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SKAG17
X FAUNA

IMPACTS OF A PROPOSED COPPER
CREEK DAM ON BALD EAGLES

For

Seattle City Light
Office of Environmental Affairs
Seattle, Washington

By

BioSystems Analysis, Inc.
San Francisco California

30.

June 1980

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SKAG 67
X FAUNA

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1.0 INTRODUCTION

The City of Seattle, City Light Department, is considering the installation of a hydroelectric re-regulating dam on the Skagit River, Skagit County, Washington to expand its electrical generating system there.

The location being evaluated for placement of the dam is at River Mile (RM) 83.7, just downstream from the Skagit River--Copper Creek confluence. The resulting reservoir is expected to flood about 2,200 acres of land and extend some ten miles up the Skagit River Valley to the existing Gorge Power Plant at Newhalem.

The Skagit River watershed has its headwaters in British Columbia, Canada, and drains the northern Cascades. The river crosses the international border and flows south-southwest through Ross, Diablo, and Gorge Reservoirs, which are all operated by City Light. These reservoirs are within the Ross Lake National Recreation Area (U.S. Forest Service), which separates the eastern and western portions of North Cascades National Park (National Parks Service). From Newhalem near Gorge Dam, the Skagit River is free-flowing along its course to the Skagit estuary and bay.

It is well documented that the Skagit River Valley is a significant wintering area for migratory bald eagles (Servheen 1975; The Nature Conservancy 1976; Wiley 1977, 1978; Skagen 1979, 1980). Annually, about 150-300 bald eagles winter along the Skagit River and forage on the carcasses of spawned salmon. The greatest concentrations of eagles are reported between Rockport and Rocky Creek (approximately seven river miles), which includes the Nature Conservancy's "Skagit River Bald Eagle Natural Area" (SRBENA).

A report prepared for City Light (Beak Consultants 1979) concluded that development of the Copper Creek dam and reservoir would have little impact on bald eagles. This preliminary conclusion was based on little field research and received considerable criticism (see "Summary of Comments, Copper Creek Dam, Draft Environmental Report," by Seattle City Light). Previous research efforts focused on eagles concentrating in the SRBENA, but little was known about the importance to bald eagles of the Skagit River upstream, between Ross Dam and the SRBENA.

Two concurrent studies were supported in the 1979-80 winter by City Light to address this paucity of data. A research team (BioSystems Analysis, Inc.) examined the ecology of bald eagles in the area in relation to the Copper Creek Dam project. Specific impacts (i.e. loss of habitat, displacement of eagles, the effects of increased human disturbance) were studied as well as general eagle ecology such as the movements of Skagit bald eagles throughout the region, habitat requirements, etc.) as it relates to better understanding the effects of the dam.

A second study team (Bierly and Associates) gathered data on the movements of salmon carcasses drifting from the proposed impoundment area (PIA) above Copper Creek Dam. This line of research was intended to elucidate the importance of salmon spawning in the PIA as a food resource for eagles wintering downstream. Where appropriate, we have integrated the findings of the salmon carcass drift study. However, the complete results of that study have been presented separately (Glock et al 1980).

1.1 The Status of Bald Eagles

The bald eagle (Haliaeetus leucocephalus) is endemic to North America. There are two subspecies: the northern race (H. l. alascanus) and the southern race (H. l. leucocephalus). Though not well defined, this separation is based on geographic variation in size with the northern race being generally larger.

Beginning in 1961, the National Audubon Society sponsored the Continental Bald Eagle Project, which was initiated in response to widespread reports of declining bald eagle populations. Sprunt (1969) reported that much of the historic breeding range of bald eagles remained occupied but at greatly reduced numbers. The decline had evidently accelerated in the years following World War II. Numerous research efforts later identified factors believed responsible for the bald eagle decline: loss of nesting habitat, reduced reproduction induced by environmental pollutants, shooting, and excessive human disturbance factors (Sprunt et al 1973; Murphy 1977; Wiemeyer et al 1972; Krantz, et al 1970; Stalmaster and Newman 1978; Sprunt and Ligas 1966). The enactment of the Endangered Species Act of 1973 provided protection for species listed as "endangered" or "threatened". On 16 March 1978, endangered status was given to bald eagles throughout the United States, except in five states where they were declared "threatened"; Washington was one of the five states.

An estimated 150 pairs of bald eagles nest each year in Washington (Grubb 1975). Nesting is generally associated with coastal and insular habitats of Puget Sound, the Olympic Peninsula, and inland lakes of southwestern Washington (Allen 1979). No bald eagle nesting activity is known along the Skagit River above Sedro Woolley (The Nature Conservancy 1976).

In winter, the number of bald eagles in Washington significantly increases.

During January of 1979 and 1980, the National Wildlife Federation sponsored nationwide winter bald eagle censuses. On the basis of these counts, in 1980, the total wintering bald eagle population in Washington was estimated to be 1,624 eagles (D'Acci, et al 1980). These figures represent more than ten percent of the nationwide total in both years.

Studies of wintering bald eagles in Washington are numerous but many basic questions remain unanswered (Servheen 1975; Stalmaster 1976; Hansen 1977; Fielder 1978, 1979; Wood 1979; Knight, et al 1979; and others). To date, no studies have integrated the available data to examine the regional dynamics of wintering bald eagle concentrations as they relate to each other. Also, no movement studies using radio telemetry have attempted to determine the origins of bald eagles wintering in Washington, whether or not eagles are sedentary in particular river drainages, and the disperal pathways of eagles leaving their wintering grounds to breed. Refer to Allen (1979) for a review of the status of bald eagles in Washington.

The research efforts reported herein focus on direct impacts of the Copper Creek Dam project on bald eagles wintering on the Skagit River. To arrive at our conclusions it also was necessary to study some of the ecological topics outlined above. The following report presents the results of the 1979-80 wintering bald eagle study on the Skagit River conducted by Bio-Systems Analysis, Inc.

2.0 OBJECTIVES

The research effort was divided into five main topics. The overall objective was to study each topic separately and then integrate the findings into a discussion of impacts expected to occur if the proposed Copper Creek Dam is constructed.

OBJECTIVE 1. Determine the number of eagles supported in winter 1979-80 by the habitat to be inundated by the proposed reservoir.

The proposed impoundment area (PIA) may currently be an important refuge for bald eagles intolerant of human activity levels present elsewhere in the Skagit River Study Area (SRSA), (Servheen 1975). Since food resources present in the impoundment area will be eliminated, this loss may affect the SRSA's total carrying capacity for wintering bald eagles.

OBJECTIVE 2. Quantify and describe the bald eagle habitat present in the SRSA, particularly in the PIA.

From these data, and with integration with other information, we can evaluate the importance of particular habitat features and the impacts through loss or alteration that will result from dam construction or operation.

OBJECTIVE 3. Study the feeding ecology of bald eagles in the SRSA in relation to Copper Creek Dam construction and operation.

A Copper Creek dam would eliminate all salmon spawning upstream of the site. A study of the importance of food supplies to bald eagles will place in perspective the overall impact to eagles of the loss of these resources.

OBJECTIVE 4. Examine the relationships between human activity and disturbance to eagles under present conditions.

These data will allow projections as to probable impacts from increased human activity in the SRSA during and following construction. Disturbance effects on eagle distribution and feeding behavior are the primary research targets.

OBJECTIVE 5. Investigate the movements of bald eagles both within the SRSA and within the larger region of northwestern Washington.

Radio telemetry studies of the movements of eagles within the study area are needed to evaluate the significance of the PIA to the Skagit eagles. Within the larger region of northwestern Washington, movement studies might identify absorption areas for eagles displaced by the proposed dam. Finally, no data exists on the origins (breeding areas) of bald eagles wintering in the Skagit Valley.

3.0 STUDY AREA

The field work was conducted primarily in the area extending from just downstream of the mouth of the Sauk River (RM 66) to the mouth of Newhalem Creek (RM 93). Figure 3a provides a map of the Skagit River Study Area (SRSA) showing the towns and tributaries. Detailed maps of each segment of the SRSA appear in the habitat evaluation section (6.0). Owing to the tendency of eagles to frequent water bodies and to the findings of Stalmaster and Newman (1978) concerning disturbance buffers we selected, as the lateral boundaries of the SRSA, zones extending along both sides of the Skagit each 500 m wide.

Eagles also frequented the adjacent parts of some of the Skagit tributaries and a few ponds; most notably, Illabot Creek and Illabot Slough attracted numbers of eagles and were thus included within the SRSA. In addition to the Illabot Creek-Slough area, nine other off-river locations were censused. These included: (1) Goodell Creek Bridge, (2) Aggregate Ponds (City Light), (3) Bacon Creek Bridge, (4) Diobsud Creek Bridge, (5) Cascade River Bridge, (6) Jordan Creek Bridge, (7) Lower Cascade River at Bud Buller's residence, (8) Barnaby Slough, and (9) Harrison Ponds. Data for the County Line Ponds area were combined with data for RM 89.0.

Physiographic, climatological, and biotic features of these and other portions of the SRSA were described by Servheen (1975), and for detail the reader may refer to his maps, maps presented in this report, the draft report on the Copper Creek Environmental Assessment (CH_2M Hill 1978), and the various Nature Conservancy reports (The Nature Conservancy 1976; Wiley 1977, 1978; Skagen 1979, 1980).

The proposed impoundment area (PIA) of the Copper Creek dam begins at Copper Creek (RM 84) and extends to Newhalem Creek (RM 93). The portion of the SRSA below the proposed dam is referred to in this report as "the lower stretch of the SRSA," which contains the holdings of The Nature Conservancy and the Washington Department of Game that serves as a sanctuary for wintering eagles.

The lower stretch of the SRSA has a relatively wide flood plain that supports farms and ranches while the PIA is in a narrow canyon. The consequence to eagles is the presence of more slowly moving water, gravel bars, and spawning salmon in the lower stretch. Steep forested slopes of the Cascade Range border the entire SRSA, though the moutains are higher and more precipitous in the PIA than downstream. In general, the incidence of coniferous trees increases while human use decreases in the upstream portions of the SRSA.

Our studies of the movements of radio-tagged eagles from the SRSA (8.0) required an examination of northwestern Washington and southwestern British Columbia in terms of bald eagle winter habitat. In this report, we refer to the area delinated in Figure 3b as the "study region" which embodies at least a portion of the overall winter range of the eagles that visit or remain in the SRSA. The study region includes the Fraser, Nooksack, Skagit, Sauk, Stillaguamish, Skykomish, and Snoqualmie Rivers, as well as the San Juan and Gulf Islands of Puget Sound and the Strait of

Georgia. As explained in the movements section of this report (8.0), the total winter range of the "Skagit eagles" undoubtedly extends beyond our study region, but cost:benefit considerations led to an otherwise arbitrary selection of its boundaries. Towns marked in Figure 3b are those that appear in locality data for radio-tagged eagles (8.0).

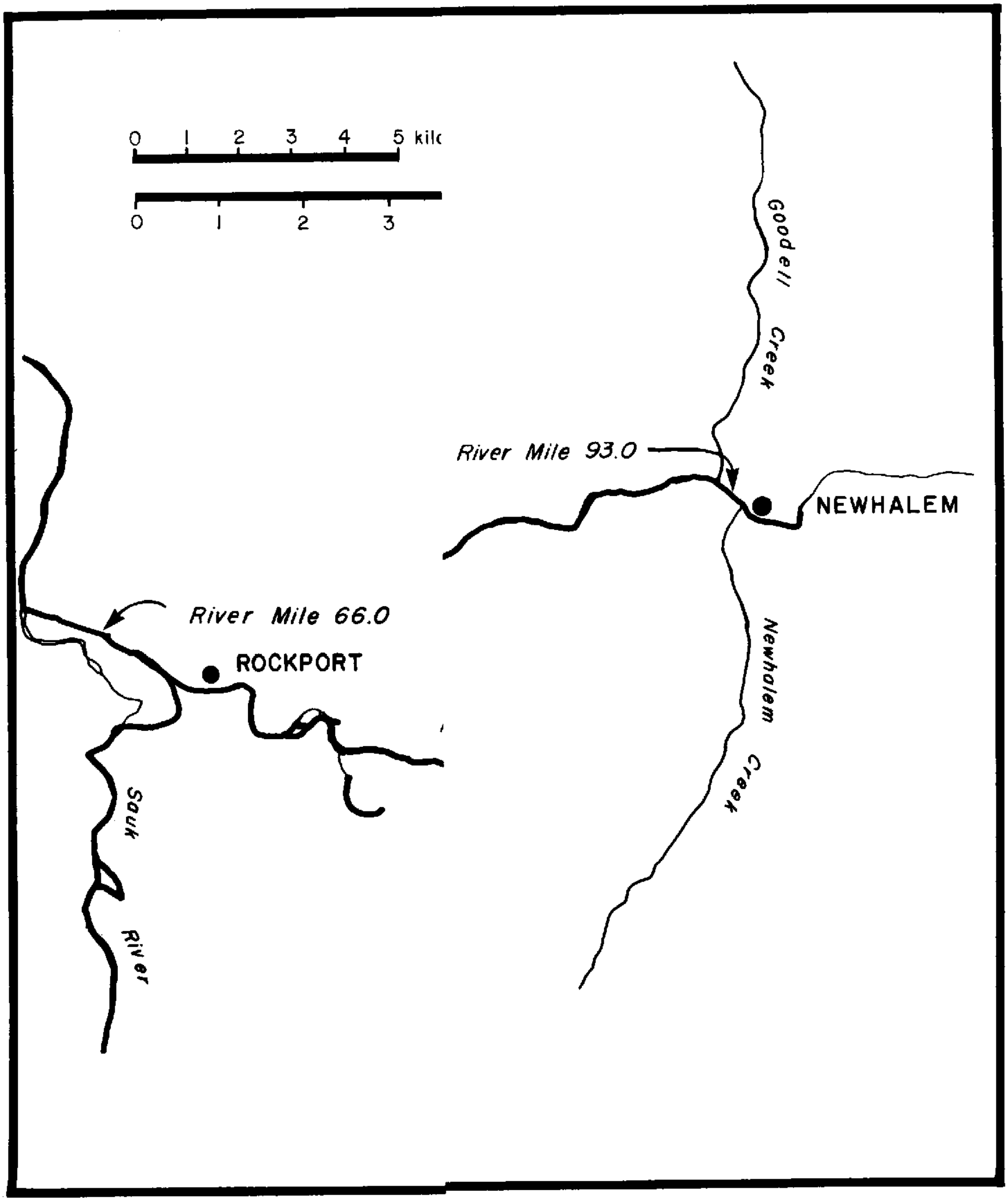


Figure 3a
Skagit River Study Area

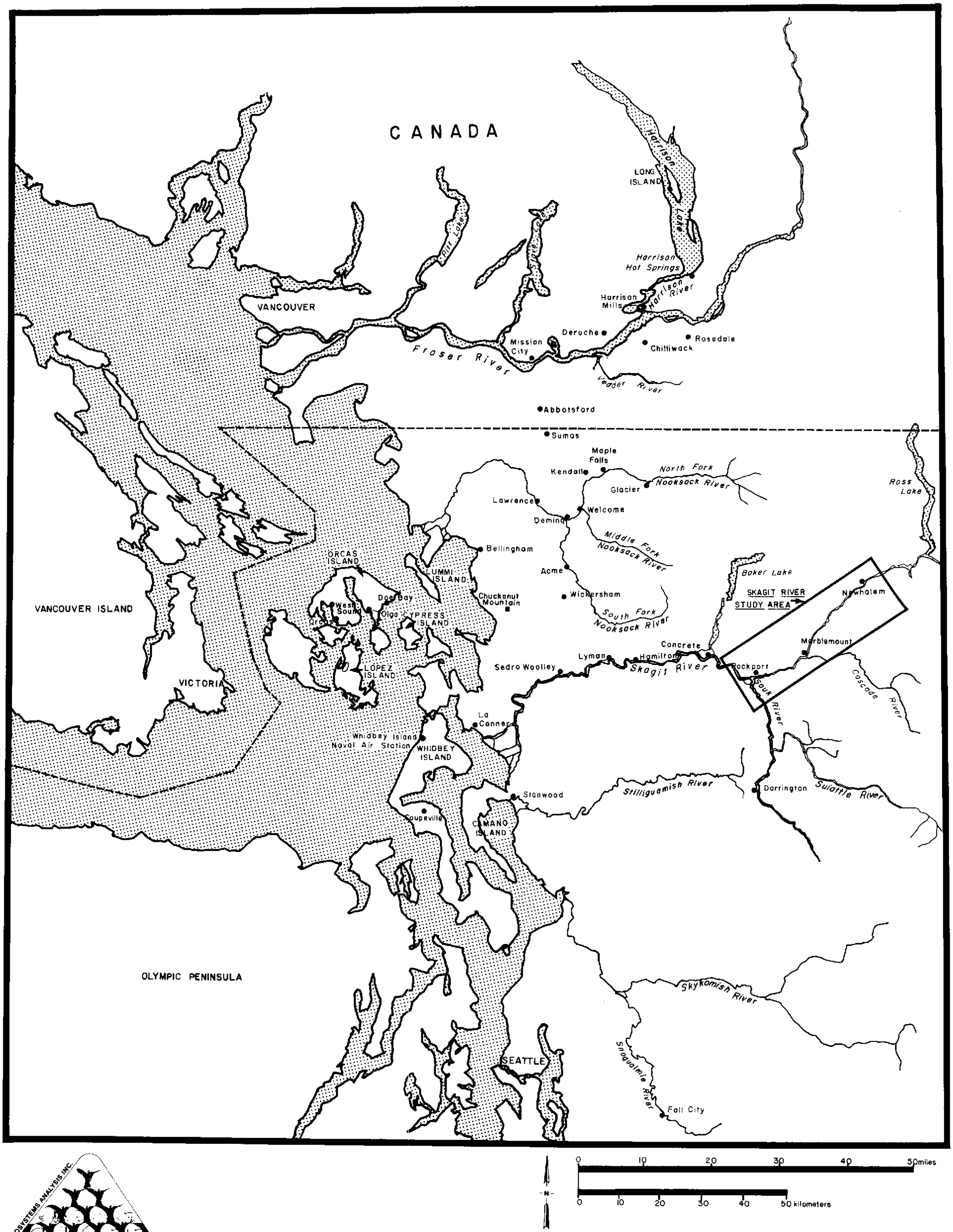


Figure 3b
Skagit River Study Region

4.0 EAGLE ABUNDANCE AND DISTRIBUTION

4.1 Background

A key source of data in evaluating the impacts of a Copper Creek dam on wintering eagles was the performance of a detailed and regular census of eagles throughout the study area. The census was particularly important in answering the question of how many eagles utilized the area of proposed impoundment. Other insights gained include: (1) identification of feeding areas and food sources, (2) comparison of this year's wintering eagle population with those of previous years, (3) effects (if any) of disturbance factors on the distribution, abundance, and behavior of eagles, and (4) how the numbers of eagles changed over time, both in the SRSA in general and within the SRSA in response to changes in the abundance and distribution of food and other factors. All of these questions either directly or indirectly bear upon the objectives of this study.

Bald eagles begin arriving on the Skagit River in mid-October. Numbers remain relatively low until early December when the number of eagles increases rapidly, reaching peak numbers in January and February. Factors including climatic conditions plus differential food availability among river systems evidently influence the fluctuations in eagle numbers (Servheen 1975; The Nature Conservancy 1976). By mid-February, salmon carcass availability declines and concommittantly so do eagle numbers. By late March, few eagles remain in the area.

Census studies conducted during the past three winters reported peak eagle counts of between 115 and 268 bald eagles (Skagen 1979). The total number of bald eagles utilizing the Skagit during the course of a winter is unknown, but undoubtedly higher than these censuses indicate, since many eagles probably remain for only a short time enroute to other wintering areas in the region.

The Skagit River supports one of less than ten major bald eagle winter concentration areas in the contiguous United States and is the largest concentration in the Pacific states. The midwestern states support nearly half of the nation's total winter population (Sprunt and Ligas 1966). The northwestern states comprise the second most important region with significant wintering eagle numbers recorded in Glacier National Park (McClelland and Shea 1978), the Nooksack River (Stalmaster 1976), the Skagit River (Servheen 1975), and Lakes Coeur d 'Alene and Pend Oreille in Idaho (Lint 1975). The Klamath Basin was recently found to support large numbers of wintering bald eagles in Oregon and northern California (Spencer 1977).

A basic question relating to the occurrence of bald eagles on the Skagit River is how they have fared during this century of gross and accelerating environmental change. Among the major developments have been the creation of three hydroelectric generating dams on the upper Skagit and another one on its tributaries, the Baker River. Logging, mining, and the building of towns, roads, and a railway have changed the face of the Skagit Valley. The prsence of increasing numbers of people and their vehicles, both for livelihood and recreation, have created influences that may have affected the welfare of wintering eagles.

Although there is little historic data available of a scientific nature, there appears to be a near concensus among the people we interviewed who have lived in the valley for 50 or more years that the Skagit study area supported many more eagles than is presently the case. The main reason given for the stated decline of eagles is that the numbers of spawning salmon as food for the eagles themselves declined. Carl (Bud) Buller and Lawrence Hornbeck maintain that the densities of spawning salmon were so great in the early days of their tenure, that fish carcasses rotting along the river bank could be smelled from one-half mile away (pers. comm.).

Since eagles were first censused in the SRSA in 1973, and salmon were first inventoried in 1968 (Mary Aguerro, Washington Department of Fisheries (WDF), pers. comm.) there will presumably be no opportunity to scientifically confirm or deny these verbal reports of eagle decline. However, given the myriad of modern factors working against eagles and salmon, we are inclined to find credible the reports of reductions. Some "old timers", however, reported to us magnitudes of eagle and fish loss (e.g., 100:1) which seem beyond current levels of reasonableness.

As stated, the first scientific study of eagles on the Skagit was conducted by Servheen (1975) during the winters of 1973-74 and 1974-75. During those two winters, he censused eagles from Rockport to Newhalem, studied eagle population structure and behavior, and investigated the temporal occurrence and availability of chum salmon carcasses on a large gravel bar in the lower stretch.

Following Servheen's work, which documented that a substantial population of bald eagles winter in the SRSA, The Nature Conservancy in 1976 created a "natural area" reserve between Rockport and Marblemount. The Conservancy's effort toward an eagle sanctuary was furthered through land purchases by the Washington Department of Game. Since 1976, several persons have yearly served as "stewards" of The Nature Conservancy's preserve (SRBENA). Their tasks have included censusing eagle numbers and collecting data on the effects of human activity on eagles. Their reports (The Nature Conservancy 1976; Wiley 1977, 1978; Skagen 1979, 1980) provide a rich background for the present study.

Another series of important studies which bear upon the present investigation are those conducted on the Nooksack River by M. Stalmaster. A thesis (Stalmaster 1976) and several publications, including Stalmaster and Newman 1978) have reported on the occurrence of bald eagles on the Nooksack River and particularly the relationship of human disturbance to eagle distribution and behavior. Stalmaster continued his studies through the winter of 1979-80 and has additionally obtained field and laboratory data on the food requirements of eagles under differing environmental conditions.

Two eagle census studies were carried out during the winter 1979-80 by the U.S. Forest Service; one on the Sauk River by D. Russel and the other on the lower Skagit River between Sedro Woolley and the mouth of the Sauk River by S. Ralph. These projects add valuably to the overall picture of eagle distribution within the region as does the midwinter bald eagle survey coordinated by R. Knight of the Washington Department of Game. The mid-winter survey is part of a large nationwide count organized by the National Wildlife Federation.

4.2 Field Work

We established a bald eagle census route to be followed three times per week along the entire SRSA from RM 66 to RM 93 at Newhalem. Since our goal was to estimate as accurately as possible the total number of eagles and their correct distribution within the SRSA, we adapted the census route to provide as detailed a picture as possible of the distribution of eagles consistent with the daily time frame selected. The first census we report was made on 24 November 1979 and the last on 13 March 1980.

The census was conducted simultaneously by two field teams, one working the lower stretch (below Marblemount) and the other team primarily censusing the area above Marblemount. Except when morning fog forced delay, we counted eagles between 0800 and 1130 hours.

Since human disturbance operates to some extent on a weekly cycle in the SRSA (e.g., there are generally more people present on weekends) we adhered to a schedule of Tuesdays, Thursdays, and Sundays. In all, we conducted 48 complete censuses over a period of 16 weeks. Subsamples of one, two, or four weeks are comparable within themselves on the basis of equal sampling, and all but the first week contain a Sunday. For much of this report, we will make comparisons on the basis of eight two-week periods. To minimize any time biases in eagle distribution we performed Thursday's census in reverse order. We recognize that further time biases do exist in our census, but the elimination of these was not practical, nor do we regard them as having much effect on the numbers of eagles counted.

The 27 miles of river were divided into 54 one-half-mile segments and 10 off-river locations. It is fortuitous and useful to the data evaluation that total river miles in the SRSA may be divided equally by three or nine, and that the PIA is nine miles in length (RM 84.0 is at the mouth of Copper Creek). The same divisions of the SRSA (using the 54 segments and 10 off-river locations) were also applied to measurements of habitat and disturbance variables so that all phases of the overall project could be integrated.

The census technique involved driving slowly along the main roads, stopping where possible, driving down unimproved access roads to the river and other census points, and walking to a number of observation points along the river. Two persons were necessary for each census team, one to drive, the other to observe. Binoculars and a 20x spotting scope were required, the latter being indispensable in obtaining crop information. The use of a four-wheel-drive vehicle, especially in the PIA, was valuable not only for negotiation of mud and snow but to minimize the necessity of walking into areas and disturbing eagles. For each eagle observation, data were recorded on a form from which one computer card for each eagle observation was ultimately punched. The data recorded included: (1) location, (2) time, (3) weather, (4) age of eagle, (5) crop condition, (6) activity, (7) perch type and (8) perch height, (9) side of river, (10) distance to water, (11) social grouping, (12) response to observer, and (13) proximity of and (14) response to other human activity. The various kinds of data entered on the form are identified in Appendix B. Weather data were recorded at several locations during the census, particularly if a weather change was taking place during the census, as often was the case.

The ages of eagles were usually classified into only two groups, subadults and adults, with five year-olds assigned to the adult group.

If an eagle had a noticeably large bulge in its crop it was scored as having a full crop. Partial and empty crops were also noted. These data were used later in identifying eagle feeding areas.

Activities of eagles were scored according to about 50 specifications (revised from Servheen 1975) under five major categories: standing, perching, feeding, flying, and soaring.

Perches were classified into nine types, some of which require explanation. Deciduous trees were categorized into Class A (large cottonwoods (Populus trichocarpa) or broadleaf maples (Acer macrophyllum) with thick upper branches), Class B (other large trees with thinner upper branches), and Class C (all other deciduous trees). Efforts were made to score the three deciduous classes independent of their relationship to surrounding trees or a forest canopy. The very large and tall firs (Pseudotsuga menziesii) were called Class A coniferous, while all other conifers were scored in Class B.

The distance from the observer to each eagle was scored along with details of the observers mode of activity. If an eagle flushed from its perch as the apparent result of proximity to the observer, then the subsequent activity of the eagle was recorded using the activity codes. The presence of all visitors and other public users was recorded on a separate form (see Appendix B). If eagles were believed to have flushed in response to them, the pertinent detail were recorded.

To accurately answer the first objective of the study, namely how many eagles utilized the PIA, we devised a technique to measure the visibility to the observer of each 0.5 mile segment of river. This was done by dividing each 0.5 mile segment into four quadrants, two on either side of the river. Each quadrant was scored as to its visibility in the census on the basis of ten points; forty points were thus awarded to a completely visible 0.5 mile segment. The score was then equated to one or a fraction thereof in the case of partially visible segments. This weighting factor was applied to the actual census data for each 0.5 mile segment to produce a projection estimate of the actual number of eagles in each 0.5 mile segment.

4.3 Analysis of Census Data

A total of 3,140 eagle observations was recorded during the 48 censuses. A computer card (Fortran) was punched for each of those entries. Approximately 1,400 additional cards were processed for eagle observations during non-census periods. The data were ordered and analyzed at the Computer Center of the University of Washington using a CDC 6400 computer. Programs were selected among the SPSS system (Statistical Package for the Social Sciences, Nie et al 1975) and included the erecting of numerous cross tabulations with automatic computations of Chi-Square. Simple, multiple, and stepwise regressions were performed where appropriate along with the computation of correlation coefficients and significance probabilities.

4.4 Results

4.4.1 Phenology of Eagle Occurrence

Because of the need to accurately estimate the number of eagles present to meet the objectives of the Copper Creek assessment, the census was performed in greater detail than in years past. For this reason, quantitative comparisons with previous years are rendered more obscure, and the assumption is reasonable that greater numbers of eagles would have been counted in those years if our more detailed census had been employed. Thus in winters when higher numbers of eagles were recorded than in 1979-80, the differences were greater than the data indicate.

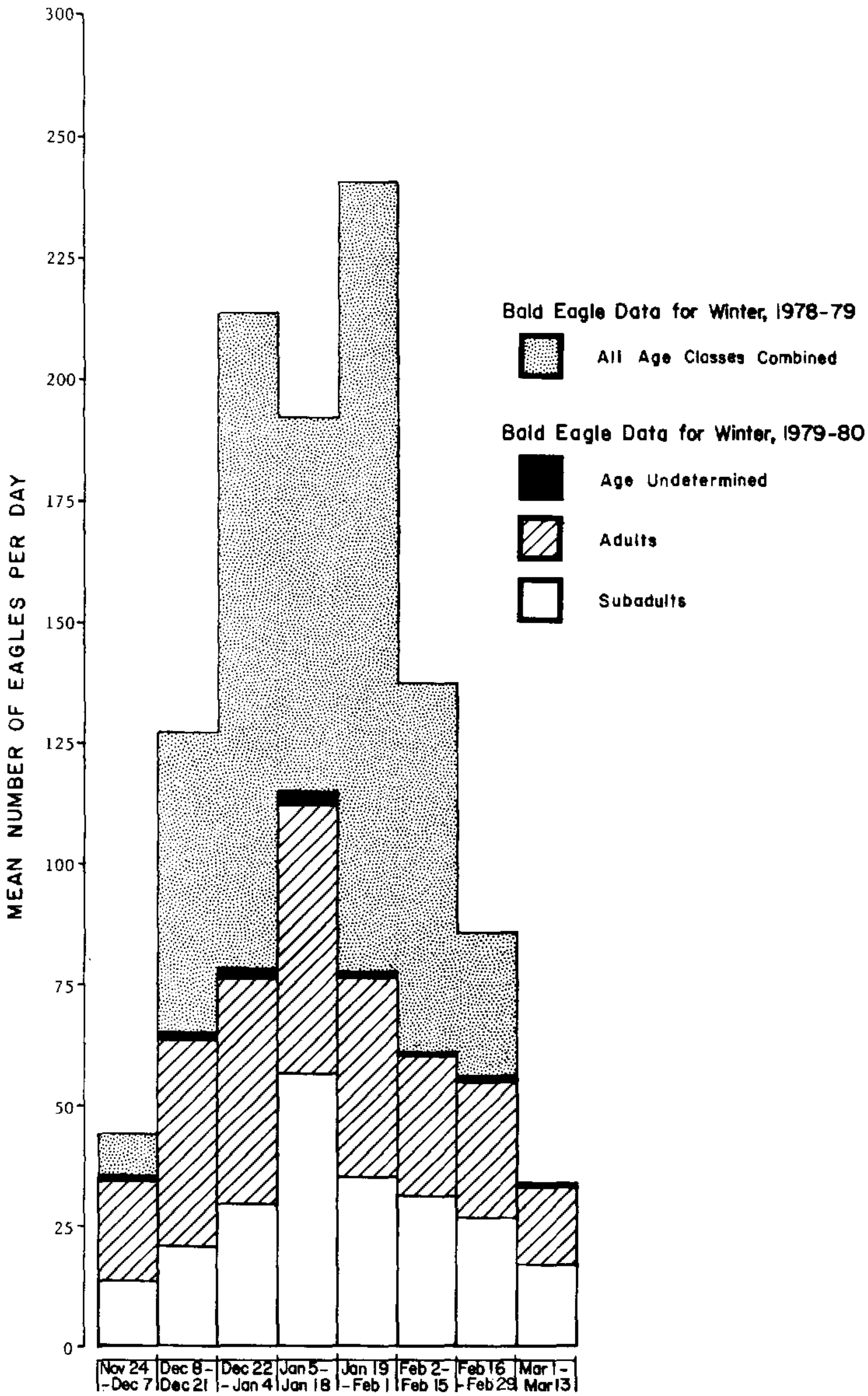
Figure 4a shows the phenology of eagle occurrence in the SRSA during winter 1979-80 and contrasts it with the census conducted by The Nature Conservancy during the previous winter. The latter census did not include the area above Marblemount; so, for that reason and the reason of differing levels of sampling explained above, the difference between the numbers of eagles present in the two years was greater than the graph shows. Bald eagles, therefore, were less than half as numerous in the SRSA in winter 1979-80 as they were the year previously. The reasons for the paucity of eagles in 1979-80 were the poor chum salmon spawn and a flood of considerable dimension occurring in a mid-December. Both of these are discussed under feeding ecology, Section 5.0.

The timing of eagle occurrence in the SRSA in 1979-80 coincided with that recorded in previous years. Table 4a gives daily summaries of the numbers of eagles, their apparent age structure, and the fraction of subadults within the sample of eagles identified as to age. Again, the patterns we observed do not appear to differ significantly from those reported by Servheen (1975) and by the various subsequent reports of The Nature Conservancy. The eagles began arriving in the SRSA in mid-November, peaked in mid-January, and had declined to a very few by late March.

Looking at Figure 4a and allowing for the discrepancy (explained above) in census distribution and detail between this year's census and those of previous years, we estimate that approximately one-third of the number of eagles were present in the SRSA this winter as were present during the previous winter, a decline from about 300 to about 100 eagles. As to where the eagles absent from the Skagit were located, it is possibly not a mere coincidence that the winter eagle population on the Nooksack River, forty miles to the north, appeared to have numbers far exceeding those recorded in previous years (M. Stalmaster, pers. comm.). R. Knight (Washington Department of Game) censused the Nooksack on January 13, 1980 and recorded 283 eagle observations in an area where about 100 birds had in years before been the maximum count. The matter may be explained circumstantially by the unusually good chum salmon run occurring this year on the Nooksack.

Table 4b compares the Nooksack eagle count with that of the Skagit on 13 January 1980. Note the similarity of age ratios of eagles on the two rivers.

Figure 4a. Phenology of bald eagle occurrence in the SRSA. Mean number of eagles per day are given for eight two-week periods in winter 1979-80 and compared with data collected by The Nature Conservancy in 1978-79 (stippled graph) in the area below RM 78. The overall difference between years in thus greater than indicated



Bald Eagle Data for Winter, 1978-79
All Age Classes Combined
Bald Eagle Data for Winter, 1979-80
Age Undetermined
Adults
Subadults
MEAN NUMBER OF EAGLES PER DAY
300
250
225
200
175
150
125
100
75
50
25
0
Nov 24 - Dec 7
Dec 8 - Dec 21
Dec 22 - Jan 4
Jan 5 - Jan 18
Jan 19 - Feb 1
Feb 2 - Feb 15
Feb 16 - Feb 29
Mar 1 - Mar 13

Table 4a. Numbers of eagles counted each census day in the Skagit River study area during winter 1979-80. Sundays (days of higher visitor use) are marked with an asterisk.

Date	Two-week Period	Subadults	Adults	Age Undetermined	Total Eagles	Subadults/ Aged Sample
24 Nov	1	5	9	0	14	.36
27 Nov	1	9	9	1	19	.50
29 Nov	1	16	20	0	36	.44
2 Dec*	1	16	25	0	41	.39
4 Dec	1	9	22	3	34	.29
6 Dec	1	23	46	1	70	.33
9 Dec*	2	17	21	2	40	.45
11 Dec	2	18	27	3	48	.40
13 Dec	2	20	37	1	58	.35
16 Dec*	2	30	65	2	97	.32
18 Dec	2	30	57	3	90	.34
20 Dec	2	11	46	0	57	.19
23 Dec*	3	25	42	6	73	.37
24 Dec	3	28	54	1	83	.34
27 Dec	3	36	44	0	80	.45
30 Dec*	3	29	39	0	68	.43
1 Jan	3	29	56	1	86	.34
3 Jan	3	33	48	0	81	.41
6 Jan*	4	37	40	2	79	.48
8 Jan	4	42	37	2	81	.53
10 Jan	4	56	46	3	105	.55
13 Jan*	4	84	90	0	174	.48
15 Jan	4	57	74	2	133	.44
17 Jan	4	59	54	5	118	.52
20 Jan*	5	30	55	0	85	.35
22 Jan	5	43	47	1	91	.48
24 Jan	5	46	51	1	98	.47
27 Jan*	5	40	20	1	61	.67
30 Jan	5	11	20	0	31	.35
1 Feb	5	44	52	1	97	.46
3 Feb*	6	31	39	1	71	.44
5 Feb	6	36	34	1	71	.52
7 Feb	6	43	40	1	84	.52
10 Feb*	6	30	19	1	50	.61
12 Feb	6	36	32	0	68	.53
14 Feb	6	13	16	1	30	.45
17 Feb*	7	34	41	0	75	.45
19 Feb	7	35	25	1	61	.58
21 Feb	7	29	23	1	53	.56
24 Feb*	7	15	22	0	37	.41
26 Feb	7	22	25	0	47	.47
28 Feb	7	29	31	0	60	.48
2 Mar*	8	18	23	0	41	.44
4 Mar	8	18	16	3	37	.53
6 Mar	8	14	12	0	26	.54
9 Mar*	8	19	13	3	35	.59
11 Mar	8	19	17	0	36	.53
13 Mar	8	14	16	0	30	.47

Table 4b. Comparison of bald eagle census counts made on the Skagit and Nooksack Rivers on 13 January 1980.

Location	Distance[2/] Surveyed	Subadults	Adults	Total Eagles
Skagit River Study Area	27[1/]	84	90	174
Nooksack River (Demming to Canyon Cr.)	25	132	151	283
TOTAL				457

1/The SRSA also includes off-river locations
2/distance given in miles

By chance, 13 January was the day when the highest number of eagles was censused in the SRSA for the 1979-80 winter. For the Nooksack, that was the only date this year on which a census was conducted.

It is appropriate to mention here that our movements studies (8.0) showed that eagles seem to freely travel from area to area within the region, presumably in search of food, and that these areas include, at minimum, the various river valleys of northwestern Washington and the islands in Puget Sound. That eagles visiting the Skagit or Nooksack spread even further into areas unknown to us is evidenced by the rather considerable proportion of "missing birds" from the radio-tagged sample prior to the presumed onset of a spring migration to breeding grounds. The concept of carrying capacity for eagles on the Skagit is, therefore, complicated by our discovery of this apparently significant amount of flux within the larger region, the real dimensions of which are still somewhat obscure.

Age class differences in the time of eagle occurrence on the Skagit did not appear to deviate significantly from those reported previously. Adults were the preponderant age-class in early winter but later, their numbers more closely matched those of subadults.

One curious aspect of our census data was that age ratios differed according to the activity of the eagle. Hancock (1964) studying wintering bald eagles on the Gulf Islands, B.C., suggested that since subadult eagles are more difficult than adults to see when they are perched in trees, that a biased age ratio in favor of adults would necessarily appear in a census sample of perched eagles. He suggested that there is no such problem in aging flying or soaring eagles. If there is no tendency of adults to fly more or less often than subadults, then a sufficient sample of observations of eagles flying would give a truer picture of actual age ratios within the total eagles present. Indeed if the assumption of age equality in the tendency to fly is correct, then extrapolations to those perched subadults missed (if any) in the census could give a more accurate estimate of the total number of eagles present.

Table 4c shows a balanced age ratio in the sample of flying birds but a preponderance of adults in the perched sample, exactly what Hancock predicted. The idea is reinforced in the sample of eagles that are standing or feeding since the age class representations there do not significantly depart from 50:50.

Table 4c. A comparison of age class frequencies within three major categories of activity.

Age Class	Flying	Standing or feeding	Perched
Subadult	244 (46%)	138 (52%)	995 (43%)
Adult	243 (46%)	125 (47%)	1321 (57%)
Unclassified	40 (8%)	1 (1%)	14 (0%)

We conclude, therefore, that if perched subadults were as readily seen as adults, then our overall sample of eagle observations would be larger by about 10 percent. This is an important consideration in developing accurate estimates of population numbers in the PIA and elsewhere in the SRSA (see visibility weighting factor discussion in 4.2).

4.4.2 Eagle Distribution

Table 4d provides information on the total numbers of eagles counted during the study period (48 censuses) for each 0.5 mile segment and off-river location (n=10). Included are age ratios, average numbers of eagles per day, projected averages based on segment visibility (4.2) and projections that additionally allow for undetected perched subadults (4.4.1). From this, we project that a daily average of 88 bald eagles occurred along the river during the morning hours, and we estimate that an additional daily mean of 20 to 40 birds occupied the off-river locations of the SRSA.

Eagles along the river miles were far from randomly distributed. Eagle concentration points along the river included the area of Washington Eddy through Illabot Bend (RM 69.5 - 73.0 in the SRBENA) and the County-Line

Table 4d. Distribution of bald eagles in the Skagit River Study Area. The visibilities to the observer (G) of each 0.5 mile segment of river (see 4.2 for explanation) were used to compute projections of the average numbers of eagles per day (H) in each 0.5 mile segment (formula: H=F/G). Because perched subadults are evidently less visible than perched adults, about 10% more eagles (I) would otherwise be counted in a given segment (see 4.4.1 for computations). Single asterisks indicate area of proposed impoundment. Double asterisks indicate census visibility insufficient for calculating projections.

No.	0.5 mile river segment	Location	Adults (A)	Sub-adults (B)	Unclassi-fied (C)	Fraction Subadults in Aged Sample (D)	Total Eagles (E)	Mean Eagles Per Day (F)	Census Visibility Coefficient (G)	Projected Mean Eagles Per Day (H)	Projected with Subadult Correction (I)
1	66.0		33	15	0	0.31	48	1.00	0.52	1.92	2.11
2	66.5		68	34	5	0.33	107	2.23	0.62	3.60	3.82
3	67.0	Sauk River Mouth	58	26	1	0.31	85	1.77	1.00	1.77	1.95
4	67.5		23	19	0	0.45	42	0.87	1.00	0.87	0.96
5	68.0		66	45	1	0.40	112	2.33	1.00	2.33	2.56
6	68.5		26	28	1	0.52	55	1.15	1.00	1.15	1.26
7	69.0		22	18	0	0.45	40	0.83	0.50	1.66	1.83
8	69.5	Washington Eddy	191	187	2	0.49	380	7.92	0.92	8.61	9.47
9	70.0		77	53	0	0.41	130	2.71	0.52	5.21	5.73
10	70.5		60	25	2	0.29	87	1.81	0.82	2.21	2.43
11	71.0		45	61	0	0.57	106	2.21	0.95	2.33	2.56
12	71.5		61	34	3	0.36	98	2.04	0.30	6.80	7.48
13	72.0	Illabot Bend	83	47	3	0.36	133	2.77	1.00	2.77	3.05
14	72.5	Illabot Bend	129	113	1	0.47	243	5.06	0.72	7.03	7.73
15	73.0		33	43	4	0.57	80	1.67	0.57	2.93	3.22
16	73.5		21	13	0	0.38	34	0.71	0.80	0.89	0.98
17	74.0	Corkindale Crk.	5	0	0	0.00	5	0.10	0.37	0.27	0.30
18	74.5		0	0	0	-	0	0.00	0.00	**	**
19	75.0		0	0	2	-	2	0.04	0.00	**	**
20	75.5		4	10	0	0.71	14	0.29	0.45	0.64	0.71
21	76.0		19	8	4	0.30	31	0.65	1.00	0.65	0.71
22	76.5		19	13	3	0.41	35	0.73	0.75	0.97	1.07
23	77.0		12	18	2	0.60	32	0.67	0.95	0.70	0.78
24	77.5	Cascade R. Mouth	13	20	1	0.61	34	0.71	0.92	0.77	0.85
25	78.0	Marblemount Bridge	14	33	0	0.70	47	0.98	1.00	0.98	1.08
26	78.5		8	1	2	0.11	11	0.23	1.00	0.23	0.25
27	79.0		9	6	0	0.40	15	0.31	1.00	0.31	0.34
28	79.5		11	4	2	0.27	17	0.35	1.00	0.35	0.38
29	80.0		8	1	0	0.11	9	0.19	0.37	0.51	0.56
30	80.5	Diobsud Crk. Mouth	17	8	0	0.32	25	0.52	0.75	0.69	0.76
31	81.0		10	1	0	0.09	11	0.23	0.50	0.46	0.51
32	81.5		2	1	0	0.33	3	0.06	1.00	0.06	0.07
33	82.0		3	0	0	1.00	3	0.06	0.62	0.10	0.11
34	82.5	Bacon Crk. Mouth	23	13	0	0.36	36	0.75	0.87	0.86	0.95
35	83.0		2	1	0	0.33	3	0.06	0.35	0.17	0.19
36	83.5		6	3	0	0.33	9	0.19	0.37	0.51	0.56
37	84.0*	Copper Crk. Mouth	15	4	0	0.21	19	0.40	0.67	0.60	0.66
38	84.5*		7	5	0	0.42	12	0.25	1.00	0.25	0.27
39	85.0*		11	2	1	0.15	14	0.29	0.52	0.56	0.61
40	85.5*		3	2	0	0.40	5	0.10	0.47	0.21	0.23
41	86.0*	Missing Bridge Gorge	1	1	1	0.50	3	0.06	1.00	0.06	0.07
42	86.5*		8	2	0	0.20	10	0.21	1.00	0.21	0.23
43	87.0*		14	3	0	0.18	17	0.35	0.97	0.36	0.40
44	87.5*		10	1	0	0.09	11	0.23	0.15	1.53	1.69
45	88.0*		30	20	0	0.40	50	1.04	1.00	1.04	1.14
46	88.5*		24	31	1	0.56	56	1.17	0.92	1.27	1.40
47	89.0*	County Line Ponds	56	99	4	0.64	159	3.31	0.75	4.41	4.85
48	89.5*		28	21	0	0.43	49	1.02	0.25	4.08	4.49
49	90.0*	Thornton Crk. Mouth	5	5	0	0.50	10	0.21	0.30	0.70	0.77
50	90.5*		8	13	0	0.62	21	0.44	0.62	0.71	0.78
51	91.0*		3	6	0	0.66	9	0.19	0.27	0.70	0.77
52	91.5*		8	2	0	0.20	10	0.21	0.37	0.57	0.62
53	92.0*		5	4	0	0.44	9	0.19	0.35	0.54	0.60
54	92.5*		11	2	0	0.15	13	0.27	0.77	0.35	0.39
55	93.0*	Newhalem	0	0	0	-	0	0.00	0.75	0.00	0.00
56		W. Illabot	73	81	2	0.53	156	3.25	-	-	
57		E. Illabot	56	65	0	0.54	121	2.52	-	-	
58		Illabot Fields	8	1	0	0.11	9	0.19	-	-	
59		Illabot Creek Bridge	2	0	0	0.00	2	0.04	-	-	
60		Barnaby Slough	47	8	4	0.14	59	1.23	-	-	
61		Roost Site	1	1	0	0.50	2	0.04	-	-	
62		Lower Cascade R. & Buller's	21	69	1	0.77	91	1.90	-	-	
63		Jordan Creek	0	1	0	1.00	1	0.02	-	-	
64		Cascade R. Bridge	14	16	1	0.53	31	0.65	-	-	
65		Diobsud Crk. Bridge	15	6	0	0.29	21	0.44	-	-	
66		Bacon Crk. Bridge	23	4	0	0.15	27	0.56	-	-	
67	*	Aggregate ponds	6	10	1	0.62	17	0.35	-	-	
68	*	Goodell Crk. Mouth	3	0	0	0.00	3	0.06	-	-	

Ponds-Whistling Hole area (RM 89.0 - 90.0 in the PIA). The stretch with the lowest numbers of eagles was roughly between the Marblemount Bridge and the Missing Bridge Gorge (RM 78.5 to 87.0). The area just above Corkindale Creek (lower stretch) was poorly visible to the census and no doubt held many more eagles than were recorded. The reasons why eagles are believed to be distributed in the SRSA as they were discussed in the sections on eagle food (5.0), habitat (6.0), and in the conclusions of this report (9.0).

The distribution of eagles within the SRSA changed during the winter. Figure 4b divides the study period into four four-week blocks, each containing 12 censuses and the river is divided into nine three-mile segments. During the first two months, eagles concentrated in the lower stretch, particularly within the SRBENA (Washington Eddy-Illabot Bend-Illabot Slough). But in the third and fourth months, another moderate concentration occurred in the County Line Ponds-Whistling Hole complex in the PIA (RM 89-90). During the last (fourth) month, this particular area of the PIA contained the highest concentration of eagles in any three mile segment or the combined off-river locations of the entire SRSA.

4.4.3 Eagle Numbers in the Proposed Impoundment Area

A prime objective of this study was to determine the numbers of eagles which were supported in winter 1979-80 by the habitat that would be inundated by the proposed Copper Creek dam. Table 4e shows the numbers of eagles recorded during the eight two week periods of the census and gives the various projection estimates of the actual number of eagles present in the PIA.

There were three main ways of projecting the numbers of eagles. The first was to divide the mean numbers of eagles observed in each 0.5 mile segment of the PIA per day by the segment visibility fractions given in Table 4d (see 4.2 for explanation). This technique stemmed from the impossibility of seeing the entire field along most 0.5 mile segments, and so produced an estimate of the number of eagles that would have been seen if a whole segment were visible (Table 4e, column C). To these projections were added a factor that takes into consideration the likelihood that a fraction of subadults is missed during the census (Table 4e, column D). This phenomenon is explained in Section 4.4.1. Very likely, there are errors in estimating the absolute numbers of bald eagles per 0.5 mile segment, but considering the good sample of segments, any errors may balance themselves in estimates for longer stretches of river.

To test the reliability of the regular census in the PIA, two censuses by jet boat were conducted (9 January and 17 January) between the Goodell Creek mouth (RM 92.5) and Shovelspur (RM 87.0). These were performed simultaneously with the regular census so that any relationship between the number of eagles counted by the two methods could be identified. The resulting factors were averaged and multiplied by the census mean for each two-week period in Table 4e. It is reassuring to note that the boat census projections (column E) are for the most part fairly similar to those values given in column D.

Figure 4b. Seasonal comparison of bald eagle distribution (mean number of eagles observed per day) above and below the proposed Copper Creek dam.

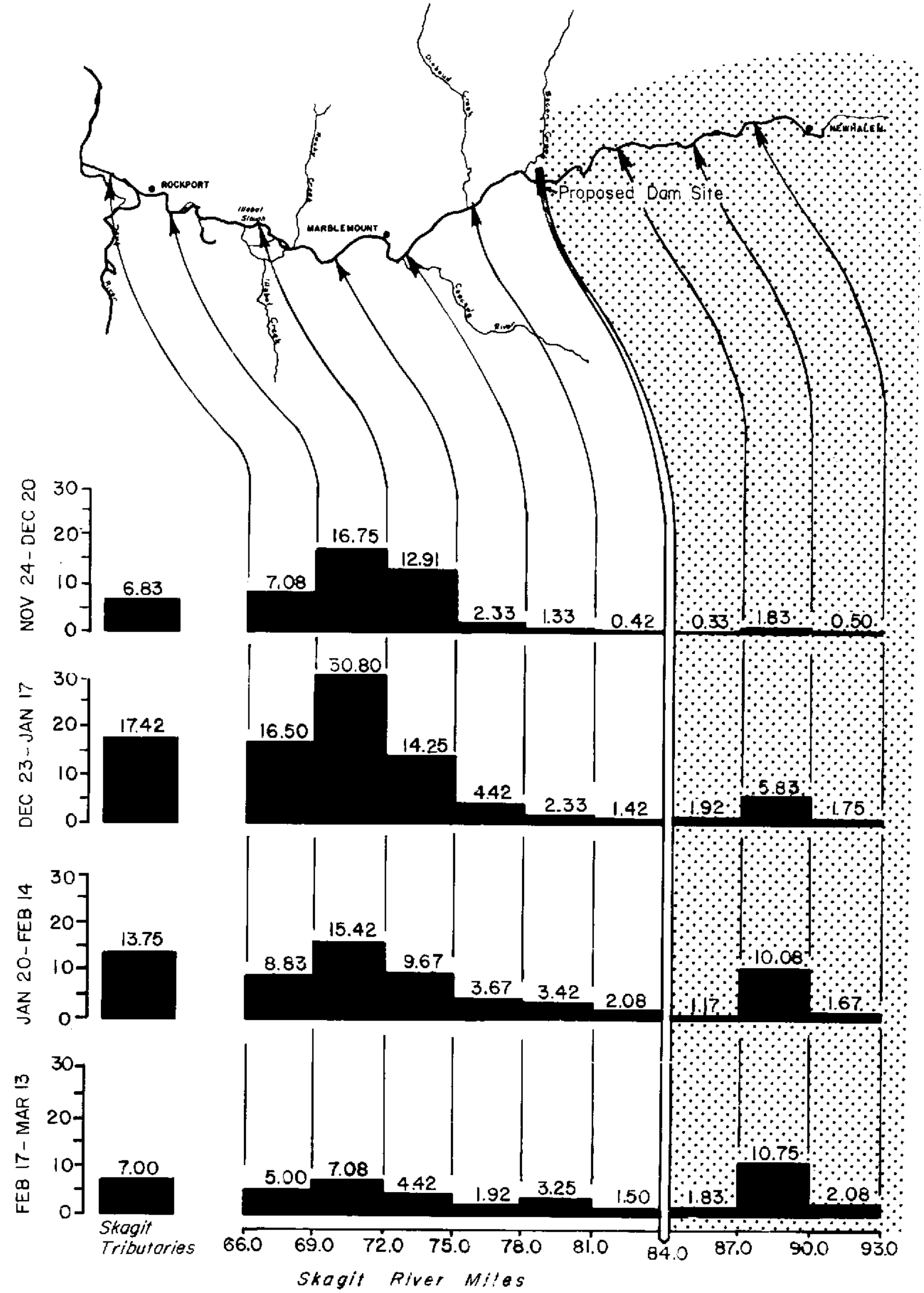

ROCKPORT
MARBLEMOUNT
NEWHALEM
Proposed Dam Site
Illabot Slough
Illabot Creek
Cascade River
Diobsud Creek
NOV 24 - DEC 20
DEC 23 - JAN 17
JAN 20 - FEB 14
FEB 17 - MAR 13
0
10
20
30
6.83
7.08
16.75
12.91
2.33
1.33
0.42
0.33
1.83
0.50
17.42
16.50
30.80
14.25
4.42
2.33
1.42
1.92
5.83
1.75
13.75
8.83
15.42
9.67
3.67
3.42
2.08
1.17
10.08
1.67
7.00
5.00
7.08
4.42
1.92
3.25
1.50
1.83
10.75
2.08
Skagit Tributaries
66.0
69.0
72.0
75.0
78.0
81.0
84.0
87.0
90.0
93.0
Skagit River Miles

Table 4.e. Observed and projected numbers of bald eagles in the proposed impoundment area of the Copper Creek dam over eight two-week periods. Column C, the projected average number of eagles per day in the PIA, was computed by dividing the mean number observed in each 0.5 mile segment by the visibility of that segment to the census (see 4.2). A correction factor for unseen perched subadults is applied to produce the column D projection (see 4.4.1). Two independent boat censuses were conducted concurrent with the regular census to produce extrapolations of the mean number of eagles (E) quite close in value to those developed by the other methods (D).

No.	Two-week Period	Total Eagles (A)	Mean No. Eagles Observed Per Day (B)	Projected Mean Eagles Per Day (C)	Projected Mean with Subadult Correction (D)	Boat Census Projection (E)
1	Nov 24 - Dec 7	14	2.33	3.03	3.31	5.31
2	Dec 8 - Dec 21	20	3.33	5.03	5.49	7.59
3	Dec 22 - Jan 4	30	5.00	10.05	10.97	11.40
4	Jan 5 - Jan 18	86	14.33	24.51	26.74	32.67
5	Jan 19 - Feb 1	71	11.83	18.45	20.13	26.97
6	Feb 2 - Feb 15	88	14.67	28.56	31.16	33.45
7	Feb 16 - Feb 29	109	18.17	36.90	40.26	41.43
8	Mar 1 - Mar 14	79	13.17	21.91	23.91	30.03

As a further test, we examined some appropriate data from our study of the movements of telemetered eagles in the PIA. On ten different days, eagles were detected in the PIA during a census period. All of these eagles were searched for visually but were seen in only 40% of the cases. When this factor is divided into the mean numbers of eagles observed per day in the PIA (Table 4e, column B), the resulting projections exceed column D by 13% and column E by 9%. The telemetry data used here represents a very small sample, but it is remarkable that this and the other methods of projection estimation have yielded such similar figures on the actual numbers of bald eagles that utilized the PIA.

In summary, we conservatively conclude that an average of about 40 eagles utilized the PIA during the seventh two-week period (Feb 16-29), and that the mean number for January and February combined was about 30 eagles.

In trying to assess the numbers of eagles which would be displaced by the proposed Copper Creek dam, it is important to remember that the winter of our study (1979-80) was an extremely poor one for chum salmon in the PIA. Not only were there reported to be less than one-tenth of the number of spawners there, as in an average year (see 5.4.4), but the mid-December flood eliminated virtually all carcasses that might have been available. We cannot predict for an average chum year what contribution chums in the PIA might make toward eagle occurrence in the PIA. We, therefore, cannot say whether more, equal, or less eagles would utilize the PIA in such years than were present during winter 1979-80.

There is some suggestion (though not verified by a sufficient sample) that chums may tend to spawn later in the PIA than downstream (Mary Aguerro, pers. comm) as is the case on an upstream portion (Maple Creek) of the Nooksack. A later chum spawn might conceivably draw eagles to fresher carcasses in the PIA. In any case, our census was the first designed to estimate eagle numbers in the PIA so we cannot address the issue of eagle numbers in the PIA in an average chum year using comparative data.

4.4.4 Daily Activities of Eagles

Each eagle observed during the censuses and at certain other times was scored according to its activity within a coding system of 47 activity variations (Appendix B). These fell into five major groups: (1) perching, (2) standing on the ground, (3) feeding on the ground, (4) flying and (5) soaring. A number of age differences in activity was detected. Some were data artifacts resulting from the lower visibility of subadults while others seemed to reflect age class differentials in disturbance tolerance, foraging strategies, and other factors. These are discussed under appropriate sections such as 5.0 and 7.0.

Table 4f provides information on the activities of eagles throughout the day. The majority of eagles seen near dawn were flying but at other times eagles were most frequently observed perching. Eagles were observed on the ground most commonly in the mid-morning and again an hour or so before dark. A good percentage of eagles on the ground may be assumed to be eating, attempting to eat or bathing.

Table 4f. Daily activity patterns of 4,450 eagle observations in the SRSA. The larger samples in the morning reflect the census periods. Observations after noon were made primarily in The Nature Conservancy preserve by Susan Skagen.

Hour	No. of Eagles Observed	Percent Perched	Percent on the Ground	Percent Airborne
0700 - 0759	17	41.2	0.0	58.8
0800 - 0859	441	73.7	6.8	19.5
0900 - 0959	1299	70.2	12.0	17.8
1000 - 1059	1062	75.5	9.4	15.1
1100 - 1159	635	76.5	7.9	15.6
1200 - 1259	307	82.4	3.3	14.3
1300 - 1359	316	83.2	4.1	12.7
1400 - 1459	205	83.4	0.5	16.1
1500 - 1559	114	73.7	7.9	18.4
1600 - 1659	54	92.6	0.0	7.4

In general, eagles leave their night roosting areas at first light or within the first few morning hours; however, movement from the site may be postponed on cloudy or foggy days. Storms, high winds, or low temperatures may even cause eagles to remain at their roosts all day. Flight to perches or feeding areas is quite direct.

Morning feeding periods are intensive when food is abundant, and foraging is usually repeated during the last two hours of light and occasionally throughout the day. But during stretches of reduced food availability, feeding (and searching for food) is not limited to two periods per day, as noted by Servheen (1975).

Wintering bald eagles may soar for hours on windy days or when the sun creates thermals, thus reducing the amount of time they are involved in feeding activities. Long periods of inactivity (e.g. perching along the river) may occur at other times (afternoons), and especially during inclement weather. Preening and bathing at the water's edge are common daytime activities. Eagles typically return to roost sites after the abovementioned afternoon foraging period, but we sometimes observed them moving into their locations early in the afternoon.

4.4.5 Night Roosts

Steenhoff (1976, 1978), Snow (1973) and Lish (1973) reviewed the literature discussing communal night roosts of wintering bald eagles. In western Washington, the subject has been treated by Stalmaster (1976) and Hansen (1978). Servheen (1976), Wiley (1977, 1978), and Skagen (1979, 1980) all reported on use of night roosts by wintering eagles in the SRSA in previous years.

In 1979-80, four major communal roosts were identified in the SRSA. Two (Eagle Island and Cascadian Farm), were first mentioned by Servheen (1975). Additionally, minor roosts were noted, and evidence was gathered that points to the existence of other sites that have not yet been specifically identified. A description of each major roost and comments on the secondary ones follow. Much of the information in this section was compiled by Susan Skagen of The Nature Conservancy. Table 4g summarizes eagle sightings at the four primary communal sites.

(1) Eagle Island

This stand of Class B black cottonwoods borders the south bank of the Skagit River and is located on property owned by The Nature Conservancy. It is a prominent site that also serves as a staging area for nearby roosts. Upwards of 30 eagles have been recorded there at last light in the evening (Skagen 1980). The greatest number of eagles seen there during this study was 28 (Table 4g). Telemetered Bird No. 5 spent three nights at this location.

(2) Cascadian Farm

This site is in a draw on a steep south-facing slope overlooking the Skagit River from about 1.5 km away. The upper part of the draw is on

Table 4g. Sightings of bald eagles at four major communal night roosts in the SRSA during winter 1979-80

Roost	Date	Time	No. Eagles Seen
Eagle Island	19 Dec 79[1/]	1630	28
	20 Dec 79	1615	15
	22 Dec 79	1630	12
	27 Dec 79	1635	7
	30 Dec 79	1645	20
	5 Jan 80	1650	14
	10 Jan 80	1725	7
	16 Jan 80[2/]	1700	23
	18 Jan 80	0710	9
	18 Jan 80[2/]	1710	2
	22 Jan 80[2/]	1730	2
	7 Feb 80	1750	1
Cascadian Farm[3/]	18 Jan 80[2/]	1710	1
	19 Jan 80	0745	8
	7 Feb 80	1640	3
	15 Feb 80[4/]	1700	6
	16 Feb 80	0700-0750	5
Barnaby Slough	29 Dec 79	1645	13
	3 Jan 80	1650	14
	16 Jan 80	1700	37
	17 Jan 80	0700	24
	4 Feb 80	1735	15
McLeod Slough	28 Dec 79	0730	9

[1/] Unless indicated, all sightings made by Susan Skagen

[2/] Observations by Kate McLaren

[3/] Landowners have seen 20 eagles here on many occasions. Our counts are low because difficult-to-observe roost trees did not permit counts of perched birds. These sightings were of birds flying to and from site, sometimes in low light conditions.

[4/] Observations by Harriet Allen

public land (U.S. Forest Service) and the lower section is privately owned by Gene and Loren Kahn. Old growth (firs) and second growth conifers scattered throughout the draw and varying in elevation from 150-700 m are used by eagles. In particular, the Kahn's have noted consistent use of a stand of old growth firs and are taking measures to ensure the security of that portion of the roost on their property. Radio-tagged birds No. 5 (one night) and 10 (three nights) both utilized this communal site.

(3) Barnaby Slough

This roost is situated about 0.4 km from the Skagit River. A stand of Class A black cottonwoods comprise the site, which borders a recent clear-cut. Both roost and logged area are owned by the Scott Paper Company. Eagles had used this area as a roost during logging operations in winter 1977-78 (N. Schaff, Scott Paper Co., pers. comm. to S. Skagen), and Servheen observed as many as 14 eagles roosting in a large deciduous tree to the north of the present Barnaby Slough communal site during his study (Servheen, pers. comm.). However, in 1979-80 that particular tree was no longer standing. Previous records of eagles roosting in the area, specifically prior to logging, are not known.

(4) McLeod Slough

Eagles have been known to roost in black cottonwoods along both shores of the river and on an island owned by the Washington Department of Game near Rockport. The site was observed on only one occasion this winter. Results of the census appear in Table 4g.

(5) Minor and Suspected Communal Night Roosts

To what extent Illabot Slough is used as a communal roost is unknown. Visual observations of eagles flying into the area at dusk, and out at dawn, in addition to detections of radio-tagged birds (No. 3 and 5 spent a total of four nights here) suggest that it may be used by quite a few eagles. Skagen has seen eagles roosting occasionally in cottonwoods along the water at Illabot Ponds. Other trees in the vicinity were used regularly by eagles in 1979-80. In particular, eagles were heard frequently in the early morning from where they perched in a large cottonwood surrounded by tall conifers near Doug Martin's field and Illabot Creek (T. Harvey, D. Baker, pers. comm.to S. Skagen).

Eagles have also been known to roost in the vicinity of Dibsud Creek. During January and February 1980, S. Meyers (pers. comm. to S. Skagen) observed birds vocalizing there at dusk in a stand of old growth firs and snags, and previous sightings of eagles in the area have been recounted to us by J. Mesa (pers. comm). We found radio-tagged Eagle No. 7 in this area on three different nights. A prominent cottonwood on the edge of a field near Marblemount Slough was used at least twice this winter, once by eight and once by two eagles. Interestingly enough, B. Buller was then conducting his eagle feeding program less than 0.4 km away. Evidence strongly indicates a communal site along Illabot Creek at least 1.5 km upstream of the Rockport-Cascade Road and another night roost on a slope overlooking the Cascade River. Eagles were seen flying to and from both places (and Bird No. 7 seemed to roost in this area on one occasion) but the exact trees were not located.

Table 4h presents a comparison of standard measurements of trees at two major communal night roosts. The specific trees used by bald eagles were measured separately from those that comprised the rest of the stand and are listed independently. At Eagle Island, eagles utilized trees with an average height of 32.8 m and an average DBH of 81.4 cm, as compared to an average height of 27.9 m and mean diameter of 56.8 cm for the surrounding trees. The same held for roost trees at the Barnaby Slough site: trees with a mean height of 32.9 m and average diameter of 98.7 cm were used and can be compared to 27.5 m and 62.4 cm, respectively, in the roost stand. These data suggest that bald eagles in the SRSA are choosing to roost in the tallest and largest trees available at a particular site.

Results from the radio-tracking portion of this study (8.0) revealed an extensive list of places where bald eagles roosted in the SRSA (Table 4i). Eight of the radio-tagged birds were detected in the study area at night a total of 62 times. Twenty-nine specific roosting locations were identified, including four known and one suspected communal site. No two radioed eagles within the SRSA were detected at the same spot on the same night; however, that does not preclude the possibility that more than one bird was present. Significantly, nine locations in the PIA were noted to have been used by eagles.

Birds No. 5 and 7 traveled widely in the SRSA and remained there for long periods (See 8.4 and Appendix C). We therefore have a good record of their night-time habits. Bird No. 5 roosted at at least 12 different locations in the SRSA during 21 nights, and Bird No. 7 slept at 11 SRSA sites during 17 nights. Other telemetered birds changed roosts just as frequently, as can be seen in Table 4i.

In Table 4i, one can also see that radio-tagged bald eagles spent nights in many different kinds of situations. River side trees were used by radioed birds, as well as trees in draws and on higher slopes. Sites in the more secluded and narrow upper canyon of the Skagit (in the PIA) were utilized as well as areas in SRBENA and the lower SRSA. The data suggest that eagles in the study area were not dependent on communal roosts, although such areas were used regularly by some birds. It is our impression that most radio-tagged eagles probably roosted solitarily, not far from feeding areas.

Table 4h. Physical characteristics of two SRSA roost sites and surrounding trees

Roost	Tree Species	ROOST STAND N	ROOST STAND Mean Height (m)	ROOST STAND Mean DBH (cm)	ROOST TREES N	ROOST TREES Mean Height (m)	ROOST TREES Mean DBH (cm)
Eagle Island	Black Cottonwood	15	36.0	95.4	18	43.6	109.8
	Bigleaf Maple	17	25.9	58.4	1	22.0	53.0
	Western Red Cedar	39	27.8	57.7			
	Red Alder	8	25.0	43.4			
	Western Hemlock	1	25.0	29.0			
Barnaby Slough	Black Cottonwood	28	31.8	55.8	14	39.7	89.9
	Bigleaf Maple	15	27.0	63.6	1	30.0	129.0
	Western Red Cedar	1	25.0	86.0			
	Red Alder	35	26.0	44.3	3	29.0	77.3

Table 4i. Locations where radio-tagged bald eagles roosted in the SRSA. Points within the PIA are marked with an asterisk. Two asterisks indicate those areas known or suspected to be communal night roosts.

Location	Bird No.	No. Nights Detected
Goodell Creek mouth*	9	1
Skagit River (RM 91.4)*	4	1
	9	1
Skagit River, vic. Aggregate Ponds - Whistling Hole*	7	2
	9	1
Whistling Hole, on slope*	4	1
Skagit River, near Thornton Creek*	7	1
County Line Ponds*	4	4
	5	1
Skagit River, between Co. Line Ponds* and Sky Creek	4	3
Alma Creek mouth*	7	1
Skagit River (RM 84.5)*	7	1
Diobsud Creek mouth	7	3
Diobsud Creek, upstream ca. 1.3 km**	7	3
Skagit River, 0.4-0.8 km downstream Diobsud Creek**	7	1
Skagit River, 1.2 km downstream Diobsud Creek	7	1
Probably up Cascade River**	7	1
Jordan Creek	3	1
North of Clark's Cabins (RM 75.5)	3	1
Between Rocky and Corkindale Creeks	5	1
Skagit River, upstream Rocky Creek	5	1
Skagit River, vic. Rocky Creek	5	1
Skagit River, between Rocky Creek and Illabot Bend	5	2
	7	2
Ezra Buller's farm, vicinity	5	1
Illabot Slough entrance	5	1
Illabot Slough**	3	1
	5	2
Illabot Area (General)	5	1
	10	2
Skagit River, just upstream Illabot Bend	5	5
Illabot Bend, vicinity	5	1
Skagit River, upstream Sutter Creek (Eagle Island)**	10	1
	5	3
Cascadian Farm, in draw and on slope**	5	1
	10	3
Skagit River, at Washington Eddy	7	1
	9	1
Sauk River mouth, vicinity	8	1
McLeod Slough (general)	6	1

5.0 EAGLES AND THEIR FOOD

5.1 Background

In wintering areas located on rivers or creeks, the food source attracting bald eagles is most often spawning salmon. This readily available and often abundant food supply is frequently virtually the only food eaten (Servheen 1975; McClelland 1973; Stalmaster 1976).

Servheen (1975) reported eagles on the Skagit River eating almost solely dead salmon. McClelland (1973), in Glacier National Park, reported that dead salmon were utilized by immature and adult eagles, but that adults seemed to prefer diving on floating or nearly dead salmon. Southern (1963), reported eagles in Illinois preferring live salmon, even when abundant dead ones were present.

5.2 Fieldwork

Salmon carcass availability during the study period was monitored by actually counting dead salmon on seven gravel bars between Newhalem and Rockport, a technique developed by Servheen (1975). Two parallel, unmarked transects, separated by a distance of 5-20 m. (depending on recent river level fluctuation) were walked weekly during night hours when disturbance of feeding eagles was at a minimum.

With the aid of battery-powered headlamp or hand-held flashlight, at least one researcher, (normally a team of two) walked the length of each gravel bar along the water's edge (returning at the high water mark), and examined all fish seen in and on the shore. Species, amount of fish present, accessibility to eagles, sex (if determinable), and length of the exposed bar were recorded in the field on specially designed waterproof forms. Whole carcasses were weighed with a portable spring scale and measured along their length. All fish remains, whether untouched carcass or dried skeleton, were left intact where found, so as not to affect the eagle food supply in any way. High water occasionally forced postponement of scheduled counts.

To further determine the distribution of salmon carcasses in the SRSA, and to supplement our gravel bar sampling, we conducted extensive surveys by jet-boat on 9 and 17 January between the upper PIA and Rockport. Gravel bars, backwaters, and eddies were examined by researchers from the boat and on foot. We recorded the location, species, sex, accessibility, portion of fish present, and the occurrence of any eagles in the vicinity.

Additionally, we conducted a survey of dead salmon on the north fork of the Nooksack River on 23 January. Selected gravel bars and sloughs were surveyed on foot and total counts of fish carcasses were made.

During the later part of the study period extra attention was given the investigation of eagle food habits in the County Line Ponds area. A time-lapse movie camera recorded eagle activity during eight days, and a ground search for eagle food remains was conducted.

The drifting of salmon carcasses from the PIA into other parts of the SRSA warranted special consideration this winter. This portion of the investigation was conducted by Bierly and Associates, Inc. and is reported separately.

5.3 Food Data Analysis

Carcass numbers counted both during night surveys of gravel bars and by jet boat were so few in number as to render statistical treatment inapplicable. Analyses of the relationships of eagles to fish were performed by tabular and pictorial comparisons between data per 0.5 mile segments of river. Crop scores, observations of feeding behavior, and other food-related data obtained during censusing are described in 4.2.

5.4 Results

5.4.1 Salmon Spawning Phenology and Distribution

Three of the five species of salmon that spawn in the Skagit River are utilized regularly by wintering bald eagles in the valley. These fish include Pink (*Oncorhynchus gorbuscha*), Chum (*O. keta*) and Coho (*O. kisutch*). Pink salmon which spawn in odd-numbered years (e.g. 1975-76, 1977-78, 1979-80) are by far the least important to eagles even though the numbers of pinks exceed by tenfold the spawning numbers of any other salmon on the Skagit. The reason for the low importance of pinks is that they spawn before the first eagles arrive on the Skagit. Their carcasses are available only for the few early-arriving eagles. Our data on gravel bar counts (see 5.2) of pink salmon carcasses are given in Table 5a. More than half of the pink salmon ascending the Skagit spawn above Marblemount with considerable numbers of them utilizing the PIA.

During the first gravel bar counts on November 15 (2 bars), a total of 94 partially consumed pink salmon carcasses were counted, but within a week these had been reduced to only a few. The last edible remains of pink salmon were found on 3 December. Incidentally, it is doubtful that eagles consumed the largest portion of the pink salmon remains. Eagles were scarce in the SRSA before the end of November and numerous crows (*Corvus brachyrhynchos*) were frequently seen on the bars eating fish. We believe that pink salmon carcasses in the SRSA, therefore, functioned as food for eagles only through the beginning of December, after which there were no edible carcasses in evidence.

It is well documented that the chum salmon spawn is the basic feature which attracts eagles to the Skagit. In a good chum year there are hundreds of carcasses to be seen during the winter months on gravel bars throughout the SRSA, particularly in The SRBENA. Not surprisingly, there is often a clear relationship annually between the size of the total chum salmon escapement (as reported by the Washington Department of Fisheries) and the number of eagles counted. The timing of eagle occurrence on the Skagit during winter 1974-75 was remarkably synchronous with the availability of salmon carcasses (nearly all chum after November) on the Washington Eddy gravel bar in the SRBENA (Servheen, 1975). The increases and decreases in carcass numbers were closely matched by similar changes in eagle numbers.

Table 5a. The occurrence of pink salmon remains on seven gravel bars in the SRSA during winter 1979-80. "Partial" indicates that 10-90 percent of each carcass remained. No complete pink salmon carcasses were found.

Date	Location: Washington Eddy	Sutter Creek	Rocky Creek	Cascade Mouth	Bacon Cr.	Bacon Cr. Mouth	County Line
Nov 15	4 partial 32 bones only	-	-	-	-	-	90 partial 92 bones only
Nov 21	-	-	-	-	1 partial 4 bones only	-	-
Nov 23	2 partial 49 bones only	-	-	-	-	-	-
Nov 28	-	-	-	-	0	-	1 partial 51 bones only
Dec 3	-	-	5 partial 63 bones only	1 bones only	-	-	-
Dec 6	-	-	-	-	-	0	20 bones only
Dec 7	4 bones only	0	10 bones only	-	-	-	-
Dec 12	-	-	3 bones only	-	0	0	0
Dec 22 - March 9 (40 bar counts) - no pink salmon remains found							

In 1968, the Washington Department of Fisheries began salmon escapement estimates on the Skagit for spawning chum salmon. Since that time, records show that larger numbers of chum salmon ascend the Skagit to spawn in "even" years than in "odd" ones. Table 5b gives spawning escapement figures (divided by 1000) for the Skagit over the past 12 years. The alternating relationship between chum numbers and those of the pink salmon may not be only coincidental. There is a hypothesis that competition between young pinks and younger chums exists in the Skagit estuary during the spring (R. Orrell, pers. comm.). The idea is that the carrying capacity for newly arriving small chums in the estuary is reduced in the presence of the larger cohort of pinks that arrive some weeks earlier. The substance of this concept may bear upon the feasibility of release programs for the enhancement of low chum runs discussed in Section 9.5.

During the winter of 1979-80, chum salmon were not available to eagles on the Skagit in the proportions of previous years. This year's run of 16,000 chums was somewhat smaller than any of those recorded since 1971, but the main factor depressing their utilization by eagles was the extraordinary (50 year) flood that occurred in mid-December. Just before the flood, chum carcasses were beginning to appear on the gravel bars as evidenced during our weekly night counts (Table 5c). The high water not only scoured the bars of all existing carcasses but seemed to preclude the subsequent accessibility of carcasses over much of the SRSA. Biologists had radio-tagged a number of post-spawn chums in the PIA during the week before the flood (Glock, Hartman 1980). Direct evidence indicates that fish were carried by the high water many miles downstream (as far as Concrete) and were often buried in the substrate at depths of several feet or were otherwise in deep water. Despite a considerable number of salmon having been tagged (n = 100 fish), we never found one of the tagged fish during our studies on gravel bars.

We are advised by WDF and by J. Glock that chum spawning success was likely poor on the Skagit this winter because of the flood. The winter of 1983-84, for which 1979-80 is a "parent" winter, may thus show a rather small chum escapement.

Fortunately, the Nooksack chum, which also experienced mid-December flood, regularly spawn several weeks later than those on the Skagit. M. Aguerro (WDF) told us that the chum on the Nooksack managed to spawn normally this winter. As discussed in Section 4.4, the Nooksack chum spawn, though smaller than that on the Skagit, does not necessarily follow in proportion to that on the Skagit. This phenomenon worked to the eagles' advantage during this winter of study, as the numbers of eagles on the Nooksack were far above normal, evidently in response to the good chum run there (see Table 5b).

Coho salmon are the third species utilized by eagles wintering on the Skagit and until this year's study, their full importance to eagles was not appreciated. Cohos are more difficult than are the other salmon to obtain adequate survey coverage for because they are widely distributed and spawn largely in tributaries (M. Aguerro, pers. comm.). For the same reason, it is difficult to observe eagles feeding on cohos since the vegetation along the smaller tributaries is often more dense than along the

Table 5b. Escapement figures (÷ 1000) of three salmon species spawning in the Skagit and Nooksack rivers (* = preliminary figures). All figures represent natural spawners (hatchery fish are excluded).

Year	Skagit River			Totals	Nooksack River			Totals
	Pink	Coho	Chum		Pink	Coho	Chum	
1968	–	18	23	41	–	1	23	24
1969	100,000	9	7	116	15	2	16	33
1970	–	18	62	80	–	6	28	34
1971	300,000	12	13	325	40	4	3	47
1972	–	12	63	75	–	2	11	13
1973	250,000	13	31	294	75	4	20	99
1974	–	22	57	79	–	6	15	21
1975	100,000	10	20	130	36	4	10	50
1976	–	5	85,000	90	–	3	7	10
1977	500,000	24,000	32,000	556	25	5	16	46
1978	–	9	61,000	70	–	2	9	11
1979	336,000	28,000	16*,000	380,000	31,000	5,000	23*,000	59,000

Table 5c. The occurrence of chum salmon remains on seven gravel bars in the SRSA during winter 1979-80

	Location						
Date	Washington Eddy	Sutter Creek	Rocky Creek	Cascade Mouth	Bacon Cr.	Bacon Cr. Mouth	County Line
Nov 28	-	-	-	-	0	-	1 partial
Nov 30	2 entire 1 partial	-	-	-	-	-	-
Dec 3	-	-	2 entire 1 partial	-	-	-	-
Dec 6	-	-	-	-	1 entire	0	1 bones only
Dec 7	8 entire 4 partial 1 bones only	0	4 entire 1 partial	1 entire 3 partial	-	-	-
Dec 12	1 entire 2 partial 1 bones only	-	1 entire 1 partial	-	0	0	0
Dec 22	1 partial	0	0	-	-	-	0
Dec 23	-	-	-	-	0	0	-
Dec 27	1 entire	0	-	-	-	-	-
Dec 28 - Mar 9	(32 gravel bar counts) - No chum remains found						

open river. There was nevertheless repeated evidence that coho salmon comprised a significant if not major part of the eagles' diet this winter, especially in the PIA. Because of the problems in conducting coho spawning inventories, their overall distribution, particularly within the upper Skagit drainage, is probably not well understood. As in the other salmon species, there is no hint of the percentage of spawning coho that ultimately become available to eagles.

Surely the availability of cohos to eagles differs among the many types of circumstances of their spawning. But the important fact is that cohos, because of their resistance, in some situations, to the effects of flooding, are likely to be more stable from year to year than are the other salmon species. By inference of the reduction of eagles in the SRSA in 1979-80 over the previous year and the general absence of accessible chum carcasses, we conclude that although the coho spawn does not support large numbers of eagles, it provides an important food buffer in low chum years. Certainly, cohos supported to a large extent the 30-40 eagles that occupied the PIA during this year of study.

5.4.2 Eagle Feeding Areas in the SRSA

The relationship of foraging habitat to the distribution of eagles during daylight hours is not, in a practical sense, subject to differentiation. In general, it appeared to us that eagles were distributed along the river and elsewhere in relation to the occurrence of food, and this impression was verified by the analyses of habitat (6.0) and disturbance (7.0) variables relative to eagle numbers. The final assessment of the geography of feeding sites, therefore, takes into consideration the census data (projected mean numbers of eagles per day) as well as observations of feeding behavior, crop condition, and salmon distribution. These relationships are shown in Figure 5a as they occur in each 0.5 mile segment of river in the SRSA (see Section 6.0 for statistics). Appendix D gives the raw scores of these measurements and supporting data used in their computation.

The SRBENA (RM 69.5-73.5) supported the largest number of eagles (mean per 0.5 mi seg. = 4.7 eagles) and also produced the highest cumulative index values of feeding behavior (eagles observed feeding or carrying food), crop condition, and chum carcass abundance for any SRSA river stretch of comparable magnitude. The second most important feeding area indicated in Figure 5a was the County Line Ponds-Whistling Hole complex (RM 89), located in the PIA. Here the presence of eagles was matched by moderate crop scores but small scores based on observations of eagles feeding or carrying food.

Chum spawning scores (based on 1976, 1977 surveys, WDF) were high along a one-mile stretch just above the County Line Ponds-Whistling Hole area but there were few, if any, chum carcasses to be found either in the routine night counts at County Line gravel bar or during the January fish survey. This implies that the eagles at the County Line Ponds-Whistling Hole complex were primarily eating coho salmon, and because coho carcasses are usually found off the main river, the feeding eagles were not subject to our view. At the SRBENA, eagles observed feeding on gravel bars were very likely eating chum carcasses, but cohos were probably also available in the Illabot area.

Figure 5a. Graphs showing five aspects of bald eagle ecology in the SRSA used in identifying feeding areas. Computations of means and index values are explained in the text (5.4.2)

A third ranking area of importance within the SRSA was the stretch roughly between the mouth of the Sauk River and Rockport where chum carcass scores, the January carcass count, and to some extent crop and behavior indices all agreed with the occurrence of eagles. Lowest in eagle numbers and average index values per 0.5 mile segment was the continuous 12 mile stretch between RM 75.5 and 87.5. The projected average number of eagles per 0.5 mile segment per day for this stretch was only 0.51 eagles.

Figure 5b shows the relationships between the crop and behavior scores and the occurrence of eagles. To achieve sufficient sample sizes for comparison, we divided the SRSA into nine three-mile segments. The behavior index (based on observations of eagles feeding or carrying food) seems to be fairly predictive of eagle numbers, while the crop index assumes all values in areas of low eagle density.

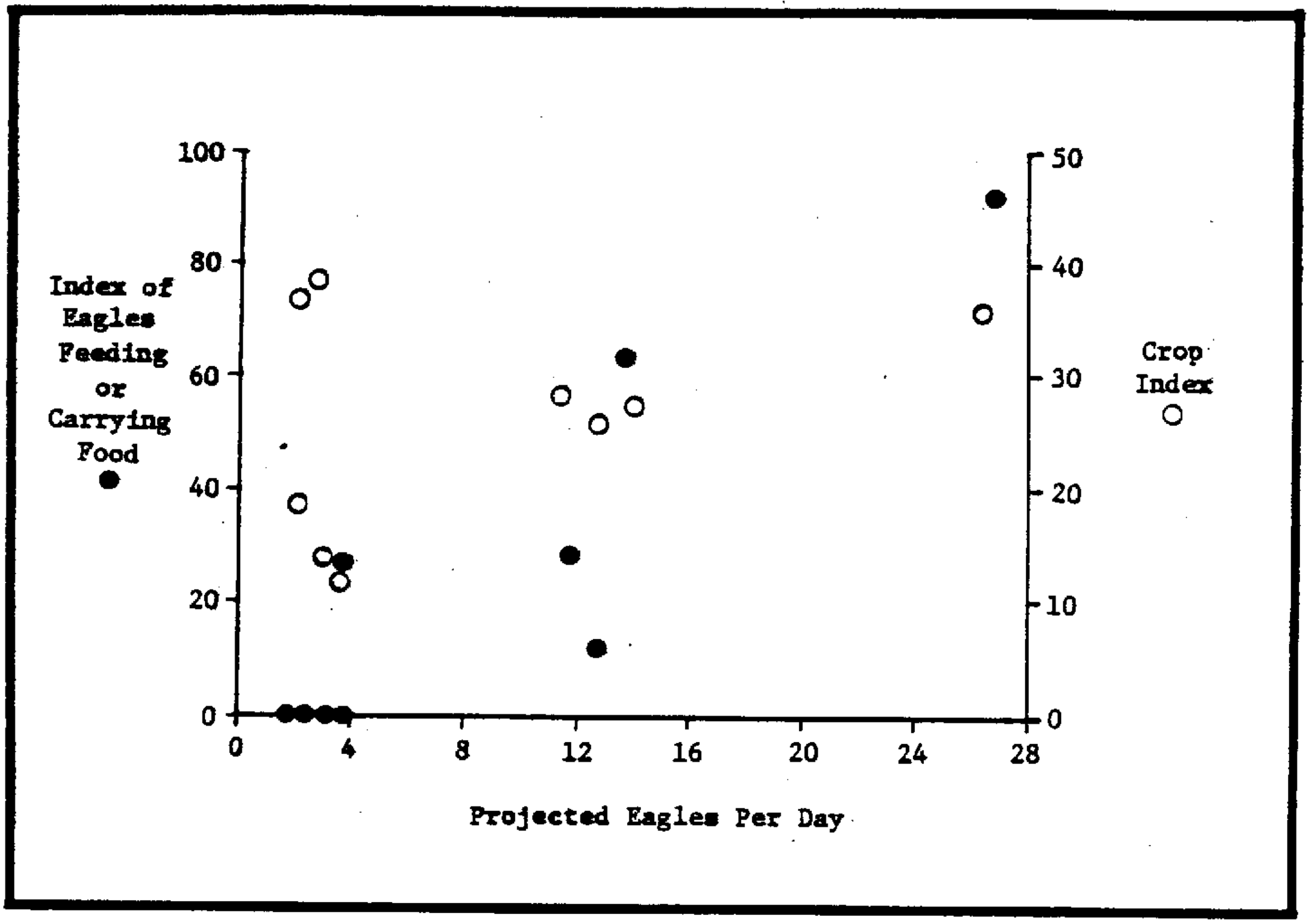


Figure 5b **Relationships of eagle distribution to a frequency index of eagles observed feeding or carrying food and crop index scores.**

5.4.3 Food Sources in the Proposed Impoundment Area

There is a peak of eagle occurrence in the PIA within the two-and-one-half-mile stretch from RM 87.5 through RM 90.0 (Figure 5a). This area may be conveniently divided into three segments which are, in descending order of their importance to eagles: (1) County Line Ponds (RM 89.0), (2) Whistling Hole (RM 89.5), and (3) the area just below County Line Ponds (RM 88.0-88.5).

The County Line Ponds are located on the left side (looking upstream) of the Skagit River (RM 89.0) at the boundary of Whatcom and Skagit counties and are situated between Highway 20 and the river. They derive from a series of pits from which earth and gravel were previously removed for construction purposes. Of the ten ponds (Figure 5c), only three actually communicate with the river, and these receive numerous spawning salmon. According to M. Aguerro (WDF), chum salmon commonly spawned in the ponds during the winter months up until a few years ago. But this year, although we observed several hundred spawning coho salmon there, we saw no chums. A possible reason for the lack of chums (M. Aguerro, pers. comm.) is that soon after chum fry emerge they move to the estuary while the young coho remain in the vicinity of their birthplaces. The result may be that the almost year-old coho eat the chum alevins shortly after they emerge.

We observed carasses of spawned coho in the County Line Ponds as early as 8 November. We have no information before that date. Through the winter there were always live coho spawners in the ponds near one of our eagle census points along the river. Not until 2 March did we have the impression that a reduction had taken place in the number of live coho. Numerous live individuals were still in evidence in the second week of March when we made our final eagle census (13 March). coho spawn in CL ponds from Nov. thru Mar.

The manner and rate at which fish become available to eagles at County Line Ponds are still not completely known to us. Some carcasses could be seen at the bottom of the main ponds in water too deep for eagles to get at them. Other coho carcasses were in water less than 30 cm deep and were thus surely accessible. On 10 January, J. Glock (pers. comm.) observed some carcasses floating in one of the main ponds and six other carcasses on the edge of the pond. During our night counts for fish on the main stem gravel bars we observed spawned coho and chum salmon actively nosing into shallow water, effectively beaching themselves in this manner. If this occurs at County Line Ponds it could explain the occurrence of carcasses around the edge. Certainly a behavior of this kind, if it exists commonly, would be quite advantageous to eagles.

Figure 5c shows the distribution of accessible fish and eagle food remains we observed in and around County Line Ponds. Remains were noticeably concentrated under one Class A deciduous tree near the river, where eagles obviously carried food to be consumed in the tree. The food remains over the entire area consisted primarily of coho salmon but also included two buffleheads (Bucephala albeola), one goldeneye (Bucephala spp), one American coot (Fulica americana), and one beaver (Castor canadensis). We believe that the buffleheads had been killed by four "hunters" who were heard repeatedly shooting a shotgun at the ponds on 20 January. One of the

Figure 5c

County Line Ponds Map

Legend

◇ Class A Conifer Perch Trees

△ Class A Deciduous Perch Trees

Accessible Whole Fish } Coho Salmon (2-26-80)

• Fish Remains } Coho Salmon (2-26-80)

═ Dam (Beaver Dam)

Gravel Bar

B Remains of Beaver (Vertebra & Rib (2-12-80)) under Tree

C Eagle Pellet Containing Skull of an American Coot plus Feathers Scattered around (2-10-80)

E On Feb. 13, 6 Eagles (2 Adults) were Observed Feeding on Unknown Object. Many Displacements from 1700 to 1745 hrs.

F On Feb. 22 a Local Fisherman Saw Eagles Feeding on Spawned-out Coho Salmon Somewhere on this Island (Pers. Comm. to R. Jackman)

G Remains of Goldeneye Found in Snow Surrounded by Eagle Prints (1-23-80)

H A Whole ♀ Bufflehead, Shot by Hunters, was Found here Floating in Water near Shore (1-23-80)

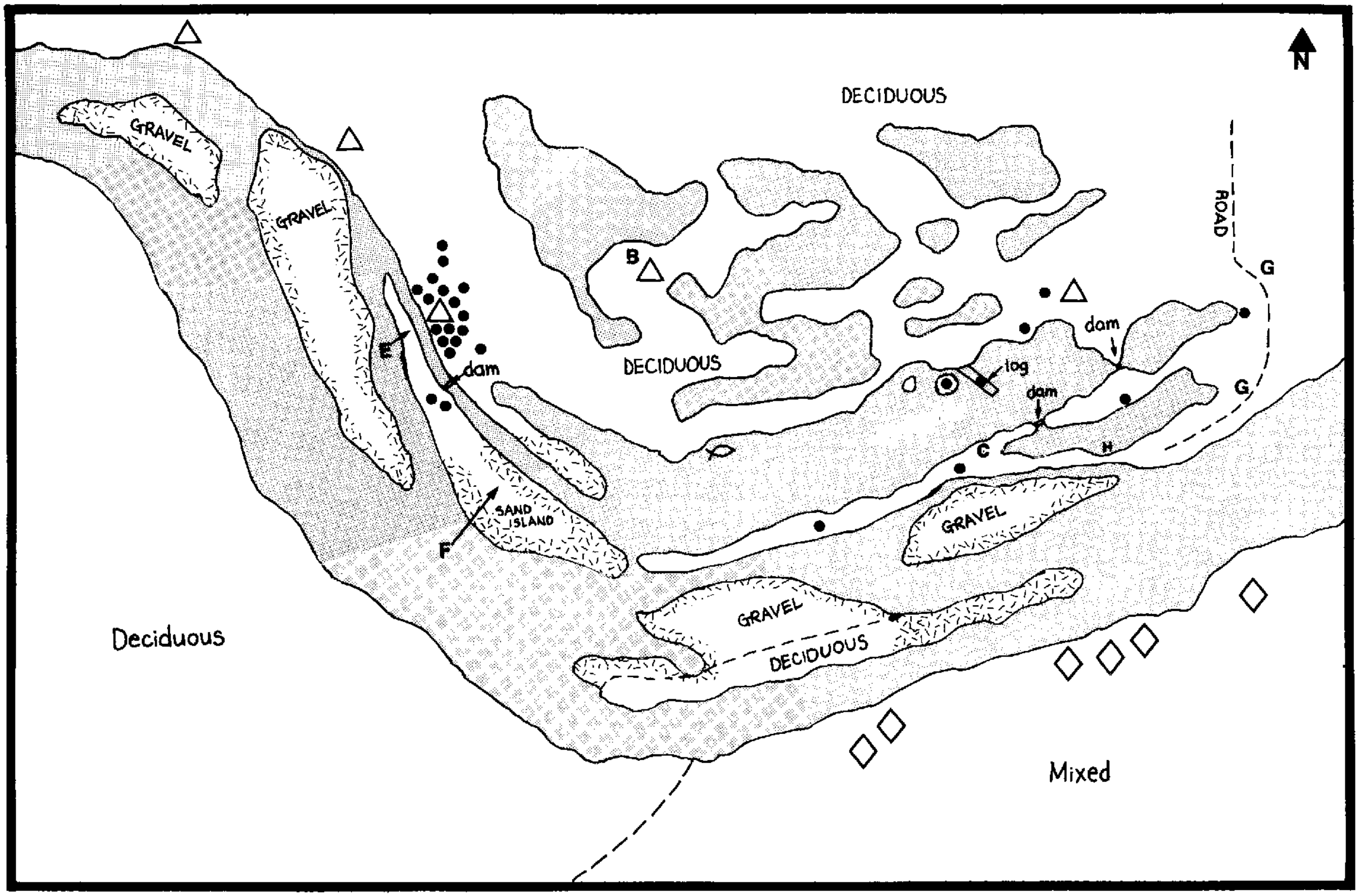


Figure 5c
County Line Ponds Map

ducks we found before the eagles consumed it had definitely been shot. However, waterfowl (including mallards, Anas platyrynchos) were seen frequently at County Line Ponds throughout the winter, and it is not unreasonable that eagles might have caught some. Neither buffleheads nor American coots rank highly in their abilities to escape raptors. The beaver was surely eaten by eagles but its cause of death is open to speculation. Attesting to some extent that prey for large raptors at the County Line Ponds continues into the spring is the presence of a pair of red-tailed hawks (Buteo jamaicensis) which set up a nesting territory just across the river from the County Line Ponds in mid-March.

Whistling Hole (RM 90.0) is less than one mile upstream from the County Line Ponds. This area consists of a left bank side-channel separated from the mainstem by a series of islands running along the length of the river. Small channels, which separate these islands from each other, serve as major spawning sites for both chum and coho (J. Glock, pers. comm.). Eagles frequented the Whistling Hole area in numbers nearly equal to those of the County Line Ponds. Because of the proximity of the two areas, it is reasonable to regard them as a single support unit for eagles. During fish tagging studies, Bierly and Associates found eagles to be quite common in the vicinity of these spawning sites.

The area on the left bank (RM 87.5 to 89.0) just below the County Line Ponds supported a small but significant number of eagles during the study. There are two small sloughs in this area where a few coho salmon spawned this year, but otherwise, there was no obvious food-related reason to expect eagles there.

A major chum spawning site occurred in the vicinity of the City Light Boat Ramp at RM 90.5 (J. Glock, pers. comm.). We saw few eagles in this area, however, indicating that chum which utilized these redds did not wash-up nearby. This conclusion was borne out by the carcass drift study, but any normal tendency of these fish to become available was complicated by the flood in mid-December.

Nowhere in the PIA did we commonly observe eagles feeding (or standing) on gravel bars (Figure 5a). On a few occasions before the flood we observed eagles feeding on the gravel bars near the County Line Ponds, but rarely elsewhere. The solution to this problem almost surely lies in the fact that chum salmon were largely unavailable to eagles in the PIA this year while the more covertly distributed coho provided the mainstay.

5.4.4 Loss of Food from the PIA

Salmon spawning data are collected over most of the Skagit each year by the Washington Department of Fisheries. Techniques include both carcass and live fish counts and sometimes the tagging of pre-spawn salmon in the estuary for later recovery at spawning sites. For projections of spawner distribution the river and tributaries are subdivided into a number of units corresponding to landmarks. Fish counted or tags recovered in each unit are expressed as percentages of the sampled portion of the watershed. For the purpose of estimating the number of spawners that would be lost to inundation by a Copper Creek dam, we have applied estimated spawner percentages in the PIA to the average escapement figures for chum and coho salmon for the past ten years. The results indicate that an average of 4,850 chum and 460 coho spawners would be lost during any average chum year in the PIA. Because of the greater difficulty of detecting coho in their dispersed spawning habitat, the estimates of projected loss for this species should be regarded as tentative.

Since the number of chum spawners in the PIA in winter 1979-80 was probably less than 10% than that of an average year and because any of those few carcasses that might have accumulated were swept away by the flood, we are in no position to adequately assess the effects of chum salmon on the occurrence of eagles in the PIA. Bierly & Associates are addressing the issue of chum salmon spawning in the PIA which may contribute to the accumulation of carcasses below the PIA.

5.4.5 Eagles and the Concept of Carrying Capacity

The concept of carrying capacity is a central issue relating to the impact of the Copper Creek dam, and for that matter, any gross environmental change which depresses the local occurrence of eagles within the area of northwestern Washington. A major point of concern in this study is whether or not eagles displaced by a Copper Creek dam, would survive (in an equal state of health and vigor) elsewhere. In one sense, our winter of study with its dearth of chum salmon availability provided a model for studying the event of eagle displacement into "absorption areas" elsewhere in the region. The radio-tagging studies (Section 8.0) have shown that eagles may move throughout the study region, and probably farther, during the course of winter. But, we have no informa tion as to the potential of the seven areas discussed in 8.4.4 to accept and maintain added numbers of eagles.

Not only is there a mosaic of alternative wintering locations for dam-displaced eagles within the geography of the study region, but there is surely a time differential, both within and between winters, in the potential of each area to support eagles. As we have seen, salmon runs, and particularly the availability of salmon carcasses to eagles, are both variable and subject to unpredictable disruptions. For these reasons, an understanding of carrying capacity within the winter range of eagles which may utilize the Skagit is a complex matter not yet within our grasp. But the issue is nevertheless essential to a full evaluation of the proposed dam project. We will, therefore, briefly address the matter from a conceptual and admittedly speculative standpoint.

It is unknown whether or not bald eagles starve in significant numbers on the wintering grounds. Neither do we know the basic mechanisms by which population numbers of bald eagles in the northwest are naturally regulated. One possibility (No. 1) is that competition for food on the wintering grounds reduced eagle numbers (e.g. through starvation) to densities compatible with food availability, which, in turn, regulates the number of adults returning to breeding grounds (see Lack 1954)

In order for food competition on the wintering grounds to regulate eagle populations, the struggle for food must ultimately impact the breeding segment of the population. Such impacts may take the form of direct mortality of adults, or they may (in the short term), be manifested as reduced fat deposition by adult females so as to reduce productivity (Newton 1979). It seems likely that winter starvation or physical impairments would first affect the younger age classes who are presumably less efficient at foraging and less effective in defending food resources.

In view of the considerable proportion of subadult eagles in wintering populations and other arguments set forth in this section, it is our opinion that winter starvation of adults is not a frequent event. A reduction in adult fat desposition during stress years and subsequent loss of reproductive performance is a matter about which we have no insight, but a careful study along these lines may well be in order. Reductions in the subadult component of a wintering population through starvation mortality will, in the long run, reduce the size of the breeding segment. But if competition for food is a function of eagle density, a loss of subadults may well be balanced by increased survivorship of older age classes. In any case, winter mortality may not be significant every year, but it probably appears (if at all), in response to combinations of negative circumstances such as widespread chance synchrony of low salmon spawns between river systems, perhaps compounded by floods.

Not necessarily exclusive of this mechanism is the possibility (No. 2) that a limited number of serviceable breeding locations within the nesting range of bald eagles ultimately limits the overall number of eagles in the population (Hunt 1974). This idea assumes that a specific set of environmental features must occur simultaneously in time and space in order for a pair of eagles to successfully breed, and further, that in a healthy population of eagles all such breeding locations are filled. Factors serving as components of a serviceable breeding location for any bald eagle pair might include a nest tree, availability of nesting material, the promise of copious and vulnernable prey, throughout the breeding season, and the absence of another pair of nesting eagles within a specified distance from the nest tree.

A hint that mechanism No. 2 has historically operated to regulate bald eagle populations is the phenomenon of long-delayed recruitment of bald eagles to the breeding population. To explain the fact that full adult plumage is not attained until the age of six years are at least two not necessarily alternative arguments. The first explanation says that it takes at least six years to amass the experience, skills, and bodily resources for breeding attempts to be compatible with long-term survival. In other words, eagles that acquire adult plumage before the age of six can expect, on the average, a lower number of eventual descendents than those whose genes dictate waiting because the risk and/or physiological wear and tear associated with high output foraging and other difficulties associated with breeding disproportionately impacts the younger age class. The second explanation agrees with this last point, as must any explanation for adaptation (Williams 1966), but the reason for delayed recruitment more simply involves direct and possibly risky competition for nesting locations.

Long-delayed recruitment into the breeding population necessarily produces a considerable non-breeding segment of the population. Because of accruing mortality there is a pyramid of age classes, the base and most voluminous part of which represents the younger age categories. In a population pyramid containing five non-breeding cohorts plus a possible floating population of non-breeding adults there is a considerably greater food demand upon the environment than is the case in early-breeding species where rapid attrition among the younger cohorts is the rule. Indeed, the most obvious correlative of long-delayed recruitment is high survivorship (Ashmole 1966). To view it another way, natural selection would prevent delayed maturity unless the expectation of surviving six years to breed was reasonably high. This point leads us to believe that mortality rates of bald eagles on their wintering grounds have historically been quite low.

If a limited number of breeding locations plays the critical role in ultimately regulating bald eagle populations, then there is no reason to assume that wintering eagles, at least historically, have been anywhere near their food limits. A super-abundance of winter food in the form of salmon carcasses may have been a factor providing the potential for long-delayed maturity, but the upper limit in the number of non-reproductive cohorts does not necessarily implicate a saturated winter range. The high mobility of the wintering eagles, as shown by our telemetry investigations in response to a mosaic of salmon runs in time and space bears a similarity to the habits of many sea birds. It is not by chance that sea birds (e.g. Procellariformes) experience both high survivorship and long-delayed recruitment to breeding populations (Ashmole 1966). Sea birds, and perhaps eagles as well, are limited by finite numbers of breeding locations.

In conclusion, we cannot yet determine whether or not eagles displaced by the Copper Creek dam will be absorbed by other areas of habitat within the region. The reason for this is that the basic questions involving the population ecology of wintering eagles (e.g. mechanism of population regulation, competition for food, and survivorship on the winter range) remain unknown.

5.4.6 Factors Influencing Eagle Occurrence on the Skagit

The previous section (5.4.5) provides a conceptual overview of the ecology of eagles within the context of their entire population in the Pacific Northwest. The following section will address more specific food-related issues which ultimately encourage or discourage the occurrence of eagles on the Skagit River. Some of these relate more strongly than others to a Copper Creek dam, but they must be considered together in an overall concept of feeding ecology.

At the top of a complex food chain, bald eagles on the Skagit ultimately derive their winter sustenance (through the salmon) from the oceanic plankton, the status of which, incidentally, is vital to all animal life on this planet. But all aspects of the life history of salmon must be in order if they are to finally become available to eagles; from the success of the eggs, to the survival of the fry from fresh water to estuary, to the growth of the salmon in the oceans, and their return to the spawning redds At each of these points in the cycle are a myriad of factors which work to reduce the numbers of salmon that return to the Skagit to spawn. Many of these impacts have influenced salmon populations throughout their histories as species and serve in integrating them with the biotic communities with which they interact. But many other factors have begun operating only within comparatively recent times and these have reduced salmon numbers in northwestern rivers at unprecedented rates. The man-induced environmental changes of which we speak exist within economic and biological systems of boundless intricacy, and represent, for better or worse, our own path in the Pacific Northwest from stone age to industrialization.

Natural factors occurring and interacting on the Skagit which work to depress the occurrence of eagles include the following: (1) flow fluctuations (e.g., flooding, droughts, etc.), which result in the mortality of salmon, their eggs and fry plus floods remove carcasses from gravel bars; (2) salmon cycles - natural yearly variation in the numbers of spawning chum and coho salmon occasionally result in low food supplies for eagles, (3) weather - snow may cover salmon carcasses for days or weeks. Bad weather may effectively prevent eagles from leaving the Skagit to search for food elsewhere. Cold weather increases eagle metabolism and food requirements; and (4) competition - crows, ravens, gulls, ducks, coyotes, and bears also eat salmon carcasses.

Eagles have long adapted to these and other natural adversities along the spawning rivers. Among these adaptations are an ability to: (1) fast through periods of food shortage, (2) move to other more productive areas many miles away, (3) eat a wide variety of prey, both alive and dead, including fish, waterfowl, rabbits, and other large mammals and birds, 4) have phenomenal eyesight allowing the detection of cryptic food sources, and (5) concentrate their numbers winter thus giving them a food-finding advantage.

Man-caused problems for eagles on the Skagit are more lengthy and deliterious. Those affecting salmon include: (1) Logging. This usually results in increased streamflow, in turn causing shifting of gravel which may kill fish embryos and dislodge food organisms. High streamflow may also accelerate riverbank erosion, causing siltation which can bury embryos, and such erosion may also cause rechannelling or loss of areas of deep water, thus destroying spawning and rearing space. In the long term, sedimentation has the potential to affect salmon embryo survival (if it decreases gravel permeability) and to decrease the attractiveness of certain redds. Salmon productivity, in addition, may be affected by changes in food supply, specifically insects, if streamside vegetation is removed or otherwise impacted by logging. Loss of such vegetation may allow sunlight to increase water temperatures beyond tolerence levels. Slash left in streams can cause substantial problems, including loss of spawning habitat (if it acts as a barrier to upstream travel by salmon) and rearing areas, reduced dissolved oxygen levels in the water, and further sedimentation downstream. (2) Dams also create a number of adverse impacts, the most significant of which is the blocking of the waterway to the ascent of spawning salmon. Electrical production requirements result in unnatural stream flows, which cause the stranding of newly-emerged young fish as well as other problems. Dams may also change the transportation of nutrients through the watershed, the composition and placement of gravel bars, and the drift and deposition of spawned-out salmon carcasses for eagle consumption. (3) Man's Use of Fish. Fishing, which includes pelagic netting and sport and commercial fishing in Puget Sound and the mouth of the Skagit, results in the attrition of the numbers of salmon that become available to eagles. While the artificial spawning of adults at hatcheries involves the sale and removal of salmon carcasses from the Skagit, it probably does not affect eagles, unless through "genetic poisoning" if such exists. The artificial spawning of wild salmon from the Skagit, however, by those who take the eggs for chum enhancement elsewhere, must surely impact future runs, especially if such egg takes are performed in poor chum years on the Skagit (e.g. Indians at Illabot Creek in winter 1979-80). (4) Pollution - Insecticides such as DDT and other compounds may impact the densities of oceanic plankton (Nelson and Myers (1976) and thus have far reaching deleterious effects on salmon populations. (5) Disturbance - Human disturbance factors which may impact eagles are discussed in 7.0.

Eagles have not had time to evolve adaptations to cope with the problems that man has brought to the Skagit. Therefore, if the eagles are to resist these great impacts, man must perform positive conservation, preventative, and managerial tasks on their behalf. For the continued occurrence of eagles on the Skagit, the most critical issue is that of food supply. Any factors which increase chum salmon numbers on the Skagit will surely benefit eagles.

6.0 EAGLES AND THEIR HABITAT

6.1 Background

Prior to this study, it was known that eagles were [redacted] heterogeneously distributed along the Skagit River during winter. Stalmaster (1976) and Servheen (1975), working on Puget Sound rivers, noted a qualitative relationship between eagle densities and wide, braided stretches of river with large amounts of open gravel bar where salmon carcasses tend to accumulate. Additionally, several researchers have found that wintering eagles perch predominantly in deciduous trees and that they exhibit a preference for trees that are taller and stouter than average for the area, although the primary factor governing perch selection appears to be proximity to food (Steenhof 1978; U.S. Army Corps of Engineers 1979).

We attempted to quantify specific habitat features for statisical analysis in hopes that a combination of variables might predict eagle distribution. This information would be used to: (1) identify and quantify habitat in the PIA, and (2) provide the standard for the identification a quantification of habitat features in the lower stretch and elsewhere where eagle displaced a the dam might go.

Under the Endangered Species Act of 1973, critical bald eagle habitat is protected from modification or destruction resulting from actions funded or authorized by the United States Government.

Loss of habitat is believed to be one of the principal limiting factors facing bald eagles today. This is particularly true for nesting areas since habitat requirements there are relatively specific in comparsion to wintering habitat (Whitfield, et al 1974; Lehman 1979).

Many man-induced habitat modifications appear beneficial to bald eagles. Most noticeable has been the number of eagles attracted to reservoirs and tail-water areas resulting from the construction of dams and locks throughout the United States. Water-management systems implemented this century have significantly increased the amount of bald eagle winter habitat (Steenhof 1976).

These newly-created bald eagle wintering areas usually occur, however, in areas not previously supporting eagle concentrations. The effects of modifying existing, bald eagle winter habitat and the food resources supporting those eagles are poorly understood.

6.2 Methods of Habitat Quantification

A number of habitat variables were measured throughout the SRSA within bands extending 500 m in width on either side of the river. The size of these bands is far in excess of requirements, both in terms of eagle distribution (as recorded during the census), the disturbance buffer minima reported by Stalmaster (1976), and the projected area of inundation affecting eagles. Table 6a shows how eagles were distributed during the censuses along the river relative to their distance to water.

Habitat components selected for measurement were those that appeared to us most involved in bald eagle ecology and thus predictive of eagle occurrence. The habitat variables measured included: (1) width of the valley floor, (2) width of the river channel, (3) surface area of gravel bars, (4) distribution and types of tributaries, (5) forest overstory composition, (6) distribution of large deciduous trees, (7) distribution and magnitude of chum salmon spawning, plus (8) distribution and (9) magnitude of chum salmon carcass accumulation. Each component was quantified on the basis of 0.5 mile segments of river and encoded on computer cards. Where appropriate, the values were further broken down as to the side of the river where they occurred. Statistical comparisons (Section 4.3) were facilitated by the fact that the census data were also recorded by 0.5 mile segment and side of river.

1. Width of the valley floor. We measured the width of the valley floor on U.S.G.S. topographic maps perpendicular to contour lines at the upstream and downstream ends and at the mid-point of each 0.5 mile segment. We then averaged the three measurements. The valley floor is here defined as the area along both sides of the river lying between the first contour lines indicating an 80. ft rise from the river.

2. Width (area) of the river channel. We calculated the surface area of the river channel (including islands and bars), in each 0.5 mile segment by laying a grid (400 squares/in^2) over aerial photographs of known scale and tracing the area contained between the two river banks. Since each 0.5 mile segment is the same length, this measurement is an expression of the width of the river and is expressive to some extent of the amount of gravel bar present and the degree of braiding of the channel.

3. Area of gravel bars. These measurements were made by tracing the periphery of gravel bars on a grid (400 squares/in^2) laid over aerial photographs and calculating surface area from the grid. Each measurement was recorded according to the position of the bar in the river channel (i.e., right bank, left bank, or island). Forested portions of bars were excluded from the calculations so that only "open" gravel bar areas were measured.

4. Tributaries. Tributary streams were rated on a scale of 1 to 4 in descending order (1 = river, 4 = small stream) according to their relative importance as salmon spawning (particularly coho) streams, as determined by the Washington Department of Fisheries (Williams, Laramie, and Ames 1975). Additionally, a rating of five was assigned to ponds with spawning coho salmon.

5. Chum salmon spawning and carcass accumulation. In the winters of 1976-77 and 1977-78, the Washington Department of Fisheries conducted comprehensive surveys that identified chum salmon spawning areas and areas where carcasses of the spawned fish accumulate. The magnitude of the spawn or carcass recovery was characterized as "light," "moderate," or "heavy" (M. Aguerro, pers. comm.). From these designations, we rated each 0.5 mile segment on a scale of 0 to 3 (0 = none, 3 = heavy) for each of the two measurements (Figure 5a).

Figure 6a. Maps of the bald eagle habitat in the SRSA

Figure 6a

Legend

C Coniferous Stand

D Deciduous Stand

M Mixed Stand

O Open Stand

--- Paved Highway

—— River Channel, Creeks, Sloughs, Ponds — i.e. Water

Gravel Bar & Sand Bar

Buildings ; each square represents up to 5 buildings

•••• Town

×× Overlook on Highway ;
difference scale × represents relative sizes of overlooks

Campground & Picnic Area

▲ Picnic Area

● Boat Ramp

○ Road access to river, but no boat ramp

△ Type A Deciduous Trees ;
each △ represents up to 5 trees

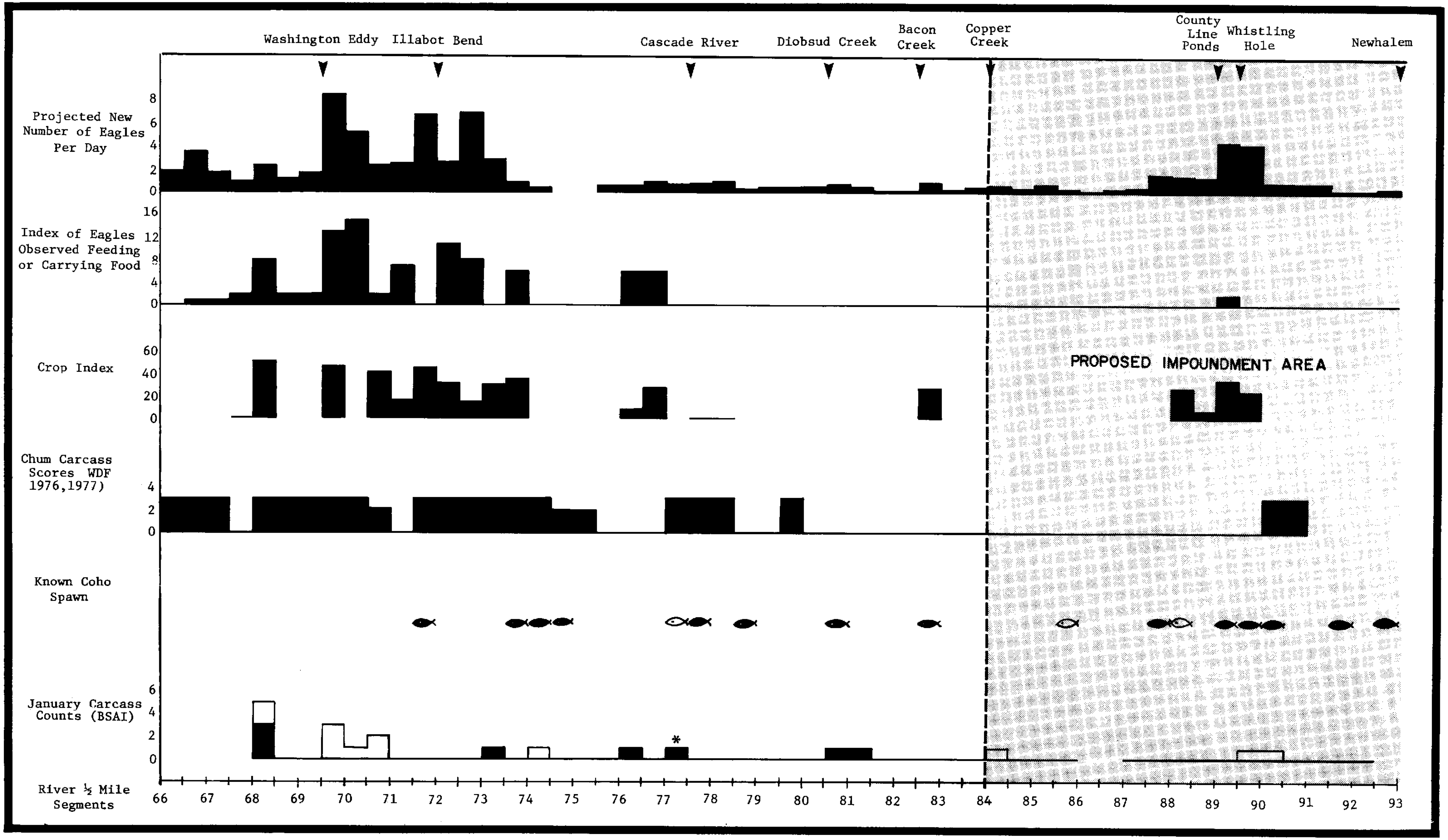
Type A Deciduous Trees ;
represents area with more than 5 trees

Chum Salmon Spawning Area

Chum Salmon Carcass Recovery Area
(area where carcases tead to accumulate)

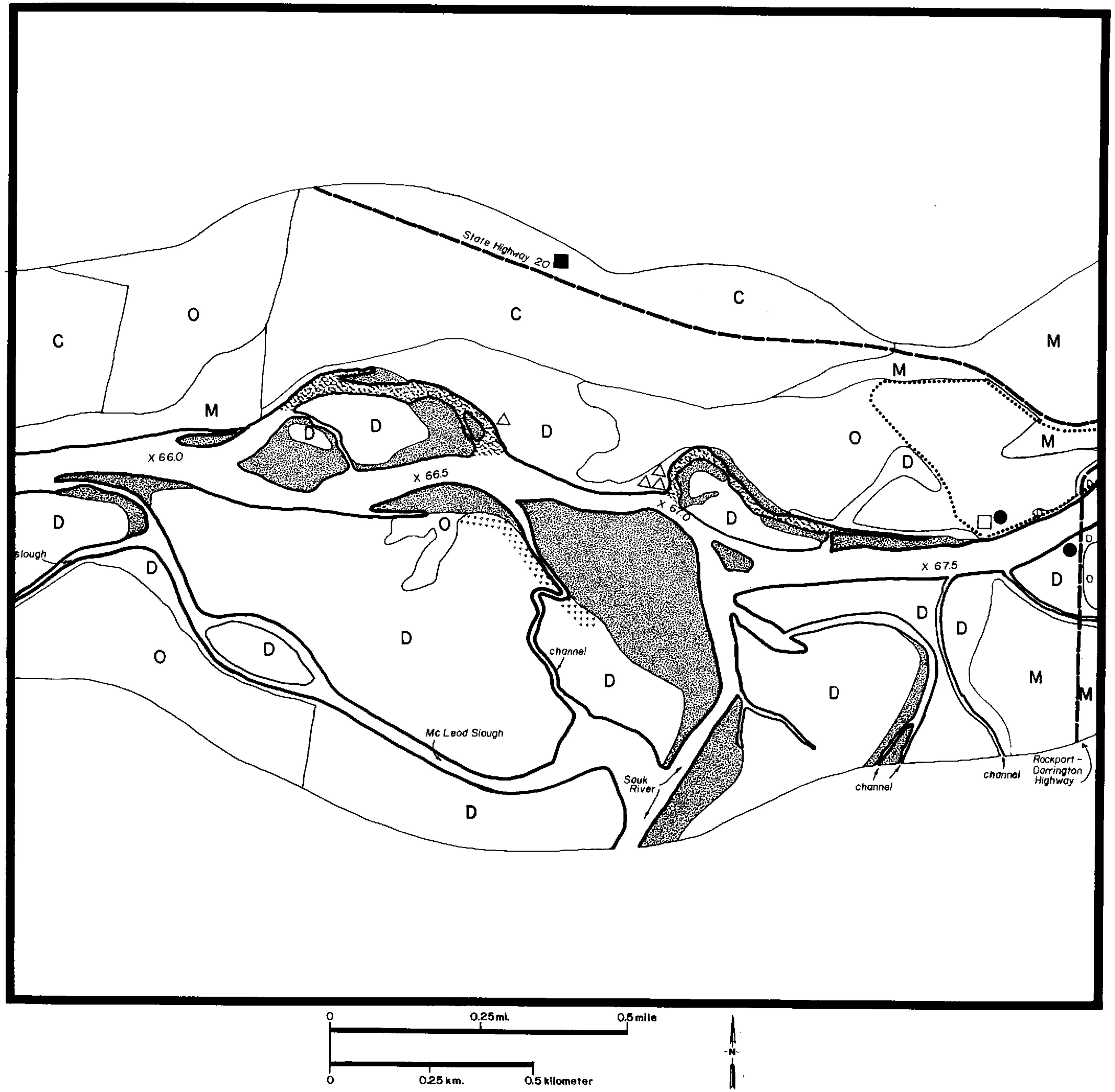
Chum Salmon Spawning & Carcass Recovery Area

Coho Salmon Spawning Area

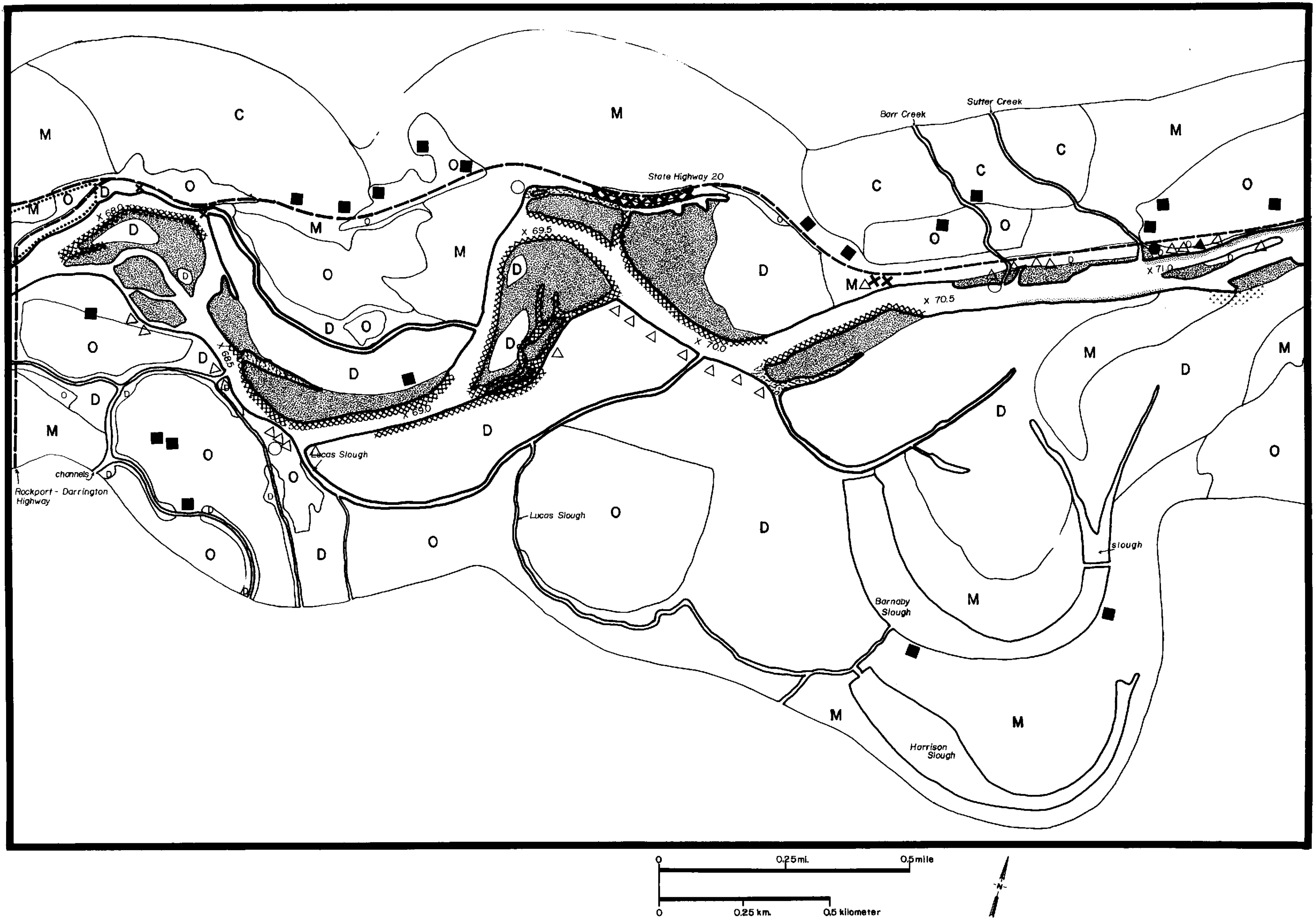


Washington Eddy
Illabot Bend
Cascade River
Diobsud Creek
Bacon Creek
Copper Creek
County Line Ponds
Whistling Hole
Newhalem
Projected New Number of Eagles Per Day
Index of Eagles Observed Feeding or Carrying Food
Crop Index
PROPOSED IMPOUNDMENT AREA
Chum Carcass Scores WDF 1976,1977)
Known Coho Spawn
January Carcass Counts (BSAI)
River ½ Mile Segments
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93

Figure 5a

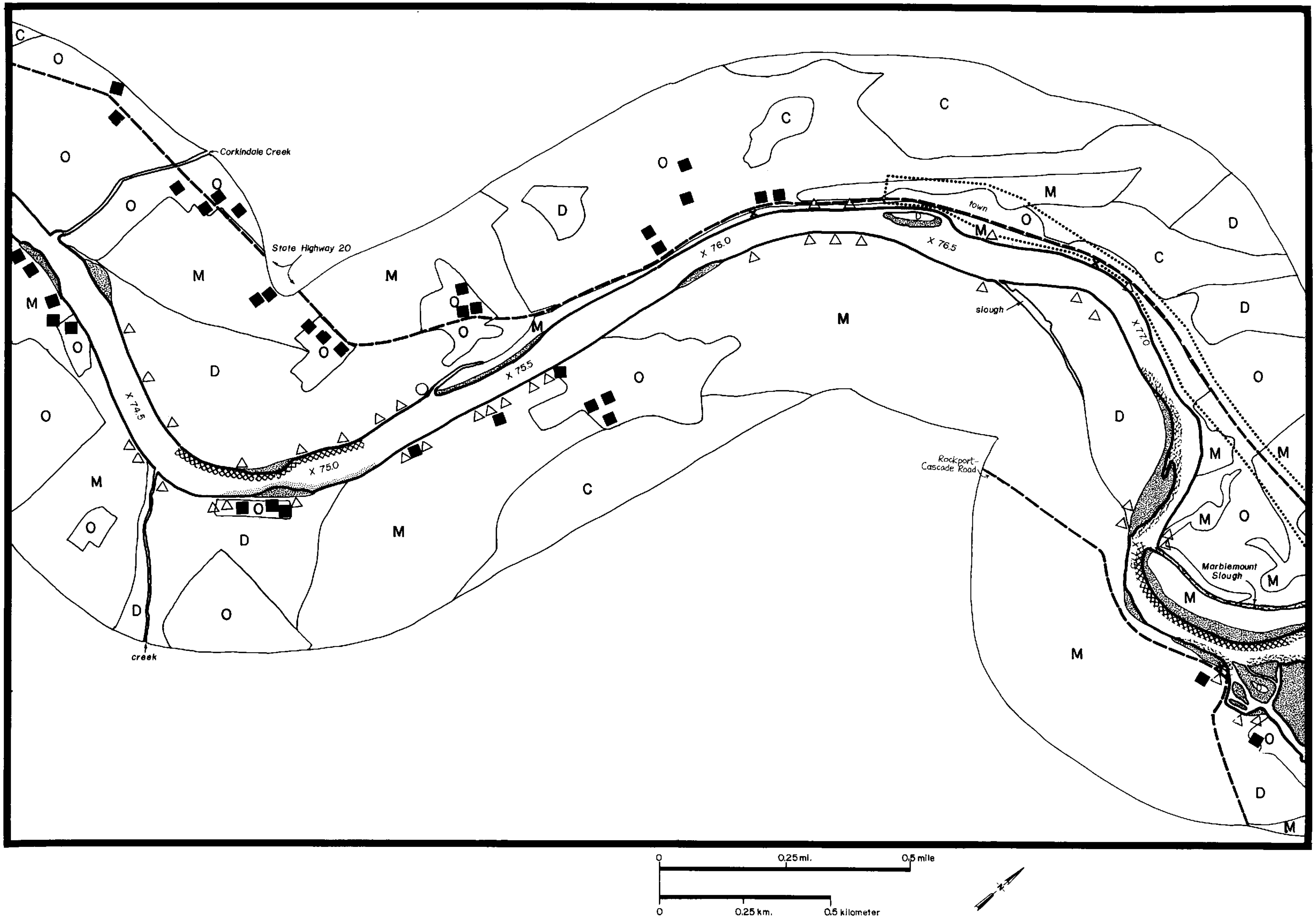


State Highway 20
x 66.0
x 66.5
x 67.0
x 67.5
Mc Leod Slough
slough
channel
Sauk River
Rockport - Darrington Highway
0
0.25 mi.
0.5 mile
0.25 km.
0.5 kilometer
N

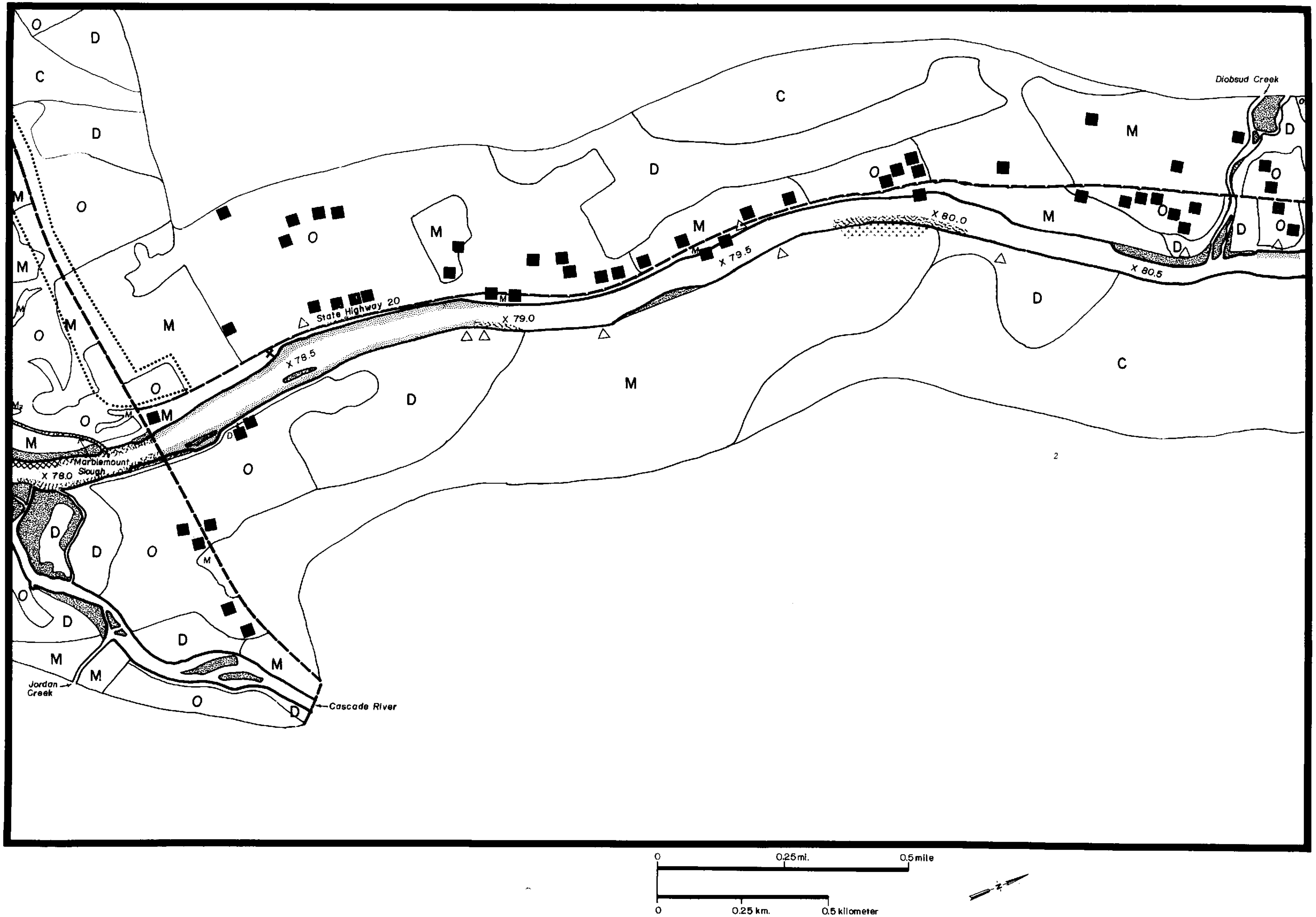


State Highway 20
Barr Creek
Sutter Creek
x 68.0
x 68.5
x 69.0
x 69.5
x 70.0
x 70.5
x 71.0
Lucas Slough
Lucas Slough
channels
Rockport - Darrington Highway
Barnaby Slough
Harrison Slough
slough
0
0.25 mi.
0.5 mile
0
0.25 km.
0.5 kilometer
N

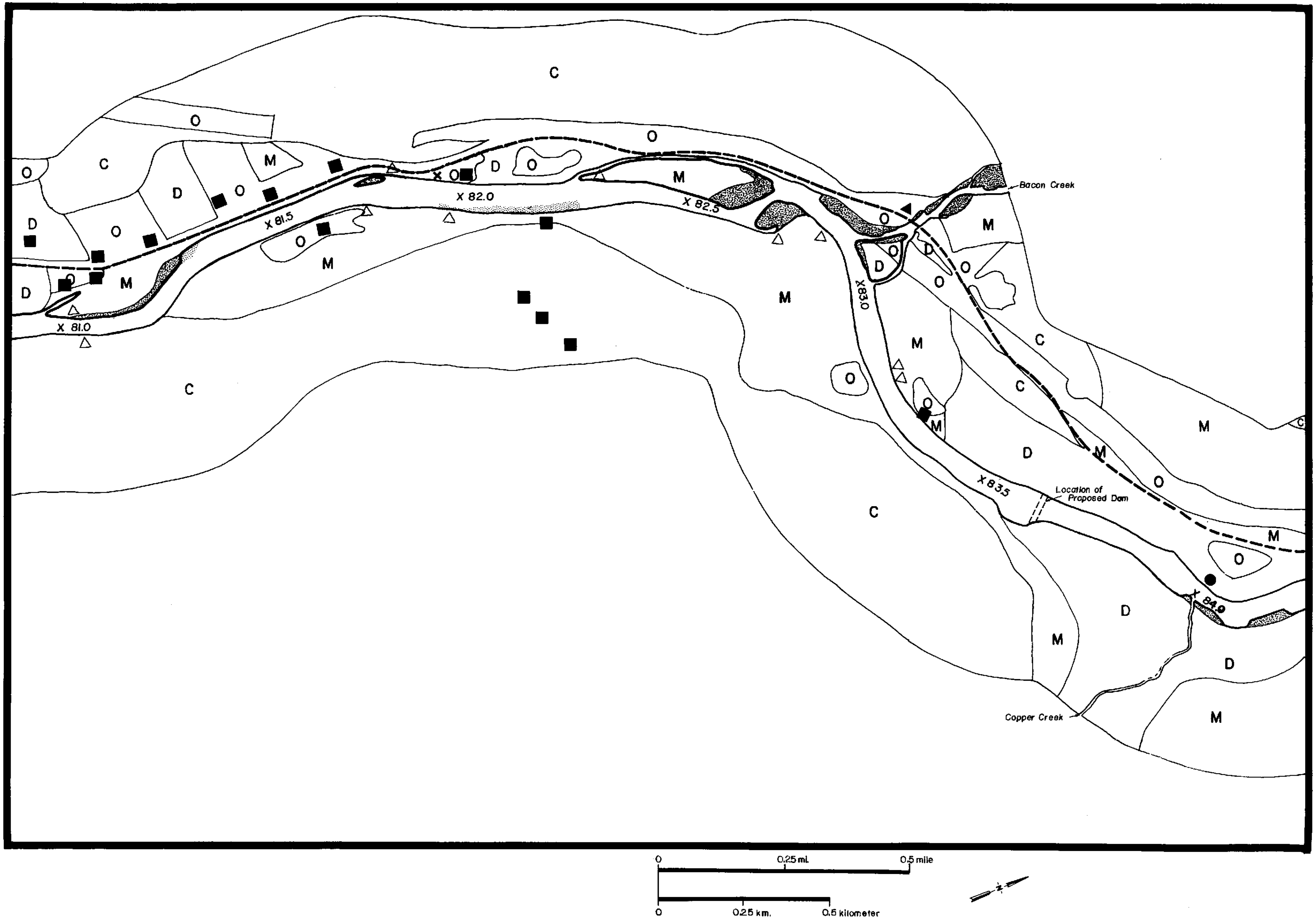

M
O
M
O
D
X 72.0
X 71.5
M
D
D
C
M
Rocky Creek
O
O
C
C
O
D
M
O
X 73.0
M
M
O
D
Corkindale Creek
slough
D
M
D
O
Illabot Slough
X 74.0
X 73.5
D
M
O
O
D
O
M
D
M
O
O
D
M
M
Illabot Ponds
D
D
M
M
Illabot Creek
0
0.25 mi.
0.5 mile
0
0.25 km.
0.5 kilometer
N



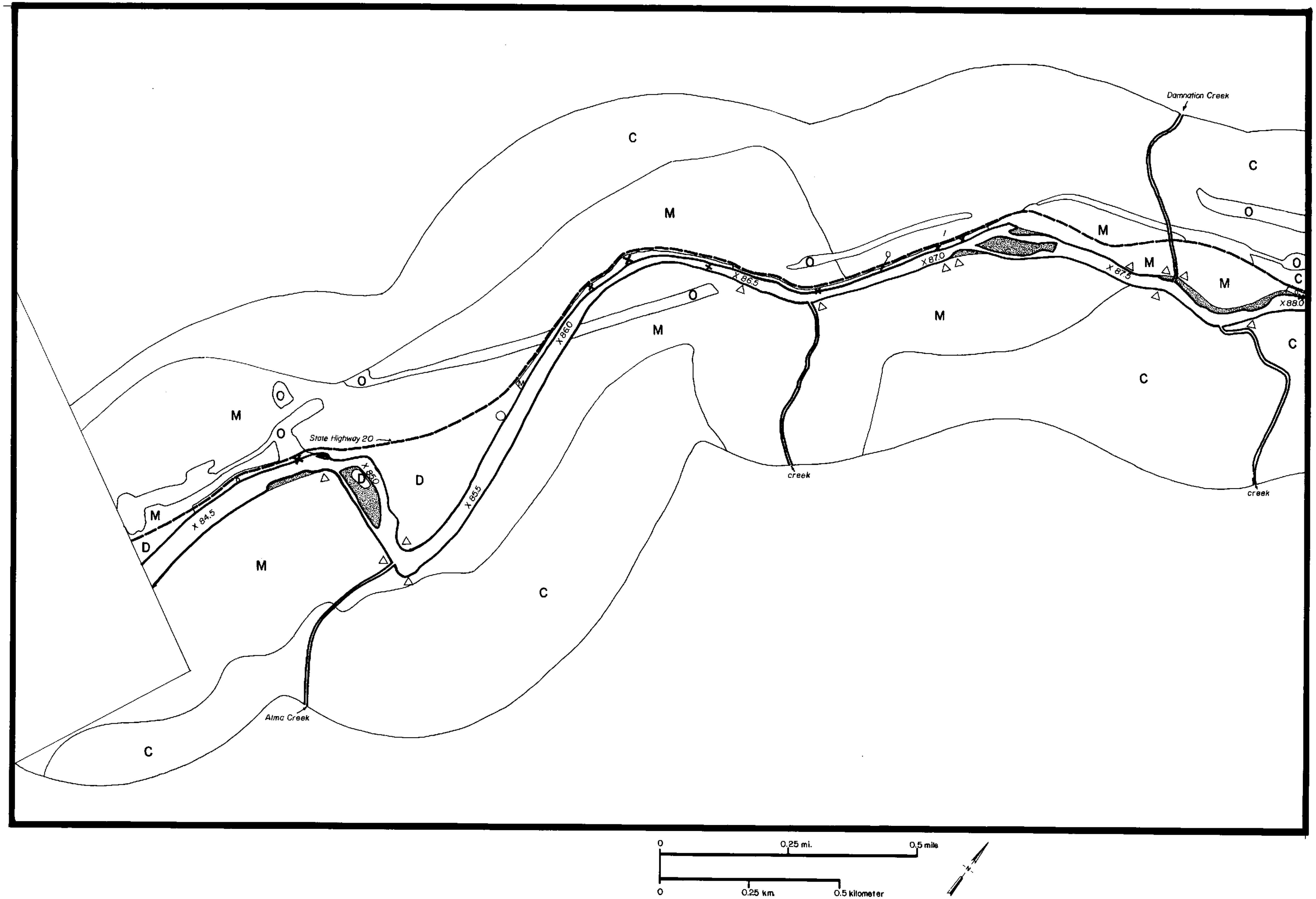
Corkindale Creek
State Highway 20
town
slough
Rockport-Cascade Road
Marblemount Slough
creek
X 74.5
X 75.0
X 75.5
X 76.0
X 76.5
X 77.0
0
0.25 mi.
0.5 mile
0
0.25 km.
0.5 kilometer



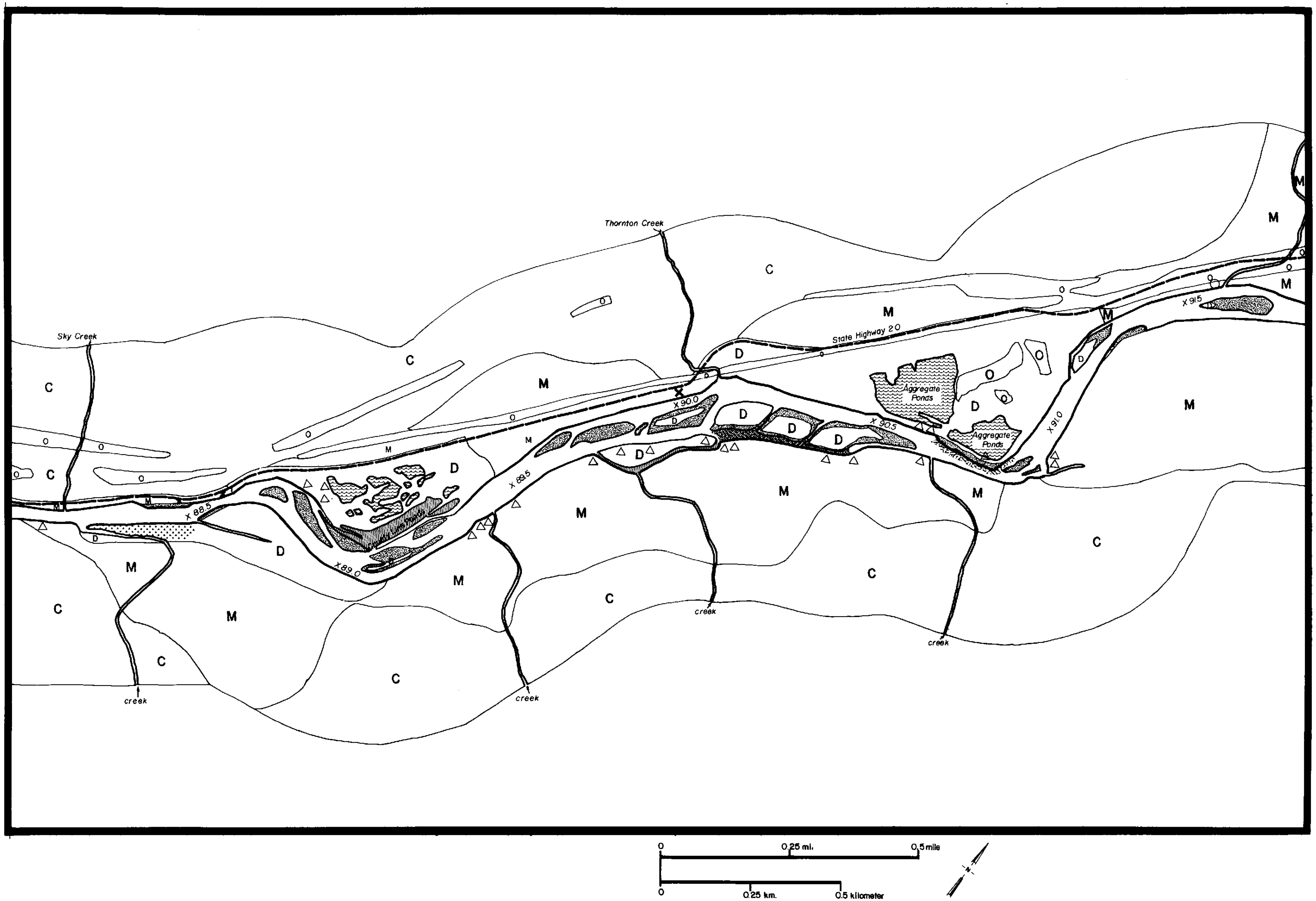
Diobsud Creek
State Highway 20
Marblemount Slough
Jordan Creek
Cascade River
X 78.0
X 78.5
X 79.0
X 79.5
X 80.0
X 80.5
0
0.25 mi.
0.5 mile
0
0.25 km.
0.5 kilometer



X 81.0
X 81.5
X 82.0
X 82.5
X83.0
X 83.5
X 84.9
Bacon Creek
Copper Creek
Location of Proposed Dam
0
0.25 mi.
0.5 mile
0.25 km.
0.5 kilometer



Damnation Creek
State Highway 20
X 84.5
X 85.0
X 85.5
X 86.0
X 86.5
X 87.0
X 87.5
X 88.0
creek
creek
Alma Creek
C
M
O
D
0
0.25 mi.
0.5 mile
0
0.25 km.
0.5 kilometer



Thornton Creek
Sky Creek
State Highway 20
Aggregate Ponds
Aggregate Ponds
X 88.5
X 89.0
X 89.5
X 90.0
X 90.5
X 91.0
X 91.5
creek
creek
creek
creek
C
M
D
O
0
0.25 mi.
0.5 mile
0
0.25 km.
0.5 kilometer
N

Babcock Creek
Goodell Creek
State Highway 20
X 91.5
X 92.0
X 92.5
X 93.0
Dirt Road
creek
Newhalem Creek
C
M
D
O
0
0.25 mi.
0.5 mile
0.25 km.
0.5 kilometer
N

6. Forest overstory composition. Overstory composition was measured along each river bank in two zones: 0-50 m from the river and 0-250 m from the river. For each zone, we estimated from aerial photographs the percent coverage (nearest 5%) of deciduous trees versus conifers, and percent forested area versus percent unforested.

7. Perch types. On censuses, eagles perched in deciduous trees were recorded as being in one of three classes of trees, Class A, B, or C (Section 4.2). Class A deciduous trees are the largest in the study area, generally exceeding 0.5 m in diameter (DBH) and 65 ft in height, with large diameter upper branches. These are almost exclusively black cottonwoods and bigleaf maples. Class B deciduous trees often are as tall as Class A trees, but generally have a DBH of less than 0.5 m and have smaller diameter branches; these, too are mostly cottonwoods and maples, though many red alders (*Alnus rubra*) also meet the criteria. Type C deciduous trees include mostly red alders and second growth cottonwoods and maples, and usually have a DBH of less than 0.3 m and small-diameter branches. Because large, stocky, well-branched deciduous trees have been reported as being favored by eagles, both for day perches and night roosts (see Table 4h), we counted the numbers of Class A trees on each bank of all 0.5 mile segments.

Habitat Mapping

A series of base maps of the study area (Figure 6a) showing distribution of habitat features were drawn from aerial photographs taken on 23 March 1979 and 20 April 1979 (scale: 1 inch = 660 ft) and from photographs taken on 3 October 1977 (1 inch = 500 ft). The mapped area in most cases extends 500 m from the river banks but goes beyond 500 m when necessary to include the tributaries and sloughs we routinely censused. Physiographic features are mapped as they appeared on the dates of photography.

Forest overstory was mapped as one of four general types: (1) unforested, (2) deciduous stand, (3) coniferous stand, and (4) mixed stand of deciduous and coniferous trees. Coverage of more than 80 percent of an area by one tree type was the criterion used in designating "pure" or "mixed" stands. Class A deciduous trees were mapped in the field.

Data on chum and coho salmon spawning and carcass distribution were obtained from the Washington Department of Fisheries office in Burlington, Washington, during conversations with M. Agguero and R. Ornell. The stream catalog of the Washington Department of Fisheries (Williams, Laramie, and Ames 1975) was also utilized

6.3 Results of Habitat Analysis

6.3.1 Perching

Bald eagles perch along the Skagit River close to water and mainly in deciduous trees. Of 2649 observations of perched eagles during censuses, 87 percent were within 25 m of water, and 94 percent were within 50 m (Table 6a). Regarding perch types, 88 percent of 2291 perched eagles (in trees only) were in deciduous trees, 6 percent were in conifers, and 6 percent were perched on snags. A further breakdown of these data to

Table 6a. Distance to water of eagles recorded during censuses Data are for river miles only and do not include ten off-river census locations.

Distance to Water (Meters)	Number of Eagles	Percent
0 - 25	2299	86.8
25 - 50	179	6.8
50 - 100	57	2.1
100 - 200	31	1.2
200 - 500	29	1.1
Greater than 500	54	2.0
TOTAL	2649	100.0

include the three deciduous tree categories shows that 18 percent perched in Class A, 52 percent in Class B, and 17 percent were in Class C deciduous trees.

We also found that about twice as many eagles perched on the left bank of the river as on the right bank. Adults did so to a significantly greater extent than did subadults (Table 6b).

Table 6b. Distribution of perched bald eagles by river bank.

Location	Subadults	Adults	Totals
Left (south) bank	561 (39%)	868 (61%)	1429
Right (north) bank	372 (54%)	320 (46%)	692
Island or Channel	153 (46%)	181 (54%)	334

Reasons for these disproportions in preference of river bank may be related to disturbance (Section 7.0), but not related (according to our correlation analyses) to natural habitat features such as perch tree types or overstory composition.

6.3.2 Habitat And Eagle Distribution

To test the relationship of the habitat variables we measured (Section 6.2) to the occurrence of eagles per 0.5 mile segment, we ran single variable regressions of each habitat variable with the mean projected number of eagles per day (per segment), over the duration of the study. Variables analyzed included width of the valley floor, width of the river channel, gravel bar area, chum spawning and carcass distribution, and Class A deciduous tree distribution. All but river channel width (r^2 = .44) and gravel bar area (r^2 = .52) showed very weak correlations to eagle numbers. The regressions involving river width and gravel bars point to these two features as being important characteristics of bald eagle wintering habitat, but leave a great deal of the variation in eagle numbers among the 0.5 mile segments unexplained.

Since eagle distribution changes with time, we generated a set of correlation coefficients between selected habitat components that might account for that change and projected daily numbers of eagles per 0.5 mile segment on a monthly (12 censuses) basis. Habitat variables included chum salmon spawning and carcass distribution, gravel bar area, and each tributary class (an indicator of coho distribution). Results indicated virtually no correlation between tributary streams and eagles during any month, and the same was true of chum spawning distribution and eagle numbers. Chum salmon carcass distribution showed a weak correlation during months one and two, as did ponds with spawning coho salmon in month four. Bar area was moderately correlated to eagles during the first month, and fairly strongly correlated in the second month.

Based on those coefficients, we ran multiple (stepwise) regression analyses of various habitat features versus monthly eagle numbers per 0.5 mile segment. Chum carcass distribution, gravel bar area, ponds with spawning coho salmon, and percentage deciduous trees in the overstory were included in the analyses.

The results of the stepwise analysis were not appreciably different from those reported above. Gravel bar area was moderately correlated to eagle numbers during the first month of study (r^2 = .42) and fairly strongly correlated in the second month (r^2 = .72). The percentage of deciduous trees in the overstory increased the predictive value of the regressions (r^2 = .49 and .78 in the first and second months, respectively). In the final two months of the study, no single variable or combination of variables came close to explaining the variation in the census data on eagle distribution.

We suspect that the fish distribution data as a habitat component would have produced a better fit with eagle distribution in a year of high eagle and chum salmon numbers in the SRSA, particularly if the geography of available chum and coho carcasses was indexed in the field each month. The best information on fish distribution available to us was that collected by the Washington Department of Fisheries for years prior to the study. The extremely low numbers of fish in our own January counts rendered the sample size for 1979-80 too low for reliable distribution estimates. Reviewing the geography of 1976 and 1977 chum carcass scores in Figure 5a, the eagles might well have distributed themselves more precisely relative to such values had the current spawn been thus distributed and the carcasses unaffected by the flood. As it stands, one prime habitat variable,namely chum carcass distribution; may be only vaguely interpreted. The matter has special significance in the full evaluation of the importance of the PIA to eagles since it is unknown whether the availability of chum, in addition to coho, would draw eagles in lower, equal, or greater numbers in years of abundant chum availability throughout the SRSA.

That eagle numbers, and hence habitat, may be predicted on the basis of our measured physical features (including trees) may not be realistic. While we often see eagles in abundance in situations of "wide, braided stretches of river" etc., on the Skagit, Nooksack, and Sauk Rivers, there are a number of stretches on all three rivers that contain such "optimum" features without a significant attendance of eagles. Had we attempted the quantitative habitat analysis for the entire Skagit (or Sauk or Nooksack), even gravel bars would have shown an extremely weak correlation. Gravel bars are important when salmon carcasses, mostly chum, are deposited on them. Whether or not they are deposited is likely to be a function of the topography of the bar, its position in the channel (relative to currents), the gradient of the riverbed, and proximity to a spawning area from which carcasses washout (and they do not, in all cases). In view of this, it is unreasonable to expect a direct relationship between numbers (or even occurrence) of salmon carcasses and extent of gravel bar.

On the basis of our study and literature review, we assert that the distribution (and availability) of salmon carcasses is the primary factor influencing eagle distribution and abundance. In winters of diminished food supply, like the one we studied, it is probably the sole factor invovlved. In years of surplus food, other factors such as disturbance, preferred trees, etc., may modify the influence of the primary factor (food), at least during those parts of the winter when food is abundant.

Our analyses showed that there is a temporal aspect to habitat that is at least as important as the spacial dimension we have considered. In a given winter, different areas of the river are utilized during different weeks or months. As important are the gross habitat changes that take place on a yearly basis. It would be erroneous to refer to the winter 1979-80 as an "abnormal year" with conditions unlikely to reappear for some time to come. Servheen (1976) reported a quite similar situation in his first year of study: a poor chum run and a flood at the peak of spawning. Floods, irrespective of the magnitude of chum runs, are not unusual winter phenomena on Puget Sound rivers. It is conceivable that any time the river floods eagles are faced with an altered food supply, probably to their detriment. It is at these times that habitat attrition (e.g. a Copper Creek Dam) on the Skagit may wield its impact on the welfare of eagles.

A fairly high percentage of the eagles in the SRSA were in the PIA during the last two months of our study. Because the area has never been adequately censused in the past, we do not know how differently the birds were distributed relative to previous years. But we do know (Figure 4b) that the County Line Ponds-Whistling Hole complex was more important to eagles during the latter part of the winter than was the SRBENA where carcass availability was decimated by the flood.

6.3.3 Projected Loss of Eagle Habitat in the PIA

The bald eagle habitat that would be innundated by the proposed Copper Creek dam is mapped in Figure 6a. By far the most important area within the ten-mile stretch involved is that lying between RM 87.5 and RM 90.0 and containing the County Line Ponds-Whistling Hole complex (Figure 6a, 5c). The principal attraction of this unit of habitat for eagles during winter 1979-80 was the substantial number of coho salmon spawning there (Section 5.4). Because cohos spawn later in the winter than do chums and because the ponds themselves are protected by a dike from high water, this habitat unit provided an important source of food for eagles after the mid-December flood had decimated food supplies downstream. Besides food, the County Line Ponds-Whistling Hole complex provided an area where human distrubance was minimal. In the entire PIA, active disturbance represented five percent of the total for the SRSA, while passive disturbance amounted to 15 percent. More than 50 Class A deciduous trees (or Class A stands) would be lost to inundation. Similarly, more than 20 gravel bars would be lost. For a graphic view of total eagle habitat loss in the PIA, refer to Figure 6a.

Spawning redds of chum salmon in the vicinity of the City Light Aggregate Ponds (RM 90.5) did not appear to produce available carcasses this year for eagle consumption (Section 5.4). But in a year without a flood, this area might well have generated carcasses and, therefore, eagles. Moreover, the question remains unanswered whether or not the Aggregate Ponds themselves would provide extensive coho spawning opportunities if suitable avenues connecting them with the river were constructed and maintained. Under the right conditions, then, the area of RM 90.5 may have the potential for supporting moderate numbers of eagles. Certainly, other aspects of habitat there such as seclusion and an abundance of Class A deciduous trees, lend themselves to eagle utilization.

7.0 EAGLES AND DISTURBANCE FACTORS

7.1 Background

The response of eagles to increasing levels of human disturbance in the Skagit River Valley is important to evaluating the impact of the Copper Creek Dam project. Servheen (1975) and Wiley (1977) expressed concern over increasing numbers of people attracted to the area for recreation. Stalmaster and Newman (1978) reported on bald eagles and their tolerance for various levels of human activity.

Copper Creek Dam will increase human activity levels in the SRSA. An estimated 520 construction personnel would be required onsite in 1987 with a range of 35-520 people being present each day between 1984 and 1988 (CH^2M Hill 1978). In addition, recreation user-days in the SRSA will increase significantly resulting in a complex array of active and passive disturbance factors facing bald eagles in the future.

Most disturbance studies with bald eagles have examined impacts on nesting behavior and productivity (Mathisen 1968; Grier 1969; Jueneman and Frenzel 1972). Shea (1978) contends, however, that human disturbance is the major threat to wintering bald eagles in Glacier National Park. Stalmaster (1976) similarily concludes that "...human activity on the feeding grounds (in winter) is beyond the limits of tolerance for most bald eagles and threatens the well being of the population".

In light of the expected increase in human activity in the SRSA if Copper Creek Dam is constructed, we designed a phase of our research to examine the effects of human-related disturbance factors on bald eagles.

7.2 Fieldwork

We recorded information on active human disturbance factors in conjunction, with the regular collection of data on eagle distribution and abundance explained in Section 4.2. The following facts were written in code on the field forms used for censusing eagles (Appendix B): the distance each eagle was from the researcher (observer), the researcher's mode of travel, the eagle's response to the researcher, the distance each eagle was from any other human (public user) or vehicle, and the eagle's response to the public user. On a separate form (Appendix B) were marked the public user type, mode of travel, and position on or along the river.

Passive disturbance features refer to areas of man-altered habitat where potential for human acitivty is high. We recognized three main categories and quantified them for analysis: roads, buildings, and areas that offer recreational opportunities. We evaluated passive factors in two zones along each half-mile segment of river (in a zone 0-50 m and in a zone 50-250 m from the river) where vegetation acted as a buffer for less than 50 m. In addition the 0-50 m zone was subdivided into areas buffered by less than 10 m of trees (essentially unbuffered for less than 50 m) and areas buffered by 10-50 m of trees. Potential disturbance features buffered by more than 50 m of vegetation were not quantified.

From aerial photographs, we calculated the percentage of northern shoreline of the river (per half-mile segment) where Highway 20 fell within each of the above-mentioned zones. Overlooks and vehicle pull-offs along the highway were counted and locations of bridges crossing the river were recorded.

Buildings were counted on both river banks in each of the two zones. The number of buildings in each zone (per 0.5 mile segment) was totaled and given a score of 0 to 4, as follows:

0 = none
1 = 1-5
2 = 6-10
3 = 11-15
4 = More than 15

Towns received a score of 4 regardless of number of buildings.

The recreation category included camp grounds, picnic areas, boat ramps, and roads that provided access to the river. These were rated on a scale of 1 to 3 according to intensity of use (light, moderate, heavy) and were recorded by river bank.

Each 0.5 mile segment received a total passive disturbance rating on a scale of 1 to 9 (1=none, 9=heavily used) based on a combination of the above factors.

The passive features were mapped within an area extending 500 m from the river bank and are delineated on the base maps showing physical and vegetative characteristics of the study area. They appear in Section 6.0.

7.3 Results

7.3.1 Public Use of the Skagit River

Table 7a summarizes the types and frequencies of occurrence of human disturbance factors recorded during 48 censuses. See Appendix E for details on disturbance per 0.5 mile segment of river and the ten off-river census locations.

We recorded a total of 386 human activity entries. A significant portion (85%) occurred between river miles 66.0 and 75.0, which encompasses the SRBENA. This activity was due primarily to fishermen, both on foot and in boats. Nearly all of the motorized boating activity took place in this area.

Human activity in the PIA was relatively low (5%) and generally was a rare event.

Figure 7a shows the number of human activity entries per census day for river miles 67.0-72.5, which is where most (72%) of the public user activity was concentrated. Steelhead fishing is particularly popular between

Table 7a. Frequencies of active disturbance recorded within the nine-mile river segments in the SRSA during 48 eagle censuses.

Disturbance Factor	Frequency			
	River Mile 66.0-75.0	River Mile 75.0-84.0	River Mile 84.0-93.0	Total
Fishermen on foot - open view	107	1	1	109 (28)
Others on foot - open view	26	5	3	34 (9)
Others on foot - buffered[1/]	2	1	5	8 (2)
Boats drifting	87	14	0	101 (26)
Boats using motors	70	3	0	73 (19)
Cars stopped - people inside	5	2	5	12 (3)
Cars stopped - people outside	17	8	2	27 (8)
Logging/Construction	9	2	1	12 (3)
Auditory	6	2	1	9 (2)
TOTAL	329 (85)	38 (10)	19 (5)	386

NOTE: Table does not include active disturbance entries for the 17 off-river census locations, which were minimal.

[1/]refers to being partially obscured from the eagle's view by vegetation

(%)

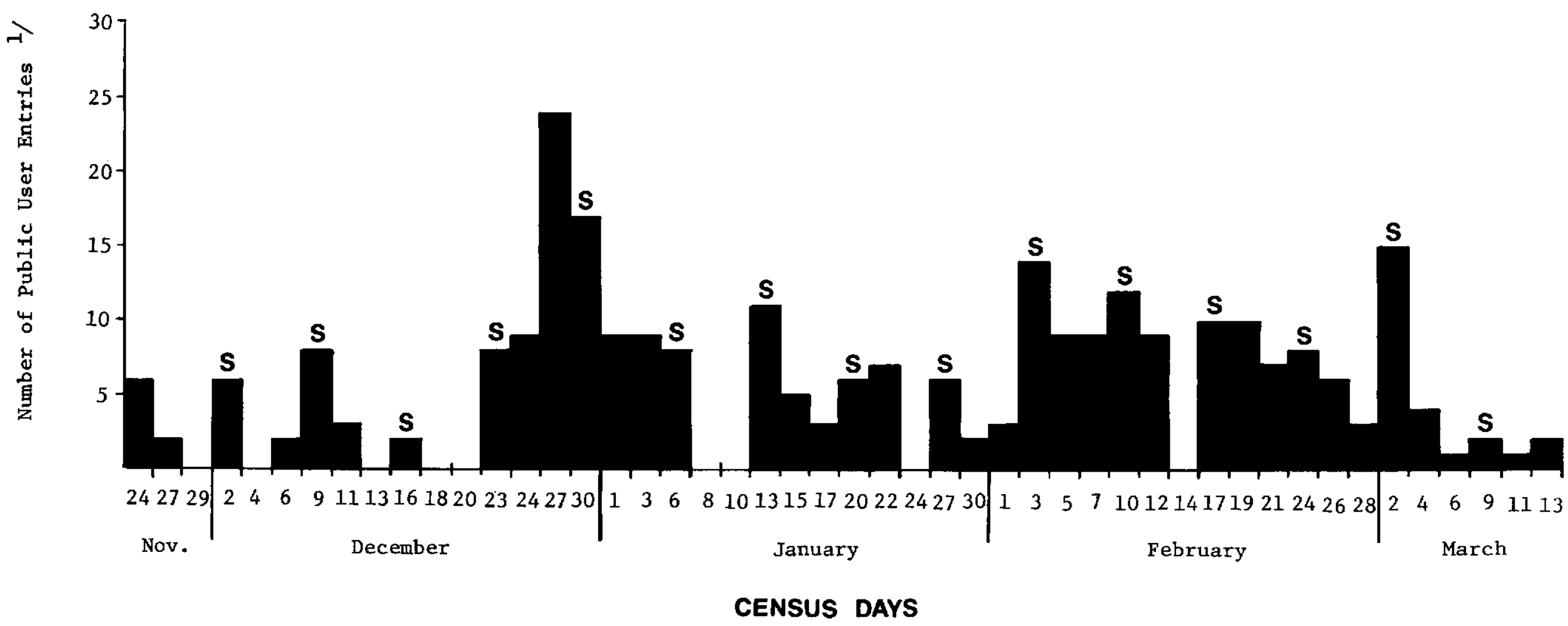


Figure 7 Levels of public use by census day for River Miles 67.0 - 72.5. Data represent 278 (72%) of all public user entries recorded.

S = Sunday census
1/ Data are for 54 0.5 mile river segments only.

the mouth of the Sauk River (RM 67.0) and the mouth of Barnaby Slough (RM 70.0). A major boat ramp is located at RM 67.5. The public user data show relatively stable activity levels (3-8 entries per census) for January and February.

Sundays (n=15) represented 133 public user entries, for a mean of 8.9 entries per Sunday census. In contrast, other days (n=33) represented 145 entries, for a mean of 4.4 entries per census (non-Sunday). S. Skagen (pers. comm.) compared eagle numbers in relation to public users on Sundays versus non-Sundays in a one-mile segment near Rockport and saw no significant reduction in bald eagle numbers despite the increase of human activity.

SRBENA stewards annually report increased human activity on Sundays (Wiley 1977, 1978; Skagen 1979, 1980). Wiley (1977) reported a pattern of bald eagle distribution whereby eagles congregated off the main river in less disturbed areas when human activity on the main river was high. His counts of eagles on the main river when relatively few humans were present indicated increased numbers of eagles in the main river areas. This shift occurred usually within a day or two, sometimes in a matter of a few hours.

The SRSA between River Miles 67.0-72.5 was an area of concentrated public use and high eagle numbers. In contrast, the Illabot/Barnaby Slough area had practically no human activity and often supported large numbers of bald eagles. In order to test the effects of human activity on bald eagle numbers and their distribution, we tested the following hypothesis. On week-end days of greatest public use and human activity between RM 67.0 and 72.5, one would expect eagle numbers to increase in areas of low human activity, namely Illabot/Barnaby Slough. Such an increase in eagles would be reflected in the eagle census data for Sundays, since Saturday human activity levels, though not quantified, should be similar to Sunday levels (known to be high). Eagles present in this refuge on the Sunday morning censuses would, if disturbance were affecting eagles significantly, reflect eagles that moved there on Saturday.

Analysis of the data failed to support the hypothesis that eagle numbers increase in areas of low human activity on Sundays following expected high levels of human activity on Saturday. Instead, we observed that eagles appeared to remain near the feeding areas utilized throughout the week.

This finding may, again, be related to the low chum availability this winter and an expected higher tolerance of eagles for human activity. In an average to high chum salmon year, eagles may move greater distances due to human activity because of the widely distributed and abundant food available to them in such years as observed in 1976-77 (Wiley, 1977).

Stalmaster and Newman (1978) reported that the distribution of bald eagles along the length of the Nooksack River study area reflected the effect of human activity. A multiple regression analysis of our data showed no such correlation between eagle distribution or abundance in the SRSA due to active or passive disturbance factors.

Secondly, they reported that where activity classification differed for adjacent sides of the river, a greater number of eagles were observed on the riverside with lower human disturbance. On the Skagit, passive disturbance factors are concentrated on the right bank in most 0.5 mile segments. The census data also revealed a significant left bank preference by bald eagles (Table 6b). However, a series of correlation coefficients failed to relate disturbance and bank preference statistically. This leads us to the conclusion that the presence or absence of passive disturbance factors does not predict if eagles will or will not utilize particular areas at least in low food years.

Given that active disturbance was greatest between river miles 66.0-75.0, we were surprised to find the greatest numbers of eagles in the same area (Table 7b) This positive correlation would not be expected if, indeed, the distribution of bald eagles was significantly disturbed by public users. Movements data, census results, and food habits studies revealed that only when chum salmon availability severely dropped did eagles leave River Miles 66.0-75.0. It was at this time that eagles significantly increased their use of river segments 89.0-89.5 (County Line Ponds area), where coho salmon were spawning (Figure 5c).

Our data support the hypothesis that bald eagles are less inclined to leave an area due to public user disturbance when food is in limited supply than when f6od is abundance and present in areas of less human distrubance. Stalmaster (1976) and Servheen (1975) reported significant negative responses by eagles to human disturbance in years when food resources for eagles were abundant. In this year of low food availability, bald eagles appeared more tolerant of human activity, more likely to return to a carcass in a short time period if flushed, and less likely to entirely leave an area if flushed where food was present.

Steenhof (1976) suggested that bald eagle tolerance levels at preferred feeding areas were relatively high. Our data support this point. Even though feeding was interrupted in some instances, eagles were observed flushing from the ground to a nearby tree and then returning to feed, usually less than one hour after the disturbance passed.

Several factors complicated a universal conclusion on the response of bald eagles to human activity. One centers on individual variation between eagles in their response, flush distance, or tolerance of activity. Individual eagles experience varying degrees of disturbance and, thus, different response potentials and tolerance levels are present in the population at all times. Additionally, habituation to disturbance probably occurs to some extent. Grier (1969), Edwards (1969), and Stalmaster and Newman (1978) each indicate that eagles are less disturbed by human activity in areas where such activity is a normal event. Studies on how much activity is tolerated before an area is entirely abandoned for extended periods of time have not been done; however, no large concentration areas for wintering bald eagles are known to have been abandoned due entirely to human activity.

Results of censuses conducted in winter 1979-80 by D. Russell (U.S. Forest Service) on the Suiattle, Sauk, and Skagit Rivers add support to the

Table 7b. The relationship of eagle occurrence per 0.5 mile segment to active and passive disturbance factors.

	River Mile 66.0-75.0	River Mile 75.0-84.0	River Mile 84.0-93.0
Eagle occurrence (per day)			
Projected number of eagles[1/]	52.4 (66)	9.0 (11)	18.2 (23)
Mean/0.5 mi unit	2.9	0.5	1.0
Active Disturbance			
Total Entries	329 (85)	38 (10)	19 (5)
Mean 0.5 mi unit	18.3	2.1	1.1
Passive Disturbance			
Total of factors	61(29)	90(42)	62(29)
Mean 0.5 mi unit	3.4	5.0	3.4

(%)

[1/]See Appendix E for projected mean ($\bar{X}$) number of eagles per day per 0.5 mi unit.

argument that eagles are more tolerant of human activity in areas where it occurs regularly. Eagle responses were recorded to the census raft on all three rivers. Table 7c shows that the Suiattle River had the greatest flush response. It also is considered to experience the least amount of human activity in winter. The Skagit River had the lowest eagle flush response and it is the river (of these three) with the greatest human activity in winter.

Our disturbance studies address the effects of human activity on bald eagle distribution and abundance in the SRSA. Neither mortality of bald eagles nor the effects of human activities within particular 0.5 mile segments are explained by this treatment.

Wherever people concentrate near eagles, illegal shooting is likely to increase. Also, mortality due to starvation is not detected if eagles remain within 0.5 mile segments and are stressed by human activity to a level whereby they are unable to obtain food. Neither of these disturbance-related mortality factors were detectable in the design of our research efforts if they occurred.

It remains possible that disturbance may compound existing stress factors, i.e. food shortages, whereby this stress is later manifested in the failure of nesting eagles to lay eggs in spring. Newton (1979) points out that some raptors do not produce eggs in years following winters in which inadequate energy reserves were stored. There is no way to test these facets of human disturbance effects on bald eagles with the data at hand.

Previous studies have attempted to quantify disturbance to eagles on the basis of eagle responses to human-related environmental stimuli. By observing eagles in a food-stressed condition on the Skagit this winter, it appears that what has in past studies been interpreted as "disturbance response" is not a limiting factor on abundance or distribution. In winters when food is abundant, eagles are less tolerant of people but probably not to an extent that affects their survivorship or utilization of an area for exploitation of available food. Our data indicate that human activity cannot be equated with disturbance in all instances.

Therefore, at current levels of human activity, it is food suppy which has by far the greater regulating effect on bald eagles, particularly in determining long-term population trends.

Table 7c. Comparisons of flush response by bald eagles along portions of three rivers in relation to levels of human activity. Data from D. Russell, U.S. Forest Service.

Location	Activity Level	Eagles Observed	Eagles Flushed	Percentage
Suiattle River RM 11.9-2.0	Low	47	39	82%
Upper Sauk River RM 12.8-25.1	Low	91	51	56%
Lower Sauk River RM 0.1-12.8	Moderate	310	197	64%
Skagit River RM 67.2-62.6	High	50	8	16%

8.0 EAGLE MOVEMENTS

8.1 Background

Recoveries of banded and/or color marked bald eagles have provided researchers with basic information on movements or migration pathways. However, in recent years, eagles trapped and equipped with radio-telemetry transmitters have greatly increased our knowledge of habitat preferences, post-fledging dispersal, and the winter ecology of eagles (Southern 1964, Kussman 1977, Griffin 1978, Servheen 1979, McClelland and Shea 1978).

Telemetry studies were selected as the best feasible method to verify whether or not bald eagles wintering in the SRBENA utilized other portions of the Skagit, particularly the PIA. Also, bald eagle movements between river valleys in the region could be examined by this technique. In addition, we could follow the spring dispersal of eagles leaving the Skagit en route to their summer territories. All of these areas of research yielded important insights to the ecology of bald eagles and the possible impacts of a Copper Creek Dam.

8.2 Fieldwork

Capture attempts began on 29 December 1979 after a thorough reconnaissance revealed (from the researcher's standpoint) three preferred trap sites. The choice of capture locations rested on four main factors: (1) predictable occurrence of eagles, (2) accessibility to researchers, (3) seclusion and (4) expected minimum impact on trap sets by fluctuations in river level.

One team of at least two persons manned each capture site, watching at a distance from dawn throughout the daylight hours. Eagles were captured by the Lockhart method baited with partially-submerged dead salmon. Upon capture each eagle was immediately secured, tethered, hooded, and restrained with a cloth wrap. Provisions were made to comfort the eagles while in captivity. Processing and transmitter application were conducted as quickly as possible; the entire procedure did not exceed 2.5 hours. Each eagle was weighed, standard measurements were made, and photographs were taken. U.S. Fish and Wildlife Service leg bands and Washington State patagial markers (red) were placed on eagles.

We applied transmitters manufactured by Telonics, Inc. in a weight range of 27 to 41 grams and having a battery-life of five months. These were tied and glued to the dorsal base of the two center tail feathers. (The flexible wire antennas were spot-tied and glued to one of the feather shafts. Transmitter frequencies, each different, were within the 164 megahertz band). Eagles were released near the capture sites and radio-tracking began immediately.

Ground tracking was accomplished with a four-wheel-drive pickup truck equipped with a 3.2-m-high (from the ground) internally-rotated antenna mast. A four-element directional Yagi antenna mounted horizontally on the mast top was connected to a Telonics TR-2 receiver coupled with a TS-1 programmable scanner. A hand-held two-element Yagi antenna was linked to a TR-2 receiver and used when a researcher was on foot or in another vehicle equipped with an auxilliary omni-directional roof-top antenna.

A bird's location (e.g., distance from the river) was sometimes pinpointed by triangulation, a process of determining a compass bearing to the bird from one location, then moving to another and again ascertaining the direction to the bird. The bird's position was judged to be at the point where point where the two lines intersect. Each directional fix was recorded on a field form (Appendix B), as was the bird's suspected location.

The ground tracking system was used to monitor movements of radio-tagged eagles along the Skagit River, some tributaries (i.e., Sauk and Cascade Rivers), and off-river areas. We attempted to locate each bird at least once a day. In addition, we systematically "searched" the SRSA for telemetered eagles during censuses. Additionally, constant monitoring was conducted during other road travel in the area.

When a signal could not be detected, we turned to aerial tracking because of its higher mobility and increased range. A Cessna 172 fixed-wing aircraft was equipped with side-facing two-element Yagi antennas clamped to the plane's steps. A switch-box inside the plane allowed us to change from one antenna to another. If, for example, an eagle was 90 degrees to the longitudinal axis of the airplane, the antenna on the side the eagle was located would be receiving the strongest possible signal. By turning the aircraft in the direction of the strongest signal and attempting to equalize the strength of the signal on each antenna using the switch-box, it was more or less possible to fly directly toward the bird, and finally fly in a circle around it, with the lower (inside) wing pointed roughly at the eagle.

Ground and aerial tracking were complicated by considerable signal bounce associated with trees and steep terrain, and weather below aviation minimums. These factors limited long-range tracking of some birds and the regularity of our flights.

8.3 Results

Ten bald eagles were captured in the SRSA between 2 January and 5 February 1980. All were fitted with radio transmitters and then released near the point of capture. Lucky circumstances made possible the radio-tagging of seven additional birds on the Nooksack River (captures and transmitter attachments were performed by Rick Knight (Washington Department of Game), thus expanding our sample of telemetered eagles in the study region. Capture locations, dates of capture, estimated ages, probable sex, and other measures, along with transmitter frequencies, are listed for each eagle in Table 8a. Two adults (both probably females) and two five-year-olds were among the radio-tagged eagles. Subadults in their first three years made up the balance of the sample.

A summary of movements by the 17 radio-tagged bald eagles is presented in Figure 8a. Many factors influenced the number of detections we made of each eagle. As shown in Appendix C, some eagles were located several times per day while others, due to weather and travel logistics, were monitored regularly, but at greater intervals. Some eagles were "lost," and then detected in an unsuspected spot, which accounts for nearly all data gaps exceeding five days.

Table 8a. Physical characteristics and capture data for the 17 radio-tagged bald eagles

Eagle No.	Estimated Age (yrs)	Probable Sex	Date of Capture	Location of Capture	Weight (kg)	Length of Middle Retrix (cm)	Wing Chord (cm)	Transmitter Frequency
1	2	M	Jan 2	Rockport[1]	4.5	33.8	60.0	164.3215
2	2	M	Jan 4	Rockport	3.1	35.6	60.0	164.3409
3	1	F	Jan 13	Marblemount[2]	5.7	35.5	64.4	164.3620
4	1	M?	Jan 16	Marblemount	5.0	34.0	61.0	164.3798
5	6+	F	Jan 21	Rocky Creek[1]	5.2	32.0	61.0	164.4202
6	5	M	Jan 25	Rockport	4.5	30.0	59.0	164.4416
7	3	F	Jan 29	Marblemount	5.9	32.5	61.0	164.4623
8	5	F	Feb 3	Rockport	5.1	30.0	61.0	164.4822
9	3	F	Feb 5	Rockport	4.9	36.5[4]	65.4	164.0120
10	2	M	Feb 5	Rockport	5.0	32.5[4]	60.7	164.0400
11	6+	F?	Feb 7	Welcome[3]	5.3	29.0	61.5	164.5227
12	1-2	F	Feb 11	Kendall[3]	4.8	36.2	65.3	164.5421
13	3	F	Feb 13	Welcome	5.2	30.9	63.0	164.0670
14	3	M	Feb 14	Kendall	4.7	30.0	62.1	164.5664
15	3	F	Feb 15	Kendall	5.4	34.0	67.1	164.5911
16	2	F	Feb 15	Welcome	6.0	33.0	63.4	164.6141
17	3	M	Feb 15	Welcome	4.7	33.0	64.0	164.6674

[1]on Skagit River
[2]on Cascade River
[3]on Nooksack River
[4]feather had broken tip

Figure 8a

Time Line Eagle Movements

Legend

Symbol	Location
—	No Information
(solid black)	Proposed Impoundment Area
(fine dots)	Skagit River Study Area
(vertical lines)	Lower Skagit River
(scattered circles)	Skagit Flats
(diagonal hatching)	Sauk River
(irregular vertical lines)	Fraser River
(dense stipple)	North Fork Nooksack River
(grid)	South Fork Nooksack River
(reverse diagonal lines)	Nooksack Flats
(wavy lines)	San Juan Islands
(irregular horizontal lines)	Snoqualmie River
(crosshatch)	Lakes North of Fraser River, B.C.
(random pattern)	Vancouver Island, B.C.
(horizontal lines)	Knight Inlet, Queen Charlotte Strait, B.C.

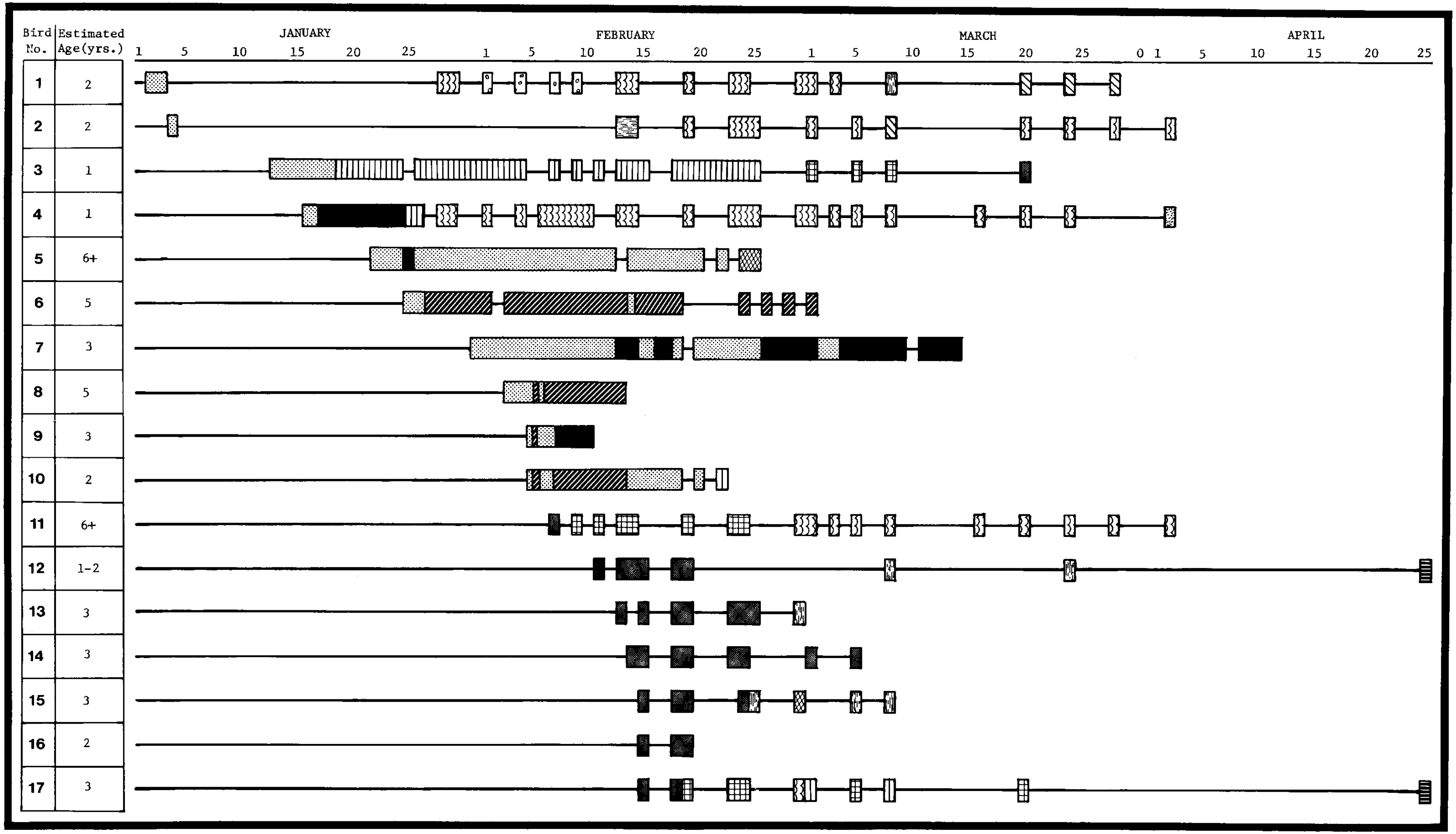

Bird No.
Estimated Age (yrs.)
JANUARY
FEBRUARY
MARCH
APRIL
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 0 1 5 10 15 20 25
1 2
2 2
3 1
4 1
5 6+
6 5
7 3
8 5
9 3
10 2
11 6+
12 1-2
13 3
14 3
15 3
16 2
17 3

Figure 8a

The movements data do not provide a complete chronicle of each eagle's movements since, on some days, no data were obtained. During longer periods of no data collection, an eagle may have traveled extensively or moved farther than our detections indicate. However, the data readily serve as a basis for a substantital "outline" of eagle movement.

The 17 telemetered eagles were detected for a combined total of 309 days. The greatest number of days any particular bird was located was 42 (Eagle No. 7). Not surprisingly, this eagle was easily accessible to the researchers because it remained in the SRSA, making detection possible almost every day until its departure (Section 8.3.2). Eagles No. 1, 4, and 17 utilized five different geographic units within the study region (see Section 8.3.4). The ten birds radio-tagged on the Skagit went to five different areas when they moved out of the lower SRSA. In contrast, the seven eagles telemetered on the Nooksack were only detected at two different areas when they initially left the north fork of the river. Within the entire sample there was much variation in eagle behavior. The eagles were highly individualistic in where they moved and how long they stayed at certain locations, as can be ascertained from the summaries provided below.

8.3.1 Regional Eagle Movements

Within one and two days after being captured, Eagles No. 2 and 1, respectively, left the study area. We thought at the time that the transmitters had failed, but the signal from Eagle No. 1 was finally (24 days later) discovered more than 80 km from the trap site. We were able to monitor this eagle's movements fairly regularly thereafter. During one nine-day period it frequented the Skagit estuary in the vicinity of both of the two Skagit river mouths and traveled south to the tide land area near Stanwood. From 13 February to 3 March it frequented the San Juan Islands, and was detected at Lopez, Orcas, Cypress, and Lummi Islands. It spent some time on the adjacent mainland coast as well. Eagle No. 1 then flew 80 km to the Harrison River in British Columbia and, amazingly, was detected to the south at the mouth of the Nooksack River near Bellingham 12 days later. There, it remained for at least eight days.

Similarly, Eagle No. 2 was found (40 days after last detecting a signal) at a point north of Everett. It was located near Fall City on the Snoqualmie River, more than 100 km from where it was originally captured. Within six days it had returned in a northerly direction to Camano Island where it was detected a total of 12 times over 44 days. During this period, we detected two relatively short movements. It moved to adjacent Whidbey Island for one day, and a week later it was detected on the mainland coast northwest of Bellingham and the mouth of the Nooksack River.

We detected Eagles No. 3 through 10 daily (sometimes several times per day) for periods of up to 22 days after their capture. Eagle No. 3 traveled westerly down the Skagit River Valley within six days of being radio-tagged. For one month, it remained on the lower Skagit. West of Concrete it frequented a man-made slough that communicates with the Skagit River at one end. This eagle seldom moved from this location, and we believe there were spawning chum and/or coho salmon in the slough. Eagle No. 3 was found regularly near creek mouths and sloughs near Sedro Woolley. Later, it moved north along the south fork of the Nooksack River. We last detected Eagle No. 3 at Kendall on the north fork of the Nooksack on 20 March. Eagle No. 3 was the only bird tagged on the Skagit that visited the upper Nooksack (Eagle No. 1 went to the mouth of the Nooksack near Bellingham).

Eagle No. 4, captured near Marblemount, frequented at least ten locations in the PIA, especially the County Lines Ponds-Whistling Hole area, beginning one day after being radio-tagged. It remained in the PIA for nine days and then it followed the Skagit River to Puget Sound. We detected this individual on Orcas Island on 28 January where it remained until at least 24 March. It made, to our knowledge, only one short trip to nearby Cypress Island. We last detected Eagle No. 4 in early April near Maple Bay on the east side of Vancouver Island.

Eagle No. 5, an adult, remained in the SRSA for one month, making one overnight trip into the PIA, specifically to the County Line Ponds. However, it was fairly mobile within the study area between Marblemount and Rockport (8.3.2). On 24 February, we detected Eagle No. 5 toward Canada; the following day we pinpointed its location at Stave Lake, British Columbia. Its signal was not heard again. It seems likely that this adult was headed north for nesting.

Two days after capture, Eagle No. 6 flew up the Sauk River from the vicinity of Rockport. It inhabited the stretch of the Sauk between the Suiattle confluence and Darrington for 35 days. We detected it flying back down to the Skagit only once. It returned to its previous Sauk River location that same day. We last detected it, in its apparently favored spot, on 1 March.

Eagle No. 7 was located in the SRSA nearly as often as Eagle No. 5, and it even frequented some of the same locations (notably, the Illabot Bend-Rocky Creek and Illabot Slough areas). This eagle travelled extensively in the SRSA, and seemed to alternate between Diobsud Creek and other locations. It often roosted in the Diobsud area (Section 4.4.5). We found Eagle No. 7 several times at the County Line Ponds-Whistling Hole complex and often around Alma and Copper Creeks. It also seemed to prefer the stretch of the PIA near Sky Creek. On 13 March, this eagle flew to Goodell Creek, near Newhalem, and disappeared.

We were able to track Eagle No. 8 for ten days, during which time it was fairly sedentary, remaining along the Sauk River within four miles of the mouth (the place where it was captured). It utilized both sides of the river and roosted in that general area for at least eight nights. After 13 February, it left the study area.

Eagle No. 9, captured near Rockport, immediately flew at least three miles up the Sauk River. It returned to the Skagit River (seen at Washington Eddy) by the following afternoon. The following day it traveled more than 30 km to the mouth of Goodell Creek, in the uppermost part of the PIA. It visited the County Line Ponds-Whistling Hole area (one day) and was detected by radio and seen soaring in the vicinity of the City Light Aggregate Ponds (one day).

On the morning of 10 February, it was detected by radio along the Skagit River at Newhalem. Because a subsequent search of the study region west of and including the slope of the North Cascades did not find another signal from Eagle No. 9, we suspect it took a rapid easterly or northerly route out of the PIA.

Eagle No. 10 showed a preference for the lower Sauk River until 14 February (nine days after capture), when it moved to the lower SRSA. It frequented the Illabot Slough-Illabot Bend-Sutter Creek stretch of river, roosting at the Cascadian Farm communal roost (Section 4.4.5), until 22 February, when we detected it just upstream from Concrete near Van Horn. Presumably it was on its way to other parts of the study region.

Eagle No. 11 flew to the south fork of the Nooksack River within two days of being tagged on the north fork. We believe that it frequented the vicinity of the Skookum salmon hatchery. However, signal bounce was particularly bad in this canyon and may have acted to confuse our directional fixes. On 29 February (22 days after capture), we located this eagle at the end of a runway at Whidbey Island Naval Air Station. It remained in the vicinity of nearby Cranberry Lake for about four days. Afterwards it frequented Deception Pass. Because of her adult status, we suspected that this bird was beginning her breeding cycle in the Deception Pass area, where bald eagles have nested in recent years (Grubb et al., 1975). However, we realized that she was probably still "wintering" when we detected her among 14 bald eagles at Deception Pass on 16 March. We located Eagle No. 11 in the same area by airplane on 2 April, and on 13 April. A ground tracking crew determined that she remained overnight at Deception Island (Bud Anderson, pers. comm). One week later, her signal was still being emitted from the island. Closer investigation revealed that the transmitter was no longer attached to the eagle: it hung, still emitting signal, in the vegetation over which it had apparently been dropped. B. Anderson and B. Gausoin retrieved the transmitter on 10 May from a clump of salal (Gautheria shallon) one meter high. They also discovered that it was still attached to the main portion of a tail feather which had evidently been broken off near the base, no doubt by the eagle's powerful beak.

Eagle No. 12 remained in the Kendall-Maple Falls vicinity on the Nooksack River until it began a move northward at least eight (and maybe up to 26) days later. It was first detected, after leaving the Nooksack (after 20 February) on a tributary of the Fraser River, between Chilliwack and Rosedale, British Columbia. Sixteen days later, we found it on the Harrison River. One month later (25 April), Jack Hodges of the U.S. Fish and Wildlife Service (pers. comm.), detected Eagle No. 12 during a reconnaissance flight in a congregation of 85 bald eagles (which also included Eagle No. 17) at Knight Inlet, near the Klinaklini River. This area had a substantial spawn of smelt (probably Thaleichthys pacificus).

We tracked Eagle No. 13 for 16 days during February. It remained on the north fork of the Nooksack River, but wandered among various areas in that drainage. On 24 February, it flew north to Sumas, near the Canadian border but it returned to the Nooksack the following day. Four days later, it travelled into Canada. We last detected this eagle on the Vedder River, near its confluence with the Fraser, in British Columbia on the last day of the month.

Eagle No. 14 was among the most sedentary of the radio-tagged eagles in terms of regional movements. It stayed on the north fork of the Nooksack River during the 20-day period over which we tracked it, moving only between Kendall and Glacier. We were not able to locate this eagle after 5 March.

Radio-tagged Eagle No. 15, like No. 13, moved locally on the north fork of the Nooksack until, on 19 February, we detected it toward Lawrence, as if it was moving out toward the flats. However, it went back to the north fork of the river, and flew into Canada on 24 pr 25 February, specifically to a tributary of the Fraser River near Deroche, British Columbia. Four days later we found it at Long Island, in the middle of Harrison Lake. Reconnaissance flights five and eight days later revealed this eagle to still be on the Fraser River, where we pinpointed it at a large gravel bar island just downstream of Mission City and later at the confluence of the Vedder River-Fraser River.

We have a paucity of movement information for Eagle No. 16. (Three detections over a four-day period). This eagle remained in the vicinity of Welcome on the Nooksack River.

After two days on the north fork of the Nooksack, Eagle No. 17 seemed to move steadily down the river to Acme on the south fork. We detected it at Lyman on the Skagit River ten days later. This was the only one of the eagles trapped on the Nooksack and detected on the Skagit. It returned to Acme, and but three days later it was back on the Skagit, where it was found soaring along a ridge south of Hamilton. On 20 March, we last detected it at Clipper, again on the Nooksack's south fork. As mentioned, Eagle No. 17 was detected with No. 12 in a concentration of 85 bald eagles at Knight Inlet, near the Klinaklini River, on the west coast of British Columbia on 25 April.

Table 8b summarizes movements of ten kilometers or more made by radio-tagged eagles. It lists the specific distances travelled, the directions moved (expressed in compass degrees, true), and gives the time interval for each movement. Eagles No. 8, 14, and 16 are not included since their movements were of distances less than ten km. Eagles No. 1, 7 and 17 ranked highest, each having made more than five long-distance moves. The table is graphically displayed through the aid of compass roses in Figure 8b. It is apparent that, although each month's movements represent a different number of eagles (most occurring in February), the trend appears to assume randomness, but with a suggestion of northerly movement in February through April. Because of time, weather, and safety considerations, we made no tracking flights to the eastern slope of the North Cascades. Therefore, the compass roses are biased with respect to this sampling component.

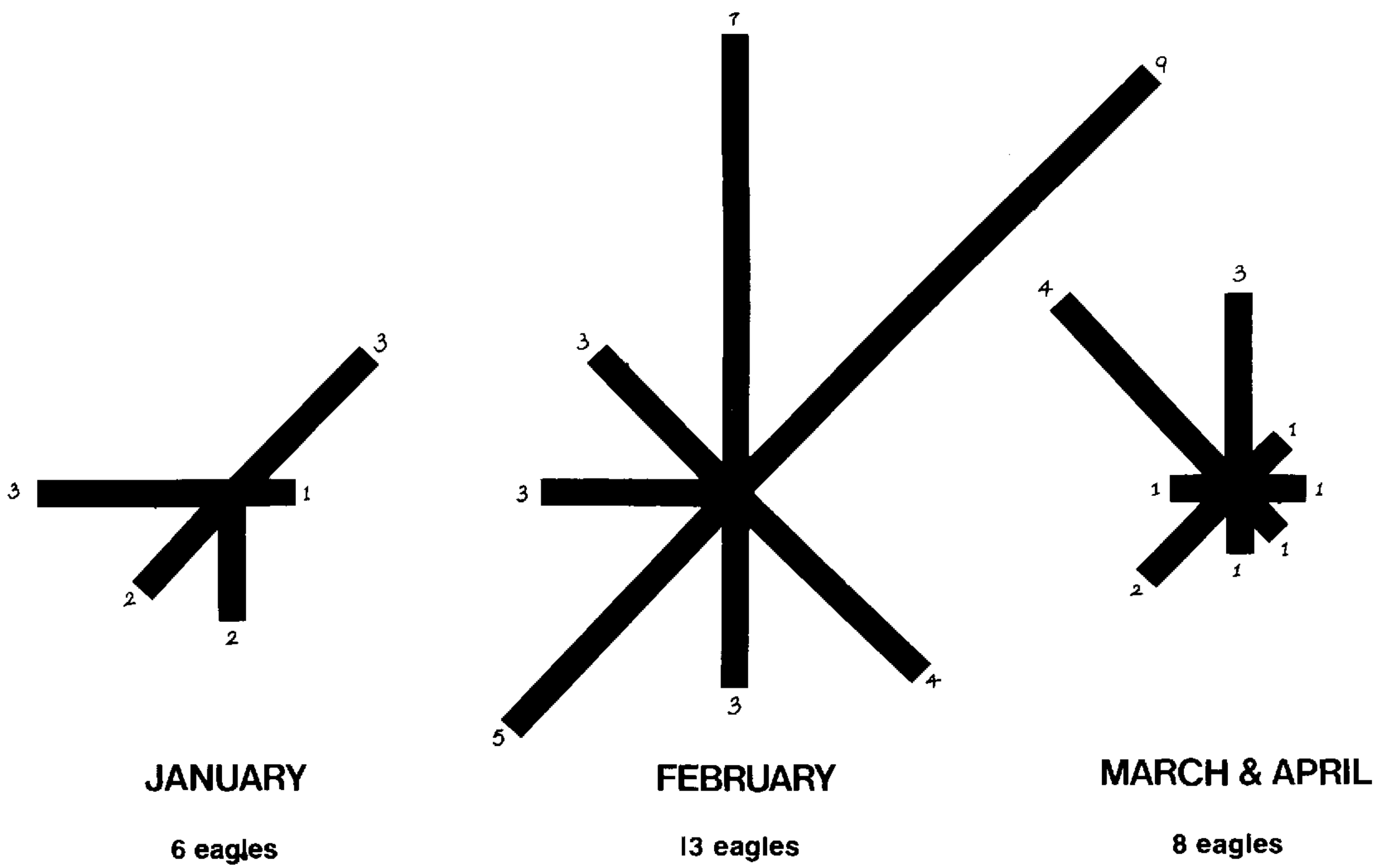
In summary of these data, eagles dispersed from the SRSA and Nooksack capture sites almost entirely to areas near water, as expected (see Section 8.3.3). While we did not perform detailed habitat surveys of the seven

Table 8.b. Radio-tagged eagle movements of ten or more km from points of previous detection. Sequence numbers refer to the complete list of movements that can be found in Appendix C. Directions are given in standard compass degrees (true).

Sequence No.	Time Interval in days	Distance[2/]	Direction[1]
1.06	24 (Jan 3-Jan 28)	82	247
1.08	3 (Jan 29-Feb 1)	13	026
1.14	3 (Feb 4-Feb 7)	18	155
1.22	4 (Feb 9-Feb 13)	40	304
1.24	1 (Feb 13-Feb 14)	16	010
1.30	4 (Feb 19-Feb 23)	18	002
1.31	1 (Feb 23-Feb 24)	18	114
1.33	5 (Feb 24-Feb 29)	14	284
1.37	5 (Mar 3-Mar 8)	80	034
1.38	12 (Mar 8-Mar 20)	75	222
2.03	40 (Jan 4-Feb 13)	104	192
2.06	5 (Feb 14-Feb 19	64	330
2.17	3 (Mar 5-Mar 8)	83	343
2.21	17 (Mar 8-Apr 2)	83	163
3.09	2 (Jan 17-Jan 19)	24	282
3.37	2 (Feb 2-Feb 4)	27	262
3.65	5 (Feb 25-Mar 1)	26	353
3.69	12 (Mar 8-Mar 20)	22	013
4.04	<1(Jan 17-Jan 17)	16	035
4.29	<1 (Jan 25-Jan 25)	48	250
4.30	1 (Jan 25-Jan 26)	10	080
4.33	2 (Jan 26-Jan28)	83	279
4.68	9 (Mar 24-Apr 2)	56	292
5.10	1 (Jan 24-Jan 25)	24	047
5.13	<1 (Jan 26-Jan 26)	24	218
5.75	3 (Feb 22-Feb 25)	106	325
6.07	1 (Jan 26-Jan 27)	24	174
6.28	1 (Feb 13-Feb 14)	24	348
6.30	<1 (Feb 14-Feb 14)	24	168
7.15	1 (Feb 3-Feb 4)	11	050
7.18	<1 (Feb 5-Feb 5)	11	230
7.24	2 (Feb 6-Feb 8)	13	050
7.40	<1 (Feb 13-Feb 13)	13	041
7.45	<1 (Feb 15-Feb 15)	16	223
7.49	<1 (Feb 16-Feb 16)	14	045
7.61	<1 (Feb 24-Feb 24)	11	225
7.64	1 (Feb 25-Feb 26)	19	033
7.89	1 (Mar 12-Mar 13)	11	042
9.07	<1 (Feb 7-Feb 7)	30	046
10.35	2 (Feb 20-Feb 22)	16	280
11.02	2 (Feb 7-Feb 9)	24	177
11.10	5 (Feb 24-Feb 29)	48	238
12.07	18 (Feb 19-Mar 8)	32	029
12.08	16 (Mar 8-Mar 24)	11	351
12.09	32 (Mar 24-Apr 25)	330	308
13.06	1 (Feb 23-Feb 24)	19	350
13.07	1 (Feb 24-Feb 25)	14	128
13.08	4 (Feb 25-Feb 29)	26	002
15.04	1 (Feb 18-Feb 19)	16	241
15.06	1 (Feb 24-Feb 25)	30	003
15.08	4 (Feb 25-Feb 29)	37	028
15.09	5 (Feb 29-Mar 5)	54	222
15.10	3 (Mar 5-Mar 8)	16	084
17.03	1 (Feb 18-Feb 19)	11	187
17.07	6 (Feb 24-Mar 1)	24	151
17.08	4 (Mar 1-Mar 5)	24	331
17.09	3 (Mar 5-Mar 8)	32	148
17.10	12 (Mar 8-Mar 20)	35	332
17.11	36 (Mar 20-Apr 25)	352	317

1/Direction is given in compass degrees.
2/Distance given in kilometers.

Figure 8b Directionality and Numbers of Times Eagles Moved 10 Kilometers or More



geographic units within the study region visited by eagles dispersing from the Skagit, we will focus, in Section 8.3.4, on the areas as potential absorption locations for eagles displaced by a Copper Creek dam. Our radio telemetry studies of movements of "Skagit" eagles within the larger study region refuted any notion that eagles on the Skagit remain sedentary in winter. Thus, the concept of carrying capacity is demonstrated to be a regional phenomenon.

8.3.2 Eagle Movements in The SRSA

The following section is a review of the movements of radio-tagged Eagles No. 4, 5, 7, 9, and 10 within the SRSA. These eagles were captured at the three different trap sites on the Skagit River (Table 8a); none were eagles trapped on the Nooksack. Except for Eagles No. 9 and 10, these local movements were made during the period immediately succeeding capture. In the cases of Nos. 9 and 10 , a brief trip up the Sauk River preceded a longer stay in the SRSA.

Eagle No. 4 remained near the Cascade-Skagit River confluence (specificially, Marblemount Slough) for the first two days of our tracking period. On the second night it roosted at the County Line Ponds and it remained in the vicinity of the Ponds for one week, when we observed it five times. However, this eagle did move during the day between the County Line Ponds and Sky Creek, Thornton Creek, Whistling Hole, and the Aggregate Ponds. Almost every night it roosted at the County Line Ponds. On 25 January, we tracked its migration down the Skagit River. Three days later it had begun its winter residence on Orcas Island (Section 8.3.1).

Eagle No. 5, captured at Rocky Creek, seemed to prefer this general area of the Skagit. It briefly left this stretch on two days (24 and 25 January), when we detected it at Bud Buller's farm and at the County Line Ponds (it roosted at the Ponds the second night). On 26 January it flew back down to the area it most frequented in the SRBENA, namely Rocky Creek, the Illabot Area (and everywhere in-between) and spots between Illabot Bend and Sutter Creek. A favored roost was Cascadian Farm (Section 4.4.5). Thirty-three days after being captured, this eagle entered Canada, and was last detected at Stave Lake (Section 8.3.1).

We have detailed information on radio-tagged Eagle No. 7 because of its proximity to our headquarters. It remained in the SRSA over a 44-day period, and during that time visited numerous places. In particular, it was often found in the vicinity of Diobsud Creek, a spot where it had been detected early in the surveillance period. As our tracking progressed, the eagle spent less time there. After visiting the Illabot-Rocky Creek area, Washington Eddy, and the Cascade River, it moved upstream. It never stayed in one place very long. After moving from Newhalem to Sky Creek to Thornton Creek to Alma Creek, Eagle No. 7 made its way back to Diobsud Creek on 2 March. It quickly returned upstream to Sky, Copper, and Alma Creeks, flew nearly up to Newhalem one day, and was last detected at Alma Creek on 14 March. As can be seen from this summary and Figure 8a, Eagle No. 7 was essentially a resident of the PIA for about three weeks. It was detected near creek mouths, and was not apparently attracted to the County Line Ponds. Instead, it probably utilized small runs of coho salmon in the Skagit tributaries.

Like Eagle No. 7, No. 9 moved upstream from the place where it was captured in the SRSA. This eagle seemed to take a rapid route up-river, utilizing Washington Eddy for two days, but then flying as far as Goodell Creek (near Newhalem). After remaining there overnight, this eagle frequented the Whistling Hole area and the Skagit mainstem between Newhalem and Thornton Creek. No doubt it, too, discovered the coho salmon resource in the upper PIA. We saw Eagle No. 9 for the final time on 10 February (see Appendix C) while it perched in snags across the river from homes at Newhalem. See Section 8.3.1 for possible explanations of its disappearance.

We detected Eagle No. 10 on 16 days during February. It had an affinity for the Sauk River (Figure 8a), but finally moved up the Skagit River on 14 February. It lingered there, particularly in the Illabot Bend-Sutter Creek area, roosting at least several times at the Cascadian Farm communal site (Section 4.4.5). Our last detection of Eagle No. 10 was just upstream from Van Horn on the lower Skagit River (Section) 8.3.1).

A sixth eagle, (No. 3) utilized Illabot Slough and the surrounding area for three days during its trip down the Skagit from Marblemount to Concrete (Section 8.3.1). We detected it at a night roost (possibly a communal one) at Illabot Slough on 15 January (Section 4.4.5).

In summary, of eagle movements within the SRSA, as they apply to a Copper Creek dam, is the fact that four eagles tagged in the lower stretch visited or remained in the proposed impoundment area, presumably to exploit the concentration of coho salmon in the County Line Ponds-Whistling Hole complex and carcasses probably distributed in smaller numbers among other PIA tributaries.

8.3.3 Eagle Departures and Origins

Two types of departures are considered here. First, the point at which an eagle left the SRSA and secondly, its implied direction of travel when last detected by us in the study region.

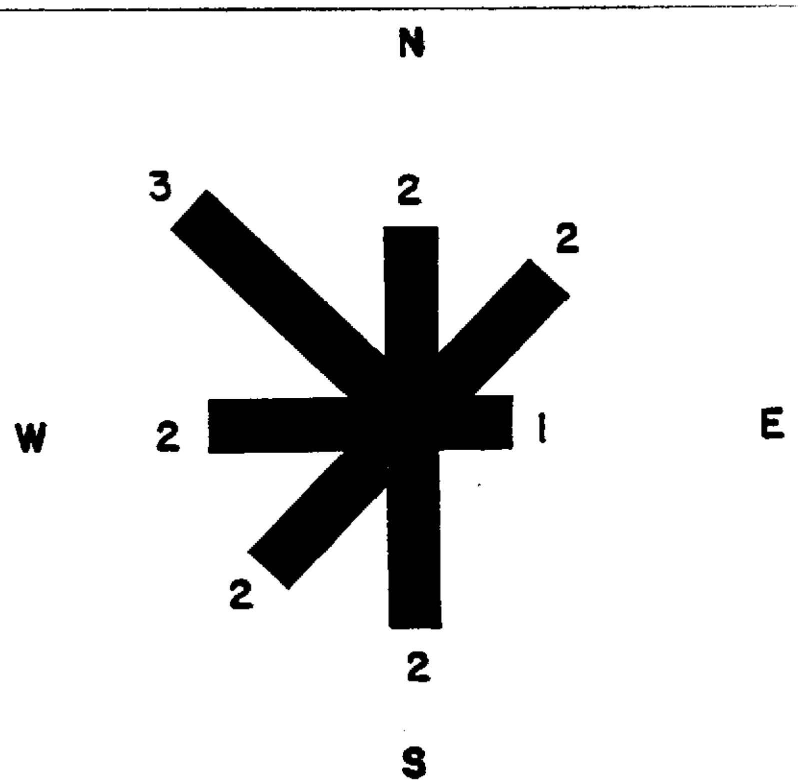
Departures from the SRSA are graphically represented in Figure 8a. Radio-tagged Eagles No. 1 and 2 left virtually immediately and were discovered at substantial distances from the capture site (Section 8.3.1). We assume they followed westerly and southerly headings, respectively; however, the specific routes they took cannot be known. Eagles No. 3 and 4 apparently followed the Skagit River downstream toward the locations they frequented during the middle part of the study period (Sedro Woolley-Lyman, and Orcas Island). A presumably direct departure in late-February from the SRSA was made by Eagle No. 5, who, within two days of leaving, went to Stave Lake, Canada, where we last detected it. Eagles No. 6 and 8, after staying in the SRSA two and three days, respectively, flew up the Sauk River, each returning to the Skagit for one day or less, and then moving again up the Sauk, where each was last detected (No. 6 in early March, No. 8 in mid-February). Eagle No. 7 remained in the SRSA for 42 days and was last detected on 14 March at Alma Creek. We have no clue to the route it took when it left the area. Finally, Eagle No. 9 was last located at Newhalem, in the uppermost part of the SRSA, on 10 February. Its departure orientation is unknown.

The data suggest that eagle departure from the SRSA was not entirely influenced by the limited chum salmon availability that began to occur early in the study period. Eagles left the SRSA in early January, but others remained through most of February, with the last of our radio-tagged eagles departing from the study area on 14 March. As has been discussed in other sections of this report (4.0 and 5.0), this year's results from the eagle census and the examination of feeding areas show that numerous birds fed on coho, rather than chum salmon, this winter.

Figure 8c shows directionality and frequency of the last detected long-distance movements made by the radio-tagged eagles. Our final reconnaissance flight on 2 April revealed the locations of only two of the telemetered birds, No. 4 (on Vancouver Island) and No. 11 (at Deception Pass). If we assume all transmitters still functioned at least into May (due to an expected battery life of five months), the data indicate that most of the telemetered birds departed the study region by early April. It is possible that Eagle No. 11 remained in the San Juan Islands, even at Deception Pass, after its transmitter was broken off. Also, we did not substantiate the location of Bird No. 4 after 2 April.

Figure 8c Direction of Eagle Movements (10 Kilometers or More) Preceding Last Detection

(Example: Three eagles travelled in a northwesterly direction before their last detection.)



Our evidence, both visual and that based on radio telemetry, suggests that bald eagles wintering on the Skagit River originated this year at two major geographic regions. Early in the study period we began to occasionally see bald eagles (the first six on 11 December) flying in a rather direct style from Gorge Canyon toward the Skagit River Valley (PIA). The eventual destination of these birds was never ascertained, but their linear flights, in contrast to aimless soaring, implied they were coming from points east of the study area, and perhaps from north of the Skagit headwaters. It is possible that they were eagles from the inland lakes and rivers of British Columbia, or that they derived from other non-coastal areas. Perhaps further supporting this hypothesis is the fact that two of our radio-tagged eagles were last detected on the Fraser River (British Columbia), which naturally winds east and north to other rivers and large inland lakes. Not surprisingly, three color-marked bald eagles released on the Skagit in previous years by Servheen and English (1979) were sighted at two such lakes.

Data on other telemetered eagles that went to the Fraser River this winter suggest that this river may also orient migrating (or wintering) eagles in a coastal direction. After its stay on the Fraser, Eagle No. 1 returned south to the mouth of the Nooksack River (Figure 8a), but Eagle No. 12 was detected much farther north and west (330 km from its previous location) at Knight Inlet. In addition, another eagle (No. 17), appeared at Knight Inlet before. As a result, one might think such birds had a predisposition for flying north along the British Columbia coastline. Eagle No. 4 was detected on the east coast of Vancouver Island nine days after it left its favored Orcas Island. This information, in combination with the facts discussed above, serves as a foundation for the hypothesis that some of the bald eagles that utilized the Skagit (and Nooksack) River during the 1979-80 winter originated in the coastal areas of British Columbia, and possibly came from places as far north as Alaska. However, coastal transects flown by J. Hodges (FWS) failed to detect any of our radio-tagged eagles north of Knight Inlet at the Queen Charlotte Strait.

8.3.4 Absorption Areas for Displaced Eagles

Our radio tracking data indicate that bald eagles wintering in the study region are highly mobile, not limited to specific "wintering territories," and that they are resourceful as individuals, capable of adapting to a variety of situations. The entire study region, outside the SRSA, offers eagles suitable winter habitat that can be divided into seven large geographic units: (1) lower Skagit River, (2) Sauk Suiattle Rivers, (3) Nooksack River, (4) San Juan Gulf Islands, (5) Skagit-Samish-Nooksack flats, (6) Fraser River, and the (7) Snoqualmie River. All of these were used to some extent by the radio-tagged eagles and are discussed below in relation to their capacity to provide habitat for wintering bald eagles. A pertinent question we cannot answer in this study is whether the habitat in any or all of these seven units contained sufficient food resources to accept additional eagles; namely those displaced by a Copper Creek dam.

The Skagit River from Rockport to Mount Vernon (lower Skagit River) functions similarly to the upper part of the river in terms of eagle habitat. All Skagit salmon species spawn along this stretch and its tributaries, but perhaps due to stream-bed dynamics, not to the extent that they do in the SRSA. In addition, the lower river has a more gentle gradient and is bordered by more agricultural and pastoral lands. As part of this year's mid-winter bald eagle survey, a census on 16 January by S. Ralph (U.S. Forest Service) revealed the occurrence of more than 90 eagles in 44 lower river miles. However, this number may represent a larger-than-normal population for this part of the river. Eagles may have moved down from the upper Skagit, as did radio-tagged Eagle No. 3, possibly due to a poor supply of salmon carcasses in the SRSA.

A combined count of nearly 75 bald eagles on portions of the Sauk and Suiattle Rivers on 6 and 13 January 1980 suggests that this area can support a sizable number of the birds during winter. The Sauk provides good spawning habitat for chinook, coho, pink, and chum salmon. However, spawning above the lower part of the river has been hindered by extensive logging activity in the area and is further affected by glacial flows in the Suiattle River system. According to the WDF, the Sauk is far less stable than is the Skagit for spawning salmon. This area seemed to be a stop-over location for at least three of the telemetered eagles (Birds Nos. 8, 9, and 10) and attracted Eagle No. 6, which spent more than a month there (Section 8.3.1).

The Nooksack River normally provides winter habitat for about 100 bald eagles. This season the total came to 283 on 13 January, almost three times the number seen there in past years. The primary food supply for bald eagles on the Nooksack consists of dead salmon, as on the Skagit. However, due to the later chum spawns, salmon carcasses were not flushed from the area during the December flood. This allowed for a substantial Nooksack food resource to be available when food was unavailable on the neighboring Skagit. Even so, only one of ten eagles radio-tagged this year in the SRSA moved to the Nooksack River (Section 8.3.1). We have no explanation as to why the radioed eagles were not drawn to the Nooksack, unless the carrying capacity there was saturated.

The San Juan Islands comprise one of the largest habitat units within the study region suitable for wintering bald eagles. Almost 300 eagles were counted there this winter. C. Nash (pers. comm.) believes 30-50 percent of the wintering eagles to be resident there. He described the food supply in the San Juan Islands for eagles as a veritable "smorgasbord," ranging from carrion sheep to rabbits to fish to birds. Although salmon spawning does occur locally on some of the islands (Williams et al 1975), the other resources are surely in better supply. Nash explained that bald eagles on San Juan Island regularly scavenge road-killed rabbits, dead sheep and afterbirth, and carrion fish, but also actively prey on the rabbits, live herring, sick or injured birds, and small rodents flushed from fields or killed by flooding or mowing. Bald eagles in this area also parasitize other raptors, especially red-tailed hawks (Buteo jamaicensis), by stealing prey that has already been caught. In general, it seems that eagles wintering on the San Juans enjoy a copious food base. and it is no surprise that five of the radio-tagged birds moved there. The Gulf Islands, the Canadian counterpart of the San Juans, serve similarly as good habitat for wintering eagles.

Three lower river valleys (Skagit-Samish-Noosack flats), encompassing the Skagit River below Mount Vernon, the Samish River west of Highway 11, and the Nooksack River below Lynden, have been grouped because of their similar structure and presumed food offerings. Wintering eagles are known to occur in all three places (radio-tagged eagles used the Skagit and Nooksack flats), but the bulk of the data come from the Samish area, where B. Anderson and others have studied wintering raptors during the past four years (Anderson and DeBruyn 1979; Anderson et al 1978; Anderson et al 1977). Bald eagles in this study area ate mainly waterfowl, and in fact had a strong tendency to actively hunt ducks. Of 28 observations of eagles with prey (not known to be carrion), 24 involved the eating of a duck. During three years of study, Anderson and his co-workers witnessed numerous attempts by eagles at catching ducks, both those resting in flocks on the bay and solitary ones in shallower water. Two successful duck kills by bald eagles were described: (1) a scaup (*Aythya* spp.) was caught in water for shallow to escape and (2) a bufflehead was captured in flight. During freezing weather one year, bald eagles killed three domestic geese, two ducks and a turkey at one residence (Anderson and DeBruyn 1979). Bald eagles were often observed to appropriate prey killed by other raptors, notably by peregrine falcons (*Falco peregrinus*), rough-legged hawks (*Buteo regalis*), red-tailed hawks, and other bald eagles. Eagles wintering on these flats are fairly territorial, but the researchers regularly saw adults perched side-by-side, leading them to suspect that locally nesting pairs may comprise part of the winter population.

The Fraser River, in southern British Columbia, supports hundreds of bald eagles during winter (W. Campbell, pers. comm.). Their major food source is chum salmon, but eagles in the general area have also been known to occasionally eat waterfowl and gulls. In particular, the area centering around the Harrison River has historically provided winter habitats for up to 300 eagles. Radio-tagged eagles (12 and 15) were found at this location in early March. Other tributaries of the Fraser also support wintering eagles (e.g., 50-100 at one slough; 200 at another), as does the mainstem of the river. We do not know how many eagles wintered in the entire Fraser River drainage this year.

The Snoqualmie River is discussed here because one of our radio-tagged eagles (No. 2) was found in this drainage in early February. Chinook, pink, chum, and coho salmon travel up the Snoqualmie and spawn in some segments. Chinooks, pinks, and chums particularly use the stretch from two to three miles downstream of Fall City to the confluence of the Raging River. Eagle No. 2 was found in this area. Cohos utilize the tributaries, as in other major Pacific Northwest watersheds.

We have no information on the number of bald eagles that used the Snoqualmie River this winter, but it seems probable that the salmon runs did provide food for some eagles. However, normal flooding caused by heavy snowmelt and a significant amount of siltation from highway construction probably have a deleterious effect on salmon abundance here.

In addition to the areas just discussed, there is a chance that eagles from the Skagit may travel to other locations even farther away than we detected. The Olympic Peninsula, other rivers in the Puget Sound basin, inland lakes (especially those in southern British Columbia) and rivers, Vancouver Island, and the coastal waters of the Strait of Georgia may all offer habitat to the eagles wandering from the Skagit.

9.0 IMPACTS AND MITIGATION

9.1 Impacts

In the proposed impoundment area, habitat supporting approximately 40 bald eagles in the late winter of 1979-80 would be lost to inundation if Copper Creek dam is constructed. The primary food source for eagles in the PIA this winter was coho salmon at the County Line Ponds-Whistling Hole complex. Chum carcass availability was extremely low, and it is unknown whether greater, equal, or lower numbers would occupy the PIA in years of average to high chum salmon availability. However, the importance of the PIA to the welfare of eagles may be most critical in years of low chum availability.

Spawning sites supporting a yearly average of 4,850 chum and 460 coho salmon would be eliminated by a Copper Creek dam. During this winter, chum salmon carcasses were so few in available numbers that their utilization by eagles in the proposed impoundment area was of negligible proportion. Coho salmon availability, on the other hand, generated a concentration of eagles in the PIA which exceeded that of any other in the SRSA during the last quarter of the study period (Figure 4b). Coho salmon are available to eagles in the PIA primarily in the County Line Ponds-Whistling Hole complex (RM 89-90). Movements data indicated that some eagles moved from the lower stretch of the SRSA into the PIA to exploit coho salmon there. The effects of a dam on food availability downstream of the damsite were addressed by Bierly and Associates (1980) who found a substantial drift of chum carcasses to areas outside the PIA; however, the proportions of these carcasses ultimately becoming available to eagles remain unknown.

A 2.5 mile section of habitat in the center of the PIA, supporting spawning coho salmon and chum salmon (in good years) would be lost to inundation. This stretch includes the County Line Ponds-Whistling Hole complex which itself provided for the highest concentration of eagles in the PIA and even the entire SRSA during the seventh week of study. Additional habitat, supporting spawning chum salmon in good years, occurs near the City Light Aggregate Ponds area (RM 90.5) and elsewhere in the PIA.

The proposed dam will inundate over 50 Class A deciduous perch trees or stands and over 20 gravel bars, the latter accumulating unknown numbers of chum salmon carcasses in good chum years. No communal roost sites were found in the PIA or on the slopes above it. Movement studies showed that a variety of roost locations in the PIA were selected on an apparently random basis.

Increased human activity associated with construction and operation of a Copper Creek dam will probably not influence the overall distribution of eagles in the SRSA. Eagles that might otherwise utilize the river from one to three miles below the damsite may temporarily avoid this area during construction.

Disturbance to bald eagles associated with increased recreational traffic to and on the reservoir will not significantly alter bald eagle numbers in the SRSA.

Our data indicate that present levels of public use do not appear to affect eagle distribution or abundance in the SRSA. We believe, however, that in winters of stress conditions (e.g. 1979-80), eagles may be adversely impacted by public users who flush feeding eagles from gravel bars. In years of moderate to high chum carcass availability, flushing eagles from bars, as would occur with present levels of public use, would not adversely influence the welfare of eagles.

9.2 Mitigation and Management

If a dam at Copper Creek is constructed, the following steps may ease the overall impact on the wintering bald eagles of the Skagit River.

If during the building of a dam, chum salmon availability during the winter lowers to a point comparable to levels observed in 1979-80, dam related disturbance could compound survival problems for already stressed eagles. In such a case, a temporary artificial feeding program for the lower SRSA using carcasses obtained from the salmon hatchery at Marblemount would be in order. Artificial feeding under any other circumstance or for extended periods is not recommended. Assessments of chum salmon carcass availability during dam construction should be made in late December and January at several test bars including the large one at Washington Eddy. Partial insight into projected salmon occurrence may be obtained in late November from the Washington Department of Fisheries to be applied in planning an artificial feeding program. Hatchery personnel require advance notice in providing salmon.

Skagit "old-timers" insist that historic numbers of chum salmon on the Skagit greatly exceeded contemporary runs. Moreover, low chum spawning numbers in odd years compounded by flooding occasionally produce stress conditions for wintering eagles. Because chum salmon availability on the Skagit is the central factor which allows for a full complement of eagles on the river in winter, research and management toward increasing chum salmon runs from Bacon Creek to Rockport should include the following items:

(a) Water regulation procedures and a Copper Creek dam should seek to maximize chum salmon spawning success and carcass deposition on gravel bars. Research toward understanding optimum flows should be immediately initiated.

(b) Lower chum spawns in odd years may result from unfavorable competition with pink salmon in the Skagit estuary. Research to determine this relationship with emphasis on corrective management should be conducted.

(c) A program for the enhancement of natural chum spawning from Bacon Creek to Rockport should be carried out during low chum years. Research findings described in items (a) and (b) should be applied here.

(d) It should be recognized that in years when low chum salmon spawning numbers on the Skagit can be predicted (by parent year analysis or by escapement values), that there is no surplus of chum to be harvested either in Puget Sound, the mouth of the Skagit, or for artificial spawning if eggs are to be taken elsewhere. Hatchery fish are excluded from these considerations.

County Line Ponds, in the proposed impoundment area, provided food (coho salmon) to a number of wintering eagles throughout the winter of 1979-80 despite the flooding which eliminated much of the total food elsewhere in the SRSA. These ponds are actually artificial "borrow pits" which provided soil and gravel for construction purposes. The ponds are unique in the SRSA in that they communicate with the river and provide abundant spawning opportunities for salmon. In contrast, the "Aggregate Ponds," a mile upstream lack functional waterways to the river and thus hold no spawning salmon. This situation, however, may be complicated by possible differences in ground-water percolation rates between the two sites. As a mitigation measure, the technology of construction and maintenance of similar borrow pit ponds as salmon spawning sites incidental with construction activities should be thoroughly researched. Moreover, a comparable series of ponds suitable for salmon spawning and consistent with the ultimate availability of carcasses to eagles even in flood years should be created and maintained below the dam site.

In summary of these mitigation and management proposals, we reemphasize the core importance of chum salmon spawning runs in the SRSA to the welfare of eagles. Coho salmon, while supporting far less eagles on the Skagit than do chums in an average year, nevertheless act as an important buffer against eagle abandonment of the SRSA during stress years. The ecology of both these salmon species, as it relates to their occurrence on the Skagit must be fully understood in order to ensure that enlightened conservation and management practices may provide a suitable environment for eagles in years to come.

10.0 RECOMMENDATIONS FOR FURTHER RESEARCH

In Section 9.2, we suggest future research efforts intended to aid the Skagit River fishery on behalf of eagles. The present section outlines further bald eagle research necessary to make a full evaluation of the impacts of a Copper Creek dam on this species.

Because of the very limited availability of chum salmon to eagles in the SRSA during the 1979-80 winter, the distribution, abundance, and behavior of eagles, particularly in the PIA, could not be fully explored. Neither could these things have been fully understood in a single year of high chum availability. At this point, we do not know (1) if higher numbers of chum in the PIA would attract larger numbers of eagles than observed this winter, or (2) if lower numbers of eagles would utilize the PIA because of abundant food supplies downstream. While eagle habitat in the PIA, as concerns the eagles' relationship to coho salmon, has been evaluated in the present study, we do not understand such a relationship as it would apply under a regime of chum abundance in the PIA. Obviously, these matters pertain cogently to estimates projections of the numbers of eagles supported by habitat that would be inundated by the proposed Copper Creek dam.

We therefore suggest that the term of research for the assessment of impacts on bald eagles be extended through the winter of 1980-81. The most important aspects of such a continuation might be as follows:

<u>Eagle Distribution</u>. A bald eagle census in the SRSA, identical to that performed in 1979-80 should be conducted. Reliability of projection estimates should be verified by boat censuses in the PIA every two weeks.

<u>Feeding Ecology</u>. Spatial distribution, availability, and consumption of salmon carcasses should be surveyed by boat over the entire SRSA in daylight hours every two weeks.

<u>Regional Carrying Capacity</u>. Both eagle and fish distributions should be sampled by boat where feasible once per month on the lower Skagit, Nooksack, Sauk, and selected locations on the Fraser River. Field investigations of eagles and their food supplies should be undertaken in the San Juan Islands during the winter. All of these studies should focus on whether or not apparent habitat in these locations could accept eagles displaced from the PIA. Censusing on the Sauk and Lower Skagit should duplicate those performed by Forest Service workers in 1979-80 to determine whether numbers reported in 1979-80 were "normal" or inflated due to low food availability in the SRSA.

<u>Movements</u>. Continued radio-tagging studies could compare the movements of eagles within the SRSA in a year of greater chum availability. If coordinated with ground studies connected with regional aspects of carrying capacity, radio-tracking could provide further insight into the potential of other areas to absorb eagles displaced by a dam.

Also, movements studies will yield more information on the threatened or endangered status of eagles utilizing the SRSA and the study region as provided by the Endangered Species Act of 1973.

Downstream Effects. Information on projected stream flow and gravel bar dynamics below the proposed dam should be provided to assess impacts on salmon spawning success and accumulation of accessible carcasses.

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APPENDIX A

To be included in the final report

APPENDIX B

Code sheets and forms used in field data collection.

<u>Exhibit A</u> Data codes used during eagle census.

<u>Exhibit B</u> Eagle census data form (each row records a single eagle and provides information for one Fortran computer card)

<u>Exhibit C</u> Area and location codes (columns 28-32, Exhibit B)

<u>Exhibit D</u> Data codes for weather and public use recorded during censuses.

<u>Exhibit E</u> Data sheet for salmon carcass counts.

<u>Exhibit F</u> The telemetry tracking data form.

CODES

BALD EAGLES

IDENTIFICATION NUMBER 3 (2)

SEE NOTES (59)
0 no data
1 more information in itinerary
2 may be duplicate of eagle already recorded

NUMBER OF EAGLES IN TREE (42)
0-8 actual no. in tree
9 nine or more

OBSERVATION NUMBER (7-12)

DATE (13-18)

TIME (19-22)

DATA TYPE (23)
1 census
2 incidental
3-9 other

WEATHER ENTRY NO. (24-27)

AREA* (28)

LOCATION* (29-32)

SIDE OF RIVER (33)
0 no data
1 left } as observer
2 right } faces downstream
3 island
4 river channel

AGE (34)
0 no data
1 1-yr-old
2 2-yr-old
3 3-yr-old
4 4-yr-old
5 5-yr-old
6 ADULT (5 or >5-yr-old)
7 IMMATURE (age unknown)

CROP CONDITION (35)
0 no data
1 empty
2 part full
3 full

* SEE AREA and LOCATION CODE SHEET

ACTIVITY (36-37) OR RESPONSE (45-46, 49-50)
00 no data
01 standing
02 standing in water
03 standing on gravel bar
04 standing on river bank
05 standing, preening
06 standing, wings drooped
07 standing, bathing
08 walking
09 other (see notes)

10 perched
11 perched, preening
12 perched, wings drooped
13 perched, vocalizing
14 perched, sleeping
15 perched, watching fish
16 perched, watching river
17 perched, watching observer
18 perched, watching other eagles
19 perched on driftwood

20 feeding
21 feeding in water
22 feeding on gravel bar
23 feeding on river bank
24 feeding on driftwood
25 feeding in tree
26 dragging fish to shore
27 actively hunting
28
29 other (see notes)

30 flying
31 flying low along river (<10 m)
32 flying along river (>10 m)
33 flying to river
34 flying away from river
35 flying among trees
36 flying, carrying food
37 flying, p → fb
38 flying, fb → p
39 flying, p → p

40 flying, fb → fb
41 flying into area along river
42 flying away fr. area along river
43 flying, vocalizing
44
45
46
47
48
49 other (see notes)

50 soaring
51 soaring low over river
52 soaring in valley
53 soaring along ridge

PERCH TYPE (38)
0 no data
1 deciduous, class A
2 deciduous, class B
3 deciduous, class C
4 coniferous, class A
5 coniferous, class B
6 dead snag
7 live conifer w/snag top
8 branch overhanging water
9 other (see activity)

PERCH HEIGHT (in tree) (39)
0 no data
1 bottom 1/3
2 middle 1/3
3 upper 1/3
4 top
5 high & away from river

PERCH DISTANCE* TO WATER (40)
0 no data
1 0-25 m
2 25-50 m
3 50-100 m
4 100-200 m
5 200-500 m
6 >500 m

NO. EAGLES WITHIN 200 m (41)
0 no data
1 alone
2 2-5
3 6-10
4 11-25
5 26-50
6 51-90
7 >90

FOR "FLUSHED", AND "MODE" CODES SEE PUBLIC USE SHEET.

* ALSO SERVES AS CODE FOR DISTANCE FROM OBS. & PUB. USER.

EXHIBIT A

EXHIBIT B

BALD EAGLE DATA

Column	Field	Group
7	OBSERVATION NUMBER	
9		
11		
13	DATE	
15		
17		
19	TIME	
21		
23	DATA TYPE	
25	WEATHER ENTRY NUMBER	
27		
	AREA	
29	LOCATION	
31		
33	SIDE OF RIVER	
	AGE	
35	CROP	
37	ACTIVITY	
	TYPE	PERCH
39	HEIGHT	PERCH
	DIST. to WATER	PERCH
41	NO. EAGLES WITHIN 200 m.	
	FLUSHED	RESPONSE TO OBSERVER
43	OBS MODE	RESPONSE TO OBSERVER
	DISTANCE	RESPONSE TO OBSERVER
45	RESPONSE	RESPONSE TO OBSERVER
47	FLUSHED	RESPONSE TO PUBLIC USER
	DISTANCE	RESPONSE TO PUBLIC USER
49	RESPONSE	RESPONSE TO PUBLIC USER
51	PUBLIC USE NUMBER	
53		
55	PUBLIC USE NUMBER	
57		
59	SEE NOTES	
61	OBSERVER (S)	
	NO. EAGLES in SAME TRE	

EXHIBIT C

AREA AND LOCATION CODES

On rivers, use standard 0.5 mile river segments

AREA

1	Skagit Mainstem
2	Skagit tributaries
3	Sauk Mainstem
4	Sauk Tributaries
5	Skagit downstream of McLeod Slough
6	Suiattle Mainstem
7	
8	
9	

LOCATION

20.0 . . .	West Illabot Creek
21.0 . . .	Illabot Slough and fields
22.0 . . .	East Illabot Creek
23.0 . . .	surrounding fields
24.0 . . .	Illabot Ponds
25.0 . . .	Illabot Creek upstream
30.0 . . .	Barnaby Slough
31.0 . . .	Harrison Ponds
40.0 . . .	Roost Site (RM 71-73)
50.0 . . .	Lower Cascade River (includes Bud Buller's)
51.0 . . .	Jordan Creek
52.0 . . .	Cascade River Bridge
53.0 . . .	Diobsud Creek, upstream
53.1 . . .	Diobsub Creek, drive up
54.0 . . .	Bacon Creek, upstream
54.1 . . .	BAcon Creek, drive up
55.0 . . .	County Line Ponds
56.0 . . .	Aggregate Ponds
57.0 . . .	Goodell Creek, upstream

9999 Grid location is specified in itinerary.

CODES

WEATHER

IDENTIFICATION NUMBER 1 (7)

ENTRY NUMBER (9-12)
DATE (13-18)
TIME (19-22)
AREA (23)
LOCATION (24-27)

STATE OF WEATHER (28-29)
- 0 no data
- 1 sunny
- 2 clear
- 3 low fog along river, clear above or nearby
- 4 fog (low stratus)
- 5 low overcast
- 6 high thin overcast
- 7 high dense overcast
- 8 drizzle or mist
- 9 raining
- 10 sleet or freezing rain
- 11 hail
- 12 snowing
- 13 clearing

VISIBILITY (30)
- 0 no data
- 1 0 - 25 m
- 2 26 - 50 m
- 3 51 - 100 m
- 4 101 - 200 m
- 5 201 - 500 m
- 6 > 500 m

% CLOUD COVER (31)
- 0 no data
- 1 0-5
- 2 5-25
- 3 25-50
- 4 50-75
- 5 75-95
- 6 95-100

TEMPERATURE (32-33) (in degrees Farenheit)

WIND DIRECTION (34-35)
- 00 No wind
- 09 east (code directly)
- 18 south (code directly)
- 27 west (code directly)
- 36 north (code directly)
- 99 no data

WIND SPEED (36-37)
- 00 No wind
- 01 etc. (code directly)
- 99 no data

RIVER LEVEL:

maximum daily gauge height (39-42) (in feet)

minimum daily gauge height (45-47) (in feet)

mean daily gauge height (49-52) (in feet)

actual value beyond range of gauge (54)
- 0 data accurate
- 1 greater than maximum or less than minimum

PUBLIC USE

IDENTIFICATION NUMBER 2 (7)

ENTRY NUMBER (8-11)
DATE (12-17)
TIME (18-21)
DATA TYPE (22)
WEATHER ENTRY NO. (23-26)
AREA (27)
LOCATION (28-31)

SIDE OF RIVER (32)
- 0 no data
- 1 left (as observer faces downstream)
- 2 right (as observer faces downstream)
- 3 island
- 4 river channel

POSITION (33)
- 0 no data
- 1 river channel
- 2 river channel along shore
- 3 gravel bar
- 4 river bank
- 5 road pull-off, open view
- 6 road pull-off, veg. buffer
- 7 away from river (>200 m)
- 8 air

MODE (34-35)
- 0 no data
- 1 on foot, open view
- 2 on foot, veg. buffer
- 3 drift boat, private raft, canoe, kayak
- 4 drift boat, commercial raft, canoe, kayak
- 5 motor boat, drifting or stopped
- 6 motor boat, using motor
- 7 road vehicle, moving
- 8 road vehicle, stopped, people inside
- 9 road vehicle, stopped, people outside
- 10 airplane, helicopter
- 11 auditory (gunshot, explosion)
- 12 logging operation
- 13 construction

USER TYPE (36)
- 0 no data
- 1 fisherman
- 2 birdwatcher
- 3 photographer
- 4 researcher
- 5 agency worker other than 4
- 6 hunter
- 7 other

NUMBER IN PARTY (37)
- 0 no data
- 1 alone
- 2 2-5
- 3 6-10
- 4 11-25
- 5 26-50
- 6 51-90
- 7 > 90

EAGLE PRESENT? (38)
EAGLE FLUSHED? (39)
- 0 no data
- 1 undetermined
- 2 no
- 3 yes
- 4 probably no
- 5 propably yes

WEATHER

WEATHER ENTRY NUMBER		
DATE		
TIME		
AREA		
LOCATION		
STATE OF WEATHER		
VISIBILITY		
CLOUD COVER (%)		
TEMPERATURE (°F)		
DIRECTION	WIND	
SPEED (MPH)		

EXHIBIT D-2

EXHIBIT D-3

PUBLIC USE

PUBLIC USE ENTRY NUMBER	DATE	TIME	DATA TYPE	WEATHER ENTRY NUMBER	AREA	LOCATION	SIDE OF RIVER	POSITION	MODE	USER TYPE	NO. IN PARTY	EAGLES PRESENT?	EAGLES FLUSHED?

EXHIBIT E

SALMON CARCASS AVAILABILITY DATA SHEET

DATE ____________ LOCATION ____________________ LENGTH __________ WIDTH __________

TIME: start __________ finish __________ OBSERVER(S) ____________________

WEATHER ____________________ RIVER LEVEL ____________________

SALMON SPECIES ____________________ MALES __________ FEMALES __________

% GONE	ACCESSIBLE: ON SHORE	ACCESSIBLE: EXPOSED	ACCESSIBLE: SUBMERGED	INACCESSIBLE: SUBMERGED
0				
EYES				
10				
50				
90				
100				
BONES ONLY				

SALMON SPECIES ____________________ MALES __________ FEMALES __________

% GONE	ACCESSIBLE: ON SHORE	ACCESSIBLE: EXPOSED	ACCESSIBLE: SUBMERGED	INACCESSIBLE: SUBMERGED
0				
EYES				
10				
50				
90				
100				
BONES ONLY				

EAGLE TRACKING DATA

BIRD NO.______ FREQUENCY 164.______ OBSERVATION NO.______

DATE______ TIME______ ENTRY NO.______ ACTIVITY______

LOCATION OF BIRD______

______ PULSE RATE______

TOPO. QUAD______ GRID______ SECTIONAL______ GRID______

OBSERVER LOCATION______ MODE______

BEARING TO BIRD______° TIME______ ANTENNA OMNI YAGI 2 YAGI 4

______° to ______ (LANDMARK), ______° to ______ (LANDMARK)

SIGNAL STRENGTH 1 2 3 4 5 (CIRCLE) STEADY INTERMITTENT RECEIVED AT 164.______

OBSERVER LOCATION______ MODE______

BEARING TO BIRD______° TIME______ ANTENNA OMNI YAGI 2 YAGI 4

______° to ______ (LANDMARK), ______° to ______ (LANDMARK)

SIGNAL STRENGTH 1 2 3 4 5 (CIRCLE) STEADY INTERMITTENT RECEIVED AT 164.______

OBSERVER LOCATION______ MODE______

BEARING TO BIRD______° TIME______ ANTENNA OMNI YAGI 2 YAGI 4

______° to ______ (LANDMARK), ______° to ______ (LANDMARK)

SIGNAL STRENGTH 1 2 3 4 5 (CIRCLE) STEADY INTERMITTENT RECEIVED AT 164.______

COMMENTS:

APPENDIX C

Sequential locations of the 17 radio-tagged bald eagles from date of capture to date of last detection. Codes (in capital letters) are as follows: C = researcher in road vehicle, A = in aircraft, X = in fixed location, W = on foot, B = in boat, T = bird captured, V = bird sighted, U = location uncertain, P = bird perched, F = bird flying or soaring, R = roosting, G = bird on ground, Z = bird located within proposed impoundment area. Code letters in parentheses indicate condition suspected but unconfirmed. Latitude and longitude coordinates refer to the southeast corner of the ten minute block in which the bird was located. Coordinates are abbreviated (e.g., 481-1213 = 48°10' lat., 121°30' long.). An asterisk indicates that the eagle was found ten or more kilometers from its previous identified location.

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
BALD EAGLE NO. 1, two-year-old					
1.01	Jan 2	1238	McLeod Slough	T	482-1213
1.02	Jan 2	1530	E. of trap site (McLeod Slough)	CPV	482-1213
1.03	Jan 2	1550	Seen toward Sauk R. at McLeod Slough	CFV	482-1213
1.04	Jan 3	1630	Vicinity of Rockport	C	482-1213
1.05	Jan 27	1505	Detected from Samish Flats - not located	AU	
1.06*	Jan 28	1345	Whidbey Island, on shore, east of Coupeville	A	481-1223
1.07	Jan 29	1648	Whidbey Island - vic. small island off S. tip NE lobe of island	A	481-1223
1.08*	Feb 1	1130	Raft island at mouth of Skagit River (north fork)	FV	482-1222
1.09	Feb 1	1718	Mouth of Skagit River near La Conner	A	482-1222
1.10	Feb 2	0715	Detected from "Colony Mtn." to south toward Whidbey Island	XU	
1.11	Feb 4	1626	Mouth of Skagit River near La Conner	A	482-1222
1.12	Feb 6	0900	Detected from "Colony Mtn." to south toward Whidbey Island	XU	
1.13	Feb 7	0800	Detected from "Colony Mtn." to south toward Whidbey Island	XU	
1.14*	Feb 7	1558	ca. 1 mi. SW Stanwood, prob. on edge of tidal flat	A	481-1222
1.15	Feb 8	0830	Detected from "Colony Mtn." toward south	XU	
1.16	Feb 9	0757	Detected from "Colony Mtn." toward south	XU	
1.17	Feb 9	1313	Detected from "Colony Mtn." toward south	XU	

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
1.18	Feb. 9	1632	Mouth of Skagit River, south fork - southernmost delta	A	481-1222
1.19	Feb 10	0750	Detected from "Colony Mtn." toward south	XU	
1.20	Feb 10	1415	Detected from "Colony Mtn." toward south	XU	
1.21	Feb 10	1735	Detected from "Colony Mtn." toward Anacortes or Lopez Island	XU	
1.22*	Feb 13	1305	N. half of Lopez Island (near Hummel Lake?)	A(F)	483-1225
1.23	Feb 13	1336	Detected from "Colony Mtn." toward south	XU	
1.24*	Feb 14	1352	Orcas Island at Doe Bay	A	
1.25	Feb 19	1900	Detected from "Colony Mtn." toward NW	XUR	
1.26	Feb 19	1320	Cypress Island	A	483-1224
1.27	Feb. 21	1425	Detected from "Colony Mtn." toward NW	XU	
1.29	Feb 23	0630	Detected from "Colony Mtn." toward NW	U	
1.30*	Feb 23	1644	North end of Lummi Island	A	484-1224
1.31*	Feb 24	1643	Mainland coast east of Eliza Island	A	484-1223
1.32	Feb 29	1119	Detected from Chuckanut Mtn. toward west	AU	
1.33*	Feb 29	1627	Lummi Island	A	484-1224
1.34	Feb 29	2300	Detected from "Colony Mtn." to west	XUR	
1.35	Mar 1	1521	Southern tip Lummi Island	A	483-1223
1.36	Mar 3	2000	Mainland adjacent to Lummi Island	A	484-1223

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
1.37*	Mar 8	1551	Harrison River (between Harrison Mills and Harrison Hot Springs), B.C., Canada	A	491-1215
1.38*	Mar 20	1738	Mouth of Nooksack R., NW of Bellingham	A	484-1223
1.39	Mar 24	1242	Mouth of Nooksack R., NW of Bellingham	A	484-1223
1.40	Mar 24	1655	Mouth of Nooksack R., NW of Bellingham	A	484-1223
1.41	Mar 28	1702	Mouth of Nooksack R., NW of Bellingham	A	484-1223

BALD EAGLE NO. 2, two-year-old

2.01	Jan 4	1235	McLeod Slough	T	482-1213
2.02	Jan 4	1608	Vicinity of McLeod Slough	C	482-1213
2.03*	Feb 13	1537	2-3 mi. downstream Fall City on Snoqualmie River	A	473-1215
2.04	Feb 14	1100	Near Fall City	C	473-1215
2.05	Feb 14	1235	ca 2 mi. W Fall City and N of Interstate 90	C	473-1215
2.06*	Feb 19	1452	Camano Island, south end	A	480-1222
2.07	Feb 21	1730	Detected from March Point (ca. Anacortes-Bayview) toward north	CU	
2.08	Feb 21	2030	Detected from "Colony Mtn." toward south	XUR	
2.09	Feb 23	1753	Detected from Anacortes in direction of Camano Island	AU	
2.10	Feb 24	1610	Camano Island	A	480-1222
2.11	Feb 25	1600	Detected from Lummi Island toward Camano Island (not located)	AU	
2.12	Feb 29	1751	Appears to be on Whidbey Island near south tip of Camano Island	A	480-1222

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
2.13	Feb 29	2300	Detected from "Colony Mtn." to SE	XUR	
2.14	Mar 1	1347	Southern tip Camano Island	A	480-1222
2.15	Mar 3	2000	Detected from "Colony Mtn." toward south	XUR	
2.16	Mar 5	1633	Southern tip Camano Island	A	480-1222
2.17*	Mar 8	1625	Small peninsula on mainland due N of Lummi Island	A	484-1224
2.18	Mar 20	1825	Detected from Deception Pass in direction of Camano Island	AU	
2.19	Mar 24	1315	Detected from La Conner in direction of Camano Island	AU	
2.20	Mar 28	1636	Detected from mouth of Skagit River toward Camano Island	AU	
2.21*	Apr 2	0950	South end of Camano Island	A	480-1222

BALD EAGLE NO. 3, one-year-old

3.01	Jan 13	1240	Cascade River - ca. 1/4 mi. upstream Cascade R. mouth	T	483-1212
3.02	Jan 13	1730	Jordan Ck area	CR	483-1212
3.03	Jan 14	1820	Vic. N. of Clark's Cabins	CR	483-1212
3.04	Jan 15	0845	Cascade River, ca. 1/4 mi. upstream mouth	WPV	483-1212
3.05	Jan 15	1835	Illabot Slough	CR	482-1213
3.06	Jan 16	1530	Illabot Slough	C	482-1213
3.07	Jan 17	1042	Illabot Slough area	C	482-1213
3.08	Jan 18	1450	Skagit R. - Sauk R. confluence	CU	482-1213
3.09*	Jan 19	1707	2.1 mi. W of Concrete	C	483-1214
3.10	Jan 20	PM	ca 2 mi. W of Concrete	C	483-1214

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
3.11	Jan 21	1343	1.9 mi. W Albert's Serv-U, Concrete	C	483-1214
3.12	Jan 21	1345	2.1 mi. W Albert's Serv-U, Concrete	C	483-1214
3.13	Jan 21	1550	1.9 mi. W Albert's Serv-U, Concrete	A	483-1214
3.14	Jan 21	1953	2.1 mi. W Albert's Serv-U, Concrete	CR	483-1214
3.15	Jan 22	1700	ca. 2 mi. W Albert's Serv-U, Concrete	C	483-1214
3.16	Jan 23	0920	ca. 2 mi. W Albert's Serv-U, Concrete	C	483-1214
3.17	Jan 23	1725	ca. 2 mi. W Albert's Serv-U, Concrete	CR	483-1214
3.18	Jan 24	1233	ca. 1 mi. W Albert's Serv-U, Concrete	CPV	483-1214
3.19	Jan 26	0906	ca. 1.5 mi. W Albert's Serv-U, Concrete	C	483-1214
3.20	Jan 26	1136	Probably same as above	A	483-1214
3.21	Jan 26	1200	South of point where Ebing Creek crosses Hwy 20	C	483-1214
3.22	Jan 26	1502	ca. 1.5 mi W Albert's Serv-U, Concrete	C	483-1214
3.23	Jan 27	1400	Slightly W of Concrete	C	483-1214
3.24	Jan 27	1712	1.7 mi. W Albert's Serv-U, Concrete	C	483-1214
3.25	Jan 28	0845	ca. 1 mi. W Albert's Serv-U, Concrete	C	483-1214
3.26	Jan 28	1709	1.7 mi. W Albert's Serv-U, Concrete	C	483-1214
3.27	Jan 29	1025	ca. 1 mi. W Albert's Serv-U, Concrete	C	483-1214
3.28	Jan 29	1643	Just W of Concrete	A	483-1214

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
3.29	Jan 29	1834	2.1 miles W Albert's Serv-U, Concrete	CR	483-1214
3.30	Jan 30	1548	2.1 miles W Albert's Serv-U, Concrete	C	483-1214
3.31	Jan 31	1409	1.6 miles W Albert's Serv-U, Concrete	C	483-1214
3.32	Feb 1	1525	2.1 miles W Albert's Serv-U, Concrete	C	483-1214
3.33	Feb 1	2100	2.1 miles W Albert's Serv-U, Concrete	CR	483-1214
3.34	Feb 2	1400	1 mile W Albert's Serv-U, Concrete	C	483-1214
3.35	Feb 2	2215	1 mile W Albert's Serv-U, Concrete	CR	483-1214
3.36	Feb 3	1600	205° from jct. Ebing Creek and Hwy 20	C	483-1214
3.37*	Feb 4	1310	ca. 3 mi. E jct. Hwys 9 and 20 near Sedro Woolley	CF	483-1220
3.38	Feb 4	1854	ca. 5 mi. W Lyman (ca. Skagit R. and Wiseman Ck.)	CR	483-1220
3.39	Feb 7	1035	3.5 mi. W Lyman toward Skagit River	C	483-1220
3.40	Feb 7	1707	3.5 mi W Lyman toward Skagit River	C	483-1220
3.41	Feb 9	1301	Probably vic. Sedro Woolley	C	483-1220
3.42	Feb 9	1511	ca. where power line crosses Skagit R, east of Sedro Woolley	A	483-1220
3.43	Feb 9	1700	ca. where power line crosses Skagit R., east of Sedro Woolley	A	483-1220
3.44	Feb 11	1645	Skagit R. SE Sedro Wooley on S. side of Skiyou Island	C	483-1220
3.45	Feb 13	1128	On Skagit 1/4 mi. E Gilligan Creek	BPV	483-1220
3.46	Feb 13	1354	ca. 2 mi. E of Sedro Woolley	A	483-1220

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
3.47	Feb 13	1530	E of Sedro Woolley	C	483-1220
3.48	Feb 14	1457	1-2 mi. upstream of where power lines cross Skagit R., east of Sedro Woolley	A	483-1220
3.49	Feb 15	1146	Easternmost power lines and Skagit R., upstream of Sedro Woolley	C	483-1220
3.50	Feb 15	1855	Easternmost power lines and Skagit R., upstream of Sedro Woolley	CR	483-1220
3.51	Feb 18	0949	2 mi. downstream of Lyman on Skagit R.	C	483-1220
3.52	Feb 19	1758	1.2 mi. W Coal Ck. toward river (vic. of powerlines)	C	483-1220
3.53	Feb 19	1900	Detected from Colony Mtn. toward Sedro Woolley	XUR	
3.54	Feb 20	1248	Toward Skagit R. from Hwy 20 and Coal Ck.	C	483-1220
3.55	Feb 20	1722	Just downstream mouth of Coal Ck. on Skagit R.	C	483-1220
3.56	Feb 21	1425	Detected from Colony Mtn. toward Sedro Woolley	XU	
3.57	Feb 22	0855	S. of Sedro Woolley	C	482-1221
3.58	Feb 23	0630	Detected from Colony Mtn. toward Sedro Woolley	XU	
3.59	Feb 23	1700	Detected in direction of Sedro Woolley from S. Fork Nooksack R.	A	482-1221
3.60	Feb 24	1420	Prob. on Skagit R. between Sedro Woolley & Lyman	C	483-1220
3.61	Feb 24	1732	Prob. on Skagit R. between Sedro Woolley & Lyman	A	483-1220
3.62	Feb 24	1846	Prob. on Skagit R. vicinity of Lyman	CR	483-1220
3.63	Feb 25	1001	Prob. on Skagit R. 2.1 mi. upstream of Wiseman Creek	C	483-1220

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
3.64	Feb 29	1756	Detected from vic. of Stanwood, toward east	AU	
3.65*	Mar 1	1340	Acme	A	484-1221
3.66	Mar 3	2000	Detected from Colony Mtn. toward south	XUR	
3.67	Mar 5	1509	Acme	A	484-1221
3.68	Mar 8	1430	Acme	A	484-1221
3.69*	Mar 20	1749	N. fork Nooksack R. at Kendall	A	485-1220

BALD EAGLE NO. 4, one-year-old

4.01	Jan 16	0845	Cascade River, ca. 1/4 mile upstream mouth	T	483-1212
4.02	Jan 16	1610	Marblemount Slough	C	483-1212
4.03	Jan 17	1042	Marblemount Slough	C	483-1212
4.04*	Jan 17	2030	County Line Ponds	CRZ	483-1211
4.05	Jan 18	2100	Between Sky Ck and County Line Ponds	CRZ	483-1211
4.06	Jan 19	1005	County Line Ponds	CZ	483-1211
4.07	Jan 19	1915	Between Sky Ck and County Line Ponds	CRZ	483-1211
4.08	Jan 20	0735	County Line Ponds	CZ	483-1211
4.09	Jan 20	1115	In slough on left side of river below County Line Ponds	CZ	483-1211
4.10	Jan 20	1930	County Line Ponds	CRZ	483-1211
4.11	Jan 21	1217	Just upstream of County Line Ponds	CZ	483-1211
4.12	Jan 21	1605	Just upstream of County Line Ponds	AZ	483-1211
4.13	Jan 21	2055	S. side of Skagit, 250 m E Sky Creek	CRZ	483-1211

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
4.14	Jan 22	0800	County Line Ponds	CPVZ	483-1211
4.15	Jan 22	1130	County Line Ponds	CGVZ	483-1211
4.16	Jan 22	1156	County Line test bar	CFPVZ	483-1211
4.17	Jan 22	2112	Vicinity Bear Hole (on side of mountain)	CRZ	483-1211
4.18	Jan 22	2119	1.0 mi. E Thornton Ck bridge	CRZ	483-1211
4.19	Jan 23	0826	Just upstream of County Line Ponds	CZ	483-1211
4.20	Jan 23	1729	Near Sky Creek, S side Skagit River	CZ	483-1211
4.21	Jan 23	1805	County Line Ponds Orcas Island from mainland	CRZ	483-1211
4.22	Jan 24	0730	County Line Ponds	CRZ	483-1211
4.23	Jan 24	0852	County Line Ponds	CZ	483-1211
4.24	Jan 24	0935	County Line Ponds	CZ	483-1211
4.25	Jan 24	1035	Across Skagit from County Line Ponds	WPVZ	483-1211
4.26	Jan 24	1150	Across Skagit from County Line Ponds	WPVZ	483-1211
4.27	Jan 24	1549	Vicinity of County Line Ponds	CZ	483-1211
4.28	Jan 25	0535	Probably around Aggregate Ponds (ca. 2 mi. downstream Newhalem)	CZ	483-1211
4.29*	Jan 25	1701	ca. 5 mi. east of Concrete	C	482-1213
4.30*	Jan 26	0902	Vicinity mouth of Baker R.	C	483-1214
4.31	Jan 26	1135	Vicinity mouth of Baker R	A	483-1214
4.32	Jan 27	1455	Detected from S. of Bellingham, (not located)	AU	
4.33*	Jan 28	1320	Orcas Island, a few miles NW of Olga	A	483-1225
4.34	Jan 29	1649	Orcas Island	A	483-1225
4.35	Feb 1	1000	Orcas Island	XU	483-1225

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
4.36	Feb 1	1657	Orcas Island	A	483-1225
4.37	Feb 3	1130	Detected from "Colony Mtn." toward Orcas Island	XU	
4.38	Feb 4	1610	Orcas Island, near town of Orcas	A	483-1225
4.39	Feb 6	0900	Detected from "Colony Mtn." toward Orcas Island	XU	
4.40	Feb 7	0800	Detected from "Colony Mtn." toward Orcas Island	XU	
4.41	Feb 7	1205	Detected from "Colony Mtn." toward Orcas Island	XU	
4.42	Feb 8	0830	Detected from "Colony Mtn" toward Orcas Island	XU	
4.43	Feb 9	0757	Detected from "Colony Mtn" toward Orcas Island	XU	
4.44	Feb 9	1313	Detected from "Colony Mtn." toward Orcas Island	XU	
4.45	Feb 9	1612	Orcas Island at Doe Bay	A	483-1224
4.46	Feb 10	0750	Detected from "Colony Mtn." toward Orcas Island	XU	
4.47	Feb 10	1415	Detected from "Colony Mtn." toward Orcas Island	XU	
4.48	Feb 10	1735	Detected from "Colony Mtn." toward Orcas Island	XU	
4.49	Feb 13	0919	Detected from "Colony Mtn." toward Orcas Island	XU	
4.50	Feb 13	1427	Orcas Island at Doe Bay	A	483-1224
4.51	Feb 14	1351	Orcas Island at Doe Bay	A	483-1224
4.52	Feb 19	1327	Orcas Island, between Orcas and West Sound on W side island	A	483-1224
4.53	Feb 23	0630	Detected from "Colony Mtn." toward Orcas Island	XUR	
4.54	Feb 23	1637	Orcas Island between Olga and Doe Bay	A	483-1224

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
4.55	Feb 24	1633	Orcas Island between Olga and Doe Bay	A	483-1224
4.56	Feb 25	1121	Detected in direction of Orcas Island from mainland	AU	
4.57	Feb 25	1548	Detected in direction of Orcas Island from mainland	AU	
4.58	Feb 29	1119	Detected from Chuckanut Mountain toward Orcas Island	AU	
4.59	Feb 29	1636	Orcas Island, at Olga	A	483-1225
4.60	Feb 29	2300	Detected from "Colony Mtn." toward Orcas Island	XUR	
4.61	Mar 1	1515	Orcas Island, at Doe Bay	A	483-1224
4.62	Mar 3	2000	Detected from "Colony Mtn." in direction of Orcas Island	XUR	
4.63	Mar 5	1235	Orcas Island, at Olga	A	483-1225
4.64	Mar 8	1624	Cypress Island (north end)	A	483-1224
4.65	Mar 16	1417	Orcas Island, vic. of Olga	A	483-1225
4.66	Mar 20	1730	Orcas Island, at Doe Bay	A	483-1224
4.67	Mar 24	1255	Orcas Island, at Rosario	A	483-1225
4.68*	Apr 2	1745	Vancouver Island, near Maple Bay	A	484-1233

BALD EAGLE NO. 5, adult

5.01	Jan 22	0800	Rocky Creek Gravel Bar	T	482-1213
5.02	Jan 22	1843	Close to Skagit R. at upstream mouth of Illabot Slough	C	482-1213
5.03	Jan 23	0700	Upstream of Rocky Creek	CR	483-1212
5.04	Jan 23	0855	Vicinity of Illabot Bend	C	482-1213
5.05	Jan 23	1651	Illabot Slough area	C	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
5.06	Jan 23	1740	Between Illabot Bend and Rocky Cr.	CR	482-1213
5.07	Jan 24	1039	Bud Buller's farm	C	483-1212
5.08	Jan 24	1136	Vicinity of Rocky Cr./Illabot Bend	C	482-1213
5.09	Jan 24	1335	Vicinity of Rocky Cr./Illabot Bend	C	482-1213
5.10*	Jan 25	1645	County Line Ponds	CZ	483-1211
5.11	Jan 25	1812	County Line Ponds	CRZ	483-1211
5.12	Jan 26	0725	Above ridge to NW of Co. Line Ponds	CFZ	483-1211
5.13*	Jan 26	0846	Vicinity of Rocky Cr.	C	482-1213
5.14	Jan 26	0905	Between Rocky Cr. and Illabot Bend	C	482-1213
5.15	Jan 26	1141	Vicinity of Rocky Cr.	A	482-1213
5.16	Jan 26	1530	Half-way between Illabot Bend and Sutter Cr.	C	482-1213
5.17	Jan 26	1600	Half-way between Illabot Bend and Sutter Cr.	C	482-1213
5.18	Jan 27	0947	Illabot Bend	C	482-1213
5.19	Jan 27	1230	Vicinity of Rocky Cr.	C	482-1213
5.20	Jan 27	1730	Entrance to Illabot Slough	CR	482-1213
5.21	Jan 27	1731	0.2 mi. downstream of Illabot Slough	CR	482-1213
5.22	Jan 28	0820	S of a point halfway between Clark's Cabins and Totem Trails Cafe, Hwy 20	C	483-1212
5.23	Jan 28	1530	Illabot Slough vicinity	C	482-1213
5.24	Jan 28	1820	Just upstream of Sutter Cr. on S side of Skagit R.	CR	482-1213
5.25	Jan 29	0835	Vicinity of Illabot Bend	C	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
5.26	Jan 29	1610	Illabot Slough vicinity	A	482-1213
5.27	Jan 29	1900	Illabot area	CR	482-1213
5.28	Jan 30	1000	Between Illabot Bend and Rocky Cr.	C	482-1213
5.29	Jan 30	1040	Between Illabot Bend and Rocky Cr.	C	483-1213
5.30	Jan 30	1618	Illabot Bend	C	483-1213
5.31	Jan 31	1310	Between Rocky Cr. and Illabot Bend	C	482-1213
5.32	Jan 31	1540	Between Rocky Cr. and Illabot Bend	C	482-1213
5.33	Feb 1	1229	Illabot Bend vicinity	C	482-1213
5.34	Feb 1	2130	Vicinity of Ezra Buller's farm	CR	482-1213
5.35	Feb 2	1330	Illabot area (back in slough?)	C	482-1213
5.36	Feb 2	2250	Illabot area near Rocky Cr.	C	482-1213
5.37	Feb 3	1030	Illabot Bend	C	482-1213
5.38	Feb 3	1635	Illabot Bend	C	482-1213
5.39	Feb 4	1929	Just upstream of Illabot Bend	CR	482-1213
5.40	Feb 5	0945	1/2 mi. downstream of mouth of Illabot Cr.	C	482-1213
5.41	Feb 5	1058	Rocky Cr. vicinity	C	482-1213
5.42	Feb 5	1510	Illabot Slough vicinity	C	482-1213
5.43	Feb 6	1210	Illabot Bend/Rocky Cr. area	C	482-1213
5.44	Feb 6	1420	Vicinity of Rocky Cr./Illabot Bend	C	482-1213
5.45	Feb 6	1830	Just upstream of Illabot Bend	CR	482-1213
5.46	Feb 7	0945	Vicinity of Illabot Bend	C	482-1213
5.47	Feb 7	1823	Vicinity of Illabot Bend	CR	482-1213
5.48	Feb 8	1702	Just upstream of Illabot Bend	C	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
5.49	Feb 8	1756	Just upstream of Illabot Bend	C	482-1213
5.50	Feb 9	1213	Just upstream of Illabot Bend	C	482-1213
5.51	Feb 9	1745	Between Illabot Bend and Rocky Cr.	CR	482-1213
5.52	Feb 9	1914	Just upstream of Illabot Bend	CR	482-1213
5.53	Feb 9	2000	Illabot Slough area	CR	482-1213
5.54	Feb 10	1028	Just upstream of Illabot Bend	C	482-1213
5.55	Feb 10	1539	Just upstream of Illabot Bend	C	482-1213
5.56	Feb 10	2015	Between Rocky Cr. and Corkin-dale Cr.	CR	483-1213
5.57	Feb 11	2005	Between Sutter Cr. and Illa-bot Bend	CR	482-1213
5.58	Feb 12	1100	Between Illabot Cr. and Sutter Cr.	C	482-1213
5.59	Feb 12	1135	Between Illabot Cr. and Sutter Creek	C	483-1213
5.60	Feb 12	1706	Just upstream of Illabot Bend	C	482-1213
5.61	Feb 14	1247	Nature Conservancy area on upper Skagit	AU	
5.62	Feb 15	1253	Vicinity of Rocky Creek	C	482-1213
5.63	Feb 15	1740	Cascadian Farm roost	CR	483-1213
5.64	Feb 16	0705	Cascadian Farm roost	C	482-1213
5.65	Feb 16	2050	Between Sutter Creek and Illabot Bend	CR	482-1213
5.66	Feb 17	1455	Vicinity of Illabot Bend	C	482-1213
5.67	Feb 17	1845	Illabot Slough area	CR	482-1213
5.68	Feb 18	1027	Just upstream of Illabot Bend	C	482-1213
5.69	Feb 18	1810	Vicinity of Rocky Cr. and Skagit R.	CR	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
5.70	Feb 19	1901	Just upstream of Illabot Bend	CR	482-1213
5.71	Feb 20	1214	Just upstream of Rocky Cr.	C	482-1213
5.72	Feb 20	1757	Between Rocky Cr. and Illa-bot Bend	C	482-1213
5.73	Feb 22	0820	On Skagit R., at Ezra Buller's farm	C	482-1213
5.74	Feb 24	1702	350° from Abbotsford (Canada) Airport	AU	
5.75*	Feb 25	1322	W. shore "lower" Stave Lake (ca. 2 mi. N. Stave Falls), B.C., Canada	A	491-1215
5.76	Feb 25	1503	W. shore "lower" Stave Lake, (ca. 2 mi. N. Stave Falls), B.C., Canada	A	491-1215

BALD EAGLE NO. 6, five-year-old

6.01	Jan 25	1445	McLeod Slough	T	482-1213
6.02	Jan 25	1734	McLeod Slough	CR	482-1213
6.03	Jan 26	0851	Rockport-McLeod Slough vicinity	C	482-1213
6.04	Jan 26	1045	McLeod Slough	C	482-1213
6.05	Jan 26	1140	Rockport-McLeod Slough vicinity	A	482-1213
6.06	Jan 26	1250	McLeod Slough	C	482-1213
6.07*	Jan 27	1530	Vicinity of Darrington	A	481-1213
6.08	Jan 28	1522	Sauk River, ca. 2 mi. upstream of confluence of Sauk and Suiattle R.	C	481-1213
6.09	Jan 29	1623	Sauk River, ca. 2 mi. upstream of confluence of Sauk R. and Suiattle R.	A	481-1213
6.10	Jan 30	1120	Vicinity of confluence of Sauk R. and Suiattle R.	C	481-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
6.11	Jan 31	1335	Sauk River, 1.9 mi. upstream of confluence of Sauk R. and Suiattle R.	C	481-1213
6.12	Feb 1	1408	Sauk River, 1.9 mi. upstream of confluence of Sauk R. and Suiattle R.	C	481-1213
6.13	Feb 3	1005	Sauk River, ca. 2 mi. up-stream of Suiattle R.	C	481-1213
6.14	Feb 4	1643	Sauk River, 1.9 mi. up-stream of Suiattle R.	A	481-1213
6.15	Feb 5	1025	Sauk River, ca. 2 mi. up-stream of Suiattle R.	C	481-1213
6.16	Feb 5	2050	ca. 4 mi. N. of Darrington on Sauk R.	CR	481-1213
6.17	Feb 6	1754	Sauk River, 1.9 mi. up-stream of Suiattle R. confluence	CR	481-1213
6.18	Feb 7	1754	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	CR	481-1213
6.19	Feb 8	1725	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C	481-1213
6.20	Feb 9	1839	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	CR	481-1213
6.21	Feb 10	1645	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C	481-1213
6.22	Feb 10	1800	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	CR	481-1213
6.23	Feb 11	1215	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C	481-1213
6.24	Feb 11	1300	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C	481-1213
6.25	Feb 12	1440	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C(F)	481-1213
6.26	Feb 12	1525	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C	481-1213
6.27	Feb 13	1140	Sauk River, 1.9 mi. upstream of Suiattle R. confluence	C	481-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
6.28*	Feb 14	1240	Along ridgeline N of Sauk R./ Skagit R. confluence	CVF	483-1213
6.29	Feb 14	1317	Sauk River, 1.9 mi. upstream of Skagit R. confluence	A	482-1213
6.30*	Feb 14	1730	Gravel Creek draw on Prairie Mtn., ca. 1.5 mi. SE Mansford	CR	481-1213
6.31	Feb 15	1030	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	C	481-1213
6.32	Feb 15	1835	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	CR	481-1213
6.33	Feb 16	1910	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	CR	481-1213
6.34	Feb 16	1958	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	CR	481-1213
6.35	Feb 17	2100	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	CR	481-1213
6.36	Feb 18	1834	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	CR	481-1213
6.37	Feb 24	0914	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	C	481-1213
6.38	Feb 26	1015	Sauk River, ca. 2 mi. upstream of Suiattle R. confluence	C	481-1213
6.39	Feb 28	1150	W. of Hwy from usual place	C	481-1213
6.40	Mar 1	1410	Vicinity Sauk River/ Suiattle River confluence	A	481-1213

BALD EAGLE NO. 7, three-year-old

7.01	Jan 29	1330	Cascade River, ca. 1/2 mi. upstream mouth	T	483-1212
7.02	Jan 29	1610	Vicinity, same as above	A	483-1212

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
7.03	Jan 29	1911	Downstream from Marblemount Bridge	C	483-1212
7.04	Jan 30	1420	Confluence, Diobsud Cr. and Skagit R.	C	483-1212
7.05	Jan 30	1630	Skagit River, 1/4 mi. downstream Diobsud Cr.	C	483-1212
7.06	Jan 31	1247	Skagit R.M. 79.0	C	483-1212
7.07	Jan 31	1619	Skagit R.M. 79.0	CPV	483-1212
7.08	Feb 1	1047	Skagit R.M. 79.5	C	483-1212
7.09	Feb 1	1330	Marblemount (on Skagit R.)	C	483-1212
7.10	Feb 1	2135	Between Illabot Bend and Rocky Cr. (S. of river)	CR	482-1213
7.11	Feb 2	2250	Between Illabot bend and Rocky Cr. (S. of river)	CR	482-1213
7.12	Feb 3	0840	Illabot Cr. area S. of river	C	482-1213
7.13	Feb 3	1030	Illabot Cr. area S. of river	C	482-1213
7.14	Feb 3	1635	Illabot Slough area (S. of river)	C	482-1213
7.15*	Feb 4	1215	Diobsud Cr. vicinity	C	483-1212
7.16	Feb 4	1944	Vicinity confluence Diobsud Cr. and Skagit R.	CR	483-1212
7.17	Feb 5	0805	Diobsud Cr., upstream of Hwy. 20	C	483-1212
7.18*	Feb 5	1100	Between Illabot Bend and Sutter Creek	C	482-1213
7.19	Feb 5	1510	Illabot vicinity	C	482-1213
7.20	Feb 6	1210	Illabot Slough area	C	482-1213
7.21	Feb 6	1825	Washington Eddy	CR	482-1213
7.22	Feb 7	0945	Somewhere in study area (up Cascade River?)	CU	483-1212
7.23	Feb 7	1815	Somewhere in study area (up Cascade River?)	CU	483-1212

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
7.24*	Feb 8	1645	Just downstream of Diobsud Cr., on Skagit R.	C	483-1212
7.25	Feb 8	1825	E. side Diobsud Creek, ca. 0.8 mi. N stop sign at Hwy 20.	CR	483-1212
7.26	Feb 9	1204	Diobsud Cr., upstream of Highway 20	C	483-1212
7.27	Feb 9	1600	Diobsud Cr., upstream of Highway 20	C	483-1212
7.28	Feb 9	1932	Skagit River, at Mouth of Diobsud Creek	CR	483-1212
7.29	Feb 9	2025	Diobsud Cr., upstream of Highway 20	CR	483-1212
7.30	Feb 10	0823	Skagit River, Just downstream of Diobsud Cr.	C	483-1212
7.31	Feb 10	1010	Skagit River, ca. 1/4 mi. downstream mouth Diobsud Creek	C	483-1212
7.32	Feb 10	1612	Skagit R.M. 79.5	C	483-1212
7.33	Feb 10	2035	Skagit River, 1/4 - 1/2 mi. downstream Diobsud Cr.	CR	483-1212
7.34	Feb 11	0905	Skagit River, 1/4 - 1/2 mi. downstream Diobsud Cr.	C	483-1212
7.35	Feb 11	2005	Skagit River, 3/4 mi. downstream mouth of Diobsud Creek	CR	483-1212
7.36	Feb 12	1000	Mouth of Diobsud Cr. vicinity	C	483-1212
7.37	Feb 12	1719	Diobsud Cr., upstream of Hwy. 20	C	483-1212
7.38	Feb 12	2030	Skagit R., ca. 3/4 - 1 mi. upstream Diobsud Cr. mouth	CR	483-1212
7.39	Feb 13	1030	Vicinity Diobsud Creek mouth	C	483-1212
7.40*	Feb 13	2100	Skagit R. near Thornton Cr.	CRZ	483-1211

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
7.41	Feb 14	0900	Not at Thornton Cr., weak signal vicinity Bacon Cr.	CU	483-1212
7.42	Feb 14	1255	Vicinity of County Line Ponds	CZ	483-1211
7.43	Feb 14	1950	Vicinity of Thornton Cr. - Babcock Cr.	CRZ	483-1211
7.44	Feb 15	0700	Vicinity of Aggregate Ponds	CZ	483-1211
7.45*	Feb 15	1300	Skagit R., just downstream Diobsud Cr.	C	483-1212
7.46	Feb 15	1415	Diobsud Cr., upstream of Hwy. 20	C	483-1212
7.47	Feb 15	1647	Diobsud Creek	C	483-1212
7.48	Feb 16	1130	Diobsud Cr. upstream of Hwy. 20	C	483-1212
7.49*	Feb 16	1630	Vicinity of Thornton Cr.	CZ	483-1211
7.50	Feb 17	0700	Skagit River, upstream from Thornton Cr. bridge, toward N. facing hill	C(R)Z	483-1211
7.51	Feb 17	1545	Alma Cr. and Skagit R.	CZ	483-1212
7.52	Feb 17	2200	Alma Cr. and Skagit R.	CRZ	483-1212
7.53	Feb 18	1040	On Skagit R. just downstream of Diobsud Cr. mouth	C	483-1212
7.54	Feb 18	1800	Diobsud Cr., upstream of Hwy. 20	C	483-1212
7.55	Feb 20	1207	Diobsud Cr. mouth	C	483-1212
7.56	Feb 20	1804	Diobsud Cr., upstream of Hwy 20	C	483-1212
7.57	Feb 21	0907	Skagit R., just downstream Diobsud Cr.	C	483-1212
7.58	Feb 22	0814	Vicinity of Diobsud Cr., prob. upstream Hwy. 20	CU	483-1212
7.59	Feb 23	2241	Vicinity of Diobsud Cr.	CR	483-1212
7.60	Feb 24	0750	Skagit R., just downstream Diobsud Cr.	C	843-1212

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
7.61*	Feb 24	1344	S. of Skagit R. at Ezra Buller's farm	C(F)	842-1213
7.62	Feb 24	1933	Vicinity of Marblemount (or up Cascade R.?)	CUR	843-1212
7.63	Feb 25	0902	Vicinity of Marblemount	C	483-1212
7.64*	Feb 26	1300	Skagit R. at RM 91.5 (ca. 1.5 mi. W. Newhalem)	C	483-1211
7.65	Feb 27	1345	Skagit R., vicinity Sky Cr.	CZ	483-1211
7.66	Feb 27	1730	Skagit R., vicinity Sky Cr.	CZ	483-1211
7.67	Feb 28	0858	Skagit R., just downstream mouth Thornton Cr.	CZ	483-1211
7.68	Feb 29	0847	Vicinity Alma Creek, S. side Skagit R.	CZ	483-1212
7.69	Feb 29	2026	Skagit R., at downstream end Alma Cr. Slide (HM 112)	CRZ	483-1212
7.70	Mar 1	1055	Alma Cr. and Skagit R.	CZ	483-1212
7.71	Mar 1	1740	Alma Cr. and Skagit R.	CZ	483-1212
7.72	Mar 2	0811	North of RM 79.5	CF	483-1212
7.73	Mar 2	1000	Skagit R., just downstream mouth Diobsud Creek	CPV	483-1212
7.74	Mar 3	0748	Vicinity mouth of Diobsud Creek	C	483-1212
7.75	Mar 3	1230	Skagit River, just downstream mouth Dibsud Creek	C	483-1212
7.76	Mar 4	1118	Skagit River mile 86.5 (Missing Bridge Slide)	CPVZ	483-1212
7.77	Mar 5	0926	General vicinity of Sky Creek (some distance south of Skagit River)	CZ	483-1211
7.78	Mar 6	0940	Skagit R., ca. 1/4 mile downstream Sky Creek	CZ	483-1211
7.79	Mar 6	1649	Skagit R., ca. 1/4 mile downstream Sky Creek	CPVZ	483-1211

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
7.80	Mar 7	1113	Skagit R., vicinity of Copper Creek	CZ	483-1212
7.81	Mar 7	1838	Skagit R., ca. 1/4 mile upstream Copper Creek	CZ	483-1212
7.82	Mar 8	1300	Skagit R., at mouth Alma Creek	CZ	483-1212
7.83	Mar 8	1956	Skagit R., between Copper Creek and R.M. 84.5	CZ	483-1212
7.84	Mar 9	0755	Skagit R., at Alma Creek	CZ	483-1212
7.85	Mar 9	1018	Skagit R., ca. 1/4 mile upstream Alma Creek	C(V)Z	483-1212
7.86	Mar 11	1135	Skagit R., just upstream Alma Creek	C	483-1212
7.87	Mar 11	1621	Copper Creek and Skagit R.	C	483-1212
7.88	Mar 12	0821	Skagit R., ca. 1/4 mile downstream Copper Creek	C	483-1212
7.89*	Mar 13	1803	Skagit R., just downstream Goodell Creek	C	483-1211
7.90	Mar 14	1605	Alma Creek and Skagit River	C	483-1212

BALD EAGLE NO. 8, five-year-old

8.01	Feb 3	1225	McLeod Slough	T	482-1213
8.02	Feb 4	1651	Vicinity of mouth of Sauk R.	A	482-1213
8.03	Feb 4	1923	Vicinity of mouth of Sauk R.	CR	482-1213
8.04	Feb 5	1055	Vicinity of Rockport	C	482-1213
8.05	Feb 5	2230	Sauk R., between Rockport-Cascade Hwy and Falls Hilt Cr.	CR	482-1213
8.06	Feb 6	1250	Vicinity of McLeod Slough	C	482-1213
8.07	Feb 6	1814	On hill W. of Sauk R., 3.8 mi. N. jct. East Sauk Valley Road and Concrete-Sauk Valley Road	CR	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
8.08	Feb 7	0955	Sauk River, upstream of mouth	C	482-1213
8.09	Feb 7	1741	W. side Sauk R., 3.6 mi. N. jct. East Sauk Valley Rd. and Concrete-Sauk Valley Rd.	C(R)	483-1213
8.10	Feb 8	1709	Sauk R., 2 mi. upstream of mouth	C	482-1213
8.11	Feb 9	1826	Sauk R., 3.6 mi. N. jct. East Sauk Valley Rd. and Concrete-Sauk Valley Rd.	CR	482-1213
8.12	Feb 9	1915	Sauk R., 2 mi. upstream of mouth	CR	482-1213
8.13	Feb 10	1300	Sauk R., 2 mi. upstream of mouth	C	482-1213
8.14	Feb 10	1534	Vicinity mouth of Sauk R.	CU	482-1213
8.15	Feb 10	1940	Sauk R., 2.5-3.0 mi. upstream of mouth	CR	482-1213
8.16	Feb 11	1005	Sauk R., ca. 3 mi. upstream of mouth	C	482-1213
8.17	Feb 11	1135	Sauk R., ca. 3 mi. upstream of mouth	C	482-1213
8.18	Feb 11	2005	Sauk R., ca. 2.5-3.0 mi. upstream of mouth	CR	482-1213
8.19	Feb 12	1745	Sauk R., ca. 2.5-3.0 mi. upstream of mouth	CR	482-1213
8.20	Feb 13	1100	Sauk River area? (weak signals)	CU	482-1213
8.21	Feb 13	1140	Detected very weak signals from Rockport Bridge	CU	
8.22	Feb 13	1410	Upper Skagit Valley	AU	

BALD EAGLE NO. 9, three-year-old

9.01	Feb 5	0940	McLeod Slough	T	482-1213
9.02	Feb 5	2235	On Sauk R., ca. 3 mi. upstream of mouth	CR	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
9.03	Feb 6	1220	Washington Eddy on Skagit R.	CPV	482-1213
9.04	Feb 6	1434	Washington Eddy on Skagit R.	C	482-1213
9.05	Feb 6	1837	Washington Eddy on Skagit R.	CR	482-1213
9.06	Feb 7	0948	Vicinity Washington Eddy	C	482-1213
9.07*	Feb 7	1846	Mouth of Goodell Creek	CRZ	484-1211
9.08	Feb 8	0725	Mouth of Goodell Creek	CZ	484-1211
9.09	Feb 8	0745	Mouth of Goodell Creek	CZ	484-1211
9.10	Feb 8	0845	On Goodell Creek upstream of Hwy. 20	CZ	484-1211
9.11	Feb 8	0915	On Goodell Creek upstream of Hwy. 20	CZ	484-1211
9.12	Feb 8	1030	Mouth of Goodell Creek	CZ	484-1211
9.13	Feb 8	1045	Skagit R., between Thornton Cr. and County Line Ponds	CZ	483-1211
9.14	Feb 8	1100	Skagit R., between Thornton Cr. and County Line Ponds	CZ	483-1211
9.15	Feb 8	1633	Skagit R., between Aggregate Ponds and Thornton Cr.	CZ	483-1211
9.16	Feb 8	1833	Skagit R., between Aggregate Ponds and Thornton Cr.	CRZ	483-1211
9.17	Feb 9	1350	Over Aggregate Ponds and along ridge N. Hwy 20 between Aggregate Ponds and Babcock Cr.	CFVZ	484-1211
9.18	Feb 9	1942	Toward Skagit R. from Aggregate Ponds gate	CRZ	483-1211
9.19	Feb 9	2055	Toward Trapper Peak between Babcock and Goodell Creeks	CRZ	484-1211
9.20	Feb 10	0740	1/4 mi. downstream mouth of Newhalem Cr. on Skagit R.	CPVZ	483-1211
9.21	Feb 10	0758	S. side Skagit R. near mouth Newhalem Creek	CPVZ	484-1211

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
BALD EAGLE NO. 10, two-year-old					
10.01	Feb 5	1255	McLeod Slough	T	482-1213
10.02	Feb 5	2235	Sauk R., ca. 3 mi. upstream of mouth	CR	482-1213
10.03	Feb 6	1250	Vicinity McLeod Slough	C	482-1213
10.04	Feb 6	1435	Vicinity McLeod Slough	C	482-1213
10.05	Feb 6	1725	Vicinity McLeod Slough	C	482-1213
10.06	Feb 7	0955	Vicinity McLeod Slough	C	482-1213
10.07	Feb 7	1809	W. side Sauk R., 3.6 mi. downstream from Jct. E. Sauk Valley Road and Concrete-Sauk Valley Road	CR	482-1213
10.08	Feb 8	1749	Sauk R., 3.1 Hwy. mi. upstream from Rockport Bridge	C(R)	482-1213
10.09	Feb 9	1232	Detected in direction of McLeod Slough	CU	482-1213
10.10	Feb 9	1856	1.9 mi. S. Rockport on E. Sauk Road toward Sauk R.	CR	482-1213
10.11	Feb 9	1915	On Sauk (?) or up on mountain side ca. 1.5 mi. upstream of Sauk mouth	CR	482-1213
10.12	Feb 10	1330	Above Knob Hill, E. side E. Sauk Valley Road ca. 1 mi. S. Rockport Cascade Hwy.	CFV	482-1213
10.13	Feb 10	1940	Sauk R., ca. 2.5 mi. upstream of mouth	CR	482-1213
10.14	Feb 11	1020	Sauk R., ca. 3 mi. upstream of mouth	C	482-1213
10.15	Feb 11	2005	Sauk R., ca. 3 mi. upstream of mouth	CR	482-1213
10.16	Feb 12	1525	Slough on Sauk River, ca. 0.5 mi. downstream Lower Sauk Bridge	CPV	482-1213
10.17	Feb 12	1745	Vicinity of Sauk R. 2.5-3.0 mi. upstream of mouth	CR	482-1213

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
10.18	Feb 13	1100	Vicinity of Sauk R., 2.5 mi. upstream of mouth	C	482-1213
10.19	Feb 13	1725	Vicinity of Sauk R., ca. 3 mi. upstream of mouth	CR	482-1213
10.20	Feb 14	1247	Upper Skagit River	AU	
10.21	Feb 14	1920	"Cascadian Farm" roost between Sutter and Rocky Creeks	CR	483-1213
10.22	Feb 15	0940	Skagit R., between Illabot Bend and Sutter Cr.	C	482-1213
10.23	Feb 15	1300	Skagit R., between Illabot Bend and Sutter Cr.	C	482-1213
10.24	Feb 15	1740	"Cascadian Farm" roost	CR	483-1213
10.25	Feb 16	0705	"Cascadian Farm" roost	C	483-1213
10.26	Feb 16	1035	Illabot Bend	C(PV)	482-1213
10.27	Feb 16	1750	"Cascadian Farm" roost	CR	483-1213
10.28	Feb 17	1720	Vicinity Illabot Bend - Sutter Creek	CU	482-1213
10.29	Feb 17	1825	Illabot Slough area	CR	482-1213
10.30	Feb 17	1845	Illabot Slough area	CR	482-1213
10.31	Feb 18	1023	Vicinity Sutter Creek	C	482-1213
10.32	Feb 18	1812	Vicinity Illabot Bend	CR	482-1213
10.33	Feb 20	1215	Vicinity Illabot Bend	C	482-1213
10.34	Feb 20	1757	Illabot Bend near cement guard rail	C	482-1213
10.3*	Feb 22	0830	Skagit R., 2.1 mi. upstream Van Horn	C	483-1214

BALD EAGLE NO. 11, adult

11.01	Feb 7	0830	N. fork Nooksack R., Welcome Bridge at Welcome	T	485-1220
11.02*	Feb 9	1528	ca., 9 mi. and ca. 130° from Acme Airport	A(F)	483-1220

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
11.03	Feb 9	1700	Up canyon E. Lyman	A	483-1220
11.04	Feb 11	1815	East of Acme	CR	483-1220
11.05	Feb 13	1348	S. Fork Nooksack R., SE Wickersham, between 4257' and 4550' peaks	A	483-1220
11.06	Feb 14	1425	S. Fork Nooksack R., directly S. of peak (4550')	A	483-1220
11.07	Feb 19	1420	S. Fork Nooksack R., SE Wickersham, between 4257' and 4550' peaks	A	483-1220
11.08	Feb 23	1725	S. Fork Nooksack R., SE Wickersham, between 4257' and 4550' peaks	A	483-1220
11.09	Feb 24	1719	S. Fork Nooksack R., SE Wickersham, between 4257' and 4550' peaks	A	483-1220
11.10*	Feb 29	1733	On shoreline at end of runway 13, Whidbey Island Naval Air Station	A	482-1223
11.11	Mar 1	1510	Cranberry Lake, Whidbey Island	A	482-1223
11.12	Mar 3	2000	Detected from "Colony Mtn." toward south	XUR	
11.13	Mar 5	1655	Cranberry Lake, Whidbey Island	A	482-1223
11.14	Mar 8	1714	Vicinity Deception Pass, Whidbey Island	A	482-1223
11.15	Mar 16	1402	Vicinity Deception Pass Bridge, Whidbey Island	A	482-1223
11.16	Mar 16	1536	NW-facing shoreline just S. Deception Pass bridge	C	482-1223
11.17	Mar 20	1820	Deception Pass, on shoreline W of bridge, Whidbey Island	A	482-1223
11.18	Mar 24	1311	Over Puget Sound just W Deception Pass	AF	482-1223
11.19	Mar 28	1643	Deception Pass, Whidbey Is.	A	482-1223

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
11.20	Apr 2	1005	Vicinity Deception Pass Bridge, Whidbey Island	A	482-1223
11.21	Apr 2	1825	Vicinity Deception Pass Bridge, Whidbey Island	A	482-1223
11.22	Apr 13	1630	Deception Island	CR	482-1223
11.23	Apr 20	-	Deception Island	CW	482-1223
11.24	May 10	-	Bud Anderson and Bret Gausoin recovered tail feather with transmitter still attached		

BALD EAGLE NO. 12, one- or two-year-old

12.01	Feb 11	0800	N. fork Nooksack R., at Kendall Creek	T	485-1220
12.02	Feb 13	1326	N. fork Nooksack R., near Maple Falls	A	485-1220
12.03	Feb 14	1414	N. fork Nooksack R., upstream of Kendall	A	485-1220
12.04	Feb 15	1954	N. fork Nooksack R., just downstream mouth of Maple Creek	CR	485-1220
12.05	Feb 18	0844	N. fork Nooksack R., mouth of Maple Creek	C	485-1220
12.06	Feb 19	1349	Vicinity of Kendall-Maple Falls	A	485-1220
12.07*	Mar 8	1540	Stream/slough (or S. of it) between Chilliwack and Rosedale, B.C., Canada	A	490-1215
12.08*	Mar 24	1611	Harrison River, half-way between confluence with Fraser R. and Harrison Lake, B.C., Canada	A	491-1215
12.09*	Apr 25	-	Knight Inlet - Klinaklini River, British Columbia	A	510-1253

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
BALD EAGLE NO. 13, three-year-old					
13.01	Feb 13	0900	N. fork Nooksack R., Welcome Bridge at Welcome	T	485-1220
13.02	Feb 15	1952	N. fork Nooksack R., at Maple Creek	CR	485-1220
13.03	Feb 18	0902	N. fork Nooksack R., 0.5 mi. downstream Kendall Creek	C	485-1220
13.04	Feb 19	1420	N. fork Nooksack R., general vicinity	A	485-1220
13.05	Feb 23	1700	N. fork Nooksack R., vicinity of Deming	A	484-1221
13.06*	Feb 24	1712	Vicinity of Sumas	A	485-1221
13.07*	Feb 25	1130	N. fork Nooksack R. - general vicinity	A	485-1220
13.08*	Feb 29	1318	Vedder R., British Columbia, Canada, ca. 1/4-1/2 mi. upstream confluence with Fraser R.	A	490-1215
BALD EAGLE NO. 14, three-year-old					
14.01	Feb 14	0900	N. fork Nooksack R., just upstream of Kendall hatchery	T	485-1220
14.02	Feb 15	1953	N. fork Nooksack R., vicinity of Maple Creek	CR	485-1220
14.03	Feb 18	0841	N. fork Nooksack R., 4 mi. upstream Maple Creek	C	485-1220
14.04	Feb 19	1353	N. fork Nooksack R., upstream of Kendall	A	485-1220
14.05	Feb 23	1713	N. fork Nooksack R., between Maple Falls and Glacier	A	485-1220
14.06	Feb 24	1712	N. fork Nooksack R., between Kendall and Glacier	A	485-1220
14.07	Mar 1	1330	N. fork Nooksack R., between Kendall and Glacier	A	485-1220

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
14.08	Mar 5	1452	N. fork Nooksack R., between Maple Falls and Glacier	AF	485-1220

BALD EAGLE NO. 15, three-year-old

15.01	Feb 15	1130	N. fork Nooksack R., at mouth of Kendall Creek	T	485-1220
15.02	Feb 15	1935	N. fork Nooksack R., near Kendall Creek Salmon Hatchery	CR	485-1220
15.03	Feb 18	0846	N. fork Nooksack R., vicinity of Maple Creek	C	485-1220
15.04*	Feb 19	1343	Nooksack R., between Lawrence and Deming (closer to Lawrence)	A	485-1221
15.05	Feb 24	1703	N. fork Nooksack - general vicinity	A	485-1220
15.06*	Feb 25	1341	Tributary of Fraser R. (B.C.) near Deroche (NW of Chilliwack)	A	491-1220
15.07	Feb 25	1450	Tributary of Fraser R. (B.C.) near Deroche (NW of Chilliwack)	A	491-1220
15.08*	Feb 29	1308	Up Harrison Lake, vinicity Long Island (B.C., Canada)	A	493-1215
15.09*	Mar 5	1345	On large gravel bar island in Fraser R., just downstream Mission City (B.C., Canada)	A	490-1222
15.10*	Mar 8	1555	At confluence Fraser R., and Vedder R., (B.C., Canada)	A	490-1220

BALD EAGLE NO. 16, two-year-old

16.01	Feb 15	1700	N. fork Nooksack R., Welcome Bridge at Welcome	T	485-1220

Seq. No.	Date	Time	Location	Codes	Lat.-Long.
16.02	Feb 18	0914	N. fork Nooksack R., upstream of Welcome (general location)	C	485-1220
16.03	Feb 19	1359	N. fork Nooksack R., - general location	A	485-1220

BALD EAGLE NO. 17, three-year-old

17.01	Feb 15	1700	N. fork Nooksack R., Welcome Bridge at Welcome	T	485-1220
17.02	Feb 18	0911	N. fork Nooksack R., 1 mi. upstream jct. Hwy. 9 and 542	C	484-1221
17.03+	Feb 19	1420	S. fork Nooksack R., near Acme - general location	AU	484-1221
17.04	Feb 23	1728	S. fork Nooksack R., downstream of Acme	A	484-1221
17.05	Feb 24	1729	S. fork Nooksack R., near Acme	A	484-1221
17.06	Feb 29	1119	Detected from Chuckanut Mtn. toward San Juan Islands	AU	
17.07*	Mar 1	1137	Skagit R. at Lyman	C	483-1220
17.08*	Mar 5	1518	S. fork Nooksack R., vicinity of Acme	AU	484-1221
17.09*	Mar 8	1417	Probably at ridge S. of Hamilton, on Skagit R.	A(F)	482-1215
17.10*	Mar 20	1802	S. fork Nooksack R., at Clipper	A	484-1221
17.11*	Apr 25	-	Knight Inlet - Klinaklini River, British Columbia	A	510-1253

APPENDIX D

INFORMATION ON BALD EAGLE FEEDING AREAS. Crop index scores (F) were obtained by dividing the total number of crop scores (D + E) for a 0.5 mi. segment by the number of partial plus full crop scores (E) and multiplying by 100. Crop index was not calculated in samples of less than 10 scores. The index of feeding observations (H) was calculated by dividing the number of eagles observed feeding or carrying food (G) by the total number of eagles observed in that 0.5 mi. segment (x 100). Chum carcass scores (I) were obtained from data provided by the Washington Department of Fisheries for surveys conducted in 1976 and 1977. Coho spawning distribution information among tributaries (J) was gotten from Washington Department of Fisheries (1975) and augmented with our own data. (Coho) = known coho spawn, (Coho) = probable but unsubstantiated coho spawn). Locations within the PIA are marked with asterisks. Double asterisks indicate that river segments were not sufficiently accessible to the census route to permit projection calculations. On Jan. 9 and 17, BSAI conducted a carcass survey of the entire SRSA (river only). Column K shows the number of available completely consumed carcasses (upper number) and the number of available and still utilizable carcasses (lower numbers).

	River Mile	Location	Observed Mean Eagles Per Day (A)	Projected Mean Per Day (B)	Projected with sub-adult Correction (C)	Empty Crops (D)	Partial or Full Crops (E)	Crop Index (F)	Observed Feeding or Carrying Food (G)	Index of Feeding Observations (H)	Chum Carcass Score (I)	Known Coho Spawn in Tributaries (J)	January Carcass Counts (BBAI) (K)
1	66.0		1.00	1.92	2.11	0	1	-	0	0	3		-
2	66.5		2.23	3.60	3.82	3	2	-	1	1	3		-
3	67.0	Sauk River Mouth	1.77	1.77	1.95	3	4	-	1	1	3		-
4	67.5		0.87	0.87	0.96	19	0	0	1	2	0		-
5	68.0		2.33	2.33	2.56	10	11	52	9	8	3		2/3
6	68.5		1.15	1.15	1.26	8	0	-	1	2	3		0
7	69.0		0.83	1.66	1.83	3	1	-	1	2	3		0
8	69.5	Washington Eddy	7.92	8.61	9.47	28	24	46	48	13	3		3/0
9	70.0		2.71	5.21	5.73	4	1	-	20	15	3		1/0
10	70.5		1.81	2.21	2.43	10	7	41	2	2	2		2/0
11	71.0		2.21	2.33	2.56	32	6	16	7	7	0		0
12	71.5		2.04	6.80	7.48	9	7	44	0	0	3	Coho	0
13	72.0	Illabot Bend	2.77	2.77	3.05	37	17	31	10	11	3		0
14	72.5		5.06	7.03	7.73	22	4	15	19	8	3		0
15	73.0		1.67	2.93	3.22	7	3	30	0	0	3		0/1
16	73.5		0.71	0.89	0.98	7	4	36	2	6	3	Coho	0
17	74.0	Corkindale Crk.	0.10	0.27	0.30	0	0	-	0	0	3	Coho	1/0
18	74.5		0.00	-**	-**	0	0	-	0	0	2	Coho	0
19	75.0		0.04	-**	-**	0	0	-	0	0	2		0
20	75.5		0.29	0.64	0.71	9	0	-	0	0	0		0
21	76.0		0.65	0.65	0.71	10	1	9	2	6	0		0/1
22	76.5		0.73	0.97	1.07	8	3	27	2	6	0		0
23	77.0		0.67	0.70	0.78	7	2	-	0	0	3	(Coho)	0/1
24	77.5	Cascade R. Mouth	0.71	0.77	0.85	11	0	0	0	0	3	Coho	0
25	78.0	Marblemount Bridge	0.98	0.98	1.08	16	0	0	0	0	3		0
26	78.5		0.23	0.23	0.25	5	1	-	0	0	0	Coho	0
27	79.0		0.31	0.31	0.34	5	2	-	0	0	0		0
28	79.5		0.35	0.35	0.38	8	1	-	0	0	3		0
29	80.0		0.19	0.51	0.56	2	1	-	0	0	0		0
30	80.5	Diobsud Crk. Mouth	0.52	0.69	0.76	4	1	-	0	0	0	Coho	0/1
31	81.0		0.23	0.46	0.51	4	1	-	0	0	0		0/1
32	81.5		0.06	0.06	0.07	1	1	-	0	0	0		0
33	82.0		0.06	0.10	0.11	1	2	-	0	0	0		0
34	82.5	Bacon Crk. Mouth	0.75	0.86	0.95	8	3	27	0	0	0	Coho	0
35	83.0		0.06	0.17	0.19	0	0	-	0	0	0		0
36	83.5		0.19	0.51	0.56	1	2	-	0	0	0		0
37	84.0*	Copper Crk. Mouth	0.40	0.60	0.66	4	2	-	0	0	0		1/0
38	84.5*		0.25	0.25	0.27	5	1	-	0	0	0		0
39	85.0*		0.29	0.56	0.61	0	0	-	0	0	0	(Coho)	0
40	85.5*		0.10	0.21	0.23	1	0	-	0	0	0		0
41	86.0*	Missing Bridge Gorge	0.06	0.06	0.07	0	0	-	0	0	0		-
42	86.5*		0.21	0.21	0.23	7	1	-	0	0	0		-
43	87.0*		0.35	0.36	0.40	6	3	-	0	0	0		0
44	87.5*		0.23	1.53	1.69	5	1	-	0	0	0	Coho	0
45	88.0*		1.04	1.04	1.14	21	8	28	0	0	0	(Coho)	0
46	88.5*		1.17	1.27	1.40	14	1	7	0	0	0		0
47	89.0*	County Line Ponds	3.31	4.41	4.85	33	16	33	4	2	0	Coho	0
48	89.5		1.02	4.08	4.49	10	3	23	0	0	0	Coho	1/0
49	90.0*	Thornton Crk. Mouth	0.21	0.70	0.77	1	3	-	0	0	3	Coho	1/0
50	90.5*		0.44	0.71	0.78	3	6	-	0	0	3		0
51	91.0*		0.19	0.70	0.77	3	1	-	0	0	0		0
52	91.5*		0.21	0.57	0.62	4	0	-	0	0	0	Coho	0
53	92.0*		0.19	0.54	0.60	4	1	-	0	0	2		0
54	92.5*		0.27	0.35	0.39	5	2	-	0	0	0	Coho	-
55	93.0*	Newhalem	0.00	0.00	0.00	0	0	-	0	0	0		-
56		W. Illabot	3.25	-	-	55	14	20	0	0	3	Coho	-
57		E. Illabot	2.52	-	-	32	6	16	3	2	3	Coho	-
58		Illabot fields	0.19	-	-	0	0	-	0	0	-		-
59		Illabot Crk. Bridge	0.04	-	-	0	0	-	0	0	-	Coho	-
60		Barnaby Slough	1.23	-	-	17	1	5	0	0	-		-
61		Roost Site	0.04	-	-	0	0	-	0	0	-		-
62		Lower Cascade R. & Buller's	1.90	-	-	33	9	21	6	7	-	Coho	-
63		Jordan Creek	0.02	-	-	0	0	-	0	0	-	Coho	-
64		Cascade R. Bridge	0.65	-	-	11	5	31	0	0	-		-
65		Diobsud Crk. Bridge	0.44	-	-	9	3	25	0	0	-		-
66		Bacon Crk. Bridge	0.56	-	-	6	5	45	0	0	-	Coho	-
67	*	Aggregate Ponds	0.35	-	-	4	1	-	0	0	-		-
68	*	Goodell Crk. Mouth	0.06	-	-	0	0	-	0	0	-		-

APPENDIX E

Human disturbance factors recorded at each 0.5 mile segment in the SRSA

	River Mile	Location	A Fisherman on Foot Open View	B Others on Foot Open View	C Others on Foot Veg. Buffer	D Boats Drifting	E Boats Using Motor	F Car Stopped People Inside	G Car Stopped People Outside	H Logging or Construction	I Auditory	Total Active Disturbance Entries (A-I)	Total Passive Disturbance Factor	Projected Eagle Numbers Per Day
1	66.0		0	0	0	2	5	0	0	0	1	8	1	1.92
2	66.5		1	1*	0	8	9	0	0	8	0	27	1	3.60
3	67.0	Sauk River Mouth	1	2	0	13	14	0	0	0	1	31	1	1.77
4	67.5		7	2	0	17	10	0	0	0	1	37	9	0.87
5	68.0		14	0	1	17	14	1	0	0	1	48	5	2.33
6	68.5		73	8	0	7	4	0	0	0	0	92	2	1.15
7	69.0		3	0	0	10	3	0	1	0	0	17	2	1.66
8	69.5	Washington Eddy	1	3	0	3	3	3	8	1	2	24	5	8.61
9	70.0		3	1	0	2	1	0	4	0	0	11	3	5.21
10	70.5		2	2	0	3	0	0	1	0	0	8	5	2.21
11	71.0		0	0	0	0	3	0	0	0	0	3	7	2.33
12	71.5		0	0	0	3	2	0	0	0	0	5	3	6.80
13	72.0	Illabot Bend	0	3	0	1	1	0	1	0	0	6	5	2.77
14	72.5		0	0	0	0	1	1	1	0	0	3	2	7.03
15	73.0		0	0	0	0	0	0	0	0	0	0	3	2.93
16	73.5		2	4	1	1	0	0	1	0	0	9	3	0.89
17	74.0	Corkindale Crk.	0	0	0	0	0	0	0	0	0	0	2	0.27
18	74.5		0	0	0	0	0	0	0	0	0	0	2	-
19	75.0		0	0	0	0	0	0	0	0	0	0	2	-
20	75.5		0	0	0	0	0	0	0	0	0	0	6	0.64
21	76.0		0	0	0	2	0	0	0	0	0	2	8	0.65
22	76.5		0	0	0	1	0	1	0	0	0	2	7	0.97
23	77.0		0	1	0	1	0	0	0	0	0	2	5	0.70
24	77.5	Cascade R. Mouth	1	0	0	0	0	1	0	0	0	2	4	0.77
25	78.0	Marblemount Bridge	0	1	0	7	2	0	5	0	0	15	9	0.98
26	78.5		0	1	0	0	0	0	0	0	0	1	8	0.23
27	79.0		0	0	0	0	0	0	0	0	0	0	8	0.31
28	79.5		0	0	0	0	0	0	1	0	0	1	8	0.35
29	80.0		0	0	0	0	0	0	0	0	0	0	2	0.51
30	80.5	Diobsud Crk. Mouth	0	0	0	0	1	0	0	0	2	3	2	0.69
31	81.0		0	1	1	0	0	0	1	0	0	3	4	0.46
32	81.5		0	0	0	0	0	0	0	0		0	7	0.06
33	82.0		0	0	0	0	0	0	0	0	0	0	2	0.10
34	82.5	Bacon Crk. Mouth	0	0	0	2	0	0	1	2	0	5	5	0.86
35	83.0		0	1	0	0	0	0	0	0	0	1	2	0.17
36	83.5		0	0	0	1	0	0	0	0	0	1	1	0.51
37	84.0*	Copper Crk. Mouth	0	0	0	0	0	0	0	0	0	0	3	0.60
38	84.5*		0	0	1	0	0	0	0	0	0	1	6	0.25
39	85.0*		0	0	0	0	0	0	0	0	0	0	1	0.56
40	85.5*		0	0	0	0	0	1	0	0	0	1	2	0.21
41	86.0*	Missing Bridge Gorge	0	0	0	0	0	0	0	1	0	1	6	0.06
42	86.5*		0	0	0	0	0	0	0	0	0	0	6	0.21
43	87.0*		0	0	0	0	0	1	1	0	0	2	5	0.36
44	87.5*		0	0	0	0	0	0	0	1	0	1	1	1.53
45	88.0*		0	0	0	0	0	0	0	0	0	0	6	1.04
46	88.5*		0	0	0	0	0	2	0	0	0	2	4	1.27
47	89.0*	County Line Ponds	0	1	2	0	0	0	0	0	0	3	1	4.41
48	89.5		0	1	0	0	0	1	1	0	0	3	4	4.08
49	90.0*	Thornton Crk. Mouth	1	0	2	0	0	0	0	0	0	3	1	0.70
50	90.5*		0	0	0	0	0	0	0	0	0	0	1	0.71
51	91.0*		0	0	0	0	0	0	0	0	0	0	3	0.70
52	91.5*		0	0	0	0	0	0	0	0	0	0	2	0.57
53	92.0*		0	1	0	0	0	0	0	0	0	1	1	0.54
54	92.5*		0	0	0	0	0	0	0	0	1	1	4	0.35
55	93.0*	Newhalem	0	0	0	0	0	0	0	0	0	0	5	0.00
56		W. Illabot	0	0	0	0	0	0	0	0	0	0	1	
57		E. Illabot	0	0	0	0	0	0	0	0	0	0	1	
58		Illabot fields	0	0	0	0	0	0	0	0	0	0	1	
59		Illabot Crk. Bridge	0	0	0	0	0	0	0	0	0	0	2	
60		Barnaby Slough	0	0	0	0	1	1	0	0	0	2	2	
61		Roost Site	0	0	0	0	0	0	0	0	0	0	1	
62		Lower Cascade R. & Buller's	2	1	0	0	0	0	1	1	0	5	7	
63		Jordan Creek	0	0	0	0	0	0	0	0	0	0	2	
64		Cascade R. Bridge	0	0	0	0	0	1	1	0	0	2	5	
65		Diobsud Crk. Bridge	0	0	0	0	0	0	0	0	0	0	5	
66		Bacon Crk. Bridge	0	0	0	0	0	0	0	0	0	0	2	
67		Aggregate Ponds*	0	0	0	0	0	0	0	0	0	0	1	
68		Goodell Crk. Mouth*	0	0	0	0	0	0	0	0	0	0	2	