	Adult Female
22 January 1983	Adult Female
25 January 1983	Adult Female
28 January 1983	Adult Female
1 February 1983	Adult Female
6 February 1983	Immature Male
7 February 1983	Adult Female
11 February 1983	Adult Female
13 February 1983	Adult Female
19 February 1983	Adult Female
27 February 1983	Adult Female
28 February 1983	Adult Female
3 March 1983	Adult Female
6 March 1983	Adult Female

occurring on all continents except Anarctica (Brown and Amadon, 1968). Three subspecies are currently recognized to inhabit North America (White, 1968): the Continental Peregrine (F.p. anatum), the Peales Falcon (F.p. pealei) and the Tundra Falcon (F.p. tundrius). In 1968, both the anatum and tundrius races were classified as endangered species by the United States Fish and Wildlife Service.

All three North American subspecies occur in Washington State. Both anatum and peali nest here (Dawson and Bowles, 1909; Jewett et al., 1953) and tundrius passes through the state during fall and presumably spring migration periods (Herman and Bulger, 1981; Anderson, unpublished data). In 1981, the Washington State Department of Game classified the Peregrine Falcon, including all subspecies, as endangered in Washington State.

Beebe (1960) was the first to report that large numbers of Peregrine Falcons wintered in the Pacific Northwest. Puget Sound has the highest wintering densities of Peregrine Falcons thus far reported in North America (Anderson and DeBruyn, 1979). During the 1960's, the vast majority of wintering peregrines were believed to be Peales Falcons (Jewett et al., 1954). Subsequent studies during the 1970's (Anderson et al., 1980) in Skagit County, Washington, revealed that a significant number of anatum peregrines also wintered in the Puget Sound Basin. In 1980, an adult female anatum peregrine was radio-tracked from her wintering grounds on the Samish flats to her eyrie in the Cascade Range of southern British Columbia, confirming its subspecific status (Anderson et al., 1980).

During this study, we observed classic examples of both anatum and Peales Falcons on the Lummi flats. As usual, we also observed several peregrines that we could not determine to subspecies. Because the ranges of two subspecies (pealei and anatum) converge in this part of the Northwest, intergrades can be expected, especially in the wintering population. Additionally, geographic races are seldom so

distinct that all individuals can be referred to race. In this study, we have identified individual peregrines to subspecies only when they were phenotypically characteristic of a race (subspecies).

Results and Discussion

We observed Peregrine Falcons on 74 of the 92 days. Sighting ratios (days with falcons sighted/days with no falcons sighted) increased each month from 45% of all observation days in September (5/11) to 76% in Octob (16/21), 86% in November (26/30) and 90% in December (27/30). Overall, we saw peregrines on 80% of the field days. The increase in ratio was due, at least in part, to increased familiarity with peregrines on the study area.

We observed peregrines 207 times, an average of 2.25 sightings per field day. The shortest sighting lasted less than a minute and the longest (16 December) extended for 6 hours and 6 minutes (1012-1618). We defined a winter sighting as "visual contact with a peregrine separated by 5 minutes from the next sighting of the same bird".

We failed to locate peregrines on 18 days; six days in September, 5 days in October, four days in November and three days in December. Particularly inclement weather conditions, usually high winds, prevailed on the majority of field days without peregrine sightings.

Sex/Age Classes

Adult females dominated the study area both behaviorally and in terms of frequency of sightings. We observed them 142 times (69% of total). Adult males accounted for 17 sightings (8% of the total). We observed immature females 13 times (6%) and immature males 7 times (3%). Peregrines of undetermined sex and/or age class made up the remaining 28 sightings.

TABLE 2

INDIVIDUAL PEREGRINES, LUMMI BAY, WASHINGTON. FALL, 1983

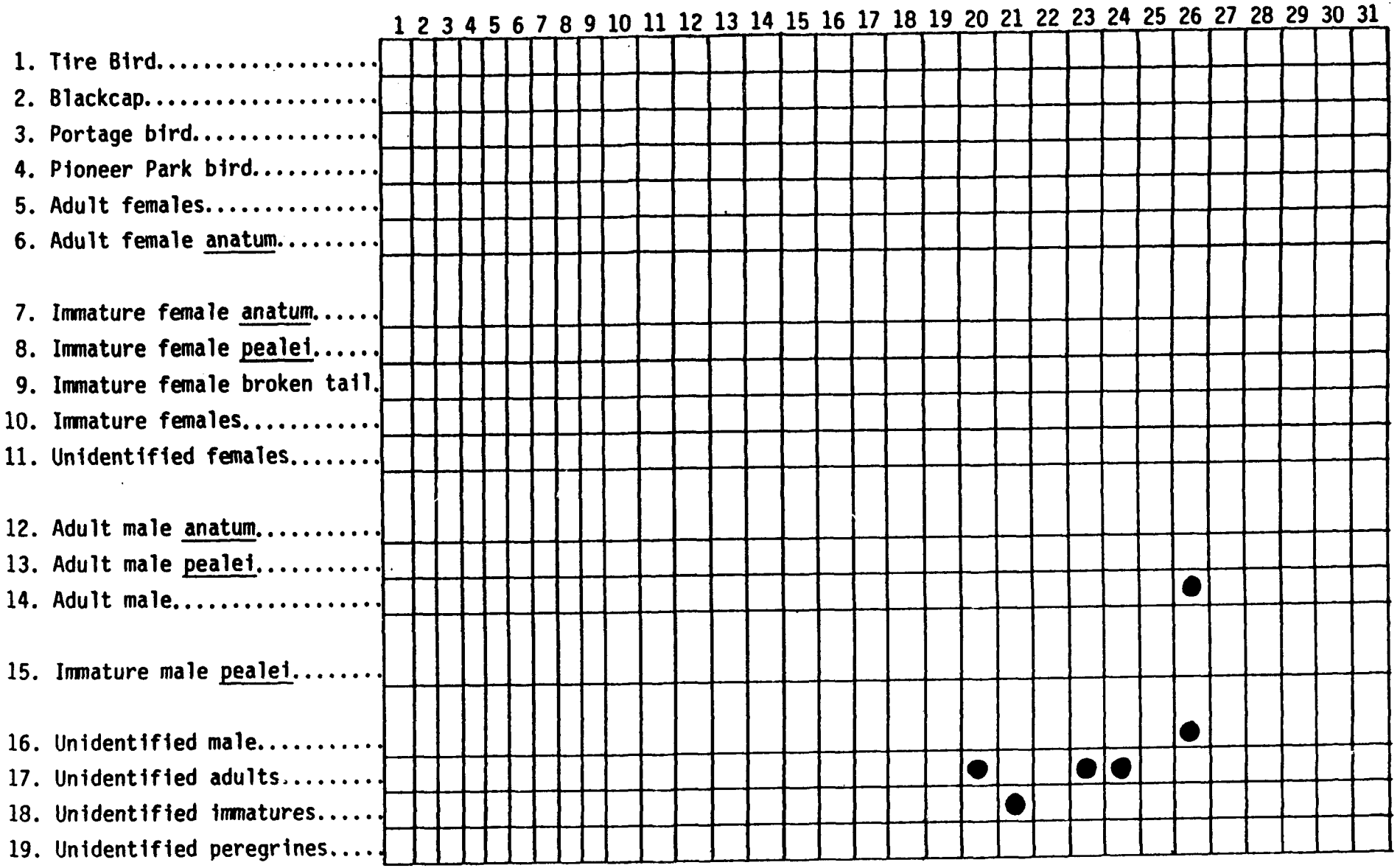
AGE/SEX	INDIVIDUAL	# OF DAYS OBSERVED
Adult Females:	"Tire Bird"	33
	"Blackcap"	6
	"Pioneer"	3
	"Lookalike"	1
	"Aquapond"	1
	Anatum	1
Immature Females:	"Blue Bomber"	1
	"Brokentail"	1
	Anatum	1
	"Blondie"	1
Adult Males:	"Spotted Breast"	1
	"Clear Breast"	1
	Anatum I	1
	Anatum II	1
Immature Male:	"Double-crescent Bird"	1

Sightings by sex/age class are listed in Tables 3, 4, 5 and 6. Each dot may represent more than one bird.

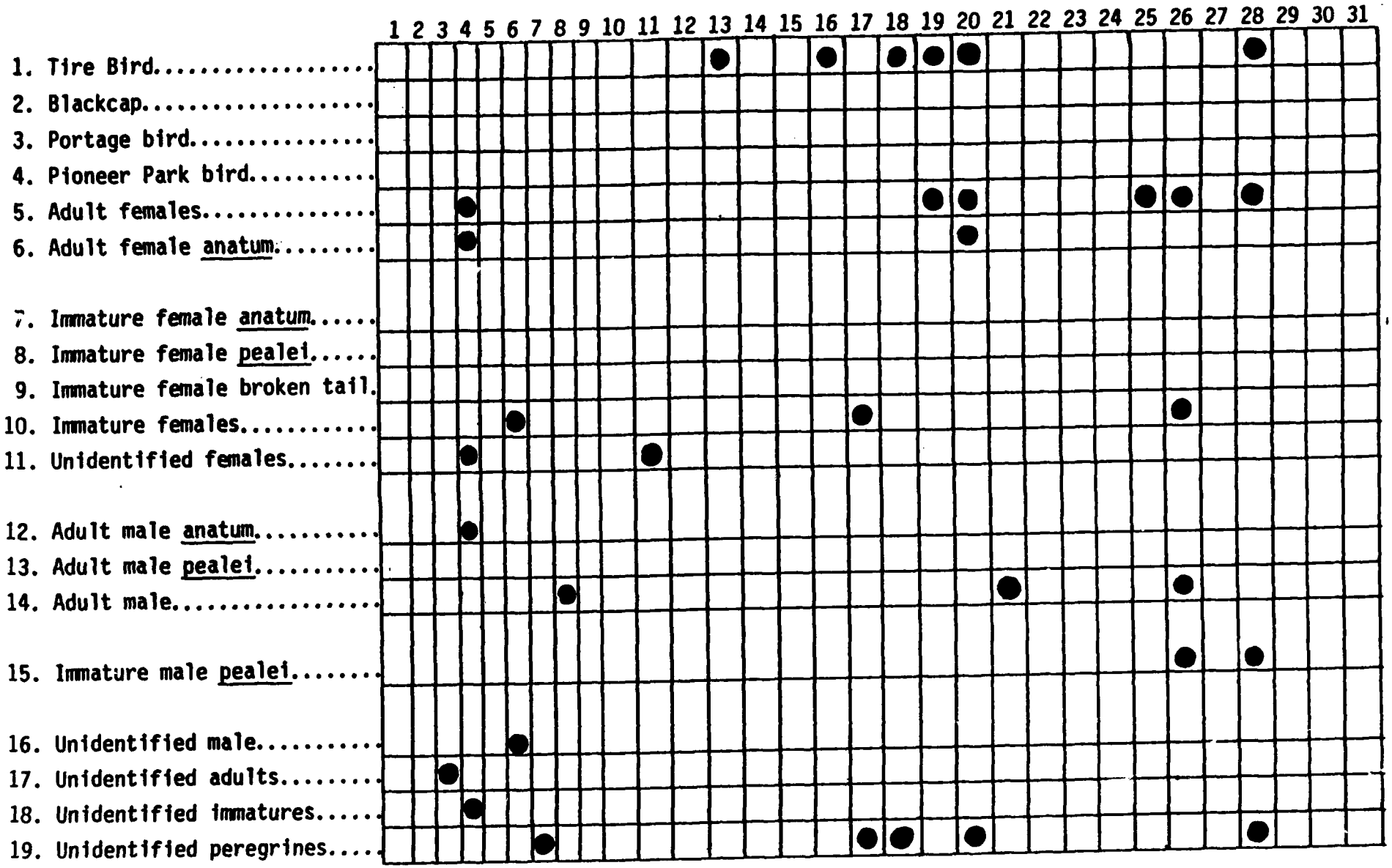
TABLES 3-6

Monthly Sightings by Age/sex Class, September through December

SEPTEMBER


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
1. Tire Bird.....
2. Blackcap.....
3. Portage bird.....
4. Pioneer Park bird.....
5. Adult females.....
6. Adult female anatum.....
7. Immature female anatum.....
8. Immature female pealei.....
9. Immature female broken tail.
10. Immature females.....
11. Unidentified females.....
12. Adult male anatum.....
13. Adult male pealei.....
14. Adult male.....
15. Immature male pealei.....
16. Unidentified male.....
17. Unidentified adults.....
18. Unidentified immatures.....
19. Unidentified peregrines.....

OCTOBER


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
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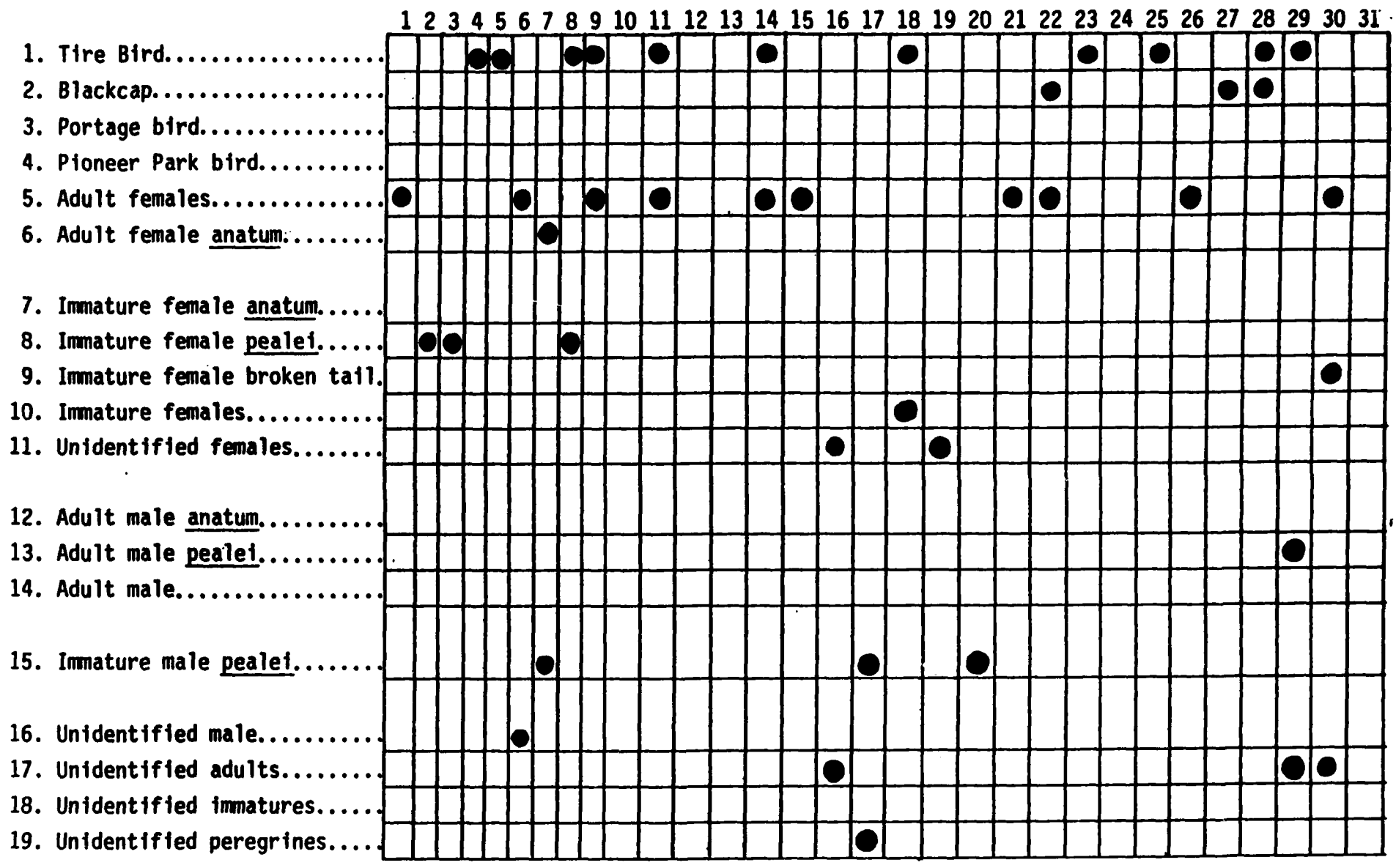
10. Immature females.....
11. Unidentified females.....
12. Adult male anatum.....
13. Adult male pealei.....
14. Adult male.....
15. Immature male pealei.....
16. Unidentified male.....
17. Unidentified adults.....
18. Unidentified immatures.....
19. Unidentified peregrines....

NOVEMBER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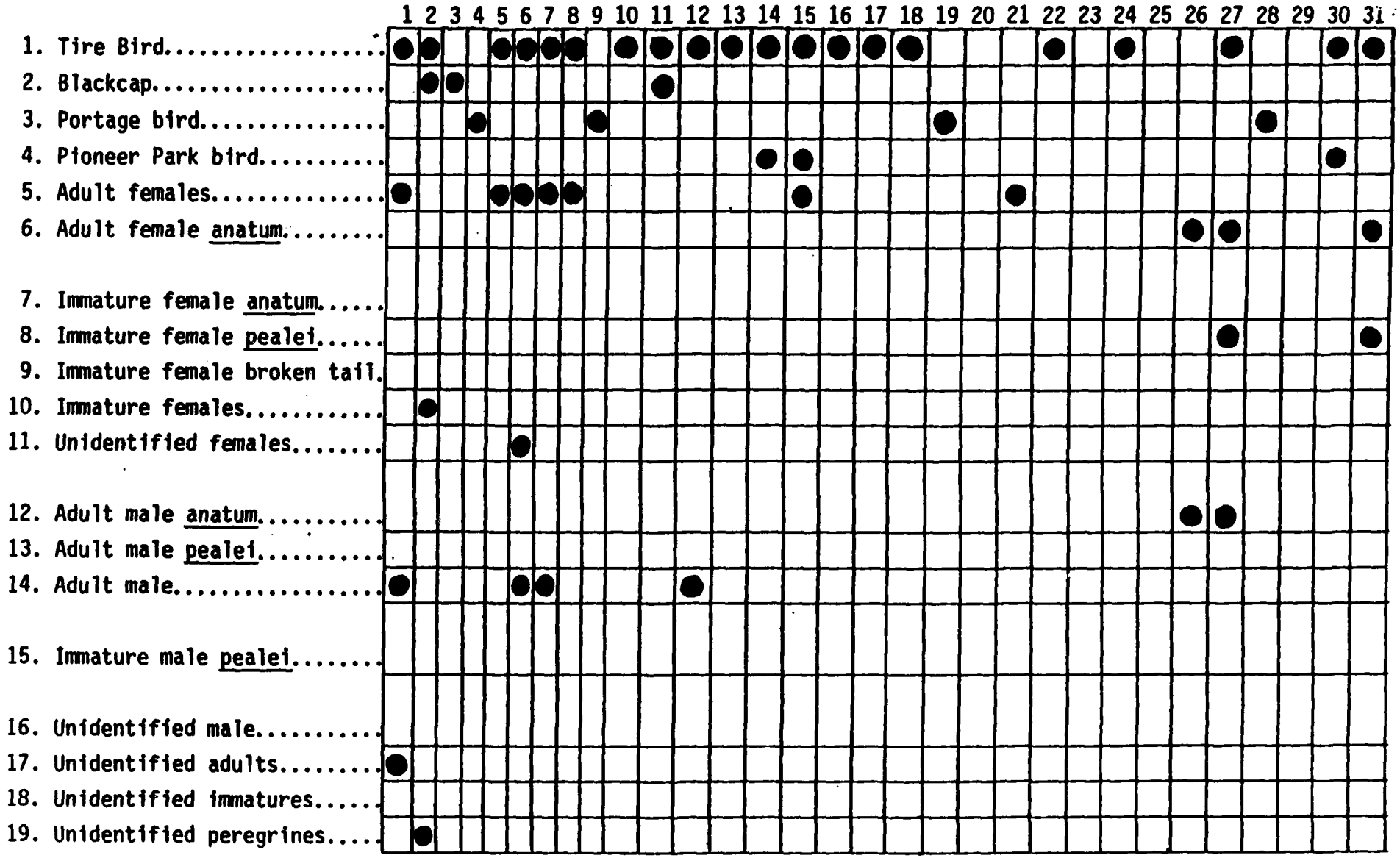
11. Unidentified females.....
12. Adult male anatum.....
13. Adult male pealei.....
14. Adult male.....
15. Immature male pealei.....
16. Unidentified male.....
17. Unidentified adults.....
18. Unidentified immatures.....
19. Unidentified peregrines....

DECEMBER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1. Tire Bird
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8. Immature female pealei
9. Immature female broken tail
10. Immature females
11. Unidentified females
12. Adult male anatum
13. Adult male pealei
14. Adult male
15. Immature male pealei
16. Unidentified male
17. Unidentified adults
18. Unidentified immatures
19. Unidentified peregrines

Minimum Number of Peregrines Using the Study Area During Fall

By identifying individual peregrines, we discovered that a minimum of 15 falcons occurred on the Lummi Bay region during the fall study period. Each of the four sex/age classes are represented among the 15 individual peregrines; 6 adult females, 4 adult males, 4 immature females and 1 immature male.

A compilation of the 15 individuals with their reference names and the known number of days each was observed is included in Table 2.

Information on the 15 individual peregrines is summarized below.

A. Adult Females

1. "Tire Bird" - The dominant adult female peregrine on the Lummi flats and our main subject of study. Captured and radio-tagged on 1 December 1983. First observed on study area on 13 October. Heavily spotted on bib, specialized in capturing Green-winged Teal. Named for habit of perching on tire in Lummi Bay. Right wing = 362 mm, left wing = 370 mm, tail = 181 mm, weight = 1,206 grams. Outer tail feathers (#2 and 11) still completing molt. Seventy-seven sightings between 13 October and 31 December.

2. "Blackcap" - A falcon that habitually perched inland in a deciduous tree near Slater Road and Haxton Way. Had a full, distinctive "cap" or "helmet", light spotting in the bib. Followed both in and out of the study area past Sandy Point, apparently roosting in the San Juan Islands. Habit of robbing harriers of food. First identified on 22 November, six sightings between then and 11 December (22, 27, 28 November, 2, 3, 11 December).

3. "Pioneer" - Hunted ducks in area just south of Pioneer Park near Ferndale. Also flew southwest in the evening toward San Juan Islands. Full black cap. Slight rufous cast to lower abdomen. Difficult to separate from "Blackcap". First sighted on 14 December (14, 15, 30 December).

4. "Aquapond" - Seen one day (6 December) at south end of Aquaculture Pond near Headquarters Building. Ranged north to mid-Hillaire Road. "Isolated" malar (i.e. no full cap). Possibly falcon from Portage Island.

5. "Lookalike" - Seen one day (6 December) at Hillaire Road. Drove Aquapond bird from area. Identical in appearance to the tire bird.

6. Anatums - We identified adult female anatum peregrines on six occasions: 20 October, 7 November and 26, 27, 30, 31 December. We do not know how many individual falcons were involved in the sightings.

B. Immature Females

7. "Blue Bomber" - An extremely large peregrine, believed to have been seen several times.

8. "Broken Tail" - A Peales Falcon very similar to bird #7, but having at least two tail feathers that appeared to be broken or damaged. Possibly the Blue Bomber, although another full-tailed immature female was sighted subsequent to this bird (1 sighting).

9. Anatum - One sighting of a very brown peregrine in October.

10. "Blondie" - One sighting of an extremely pale-headed female during migration. Possibly an example of F.p. tundrius.

C. Adult Males

11. "Spotted-Breast" - An adult with a heavily-spotted breast against a solid-white bib background color.

12. "Clear-Breast" - A second white-fronted adult male, only with a completely clear, instead of spotted, breast.

13/14. Anatums - Two adult male salmon-breasted peregrines were observed interacting together along Hillaire Road on 4 October by Knapp. They were seen with an adult female anatum.

D. Immature Male

15. "Double-Crescent Bird" - An immature male Peales Falcon, named for the distinctive, dual-scimitar shape of its nuchal collar. Observed at least twice on the study area.

It was not unusual to find more than one peregrine on the study area on a single day. In fact, the number varied from zero to as many as six individual falcons on different days. Knapp observed six different peregrines on 4 October 1983. Table 7 lists in calendar form how many individual peregrines we observed on each day of the study.

Comments on Distribution

The distribution of peregrines in Whatcom County is extremely complex. Our results reflect several biases inherent to our study. First, we focused our research primarily on the Lummi Bay area. Second, we spent the majority of our time following the radio-tagged adult female which dominated this area. While at least 14 other peregrines occurred on the study area, we know very little about their individual ranges outside Lummi Bay thus far.

We did establish that the radio-tagged female spent the majority of her time at Lummi Bay perched atop the conifers at the north end of the Bay. Her second favorite area included perches on the mudflat area near the Aquaculture Pond.

Ranges During the Fall Months

The fall range of the radio-tagged peregrine is shown on Map 2. This range is based on 77 actual sightings over an 85 hour and 16 minute observation period. While the mainland range (including Lummi Island) is based on sightings, the areas on Orcas and Matia Island were extrapolated through radio-triangulation. The radio-tagged falcon was on this range by mid-October at least, suggesting that she will occupy the area for approximately five months if she leaves, as expected, in mid-March.

The range of this study bird is the largest in area so far documented in Washington State (Anderson and DeBruyn, 1979; Anderson et al., 1980). Four of the winter ranges

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
SEPTEMBER																				1	1		1	1		2					
OCTOBER			1	6		2	1	1			1		1			1	2	1	2	2	1				1	4		2			
NOVEMBER	1	1	1	1	1	2	2	2	1		1			2	1	1	1	2	1	1	1	2	1		1	1	1	2	2	2	
DECEMBER	2	4	1	1	2	5	3	2	1	1	2	2	1	2	2	1	1	1	1		1	1		1		2	4	1		2	3
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

TABLE 7 Number of Individuals Sighted Per Field Day.

established during the latter two studies on the Samish Flats are also included in Map 2, for comparison.

It is not yet known how similar fall ranges are to winter ranges in the Puget Sound Basin.

The partial ranges of two other adult female peregrines (Blackcap and Portage) are indicated by dashed lines in Map 2. The purpose for their inclusion is to illustrate the degree of spacing of adult female winter ranges and to suggest a direction for future research. Brief descriptions of these ranges are included below.

1. Blackcap (based on six sightings)

The range of this bird minimally included the inland areas of the Lummi flats from Ferndale to Marietta and west to Lummi Bay. There is some evidence to indicate that her area extended northeast across the I-5 freeway. The falcon was sighted most often in the area around the Slater Road-Haxton Way junction. This range was also used by the radio-tagged falcon.

2. Portage Bird (four sightings)

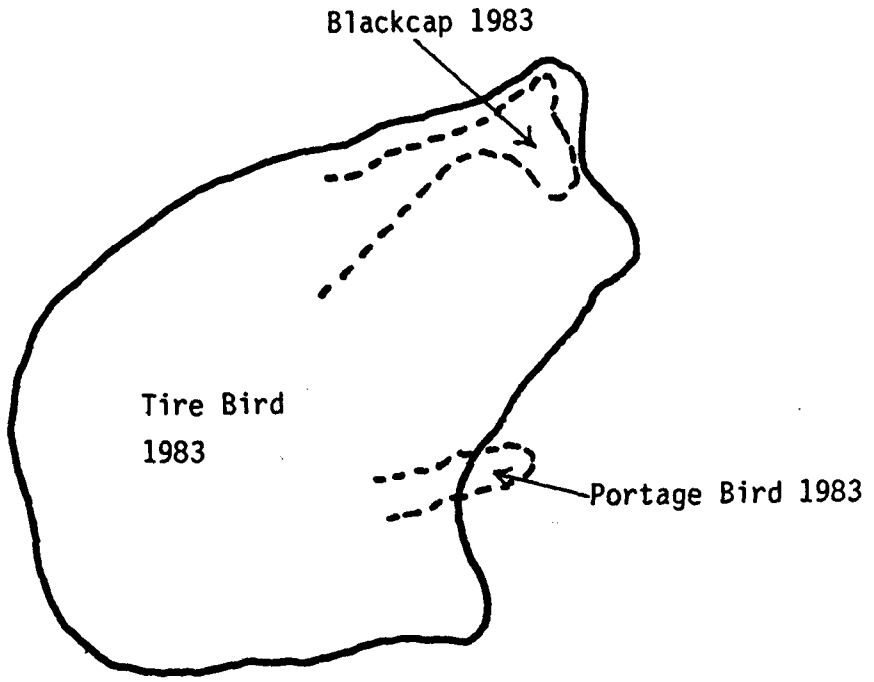
Four observations of an adult female peregrine perched on Brant Point and the portage at Point Francis. Thought to be the same bird, although not established positively. Hunted salt-water bay north of Point Francis. Flew west over Lummi Island to roost.

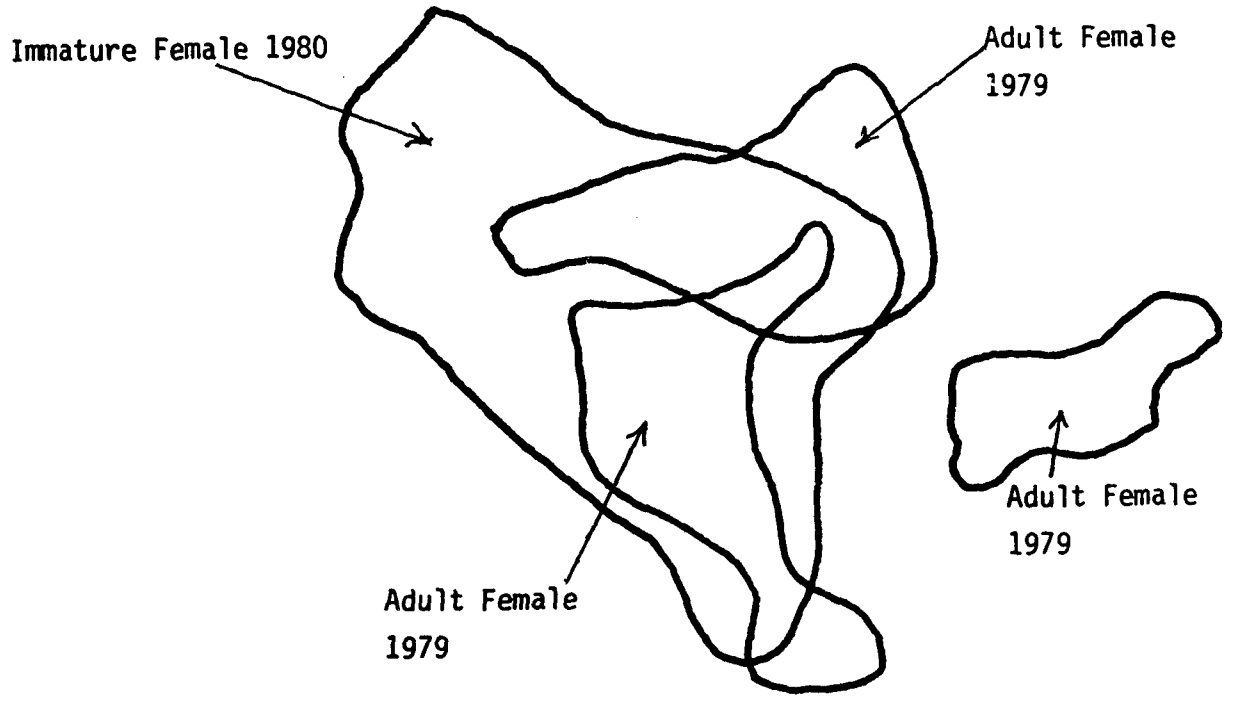
3. Pioneer Park (three sightings)

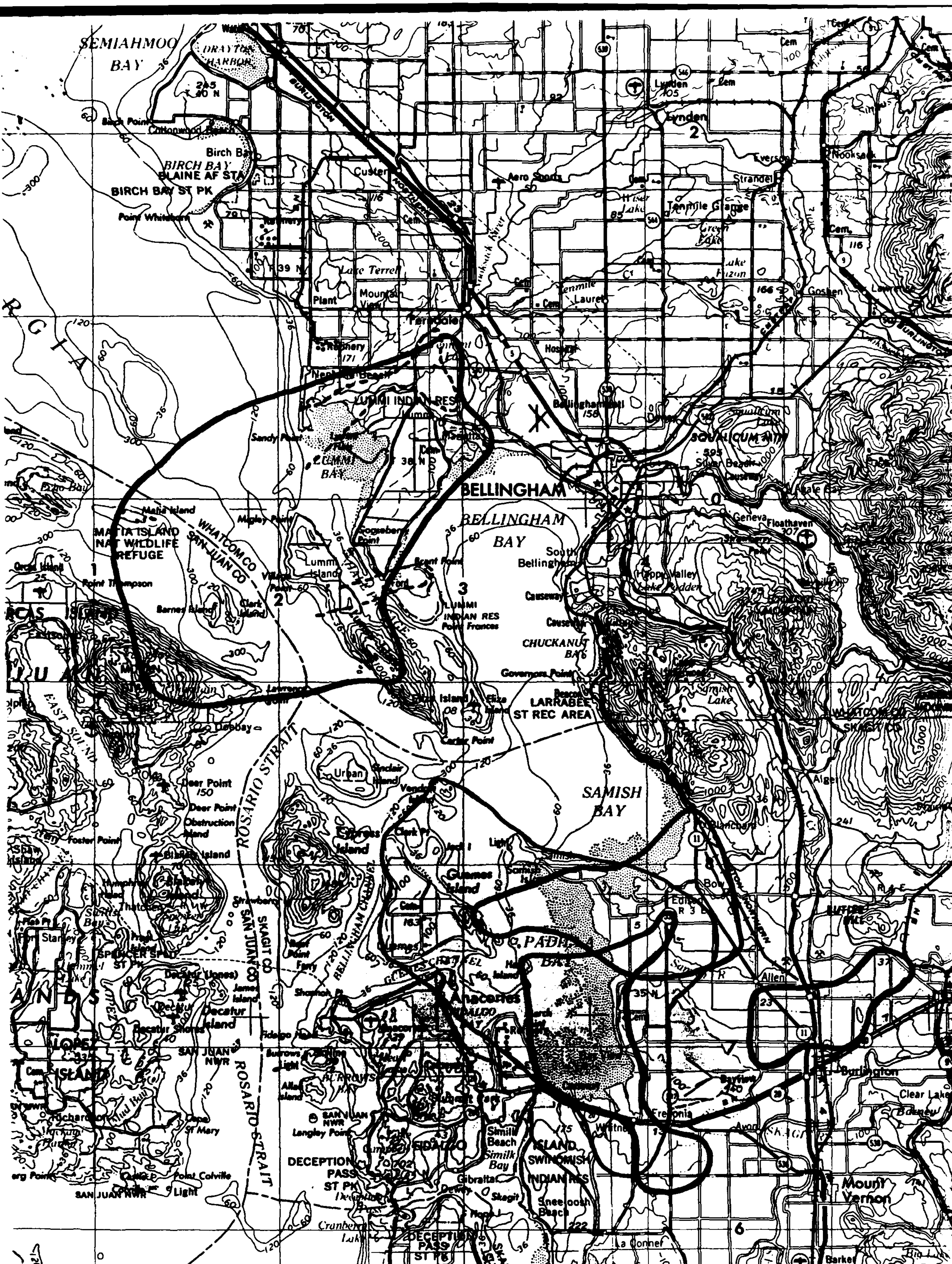
Observed perching and hunting in the area just south of Ferndale along the Nooksack River. Range not indicated on Map 2. Falcon flew southwest as far as Lummi Bay en route to roost. Also observed during January 1984.

The distribution of peregrines during winter in western Washington appears to coincide with the availability of prey and open hunting habitat. Peregrines are, in our experience, most often encountered in winter on flat, open areas such as mudflats or agricultural fields. The best known regions for peregrines in the state are always associated with salt-water coastlines (Anderson, unpublished data).

MAP 2. Peregrine Range During Fall, 1983.


Blackcap 1983
Tire Bird
1983
Portage Bird 1983


Immature Female 1980
Adult Female
1979
Adult Female
1979
Adult Female
1979



SEMIAHMOO BAY
DRAYTON HARBOR
Birch Point
Cottonwood Beach
Birch Bay
BIRCH BAY
BLAINE AF STA
BIRCH BAY ST PK
Point Whitehorn
Custer
Lynden
Everson
Nooksack
Strandel
Aero Sports
Tenmile Grange
Lake Terrell
Mountain View
Laurel
Goshen
Ferndale
Neptune Beach
LUMMI INDIAN RES
Sandy Point
LUMMI BAY
Bellingham Intl
SQUALICUM MTN
BELLINGHAM
BELLINGHAM BAY
Geneva
Floathaven
South Bellingham
Lake Padden
Matia Island
MATIA ISLAND NAT WILDLIFE REFUGE
WHATCOM CO
SAN JUAN CO
Point Thompson
Barnes Island
Clark Island
Lummi Island
Migley Point
Brant Point
Point Frances
CHUCKANUT BAY
Governors Point
LARRABEE ST REC AREA
Eliza Island
Carter Point
WHATCOM CO
SKAGIT CO
Sinclair Island
Vendovi Island
SAMISH BAY
ROSARIO STRAIT
Deer Point
Obstruction Island
Blakely Island
Cypress Island
Guemes Island
Samish Island
Blanchard
Alger
Bow
Edison
Allen
Decatur Island
James Island
Anacortes
Burlington
Bay View
Fredonia
Clear Lake
Similk Beach
Similk Bay
SWINOMISH INDIAN RES
DECEPTION PASS ST PK
Point Colville
Mount Vernon
La Conner

Although peregrines are capable of a free-ranging existence (e.g. during migration) and could conceivably move over large distances from area to area on a random basis during winter, recent studies (Anderson et al., 1980; Anderson and DeBruyn, 1979) have demonstrated that at least three adult female peregrines wintering on the Samish flats were quite regular in their use of specific ranges. Each bird has also shown a high degree of winter philopatry, returning to the same area year after year. Within its range, the dominant falcon uses several perches, some regularly, some infrequently.

We have observed peregrines leaving their main wintering areas and flying to seldom-visited "alternate areas" on three occasions, one in 1979, one in 1983 and one in 1984 (Anderson and DeBruyn, 1979; this study). The alternate areas were located 18, 4 and 18 miles from the main ranges. In all three instances, the falcon spent several hours at the alternate area before returing to the main range. The two areas of the radio-tagged falcon from this study were located at the mouth of the Nooksack River and at Sumas, Washington (18 miles).

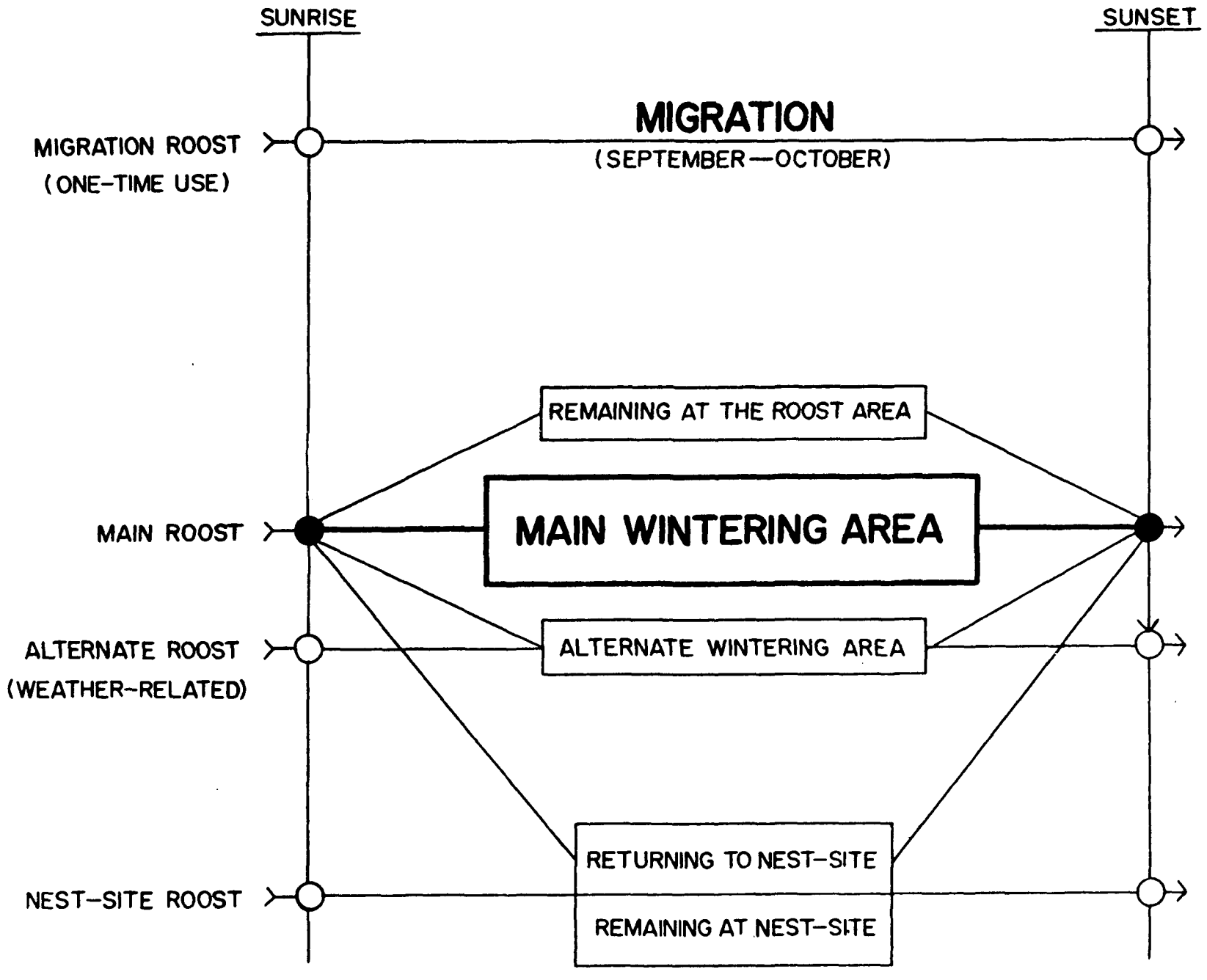
Figure 1 represents the theoretical locations of adult peregrine falcons during the fall and winter months in the Puget Sound Basin. It is based on our combined experience studying wintering peregrines during six seasons of field studies from 1976 through 1983. It is presented here to suggest where others might look for peregrines and to encourage further research.

Behavior

The typical pattern of daily peregrine behavior at Lummi Bay in fall usually included the following nine elements:

1. At the roost
2. Incoming flight from the roost to the mainland
3. Perching (multiple)
4. Hunting (multiple)

Figure 1. Theoretical Locations of Adult Peregrines During Fall and Winter Months in the Puget Sound Basin.


SUNRISE
SUNSET
MIGRATION
(SEPTEMBER—OCTOBER)
MIGRATION ROOST
(ONE-TIME USE)
REMAINING AT THE ROOST AREA
MAIN ROOST
MAIN WINTERING AREA
ALTERNATE ROOST
(WEATHER-RELATED)
ALTERNATE WINTERING AREA
RETURNING TO NEST-SITE
NEST-SITE ROOST
REMAINING AT NEST-SITE

5. Killing
6. Eating
7. Perching (multiple)
8. Outgoing flight to roosting area
9. At the roost

The elapsed time to complete this pattern or daily cycle varied considerably, depending primarily on hunting success. For example, on 14 December, the radio-tagged falcon completed the entire process in approximately one hour and then returned to the roosting area where she spent the remainder of the day. On other days, she took the majority of the daylight hours to go through the process.

Each of the elements of the daily cycle are important and are discussed in the following sections (perching, hunting behavior, feeding, roosting).

The behavioral aspect of this study was based on 154 hours and 46 minutes of direct observation of peregrine activities completed during the three month study period. Perching activities accounted for 84% of the total time (130 hours and 31 minutes), while flying activities accounted for 16% (24 hours and 15 minutes). We identified 29 specific peregrine activities, four within the perching category and 25 within the flying category. They are listed in Tables 8 and 9. Most of the activities listed are self-explanatory, although a few require clarification and are described below.

Flying

Undetermined flights include flights not observed at either their start, finish or both. Crabbing refers to birds grabbing at each other in mid-air with the feet. Stooping signifies diving at another bird. "Play-stooping" involves playful diving at other birds (often not prey species) without intending to capture them. A post-pirated kill flight occurs when a peregrine flies away from a location where its kill was kleptoparasited (robbed) by another raptor.

Perching

This category includes all activities that do not

TABLE 8

PEREGRINE ACTIVITIES WHILE FLYING

ACTIVITY	FREQUENCY OF OCCURRENCE	TOTAL TIME
1. Undetermined flight	120	5:45
2. Perch to perch flight	101	2:39
3. Hunting flight (successful)	34	1:27
4. Hunting flight (unsuccessful)	119	5:05
5. Carrying prey	25	:41
6. Flight toward roosting area	20	1:32
7. Flight in from roosting area	3	:03
8. Flying with male peregrine	1	:01
9. Flying with female peregrine	1	:01
10. Soaring	46	3:58
11. Soaring with peregrine	4	:48
12. Stooping at peregrine	6	:22
13. Crabbing with peregrine	12	:16
14. Chased by peregrine	3	:07
15. Chased by redtail while laden	1	:01
16. Stooping at redtail	5	:06
17. Stooping at harrier	7	:18
18. Stooping at Bald Eagle	4	:14
19. Crabbing with harrier	1	:01
20. Hovering over kill in water	1	:01
21. Defending kill	2	:02
22. Flushed from kill	1	:07
23. "Play-stooping"	3	:45
24. Stooping at Great Blue Heron	1	:02
25. Post-pirated kill flight	1	:03
	522 Total	24:15 Total

TABLE 9

PEREGRINE ACTIVITIES WHILE PERCHED

ACTIVITY	FREQUENCY OF OCCURRENCE	TOTAL TIME
26. Perching (resting, hunting)	317	111:53
27. Bathing	5	:45
28. Feeding related behavior	19	:42
(eating prey)	30	(8:04)
29. Trapping efforts	9	5:07
	380	130:31

involve active flight. They include perching (resting and hunting), bathing, our trapping attempts, and feeding-related behavior (e.g. walking to kill, perched on kill, etc.). Incidentally, preening activity took place sporadically throughout the day and on a variety of perches.

There are three major, critical peregrine activities (excluding roosting) that occur during the fall and winter at Lummi Bay. They are perching, hunting and feeding. Peregrines require a variety of perches to rest on and hunt from. They need an adequate amount of prey to capture and eat. Finally, they must have suitable areas to eat their quarry without interruption from man or other animals. The areas that met these requirements most often were coniferous trees, mudflats, inland fields and the Aquaculture dike. This is a clear example of distribution being related to the behavioral needs of the species. A discussion of each of the four habitats is included below.

Conifers

We observed peregrines most often in conferous trees located along the wooded ridge at the north end of Lummi Bay. The same area was used by peregrines in 1968 (see Historical Records) and probably each year since. Falcons apparently prefer this area for three reasons. First, the perches provide an excellent vantage point of Lummi Bay and its duck flocks. Second, the trees are located in an area that probably receives the least human disturbance of any location around Lummi Bay. Third, the elevation and height of the trees allow rapid acceleration at the beginning of hunts. The falcons appeared to favor three individual trees along the ridge. All three were over 100' high and two had dead, bare branches at their tops. Peregrines always perched in the tops of the three trees which appeared to be Douglas firs (Pseudotsuga menziesii).

Mudflats

We repeatedly observed peregrines utilizing the mudflats of Lummi Bay for perching, hunting and feeding. Perch

types included mudflat (11), partially buried logs (26) and discarded automobile tires (12). Total perching time in this habitat was 16 hours, 41 minutes (approximately 13% of the perching time).

The mudflat area was used for perching most often during October when the diurnal tides were low. During November and December the same area was usually unavailable because of high diurnal tides. The majority of mudflat use was by the radio-tagged falcon, who favored two perches located just north of the Aquaculture dike.

Inland Fields

This category includes plowed fields (14), cut corn fields (25), grassy fields (11), cottonwoods (25), deciduous trees (21), and the Haxton-Slater maple (12). Several different peregrines were observed using this habitat including the radio-tagged bird.

Falcons utilized these habitats for a variety of purposes including hunting, perching, feeding, "socializing", and bathing.

Aquaculture Dike

The Aquaculture dike was used on a daily basis by several species of raptors. We observed Bald Eagles, Red-tailed Hawks, Northern Harriers, Peregrine Falcons, Merlins, Coopers Hawks and Short-eared Owls all hunting the area. The dike was used as a hunting perch, feeding location and roost (owls). The outer pilings (62) located on the southwest side of the dike were used occasionally by Bald Eagles. The inner pilings (103) were used by Bald Eagles, redtails, harriers and peregrines. Eagles, buteos and harriers prey on sick and crippled ducks that concentrate along the dike. During almost all dike censuses, we observed either crippled ducks or their remains on the dike top. We saw raptors feeding on ducks on the dike in excess of 20 times.

Peregrines used the road on the dike for feeding. The area located at the northwest seagate was a favored site. We observed peregrines eating there four times and one time 1/2

mile further south on the dike. In addition, we saw peregrines carrying prey to the dike twice but could not locate them later. Finally, we collected approximately eight additional kills that appeared to be peregrine prey based on their appearance (heads gone, necks broken, sternums notched).

The Pond itself provides an excellent hunting habitat for peregrines as well as excellent cover for ducks and shorebirds. We observed peregrines hunting there 11 times, twice successfully.

At least seven individual peregrines were seen within the Aquapond boundaries during the study period.

Perching

We identified 18 perch types used by peregrines during this study. Each perch type and the frequency of its use is listed in Table 10. The major perch type was coniferous trees. Perching activity can include resting or hunting.

Hunting

We defined a hunt as any flight during which a peregrine attempted to capture prey, whether successful or not. We observed 153 hunting flights during the study period. Some hunts contained multiple attempts at several different prey species; some contained a single attempt at one bird. We considered a hunt as successful if the peregrine either caught or knocked down the prey, even if it was not killed or retrieved.

Of the 153 hunting flights, falcons caught prey on 33, a relatively high success rate of 22%. The large majority of hunts were unsuccessful (78%).

In comparison, Rudebeck (1950-51) documented a success rate of 7.5% in migrant peregrines at Falsterbo, Sweden and Dekker (1980) reported a range of 2.4-9.8% success in peregrines migrating through Alberta.

During this study the average duration of a successful hunt was 2.5 minutes; for unsuccessful hunts 2.6 minutes.

We observed hunts on an almost daily basis. Hunting flights took place over virtually every segment of Lummi Bay,

TABLE 10

PEREGRINE PERCH TYPES

PERCH TYPE	TOTAL TIME USED	# TIMES RECORDED
1. Conifer	58:40	136
2. Tire on mudflat	9:26	12
3. Log on beach	9:04	18
4. Cut-corn field	8:33	25
5. Cottonwood (*Populus* Spp.)	5:56	6
6. Log on mudflat	5:35	26
7. Unidentified, deciduous tree	4:50	21
8. Plowed field	4:15	14
9. Maple (*Acer* Spp.)	3:12	12
10. Grassy field	1:58	11
11. Mudflat	1:40	11
12. Piling	1:34	17
13. Vertical stick in marsh	:35	1
14. Aquadike rock	:23	2
15. Ice in Aquaculture pond	:04	2
16. Aquadike log	:04	1
17. Cliff	:01	1
18. Unidentified	:03	1
	115:53	317

including the Aquaculture Pond and mudflats (Table 11). They occurred under a variety of conditions, morning and afternoon, high-tide and low-tide, in sun and in rain. Data on the hunting locations are biased by both our location (which usually tended to be near the Bay) and by the presence of the radio-tagged bird.

Peregrines are predators. They have evolved into somewhat specialized feeders, preferring to capture flying birds during the daylight hours. Their hunting flights are aerial and often spectacular.

Temporally, their hunting behavior may occupy a relatively short part of the daily cycle, depending on hunting success. Beebe (1960) recognized that peregrines not only require sufficient number and variety of prey to hunt but also opportunities to capture their quarry. In western Washington and elsewhere peregrines are known to prefer hunting over areas where prey can be pursued without recourse to cover. They also favor areas where prey can be retrieved if struck down.

Open substrates such as mudflats, agricultural fields and bodies of water all form excellent peregrine hunting habitat. At Lummi Bay, all of these factors (high prey density, opportunity to hunt and open substrate) combine to produce an ideal location for wintering peregrines.

Prey Species

We observed peregrines hunting a wide variety of prey during the study. Virtually all of the hunted species were birds. For the purpose of discussion, we have divided the prey species into two categories: those that were pursued during unsuccessful flights and those that were captured by peregrines during successful flights. We consider this division to be necessary to separate the successful hunts (characterized by capture of prey) from the unsuccessful hunts. Although the latter are always the result of a subjective value judgment by the observer, we believe that

TABLE 11

PEREGRINE HUNTING LOCALITIES

TOTAL HUNTS

(153)

Lummi Bay	104	(68%)
Aquapond	11	(7%)
Haxton-Slater Area	6	
Hillaire Road	6	
Ferndale Road	5	
White Bridge Area	4	
Portage Bay Area	4	
Sandy Point Area	3	
Pioneer Park Area	3	
Golf course area	3	
Northeast Aquapond fields	2	
Mouth of Nooksack	1	
Haxton/Smuggler Slough field	1	
	153	

they were in fact hunts in earnest.

Target species hunted unsuccessfully by peregrines are shown in Table 12. The majority of species (101 hunts) were ducks and shorebirds. Three of the flights included attempts at more than one type of prey. Most flights consisted of multiple attempts to capture.

We observed peregrines capturing and/or eating prey 42 times (Table 13). Forty-one items were birds and one item was unidentified. At least 10 bird species were taken as food (Table 14). The majority of prey consisted of ducks (67%) and shorebirds (16%) as shown in Table 15. In general, an individual peregrine killed and ate one small duck (e.g. Green-winged Teal) per day in the Lummi Bay region. Locations of 33 kills are shown on Map 3.

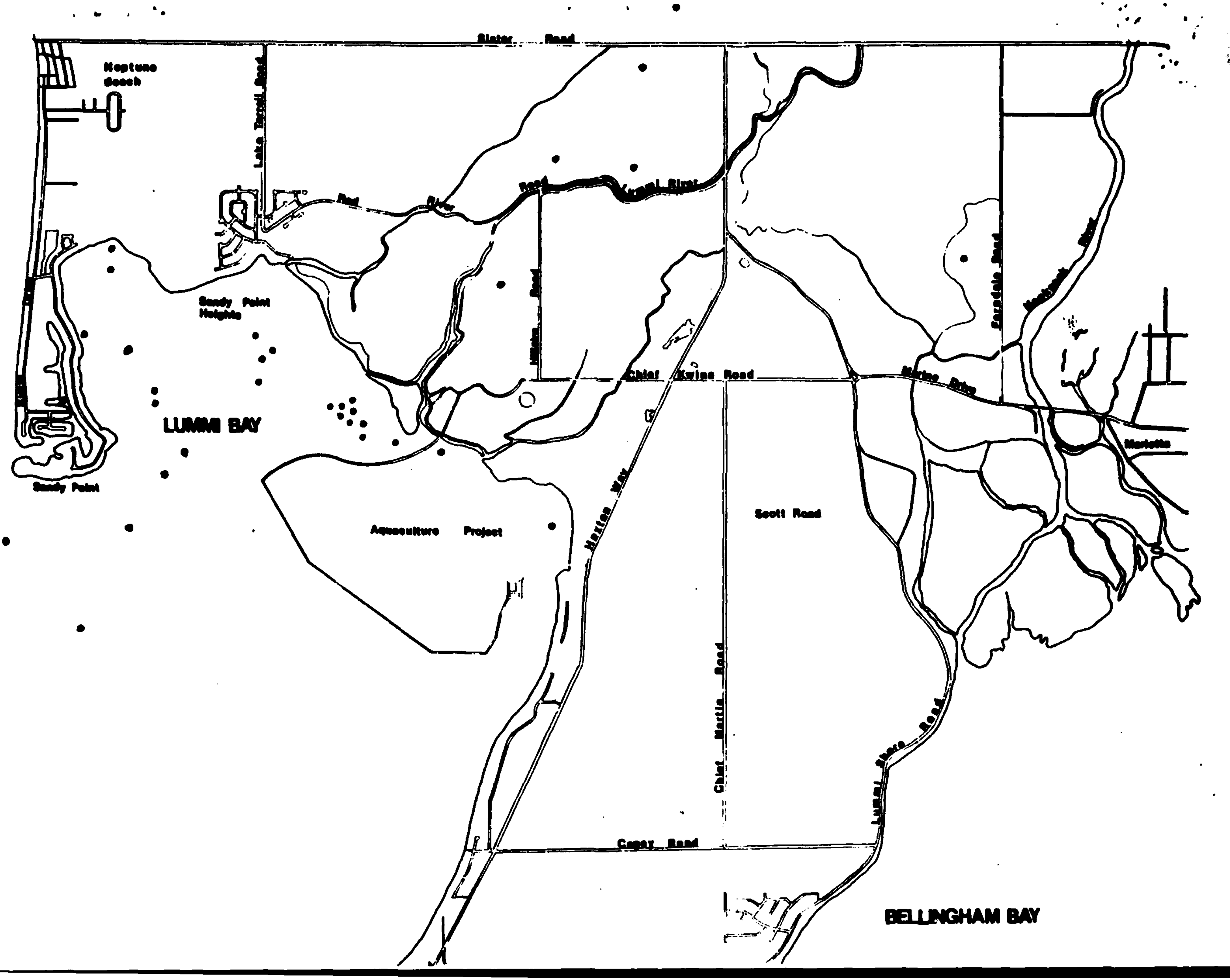
Table 16 illustrates the time of day (by hour intervals) of each kill. The majority of prey (67%) was captured during the morning hours (0700-1200). The most productive hour for witnessing kills was between 0900 and 1000, when we observed 8 successful hunts.

Kleptoparasitism

In areas with high densities of wintering raptors, kleptoparasitism (i.e. robbing of prey) can be frequent (Anderson and DeBruyn, 1978). Bald Eagles, Red-tailed Hawks, Rough-legged Hawks and Northern Harriers all take kills from peregrines. To successfully complete the hunting cycle, a falcon must not only hunt and capture prey but also consume it. If the kill is pirated during the transport or feeding phase, the peregrine is forced to repeat the entire hunting cycle a second time, adding greater expenditures of energy, risk, and increased stress.

We observed six instances of kleptoparasitism by other raptors; two by Bald Eagles and four by Red-tailed Hawks. On 16 December, we observed the radio-tagged falcon kill a duck at 0917 in Lummi Bay. The kill was pirated within 6 minutes by an adult Bald Eagle. The falcon caught a second duck at 1225 but dropped it in the Bay, apparently accidentally, and was

MAP 3. Kill Locations



Slater Road
Neptune Beach
Lake Terrell Road
Red River Road
Lummi River
Sandy Point Heights
Sandy Point
LUMMI BAY
Aquaculture Project
Haxton Way
Chief Kwina Road
Marine Drive
Ferndale Road
Nooksack River
Marietta
Scott Road
Chief Martin Road
Lummi Shore Road
Cagey Road
BELLINGHAM BAY

TABLE 12

PREY PURSUED BY PEREGRINE FALCONS DURING 119 UNSUCCESSFUL FLIGHTS

ORDER	NUMBER OF HUNTS
Anseriformes	
Canada Goose	1
Unidentified duck	82 (67%)
Green-winged Teal	3
Bufflehead	2
Charadriiformes	
Unidentified shorebird	4
Dunlin	10 (8%)
Unidentified gull	3
Falconiformes	
Merlin	1
Passeriformes	
Unidentified field birds	5
Unidentified Prey	11
TOTAL	122

TABLE 13

PEREGRINE FALCON KILLS, LUMMI BAY AREA, FALL 1983

#	DATE	PREY ITEM	TIME
1	13 October 1983	Unidentified small duck	0922
2	18 October 1983	Immature male Redwinged Blackbird	1104
3	19 October 1983	Adult male Ring-billed Gull	0730(?)
4	21 October 1983	Unidentified small duck	1611
5	26 October 1983	Golden Plover	0914
6	1 November 1983	Unidentified small duck	
7	4 November 1983	Green-winged Teal	0919
8	5 November 1983	Green-winged Teal	1004
9	9 November 1983	Green-winged Teal	0834
10	11 November 1983	Green-winged Teal	1037
11	11 November 1983	Unidentified seabird	1600
12	23 November 1983	Female Greater Scaup	0919
13	25 November 1983	Green-winged Teal	1129
14	26 November 1983	Unidentified small duck	0847
15	29 November 1983	Dunlin	0935
16	1 December 1983	Dunlin	1045
17	2 December 1983	Green-winged Teal	0738
18	2 December 1983	Mallard	1049
19	3 December 1983	Unidentified small prey	1145
20	3 December 1983	Unidentified duck	1304
21	3 December 1983	Unidentified large duck	1403
22	4 December 1983	Unidentified duck	1046
23	5 December 1983	Green-winged Teal	1240
24	6 December 1983	Unidentified duck-sized bird	1334
25	7 December 1983	Dunlin	0853
26	7 December 1983	Green-winged Teal	1117
27	8 December 1983	Green-winged Teal (found on dike)	
28	10 December 1983	Green-winged Teal	1530
29	11 December 1983	Male Green-winged Teal	1258
30	12 December 1983	Dunlin	0735
31	12 December 1983	Pied-billed Grebe	0950
32	14 December 1983	Female Green-winged Teal	0822
33	14 December 1983	Female Lesser Scaup	1404
34	16 December 1983	Unidentified duck	0917
35	16 December 1983	Unidentified duck	1225
36	16 December 1983	Dunlin	1600
37	17 December 1983	Unidentified small duck	0925
38	17 December 1983	Male Green-winged Teal	1003
39	27 December 1983	Unidentified small bird	1546
40	28 December 1983	Unidentified small duck	1208
41	30 December 1983	Horned Grebe	0812
42	31 December 1983	Unidentified duck	1222

TABLE 14

PEREGRINE FALCON PREY BY SPECIES

LUMMI BAY, WASHINGTON, 1983

SPECIES		NUMBER
1.	Green-winged Teal	13
2.	Dunlin	5
3.	Pied-billed Grebe	1
4.	Horned Grebe	1
5.	Mallard	1
6.	Greater Scaup	1
7.	Lesser Scaup	1
8.	Golden Plover	1
9.	Ring-billed Gull	1
10.	Red-winged Blackbird	1
	Unidentified duck	12
	Unidentified bird	3
	Unidentified small bird	1
	TOTAL	42

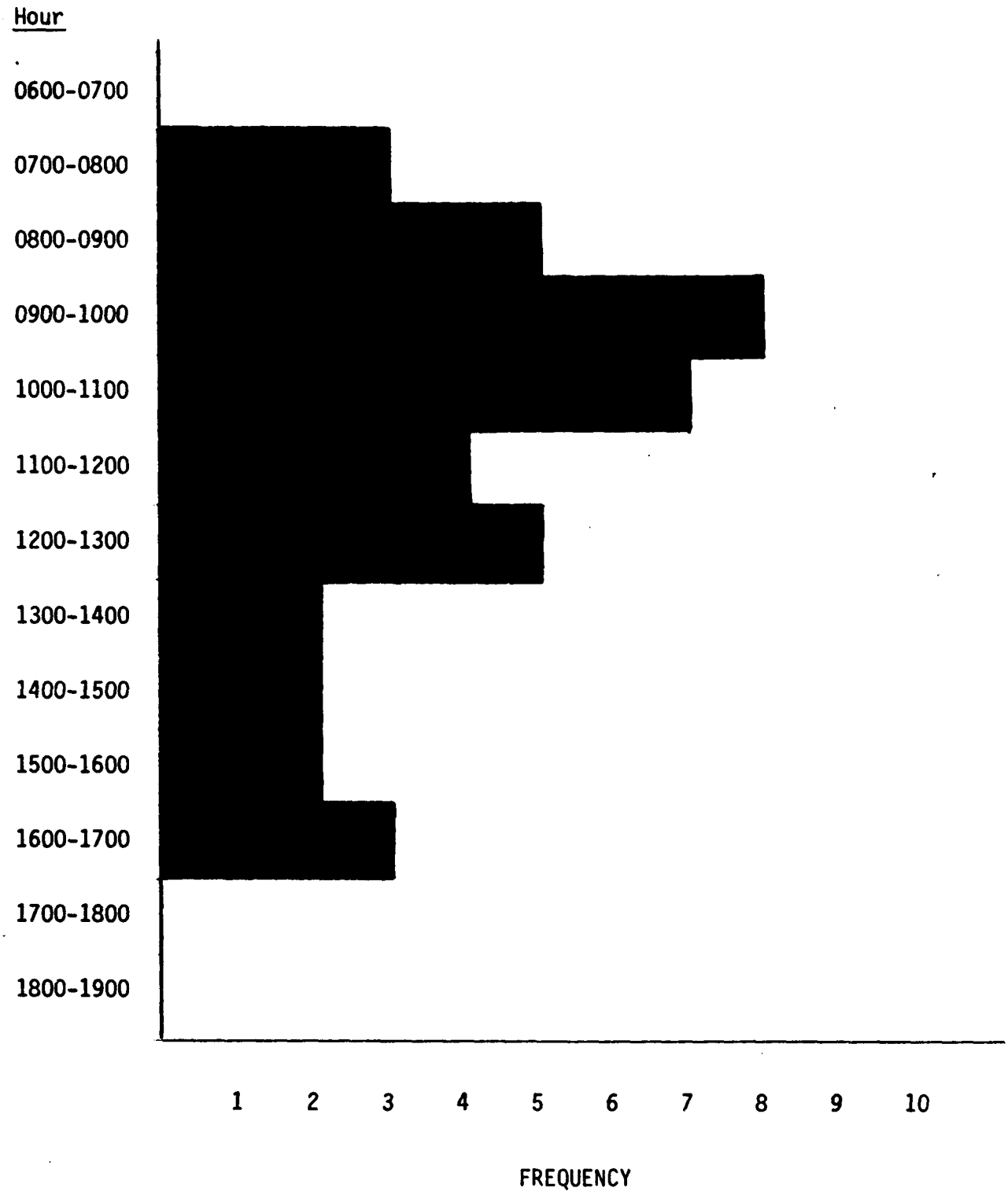
TABLE 15

PEREGRINE FALCON PREY BY GROUP

LUMMI BAY, WASHINGTON, 1983

GROUP	NUMBER/PERCENT
Ducks	28 (67%)
Shorebirds and gulls	7 (16%)
Unidentified	4 (10%)
Grebes	2 (5%)
Passerines	1 (2%)
TOTAL	42

SUCCESSFUL HUNTS, TIME OF DAY



unable to recover it. She captured her third kill of the day, a dunlin, at 1600 within Onion Bay and ate it. Her total food intake on that day was apparently one shorebird weighing approximately 45 grams. She had made 12 hunting flights (including 18 attempts). Not surprisingly, the falcon returned to the study area extremely early the next morning (0714) and began hunting immediately.

Feeding

We define the feeding period as the interval of time required for a falcon to consume its prey, from the first plucking of feathers to when the peregrine steps off its kill. As in hunting, the feeding period usually occupies a relatively small part of the daily cycle. Nevertheless, it is an extremely critical time and an important aspect of peregrine behavior and ecology

Typical perches selected for feeding included plowed fields, mudflats, logs or tires on mudflats, and wooden pilings (Table 17). Map 4 shows the location of each feeding perch within the Lummi Bay region.

Local wintering peregrines apparently prefer to eat their prey on or near the ground, almost invariably in areas with relatively flat, open substrates. The ability to detect approaching predators during the vulnerable feeding period is likely to be the primary factor in choosing such sites. For example, in over 50 observations of wintering peregrines feeding in the Puget Sound Basin, we have never observed them taking their prey into brush, tall grass or any other type of ground cover (Anderson, unpublished data). To our knowledge, prey is seldom transported to trees either, although we observed this behavior twice during the study.

We witnessed prey-carrying behavior 23 times, far more than in the combined five winters of observation on the Skagit Flats (Anderson et al., 1977, 1978, 1980). We saw peregrines carrying prey over distances varying from approximately 200 yards to over a mile. The radio-tagged falcon showed a preference for carrying her prey to two specific feeding

MAP 4. Feeding Locations.

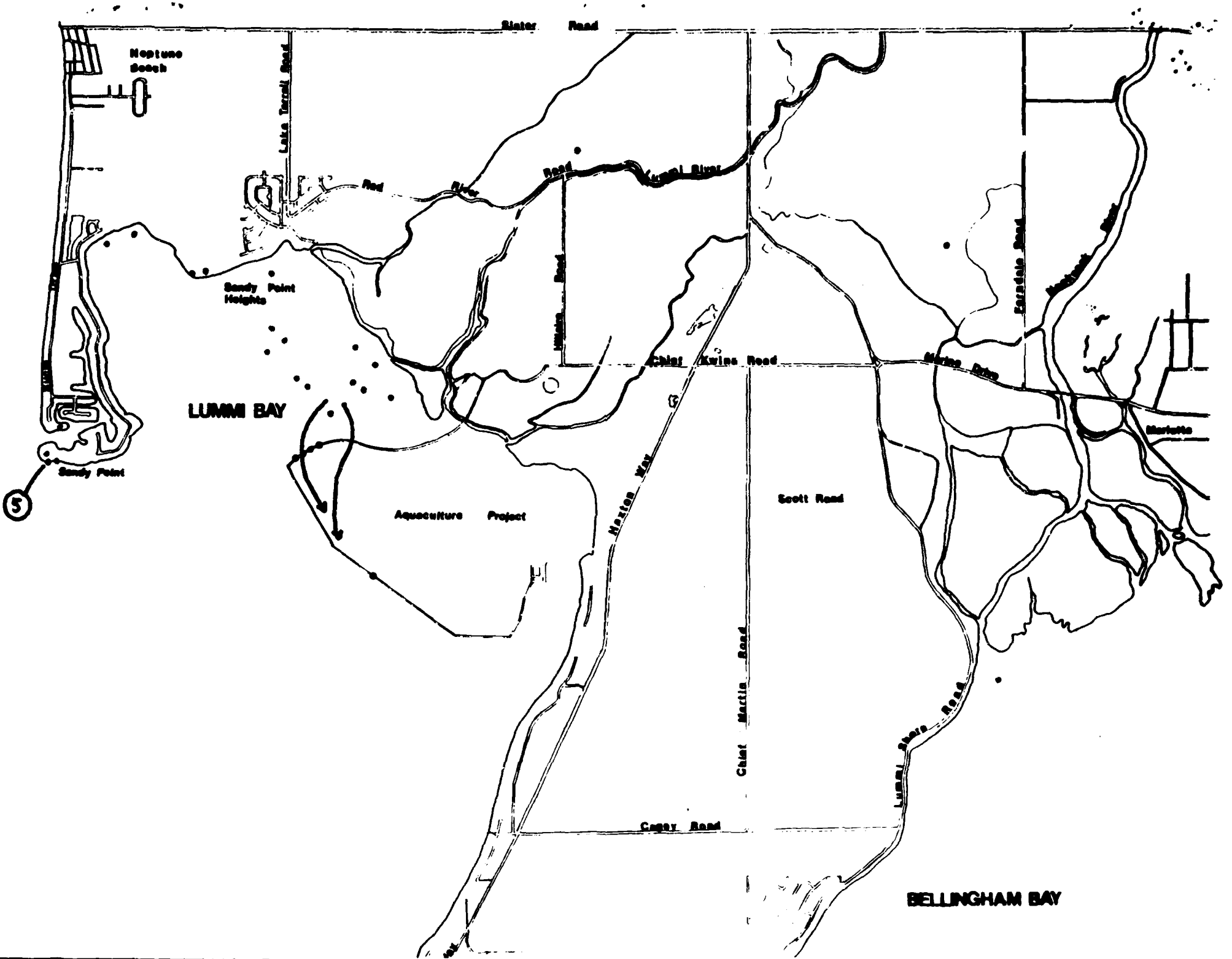

Bister Road
Neptune Beach
Lake Terrell Road
Red River
Kwina River
Sandy Point Heights
Hillaire Road
Chief Kwina Road
Ferndale Road
Marine Drive
Marietta
LUMMI BAY
Sandy Point
5
Aquaculture Project
Hannon Way
Scott Road
Chief Martin Road
Lummi Shore Road
Cagey Road
BELLINGHAM BAY

TABLE 17

FEEDING PERCHES UTILIZED BY PEREGRINE FALCONS

#	TYPE	FREQUENCY OF USE	%
1.	Aquaculture Pond dike	6	18%
2.	Mudflat (Lummi Bay)	6	18%
3.	Piling top (Sandy Point)	6	18%
4.	Log on mudflat (Lummi Bay)	4	12%
5.	Grassy field	3	10%
6.	Driftwood on beach	2	6%
7.	Conifer	2	6%
8.	Corn-stubble field	1	3%
9.	Plowed field	1	3%
10.	Gravel beach (Brant Point)	1	3%
11.	Gravel road (Sandy Point)	1	3%
	TOTAL	33	

perches: one at the southwestern tip of Sandy Point and the other along the northwestern edge of the Aquaculture Pond dike (Map 4). At least 14 kills (33%) were carried to these two sites. We never observed this type of preferred feeding-site behavior during the studies of winter peregrine ecology on the Samish flats (Anderson and DeBruyn, 1979; Anderson et al., 1977, 1978, 1980).

We recorded the time required for peregrines to eat their prey on 13 occasions (Table 18). Periods ranged from a minimum of 8 minutes (Dunlin) to a maximum of 47 minutes (Horned Grebe). Average feeding time for 7 Green-winged Teal was 34 minutes (range 25-41 minutes).

On 14 December, the radio-tagged falcon caught and ate a Green-winged Teal. Over a 41-minute period, she consumed the duck in what appeared to be 963 "bites": 176 feather plucks (18%), 777 eating bites (81%) and 11 intestinal discards (1%).

Roosting Behavior

Very little is known about the roosting behavior of migrant and wintering peregrines. Recently radio-telemetry techniques have been applied to this problem. Hunt et al. (1980) identified seven roosting sites used by a radio-tagged adult female peregrine followed north on spring migration from Texas to Michigan. In addition, F. Dobler (personal communication) studied several roosting sites used by a radio-tagged immature male wintering at Gray's Harbor, Washington in 1982. Anderson and DeBruyn (1979) and Anderson et al. (1980) located the winter roosts of four female peregines in Skagit County via radio-telemetry. During the latter two studies, it was found that the four peregrines roosted on offshore islands near mainland winter ranges. Each falcon had a preferred site that it returned to regularly each night.

The same situation apparently exists among Lummi peregrines. The radio-tagged falcon roosts regularly on Orcas Island. We suspect others may do so too since we have observed five study area peregrines flying southwest out of sight

TABLE 18

PREY CONSUMPTION TIMES

SPECIES	TIME TAKEN TO CONSUME (MINUTES)
1. Horned Grebe	47
2. Pied-billed Grebe	41
3. Green-winged Teal	41
4. Unidentified small duck	40
5. Green-winged Teal	38
6. Green-winged Teal	37
7. Green-winged Teal	35
8. Lesser Scaup	35
9. Green-winged Teal	34
10. Green-winged Teal	28
11. Green-winged Teal	25
12. Dunlin	9
13. Dunlin	8

toward the San Juan Islands in the evening.

We classified roosting flights as either incoming or outgoing based on their direction from or toward the roosting area respectively. Temporal variability prevented us from calling them "morning" and "evening" flights since an outgoing flight might occur before 1000.

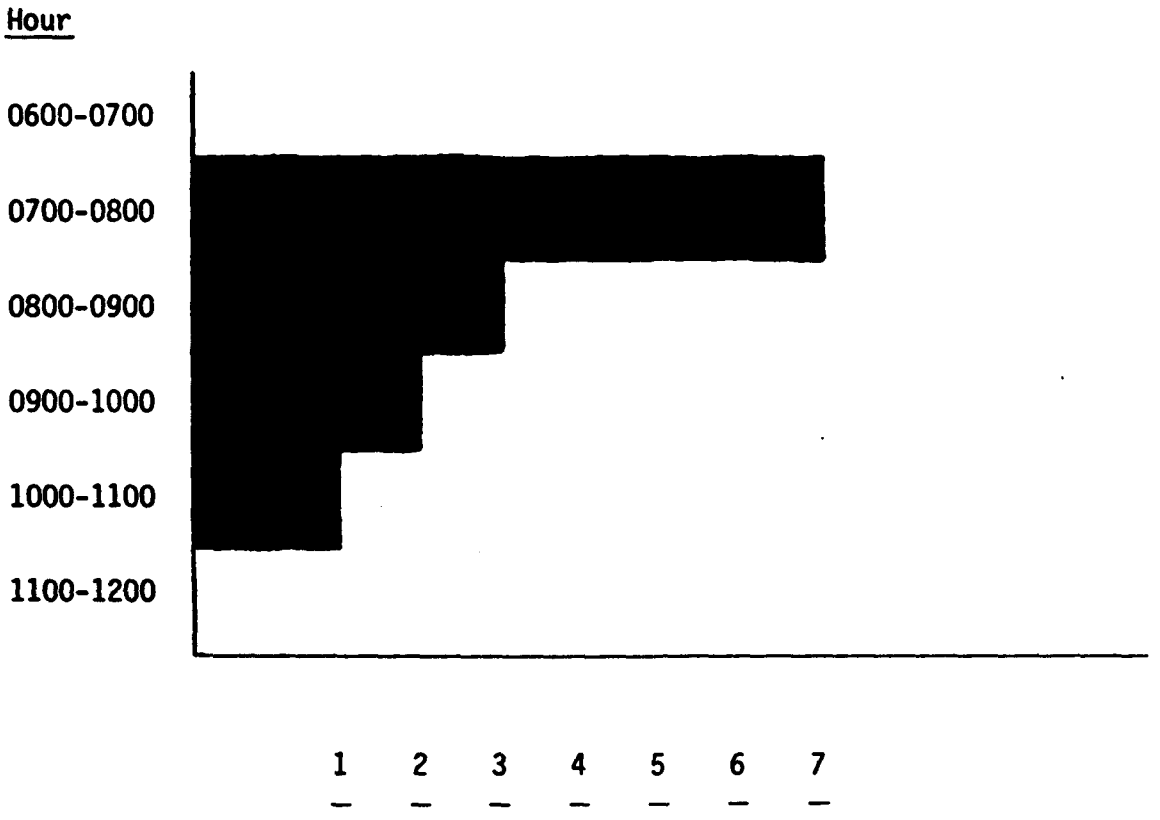
We recorded a total of 44 roosting flights, 13 incoming (30%) and 31 outgoing (70%). Incoming flights were the most difficult to intercept. Outgoing flights were easier to observe since they often began with a falcon already under observation. Under ideal weather and light conditions, we could follow an outgoing falcon for a maximum of 8 minutes, or approximately 6 miles.

Of the 44 roosting flights detected, 20 (65%) outgoing and 13 (100%) incoming involved the radio-tagged falcon. Of the remaining 11 outgoing flights, three were of the Tire Bird prior to her being radio-tagged and 10 others involved other peregrines; three adult females (Blackcap, Portage and Pioneer) and an undesignated male.

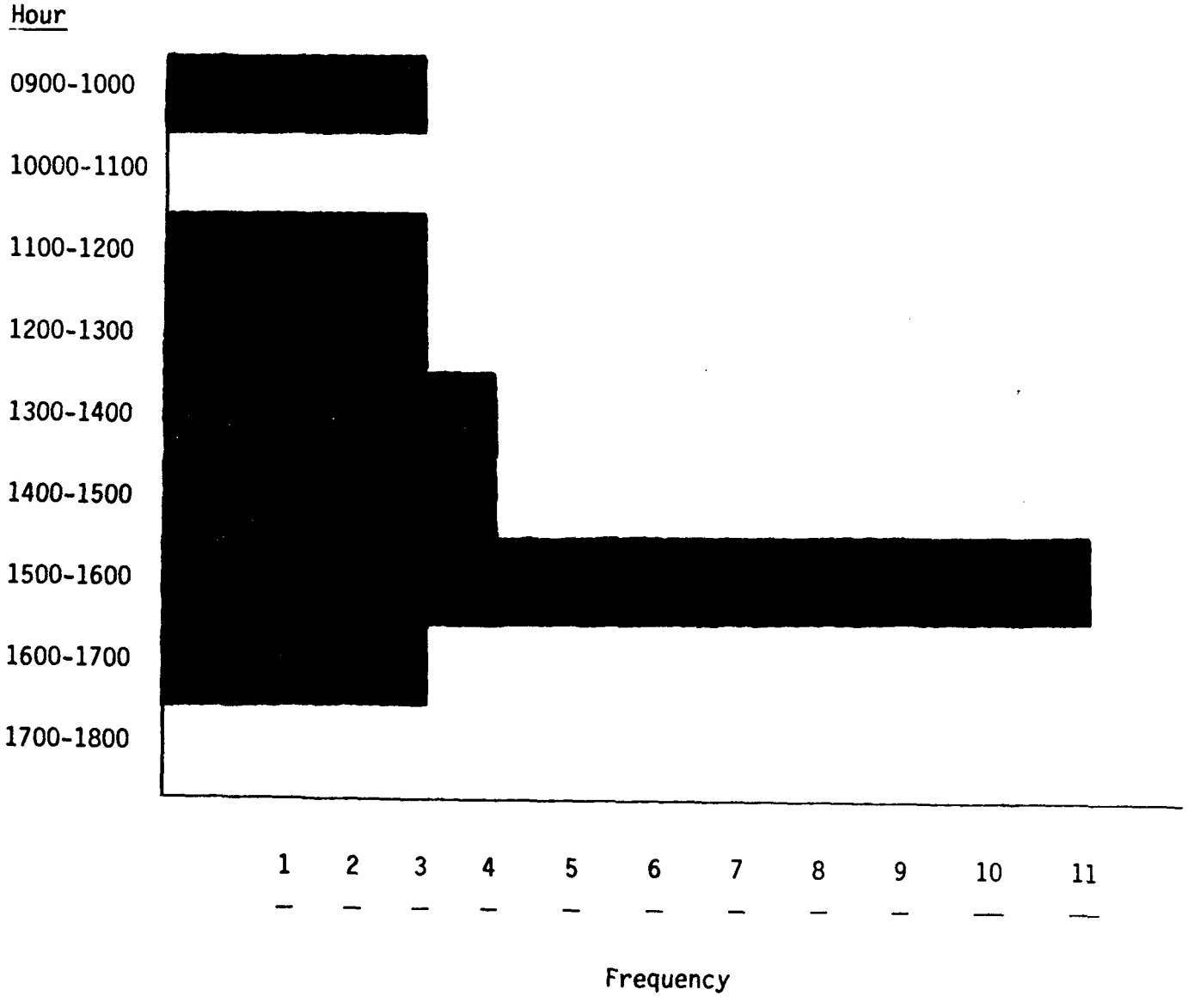
We recorded incoming flights taking place between 0700 and 1100, a range of four hours (Table 19). Outgoing flights (Table 20) exhibited a much wider variation, ranging from 0900-1700 (8 hours). The majority of incoming flights (7) took place between 0700 and 0800, the majority of outgoing flights (11) from 1500-1600.

The roosting site is evidently of great importance to wintering peregrines. Anderson and DeBruyn (1979) and Anderson et al. (1980) discovered that four radio-tagged peregrines habitually used the same roosting sites each night during January and February. It is also clear that the radio-tagged Lummi peregrine spent the majority of her roosting time at the Orcas Island site. In addition to sleeping there on at least 28 nights in December, she often spent a large part of a day at or near the roosting area (based on radio data). On 29 December, the falcon spent the entire day there. Five peregrines so far studied in the Puget Sound Basin (Anderson

INCOMING ROOSTING FLIGHTS



OUTGOING ROOSTING FLIGHTS



and DeBruyn, 1979; Anderson et al., 1980; this study) have demonstrated that peregrines have a clear preference for a particular roosting site. For example, we observed the Lummi study falcon returning to Orcas Island from Ferndale, Sandy Point, the Nooksack River delta and Lummi Island, even though other suitable-appearing roosting sites (i.e. forested hillsides, cliffs) were located on the nearby mainland. The longest linear distance (Ferndale-Orcas Island) that she returned from was 15 miles, illstrating her strong attachment to her selected roosting area. She even returned to the area when it was covered in snow for several days in December.

The elevation of her roosting area, based on radio-triangulation, was between approximately 2,000 and 2,300 feet, the highest winter roosting site so far on record.

We also examined when peregrines entered the study area during their daily cycle. In some cases, they arrived shortly after astronomical dawn. For example, on 6 December, we observed an adult female perched on a piling top at 0719, 45 minutes prior to sunrise. The bird could only be identified by automobile headlight because of darkness.

The radio-tagged falcon demonstrated a wide range of entry times, from astronomical dawn at 0714 (2 and 17 December) to 1014 (15 December). We suspect that extremely early arrival times are related to hunger. In both instances of early entry by the radio-tagged falcon, we had been able to establish that she had not eaten a full meal on the day before. On each succeeding day, she began hunting immediately and killed soon after arriving on the study area (0738 and 0925).

Early activity during winter is not unusual. We recorded 12 other instances of falcons being active on the study area between 0700 and 0800 (Table 21).

Identification of peregrine roosting sites and their protection from development by man is an important element in the protection of the Peregrine Falcon.

TABLE 21

ONSET OF MORNING ACTIVITY BY PEREGRINES

#	DATE	TIME	COMMENTS
1.	18 October	0720	Perched
2.	19 October	0740	Perched on tire
3.	28 October	0730	Perched
4.	3 November	0704	Perched
5.	9 November	0729	Perched in conifer
6.	14 November	0743	Perched on mudflat
7.	15 November	0734	In flight, with full crop
8.	23 November	0716	Perched in conifer
9.	26 November	0737	Perched in conifer
10.	2 December	0714	Hunting
11.	6 December	0719	Perched on pilings
12.	6 December	0752	Hunting
13.	8 December	0755	Hunting
14.	12 December	0728	Hunting
15.	17 December	0714	Hunting

Summary

1. The Peregrine Falcon occurs in both the fall and winter at Lummi Bay, Washington. We recorded 207 sightings over 80% of the field days.

2. A minimum of 15 individual peregrines were observed during the study period (2 October-31 December).

3. Peregrines were under direct observation for 154 hours and 46 minutes.

4. Adult females were the dominant sex/age class (69% of the sightings) although all other classes (adult males, immature males, immature females) were also observed.

5. The primary prey of the study peregrines was ducks (67%) and shorebirds/gulls (16%). The large majority were captured within the borders of Lummi Bay. We recovered forty-two prey items during the study.

6. Peregrines displayed a relatively high hunting success rate of 22%.

7. The roosting site of a radio-tagged adult female was located 11 miles southwest of the study area on Orcas Island. At least four other individual peregrines were also observed heading in that direction in the evening, suggesting they also roost in the San Juan Islands.

Acknowledgments

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APPENDIX 1

BIRD SPECIES LIST

LUMMI BAY REGION, WHATCOM COUNTY

FALL, 1983

1. Red-throated Loon (Gavia stellata)
2. Arctic Loon (Gavia arctica)
3. Common Loon (Gavia immer)

4. Pied-billed Grebe (Podilymbus podiceps)
5. Horned Grebe (Podiceps auritus)
6. Red-necked Grebe (Podiceps grisegena)
7. Western Grebe (Aechmophorus occidentalis)

8. Double-crested Cormorant (Phalacrocorax auritus)
9. Brandt's Cormorant (Phalacrocorax penicillatus)
10. Pelagic Cormorant (Phalacrocorax pelagicus)

11. Great Blue Heron (Ardea herodias)
12. Great Egret (Casmerodius albus)

13. Tundra Swan (Cygnus columbianus)
14. Trumpeter Swan (Cygnus buccinator)

15. Greater White-fronted Goose (Anser albifrons)
16. Snow Goose (Chen caerulescens)
17. Brant (Branta bernicla)
18. Canada Goose (Branta canadensis)

19. Green-winged Teal (Anas crecca)
20. Mallard (Anas platyrhynchos)
21. Northern Pintail (Anas acuta)
22. American Wigeon (Anas americana)
23. Canvasback (Aythya valisineria)
24. Greater Scaup (Aythya marila)
25. Lesser Scaup (Aythya affinis)
26. Harlequin Duck (Histrionicus histrionicus)
27. Oldsquaw (Clangula hyemalis)
28. Black Scoter (Melanitta nigra)
29. Surf Scoter (Melanitta perspicillata)
30. White-winged Scoter (Melanitta fusca)
31. Common Goldeneye (Buchephala clangula)
32. Barrow's Goldeneye (Buchephala islandica)
33. Bufflehead (Bucephala albeola)
34. Hooded Merganser (Lophodytes cucullatus)
35. Common Merganser (Mergus merganser)
36. Red-breasted Merganser (Mergus serrator)
37. Ruddy Duck (Oxyura jamaicensis)

38. Turkey Vulture (Cathartes aura)
39. Bald Eagle (Haliaeetus leucocephalus)

40. Northern Harrier (Circus cyaneus)
41. Sharp-shinned Hawk (Accipiter striatus)
42. Cooper's Hawk (Accipiter cooperi)
43. Northern Goshawk (Accipiter gentilis)
44. Red-tailed Hawk (Buteo jamaicensis)
45. Rough-legged Hawk (Buteo lagopus)

46. Golden Eagle (Aquila chrysaetos)
47. American Kestrel (Falco sparverius)
48. Merlin (Falco columbarius)
49. Peregrine Falcon (Falco peregrinus)
50. Gyrfalcon (Falco rusticolus)

51. Ring-necked Pheasant (Phasianus colchicus)
52. Ruffed Grouse (Bonasa umbellus)

53. Virginia Rail (Rallus umicola)
54. American Coot (Fulica americana)

55. Sandhill Crane (Grus canadensis)

56. Black-bellied Plover (Pluvialis squatarola)
57. Lesser Golden Plover (Pluvialis dominica)
58. Killdeer (Charadrius vociferus)
59. Greater Yellowlegs (Tringa melanoleuca)
60. Lesser Yellowlegs (Tringa flavipes)
61. Spotted Sandpiper (Tringa erythropus)
62. Black Turnstone (Arenaria melanocephala)
63. Red Knot (Calidris canutus)
64. Sanderling (Calidris alba)
65. Western Sandpiper (Calidris mauri)
66. Least Sandpiper (Calidris minutilla)
67. Baird's Sandpiper (Calidris bairdii)
68. Pectoral Sandpiper (Calidris melanotos)
69. Sharp-tailed Sandpiper (Calidris acuminata)
70. Dunlin (Calidris alpina)

71. Short-billed Dowitcher (Limnodromus griseus)
72. Long-billed Dowitcher (Limnodromus scolopaceus)
73. Common Snipe (Gallinago gallinago)

74. Bonaparte's Gull (Larus philadelphia)
75. Heerman's Gull (Larus heermanni)
76. Mew Gull (Larus canus)
77. Ring-billed Gull (Larus delawarensis)
78. California Gull (Larus californicus)
79. Herring Gull (Larus argentatus)
80. Glaucous-winged Gull (Larus glaucescens)

81. Caspian Tern (Sterna caspia)
82. Common Tern (Sterna hirundo)

83. Common Murre (Uria aalge)
84. Pigeon Guillemot (Cepphus columba)

85. Marbled Murrelet (Brachyramphus marmoratus)

86. Rock Dove (Columba livia)
87. Band-tailed Pigeon (Columba fasciata)
88. Mourning Dove (Zenaida macroura)

89. Great Horned Owl (Bubo virginianus)
90. Short-eared Owl (Asio flammeus)
91. Northern Saw-whet Owl (Aegolius acadicus)

92. Belted Kingfisher (Ceryle alcyon)

93. Northern Flicker (Colaptes auratus)
94. Pileated Woodpecker (Dryocopus pileatus)

95. Steller's Jay (Cyanocitta stelleri)
96. American Crow (Corvus brachyrhynchos)
97. Common Raven (Corvus corax)

98. Black-capped Chickadee (Parus atricapillus)
99. Bushtit (Psaltriparus minimus)
100. Winter Wren (Troglodytes troglodytes)
101. Marsh Wren (Listothorus palustris)
102. Golden-crowned Kinglet (Regulus satrapa)
103. Ruby-crowned Kinglet (Regulus calendula)
104. American Robin (Turdus migratorius)
105. Varied Thrush (Ixoreus naevius)
106. Water Pipit (Anthus spinoletta)
107. Northern Shrike (Lanius excubitor)
108. European Starling (Sturnus vulgaris)
109. Rufous-sided Towhee (Pipilo erythrophthalmus)
110. Song Sparrow (Melospiza melodia)
111. White-crowned Sparrow (Zonotrichia leucophrys)
112. Dark-eyed Junco (Junco hyemalis)
113. Lapland Longspur (Calcarius lapponicus)
114. Snow Bunting (Plectrophenax nivalis)
115. Red-winged Blackbird (Agelaius phoeniceus)
116. Western Meadowlark (Sturnella neglecta)
117. Brewer's Blackbird (Euphagus cyanocephalus)
118. Purple Finch (Carpodacus purpureus)
119. Pine Siskin (Carduelis pinus)
120. American Goldfinch (Carduelis tristis)
121. House Sparrow (Passer domesticus)

APPENDIX 2

DIKE CENSUSES

NOVEMBER						DECEMBER					
DATE	#	TIME	DATE	#	TIME	DATE	#	TIME	DATE	#	TIME
1	2	(1039/1400)	16	2	(0854/1219)	1			16	2	(1101/152)
2	3	(0135/1341/ 1635)	17	1	(0922)	2	1	(1317)	17	2	(0750/135)
3	2	(0902/1432)	18	1	(1410)	3			18	1	(1219)
4	1	(1329)	19			4			19		
5	1	(1423)	20			5	1	(1500)	20		
6			21	2	(0955/1415)	6	2	(0716/1100)	21	2	(0930/153)
7			22	1	(1348)	7	1	(0802)	22		
8	1	(0949)	23	1	(1157)	8			23	2	(0807/14)
9	2	(1116/1556)	24	1	(0839)	9	1	(0944)	24	1	(0924)
10	1	(0854)	25	1	(1200)	10			25		
11			26			11			26		
12			27			12			27	1	(1220)
13	1	(1130)	28	1	(1045)	13			28	2	(0925/14)
14	2	(0917/1554)	29	2	(1210/1526)	14	1	(1030)	29	1	(1110)
15	2	(0846/1334)	30	2	(1200/1607)	15	2	(0904/1256)	30		
									31		