STATUS OF THE BALD EAGLE IN BRITISH COLUMBIA

by
D.A. Blood
and
G.G. Anweiler

Wildlife Branch
Ministry of Environment, Lands & Parks
Victoria, B.C.

Wildlife Working Report No. WR-62

February 1994

STATUS OF THE BALD EAGLE IN BRITISH COLUMBIA

by
D.A. Blood
and
G.G. Anweiler

Wildlife Branch
Ministry of Environment, Lands and Parks
Victoria, B.C.

Wildlife Working Report No. WR-62

February 1994

"Wildlife Working Reports frequently contain preliminary data, so conclusions based on these may be subject to change. Working Reports receive little review. They may be cited in publications, but their manuscript status should be noted. Copies may be obtained, depending upon supply, from the Ministry of Environment, Lands and Parks, Wildlife Branch, 780 Blanshard Street, Victoria, B.C., V8V 1X4."

Canadian Cataloguing in Publication Data
Blood, D. A.
Status of the bald eagle in British Columbia

(Wildlife working report ; no. WR-62)

Includes bibliographical references: p.
ISBN 0-7726-2060-1

1. Bald eagle - British Columbia. I. Anweiler, G. G. II. BC Environment. Wildlife Branch. III. Title. IV. Series.

QL696.F32B56 1994 598.916 C94-960087-3

FORWARD

In cases where a Wildlife Working Report is also a Species' Status Report, it may contain a recommended status for the species by the author. This recommendation is the opinion of the author and may not necessarily reflect that of the Wildlife Branch.

Official designations will be made by the Wildlife Branch in consultation with experts, and the data contained in the Status Report will be considered during the evaluation process.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SUMMARY

I. GENERAL BIOLOGY

i. Reproduction

The Bald Eagle (*Haliaeetus leucocephalus*) is a large bird with delayed maturation, small clutch size, and long lifespan. Though capable of breeding at 4 years of age, many do not nest until they are 6 or 7 years old. Only one clutch is raised per year, and in saturated populations, a large proportion of the adults do not breed every year.

Bald Eagles nest earlier in the season than most other birds in the same area. In British Columbia, egg laying varies from late February/ early March on the south coast to about mid-April in the northern Interior. The incubation period is about 35 days. Young remain in the nest for l0 to 13 weeks, and may frequent the nest site for several additional weeks. Young may fledge from nests as early as the end of June on the south coast and as late as late August in the northern Interior.

Bald Eagles are territorial during the nesting period. Although active nests may be as little as 500 m apart, the average distance between active nests in good coastal habitat is about 3 to 4 km. Nesting eagles cannot be expected to crowd into scattered remnants of old growth as shoreline forests are clear-cut.

Nest records for British Columbia indicate that 63% of clutches had 2 eggs, 31% had l egg, and 6% had 3 eggs. Based on a few studies in the southern part of the province, nesting success was 62% to 91% in recent years, and the number of young fledged per occupied site varied from 0.9 to l.5. These statistics are similar to those for adjacent jurisdictions and suggest that eagle populations here are stable or increasing. However, survival rates of adults and the percentage of adults that do not successfully nest, statistics which are not generally available, may be more important in maintaining eagle populations than the productivity of the adults that do breed.

ii. Population Structure

Sex ratios are not available for either juvenile or adult eagles. Immature eagles make up 35% to 41% of the population in British Columbia in mid-winter, suggesting a normal rate of reproduction and juvenile survival.

iii. Mortality and Survival Rates

Mortality between egg and fledging stages is about 40% to 50%, and only 5% to 20% of fledged young reach breeding age. The annual mortality rate of adults has been estimated at 5%. In the wild, eagles have been known to live at least 27 years.

iv. Movements and Seasonal Concentrations

Bald Eagles that nest in interior British Columbia and across the boreal forest of Canada migrate south into the United States for the winter. Major wintering areas of those birds are along the Mississippi and Missouri rivers and other rivers in the west, where they concentrate at many reservoirs and National Wildlife Refuges. Many eagles that nest on the British Columbia coast make late-summer movements to southeast Alaska or the interior of B.C. where early salmon runs occur, and then return to the British Columbia Coast for the winter. Salmon spawning streams are the major concentration areas from late autumn to mid-winter. In spring, concentrations are often associated with staging and spawning herring and with eulachon runs. Minor summer concentrations occur at food sources, such as seabird colonies and places where tidal currents bring hake to the surface. Eagles move a great deal to take advantage of seasonal food sources.

v. Behaviour and Adaptability

Food habits — The Bald Eagle is one of the most versatile birds in North America, with respect to its food habits. Fish make up the bulk of the annual diet in most areas; however, seabirds, waterfowl, and intertidal invertebrates may be of high seasonal importance, and such diverse items as gull eggs, Chukar Partridge, rabbits, hares, and Muskrats are taken where locally abundant. Much of the above food is obtained as carrion; however, apparently healthy fish, birds, and mammals are captured. Large mammals, such as dead livestock; ungulates killed by traffic, wolves or severe weather; and beached whales or sea lions, are important foods. Bald Eagles have adapted to many food sources made available by humans.

Nesting habits — Nests are almost always in dominant old-growth trees near saltwater or freshwater shorelines. Many tree species, both coniferous and deciduous, are used. Two or more alternative nests may occur in a breeding territory, but eagles normally use the same nest for several years in succession. Being dependent on large, hence old, trees located near an abundant food source, Bald Eagles are somewhat specialized in their nesting habits. They cannot be expected to adapt to second-growth nest trees or to nest far from shorelines.

Roosting behaviour — In winter, Bald Eagles typically use communal night roosts in large coniferous or deciduous trees. These are usually near food concentrations; however, eagles will fly up to 30 km to roost. The importance of roosts for eagle survival has not been conclusively demonstrated.

Disturbance — Although chronic disturbance may result in disuse of some otherwise suitable habitats, continued nesting in settled areas suggests considerable tolerance of human activity. However, frequent flushing of eagles from feeding sites, particularly in winter, is expected to have adverse bioenergetic consequences.

Adaptability to human-caused habitat change — Bald Eagles are relatively tolerant of land use changes surrounding their nest sites, but, of course, cannot adapt to a complete loss of old-growth trees. Eagles are not expected to be very adaptable to adverse impacts on their food resources; however, documentation of such effects is lacking. Eagles have responded favourably to human-caused habitat changes that have enhanced forage resources.

Vulnerability to severe natural events — Local populations may sometimes suffer setbacks from natural events like severe storms; however, the species as a whole is not particularly vulnerable.

II. HABITAT

i. Habitat Characteristics

North America — The main components of Bald Eagle nesting habitat throughout North America are large trees for nest sites and hunting perches in proximity to relatively extensive aquatic habitats, preferably shallow waters, and an abundant supply of food in the form of fish or aquatic birds. On treeless offshore islands, nesting may occur on the ground. Open water is the most important component of winter habitat, since this provides access to the major winter foods: fish and waterfowl. Nocturnal roost trees are also important in winter. Diurnal perches adjacent to food sources are important at all seasons.

British Columbia — Nesting season habitat consists of large, usually old, nest trees plus adjacent aquatic foraging habitat. Best habitats are along the seacoast, especially at or near estuaries and broad intertidal zones, island and reef complexes, seabird colonies, and sites with strong tidal currents. Most important Interior nesting habitats are along large low-gradient rivers with high floodplain/wetland development, and at low elevation lakes and wetland complexes of the Interior Plateau. At least 13 species

of nest trees are used in British Columbia; Sitka spruce, Douglas-fir, western redcedar, cottonwood, and aspen are the most frequent. These are dominant or co-dominant specimens in the nest vicinity - often gnarled and very old. Mean distances of nests from shorelines in various study areas varied from 24 m to 173 m. Distances appear to be greatest where the nearshore area is most developed. Nests occur in extensive old-growth stands, fragmented old-growth parcels, and lone veteran trees in second growth or slash. The nest tree environments vary from remote wilderness to urban landscapes.

Winter foraging habitat on the coast includes the intertidal zone, salmon and eulachon spawning streams, herring staging/spawning sites, and estuaries with waterfowl concentration. In the Interior, large southern lakes with wintering coots and diving ducks, rivers below power dams, and low-elevation ungulate ranges are the usual winter habitats. On the coast, old-growth conifers and/or cottonwoods provide communal night roosts near some concentrated food sources.

ii. Habitat Impacts and Trends

Removal of nest trees is mostly attributable to logging; however, clearing for settlement, agriculture, and other purposes also contributes to the impact. Linear developments like highways, powerlines, and pipelines often follow valley bottoms or parallel rivers, further reducing the stock of nest trees. Hydro dams have flooded habitat in some areas. The same factors also threaten diurnal perches and night roosts. Industrial pollutants are a potential threat through contamination of eagle foods. Shoreline development may inhibit eagle foraging in some areas. Excessive harvest of eagle foods by humans could also have an adverse impact on eagle populations.

Significant, permanent reduction of nesting populations has probably only occurred in urban areas like Greater Vancouver and Victoria, but nesting habitat loss is accelerating on southeast Vancouver Island, the Gulf Islands, and in the Fraser Valley. In those areas the current rate of change is at least moderate and of concern because the losses are permanent. Nesting habitat is also changing rapidly in coastal areas subject to clear-cut logging; however, this is of less concern because logging companies are starting to inventory for nests before logging and, therefore, nest trees are often spared, many sites are non-operable, and, as a last resort, some second-growth trees can be allowed to advance to old-growth status. Impacts on feeding habitat have probably been significant only in the Georgia Depression, and even there the current rate of degradation would be rated as slow.

About 90% of British Columbia's Bald Eagles nest on Crown lands, where government could institute programs to control logging impacts on nesting populations. Probably less than l0% of nest sites are in protected areas such as parks or Ecological Reserves. Nest tree protection is presently not adequate on either Crown or private land. Most critical habitat, particularly on Crown lands, can probably be protected by means other than land acquisition. Some land acquisition would be desirable in the Georgia Depression, but waterfront lands here are very expensive.

III. DISTRIBUTION

i. North America

Nesting is widespread in North America, occurring from the Aleutian Islands to Newfoundland, and south to California, Arizona, and Florida. Major wintering areas are the Pacific Coast from Alaska to Oregon, and major river valleys of the central and western United States.

ii. Canada

Bald Eagles nest across boreal Canada north to the tree line, and south to the U.S. border. Exceptions include the treeless prairies and urbanized areas. Most Canadian nesting populations outside B.C. winter in the U.S.

iii. British Columbia

The nesting range includes the whole province except for alpine/subalpine zones. Over 90% of eagles wintering here are on the coast; the remainder occur at scattered southern Interior sites, especially large lakes and ice-free rivers.

IV. POPULATION SIZE AND TRENDS

i. North America

The continental population of about 70,000 birds is stable or increasing in most areas, but the geographic range is gradually shrinking in heavily developed parts of the U.S. and southern Canada.

ii. British Columbia

The nesting season population is estimated at about 21,000 birds, including immatures (28%), non-breeding adults (30%), and nesting adults (42%), but excluding nestlings. The winter population is estimated at 20,000 to 30,000 birds, of which 35%-40% are immatures. Populations in most regions are stable because the habitat is saturated. Declines in nesting abundance have probably occurred in heavily settled areas such as southeast Vancouver Island, Greater Vancouver, and the lower Fraser Valley, and may be continuing.

V. LEGAL PROTECTION

In the United States, the Bald Eagle is protected federally by the *Bald Eagle Protection Act*, *Endangered Species Act*, and various State laws. It is listed as Endangered or Threatened in all of the lower 48 states. The *Endangered Species Act* includes provisions for habitat protection.

In Canada, the species has no direct federal protection, but direct killing and harassment is illegal under provincial and territorial statutes. Bald Eagles are listed as Endangered in Ontario and New Brunswick.

In British Columbia, no legislation exists to protect potential nest or roost trees on lands outside of parks or related reserves; however, actual nest trees are protected, whether or not they are occupied. It is the policy of both the ministries of Forests and Environment, Lands and Parks to designate “wildlife trees” and protect them from cutting.

VI. LIMITING FACTORS

i. Causes of Regional Population Declines

Bounty hunting in Alaska up to l950, and pesticide contamination in eastern North America prior to l970, caused significant declines, but populations in many areas have largely recovered. Pesticide residue (DDT) is still hampering recovery in some areas, such as southern California (R. Davies, pers. comm.). Habitat loss has been going on for 200 years and has affected populations in southern Canada and the United States.

ii. Direct Mortality

Natural mortality factors and rates in wild eagles are poorly known. Important human-related mortality factors in British Columbia are collisions with vehicles and structures, poisoning, electrocution, shooting, trapping, plumage fouling, and accidents such as entanglement in nets or fences. The proportion of the population affected is not known, but eagles appear to be maintaining their numbers in the face of such losses.

iii. Reproductive Failure

This is not a problem in British Columbia, although monitoring of pollutants such as dioxins and furans is needed.

iv. Disturbance

Human disturbance may adversely affect a few nesting or wintering eagles in localized areas in

the province, but is not felt to be a significant limiting factor. However, this may be of greater concern in the future.

v. Limiting Factors

Loss of nest trees to date has probably had a minor impact on the nesting season carrying capacity of British Columbia for Bald Eagles, however local reductions are expected to have occurred and further declines are expected. The availability of food, together with the territorial nature of nesting eagles, is felt to be the major factor presently limiting population increase.

VII. SPECIAL SIGNIFICANCE OF THE SPECIES

Although listed as Threatened or Endangered across much of its geographic range, the bulk of the population occurs in Alaska, British Columbia, and the Canadian boreal forest, locations where populations and habitats are quite secure. Public interest in the species is very high because of a general fascination with large raptors, and because this one is the national bird of the United States. Predation impacts by Bald Eagles are of little economic concern. Nature tours featuring Bald Eagles have much economic potential in British Columbia and elsewhere.

VIII. PROTECTION AND MANAGEMENT

i. Inventory Needs

A province-wide inventory of nest trees and communal roosts is needed in order to protect these habitat requirements.

ii. Protection Needs

Recent changes to the *Wildlife Act* have provided a formal provincial policy, backed by regulation, that is providing needed protection of nest trees in British Columbia. On private lands, a public information program aimed at land owners/managers is the most urgent need. Protection from degradation and pollution of buffer areas around nest trees, key forage resources, and habitats is also needed.

Reduction of direct mortality could be achieved by province-wide elimination of lead shot, discontinued use of some pesticides, movement of ungulate carcasses away from road edges, modified design of power lines, reduced use of leg-hold traps and snares, increased enforcement where shooting is a problem, and increased support of rehabilitation programs. Areas where protection from human disturbance is required need to be identified and managed accordingly.

iii. Research Needs

The following research needs are discussed:

1. Assessment of forest practices in relation to nesting abundance
2. Assessment of mortality rates and causes
3. Monitor contaminants in eagles and their food
4. Evaluation of eagle movement patterns
5. Assess tolerance of nesting eagles to human civilization
6. Determine rates of non-breeding by adults

IX. EVALUATION

The Bald Eagle should be removed from the provincial Blue List and placed on the Yellow List. If criteria were applied on a regional basis, the species might warrant Blue-list status in the Georgia Depression Ecoprovince[1]. Localized declines in nesting status will probably occur unless more effort is made to preserve known and potential nest trees.

[1] Ed. Note: The current (1993) edition of the Provincial Blue List includes the Bald Eagle.

1.0 GENERAL BIOLOGY

1.1 Reproduction

The basic elements of Bald Eagle reproductive biology have been known for some time (Bent l937), and have been recently summarized by several authors (Snow l973; Beebe l974; Brownell and Oldham l983; Gerrard and Bortolotti l988). Parameters such as breeding age and clutch size are quite similar throughout the species range, however, seasonal timing of events varies greatly with latitude, elevation, and continentality. Most reproductive information is from studies done outside British Columbia, but information for this province is introduced for comparative purposes when available. Campbell *et al.* (l990) summarize Bald Eagle breeding information for British Columbia.

1.1.1 Breeding age and frequency

The Bald Eagle is a large bird with delayed maturation, small clutch size, and long lifespan. The species undergoes a prolonged maturation process, with corresponding plumage changes from the all-dark plumage of the first year bird to the white head and tail of the mature eagle, essentially obtained when four years old (Bortolotti l984). Bald Eagles are capable of breeding at four years of age and, in areas where populations are depressed and vacant habitat is available, they do so; however, in stable populations where most territories are already occupied, most Bald Eagles may not mate or breed until six years old or older (Gerrard and Bortolotti l988).

There is little information on how long eagles live in the wild or on how long they remain productive. A female, recaptured in Alaska at the age of 21 years and ll months, was breeding (Cain l986). The oldest known age of a wild eagle is 27 years (Evans l982). In captivity, eagles have lived to 50 years (Snow l973).

Many authors have stated that eagles remain mated for life and occupy the same nesting territory for many years (Retfalvi l965; Robards and King l966, Brown and Amadon l968). Recent work with colour-marked eagles in Saskatchewan has tended to support this, although it was also suggested that some adults may remate following a failed nesting attempt (Gerrard and Bortolotti l988). In Alaska, three adults were observed attending one nest; the same behaviour was observed at one nest in Maine (Fraser *et al.* l983).

Bald Eagles are capable of producing only one brood per year. The first set of eggs may be replaced if lost early in incubation (Bent l937). The frequency with which pairs reproduce is not well documented, but many nests are active year after year and it is possible that under optimal conditions most pairs will attempt reproduction annually. However, in most populations studied, a number of pairs either fail early in the incubation process or fail to breed at all. The factors that determine whether or not a pair attempts reproduction are not well understood, although weather, disturbance, availability of food, and the outcome of the previous year's nesting attempt have all been suggested as possible factors (Gerrard and Bortolotti l988). In some years, up to 86% of the adults in southeast Alaska did not breed (Hansen and Hodges l985). In Saskatchewan, about 40% of the population in an average year was made up of breeding adults, 20% consisted of adults not associated with nests, and the remainder were immature birds (Gerrard and Bortolotti l988). These percentages suggest that where the

breeding habitat is fully occupied, many adult eagles do not nest every year.

1.1.2 Timing of reproductive events

Major events in the reproductive cycle of Bald Eagles include courtship and nest repair, egg laying, incubation, care of young in the nest, fledging of young, and post-fledging association of young with the nest site. In total, these activities may encompass six months or more. Where food is available in winter, adults may be seen at or near their nests at any time of the year. Bald Eagles nest earlier in the season than most other birds occurring in the same area (Figure 1).

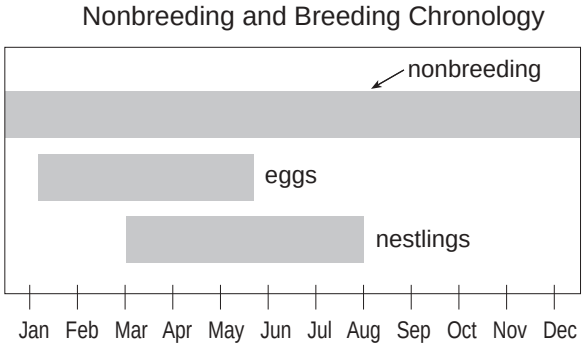


Figure 1. Seasonal occurrence of nonbreeding Bald Eagles, and of egg and nestlings, in British Columbia. (From Campbell *et al.*

Territorial defence and courtship may start two or three months before eggs are laid. Rehabilitation of established nests occurs every year. The number of days taken for egg laying is not explicitly stated in the literature, but Gerrard and Bortolotti (l988) state that eggs are laid "... a few days apart." Incubation is reported to take 33-36 days (Herrick l932; Newton l979); up to 40 days has also been suggested (Beebe l974). Young remain in the nest for l0-ll weeks on average, but in some cases up to 13 weeks (Gerrard *et al.* l974; Newton l979). The young often remain in the vicinity of the nest for a month or more after fledging, sometimes returning to it (Gerrard *et al.* l974).

For British Columbia as a whole, dates for ll8 egg clutches varied from 12 February to 27 June, with 50% recorded between 20 April and 12 May; dates for 425 broods were 30 March to l September, with 52% between 22 June and 12 July (Campbell *et al.* l990; Figure 1). Egg laying is earliest on the south coast (mid-February onward, but primarily early March), somewhat later on the north coast and southern Interior (mostly late March to early April) and later still in the northern Interior or anywhere in the Interior at high elevations. Young may fledge from late June to late August, depending on location. In the Yellowstone area in the U.S., Swenson *et al.* (l986) found a breeding chronology difference of l month associated with an elevational difference of 765 m. As one moves north in British Columbia, eagles return to the breeding areas progressively later; Campbell *et al.* (l990) give arrival dates at the nest as follows: Fort St. John, 24 Feb.; Williams Lake, 29 Feb.; Prince George, 14 March; Atlin, l April. In southwest Yukon, the first eagles returned to the nest sites in late March (Blood and Anweiler l990a).

1.1.3 Nest dispersion

Regional nesting densities vary greatly, but are highest where food is most abundant during the brood-rearing period. However, Bald Eagles are territorial during the nesting period and will nest only so close together. Breeding eagles defend territories of l.5 km^2 to 6.0 km^2 (Broley l947), but will forage outside of the defended zone. In areas of discontinuous habitat, nests may be widely dispersed, but this is not a function of territoriality.

Mean nesting densities along shorelines in areas of high eagle abundance are about l nest per 3 km to 4 km (Hodges l982), however, minimum observed distances between active nests are less than this, i.e., 650 m at Admiralty Island, Alaska (Robards and King l966) and 500 m near Nanaimo (Blood l989a). Mahaffy and Frenzel (l987), by observing responses to decoys, determined the average defended distance from active nests to be 600 m.

The territorial nature of Bald Eagles is of significance for conservation planning in areas where old-growth forest is being lost. In such areas, nesting eagles cannot be expected to crowd into remaining forest fragments. Rather, the carrying capacity is reduced in proportion to the amount of habitat lost.

1.1.4 Productivity

Reproductive terminology follows Postupalsky (l974) and Swenson *et al.* (l986); definitions are given in Appendix l. The normal clutch size is two eggs, although l- and 3-egg clutches are also common (Bent l937; Snow l973). In Saskatchewan, 74% of clutches were 2-egg, 24% were 3-egg and only 3% were l-egg. For British Columbia, Campbell *et al.* (l990) reported on ll8 clutches; 63% contained 2 eggs, 31% contained l egg and 6% contained 3 eggs.

One or two young are the normal production, although three young are also fledged from some nests (Gerrard and Bortolotti l988; Blood and Anweiler l990a). Campbell *et al.* (l990) reported the size of 425 British Columbia broods of various ages as follows: l young 60%; 2 young 37%; 3 young 3%. These figures do not provide a direct estimate of productivity because many broods were not at the fledging stage.

Many Bald Eagle nest surveys have been carried out in British Columbia to assess distribution and abundance, however, there have been few studies from which the commonly used indices of success - the number of occupied sites producing young to fledging age and number of young fledged per occupied site - can be calculated. Obtaining such statistics requires an early survey to determine the number of nest sites occupied by adult pairs, and a late survey to record the number of sites having near-fledged young and the total number of fledglings present. A single survey just prior to fledging can indicate the number of young per successful nest, but this is not a particularly useful statistic because the number of unsuccessful breeding attempts is not known.

Available productivity data for British Columbia and nearby areas are given in Table l. They indicate that breeding success here is similar to and within the range of that in adjacent areas. Data on the relationship between Bald Eagle productivity and population trends is given in Table 2. The provincial productivity statistics in Table l indicate that our populations should be in the stable or increasing categories. Sprunt *et al.* (1973) stated that for an eagle population to remain stable, at least 50% of the pairs occupying territories must breed and an average of 0.7 young must be produced per pair. However, Swensen *et al.* (l986) determined that a population in the Yellowstone Unit of the Greater Yellowstone Ecosystem (in the Western U.S.) did not meet those criteria, and yet was considered stable (Table 2). It has also been stressed by Grier (l980) that the survival rates of adults and the percentage of adults that do not successfully nest may be more important in maintaining populations of long-lived birds like eagles than the productivity of the adults that do breed.

Table l. Nesting success of Bald Eagles in British Columbia and nearby areas in recent years.

Location	No. of [1] occupied territories	Nest [2] success (%)	Productivity[3]	
			Young fledged/ occupied site	Young fledged/ successful site
BRITISH COLUMBIA				
Gulf Islands (Sprunt l969)	l75	73	?	?
Nanaimo area (Blood l989a)	53	62	0.9	l.5
Fraser Valley (Dunbar l988)	32	84	1.5	l.7
S.E. B.C. (Forbes and Kaiser l984)	ll	91	1.4	1.5
Nechako R. (Blood and Anweiler 1983)	?	?	?	1.4
ADJACENT AREAS				
S.W. Yukon (Blood and Anweiler l990)	39	72	1.1	1.5
Wash. State (McAllister *et al.* l986)	144	66	0.9	1.4
Idaho (Forbes and Kaiser l984)	35	?	1.1	l.8
Montana (Forbes and Kaiser l984)	71	?	1.4	l.9

[1] may include cumulative observation in the same area for >1 year.

[2] % of occupied nest sites producing young to fledging age.

[3] an occupied nest has paired adults present early in the nesting season; a successful site produces at least one young to fledging age.

1.2 Population Structure

Although criteria have been developed to differentiate the sexes of both adult and nestling eagles based on external morphology (Bortolotti l984a,b), these are not readily used in the field and sex ratio data for wild populations are not available.

Ratios of adult to immature eagles, based on presence or absence of the white head and tail, may be quite variable due to differential sightability and movements. Ratios may vary greatly from place to place and season to season. However, some data are available from intensive studies over fairly large areas and provide an indication of normal conditions.

In summer, when nestlings and subadults are included together as immatures, the immature proportion in inland areas is about 50% (Table 3). Based on Amchitka Island data (Sherrod *et al.* l976), the proportion may be lower on the coast; however, differential distribution may be involved. Normal early autumn immature proportions appear to be in the 40% to 50% range, and mid-winter proportions in the 30% to 40% range (Table 3). During a period of pesticide-induced population decline in eastern North America in the l960s, the immature proportion dropped from 37% to 23% at Hawk Mountain, Pennsylvania (Sprunt l969), and as low as 6% in Illinois (Southern l963).

Table 2. The relationship between Bald Eagle productivity and population trends in North America.[1]

Area	Product-ivity[3]	Nest success (%)[4]	Population trend	Study period	Source
Continental Unit, GYE	1.22	68	Increasing	l976-82	Swenson *et al.* (l986)
Besnard Lake, Saskatchewan	l.l7	73	Stable	l968-81	Gerrard *et al.* (l983)
Snake Unit, GYE	l.06	67	Increasing	l976-82	Swenson *et al.* (l986)
Wisconsin	l.00	66	Stable	l962-70	Sprunt *et al.* (l973)
Kodiak Island, Alaska	l.00	63	Stable	l963-70	Sprunt *et al.* (l973)
Greater Yellowstone Ecosystem	0.98	60	Increasing	l976-82	Swenson *et al.* (l986)
Amchitka Island, Alaska	0.86	60	Increasing	l969-84	Sherrod *et al.* (l976)
San Juan Islands, Wash.	0.84	62	Stable	l975-80	Grubb *et al.* (l983)
Arizona	0.80	49	Stable	l975-80	Grubb *et al.* (l983)
Everglades, Florida	0.73	50	Stable	l961-70	Sprunt *et al.* (l973)
Yellowstone Unit, GYE	0.53	34	Stable	l976-82	Swenson *et al.* (l986)
Michigan	0.52	37	Declining	l96l-70	Sprunt *et al.* (l973)
Maine	0.35	26	Declining	l962-70	Sprunt *et al.* (l973)
Great Lakes shores	0.14	l0	Declining	l961-70	Sprunt *et al.* (l973)

1 Table from Swenson *et al.* 1986.

2 GYE = Greater Yellowstone Ecosystem.

3 Based on occupied nests.

4 Based on occupied nests.

Although summer data are lacking for British Columbia, the winter age-ratio data (Table 3) are for a large segment of the wintering population in which immature and adult eagles are thought to be well mixed. The range of 35% to 41% immatures suggests that reproduction and juvenile survival rates are normal in this population.

Table 3. The proportion of immature age-classes in stable or increasing Bald Eagle populations in northwestern North America.

Location	Season	Percent immature			Source
		Nestlings	Subadult	Total	
Northern Saskatchewan	Summer	l8	33	51	Leighton *et al.* l979
Greater Yellowstone Ecosystem	Autumn	23	21	44	Swenson *et al.* l986
Nooksack River, Washington	Winter			32-36	Stalmaster *et al.* l979
Southwestern B.C.	Winter l986			35	Farr and Dunbar l986
	Winter l987			35	Farr and Dunbar l987
	Winter l988			37	Farr and Dunbar l988
	Winter l989			40	Farr and Dunbar l990
	Winter l990			41	Dickie l990

1.3 Mortality/Survival Rates

1.3.1 Nestlings

Hodges (l982) calculated the survival rate of nestlings in southeast Alaska to be 0.57 between 8 June and 6 August. Blood and Anweiler (l990a) suggested a loss of 50% between the egg and fledging stages in southwest Yukon. In northern Saskatchewan, Gerrard and Bortolotti (l988) found that about 8% of eggs laid did not hatch, that one nestling in 3-nestling clutches usually did not survive, and that some nestling losses occurred when nests fell out of trees. Most nestling mortality apparently occurs in the first week or two after hatching.

1.3.2 Subadults

Gerrard *et al.* (l978) calculated survival rates for the first three years of life for two samples of Saskatchewan Bald Eagles; a colour-marked population, and a population consisting of all eagles banded in Saskatchewan. Survival rates for the colour-marked sample were 37% at the end of the first calendar year, 22% at the end of the second year, and l9% at the end of the third year. For the banded population, survival rates were 53%, 26%, and 20%, respectively. Brown and Amadon (l968) also published survival rates for banded eagles; their figures for the same time periods were 21%, 9%, and 4%. Sherrod *et al.* (l976) estimated that total mortality of immature eagles prior to breeding was about 90%.

1.3.3 Adults

Mortality or survival rates for adult Bald Eagles are poorly known, because few have been banded to date. On Amchitka Island, Sherrod *et al.* (l976) estimated that annual mortality of adults was 5.4%. Additional information on subadult and adult survival rates is needed. Grier (l980) has stressed that the population dynamics of Bald Eagles appear to hinge more on survival than on reproduction, yet our knowledge "... is concen-

trated on reproduction with almost no information on survival." Fraser (l985) also points out that for proper assessment of population trends, natality, mortality, immigration, and emigration rates should be measured. This has not yet been accomplished for any Bald Eagle population.

1.4 Movements and Seasonal Concentrations

1.4.1 Movements

Continental population — The seasonal movements of Bald Eagles are among the most complex of any bird (Beebe l974; Gerrard and Bortolotti l988). Seasonal movements vary from population to population, depending on geographic location, weather, food availability, age and status of the birds, and other factors.

In coastal and other temperate areas, adults may be largely non-migratory while the non-breeding or immature members of the same population may undertake long movements (Hodges *et al.* l987). Eagles from Florida are known to summer as far north as the Maritime Provinces, after the Florida breeding period (Gerrard and Bortolotti l988).

Populations breeding in northern interior North America undertake long distance movements into the southern United States, where they winter before returning to breeding areas in early spring. Eagles may winter further south than usual during severe winters, and a few may occasionally winter far north of the usual wintering areas. Adults tend to depart later and return earlier than young birds, and immatures tend to move farther than adults. Even among immatures, the youngest birds move earlier and farther than the older ones. Some populations move north after breeding, while others move south. Even on the breeding areas, age determines mobility. Breeding adults confine themselves to small territories, while non-breeding adults, and immatures in particular, may wander widely (Gerrard and Bortolotti l988). While many individuals from one area may move to the same wintering and breeding areas over a period of years, others from the same population may wander widely. Although some young eagles from Saskatchewan were found to move to the same winter area along the Missouri River over a period of several years, and to return to their lake of origin for the summer, others have been found as far as the Great Lakes, Texas, California, and even southeast Alaska (Gerrard and Bortolotti l988).

The large-scale and more traditional movements of non-coastal populations can be summarized as follows: populations breeding in the Great Lakes area and Ontario move south to winter mainly along the Mississippi River drainage; populations from western Manitoba and Saskatchewan move south to winter across the midwestern and central states, mainly along the Missouri River drainage; and populations from Alberta and Mackenzie, and possibly interior British Columbia, move into the interior western states (Gerrard l983). These birds move south in late fall (October-November) and return in early spring (March-April) (Spencer l976; Millsap l986; Gerrard l983).

Pacific Northwest populations — Movements of eagles in the Pacific Northwest are still poorly known, particularly the movements of inland populations (Beebe l974; Hodges *et al.* l987; Campbell *et al.* l990). Although eagles that breed at the coast do not undertake migrations of continental magnitude, they do move locally; immature birds in

particular engage in complex, long-distance movements. Populations in the interior are more migratory, being forced south from the breeding grounds by severe winter weather.

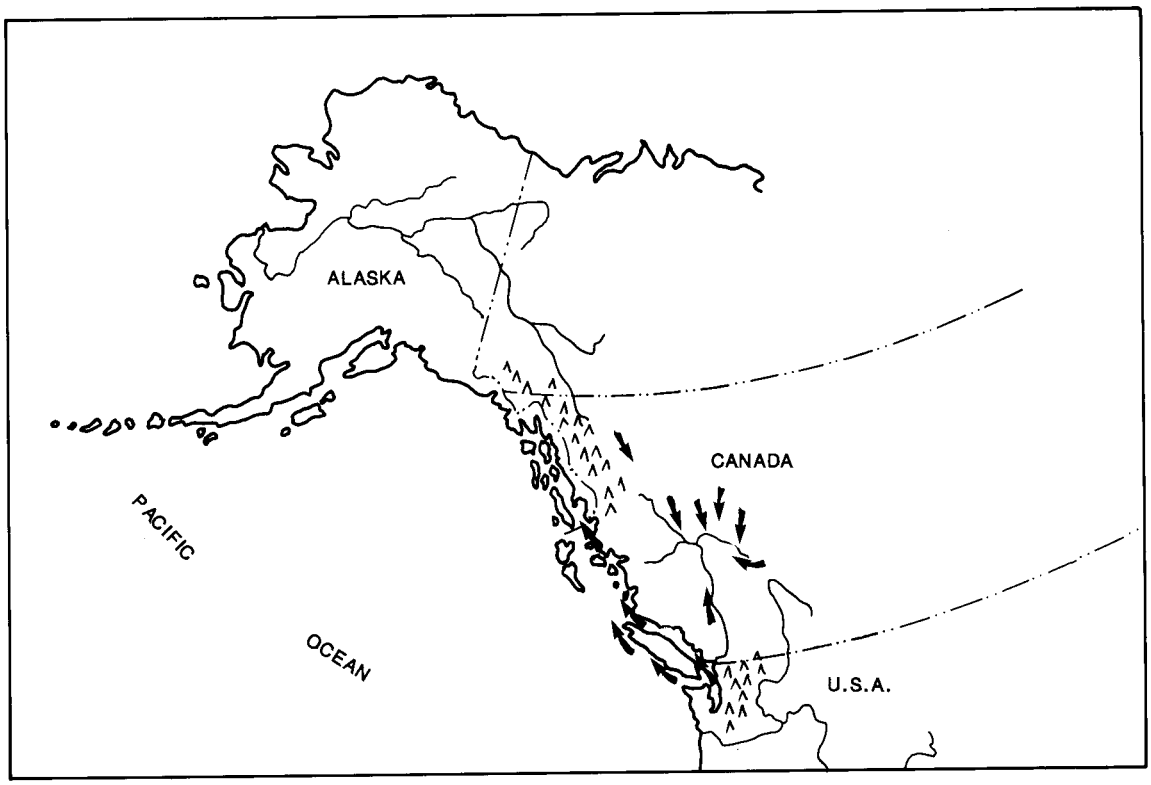
Although no part of the British Columbia coast is devoid of eagles at any time (Beebe l974), numbers in many areas fluctuate greatly at different seasons, and large numbers can be found congregating wherever fish or aquatic bird concentrations occur. Movements of eagles along the coast are largely a response to these seasonal food concentrations (Beebe l974; Servheen and English l979; Campbell *et al.* l990).

There is a rather abrupt and large-scale departure from the south coast of British Columbia in late summer, and at this time (August-September) areas such as the Gulf Islands may be almost devoid of eagles (Hancock l964; G. Anweiler, pers. comm.). It is thought that these birds move north as far as Alaska to take advantage of salmon spawning runs that peak there in mid-August. Servheen and English (l979) proposed a hypothetical late summer and early fall dispersal from the south coast of British Columbia and adjacent Washington in two directions, north to southeast Alaska and northwest over the mountains or up river valleys to salmon spawning rivers in Interior British Columbia (Figure 2). Eagles from the north coast and Interior begin to return to the south coast in late October, and spend most of the winter there (Hancock l964; Campbell *et al.* l990). Adults return earliest, then immatures. Servheen and English (l979) proposed two routes for eagles returning to the south coast of B.C. in late fall: one south along the coast from southeast Alaska, joined by birds moving from the Interior west to the coast, and a movement back down the major river systems southwest to the coast (Figure 2). Hodges *et al.* (l987), by means of radio telemetry, showed that this southward movement down the coast does involve some birds from Alaska, but found no evidence of a movement from interior British Columbia to southeast Alaska. They did note that a nestling banded at Whitehorse, Yukon, was found the following winter on the Olympic Peninsula of Washington.

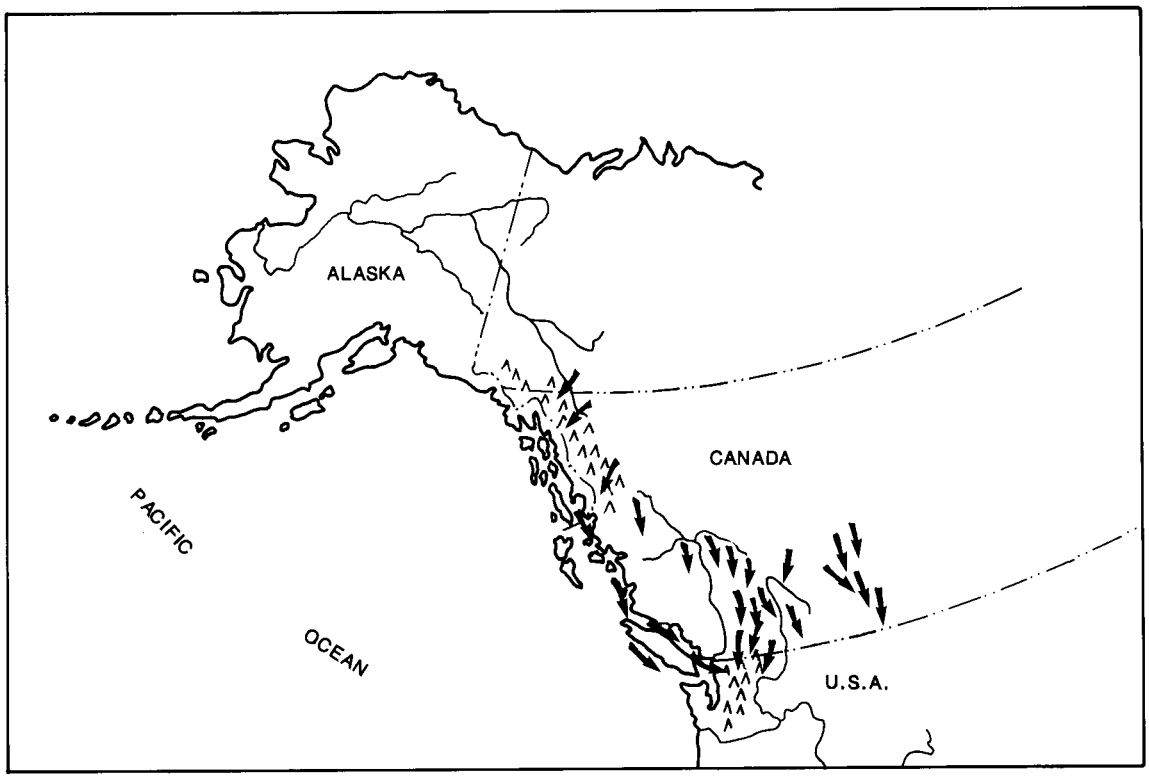
On the south coast of British Columbia, peak numbers occur in December and January, largely in response to availability of salmon carcasses along rivers (Farr l988; Farr and Dunbar l988; Teske l989). In late winter and early spring, many of these birds disperse to other coastal food concentrations, such as staging and spawning herring and eulachon runs.

Based on observations of colour-marked eagles, Servheen and English (l979) proposed that there are two general migration routes for the Skagit wintering population. The first route is over the mountains in a north and northeast direction toward interior British Columbia. The second route is down the Skagit Valley to the west, then north through Puget Sound and the Strait of Georgia. Birds wintering in the Lower Mainland area may have a similar spring pattern, but this remains to be confirmed.

Movements of populations in interior British Columbia appear to be similar to those of eagles that nest east of the Rockies, with the birds moving south in late fall and returning to their breeding areas in early spring. Eagles begin to appear in the Okanagan Valley in early December, building to a peak in February and March; they begin to disperse in late March, and by mid-April all but the



Hypothetical movement patterns of Bald Eagles during August and September in the Pacific Northwest.



Hypothetical movement patterns of Bald Eagles during October, November, and December in the Pacific Northwest.

Figure 2. Hypothetical movement patterns of Bald Eagles in the Pacific Northwest. (From Servheen and English 1979).

local breeding population has departed (Cannings *et al.* l987). Earliest dates of arrival back at some interior British Columbia nesting sites are as follows: Lumby, 22 February; Prince George, 14 March; Atlin, 1 April (Campbell *et al.* l990). Arrival of spring migrants in the Peace River area, l983-l989, has varied from 4 to 24 April, with a mean of l5 April (Siddle l990). In southwest Yukon, eagles return to their nest sites in late March and April (Blood and Anweiler l990a). In Washington State, along the Columbia River, wintering eagles begin to arrive in late October, with numbers increasing to a peak in the third week of February; all have departed by the middle of April (Knight *et al.* l979).

The above review indicates that part of the British Columbia Bald Eagle population is an international one. This is based largely on the marking of small numbers of birds in Alaska and Washington, and requires further investigation.

1.4.2 Seasonal Concentrations

North American population — When nesting, eagles tend to be dispersed throughout the breeding habitat, but at other seasons they may be highly sociable and gather in large numbers where food is abundant. Wintering eagles will also roost communally and several hundred may gather to roost at night. Even during the breeding season, large numbers of non-breeding adult and immature eagles may gather at seasonal sources of abundant food.

By far the largest and best known concentration of Bald Eagles occurs each fall on the Chilkat River in Alaska, where up to 4,000 eagles may feed at a unique late spawning run of salmon (Cline l982; Hodges *et al.* l987). Eagles also concentrate at inland sites where fish spawn. Each fall, up to l000 stop to feed on spawning kokanee in Glacier National Park, Montana (McClelland l973). Wintering Bald Eagles also congregate at many reservoirs and dams in the northern and central United States, as well as National Wildlife Refuges, where they are attracted by the abundance of fish killed by turbines or oxygen depletion, or by large numbers of wintering waterfowl. (Snow l973; Griffin *et al.* l982).

Millsap (l986) stated that the largest concentrations of wintering eagles in the United States were found along the major river systems, in particular the Missouri and Mississippi, but also along most other systems in the west. Sites where wintering concentrations of eagles were found were mapped for North America by Spencer (l976).

Smaller seasonal concentrations of eagles may be found wherever food, particularly carrion, is available, such as at garbage dumps, lambing areas, and seabird colonies.

British Columbia — Bald Eagles also concentrate seasonally at many sites of food abundance in British Columbia. These are described in Section 2.0 Habitat. Most seasonal concentrations are along rivers or in the marine environment, both of which receive some protection under the *Fisheries Act* (Canada) and other legislation. Many other sites of concentration, such as large seabird colonies, have been given Ecological Reserve status.

1.5 Behaviour and Adaptability

1.5.1 Food habits

The diet of Bald Eagles is restricted to animal matter, but the range of animals consumed is extremely broad, ranging from marine invertebrates, such as crab and shellfish, to mammals, including seals, whales and livestock carrion. The diet can be grouped into three major categories: fish, aquatic birds, and carrion of all types. Bald Eagles are opportunists and shift quickly from one food to another as it becomes available. Large numbers will congregate to take advantage of seasonally abundant foods.

The methods of obtaining food, summed up by Beebe (l974), indicate the remarkable versatility of this species:

"To a singular degree the Bald Eagle emulates the behaviour and hunting techniques of every other kind of raptorial bird on the continent, but is has also developed a trick or two of its own. Bald Eagles are variously (depending on circumstances and individual food preferences) scavengers, carrion-feeders, pirates, fishermen, mammal or bird predators, and they capture the latter either from the air, on the ground, or from the water."

Adults are more adept at taking live prey than are immature birds. The immatures are more dependent on carrion, and along with the non-breeding adults, are more mobile and better able to take advantage of local or seasonal abundances.

Throughout its range, the main prey of the Bald Eagle is fish, and in many areas, 90% or more of the Bald Eagle annual diet is composed of fish (Oberholser l906). Fish may be under-represented in the food remains reported at nests because fish remains are much less persistent or obvious than are remains of birds and mammals, and because fish bones are digested by Bald Eagles and may not appear in castings (Steenhof l976). In food choice studies, Bald Eagles invariably chose fish over birds and mammals when offered all three (Wright l953). Bald Eagles have also been observed to switch from mammalian and avian prey, even in the nest, when fish were available (Retfalvi l970; Griffin *et al.* l982). Many different species of fish are recorded from Bald Eagle diets, ranging from large salmon and dogfish on the coast, to smelt, suckers, and trout. Whatever fish are available and obtainable will usually be taken. A large portion of the fish taken may be scavenged, although eagles do take healthy fish, including salmon, when they can.

The second most important food of Bald Eagles at all seasons appears to be waterfowl and seabirds of all types. These may be taken as dead or crippled birds, but eagles also pursue and capture a wide variety of apparently healthy waterfowl, and have even been observed successfully hunting and capturing birds as large and agile as Common Loons. Eagles often nest in proximity to seabird colonies, which make up the bulk of their diet as long as they are available. This has been noted on both the Pacific and Atlantic coasts. Seabird eggs are also eaten. Bald Eagles also prey on Great Blue Heron colonies, and have been cited as the major cause of failure for some colonies. Wintering eagles are attracted to many National Wildlife Refuges across the United States, in particular to the large numbers of crippled and dead waterfowl found in these areas (Griffin *et al.* l982). Wherever they occur, coots appear to be a favoured prey of Bald Eagles, especially

in winter, possibly because of their relative ease of capture (Bent l937; Snow l973).

Carrion of all sorts, including dead fish, road-killed mammals, dead waterfowl and garbage, are important Bald Eagle foods. As noted previously, salmon carcasses are a major food of eagles wintering along the west coast, and dead waterfowl and winter-killed fish are important on wildlife refuges in the United States. Ungulate carrion is important in many mountainous areas (Swenson *et al.* l986). Locally, items such as domestic sheep carrion and road killed rabbits may be seasonally important (Hancock l965; Retfalvi l970). On Amchitka Island, Alaska, Sherrod *et al.* (l976) found that eagle numbers increased with the opening of the garbage dump. It is possible that the bulk of eagle food is scavenged, and that many prey items recorded at nest studies were picked up as carrion.

Though commonly associated with aquatic environments, Bald Eagles have been shown to prey heavily on jackrabbits and Chukar Partridge in dry upland areas in winter (Platt l976; Fielder l982). On California's Channel Islands, they have been recorded as taking live piglets and young goats (R. Davies, pers. comm.), further evidence of the versatility of this species.

Food habits data for British Columbia are given in Tables 8 & 9 in Section 2.

1.5.2 Nesting habits

Although Bald Eagle nests have been found in a variety of sites, including the ground on offshore sea stacks and islands, cliffs, and relatively small trees, eagles usually place their nests in the tallest old-growth trees found in the areas where they are nesting. In most regions of the continent, old-growth trees may be a prerequisite for Bald Eagles to nest successfully (Beebe l974).

Bald Eagles tend to repair and reuse the same nest for many years, and their nests may become as large as those of any bird in the world (Beebe l974). Often, more than one nest is built in a breeding territory, with alternate nests being used in different years. As many as four nests may occur in one territory, although not more than one is active in a given year (Isaacs *et al.* l983). Nests fall down with some regularity, and may be rebuilt, often in the same tree. In Alaska, about 5% of the nests were lost annually, and in Saskatchewan, about l0% were lost each year, with nests lasting on average 5 years; in other locations, a single nest may last for decades (Bent l937; Hodges l982; Gerrard and Bortolotti l988).

The species of tree used varies greatly from region to region, and even within regions. Both live and dead coniferous and deciduous trees are used. Usually the tallest suitable old-growth trees in the area are selected. This is based on structure rather than species (Anthony *et al.* l982). Important factors identified in the selection of nest trees were enumerated by Snow (l973) as: a clear flight path to a point on a beach or river, an open view of the surrounding area, and proximity to water and a food source. Gerrard and Bortolotti (l988) found that eagles needed to be able to approach the nest from more than one direction, depending on wind direction. Burke (l983) stressed that nest trees had to be strong enough to support the large nest over time and prominent enough to provide a commanding view.

Nests are rarely placed more than a few hundred metres from shore in wilderness areas,

although in areas of human activity, eagles may respond by nesting away from shorelines (Gerrard *et al.* l975). Few nests are located more than l.6 km from water.

The effects of human disturbance on nest site selection have not been clearly identified (Snow l973). In many areas, eagles have avoided nesting where human activity takes place; in other areas, they may continue to do so or may respond by relocating nests further back from the shoreline. Beebe (l974) stated that in areas where human activity occurred, tall nest trees were probably a prerequisite for eagles to feel secure. This suggests that eagles may be more tolerant of human activity where tall trees, like veteran Douglas-firs, are available than in locations where only smaller ones, like aspen and lodgepole pine, occur.

Opportunities for eagles to nest on the ground are extremely restricted. Population maintenance is dependent upon availability of large trees capable of supporting heavy nests and provide freedom from human disturbance and ground predators. In this sense, the Bald Eagle has rather specialized nesting habitat needs. It cannot be expected to adapt to nesting in second-growth trees, or to relocate nests many kilometres away from feeding areas.

Additional details on nest site selection and nesting environments in British Columbia are given in Section 2.

1.5.3 Roosting behaviour

Wintering Bald Eagles typically use communal night roosts, and there is some evidence that there is a group identity associated with the various roosts. In the Pacific Northwest, up to 400 Bald Eagles are known to gather at some roosts (Anthony *et al.* l982). Roosts are invariably located in the vicinity of large aggregations of prey, such as spawning salmon or wintering waterfowl, and the location may shift according to weather, prey movements, or disturbance (Snow l973; Keister and Anthony l983). Eagles may move long distances between the nearest suitable roost and the feeding area, in some instances up to 28 km. Typically, they choose the closest suitable trees, usually old-growth conifer stands, which provide protection from wind and rain and generally have more favourable micro-climates than surrounding areas (Keister and Anthony l983).

During harsh weather, eagles may remain in the roost all day (Waste l982). Along the Nooksak River in Washington State, eagles spent 67.5% of the day in the roosts and used conifer stands even though mature deciduous trees were closer, perhaps because the conifers offered greater shelter. By roosting in the conifers they saved up to 5% of their daily energy budget, even after accounting for the extra energy expended in flying farther (Stalmaster and Gessaman l984). Eagles may also follow each other from roosts, which may facilitate food-finding in times of shortages (Knight and Knight l983).

1.5.4 Disturbance

The impacts of human disturbance on Bald Eagles, either during the breeding or wintering periods, are still being argued. Many factors are involved, including the kinds and duration of disturbance, the period in the seasonal life cycle when disturbance occurs, previous conditioning of the birds, age of the birds, and the amount of direct versus indirect disturbance. However, disturbance has been identified as a major concern in many areas where eagles occur.

As pointed out by Fraser (l985), ".... while a number of observers have attributed lowered productivity and even territorial abandonment to human disturbances, ... others have found little or no evidence of disturbance-caused nest failures." He goes on to state that the effect of human disturbance on wintering eagles has also been equivocal, and that while modelling studies and theoretical considerations have suggested potential population consequences of disturbing wintering eagles, no actual changes have yet been documented.

What does seem fairly clear is that chronic disturbance results in disuse of areas by Bald Eagles. Fraser (l985) concluded that :

"Human activities which chronically exceed the limits of eagle tolerance may be considered a form of habitat destruction. This is a particularly insidious impact because there is no overt indication of the impact obvious to untrained or casual observers."

Beebe (l974) noted some adaptability of nesting eagles with respect to human activity at nest sites, as follows:

"In wilderness situations, Bald Eagles are greatly disturbed by human intrusion into their territories, but also they show a high degree of adaptability and tolerance if the human activity is not directed toward them."

He reports that in places where nesting eagles see humans afoot or in vehicles regularly, they become excited only when the nest tree is climbed, and that:

"Their sensitivity to human intrusion is... conditioned by the degree to which the adults are exposed to human activity."

Human invasion of the nest itself during incubation normally causes abandonment of the eggs, and the birds do not renest in the same season. A similar invasion when young are in the nest is usually tolerated and the young are not deserted. Beebe (1974) suggested that this type of disturbance may be remembered and result in the abandonment of the nest after the young are flying, and the relocation of the pair in a new nest some distance away the year following (Beebe l974). However, five years of eagle chick captures on Vancouver Island (for transplant to California) did not result in any abandonment or relocation activity (R. Davies, pers. comm.).

Continued nesting by Bald Eagles in settled areas (Blood l989b) suggests considerable tolerance of human activities. Young eagles raised in nests overlooking subdivisions and other developments are expected to accept similar nest sites when of breeding age, provided that a secure nest tree and adjacent foraging areas remain. Bald Eagles are long-lived and capable of learning that human presence is not necessarily a threat. Human activities that displace eagles from critical feeding areas, for example water-skiing on small lakes or travel along salmon spawning streams in winter, may be of some long-term concern.

1.5.5 Adaptability to human-caused habitat change

Like any living thing, Bald Eagles cannot be expected to adapt to complete loss of critical habitat, such as old-growth nest trees or important foraging sites. Whenever these resources disappear, the habitat will be vacant. However, eagles show tolerance for some degree of habitat change.

Nesting habitat — Bald Eagles do not require extensive wilderness or old-growth forest for nesting. Scattered old-growth trees in large stands of second growth are readily used for nesting (Hodges *et al.* l984). Pairs will continue to nest in small patches of old growth, in lone trees left standing in logged clear-cuts, and in trees surrounded by subdivisions or adjacent to industrial activity. However, long-term acceptability of such sites has not been studied. Mathisen (l968) found that habitat modified by timber management in the immediate vicinity of nest sites did not appear to affect nesting activity. In some areas, nesting eagles have apparently abandoned shorelines used for cottage development (Gerrard and Bortolotti l988), or have responded by nesting further away from shorelines (Fraser l985). However, this may be a response to direct disturbance, such as noise and human activity, rather than to habitat change. It seems that the nature of the upland landscape surrounding nest trees is relatively unimportant for nesting eagles as long as secure nest trees are available and disturbance levels are not excessive.

Foraging habitat — Bald Eagles are not expected to be very adaptable to negative impacts on their foraging habitat. Although such impacts have undoubtedly occurred, they are poorly documented. On the other hand, this species has shown much adaptability in finding and using foraging habitats and food resources made available by humans. The distribution of Bald Eagles wintering in the lower 48 states has been greatly altered in the past 50 years by the creation of dams, reservoirs, and waterfowl refuges along the major river systems (Evans l982; Snow l973). Eagles now concentrate at these ice-free areas where an abundance of fish, waterfowl, and carrion is available (Evans l982; Griffin *et al.* l982). Eagles have also been found concentrating at areas where a seasonal abundance of food has been created as a result of livestock production (Hancock l964), garbage dumps (Sherrod *et al.* l976), or the introduction of wildlife such as feral rabbits (Retfalvi l970), Chukar (Feilder l982), and kokanee salmon (Snow l973).

Although eagles have shown an ability to adapt to many changes in habitat, and in some cases these are considered to be favourable, they must be evaluated with caution. For example, the creation of dams and reservoirs may have created new and valuable winter habitat at the expense of riparian habitat, which was capable of supporting nesting eagles. The assumption that such changes are a net benefit for eagles cannot be entirely supported (Fisher and Hartman l983).

1.5.6 Vulnerability to severe natural events

Bald Eagles are relatively widespread, numerous, mobile, and adaptable birds, and therefore not unduly vulnerable as a species to severe natural events. However, local populations may from time to time suffer setbacks from natural events.

Extensive wildfires may destroy nests or cause adults to abandon nests. Blood and Anweiler (Unpubl.) believed that the reason eagles were absent as a breeding bird along a reach of the Rancheria River on the Yukon/British Columbia border was because potential nesting trees had all been removed by wildfire. Bald Eagles are largely dependent on wetlands for food, consequently, food supplies are relatively unaffected by fire.

Severe storms may blow down nests and nest trees, both during the time they are active and between nesting seasons. This may also affect nesting in the following year, as was observed in Florida following nest losses from a hurricane (Broley l947). Severe winter or spring weather may result in mortality to eagles, particularly immature eagles who may already be stressed by food shortages. Severe spring storms were believed to be responsible for a widespread reduction in eagle productivity in Saskatchewan (Gerrard and Bortolotti l988). Spring storms may also cause eagles to abandon nests, resulting in egg and nestling losses (Evans l982).

2.0 HABITAT

2.1 Habitat Characteristics

2.1.1 North America

Nesting habitat — Bald Eagle nesting habitat embraces the Florida Everglades and the Aleutian Islands, arid Arizona and the rain-drenched northwest Pacific coast; a range of climatic and biotic conditions to which few North American birds are adapted. As noted by Beebe (l974):

"Bald Eagles are not restricted to any one habitat or climatic zone. Their hunting habits, food, and even reproductive period have evolved to suit extremely diverse situations. Over their entire range, Bald Eagles are closely associated with water and large trees."

In spite of their dependence on trees for roosting, nest sites, and hunting perches, Bald Eagles are not woodland birds. Their huge wingspan prevents them from being able to fly in any but the most open woods, consequently, their use of forested areas is more or less restricted to using the largest trees along the forest edge, or those treetops that protrude above the canopy.

The main components required for nesting habitat are large trees for nest sites and hunting perches, closely associated with relatively extensive aquatic habitats, preferably shallow waters, and an abundant supply of food in the form of fish or aquatic birds. On treeless offshore islands, nesting may occur on the ground, usually on cliffs or steep slopes. Rarely, cliffs or rock pinnacles are used in inland areas. Anthony *et al.* (l982) described Bald Eagle breeding habitat in the Pacific Northwest as primarily occurring in the ponderosa pine, mixed conifer, Douglas-fir, and Sitka spruce/western hemlock forest types. Some nesting also occurs in riparian woodlands, mainly along large river systems in the Interior, where nests are usually placed in cottonwoods. Most nests are located within l.6 km of large waterbodies, usually lakes, reservoirs, large rivers, or coastal estuaries. Old-growth ponderosa pine, Douglas-fir, Sitka spruce and western hemlock are the usual nest trees. Trees with a diameter breast height (DBH) of less than 76 cm are rarely used. Where nesting in undisturbed forests, a component of old growth is invariably present. Nest trees are the dominant or co-dominant individuals in the forest stand and are selected for structure, and not by species.

In southeast Alaska, Hodges and Robards (l982) reported that nesting eagles were dependent on old-growth stands near the water's edge. They described the ideal nest tree as follows:

"The ideal nest is located probably on a prominent point or islet exposed to a broad channel, or narrow passage if tidal currents are present. The nest tree is a large, old-

growth Sitka spruce or western hemlock, with massive limbs in the upper crown, usually the result of a deformity, a broken top or a bushy top. The nest is high in the tree, with a commanding view over the water and easy access to the eagle on the wing."

Bangs *et al.* (l982) state that throughout the breeding range of Bald Eagles, nest trees are typically "

... close to water, have a clear view to water, are usually the oldest and largest living members of the dominant overstory, and often provide some type of sparse cover above the nest."

On the Kenai National Wildlife Refuge in Alaska, they found most nests in riparian cottonwoods that were less than 200 m from water, and observed that eagles tended to select sites along slow-moving, clear streams that were used by spawning salmon in fall and spawning trout in spring; and sites near clear, fish-producing lakes.

In the Tanana River area in interior Alaska, Richie (l98l) found most nests in deciduous trees (cottonwood and aspen) in a variety of woodland types. Over 70% were in poplar or mixed poplar/spruce forest, with 94% in living trees. He stated that distance to ice-free waterbodies early in the nesting period may have been a critical factor in determining nest site locations.

In Oregon, Isaacs *et al.* (l983) found 85% of nests to be within l.6 km of major waterbodies, with one as far as 7 km away. Ninety-five percent of the nests were in dominant or co-dominant ponderosa pine, Douglas-fir, and Sitka spruce.

In northern Saskatchewan and Manitoba, Gerrard *et al.* (l975) found that eagles preferred to nest within 200 m of large lakes and rivers in large aspens more than 21.5 m tall. Nests near spawning streams that were open in early spring had the highest productivity. A considerable number of the nests found at small lakes were within 3.2 km of large lakes, and the presence of the larger lakes was an important factor in eagles being able to nest by smaller waterbodies. A preference was also found for island nest sites.

Detailed analysis of nest habitat in the Pacific Northwest is presented by Anthony *et al.* (l982). Hodges and Robards (l98l) provide similar information for Alaska.

Winter habitat — The term "winter" is used here to refer generally to the non-nesting season, that is fall, winter, and early spring, and includes habitats used by migrating eagles. Open water has been identified as the most important component of winter habitat (Brown and Amadon l968; Snow l973; Steenhof l978), but the supply of food that is found at open water areas is the critical factor. Large numbers of wintering eagles may also occur in arid valleys of the western U.S. where carrion or jackrabbits are available (Murphy l975). In most regions, eagles winter where there are abundant fish or waterfowl concentrations.

l. Food supply

In late fall and early winter, most eagles along the west coast are found concentrated along salmon spawning streams. In late winter and early spring, eagles may shift to take advantage of other fish, such as spawning herring or eulachons. Throughout interior North America, eagles winter wherever open

water occurs; in many areas waterfowl concentrations provide the food base, and the large numbers of crippled and dead waterfowl found around National Waterfowl Refuges attracts many wintering eagles (Steenhof l978). Coots are also an important food for many inland populations of wintering eagles. Below dams and along certain rivers, fish are the main winter food.

2. Perching and roosting habitat

Diurnal perches are an important component of winter habitat because they allow surveillance of potential prey with a minimum of energy expenditure. Proximity to a food source has been demonstrated to be the most important factor influencing perch site selection (Steenhof l978; Stalmaster and Newman l979). Although eagles perch on a wide range of substrates, trees are the preferred sites, and eagles consistently use certain trees and even certain branches on the tree. As much as 75-83% of the daylight hours may be spent on a perch (Steenhof l978). Most perches border open areas and provide a good view of the surrounding habitat. Exposure to the sun may also be important by helping to reduce heat loss. Favoured perch trees tend to be tall and stout; both live and dead trees are used. Species of tree varies from region to region, with certain species preferred in different areas; location and structure appear to be more important than species (Steenhof l978).

Wintering eagles frequently roost communally at night, with up to 400 eagles sharing a single site (Anthony *et al.* l982). Night roosts may be located some distance from feeding areas; in the Klamath Basin they were found to be as much as l6 km from feeding areas, and changed as the distribution of waterfowl changed. In Utah, eagles were observed to roost 28.7 km from the nearest feeding area. Most roosts are well protected from the wind, and locations may change according to weather. Roosts tend to be located in the largest trees available and may vary from a single tree to a stand several hectares in size. Many are used year after year. Both dead and live trees are used, and tree selection is apparently based more on structure than on species. Anthony *et al.* (l982) found that Pacific Northwest roosts were invariably located in forest stands that had at least a remnant of old-growth; stands were variable in species composition, area, and tree size, but the old-growth component provided the roost trees. In Washington State, Stalmaster and Gessaman (l984) found that along the Nooksack River coniferous trees were preferred, and that conifers provided shelter that was thermally superior to that offered by deciduous trees. Detailed analysis of roost site characteristics is provided by Anthony *et al.* (l982) for the Pacific Northwest and by Steenhof (l978) for the general range of the Bald Eagle.

2.1.2 British Columbia

Nesting habitat

l. General features

Bald Eagle nesting requirements in British Columbia, as elsewhere, consist of large trees for nest support, and adjacent aquatic food sources. This habitat occurs at low elevations along the entire coast, and along major rivers and around lakes or wetland complexes in the Interior, particularly the Southern and Central Interior. These productive lowlands are precisely the area where most of British Columbia's human population is concentrated, as well as much forest harvesting and land clearing for agricultural and other purposes.

An exception to the requirement for trees occurs in a few very limited locations, such as Triangle Island, off the north end of Vancouver Island, where an abundance of food, together with freedom from land predators and human disturbance, allows ground-nesting (Vermeer *et al.* l976).

Campbell *et al.* (l990) described the location of Bald Eagle nests in B.C. as follows:

"On the coast, most nests (65%; n = 543) were near the seashore, on islands, in estuaries, and at the mouths of rivers and creeks. Other nests sites on the coast included lakeshores, marshes, sloughs, lagoons, and rivers. In the interior, nests were found along lakeshores (58%; n = 87), on islands in rivers and lakes (22%), and on river banks (16%) also being important. Other nests were located at the mouths of creeks, along railway tracks, and on hillsides."

Suitable nest trees occur across most of the province; however, nesting abundance is not random, but strongly associated with food resources that are abundant and available during the nesting season. The most extensive and productive nesting habitats are along the coast where fish, aquatic birds, and intertidal invertebrates are abundant. The best coastal nesting habitats usually have one or more of the following features:

- high shoreline length per unit area due to many islands, channels or inlets;
- a broad intertidal zone and/or many offshore reefs exposed at low tide;
- presence of estuaries or mudflats;
- proximity to strong tidal currents;
- regularly used herring spawning habitats nearby;
- seabird or Great Blue Heron nesting colonies in the vicinity.

Habitats such as steep-sided fjords are less suitable. In the coastal zone, Bald Eagles also nest around lakes and along rivers, but in lower densities than along the seacoast. This is undoubtedly because food resources are less abundant. Floodplains of major rivers like the Fraser and Skeena, where not seriously modified by humans, appear to provide the best non-marine coastal nesting habitat (Dunbar l988). Almost all coastal nesting habitat, even along rivers and around lakes, is within a few hundred metres of sea level.

In the B.C. Interior, nests most commonly occur along medium to large rivers characterized by low gradient, a sinuous channel, and extensive floodplain development; around lakes and reservoirs of various sizes, particularly low-elevation lakes with good fish populations; and where many small lakes or wetlands occur in proximity (Blood and Anweiler unpubl.; Forbes and Kaiser l984). The best Interior nesting habitats are in the southern valley and central plateaus, although nesting occurs north into the Yukon. All known nests in the Interior are below 1370 m elevation (Campbell *et al.* l990).

2. Habitat distribution

As noted in the previous section, nesting habitat occurs throughout the province. Nest records mapped by Campbell *et al.* (l990) indicate the coast provides more or better habitat than the Interior, and that the southern Interior is better than the north.

The distribution and importance of nesting habitat is described in tables 4 and 5 for each major biogeoclimatic zone within each of

nine ecoprovinces (Figure 3) occurring in British Columbia. The Coastal Western Hemlock (CWH) Zone in the Coast and Mountains Ecoprovince contains by far the most extensive and important nesting habitat. The Coastal Douglas-Fir (CDF) and CWH zones of the Georgia Depression are also important, but less extensive. In the Interior, much of the best nesting habitat is in the Interior Douglas-Fir (IDF) and Sub-boreal Spruce (SBS) zones of the Southern Interior, Central Interior, and Sub-boreal Interior ecoprovinces, which comprise part of the Interior Plateau. Locally good habitats occur along valley bottoms in the Southern Interior Mountains Ecoprovince, primarily in the IDF and Interior Cedar-Hemlock (ICH) biogeoclimatic zones. Minor habitats occur in the Boreal White and Black Spruce (BWBS) zone in three northern ecoprovinces (Northern Boreal Mountains; Boreal Plains; Taiga Plains); for example, along the Peace River.

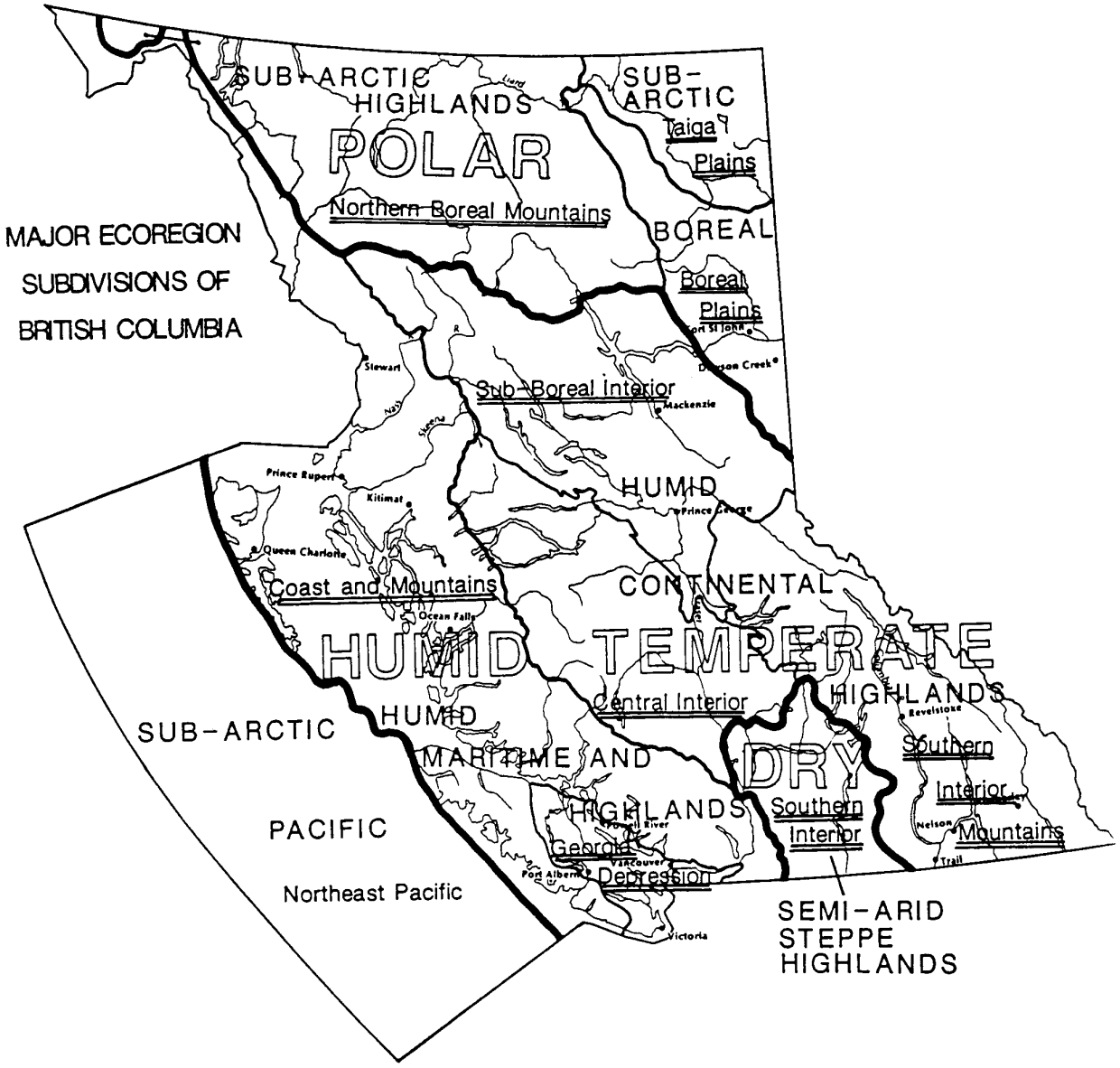


Figure 3. Major Ecoregion subdivisions of British Columbia. Ecoprovinces discussed in this report are underlined. (From Demarchi 1988).

Table 4. Distribution and importance of Bald Eagle nesting and winter habitat in British Columbia.

Ecoprovince[1] and Biogeoclimatic Zone	Season[2] of Use	Habitat Features[3] and Importance
Georgia Depression		
Marine	N	Extremely important, especially intertidal and shallow inshore waters, since these supply almost all eagle food during the nesting season.
	W	As for nesting. Large numbers of eagles from outside this ecoregion also feed in marine/estuarine environments in winter/spring.
CDF	N	Old-growth stands and veteran trees in second growth or settled areas are very important for nesting along or near the shoreline of southeast Vancouver Island and the Gulf Islands. Nest trees are predominantly Douglas-fir.
	W	Shoreline trees are important perches for prey-spotting and night-roosting. Salmon-spawning streams in this zone also provide important fall and winter food for many eagles from outside the ecoregion.
CWH	N	Provides important nest trees in Campbell River, Sunshine Coast and Fraser Valley areas. Nesting trees mostly Douglas-fir and cottonwood.
	W	As for CDF.
Coast and Mountains		
Marine	N	As for Georgia Depression. Many seabird islands in this area.
	W	As for Georgia Depression. Many seabird islands in this area.
CWH	N	Provides important nest trees along most of the coast. These probably support over 75% of Bald Eagles nesting in the province. Sitka spruce is the most used tree species, but western redcedar, western hemlock, Douglas-fir, and cottonwood are also used.
	W	Shoreline trees are important perches for prey-spotting and night roosting. Many salmon-spawning streams provide fall-winter food; eulachon runs occur in some rivers in early spring.
ICH	N	Nesting habitat for small numbers of eagles along rivers and around lakes in the Nass Basin-Upper Skeena area.
	W	A very small number of eagles may winter in ice-free locations along major rivers.
Southern Interior (Steppe)		
BG/PP	N	Ponderosa pine and Douglas-fir trees provide nest sites for a small nesting population around large lakes in valley bottoms.
	W	The most important Southern Interior winter habitat is at ice-free lakes in these zones.
IDF	N	Provides nest trees for a few pairs that nest around smaller lakes or along meandering rivers/streams.
	W	A very limited amount of winter habitat occurs along larger rivers or at lake outlets in the lower elevations of this zone.

Table 4. (Continued)

Ecoprovince[1] and Biogeoclimatic Zone	Season[2] of Use	Habitat Features[3] and Importance
Southern Interior (Steppe) (continued)		
MS	N	Small areas of nesting habitat probably occur around lakes in the lower part of this zone (e.g., Pennask, Tunkwa, or Loon Lakes).
	W	No wintering expected.
Southern Interior Mountains		
PP/IDF	N	Some of the best nesting habitat in this ecoregion occurs in these zones, i.e., along major rivers and around lakes and wetlands on the floor of the Rocky Mountain Trench from the U.S. border to Donald. The main nest trees are cottonwoods on river floodplains.
	W	Winter habitat includes ice-free areas at lake outlets (e.g., Columbia, Windermere) and other valley bottom areas where traffic-killed ungulates are available. However, few eagles winter here.
ICH	N	Best nesting habitat are at wetland complexes, such as Creston Valley, where a variety of food is available. Nest trees there are mostly cottonwood. Nesting habitat used by scattered pairs occurs around major lakes/reservoirs like Kootenay, Arrow, Shushwap, and Quesnel.
	W	Small areas of winter habitat occur where rivers do not freeze (e.g., Columbia between Castlegar and U.S. border).
MS	N	The occasional pair may nest at lakes in this zone.
	W	No winter use expected.
Central Interior		
IDF	N	Many lakes and wetland complexes on the southern part of the Interior Plateau Ecoprovince provide fair to good feeding habitat during the nesting period. Douglas-fir is the main nest tree.
	W	Very little winter habitat in this zone. The occasional eagle winters along major valleys and subsists largely on carrion.
SBS	N	Forest stands at large lakes in the Tweedsmuir-Burns Lake region support some nesting eagles, as do those along rivers like the Morice. Cottonwoods are frequent nest trees, but aspen, Douglas-fir, and spruce are also used.
	W	Small areas of winter habitat occur at outlets of large lakes (e.g., Morice) or below dams (Skins Lake). However, very few eagles winter in this zone.
SBPS	N	This zone has few large lakes; however, a few eagles nest along lake/river systems like the Blackwater (West Road).
	W	No winter use expected.
Sub-Boreal Interior		
SBS	N	Nesting habitat occurs around large lakes, such as Babine, Stuart, and Takla; at smaller lakes in the Vanderhoof and Quesnel areas, and along rivers like the Nechako and Fraser. A variety of species of trees is used for nesting, but cottonwoods and aspens appear to predominate along rivers.
	W	Very little winter habitat is present. The occasional eagle winters along major rivers and at garbage dumps.

Table 4. (Continued)

Ecoprovince[1] and Biogeoclimatic Zone	Season[2] of Use	Habitat Features[3] and Importance
Northern Boreal Mountains		
BWBS	N	Virtually all nesting in this ecoregion is expected to be in the BWBS Zone. Most nests are associated with large lakes, such as Atlin, Teslin, or Kinaskan. Nesting records are very sparse in this area.
	W	No significant winter habitat is present.
Boreal Plains		
BWBS	N	Cottonwood stands along the Peace River between Hudson Hope and the Alberta border support a few nesting pairs. Occasional pairs nest elsewhere around lakes/wetlands.
	W	Occasional birds winter along the Peace, which does not freeze for some distance below the Bennett Dam.
Taiga Plains		
BWBS	N	Scattered nesting probably occurs at large lakes like Kotcho. Trees used for nesting, and important food sources in this area are not known.
	W	No winter use is expected.

[1] Biogeoclimatic zones of marginal occurrence in any ecoprovince and those in which little or no nesting or winter use are expected to occur are omitted. Ecoregion names follow Demarchi (1988); biogeoclimatic zones are from Ministry of Forests (1988).

[2] N = Nesting season use
W = Winter (Fall/Winter/early Spring) use.

[3] Habitat importance is subjectively rated in Table 5.

3. Characteristics of nest trees

Campbell *et al.* (l990) list ll species of trees used for nesting in British Columbia and note that, on the coast, Sitka spruce is used most frequently (70%), followed by Douglas-fir (l8%), other conifers (western redcedar, western hemlock, and lodgepole pine combined = 7%), cottonwood (5%), red alder (<l%), and willow (<l%). In the Interior, those authors found cottonwood to be most often used (52%), followed by aspen (21%), Douglas-fir (21%), ponderosa pine (5%), and spruces (l%). R. Davies (pers. comm.) states that western hemlock is used as frequently as, or more than, any other tree species along the southwest coast of Vancouver Island. Two additional species used occasionally on the coast are grand fir and bigleaf maple (D. Blood, pers. comm.).

Local and regional variation in tree species selection is indicated in Table 6. On the coast, Douglas-firs predominate in the Gulf of Georgia area and Sitka spruce on the north coast, while western redcedar may be the most used tree in some outer coast locations where old-growth stands still occur. All three of these species are highly valued by the forest industry. Coastal nesting in cottonwoods is primarily along river floodplains and deltas. In the Interior, most eagles nesting along rivers use cottonwoods; those on uplands around lakes, at least in the South and Central Interior, largely use Douglas-firs or aspen. Ponderosa pines are locally important along valley bottoms in the Thompson-Okanagan region.

Table 5. Estimated relative importance of ecoprovinces, and biogeoclimatic zones within them, for providing Bald Eagle nesting and wintering habitat.

Ecodivision/Ecoprovince[1]	Habitat[2]	Habitat importance[3]	
		Nesting season	Winter
HUMID MARITIME AND HIGHLANDS			
Georgia Depression	Marine	H	H
	CDF	H	H
	CWH	H	H
	MH	N	N
Coast and Mountains	Marine	H	H
	CWH	H	H
	ICH	L	L/N
	MH	N	N
	AT	N	N
SEMI-ARID STEPPE HIGHLANDS			
Southern Interior	PP/BG	L	L
	IDF	M	L
	MS	L	N
	ESSF	N	N
	AT	N	N
HUMID CONTINENTAL HIGHLANDS			
Southern Interior Mountains	IDF/PP	M	L
	ICH	M	L
	MS	L/N	N
	ESSF	N	N
	AT	N	N
Central Interior	BG	L/N	L/N
	IDF	M	L/N
	SBS	M	L
	SBPS	M	N
	MS	L/N	N
	ESSF	N	N
	AT	N	N
Sub-boreal Interior	SBS	M	L
	ESSF	N	N
	AT	N	N
SUB-ARCTIC			
Taiga Plains	BWBS	L/N	N

Table 5. (Continued)

Ecodivision/Ecoprovince[1]	Habitat[2]	Habitat importance[3]	
		Nesting season	Winter
SUB-ARCTIC HIGHLANDS			
Northern Boreal Mountains	BWBS	L	L/N
	SWB	L/N	N
	AT	N	N
BOREAL			
Boreal Plains	BWBS	L	L

[1] Demarchi 1988.

[2] Biogeoclimatic zones based on Ministry of Forests 1988. Marine habitat type added in coastal ecoprovinces.

- CDF = Coastal Douglas-Fir
- CWH = Coastal Western Hemlock
- MH = Mountain Hemlock
- BG = Bunchgrass
- PP = Ponderosa Pine
- IDF = Interior Douglas-Fir
- MS = Montane Spruce
- ESSF = Englemann Spruce-Subalpine Fir
- ICH = Interior Cedar-Hemlock
- SBPS = Sub-boreal Pine Spruce
- BWBS = Boreal White and Black Spruce
- SWB = Spruce-Willow-Birch
- AT = Alpine Tundra

Biogeoclimatic zones only marginally represented in an ecoprovince are not included (e.g., IDF in Coast and Mountains Ecoprovince).

[3]
- H = High importance
- M = Moderate importance
- L = Low importance
- N = No importance

Table 6. Regional variation in tree species used for nesting by Bald Eagles in British Columbia.

Location and source	Number of nests	Tree species
Fraser Delta and Valley		
(Butler and Campbell l987)	3	All cottonwood
(Dunbar l988)	14	8 cottonwood; 4 Douglas-fir; l spruce; l bigleaf maple
Gulf Islands		
(Vermeer *et al.* l989)	35	All Douglas-fir
Nanaimo area		
(Blood l989a)	65	61 Douglas-fir; 3 grand fir; l cottonwood
Barkley Sound		
(Vermeer and Morgan l989)	25	l5 w. redcedar; 5 w. hemlock; 4 Sitka spruce; l Douglas-fir
Quatsino Sound		
(Lueke-Joyce l989)	61	32 Sitka spruce; l5 w. redcedar; 9 Douglas-fir; 5 w. hemlock
Queen Charlotte Islands		
(Rodway *et al.* l988)	85	74 Sitka spruce; 2 w. redcedar; l red alder; 8 snags
Okanagan		
(Cannings *et al.* l987)	5	4 ponderosa pine; l cottonwood
East Kootenay		
(Forbes and Kaiser l984)	26	25 cottonwood; l Douglas-fir
Cariboo		
(Blood and Anweiler l990)	l8	l5 Douglas-fir; 3 cottonwood
Cheslatta Lk.-Nechako R.		
(Blood l983)	30	21 cottonwood; 8 aspen; l Douglas-fir
Peace River area		
(Siddle l990)	6	All cottonwood

In British Columbia, as elsewhere, tree size, form, and location are more important than tree species. Nest trees are usually dominant or co-dominant specimens (in size) in the stand in which they occur, have developed sturdy branches and a fairly open branch structure, and are located at or near shorelines. On the coast, gnarled old-growth conifers, often approaching decadence, are selected if available, although few actual ages of nest trees have ever been determined. A Douglas-fir nest tree felled near Duncan was about l90 years old (D. Blood, pers. comm.). Conifers as small as 0.6 m DBH have been used on the coast (Table 7); however, small diameter trees may still be locally the largest, and may be old trees on poor growing sites. Lueke-Joyce (l990) reported two nests in second-growth trees on northern Vancouver Island; however, actual size and age of those

trees is not stated. Cottonwood and aspen nest trees are probably younger on average than are coniferous nest trees, although data to confirm this are lacking. Information is needed on the time needed for various tree species in various regions to reach a size and form suitable for Bald Eagle nesting.

Nests are often in partly dead trees and occasionally in completely dead ones. None of 65 trees used for nests in the Nanaimo area was completely dead at the time they were used by eagles (Blood l989a). At Barkley Sound, Vermeer and Morgan (l989) reported that three of 25 nest trees were dead. Data from three Interior areas (Blood l982; Blood and Anweiler l983, l990b) indicate ll of 61 nest trees (l8%), most of which were cottonwoods, to be dead. Some dead trees may have been living when nesting in them was initiated. Bald Eagles sometimes use nests built by ospreys (Campbell *et al.* l990) and these are frequently in dead trees.

Table 7. Some characteristics of Bald Eagle nest trees in British Columbia.

Parameter[1]	Location[2]				
	Nanaimo (65)	Gulf Islands (35)	Barkley Sound (25)	Queen Charlotte Isl. (73)	Nechako R. (21)
Tree diameter (DBH)					
Mean	1.3	l.l	2.3		
Range	0.6-2.1				
S.D.		0.3	0.8		
Tree height					
Mean	36.l	38.6	35.6		
Range	l6.9-58.5				
S.D.		l0.8	13.8		
Nest height					
Mean	30.3	32.4	30.3		
Range	12.5-48.8				
S.D.		4.5	13.3		
Distance from shoreline[3]					
Mean	l73	62	42	24	77
Range	4-850			0-300	3-250
S.D.		45	24		

1 all measurements in meters

2 Sample sizes in parentheses
Nanaimo data from Blood 1989a
Gulf Islands data from Vermeer *et al.* 1989
Barkley Sound data from Vermeer and Morgan 1989
Queen Charlotte data from Rodway *et al.* 1988
Nechako River data from Blood and Anweiler 1983.

3 distance from high tide in coastal areas and from nearest river channel along the Nechako.

4. The nest tree environment

Nest trees are almost always near aquatic habitats of one kind or another, and usually situated so that at least part of the aquatic foraging habitat is visible from the nest. The mean distance of nests from adjacent shorelines in various parts of British Columbia ranged from 24 to l73 m (Table 7). The number of nests normally decreases with increasing distance from shorelines. Although not indicated in Table 7, some nests are known to occur l km or further inland. These are usually missed during aerial surveys that follow shorelines. Inland nesting appears to be most common where the nearshore area is heavily settled or logged and hence supports few or no suitable nest trees, for example, the southeast coast of Vancouver Island.

Nests occur in extensive, dense old-growth stands, fragmented old-growth parcels, and in lone veteran trees standing in second-growth forest or logging slash. The age and species composition of the surrounding forest appear to have little influence on nesting occurrence. Although some lone trees left standing in large logging slashes continue to be used (Farr l988), the generality of this behaviour is not known and the long-term acceptability of such trees requires further study.

The environment of Bald Eagles nesting in British Columbia varies from pristine wilderness to urban landscapes. Nesting eagles are remarkably tolerant of human activity in their vicinity as long as their nest, nest tree, and forage resources are not disturbed. Blood (l989b) reported that several nests occur within the city limits of Nanaimo, some virtually surrounded by residential or industrial development. In Greater Vancouver, nests have been reported at Lighthouse Park and 4 km west of Park Royal (A. Rahme, pers. comm.), in Stanley Park (Campbell *et al.* l974), at Alaksen National Wildlife Area and along the South Arm of the Fraser River (Butler and Campbell l987), and in the Beach Grove and Tsawwassen area (A. Poynter, pers. comm.). There are undoubtedly other examples of nesting in urban and suburban environments in the province. Juvenile eagles fledged in such environments are expected to accept similar situations for nesting when they reach breeding age. Heavily developed areas however, appear to support fewer nesting pairs than would be expected under pristine conditions. This is largely due to loss of nest trees and foraging habitat, rather than a simple aversion to the presence of people and cultural landscapes.

The nesting environment always includes a foraging area of sufficient productivity to support the nesting pair and their young until fledging. On the coast, this invariably includes the adjacent intertidal zone and nearshore waters. Inland, foraging habitat at nest sites includes river channels, shorelines and surface waters of lakes, and wetlands of various kinds. Information on forage resources is given in Section 6.5.1 Food Resources (Also see Table of Contents)

2.1.3 Food Resources

Winter habitat

l. Food supply

Ice-free aquatic environments are the major component of Bald Eagle winter habitat in British Columbia. This includes marine habitats along the entire coast, most low-elevation rivers, lakes and wetlands west of the Coast Range, and large lakes and rivers in the Southern Interior. Within their British Columbia winter range, the abundance of eagles varies greatly from place to place and

month to month in response to availability of food. There is a greater tendency for large numbers of eagles to concentrate in local areas during winter than during the nesting season.

Salmon-spawning streams are the most important coastal habitats in winter especially those with large runs of chum, pink, or coho salmon (Dickie l990). Spent carcasses are available from October to January or later. Tree stands along these streams provide perches for food-spotting and cover for night-roosting. Other fish concentrations, such as staging and spawning herring in marine waters and eulachon runs into coastal rivers, attract many eagles in spring. Estuaries and tidal mudflats that support wintering waterfowl are also important, especially on the south coast (Butler and Campbell l987). Although the above habitats are of greatest importance, eagles use the entire coastline in winter. In the Interior, large lakes in the Southern Interior that support wintering coots and ducks are of some importance (Cannings *et al.* l987), but the number of eagles present is small when compared to coastal habitats. Valley bottoms where ungulate carrion is available, and ice-free rivers below power installations, also provide winter habitat for a few Interior birds.

2. Perching and roosting habitat

Daytime perches and night roosts are important components of winter habitat in British Columbia. Diurnal perches, used for surveillance of potential prey, are primarily snags and deciduous trees along salmon-spawning streams (Farr l988), or snags and decadent or spindly conifers along marine shorelines. Eagles here also perch on pilings and log booms, and on the ground on mudflats, river bars, or offshore reefs.

The use of communal night roosts has been evaluated in the Fraser Valley by Farr (l988) and Teske (l989). Eighteen night roosts have been identified in the eastern Fraser Valley, seven in valley bottom cottonwood stands and ll in hillside conifer stands. Roost trees were usually the tallest and largest Douglas-firs and cottonwoods at each site. Distances of roosts from major feeding areas varied from 0 to 5 km. Cottonwood roosts are mostly along river channels and are used for both diurnal perching and night roosting. Communal roosts undoubtedly occur throughout the winter range of Bald Eagles in the province, but have yet to be identified.

3. Habitat distribution

The distribution and relative importance of winter habitat in British Columbia is summarized by ecoprovince and biogeoclimatic zone in Tables 4 and 5. Based on data in Farr and Dunbar (l988), it is likely that habitats west of the Coast Range support over 95% of the British Columbia eagle population in mid-winter. This probably does not apply in autumn, when spawning salmon and kokanee runs are available in the Interior and waters there are still ice-free.

The CWH Zone of the Coast and Mountains Ecoprovince, including adjacent marine waters, provides the bulk of Bald Eagle winter habitat; although habitats in the Georgia Depression probably support more eagles per unit area than the north and outer coast. Most Interior wintering habitat is in the Bunchgrass, Ponderosa Pine, Interior Douglas-fir, and Interior Cedar-Hemlock zones of the Southern Interior, Central Interior, and Southern Interior Mountains ecoprovinces (Table 5).

Migration habitat — On the coast, habitats used by spring migrants are similar to those used in winter, except that salmon-spawning streams are no longer important. Herring-spawning sites, eulachon-spawning rivers, and estuaries/mudflats used by migrant waterfowl are of key importance, but marine habitats along the entire coast are used. In the Interior, wintering habitats are also important for spring migrants; however, they also use a variety of other sites, such as small ice-free areas at lake inlets or outlets, game winter ranges where carrion is available, or flooded farmlands that attract waterfowl. Spring habitat in the Interior is largely restricted to low elevation valleys and plateaus.

In fall, important habitats for coastal migrants include salmon-spawning streams, estuarine waterfowl habitat, and the marine environment generally. In the Interior, Bald Eagles occur very widely in fall and may be seen at kokanee- and sockeye-spawning streams, waterfowl and muskrat marshes, or anywhere that carrion is available.

Food resources — Food habit information tells a great deal about the ecology of a species - why certain habitats are selected for nesting and why certain seasonal aggregations occur - and assists in defining critical habitats. These are matters of importance for assessing the present and future status of Bald Eagles in the province, therefore, some attention to food habits within British Columbia is in order.

General information on Bald Eagle food habits in British Columbia is given by Brooks (l922), Munro (l938), Beebe (l974), and Campbell *et al.* (l990). The versatility of this species was noted by Munro (*op. cit.*), who stressed

"... how local conditions and time of year modify the food habits of the Bald Eagle."

Information for British Columbia (Tables 8 and 9) confirms the wide range of food items noted by investigators in other areas. However, the seasonal and regional importance of various food items is more difficult to assess. Semi-quantitative studies here are confined to the coast, involve primarily the nesting season, and are based on food remains picked up under nests (Vermeer *et al.* l989; Vermeer and Morgan l989). For various reasons, these may not accurately reflect the weight of various food items ingested by eagles. Other food habit information largely involves lists of species that eagles have been seen to catch or scavenge upon. Though not quantitative, these provide a fair appreciation of seasonally and locally important food sources.

On the coast, frequently observed concentrations of eagles at sites of spawning salmon (late August through January), eulachon runs (March-April), pre-spawning and spawning schools of herring (January-April), and hake at tidal rapids (May-June) suggest that fish, obtained live or as carrion, is the most important dietary item on a year-round basis. Where locally abundant, birds may predominate in the diet, for example, at and near seabird colonies during the nesting season and in the Fraser Delta-Boundary Bay area in winter. Intertidal invertebrates are of widespread importance on the coast and may be of high importance on the outer coast in summer.

In the Interior, fish are also important eagle foods. This includes spring spawning concentrations (rainbow trout, suckers, squawfish) available in the nesting season, fall spawners (salmon, kokanee, char) taken by a more mobile post-breeding eagle

population, as well as surface-dwelling fish at any season. The association of eagle nests with many lakes and rivers that support few waterfowl in late spring and early summer, and heavy reliance of other inland eagles on fish in the nesting season (Gerrard and Bortolotti l988), suggest that fish are the most important dietary item for interior British Columbia eagles during nesting. In restricted areas with significant waterfowl production (e.g., Creston Valley), waterfowl may assume some importance for nesting eagles. Waterfowl seem to be most commonly taken during spring migration, in fall migration/staging areas where sport hunting provides ducks that are crippled or unretrieved, and in winter on the southern interior lakes that do not freeze. In the latter situation, coots and diving ducks may form the bulk of the diet. Ungulate carrion resulting from traffic or predator kills, and viscera left by hunters are also important in the southern Interior from autumn to early spring.

Table 8. Food habits observations for Bald Eagles in coastal British Columbia.

Location and Source	Food Habit Observations
Lower Mainland	
Butler and Campbell l987:	Bald Eagles at the Reifel Sanctuary have been observed feeding on Red-necked Grebe, Great Blue Heron (frozen carcass), Trumpeter Swan carcass, Canada Goose, Snow Goose (crippled), Green-winged Teal, Mallard, American Wigeon, Greater Scaup, Surf Scoter, Short-eared Owl, Ring-necked Pheasant, American Coot, Mew Gull and California Gull. Mammals identified included Muskrat and River Otter caught in traps, and dead domestic stock.
A. Poynter, pers. comm. l990:	In winter l989/90, observed eagle kills at Boundary Bay involved Northern Pintail (12±), Green-winged Teal (several), Bufflehead (several), Greater Scaup (2 or 3), Glaucous-winged Gull (3), Mallard (2), American Wigeon (l), Ruddy Duck (l), Thayer's Gull (l), Western Grebe (l), Common Loon (l), and Red-breasted Merganser (l). Two of the ducks were taken from Northern Harriers. Many of the birds taken were crippled or injured, presumably by hunters.
Fry l980:	Bald Eagles were seen from January onward, sitting on tidal flats with duck kills. An eagle was observed eating what appeared to be a Dunlin.
Campbell *et al.* l972:	Reported an eagle carrying a Muskrat at Reifel Island.
Farr and Dunbar l988:	Report a strong association of eagles with salmon-spawning streams (e.g., Squamish R., Harrison, R.) in January.
Southeast Vancouver Island and Gulf Islands	
Vermeer *et al.* l989:	Frequency of prey remains beneath nests was 52% birds (mostly Glaucous-winged Gulls), 34% fish (mostly Ling Cod and rockfish), 12% marine invertebrates (mostly crabs and clams), and 2% mammals (mostly carrion). Glaucous-winged Gulls were by far the most frequent species of prey. Up to 50 eagles attracted to hake brought to surface by upwelling in Active Pass.
Trenholme and Campbell l975:	Noted eagle concentrations in February associated with lambing of domestic sheep, and reported that eagles had been seen feeding on still-born lambs and afterbirth.
Hancock l964:	Dead sheep reported to be a major winter food on several Gulf Islands; however, fish were felt to be the most common food. Predation on Glaucous-winged Gulls and on a crippled American Wigeon also noted.

Table 8. (Continued).

Location and Source	Food Habit Observations
Southeast Vancouver Island and Gulf Islands (cont.)	
Tatum l972:	Reported 21 eagles feeding on a deer carcass near Duncan in winter.
Cassidy l985:	Described up to 270 eagles attracted to spawning salmon at the Qualicum River in late fall and early winter.
West Coast Vancouver Island	
Vermeer and Morgan l989:	Frequency of prey items under nests in Barkley Sound was 45% marine invertebrates (mostly littleneck clam and mussels), 41% birds (Glaucous-winged Gull most frequent species), l0% fish, and 4% mammal.
Hatler *et al.* l978:	Evidence is given for feeding on octopus, crabs, skate, herring, salmon, seaperch, Kelp Greenling, Red Snapper, Cabezon, Midshipman, Pacific Loon, Pelagic Cormorant, Canada Goose, ducks, gulls, River Otter, Northern Fur Seal, Northern Sea Lion, and Mink. Some of the fish had been discarded by fishermen or taken from otters, and many of the waterfowl were thought to have been disabled by hunters. Marine mammals were obtained as carrion.
Carl *et al.* l950:	On several occasions, eagles were flushed from the remains of sea lion pups at Triangle Island, a sea lion breeding site.
Vermeer *et al.* l990:	One eagle nest at Triangle Island, examined after the breeding season, contained the remains of one young Common Murre, at least l0 Cassin's Auklets, one Tufted Puffin, and two large unidentified alcids.
Rodway *et al.* l990:	At the Triangle Island seabird nesting colony, observed prey of eagles included Glaucous-winged Gull chicks, Common Murres, Cassin's Auklets, Rhinoceros Auklets, Tufted Puffins, and rabbits. Scavenged sea lion pups were regularly encountered.
Queen Charlotte Islands	
Vermeer *et al.* l984:	Ancient Murrelets were the main eagle prey in a mixed nesting colony of that species and Cassin's Auklet. Murrelets were killed by eagles when they arrived at their nesting burrows at night.
Rodway *et al.* l988:	Document considerable predation by Bald Eagles on Ancient Murrelets, Cassin's Auklets, storm-petrels and many other seabirds at seabird nesting islands along the east coast of Moresby Island. Most eagle nests in this area were in or near seabird colonies.
Reimchen and Douglas l977:	60% of eagle feeding observations involved active predation on fish and birds. Attempted or successful predation was recorded for Common Loon, Red-throated Loon, Mallard, Northern Pintail, Green-winged Teal, Common Goldeneye, Bufflehead, Oldsquaw, and Cassin's Auklet. Carrion sources included spawned salmon, Lingcod, pinnipeds, cetaceans, and deer.
Douglas and Reimchen l988:	24% of pre-fledged Red-throated Loon chicks were taken by Bald Eagles.
Munro l938:	"... in the spring... most of their food (at Tlell) is taken from the sea beach and from the boulder reefs exposed at low tide." Many dogfish and one deer eaten as carrion along the beach. Food items under a perch included crabs (the most frequent item), dogfish heads and tails, feathers of a pintail, sternum of a duck, and bones of a rabbit. Includes accounts of predation on juvenile Common Mergansers.
Brooks l922:	Reported having seen eagles take Holboell's (Red-necked), Horned, and Western Grebe, Red-throated and Common Loon, Glaucous-winged Gull, American Coot, mergansers, Mallard, Northern Pintail, American Wigeon, Scaup, Bufflehead, and scoters near Masset.

Table 8. (Continued).

Location and Source	Food Habit Observations
Northern Coast	
Ofelt l976:	Describes eagles feeding on salmon chased to the surface by killer whales in Johnstone Strait in summer.
J. Barrett pers. comm. l990:	Reports up to ll0 eagles at Jimmy Judd Island in May and June, feeding on hake in tidal rapids of Gillard Passage, near Stuart Island.
R. Pojar, pers. comm. l990:	Noted 320 eagles associated with a eulachon run in the lower Skeena River in March l989.
Kaiser l989:	Reports eagle depredation on adult Rhinoceros Auklets and on Glaucous-winged Gull eggs at a seabird nesting colony near Prince Rupert.

Being intelligent scavengers and also quite tolerant of non-threatening human activity, eagles have taken advantage of many food sources made available by humans. These probably allow some areas at some seasons to support more eagles than would otherwise be the case. They may also present problems, such as ingestion of lead shot and the picking up of toxic substances through feeding on waste matter. Some human influences on eagle food habits that have been observed in British Columbia are described below.

1. Fish and Wildlife Harvest

Discarded fish: Unwanted fish and heads/entrails of desirable ones discarded by commercial and sport fishermen are of considerable importance for coastal eagles from spring to fall. Beebe (l974) described eagles flying 5 km to sea to pick up discarded rockfish or ratfish drifting behind a salmon troller. Hatler *et al.* (l978) report a sighting of 63 eagles feeding around a shrimp boat in Barkley Sound. Blood (l989b) noted that eagles frequently perched near boat ramps, waiting for incoming fishermen to eviscerate their catch. Vermeer *et al.* (l989) felt that many benthic fish remains beneath Gulf Island nest sites probably originated from fishermen because they consisted only of heads and parts of the pectoral girdle. Barrett (pers. comm. l990) reports that sport fishermen in the Stuart Island area regularly feed non-releasable rockfish to waiting eagles, some of which have learned to respond to a whistle. Ten lodges and l00 guides operate in that area.

Parts of harvested game and fur animals: Entrails from hunter-killed ungulates are widely available in fall. Carcasses of trapped furbearers may be a minor food source, but are fed on by some migrant eagles in spring. Ravens and other scavengers compete with eagles for these foods.

Traffic-killed ungulates: Hundred of big game animals are killed by road and rail traffic each year in British Columbia, and many of these are scavenged by Bald Eagles. This appears to be a fairly important food source for Southern Interior eagles in winter and spring (Hatler l983; Kinley, pers. comm. l990).

Wounded waterfowl: Waterfowl crippled by hunters or shot and not retrieved are locally important in fall and winter at locations such as Boundary Bay (Poynter, pers. comm. l990), Tofino (Hatler *et al.* l978), and Fort St. John (Siddle l990).

Table 9. Food habits observations and inferences for Bald Eagles in the Interior of British Columbia.

Location and Source	Food Habit Observations
Okanagan	
Cannings *et al.* l987:	Noted association between eagles and waterfowl concentrations in late March; American Coot felt to be a favoured winter prey; describes attack on a Western Grebe.
Brooks l922:	"On Okanagan Lake... the Bald Eagle preys very largely on coots during the winter when these birds are out in the open water in large flocks."
Kootenay	
Forbes and Kaiser l984:	13 prey items under two nests included 4 American Coots, 3 pintails, l diving duck, 2 Muskrats, 3 squawfish and l Black Bullhead. Foraging eagles were seen capturing an American Coot and a Muskrat and scavenging 2 Black Bullheads and a Largescale Sucker.
Kinley, pers. comm. l990:	Commonly saw one to six eagles on road-killed elk or deer in winter in the Rocky Mountain Trench. Larger numbers apparently associated with Kokanee spawners in fall.
Interior Plateau	
Munro l938:	Reported many eagles attracted to spawning runs of Kamloops trout and suckers in spring, near Vanderhoof.
Munro l938:	Found remains of l Goldeneye Duck, l Ruffed Grouse, one or more suckers, and two or more Kamloops trout under a nest at Horse Lake. Also noted importance of American Coots in winter on large lakes of southern B.C. that do not freeze.
Peace River	
Siddle l990:	Reported that migrant eagles are attracted to large flocks of early arriving ducks in spring - Mallard, Northern Pintail, and American Wigeon. Describes an attack on a pintail. Other reported foods were discarded Beaver carcasses, remains of a hunter-killed Moose, spawning suckers at Charlie Lake, fish that have passed through turbines at dams near Hudson Hope, and ducks wounded by hunters.
Northern Interior	
Beebe l974:	"... the most frequently captured mammals are hares. Where Bald Eagles live and reproduce inland, such as in the boreal forest, some pairs become highly oriented to this kind of prey...".
Various locations	
Farr and Dunbar l988:	During the l988 mid-winter count, deer carcasses were reported as food items at Castlegar, Grand Forks, and Smithers.

2. Agricultural Activity

Winter-killed sheep, stillborn lambs, and afterbirth attract eagles in the Gulf Islands and a few other areas. Farm and ranch offal is available in a variety of rural areas. Campbell *et al.* (l990) noted an attraction to livestock calving grounds in the Interior in spring.

3. Habitat Alteration

Enhancement projects: Wetland developments, such as Reifel Refuge, Serpentine Fen, Creston Valley, and numerous Ducks Unlimited projects have increased populations of breeding and/or wintering waterfowl, plus those of Muskrats and fish in some locations. Forbes and Kaiser (l984) noted that extensive impoundment of marshes at Creston resulted in large increases in breeding waterfowl, Coots, Muskrats, and coarse fish, and that this was probably responsible for an increase in the nesting eagle population. Salmonid enhancement projects, such as spawning channels and passage facilities have increased the availability of eagle food in some areas.

Hydroelectric projects: Fish that are killed or stunned when passing over spillways or through turbines, and others that congregate below dams because upstream movement is impeded, are food for a few eagles that have learned to capitalize on this source. Because rivers are ice free for some distance below these dams, eagles are able to find food and over-winter in Interior areas where they were formerly rare.

Waste disposal sites: Farr and Dunbar (l988) reported that about 2% of Bald Eagles seen during the l988 mid-winter count were at or near garbage dumps. Dumps are also feeding sites in summer, although the proportion of the population using them is probably smaller than in winter. Sewage lagoons and outfalls attract many ducks, gulls and other birds, which in turn attract eagles. Use of these sites is primarily by migrants in the Interior and wintering birds on the coast.

4. Faunal Introductions

Introductions, such as deer into the Queen Charlotte Islands and cottontail rabbits to Vancouver Island, provide carrion and prey that were previously not available. Introduction of sport fish to various Interior lakes and reservoirs, and of invertebrates like the Japanese oyster and Japanese little-neck clam on the Coast have also provided new food sources (Carl and Guiguet l958).

2.2 Habitat Impacts and Trends

A variety of human-caused impacts have affected Bald Eagle habitat in British Columbia, or could do so in the future. These may be summarized as follows:

2.2.1 Removal of nest trees

This is mostly attributable to logging; however clearing for settlement (residential, industrial, commercial), agriculture, and other purposes also contributes to the impact. Linear developments, such as highways, transmission lines, and pipelines, frequently follow valley bottoms or parallel rivers, further reducing the stock of potential nest trees. Hydro dams have flooded habitat in some areas.

Logging — Logging is of greatest concern because it is so widespread; because the most valuable forestry lands are at low elevation in Interior valleys and along the coast where most eagle nesting also occurs; and

because standard forest rotations are too short to allow preferred species of nest trees to develop the old-growth size and form needed for nesting (Morgan *et al.* l985). Although little information is available on the actual age of nest trees, there is little doubt that most conifers used in the Pacific Northwest could be called "old growth" based on their large diameter and height (Blood l989a; Vermeer and Morgan l989; Vermeer *et al.* l989). Hodges and Robards (l982) estimated the mean age of nest trees in southeast Alaska to be 400 years. Aspen and cottonwood, important nest trees in Interior British Columbia, are relatively fast growing and may provide nest sites at a younger age than conifers, but this requires evaluation. In any event, deciduous trees used for eagle nesting are probably old-growth specimens of the species involved. Second-growth conifers, and probably deciduous trees as well, do not attain a size and form needed for nesting by Bald Eagles prior to being harvested. Therefore, much of British Columbia's commercial forest land will never be suitable nesting habitat for Bald Eagles. The proportion of forest land supporting second growth is steadily increasing. Increasing harvest of floodplain cottonwoods and upland aspens is of great concern. Although data on pre- and post-logging nest densities are not available, it seems obvious that nesting populations must have been reduced in areas where extensive clear-cut logging of shoreline and backshore habitats has occurred. Relatively normal nesting populations may remain in areas that are extensively logged if remnant old-growth trees or small stands are left and are distributed in a pattern that allows optimal access to aquatic food resources during the nesting season. Some areas logged prior to l950 support many scattered veteran trees among the second growth and may have near-natural nesting populations. The trend toward extensive clear-cutting in recent decades is not encouraging, even if existing nest trees are identified and protected.

Settlement — Land clearing for settlement, including residential, commercial, institutional, and industrial uses, has been going on for decades, and is accelerating. It is of most concern on the south coast and in Southern Interior valleys, areas that have historically provided above-average Bald Eagle nesting habitat. Waterfront and water view properties are in high demand, both on the seacoast and along Interior lakes and rivers, where increased land clearing can be expected as long as the human population of the province continues to grow. There are recent documented cases of nest trees having been felled during land clearing for residential development on Vancouver Island; in one case, fledgling eagles were in the nest. In other situations, voluntary restraint by clearing contractors and/or vigilance by nearby residents have resulted in lone nest trees being left in subdivided land. Such trees may or may not continue to be used by eagles and are vulnerable to windthrow and other environmental stresses, and will eventually die. If no nearby alternative trees are available, the nesting territory is permanently lost. Fortunately, most nesting habitat on the outer and northern coast is probably safe from settlement impacts.

Agriculture — Land clearing for agriculture is of some concern in the Fraser Valley and in Interior valleys. Removal of riparian and floodplain woodlands has been increasing in order to maximize farm production. It is likely that relatively few nest sites have been removed to date, and it is hoped that these activities will not have a major impact in the future because so much of the British Columbia landscape is unsuited for intensive agriculture.

Other activities — Forest clearing for highways, transmission lines, pipelines, and other linear developments is of concern where these parallel marine, lake, or river shorelines, which many of them do. These are of most concern in valleys where logging, agriculture, or settlement have already removed much of the nesting habitat. Even if existing nest trees are identified and avoided, linear developments still remove potential nesting habitat. In more remote areas, individual linear developments probably do not remove enough nesting habitat to result in a decline in the eagle population. Hydro reservoirs have flooded river valley nest sites in some Interior valleys. Some eagles nest at these reservoirs, but it is not known if their numbers are lower or higher than prior to reservoir development.

2.2.2 Removal of perching and roosting trees

During the nesting season adult eagles use favourite perches near the nest tree for watching the nest, and elsewhere in their foraging territory for surveillance of prey or carrion. In winter, they also perch by day adjacent to critical feeding sites, and resort at night to roosts, usually in the shelter of coniferous trees. As in the case of nest trees, perching/ roosting trees and snags may be lost due to logging, settlement, agriculture, or other kinds of forest removal. Although many historically used perches have undoubtedly been removed, many remain. As well, requirements for perching do not appear to be as specific as for nesting - a wide variety of tree species and ages, snags, pilings, log booms, etc., are acceptable. Of greater concern is the need for thermally favourable night roosts in winter. These are usually adjacent to concentrated food sources that attract large numbers of eagles. A variety of tree species are used for communal night roosts in the Pacific Northwest; however, most are old-growth stands, and coniferous trees are thermally more favourable than deciduous species (Anthony *et al.* l982). Old-growth forest stands along coastal streams having large late-fall/early-winter salmon runs probably provide the most important winter roosting habitat for Bald Eagles in British Columbia, although little inventory has been done and other kinds of sites may also be important. It is not known if the removal of such stands to date has had an impact on the fall-winter carrying capacity or survivorship of Bald Eagles. It is presumed that extensive removal of night roosting habitat would be harmful; however, more information is needed on how much and what kind of roosting habitat is required in various areas.

2.2.3 Contamination of food sources

Although isolated cases of accidental poisoning are known, there is no evidence that pollutants such as pesticides, heavy metals, dioxins, or furans have caused direct mortality or reproductive failure in Bald Eagles in British Columbia. However, as predators and scavengers of animal matter, eagles are vulnerable to trophic magnification of these substances, particularly in aquatic food chains. The greatest threat is in heavily settled and industrialized areas of the province. Increasing industrial development is to be expected and could worsen the situation. Conversely, increasingly stringent pollution control regulations may reduce this threat in future. Monitoring is needed to assess trends in contamination of key food species.

2.2.4 Loss of foraging habitat

Harbour developments like that along the shoreline of Burrard Inlet, together with dredging and filling projects in many intertidal areas, have removed some potential feeding habitat. However, this is small in a provincial context. Historically, drainage of wetlands like Sumas Lake has had local impacts, as has the flooding of valley bottom wetlands by reservoirs in more recent years. Development of waterfront land, both along the seacoast and Interior lakes and rivers, has resulted in much human activity along the foreshore and beaches, and this probably inhibits eagle foraging in such areas. Although localized, these kinds of impacts are expected to increase in future years.

2.2.5 Human competition for food

Many forage species important to eagles (e.g., herring, salmon, shellfish, and waterfowl) are also harvested by humans. Exploitation to the point of population collapse, locally or regionally, would adversely affect eagles and other vertebrates that share those foods. Human impacts on seabird colonies, for example by introduction of predators or by heavy harvest of their marine foods, could also have secondary effects on eagles. Impacts of this nature have probably occurred on a minor scale in past years, but should be of little significance in the future if the prey populations are managed for sustained yield.

2.2.6 Regional Impacts in British Columbia

Georgia Depression Ecoprovince — This small ecoprovince contains 2 million people, and habitats in it have been more extensively modified by humans than those of any other ecoprovince. Despite this, large numbers of Bald Eagles winter here (Farr and Dunbar l988; Dickie l990) and there is still a substantial nesting population (Blood l989; Vermeer *et al.* l989). Although this suggests considerable adaptability on the part of the eagles, adaptability has its limits and trends in habitat alteration and loss are of great concern.

l. Nesting trees

Historically, logging of old-growth Douglas-fir stands along and near shorelines throughout the ecoprovince must have had a considerable impact on nest tree availability. Morgan *et al.* (l985) state that prior to logging, late mature and old-growth forests made up more than 70% of the Coastal Douglas-Fir Zone in the Georgia Strait area, and that these crucial habitats have declined to less than 20% and are expected to be nearly eliminated within the next century. Present logging is mostly inland, but cutting within 2 km of shorelines is still a threat in restricted locations on the Sunshine Coast, Vancouver Island between Qualicum and Courtenay, and on several of the Gulf Islands. Logging of floodplain cottonwoods and adjacent uplands in the Fraser Valley is also a potential threat. However, Farr (l988) reported that eagles continued to nest successfully in a cottonwood on Herrling Island in the Fraser Valley after the site was selectively logged, and in a nest at Nicomen Mountain after all surrounding trees were clearcut. In the Nanaimo area, Blood (l989b) noted accelerating logging of old-growth stands on private land parcels. Where nest trees are known they are usually left standing; however, logging has greatly reduced the extent of potential nesting habitat and continues to do so.

Land clearing for various settlement uses is currently the greatest threat to nesting habitat,

and is much more serious here than in any other ecoprovince. Very little nesting habitat remains in urban areas (Greater Vancouver and Greater Victoria), and significant reductions have occurred along the Vancouver Island shoreline from Campbell River to Victoria, on some of the Gulf Islands, and in the Fraser Valley. In the Fraser Delta, Butler and Campbell (l987) stated that "... wooded habitats have undergone massive alterations." Despite abundant food resources, they report only three nest sites in that area. Clearing for settlement purposes is proceeding rapidly, especially on Vancouver Island, and the trend is expected to continue for some time. Predominantly private tenure and high real estate values in this area are major obstacles to preservation of old-growth trees for nesting habitat. In the Greater Vancouver area, most known nest trees are in protected areas (Lighthouse Park, Stanley Park, U.B.C. Endowment Lands, Alaksen National Wildlife Area) because few nest trees remain on adjacent lands. In the Nanaimo area, Blood (l989b) found that only ll% of 65 nest trees were in relatively secure sites, such as dedicated parks.

Agricultural land development has historically removed some nesting habitat in the Fraser Valley and on Vancouver Island (Comox Valley; Cowichan Valley; Saanich Peninsula). Current agricultural expansion is of minor significance in the ecoregion as a whole, but may still be of concern in some parts of the Fraser Valley.

Linear developments in the Fraser Valley and on south east Vancouver Island are of moderate concern because they tend to parallel rivers and coastlines, and because the need for such developments is expected to increase in proportion to human population growth. At present, impact assessments usually identify occupied nest trees, which are then avoided by the development (Eccles and Cooper l989). However, considerable potential nesting habitat is being taken up by rights-of-way of various kinds in this ecoprovince.

2. Perching and roosting trees

Diurnal perch trees at nests and at feeding sites are subject to the same threats and rates of loss as listed above for nest trees; however, the urgency for conservation action is rated somewhat lower than for nesting trees because a variety of sites, such as snags, pilings, and second-growth trees, are acceptable for perching but not for nesting. Farr (l988) noted that eagles continued to use a shoreline strip of cottonwoods at Waleach Slough in the Fraser Valley for winter perching after the adjacent inland area was clearcut; however, numbers were lower than in pre-logging years. She suggested that leaving patches rather than strips in such situations may be desirable.

Winter night-roosts are of particular concern in this ecoprovince because so many eagles are concentrated here in winter (Farr and Dunbar l988) and are expected to use communal roosts. Some formerly used roosting areas have undoubtedly been affected by logging/land clearing activities, especially in the Fraser Valley. Although some roosting areas have been located in the Georgia Depression (Teske l989; Cassidy 1985; Farr l987), others undoubtedly occur, and many are likely to be threatened by forest removal. In the Fraser Valley, comments by Farr (l988), with respect to conservation of communal roosts, are of note:

"Future conflicts between logging and maintaining coniferous roost sites may be minimal

in some areas because the roost trees are situated on steep, unstable slopes or near rock bluffs. In other areas where logging is feasible, cooperation with forest companies may be needed to ensure that adequate roosting habitat is maintained. Scott Paper Ltd. has set a commendable example by taking the Carey Roost out of their cut block boundaries to preserve it for future eagle use. As no other communal night roosts have been located within 5 km of this roost, it is a very important site for the eagles that forage along the Fraser River. It is also British Columbia's first protected communal winter night roost for Bald Eagles."

3. Foraging habitat

Contamination of food sources and loss of foraging habitat are potential impacts that are both of greater concern here than in any other ecoprovince. Within the ecoprovince, the most seriously affected locations are urban waterfronts and intertidal/inshore habitats adjacent to pulp mills. Loss of habitat due to foreshore development involves a relatively small amount of total shoreline in the ecoregion, but is steadily increasing. Increasingly stringent emission standards for pulp mills should arrest, and hopefully reverse, contamination of Bald Eagle foods in this area; however, cumulative pollutant loads entering the Gulf of Georgia from the entire Fraser River watershed and from Howe Sound, and possibly Puget Sound, are of long term concern.

Human harvest of eagle food resources, such as herring and salmon, though probably more intensive here than in other ecoregions, is expected to have little future impact on eagles as long as sustained yield management is practiced.

Coast and Mountains Ecoprovince —

l. Nesting trees

Logging prior to l950, largely A-Frame and hand-logging operations, were localized and selective, leaving many poor quality trees uncut and available for nesting eagles. Since l950, clearcut logging has become widespread, especially in the southern half of the ecoprovince, and on the Queen Charlotte Islands. Extensive clearcuts, especially those to the shoreline, have probably reduced breeding populations in local areas.

With respect to Coastal Western Hemlock forests on islands in the Queen Charlotte Sound-Johnstone Strait area, Morgan *et al.* (l985) note that avian species in lifeform 12 (which includes the Bald Eagle)...

"prefer to build their nests on large branches in tall trees. The removal of trees bordering lakes and marine coasts has undoubtedly reduced the number of potential nest sites."

Hodges et al. (l984) surveyed about 9% of the British Columbia coast in l980, and estimated that 21% of the coastline south of Cape Caution (including the Georgia Depression), and l0% of that to the north was disturbed habitat with no old-growth trees present. No active nests were found in those disturbed areas. This provides a rough estimate of the extent of nesting habitat loss on the Coast up to l980. Further logging could increase those percentages, although it is now customary to leave shoreline and streamside strips of old growth, and to identify and protect trees with eagle nests in them.

Future trends depend on the extent and success of such programs. It is possible that considerable remaining old growth could be

removed without further reducing the breeding population if presently used trees, and some to replace them when they die, are left in place. This assumes that nest trees in narrow strips, or isolated in logging slashes, are as acceptable to eagles as they were prior to logging; a subject that requires more study. It is possible that breeding populations could eventually be increased in areas where no old-growth specimens presently occur if strategically located second-growth trees or small groups of trees are allowed to advance to old-growth status. However, this could take 200 years or more to occur.

In any event, logging is expected to proceed indefinitely throughout most of this ecoprovince, to continue to reduce the amount of potential nesting habitat available, and to restrict the choices available to eagles for nest site selection. This seems likely to cause a continued, gradual decline in breeding abundance, the extent of which is difficult to predict or to measure.

Some protected habitat occurs in National Parks (Pacific Rim; South Moresby Reserve), in Provincial Parks and Recreation Areas (Brooks Peninsula, Cape Scott, Hakai; Fjordland, Naikoon, and several smaller units), Ecological Reserves (most of the seabird islands), and forest company or Ministry of Forests Recreation Sites. These encompass less than l0% of the ecoregion coastline, but include some of the most productive nesting habitat.

In addition, the windswept outer coasts of Vancouver Island, the Queen Charlottes, and islands along the northern Mainland Coast have tree stands that are suitable for eagle nesting but not for logging. Hodges *et al.* (l984) estimated that l6% to l8% of the British Columbia coastline supported naturally stunted “scrub trees” typically under 20 m in height. These contained l8% to 27% of the active nests they found on the coast. Lands having reserve status, supporting non-merchantable timber, or inoperable due to slope steepness or other factors might comprise 25% to 30% of Bald Eagle nesting habitat in this ecoprovince.

Clearing for settlement and related purposes has removed a very small proportion of nesting habitat in the ecoprovince, and this situation is expected to change very little in the future.

2. Perching and roosting trees

Perch trees, like nest trees, have been, and will continue to be, lost due to logging. Since large numbers of eagles winter here, communal night-roosts are expected to occur near major winter food concentrations, such as salmon and eulachon spawning streams. Locations of these roosts are largely unknown; however, many are probably vulnerable to logging activity.

3. Foraging habitat

Contamination of food sources is a very localized threat, but of concern where pulp mills or other industries occur (Squamish, Gold River, Port Alice, Kitimat, Prince Rupert). Loss of feeding habitat is of minor concern, and not expected to increase significantly. Human harvest of eagle foods is widespread, but not felt to have reduced eagle abundance, and not likely to be of future significance.

Dry Southern Interior Ecoprovince — This is the second most heavily settled ecoprovince in British Columbia. There is considerable agricultural development along

the valley bottoms and logging on adjacent uplands. Eagle nesting habitat occurs along major lakes and rivers in the valley bottoms and around some lakes on the adjacent plateau. Winter habitat is mostly associated with the Thompson River and large lakes.

1. Nesting trees

Logging may be a threat around lakes on the Okanagan and Shushwap Highlands and Thompson Plateau; however, the number of nest sites involved is probably low. Cannings *et al*. (l987) noted that eagles "still nest around smaller mountain lakes east and west of the (Okanagan) valley," but suggested that the nesting population along the main valley lakes had declined in recent decades due to human persecution and destruction of nest trees. Logging on the uplands, and expansion of settlement and agriculture in the valleys, are expected to continue to reduce nesting habitat in the ecoprovince.

2. Perching and roosting trees

Continued loss is expected for reasons mentioned above; however, the over-all impact should be minor.

3. Foraging habitat

Contamination of food sources, for example from agricultural pesticides, is more likely here than in other parts of the Interior, although specific examples are lacking. Loss of aquatic foraging habitat has probably been minor, and should remain so. Road-killed animals, livestock yards, and garbage dumps probably result in greater food availability in winter than in pre-settlement times.

Southern Interior Mountains Ecoprovince

—

1. Nesting trees

In this mountainous region it appears that most known nests are along valley bottoms (Campbell *et al.* l990), and that the best habitats are wetland complexes along the Columbia and Kootenay Rivers (Forbes and Kaiser l984). Nest trees along the Columbia Marshes and at Creston Valley are largely cottonwood, although this may not be true for the entire region.

Hydro dams (Libby, Mica, Revelstoke, Arrow, Duncan) have flooded considerable nesting habitat in this region; further losses of this kind are not probable. Although some eagles nest along the reservoirs, it seems likely that these steep-sided fluctuating waterbodies are less suitable for eagles than the floodplains they have inundated.

Logging is widespread in the region, and undoubtedly has removed some potential nesting habitat, and will continue to do so. Land clearing for settlement and agriculture has affected small areas, but often has an impact on floodplain cottonwood stands; minor but continuing losses can be expected. Smelter emissions have reduced tree cover in the Trail area.

Although these combined factors have reduced the extent of old-growth forest in the region, some acceptable nest trees remain in most areas, and it is probable that forest removal has had little effect on the total breeding population.

2. Perching and roosting trees

Continued loss is expected for reasons given above, however the long-term impact should be low.

3. Foraging habitat

Reservoir flooding has caused a loss of riverine and wetland feeding habitat in some valleys, and this has probably reduced the regional nesting population slightly. Wetland developments, such as at Creston Valley, have had a positive effect (Forbes and Kaiser l984). Contamination of food is a potential threat in very restricted areas like Castlegar-Trail and Skookumchuck. The winter carrying capacity of the region has likely been improved through availability of fish below power dams and traffic-killed ungulates along highways.

Central Interior Ecoprovince—

l. Nesting trees

Logging is widespread on the Interior Plateau and threatens nesting habitat along some lakes, wetlands, and rivers. Clearing for agriculture and settlement are of little concern. Sufficient nest trees probably remain to maintain the historical breeding population; however, this situation could change.

2. Perching and roosting trees.

Availability of perching/roosting trees is probably not a problem for the foreseeable future.

3. Foraging habitat

Flooding by the Nechako Reservoir removed some valley bottom habitat, but the impact of this on eagle nesting abundance is not known. Historical loss of wetlands, largely due to agricultural land improvement, amounts to only about 2% of total wetland area (McKenzie l983). Wetland developments, like Chilanko Marsh, should improve foraging habitat in restricted areas. Loss of foraging habitat should have had a negligible impact on eagles in the ecoprovince as a whole, and the future rate of loss should be very slow.

Sub-Boreal Interior Ecoprovince —

1. Nesting trees

Logging is also widespread in this region and is the major threat to nesting habitat. Clearing for agriculture and settlement are of concern in the Vanderhoof-Prince George-Quesnel area, especially along rivers and around lakeshores. Enough nest trees probably remain to support the historical nesting population, although local exceptions could occur. Gradual loss of nesting habitat is expected to continue.

2. Perching and roosting trees

Availability of perching and roosting trees should be of little concern for the foreseeable future.

3. Foraging habitat

Flooding by the Williston Reservoir removed some valley bottom habitat, but the impact of this on nesting abundance is not known. Hydroelectric developments like Kemano Completion, if they affect fish abundance, could also affect eagles. Contamination of eagle foods is a possibility near pulp mills (Mackenzie, Prince George, Quesnel), although no adverse effects are currently known. To date, impacts on foraging habitat have probably had little effect on nesting season or autumn populations. So few eagles winter here that winter foraging habitat is not of concern.

Northern Boreal Mountains Ecoprovince — Few Bald Eagles nest in this region, and the habitats of those that do, or that migrate through the area in spring or fall, appear to be quite secure at present and for the foreseeable future. There is essentially no winter habitat in this area.

Boreal Plains Ecoprovince —

l. Nesting trees

Much land has been cleared for agriculture, but this has likely had little effect on nesting eagles. Enough trees apparently remain around the few lakes that have sufficient food resources to support nesting eagles; i.e., Charlie, Cecil, and Boundary Lakes. Most known nesting in this ecoregion (six to ten sites) is in cottonwoods along the Peace River between Hudson's Hope and the Alberta border (Siddle l990). Some of those nest sites would be lost if the Site C Dam is built. Some logging occurs in the region but is not a known threat to nesting habitat. Barring hydro development, the supply of nest trees appears to be relatively secure.

2. Perching and roosting trees

Loss of perching and/or roosting trees is not a significant concern.

3. Foraging habitat

Impacts on foraging habitat are mostly of concern for migrant and nesting eagles. Some drainage of wetlands that formerly attracted migrant waterfowl and eagles has already occurred (Siddle l990), and the trend is expected to continue. Construction of the Site C Dam would flood foraging habitat used by several nesting pairs. The reservoir would provide less suitable habitat than presently occurs. Foraging at Charlie Lake could be interfered with if cottage development continues. Hydro dams (W.A.C. Bennett and Site One) have enhanced winter habitat by providing fish that pass through turbines or over spillways and by maintaining year-round open water for some distance downstream.

Taiga Plains Ecoprovince — Habitats of the few eagles that nest in or migrate through this region are probably quite secure. No winter habitat is present.

2.2.7 Habitat trends

As discussed in Section 2.2.6 above, trends in habitat loss vary considerably from place to place in British Columbia. Significant permanent reduction of nesting populations has probably only occurred in urban areas like Greater Vancouver and Victoria, but nesting habitat loss is accelerating in adjacent areas on the southeast coast of Vancouver Island, the Gulf Islands, and in the Fraser Valley. In those areas, the current rate of change is at least moderate and is of concern because the losses are more or less permanent.

Nesting habitat is also changing rapidly in coastal areas subject to clear-cut logging; however, this is of less concern because nest trees are usually spared, many sites are non-operable, and, as a last resort, some second-growth trees can be allowed to advance to old-growth status in the future.

Impacts on feeding habitat have probably only been significant in the Georgia Depression, and even there the current rate of degradation would be rated as slow.

2.2.8 Habitat status and protection

It is probable that about 90% of British Columbia's Bald Eagle nest sites are on Crown Lands. This affords the opportunity for government to institute management and protection programs that will control forest harvesting impacts on nesting populations. It is estimated that less than l0% of nest sites are currently inside protected areas like parks or Ecological Reserves. Nests in such reserves are mostly along the coast. Many nest trees in the Georgia Depression are on private land.

The current level of nest tree protection is not adequate on either Crown or private land. Leaving only a single nest tree in clear-cut lands will not provide for long term population maintenance. The same is true for lands cleared for settlement.

Most critical habitat, particularly on Crown lands, can probably be protected by means other than land acquisition. Some land acquisition would be desirable in the Georgia Depression, but waterfront lands here are very expensive. However, acquisition of strategic parcels having old-growth trees may be justified where multiple values are involved; i.e., parkland, greenbelt, and use by a variety of wildlife species that need old growth.

3.0 DISTRIBUTION

The breeding range of the Bald Eagle is restricted to North America, although non-breeding birds have wandered to the Siberian coast, Ireland, and Puerto Rico (A.O.U. l983).

3.1 North America

3.1.1 Breeding range

The present breeding range of the Bald Eagle extends from the southern Brooks Range in Alaska, east through most of the Yukon, northwestern and southern Mackenzie District, across northern Saskatchewan and Manitoba, central Ontario, central Quebec, Labrador and Newfoundland; south through the Commander and Aleutian Islands, and along the coast to Baja and Sonora Mexico; and along the Gulf Coast of southeastern Texas to Florida. It is absent as a breeding bird through much of the Great Basin and most of the prairie and plains region, and very locally distributed in the interior of the lower 48 states (A.O.U. l983).

The former breeding range evidently included "every state except Hawaii" (Brownell and Oldham l983), although documentation for this is poor. In the United States, the nesting distribution receded through the l9th and 20th centuries, and now most active nests are restricted to the Great Lakes states (Michigan, Minnesota, Wisconsin), Florida, the Pacific Northwest (Oregon, Washington), the Chesapeake Bay area, and coastal New England (mostly Maine), with scattered nests elsewhere (Snow l973; Marshall and Nickerson l976).

3.1.2 Winter distribution

Major wintering areas include the northwest Pacific Coast from the Aleutians to Puget Sound, and the central interior of the United States. Millsap (l986) reported that winter concentrations occur on most major western United States river systems. The majority are associated with either the Mississippi or

Missouri rivers and tributaries; other important river systems are the Arkansas, Columbia-Snake, Colorado, Platte, Illinois, Klamath, Red, Skagit, Rio Grande-Pecos, Tennessee, and Sacramento. Concentration areas in the east are associated with several tributaries of Chesapeake Bay, the Delaware River in New York, and Quabbin Reservoir in Massachusetts.

The former winter distribution is not reliably known, but probably differed little from the current winter range.

3.2 Canada

3.2.1 Breeding range

In Canada, Bald Eagles presently nest from coast to coast (Figure 4). In the south, they are absent from most of southern and central Alberta and Saskatchewan, and southwestern Manitoba. To the north, they are found across all but the extreme northern edge of the Yukon, to the Mackenzie delta, and thence south of a line running from just north of Great Bear and Great Slave lakes to the extreme northeast corner of Saskatchewan; east to the Churchill area of Manitoba, and then south around Hudson Bay and James Bay, and northeastward across central Quebec and southern Labrador, including all of Newfoundland and the Maritime provinces. The northern limit of the range east of James Bay is poorly known (Godfrey l986). East of the Rockies there are few significant populations nesting south of the Canadian Shield; to the north the population appears to be confined by a temperature or seasonality limit.

The largest known populations of breeding eagles are found along the coast of British Columbia and across the lake-studded Boreal Forest region of Saskatchewan, Manitoba, and northwestern Ontario. Smaller and more scattered populations occur across the Yukon, interior British Columbia, southwest Mackenzie, Alberta, and from southern Ontario eastward to the Maritimes (Brownell and Oldham l983).

The former Canadian breeding range is believed to have been quite similar to the present distribution, but was probably more continuous in areas that are now heavily settled and support few breeding pairs. This includes southern Ontario and Quebec, and parts of the Maritime Provinces.

3.2.2 Winter distribution

With the exception of eagles that winter along the entire coasts of British Columbia and the Maritimes, most Canadian Bald Eagles winter in the United States. Small numbers also winter in southern interior British Columbia (Figure 4), and scattered individuals also occasionally winter across southern Canada, particularly where open water is present (Brownell and Oldham l983; Godfrey l986).

Power dams and thermal plants now allow a few eagles to winter beyond their former range; however, the number of birds involved is small.

3.3 British Columbia

3.3.1 Breeding range

The breeding range of Bald Eagles in British Columbia essentially includes the whole province (Campbell *et al.* l990); however, nesting abundance varies greatly from place to place (Figure 5). Nesting abundance is high on the coast where 30 to 70 adults, and eight to 20 or more active nests, per l00 km

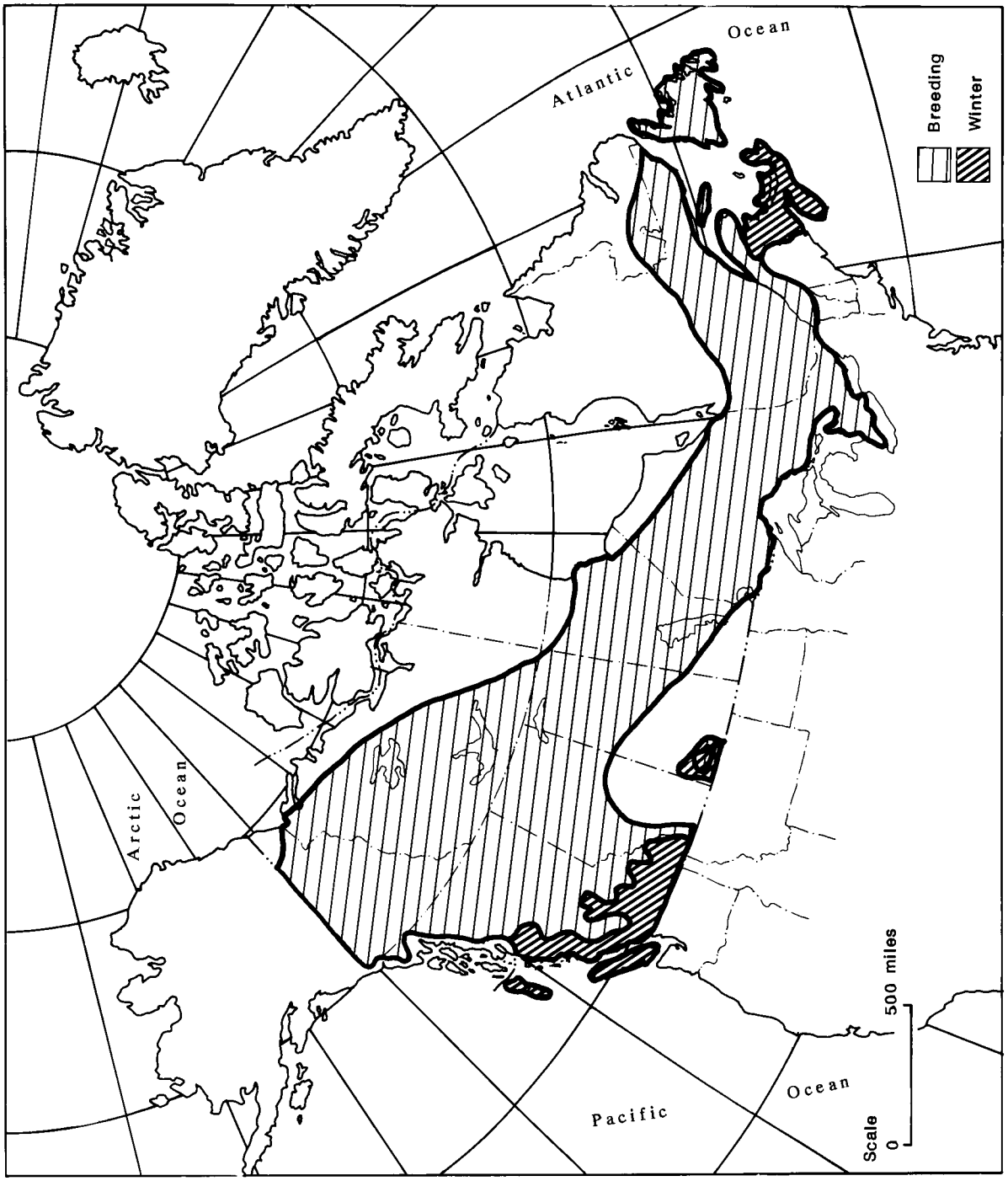


Figure 4. The breeding and wintering distribution of the Bald Eagle in Canada. (Adapted from Brownell and Oldham 1983).

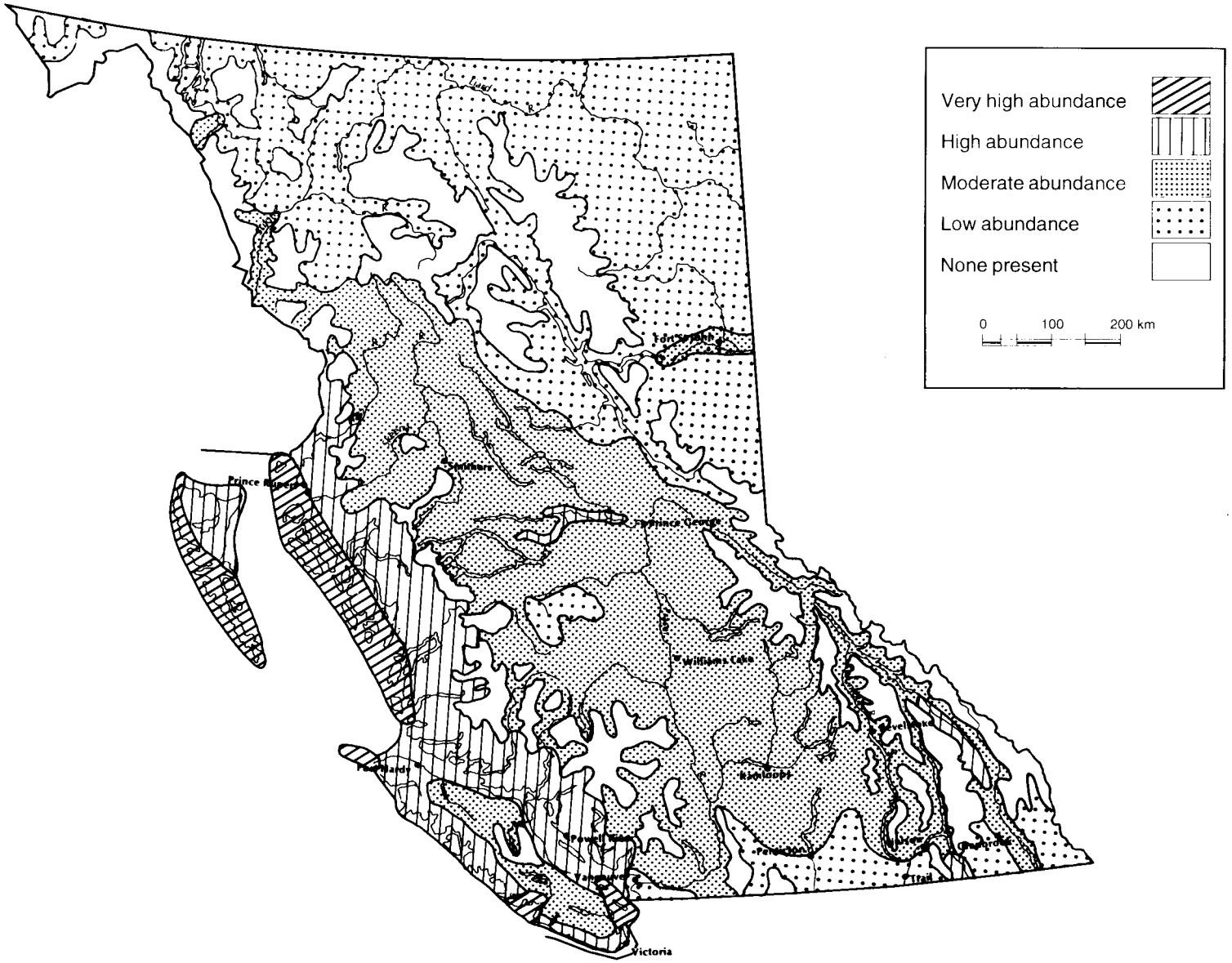


Figure 5. The distribution and relative abundance of nesting Bald Eagles in British Columbia.

of shoreline have been reported in various areas (Table 10). These numbers are mostly based on single aerial surveys and are therefore conservative. Observations made at seabird nesting islands (Vermeer *et al.* l984; Rodway *et al*. l988), though not directly comparable because most surveys were by boat, suggest that seabird islands have nesting densities higher than the coastal average. This is also suggested by data of Harris (l978) for islands on the east coast of Moresby Island.

In the Interior, nesting densities along the most productive rivers may be similar to the coast (Table 10), but such habitats are not of widespread occurrence. Many high-gradient and high-elevation rivers support no nesting eagles, and nesting is not known to occur above 1370 m elevation. Medium-sized lakes appear to have relatively low nesting densities, and this is probably also true for large lakes and reservoirs. Complexes of small lakes and wetlands, such as occur in the Cariboo region, also appear to support many

Table 10. Linear frequency of adult Bald Eagles and eagle nests along shorelines in British Columbia.[1]

Location and source	Shoreline length (km)	Adults/ l00 km	Active nests /l00 km	Total nests/ l00 km
Marine shorelines				
North of Cape Caution (Hodges *et al.* l984)	1360	39	9	15
South of Cape Caution (Hodges *et al.* l984)	1250	37	8	-
Gulf Islands (Vermeer *et al.* l989)	796	63	12	15
Barkley Sound (Vermeer and Morgan l989)	573	29	9	-
Quatsino Sound Area (TFL6) (Lueke-Joyce, unpubl)	209	-	17	36
Queen Charlotte Islands (Harris l978)	391	70	19-29	36
Freshwater habitats				
Lower Fraser/Harrison rivers (Farr l988)	l00	-	12	-
Nechako R. above Stuart R. (Blood and Anweiler unpubl.)	176	-	9	-
Columbia R. (Athalmer-Donald) (Blood and Anweiler unpubl.)	162	-	9	-
Peace R. above Moberly R. (Blood and Anweiler unpubl.)	81	-	4	-
Cheslatta/Murray Lakes (Blood and Anweiler unpubl.)	ll5	-	4	-
Nanika/Kidprice/Stepp Lakes (Blood and Anweiler unpubl.	85	-	2	-

[1] All surveys were by aircraft, except Harris 1978, which was by boat.

breeding eagles (Blood and Anweiler l990b); however, nests per kilometre of shoreline cannot be reliably determined for such areas.

3.3.2 Winter distribution

It is probable that over 90% of Bald Eagles wintering in British Columbia do so along the coast. This includes both the marine environment and river valleys west of the Coast Range. The Gulf of Georgia may have the highest winter concentration (Farr and Dunbar l988). Wintering in the Interior is almost entirely along the bottoms of major valleys in the southern third of the province (Figure 6).

4.0 POPULATION SIZE AND TRENDS

4.1 North America

4.1.1 Population size

Over the past 50 years, various individuals and agencies have attempted estimates of the North American Bald Eagle population (Lumley l939; Sprunt and Ligas l964; Braun *et al.* l975; Lincer *et al.* l979; Evans l982; Gerrard l983; Millsap l986). These were usually based on estimates of the number of breeding pairs in a state or region, or estimates of numbers wintering in the lower 48 states. The large numbers in British Columbia and elsewhere in Canada were often not included. Braun *et al.* (l975) estimated the North American population in the mid-70s at 35 000-60 000, but gave no information on distribution or how they arrived at that number.

Breeding population estimates are available for only portions of the species range and do not provide a basis for estimation of the total population. Winter counts, when eagles are concentrated in more observable southern and coastal locations, presently provide the best estimates of total population size. Gerrard (l983) analysed Christmas Bird Count data for the entire continent for the years l955 through l980. He arrived at an estimate of approximately 70 500 Bald Eagles as of l980, with l9 000 in Alaska, 30 000 in Canada (28 500 of these in British Columbia), and 21 500 in the lower 48 states in mid-winter. More recent estimates based on mid-winter eagle counts; i.e., 14 000-22 000 in the lower 48 states (Millsap l986) and 20 000 to 30 000 in British Columbia (Farr and Dunbar l988), tend to support Gerrard's results.

Based on a ratio of one-third immature and two-thirds adult eagles, the population of 70 000 should contain about 47 000 adults. Although this could translate to 23 500 breeding pairs, the actual number of active nest sites would be somewhat less because many adults do not breed, especially where the nesting habitat is saturated (Hansen and Hodges l985).

4.1.2 Population trends

The long term trend in Bald Eagle populations is hard to document because historical information is sparse. However, it is widely accepted that there has been a decline in numbers across most of the continent since the advent of European settlement, particularly in the eastern and mid-western United States (Snow l973; Griffin *et al.* l982). Review of available historical information by Lincer *et al.* (l979) tends to support this contention. Beebe (l974) believed that populations along the British Columbia and Alaska coasts were little changed from prehistoric times, although the

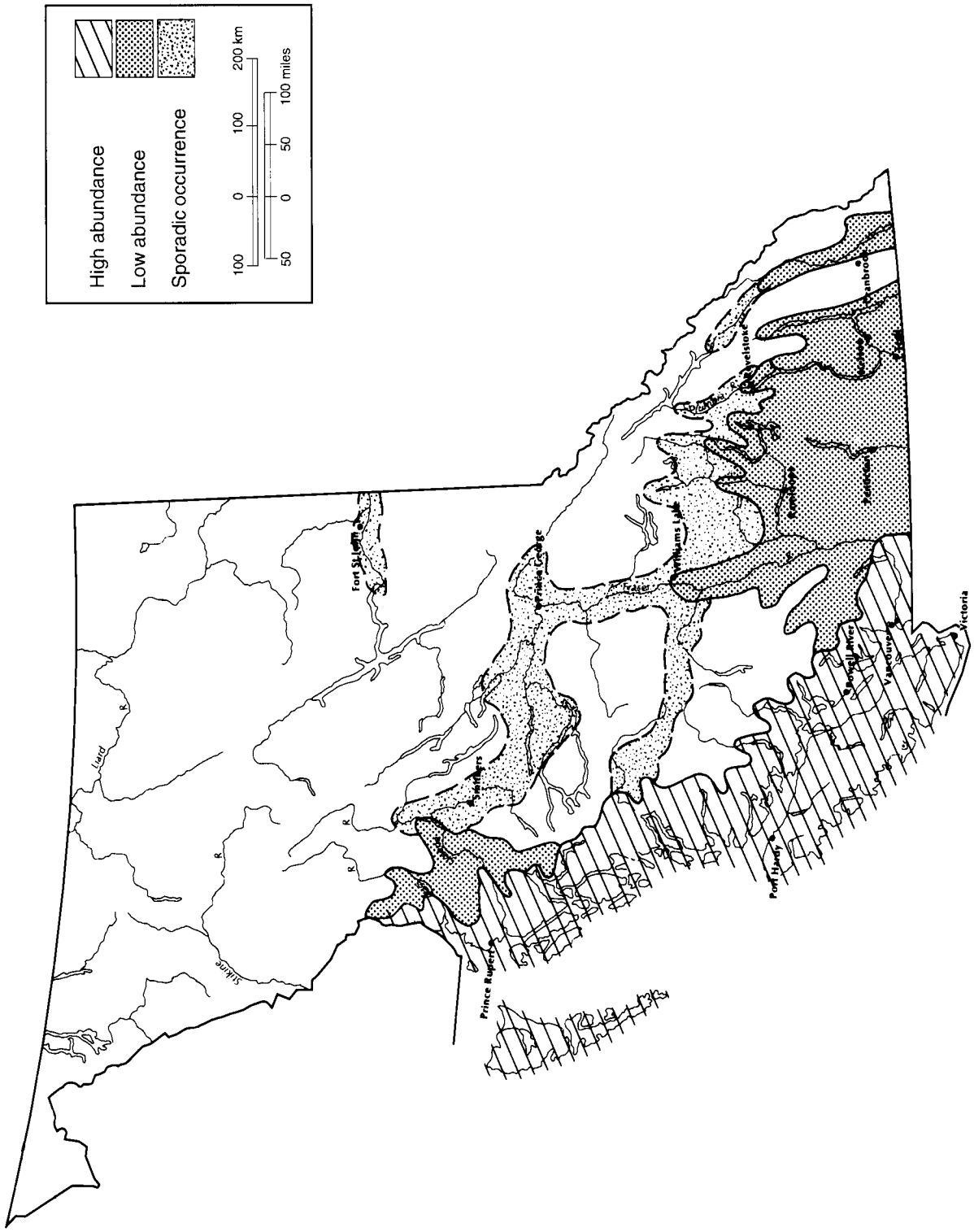


Figure 6. The distribution and relative abundance of wintering Bald Eagles in British Columbia.

large numbers killed in Alaska over the first half of this century under the bounty system undoubtedly had some impact (Alcorn l975).

In the l950s, a rather abrupt and drastic decline in Bald Eagle populations and productivity was observed in many populations in the eastern part of the continent, which was correlated to the widespread use at that time of the pesticide DDT. (Snow l973; Brownell and Oldham l983). Populations across much of the northern and western parts of the continent appeared largely to escape this problem. However, populations in California experienced a similar decline due to major DDT producers in Los Angeles discharging toxic waste into the ocean (R. Davies, pers. comm.). In the late l960s, Sprunt (l969) examined productivity data for various populations across the continent and concluded that populations in Alaska and British Columbia appeared to be stable, while those east of Lake Erie, along the Atlantic and Gulf coasts, and over much of Florida, were declining due to low reproductive rates. Fyfe (l977) stated that Canadian populations appeared to be stable in the mid-l970s.

Based on his analyses of Christmas Bird Count data, Gerrard (l983) estimated that Bald Eagles along the east coast and parts of Florida in l980 were at about one-half to one-third their l955 level. He found that in the central and interior western states, wintering eagles had increased by a factor of two or three over the same period. Trends for the west coast and Alaska were less clear. He also noted that where populations had decreased, the trough of the decline had occurred about l970, and that an upward trend was evident since. Swenson *et al.* (l986) reported an exponential increase in the Yellowstone nesting population from l97l to l982. Swenson (l983) analysed a wide range of data, and concluded that populations nesting across the boreal forest regions west of Ontario had increased steadily since the l930s. Hansen and Hodges (l985) estimated that Bald Eagle densities in southeast Alaska were double those of l941.

Grier also indicated that Bald Eagle populations appear to be increasing throughout much of their range in the east, following the reduction in productivity observed in the l960s, and ‘70s (Grier l982). Populations have also increased in the lower peninsula of Michigan, northwestern Ontario and at Chesapeake Bay in recent years (Brownell and Oldham l983).

4.2 British Columbia

4.2.1 Population size

Breeding population — The number of adult Bald Eagles in British Columbia was recently estimated at l5 000, with about 4000 along the north coast, 5000 along the south coast, and another 6000 scattered throughout the Interior (Davies l985). Estimates for the coast were derived from aerial surveys of a number of stratified random plots (Hodges *et al.* l984); that for the Interior was extrapolated from meagre survey data for major river systems. The coast population estimates, being based on a single aerial survey, are probably quite conservative. Based on the estimate of l5 000 adults, 7500 breeding pairs could occur in the province. However, a variable percentage of the adult population is made up of non-breeding adults, therefore the number of active nests may be well below 7500. Hodges *et al.* (l984) estimated that 56% of adult eagles on the British Columbia coast were not breeding, which leaves a potential 3960 breeding adults, or l980 pairs. The percentage of non-

breeding adults in Interior populations is probably lower than that in the rich coastal environment, perhaps closer to the l9% non-breeding adults in Saskatchewan populations (Gerrard and Bortolotti l988). This would leave approximately 2400 breeding pairs in the Interior, and a total of about 4500 breeding pairs in the province. W.T. Munro (*in* Brownell and Oldham 1983) estimated the provincial population as 6000 to 7000 breeding pairs.

Immature eagles present during the breeding season make up about 27% to 33% of the population (Davies l985; Gerrard and Bortolotti l988), which would account for an additional 6000 eagles, bringing the total British Columbia population during the breeding period to about 21 000 birds (Table 11).

Winter population — The total number of Bald Eagles wintering in the province is likely somewhat larger than the summering population, due to the year's production of young, and some immigration from Alaska (Hodges *et al.* l987; Campbell *et al.* l990). However, some eagles from the interior of British Columbia also move south to the U.S. in winter. Based on an analysis of Christmas Bird Count data, Gerrard (l983) estimated the mid-winter population in British Columbia in l980 was about 30 000, with 24 000 of these found in the southwest quarter of the province. Based on mid-winter surveys in recent years, Farr and Dunbar (l988) estimated the wintering population at 20 000 to 30 000 eagles, of which slightly more than one-third were immatures.

4.2.2 Population trends

As for North America in general, historical trends in British Columbia are difficult to document. In the extreme southwest corner and southern interior valleys, settlement and forest clearing may have caused some reduction in the breeding population since the pre-settlement era. Beebe (l974) believed that populations along the largely unsettled coast had changed little if any since prehistoric times. Recent surveys and re-surveys of populations along the south coast area have indicated stable or increasing populations of

Table 11. Estimates of the abundance of adult and immature Bald Eagles in British Columbia during the nesting season.

Breeding status	Coastal[1]	Interior[2]	Total
Adults			
- Breeding	3960	4800	8760
- Non-breeding	5040	l200	6240
- Total	9000	6000	15 000
Immature	3400	2570	5970
Total eagles	12 400	8570	20 970

1 Adult data from Hodges *et al.* (1984).

2 Total adult estimate from Davies (1985). Non-breeders estimated to make up 20% of the adult population. Immatures estimated to comprise 30% of total eagle population. "Interior" population includes non-marine habitats west of the summit of the Coast Range.

breeding eagles since the l960s (Hancock l964; Trenholme and Campbell l975; Retfalvi l977; Vermeer *et al*. l989; Vermeer and Morgan l989). In the Gulf Islands, spring surveys by Trenholme and Campbell in l974 found no change from the numbers found by Hancock in l963 and l964. Vermeer *et al.* (l989) surveyed this area again in l987, and found an increase of 30%. Vermeer and Morgan (l989) surveyed the Barkley Sound area in l988, and found numbers had not changed significantly since Retfalvi surveyed the area in l97l-l973.

Recent surveys in Washington (l980-l985) have also found populations there to be increasing (McAllister *et al.* l986). Hansen and Hodges (l985) found that eagle densities along the southeast coast of Alaska had approximately doubled since l941, possibly as a result of the elimination of the bounty system in the l950s which was responsible for the death of many eagles. The high numbers of non-breeding adults observed along the coasts of British Columbia and southeast Alaska may be an indication that the available breeding habitat is saturated with territorial breeding pairs (Hodges *et al*. l984; Hansen and Hodges l985).

Pacific Northwest eagles seem largely to have escaped the heavy pesticide contamination that was believed to be responsible for declines in populations and productivity of Bald Eagles in eastern North America. However, continued clearcut logging of old-growth forests and pollution of coastal waters by dioxins, furans, and other chemicals may have negative impacts on Bald Eagles in future, and this should be monitored. Increasing recreational use of Interior lakes and rivers may also have negative impacts on nesting Bald Eagles.

While British Columbia Bald Eagle populations appear to be large and either stable or increasing at present, future trends are difficult to anticipate.

5.0 LEGAL PROTECTION

5.1 United States

In l940, the United States *Bald Eagle Protection Act* was passed and it became illegal to harm Bald Eagles and their nests and eggs. This Act did not apply in Alaska until statehood was granted in l959. In l953, the territorial Bald Eagle bounty law in Alaska was repealed, thereafter allowing eagles to be killed only when causing damage.

The United States *Endangered Species Act* of l966 extended protection to include habitat. Under this Act, only the Southern Bald Eagle was listed as Endangered, but Bald Eagle nest sites on National Wildlife Refuges were closed to the public during the nesting season, an order was issued prohibiting timber cutting within l/2 mile of trees containing Bald Eagle nests, and provisions were made to protect future nesting habitat. This Act was amended and broadened under the *Endangered Species Conservation Act* of l969. In l978, due to the difficulties in distinguishing between Northern and Southern Bald Eagles, the entire species was listed as Endangered in the lower 48 states (except in Washington, Oregon, Minnesota, Wisconsin, and Michigan, where it was listed as Threatened); the Alaskan population was excluded. In addition to these Federal laws, the Bald Eagle has also been extended various degrees of protection under State law in all states but Hawaii (Snow l973; Brownell and Oldham l983).

5.2 Canada

Contrary to published reports (Lincer *et al.* 1979), the Bald Eagle is offered no direct protection in Canada under Federal law, other than the prohibition of import or export of eagles and eagle parts under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) convention, administered under the *Export and Import Permits Act*. Raptors, including the Bald Eagle, are not included in the *Migratory Birds Convention Act* of l9l6 (C.W.S. 1978). Under the *British-North American Act* (*B.N.A.*), each province has jurisdiction over the wildlife within its borders, and various laws have been enacted in all provinces offering some protection to the Bald Eagle. Two provinces, Ontario and New Brunswick, have passed Endangered Species legislation, and the Bald Eagle is listed as Endangered in both provinces (Brownell and Oldham l983).

5.3 British Columbia

In British Columbia, Bald Eagles are protected by the *Wildlife Act*, under which it is illegal to harm or molest Bald Eagles, their nests and eggs. Recent amendments now protect the nests, whether or not they are occupied. Other Acts, both Provincial and Federal, indirectly offer some protection to Bald Eagle habitat; including the provincial *Pesticides Control Act*, which controls the use of pesticides; the *Waste Management Act*, which regulates water quality and discharge of pollutants; and the *Park Act* and *Ecological Reserves Act*, which protect some nesting habitat.

Munro (l982) stated that no legislation exists to protect roost trees, or potential nesting and roosting habitat on lands outside of designated reserves, although trees having nests in them now have protection under the *Wildlife Act*.

Protection of areas around actual and potential nest trees on Crown lands managed for timber harvest is a major need. Although the British Columbia ministries of Forests and Environment, Lands and Parks have policies to designate and protect from cutting "wildlife trees", and some forest companies now carry out eagle nest surveys and refrain from cutting known nest trees, a more comprehensive province-wide program of nesting habitat protection is needed.

6.0 LIMITING FACTORS

6.1 Causes of Regional Population Declines

Historically, three major factors are considered to have caused significant regional declines in Bald Eagle populations in North America: shooting mortality, pesticide contamination, and habitat loss. The Alaskan eagle bounty severely reduced eagle populations there in the first half of the century, but populations have since recovered. Indiscriminate shooting may have also affected populations in other areas (Beebe l974). Pesticide contamination in eastern North America, primarily from DDT and its metabolites, caused drastic declines from the Great Lakes to Florida between l950 and the l970s. A similar occurrence took place in California. Forest spraying with DDT also affected some western populations (Swenson *et al.* l986). This problem, in which population declines resulted from reproductive failure, has been extensively documented (Sprunt *et al.* l973; Brownell and Oldham l983) and will not be discussed in detail here. Since widespread use of DDT was banned in

Canada and the United States in the l960s, Bald Eagle populations in many areas have begun to increase (Grier l982). Permanent loss of habitat, particularly nesting habitat, has undoubtedly reduced some eagle populations from Southern Ontario to Florida, and in the midwest states. This has been a gradual process over a period of 200 years, and is not well documented. In contrast to direct shooting and pesticide contamination, there is little chance that population losses caused by permanent habitat alienation can be regained.

6.2 Direct Mortality

6.2.1 Natural mortality

In pre-settlement times, Bald Eagles undoubtedly died of a variety of natural causes, including parasitism and disease, intraspecific aggression, starvation, predation on nestlings, destruction of nests by storms, and various accidents. These factors still occur today, plus a variety of hazards attributable to humans. Nestlings have been reported to die from sibling competition, from nest destruction caused by storms, and from falling out of nests. Black Bear predation may also occur (McKelvey and Smith l979), but is undoubtedly rare. Natural mortality of nestlings is not considered to be a significant limiting factor.

Natural mortality factors in wild juvenile and adult eagles are poorly known. Starvation and accidents are undoubtedly important for immature eagles, while disease and degenerative processes, sometimes coupled with malnutrition, are probably important for the long-lived adults.

Although most eagles submitted to rehabilitation centres or pathology laboratories suffer from human-caused conditions, a few cases involve natural agents. Live Bald Eagles treated by Redig (*et al.* l983) included cases of developmental anomalies, cataracts, respiratory disease, septic polyarthritis, porcupine quill damage, and fighting injuries. Major natural morbidity and mortality factors in British Columbia appear to include: falling from the nest, colliding with various objects when learning to fly, intraspecific aggression, disease (including cardiac disease, aspergillosis and avian pox), and starvation (K. Langelier, unpublished data).

6.2.2 Human-caused mortality

The relative importance of various human-related mortality factors appears to vary from place to place. Until at least l980, shooting was the major known cause of mortality in the United States, although losses to this cause have been steadily declining in recent years. Accidental trapping is still a significant cause of death, particularly where Muskrat trapping is common. Collisions with cars, trains, overhead wires, and antennae appear to be taking an increasing toll in settled areas. A related problem, electrocution by power lines, is also of fairly widespread occurrence. Eagles have also died after becoming tangled in protective netting at fish-rearing facilities, in fishing gear, and in barbed wire. Poisonings of various kinds are also prevalent, and result mainly from ingestion of poison bait set out for predator or pest control. Plumage fouling by oil and sewage have also been reported (Schmeling and Locke l982; Redig *et al.* l983; Fraser l985).

In British Columbia, the order of importance of anthropogenic mortality causes is approximately as follows: collisions with various vehicles and objects, poisoning, electrocu-

tion, shooting, trapping, and other accidents such as becoming tangled in nets, or plumage fouling (K. Langelier, unpubl. data). Lead poisoning caused by ingestion of shot when feeding on waterfowl is the most frequent form of toxicosis in southwestern British Columbia (Langelier *et al.* l99l). Sub-clinical lead toxicosis, by affecting sensory perception and coordination, may also predispose eagles to many other kinds of mortality. Improper disposal of livestock carcasses euthanized with barbiturates has resulted in some mortality. Carbofurans have been identified as a potential toxicity problem.

Some mortality factors, such as lead poisoning, may decrease in the future as lead shot is phased out; others, such as vehicle collisions and electrocution, may increase.

There is no doubt that human civilization has introduced many hazards with which eagles (and other wildlife) must contend, and new ones will probably arise in the future. However, the proportion of any eagle population suffering such losses on an annual basis, and the over-all role of human-caused mortality as a limiting factor, are not known. At present, populations in most areas appear to be maintaining their numbers in the face of this mortality.

6.3 Reproductive Failure

As noted earlier, reproductive failure caused by bioaccumulation of persistent chemicals, particularly organocholorine compounds, has the potential to cause population declines. This does not appear to be a major threat at present; however, continued monitoring is needed to assess the potential of industrial pollutants, such as dioxins and furans, for causing reproductive failure. These and other related chemicals are known to occur in foods eaten by eagles on the British Columbia coast.

6.4 Disturbance

There is considerable debate about whether human activities in the vicinity of nesting or foraging sites will adversely affect Bald Eagles (see review by Fraser l985). There is little doubt that serious disturbance, such as climbing to nests during incubation, will cause eagles to desert their nests; however, this level of disturbance is rare. The usual kinds of disturbance do not cause direct mortality, and assessment of their effects is very difficult.

Effects of disturbance on nesting eagles vary greatly with previous conditioning of the birds. Some eagles have adapted to nesting in areas with much human activity; however, there is probably a limit to this. Eagles may no longer nest in many urban areas because suitable trees are lacking, food resources no longer occur, or disturbance levels are too high. Disturbance levels probably do limit the distribution and abundance of nesting eagles in some built-up areas. Fraser (l985) reported that nests in Minnesota and Maryland are further from human activity centres than from random points.

Human activity frequently causes eagles to vacate feeding sites, both during the nesting and winter seasons. This is of particular concern in winter, when the birds are in a negative state of energy balance. Frequent disturbance of wintering eagles could theoretically reduce survivorship and have population consequences (Stalmaster l983); however, real effects have not yet been documented. Fraser (l985) concluded that

"... human activities that chronically exceed the limits of eagle tolerance may be considered a form of habitat destruction. This is a particularly insidious impact because there is no overt indication of the impact obvious to untrained or casual observers."

Human disturbance may adversely affect a few eagles in localized situations in British Columbia, but is not presently thought to be a significant limiting factor. However, disturbance levels are expected to increase in the future and the situation should be monitored.

6.5 Limiting Factors

6.5.1 Food resources

The availability of food, together with the territorial nature of nesting Bald Eagles, is thought to be the major factor presently limiting population increase. Nesting densities are highest where food is abundant (e.g., coastal seabird islands), and low where it is not (e.g., interior lakes). Increased food resources in areas having limited food would presumably result in higher nesting densities, therefore food may be considered a limiting factor. Food availability in winter is probably also important, especially for immature eagles.

At present, there is no indication that Bald Eagle food supplies in British Columbia are decreasing, although factors such as introduction of predators to seabird islands, or over-fishing of rockfish or herring stocks, have the potential to adversely affect eagle populations. Human activities have actually resulted in many new sources of food for eagles, probably allowing some areas at some seasons to support larger populations than would otherwise be possible (see Section 2).

6.5.2 Nesting sites

Bald Eagles are generally precluded from nesting where suitable nest trees are not present. The breeding range has shrunk in some parts of the United States where large areas have been cleared for farming or other purposes. Loss of nesting trees to date has probably had a minor impact on the nesting season carrying capacity of British Columbia for Bald Eagles, although local reductions are expected to have occurred in urbanized areas and on some clear-cut lands, and further declines of this nature are expected. Gradual loss of nesting habitat is expected to be the most significant factor affecting Bald Eagle abundance in British Columbia in the future.

7.0 SPECIAL SIGNIFICANCE OF THE SPECIES

7.1 Status

The Bald Eagle is included on the 1993 Blue List of wildlife species prepared by the B.C. Ministry of the Environment, Lands and Parks as part of its Provincial Wildlife Strategy, indicating that it is a sensitive or vulnerable species, or one for which there is inadequate information for evaluation.

In l970, the Bald Eagle was included on a list of Endangered Wildlife in Canada (Godfrey l970). It is currently listed as Endangered in two Canadian provinces, Ontario and New Brunswick. The Bald Eagle is currently listed as "Species Examined and Not Designated In Any Risk Category" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

In the United States, the Bald Eagle is currently officially listed as Endangered in 43 states, and as Threatened in five. It is not listed as Endangered or Threatened in Alaska. The Southern Bald Eagle is listed as Endangered in the IUCN Red Data Book; the Northern Bald Eagle is not listed by IUCN. The Bald Eagle is the only member of the genus in North America, and is restricted to North America. Two related forms, the Madagascar Sea Eagle (*Haliaeetus vociferoides)* and the White-tailed Eagle (*H. albicilla)*, are listed in the IUCN Red Data Book, the former as Endangered and the latter as Threatened.

7.2 Public Interest

"Wherever eagles occur common they are among the best known of birds. They appear frequently in the language and legends of ancient peoples, and have often been chosen as national emblems, since for size, powerful flight, and fierce nature they have been celebrated since earliest historic times." (Oberholser l906).

On 20 June l792, the Bald Eagle was officially adopted as the emblem of the United States of America, and since that time has played a large part in the symbolism and culture of that nation, as it did among the native peoples of the continent since time immemorial.

Bald Eagles are one of the best known birds, and attract many viewers and non-consumptive recreational users to areas where they may be seen. In recent years, several areas in the United States have been set aside for Bald Eagle use; towers, blinds, and camouflaged trails have been built to accommodate viewing without disturbing the birds (Spencer l976). Bald Eagles have a great potential as tourist attractions wherever they occur in any numbers.

7.3 Economic Value

Bald Eagles have little economic value *per se*, although there is an illicit trade in feathers and parts for the manufacture of artifacts, which can be quite extensive. An estimated 200-300 eagles were killed for feathers and other body parts over a three-year period ending in l983 at a roost in South Dakota (Gerrard and Bortolotti l988).

The negative economic value attributed to eagles in the past, through the supposed destruction of livestock, gamebirds, and fish, has largely been discounted, although they do take waterfowl in many areas. Depredations of livestock are almost non-existent, although there are a few documented cases.

Bald Eagles are an important component of nature tours in many areas, and this value is growing steadily. British Columbia is well situated for viewing of nesting and wintering eagles by American visitors.

7.4 Species Security

With a total population approximating 70,000 individuals and most regional populations now either stable or increasing, the Bald Eagle appears to be relatively secure as a species. Although designated as Threatened or Endangered over much of its geographic range (all of the lower 48 states and two Canadian provinces), the bulk of the population occurs in Alaska, British Columbia, and the boreal forest of western Canada, locations where habitat and populations seem to be quite secure. Current trends do not suggest

any worsening of the present continental status in the near future, although the long-term outlook is less optimistic. Increasing human populations, land development, and pollution are bound to have a gradual long-term impact on available habitat.

8.0 PROTECTION AND MANAGEMENT

In the United States, where the Bald Eagle is considered to be Threatened or Endangered in all states except Alaska, and where the species enjoys a high profile as the national emblem, management and protection matters have received considerable attention. These include intensive activities such as captive breeding, reintroductions to former nesting habitat, construction of artificial nest sites, artificial feeding of free-ranging birds with non-contaminated food, and nest-watch programs to prevent disturbance. None of those programs appear to rate immediate attention in British Columbia, although a certain amount of nest surveillance in settled areas could be worthwhile.

In the Pacific Northwest states, including Alaska, much attention has been given to protection of nesting and roosting habitat from logging impacts, and protection of both nesting birds and winter concentrations from human disturbance. Many findings there are directly applicable to British Columbia.

8.1 Inventory Needs

Although regional population densities and the total number of eagles nesting and wintering in British Columbia are relatively well known, the exact location of most nest trees and roosting sites has not been recorded. One cannot manage and protect the resource without this information. Locations of most nests in southeast Alaska (Hodges and Robards l98l), Washington (McAllister *et al.* l986), and Oregon (Isaacs *et al.* l983) are now known, but similar data for British Columbia are lacking. Location of all nests in British Columbia would be a mammoth undertaking, but could be phased over a period of years, with earliest attention given to high priority locations, such as coastal old growth destined for logging. Several logging companies are presently carrying out such inventories, and all should be required to do so, and to submit maps showing nest locations. This should also apply to Interior operators, who are logging lands adjacent to rivers and lakes. Provincial coordination of such a program is needed. Inventory is also needed on private lands, primarily in the Georgia Strait region and southern Interior valleys. Identification and mapping of important winter roosts is also needed.

8.2 Protection Needs

8.2.1 Habitat protection

A formal provincial policy, preferably backed by regulation, is needed for protection of nest sites on Crown lands, particularly on those lands designated for timber production. This should specify that all nest trees be preserved, that a certain number of trees around them be retained for long-term replacement, and that logging adjacent to nest trees be done outside the nesting season. The number of trees or size of patch to be left at any site requires more study, and may vary according to the relative availability of adjacent old growth left uncut for other reasons. Many logging operators now attempt to protect known nest trees, but some inconspicuous ones have inadvertently been cut. In some cases, only the

nest tree has been left standing in a sea of slash. Without replacement trees, future logging on an 80-year rotation will result in the loss of many nesting territories. Protection of key perching and roosting sites used in winter, as described for the Fraser Valley (Farr l988; Teske l989), probably needs to be expanded to other areas. Voluntary restraint by logging companies may be sufficient to meet this objective.

Protection of nest sites on private land is a more complex matter. On southeast Vancouver Island, most nest trees appear to be cut as a result of ignorance; therefore a public information program aimed at voluntary preservation by land owners/managers is considered to be the most urgent need (Blood l989b). Other mechanisms to preserve known nest trees - easements, restrictive covenants, landowner agreements, and administrative transfer of Crown parcels - may be appropriate where voluntary preservation is not promising. Land purchase is too expensive to offer as a general approach, but should be considered where sites have value as parkland.

Protection of key forage resources and habitats from degradation and pollution is also needed. This is generally accommodated by existing environmental legislation; however, more monitoring and enforcement is needed in some areas.

8.2.2 Eagle protection

Based on known causes of injury and death recorded for eagles in southwestern British Columbia, K. Langelier (pers. comm.) has recommended the following management/ protection measures, in approximate order of priority:

l. Eliminate the use of lead shot for sport hunting.
2. Control or eliminate the use of carbofuran pesticides.
3. Move road-killed animals away from roadsides to reduce eagle collision mortality.
4. Investigate design of power lines and modify this (e.g., greater spacing between conductors) in areas where electrocution is a persistent problem.
5. Reduce or eliminate the use of leghold traps and snares by trappers.
6. Investigate predator control nets and control methods at fish farms and make appropriate modifications.
7. Intensify enforcement in areas where shooting is a problem.
8. Publicize the need for careful disposal of the carcasses of livestock that have been euthanized with barbiturates.

Rehabilitation centres can play an important role in reducing eagle mortality, and such efforts should be supported.

Protection from disturbance will probably become increasingly important in British Columbia, particularly where large numbers of eagles concentrate along salmon-spawning rivers in winter. Stalmaster (l983) recommended restricting land activities within 250 m of eagles perched in shoreline trees, and suggested that the distance could be shortened to 75 to l00 m if dense shielding vegetation was present. Knight and Knight (l984) found that restriction zones of 350 m would be required in order to protect 99% of eagles perched in shoreline trees from disturbance by passing canoes along the Skagit and Nooksack rivers. Where eagles are resting on river bars, a zone of 450 m is needed to

achieve the same level of protection. Restriction of boating activity during early morning and late afternoon feeding peaks has also been recommended. These guidelines may be applicable to British Columbia rivers if recreational boating becomes a problem in areas where wintering eagles are concentrated.

8.3 Research Needs

The following are perceived as the most important research needs applicable to Bald Eagle management and conservation in B.C.:

l. Assessment of forest practices in relation to nesting abundance

The major need is to determine how much old growth is needed, either as scattered individual trees or as patches, and what its spatial arrangement should be in order to retain nesting eagle populations that are as high as prior to logging. Evaluation of nesting activity before, during, and after logging is needed on a fairly large study area. The relative importance for eagle nesting of old growth left for other purposes, such as stream protection, fire-breaks, or because it is not operable or of poor commercial quality, should also be determined. Possibilities for satisfying the needs of other old-growth nesters like Marbled Murrelets at the same time as preserving eagle nest sites require study.

2. Assessment of mortality rates

Information is needed on mortality rates in British Columbia and on the proportion of that mortality attributable to natural versus human causes. Present programs in which dead or injured eagles are submitted to pathologists will continue to provide some information of this kind; however, a comprehensive long-term banding program is needed. Biases resulting from the submission of more eagles from settled areas where human-related mortality is highest need to be evaluated.

3. Contaminants in eagles and their foods

Continued monitoring of prey items, and of sick or dead eagles turned in to pathology labs, is needed to determine whether known problems like lead poisoning are decreasing, or if any new contaminants are evident.

4. Movements

The degree to which the British Columbia Bald Eagle population is shared with other jurisdictions should be evaluated. The above banding program would shed light on this; however, marking with coloured vinyl tags is also recommended, together with notification of wildlife agencies in adjacent jurisdictions of the program and the colour combinations used. This would also aid in assessment of the movement of eagles between various food sources within the province.

5. Tolerance of human civilization

Monitoring of nesting populations in areas where human settlement and related land uses are expanding is needed to determine tolerance levels, and whether any decrease in nesting abundance is due to loss of nest trees, loss of food resources and foraging sites, or simply to increased levels of human activity. Eagles nesting in populated areas need to be studied more thoroughly to determine how they adapt to, and cope with, the trappings of civilization. Such studies would aid in predicting impacts, such as cottage development

around lakes, where only relatively low trees like aspens are available for nesting.

6. Non-breeding by adults eagles

There is evidence that, in saturated populations, over 50% of adult eagles may not nest. Knowledge of the proportion that is not breeding provides an index of the degree to which the habitat in any area is saturated. The presence of few or no non-breeders may indicate that a population is either declining or has not reached carrying capacity. Sample aerial surveys repeated every few years could provide this information.

9.0 EVALUATION

Concern for the world status of the Bald Eagle (entirely confined to North America) has arisen because of gradual long-term habitat loss or alteration, shooting mortality prior to the l950s, and pesticide-induced declines from the l950s to the l970s. The species has recovered from shooting losses, and appears to be recovering from pesticide impacts. Habitat loss in the southern part of the species' breeding range has probably reduced the continental population below that present l00 or 200 years ago; however, historical census data are not available to confirm this. At present, the bulk of the continental population occurs in Alaska, British Columbia, and across the boreal forest of Canada. These populations are mostly stable, and the habitat is relatively secure, therefore the species as a whole does not appear to warrant Rare, Threatened, or Endangered status. Threatened or Endangered status has been assigned in jurisdictions where population size is small, and/or has recently decreased due to pesticide or other impacts. This includes Ontario, New Brunswick, and all of the lower 48 states.

The Bald Eagle population in British Columbia is large (20,000-30,000), and apparently stable or increasing in most regions. Designation of the provincial population as Rare, Threatened, or Endangered does not appear warranted. The species is currently on the MOELP Wildlife Program's Blue List, which includes taxa that are considered vulnerable or sensitive. Species may also be on this list because of an inadequate understanding of their status.

The Bald Eagle is sensitive to extensive loss of nest trees, but will continue to nest where only scattered veteran trees remain. It is relatively tolerant of non-threatening human activity, will nest in suburban environments, and has adapted to many food sources made available by humans. Although eagles require trees for nesting, they forage largely in aquatic habitats, and these are mostly secure. They appear to be less threatened than many other species that require old-growth forest for both nesting and foraging. On a provincial basis, the Bald Eagle does not appear to deserve Blue List status. In view of the high profile of this species and its potential importance for nature-based tourism, inclusion on the provincial Yellow List appears to be desirable.

If Red, Blue, and Yellow List criteria were applied on a regional basis, then the Bald Eagle might warrant Blue List status in the Georgia Depression Ecoprovince. Its long term prospects here would seem to approximate those of adjacent Washington State, where it has been designated as Threatened.

In the absence of management action, a gradual decline in nesting populations could be expected in localized areas subject to extensive clear-cutting or land settlement. However, programs aimed at identification and

preservation of existing nest trees, plus additional replacement trees, could arrest such declines. More effort is needed to achieve this objective.

10.0 LITERATURE CITED

Alcorn, G. l975. The bald eagle. Pacific Search 9(6):12-13.

A.O.U. l983. Checklist of North American Birds. 6th Edition. Am. Ornithol. Union, Baltimore, Md.

Anthony, R.G., R.L. Knight, G.T. Allen, B.R. McClelland, and J. I. Hodges. l982. Habitat use by nesting and roosting bald eagles in the Pacific Northwest. Pages 332-342 *in* Trans. 47th North Am. Wildl. and Nat. Res. Conf.

Bangs, E.E., T.N. Bailey, and V.D. Berns. l982. Ecology of nesting bald eagles on the Kenai National Wildlife Refuge, Alaska. Pages 47-54 *in* W.N. Ladd and P.F. Schempf, eds. l982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv. Anchorage, Alas.

Beebe, F.L. l974. Field studies of the Falconiformes of British Columbia. B.C. Prov. Mus. Occas. Pap. No. l7. l63pp.

Bent, A.C. l937. Life histories of North American birds of prey, Order Falconiformes. Part 1. U.S. Nat. Mus. Bull. l67. 409pp.

Blood, D.A. 1982. Kootenay River Diversion Study, Environmental Impact Assessment. Draft final report on wildlife inventory and potential impacts. Prepared for B.C. Hydro and Power Authority. 144pp.

___. l989a. Conservation plan for bald eagle nesting trees in the Nanaimo area. Progress report - inventory phase. Revised March l989. Prepared for the B.C. Minist. of Environ., Habitat Conservation Fund. 33pp.

___. l989b. Conservation plan for bald eagle nest trees in the Nanaimo area. Prepared for the B.C. Minist. of Environ., Habitat Conservation Fund. 33pp. + 2 maps.

Blood, D.A., and G.G. Anweiler. l983. Kemano completion hydroelectric development, baseline environmental studies. Supplementary wildlife information. Prepared for Envirocon Ltd., Vancouver, B.C. 75pp.

____, and ___. l990a. Nesting chronology and success of bald eagles in southwest Yukon. Northwestern Nat. 71:9-11.

____, and ___. l990b. Williston-Kelly Lake transmission line: survey of raptor nests, Spring l990. Report to B.C. Hydro and Power Authority, Vancouver, B.C. 36pp.

_____, and ____. Unpubl. Bald eagle nests per km of shoreline, Interior British Columbia and Southern Yukon. D. Blood and Assoc. Ltd., Nanaimo, B.C. 6pp.

Bortolotti, G.R. l984a. Sexual size dimorphism and age-related size variation in bald eagles. J. Wildl. Manage. 48:72-81.

___. l984b. Criteria for determining age and sex of nestling bald eagles. J. Field Ornithol. 55:467-481.

Braun, C.E., F. Hammerstrom, T. Ray, and C.M. White. l975. Conservation Committee report on the status of eagles. Wilson Bull. 87(1):140-143.

Broley, C.L. l947. Migration and nesting of Florida bald eagles. Wilson Bull. 59:3-20.

Brooks, A.R. l922. Notes on the abundance and habits of the bald eagle in British Columbia. Auk 39:556-559.

Brown, L., and D. Amadon. l968. Eagles hawks and falcons of the World. Vol. 1. McGraw-Hill, New York, N.Y. 395pp.

Brownell, V.R., and M.J. Oldham. l983. Status report on the bald eagle (*Haliaeetus leucocephalus*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont. 80pp.

Burke, M. l983. Bald eagle nesting habitat improved with silvicultural manipulation in northeastern California. Pages 101-105 *in* D.M. Bird, chief ed. Biology and management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

Butler, R.W., and R.W. Campbell. l987. The birds of the Fraser River delta: populations, ecology and international significance. Can. Wildl. Serv. Occas. Pap. No. 65. 71pp.

Cain, S.L. l986. A new longevity record for the bald eagle. J. Field Ornithol. 52(2):173.

Campbell, R.W., N.K. Dawe, I. McT.-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. l990. The Birds of British Columbia. Vol. 2. Nonpasserines: Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C. 636pp.

____, M.G. Shepard, B.A. Macdonald, and W.C. Weber. l974. Vancouver birds in l972. Vancouver Nat. Hist. Soc. Spec. Publ. 96pp.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. l987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C. 420pp.

Carl, G.C., and C.J. Guiguet. l958. Alien animals in British Columbia. B.C. Prov. Mus. Handbook No. 14. Victoria, B.C. 94pp.

____, ____, and G.M. Hardy. l950. Biology of the Island Group, British Columbia. Pages B21-B63 *in* Prov. Mus. of Nat. Hist. and Anthrop. Report for l950, Victoria, B.C.

Cassidy, A. l985. Winter ecology of bald eagles at Qualicum River estuary, British Columbia. Abstract *in* J.M. Gerrard and T.N. Ingram, eds. The bald eagle in Canada. White Horse Plains Publishers, Headingley, Man. 272pp.

Cline, D.R. l982. Citizen action to protect the Chilkat bald eagles. Pages 83-98 *in* W.N. Ladd and P.F. Schempf, eds. 1982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage, Alas.

C.W.S. l978. Birds protected under the Migratory Birds Convention Act. Fish. and Environ. Canada, Ottawa, Ont. Can. Wildl. Serv. Occas. Pap. No. 1. 16pp.

Davies, R.G. l985. A note on the population status of bald eagles in British Columbia. Pages 63-65 *in* J.M. Gerrard, and T.N. Ingram, eds. The bald eagle in Canada. White Horse Plains Publishers, Headingley, Man.

Demarchi, D.A. l988. The ecoregions of British Columbia. B.C. Minist. of Environ., Wildlife Br., Victoria, B.C. 7pp.

Dickie, T. l990. Results of the British Columbia 1990 midwinter bald eagle survey. Report in files of B.C. Minist. of Environ., Surrey, B.C.

Douglas, S.D., and T.E. Reimchen. l988. Reproductive phenology and early survivorship in red-throated loons. The Can. Field-Nat. 102(4):701-704.

Dunbar, D. l988. Bald eagle nest production survey (Fraser Valley). Unpubl. Report, B.C. Minist. of Environ., Surrey, B.C. 4pp. + Table, Appendices and maps.

Eccles, T.R., and C.R. Cooper. l989. Raptor nests, heron colonies, and important wetlands encountered along the proposed Vancouver Island natural gas pipeline. Report to Pacific Coast Energy Inc., Vancouver, B.C. 29pp.

Evans, D.L. l982. Status report on twelve raptors. U.S. Dept. Interior, Fish and Wildl. Serv., Special Scientific Report, Wildlife No. 238, Washington, D.C.

Farr, A.C.M. l987. Managing habitat for bald eagles in the Fraser Valley of British Columbia: 1986-1987 observations. Report to World Wildlife Fund (Canada), Toronto. 40pp.

____. l988. Managing habitat for bald eagles in the Fraser Valley of British Columbia: l987-l988 observations. World Wildlife Fund, Scott Paper Co., and B.C. Minist. of Environ. 27pp.

____, and D. Dunbar. l986. A mid-winter bald eagle survey in southwestern British Columbia, l986. B.C. Naturalist 24(3):13-16.

____, and ___. l987. Results of British Columbia's midwinter bald eagle survey. B.C. Naturalist 25(4):13.

____, and ___. l988. British Columbia's 1988 midwinter bald eagle survey. B.C. Minist. of Environ., Surrey, B.C. 34pp.

____, and ___. l990. British Columbia's l989 midwinter bald eagle survey. B.C. Minist. of Environ., Surrey. 20pp. + Appendix.

Fielder, P.C. l982. Food habits of bald eagles along the mid-Columbia River, Washington. Murrelet 63:46-50.

Fisher, L.E., and J.G. Hartman. l983. Changes in winter distribution of bald eagles at reservoirs in Kansas and Nebraska. Pages 69-77 *in* D.M. Bird, chief ed. Biology and Management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

Forbes, L.S., and G.W. Kaiser. l984. Observations of breeding bald eagles in

southeastern British Columbia. The Murrelet 65:22-25.

Fraser, J.D. l985. The impact of human activities on bald eagle populations - a review. Pages 68-84 *in* J.M. Gerrard and T.N. Ingram, eds. The bald eagle in Canada. White Horse Plains Publishers, Headingley, Man.

____, L.D. Frenzel, J.E. Mathisen. l985. The impact of human activities on breeding bald eagles in north-central Minnesota. J. Wildl. Manage. 49:585-592.

____, ____, ____, and M.E. Shough. l983. Three adult bald eagles at an active nest. Raptor Research l7:29-30.

Fry, K. l980. Aspects of the wintering ecology of the Dunlin (*Calidris alpina*) on the Fraser River delta. Unpubl. Report. Can. Wildl. Serv. Delta, B.C. 45pp.

Fyfe, R.W. l977. Status of Canadian Raptor populations. Pages 34-39 *in* R.D. Chancellor, ed. Proc. World Conference on Birds of Prey, Vienna, Austria.

Gerrard, J.M. l983. A review of the current status of bald eagles in North America. Pages 5-22 *in* D.M. Bird, chief ed. Biology and Management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

_____, and G.R. Bortolotti. l988. The bald eagle. Haunts and habits of a wilderness monarch. Western Producer Prairie Books, Saskatoon, Sask. l78pp.

____, P.N. Gerrard, G.R. Bortolotti, and D.W.A. Whitfield. 1983. A 14-year study of bald eagle reproduction on Besnard Lake, Saskatchewan. Pages 47-57 *in* D.M. Bird, chief ed. Biology and management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

____, ____, W.J. Maher, and D.W.A. Whitfield. l975. Factors in-fluencing nest site selection of bald eagles in northern Saskatchewan and Manitoba. Blue Jay 33:169-176.

____, D.W.A. Whitfield, P. Gerrard, P.N. Gerrard, and W.J. Maher. l978. Migratory movements and plumage of subadult Saskatchewan bald eagles. The Can. Field-Nat. 92:375-382.

Gerrard, P., J.M. Gerrard, D.W.A. Whitfield, and W.J. Maher. l974. Post-fledging movements of juvenile bald eagles. Blue Jay 32:218-226.

Godfrey, W.E. l970. Canada's endangered birds. The Can. Field-Nat. 84(l):24-26.

____. l986. The Birds of Canada. Nat. Mus. Can. Ottawa. Rev. Ed. 595pp.

Grier, J.W. l980. Modeling approaches to bald eagle population dynamics. Wildl. Soc. Bull. 8:316-322.

_____. l982. Ban of DDT and subsequent recovery of reproduction in bald eagles. Science 218:1232-1235.

Griffin, C.R., T.S. Baskett, and R.D. Sparrowe. l982. Ecology of bald eagles wintering near a waterfowl concentration. U.S. Dept. Interior, Fish and Wildl. Serv., Spec. Sci. Report-Wildlife No. 247. Washington D.C. 12pp.

Grubb, T.G., R.L. Knight, D.M. Rubink, and C.H. Nash. l983. A five-year comparison of bald eagle productivity in Washington and Arizona. Pages 35-45 *in* D.M. Bird, chief ed. Biology and management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

Hancock, D. l964. Bald eagles wintering in the southern Gulf Islands, British Columbia. Wilson Bull. 76:111-120.

____. l965. West coast eagle survey. Can. Audubon 27(2):37-41.

Hansen, A.J., and J.I. Hodges, Jr. l985. High rates of nonbreeding adult bald eagles in southeastern Alaska. J. Wildl. Manage. 49:454-458.

Harris, B.S. l978. Eagle nest inventory southern Queen Charlotte Islands, Spring l978. Report to Islands Protection Committee. l6pp.

Hatler, D.F. l983. Concerns for ungulate collision mortality along a new surface route - Rogers Pass project report. Report to MacLaren Plansearch Corp., Vancouver, B.C. l09pp.

____, R.W. Campbell, and A. Dorst. l978. Birds of Pacific Rim National Park. B.C. Prov. Mus. Occas. Pap. No. 20. l94pp.

Herrick, F.M. l932. Daily life of the American eagle: early phase. Auk 49:307-323.

Hodges, J.I. l982. Bald eagle nesting studies in Seymour Canal, Alaska. Condor 84:125-127.

_____, and F.C. Robards. l982. Observations of 3,850 bald eagle nests in southeast Alaska. Pages 37-47 *in* W.N. Ladd and P.F. Schempf, eds. 1982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage, Alas.

____, E.L. Boeker and, A.J. Hansen. l987. Movements of radio-tagged bald eagles, *Haliaeetus leucocephalus*, in and from southeast Alaska. The Can. Field-Nat. 101(2):136-140.

___, J.G. King, and R. Davies. l984. Bald eagle breeding population survey of coastal British Columbia. J. Wildl. Manage. 48(3):993-998.

Isaacs, F.B., R.G. Anthony, and R.J. Anderson. l983. Distribution and productivity of nesting bald eagles in Oregon, l978-l982. The Murrelet 64:33-38.

Kaiser, G.W. l989. Nightly concentration of bald eagles at an auklet colony. Northwestern Naturalist 70(1):12-13.

Keister, G.P., and R.G. Anthony. l983. Characteristics of winter roosts and populations of bald eagles in the Klamath Basin of Oregon and California. Abstract *in* D.M. Bird, chief ed. Biology and Management of bald eagles and ospreys. Harpell Press, St. Anne de Bellevue, Que.

Knight, R.L., and S.K. Knight. l984. Responses of wintering bald eagles to boating activity. J. Wildl. Manage. 48(3):999-1004.

Knight, R.L., J.B. Athearn, J.J. Brueggeman, and A.W. Erickson. l979. Observations on wintering Bald and Golden Eagles on the Columbia River, Washington. The Murrelet 60(3):99-105.

Knight, S.K., and R.L. Knight. l983. Aspects of food finding by wintering bald eagles. Auk l00:477-484.

Ladd, W.N., and P.F. Schempf (eds.). l982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildlife Service, Anchorage, Alas.

Langelier, K.M., J. Elliott, and A.M. Scheuhammer. 1991. Bioaccumulation and toxicity of lead in bald eagles (*Haliaeetus leucocephalus*) of British Columbia. Paper given at Western Canada Wildlife Health Workshop, Victoria, B.C. February 15-16, 1991. 9pp.

Leighton, F.A., J.M. Gerrard, P. Gerrard, D.W.A. Whitfield, and W.J.Maher. l979. An aerial census of bald eagles in Saskatchewan. J. Wildl. Manage. 43:61-69.

Lincer, J.L., W.S. Clarke, and M.N. Le Franc Jr. l979. Working bibliography on the bald eagle. Nat. Wildl. Fed. Tech. Series No. 2, Washington D.C. 245pp.

Lueke-Joyce, T. l989. Summary bald eagle nest inventory, l988 and l989. Report to Western Forest Products Ltd., Port McNeill, B.C. 3pp.

___ . l990. l990 bald eagle nest survey report. Report to Western Forest Products Ltd., Port McNeill, B.C. 3pp. + maps.

Lumly, E.D. l939. The two eagles of North America. Publ. No. 78, Conservation unit III, New York Emerg. Conserv. Comm.

McAllister, K.R., T.E. Owens, L. Leschner, and E. Cummins. l986. Distribution and productivity of nesting bald eagles in Washington, 1981-1985. The Murrelet 67(2):45-50.

McClelland, B.R. l973. Autumn concentrations of bald eagles at Glacier National Park. Condor 75:121-123.

McKelvey, R.W., and D.W. Smith. l979. A black bear in a bald eagle nest. The Murrelet 60(3):106-107.

McKenzie, E. l983. Preliminary assessment of wetland alienation in the Cariboo-Chilcotin area, B.C. Can. Wildl. Serv., Delta, B.C. 66pp.

Mahaffy, M.S., and L.D. Frenzel. l987. Elicited responses of northern bald eagles near active nests. J. Wildl. Manage. 51(3):551-554.

Marshall, D.B., and P.R. Nickerson. l976. The bald eagle: l776-l976. Nat. Parks and Conserv. Mag. (July):14-19.

Mathisen, J.E. l968. Effects of human disturbance on nesting of bald eagles. J. Wildl. Manage. 32(1):1-6.

Millsap, B.A. l986. Status of wintering bald eagles in the conterminous 48 states. Wildl. Soc. Bull. 14:433-440.

Min. of Forests. l988. Biogeoclimatic Zones of British Columbia, 1988. Map at scale of 1:2,000,000. B.C. Minist. of For., Victoria, B.C.

Morgan, K., A. Hetherington, and S. Wetmore. l985. The effects of forest management on bird communities of the coastal islands of southern British Columbia: problem analysis. Res. Branch, Minist. of For. WHR-19. Victoria, B.C. 59pp.

Munro, J.A. 1938. The northern bald eagle in British Columbia. Wilson Bull. 50:28-35.

Munro, W.T. 1982. Programs and policies relating to raptor management in British Columbia. Pages 30-34 *in* W.N. Ladd and P.F. Schempf, eds. 1982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage, Alas.

Murphy, J.R. l975. Status of eagle populations in the western United States. Proc. World Conf. Birds of Prey, Vienna, Austria 1:57-63.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, S.D. 399pp.

Oberholser, H.C. 1906. The North American eagles and their economic relations. U.S. Dept. Agric., Biol. Surv. Bull. No. 27. 31pp.

Ofelt, C.H. l976. Unusual feeding behavior of bald eagles in British Columbia. The Murrelet 57(3):70.

Platt, A.B. l976. Bald eagles wintering in a Utah desert. Am. Birds 30(4):783-788.

Postupalsky, S. l974. Raptor reproductive success: some problems with methods, criteria, and terminology. Pages 21-31 *in* F.N. Hamerstrom, Jr., B.E. Harrell, and R.R. Olendorff, eds. Management of raptors. Raptor Res. Rep. 2, Raptor Res. Found., Inc., Vermillion, S.D.

Redig, P.T., G.E. Duke, and P. Swanson. l983. The rehabilitation and release of Bald and Golden Eagles: a review of 245 cases. Pages 137-174 *in* D.M. Bird, chief ed. Biology and Management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

Reimchen, T.E., and S. Douglas. l977. The bald eagle as a predator of aquatic birds. Unpublished report. 5pp.

Retfalvi, L.I. 1965. Breeding behavior and feeding habits of the bald eagle (*Haliaeetus leucocephalus*) on San Juan Island, Washington. M.Sc.F. Thesis, Univ. of B.C., Vancouver, B.C. 193pp.

___. 1970. Foods of nesting bald eagles on San Juan Island, Washington. Condor 72(3):358-361.

___. 1977. Surveys of bald eagles in Berkley Sound British Columbia, l970-l973. Unpubl. Report. Can. Wildl. Serv., Delta, B.C. 24pp.

Ritchie, R.J. l982. Investigations of bald eagles, Tanana River, Alaska, l977-l980. Pages 55-67 *in* W.N. Ladd and P.F. Schempf (eds.). 1982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage, Alas.

Robards, F.C., and J.G. King. 1966. Nesting and productivity of bald eagles in southeast Alaska. U.S. Bureau Sport Fisheries and Wildlife, Washington, D.C.

Rodway, M.S., M.J.F. Lemon, and G.W. Kaiser. l988. British Columbia seabird colony inventory: Report No. 1 - East Coast Moresby Island. Can. Wildl. Serv. Tech. Report Series No. 50. 276pp.

____, ____, and K.R. Summers. l990. British Columbia seabird colony inventory: Report No. 4. Scott Islands. Can. Wildl. Serv. Tech. Rep. Series No. 86. 109pp.

Schmeling, S.K., and L.N. Locke. 1982. Causes of mortality in 87 Alaskan eagles. Page 253 *in* W.N. Ladd and P.F. Schempf (eds. 1982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada., U.S. Fish and Wildl. Serv., Anchorage, Alas.

Servheen, C.W., and W. English. 1979. Movements of rehabilitated bald eagles and proposed seasonal movement patterns of bald eagles in the Pacific Northwest. Raptor Res. 13:79-88.

Sherrod, S.K., C.M. White, and F.S.L. Williamson. 1976. Biology of the bald eagle on Amchitka Island, Alaska. Living Bird 15:143-182.

Siddle, C. 1990. The bald eagle in the Peace River region of British Columbia. Report prepared for D. Blood and Associates Ltd., Nanaimo, B.C. 15pp.

Snow, C. 1973. Habitat management series for endangered species. Southern bald eagle, *Haliaeetus leucocephalus leucocephalus* and Northern bald eagle, *Haliaeetus leucocephalus alascanus*. U.S. Dept. of the Int., Bur. of Land Manage. Tech. Note No. 5. 58pp.

Southern, W.E. l963. Winter populations, behavior and seasonal dispersal of bald eagles in northwestern Illinois. Wilson Bull. 75(1):42-55.

Spencer, D.A. l976. Wintering of the migrant bald eagle in the lower 48 States. Natl. Agric. Chemicals Assoc., Washington, D.C. 170pp.

Sprunt, A. l969. Population trends of the bald eagle in North America. Pages 347-351 *in* J.J. Hickey, ed. Peregrine Falcon Populations. Univ. of Wisconsin Press.

Sprunt, A., and F.J. Ligas. l964. The l963 baldeagle count. Audubon 66:45-46.

Sprunt, A., W.B. Robertson, Jr., S. Postupalsky, R.J. Hensel, C.E. Knoder, and F.J. Ligas. l973. Comparative productivity of six bald eagle populations. Pages 96-106 *in* Trans. 38th North Am. Wildl. and Nat. Resour. Conf., Washington, D.C.

Stalmaster, M.V. l983. An energetics simulation model for managing wintering bald eagles. J. Wildl. Manage. 47(2):349-359.

Stalmaster, M.V. l987. The bald eagle. Universe Books, New York, N.Y. 227pp.

____, and J.A. Gessaman. l984. Ecological energetics and foraging behavior of overwintering bald eagles. Ecol. Monogr. 54:407-428.

____, and J.R. Newman. l978. Behavioral responses of wintering bald eagles to human activity. J. Wildl. Manage. 42(3):506-513.

_____, and___. l979. Perch-site preferences of wintering bald eagles in northwest Washington. J. Wildl. Manage. 43(1):221-223.

____, J.R. Newman, and A.J. Hansen. l979. Population dynamics of wintering bald eagles on the Nooksack River, Washington. Northwest Sci. 53:126-131.

Steenhof, K. l976. The ecology of wintering bald eagles in southwestern South Dakota. M.Sc. Thesis, The Univ. of Missouri, Columbia, Mo. 146 pp.

_____. l978. Management of wintering bald eagles. U.S. Dept. of Interior, Fish and Wildl. Serv. 59pp.

Swenson, J.E. l983. Is the northern interior bald eagle population in North America increasing? Pages 23-24 *in* D.M. Bird, chief ed. Biology and Management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Que.

____, K.L. Alt, and R.L. Eng. l986. Ecology of bald eagles in the Greater Yellowstone ecosystem. Wildl. Monogr. No. 95. 46pp.

Tatum, J.B. l972. Annual bird report for southern Vancouver Island, Victoria Nat. Hist. Soc. 80pp.

Teske, I.E. l989. Managing habitat for wintering bald eagles in the Fraser Valley of British Columbia, l988-l989. Report to B.C. Minist. of Environ., Wildlife Branch, Victoria, B.C. 39pp.

Trenholme, N.S., and R.W. Campbell. l975. Survey of bald eagles in the Southern Gulf Islands, British Columbia. Syesis 8:109-111.

Vermeer, K., and K.H. Morgan. l989. Nesting population, nest sites and prey remains of bald eagles in Barkley Sound, British Columbia. Northwest Naturalist 70:21-26.

_____, ____, R.W. Butler, and G.E.J. Smith. l989. Population, nesting habitat and food of bald eagles in the Gulf Islands. Pages 123-130 *in* K. Vermeer and R.W. Butler (eds.). The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Spec. Publ. Can. Wildl. Serv., Ottawa, Ont. 186pp.

____, S.G. Sealy, M. Lemon, and M. Rodway. l984. Predation and potential environmental perturbances on Ancient Murrelets nesting in British Columbia. Pages 757-770 *in* ICBP Tech. Publ. No. 2.

____, K.R. Summers, and D.S. Bingham. l976. Birds observed at Triangle Island, British Columbia, l974 and l975. The Murrelet 57(2):35-42.

Waste, S.M. l982. Winter ecology of the bald eagles of the Chilkat Valley, Alaska. *In* D.M. and P.F. Schempf, eds. 1982. Proceedings of a symposium and workshop on raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage, Alas.

Wright, B.S. l953. The relation of bald eagles to breeding ducks in New Brunswick. J. Wildl. Manage. 17(1):55-62.

11.0 ACKNOWLEDGEMENTS

The lead agency in the production of this report was the British Columbia Ministry of Environment, Lands and Parks, Wildlife Branch. The report was authored by D.A. Blood and G.G. Anweiler, under the direction of W.T. Munro. This project was coordinated by Myke Chutter, Bird Specialist

The following individuals provided unpublished information or advice: Jack Barrett, Denise Brownlie, Wayne Campbell, Bill Dumont, David Dunbar, Gary Kaiser, Trevor Kinley, Ken Langelier, Alan McLeod, Mike McNall, Rosamund Pojar, Allen Poynter, Anne Rahme, Jim Shaver, Chris Siddle and Peter Van Kerkoerle.

Maggie Paquet was responsible for the English edit, and Gail Harcombe produced the final figures, design, layout, and final edit of the document.

Appendix 1. Reproductive terminology[1]

Breeding area - An area containing one or more nests within the range of one mated pair of eagles.

Occupied nest - A nest at which a mated pair of adult eagles is present, has repaired the nest, and/or has laid eggs as evidenced by an adult in incubating or brooding posture, observed eggs, or young.

Active nest - An occupied nest in which eggs are laid, as determined by observing an adult eagle in brooding or incubating posture, or observing eggs or young.

Successful nest - A nest in which at least one nestling is raised to fledging or near-fledging age.

Brood size - The number of young at fledging or near-fledging age per successful nest.

Productivity - The number of young at fledging age per occupied or active nest, as indicated.

Alternate nest - An unoccupied nest within the breeding area of a pair of eagles.

---

[1] Based on Postupalsky 1974 and Swenson *et al.* 1986.

Appendix 2. The number of Bald Eagles counted on Christmas Bird Counts in British Columbia, December 1973 through December 1988.[1]

Location	Total Counts Done	% Counts Eagles Seen	No. Bald Eagles Seen	
			Range	x/count
COASTAL				
Marine Shorelines				
Bamfield	3	100	25 - 68	46
Bella Bella	1	100	-	19
Campbell River	12	100	9 - 160	54
Comox	16	100	20 - 191	100
Deep Bay	14	100	67 - 424	252
Duncan	16	100	11 - 249	70
Hecate Strait	1	100	-	9
Kitimat	11	100	2 - 56	19
Ladner	16	100	3 - 96	34
Massett	6	100	9 - 52	32
Nanaimo	16	100	32 - 241	77
Pender Island	16	100	11 - 117	48
Port Alberni	1	100	-	19
Port Clements	5	100	1 - 20	9
Prince Rupert	9	100	8 - 60	35
Rose Spit	3	100	8 - 13	10
Sayward	12	100	3 - 25	12
Skidegate Inlet	7	100	37 - 65	8
Sooke	6	100	11 - 50	28
Squamish	9	100	131 - 1,398	732
Sunshine Coast	9	100	14 - 71	30
Vancouver	16	100	7 - 88	31
Victoria	16	100	9 - 48	27
White Rock	14	100	1 - 32	10
Non-Marine				
Chilliwack	13	100	5 - 134	37
Pitt Meadows	15	100	7 - 77	24
Terrace	16	100	1 - 58	18

Appendix 2. (Continued).[1]

Location	Total Counts Done	% Counts Eagles Seen	No. Bald Eagles Seen	
			Range	x/count
INTERIOR				
Okanagan/Shushwap				
Kamloops	5	60	0 - 7	3
Kelowna	4	100	2 - 12	6
Oliver/Osoyoos	10	100	1 - 9	4
Penticton	13	100	1 - 15	5
Salmon Arm	1	100	-	6
Shushwap Lake Park	16	94	0 - 27	9
Vaseux Lake	15	93	0 - 7	4
Vernon	14	100	3 - 13	7
Kootenay/Columbia				
Cranbrook	5	60	0 - 2	1
Creston	2	100	2	2
Fauquier	5	100	1 - 3	2
Lake Windermere	6	100	2 - 7	5
Nakusp	10	60	0 - 1	1
Nelson	1	100	-	2
Revelstoke	8	63	0 - 3	1
Yoho National Park	5	20	0 - ?	<1
Central and Northern				
Fort St. James	2	100	3	3
Fort St. John	4	0	-	0
Mackenzie	1	0	-	0
North Pine	6	0	-	0
Quesnel	4	75	0 - 1	<1
Smithers	12	92	0 - 10	4
Wells Gray Park	2	0	-	0

[1] Source: American Birds

Wildlife Working Reports should not be cited because of the preliminary nature of the data they contain. Working Reports 1 - 10 are out of print.

WR-11 Effect of wolf control on black-tailed deer in the Nimpkish Valley on Vancouver Island. Progress report -1983 August 31 to 1984 August 31. K. Atkinson and D. Janz. March 1985. 22pp.

WR-12 1983 southeastern Skeena regional moose abundance and composition survey. B. van Drimmelen. June 1985. 47pp.

WR-13 Kechika Enhancement Project of northeastern B.C.: wolf/ungulate management. 1984-85 annual report. J.P. Elliott. September 1985. 28pp.

WR-14 Muskwa Wolf Management Project of northeastern B.C. 1984-85 annual report. J.P. Elliott. September 1985. 44pp.

WR-15 Caribou habitat use on the Level Mountain and Horseranch ranges, British Columbia. M.A. Fenger, D.S. Eastman, C.J. Clement, and R.E. Page. 1986. 41pp + 4 maps. (Also printed as Surveys and Resource Mapping Branch Working Report WR-8).

WR-16 Working plan - coastal grizzly research project. W.R. Archibald and A.N. Hamilton. October 1985. 27pp. (Also printed as WHR-21).

WR-17 Progress report - year 3 - 1984, working plan - year 4 - 1985. Coastal grizzly research project. W.R. Archibald, A.N. Hamilton, and E. Lofroth. October 1985. 65pp. (Also printed as WHR-22).

WR-18 Morice biophysical study, 93L/SW. B. Fuhr, M. Fenger, L. Lacelle, R. Marsh, and M. Rafiq. March 1986. 63pp + 9 maps.

WR-19 Effect of wolf control on black-tailed deer in the Nimpkish Valley on Vancouver Island. Progress report - 1984 August 31 to 1985 August 31. K. Atkinson and D.W. Janz. March 1986. 27pp.

WR-20 Kechika Enhancement Project of northeastern B.C.: wolf/ungulate management. 1985-86 annual report. J.P. Elliott. December 1986. 17pp.

WR-21 Muskwa Wolf Management Project of northeastern B.C. 1985-86 annual report. J.P. Elliott. December 1986. 15pp.

WR-22 Progress report - year 4 - 1985, working plan - year 5 - 1986. Coastal grizzly research project. A.N. Hamilton, W.R. Archibald, and E. Lofroth. November 1986. 100pp. (Also printed as WHR-26).

WR-23 Critical habitat of caribou (*Rangifer tarandus caribou*) in the mountains of southern British Columbia. K. Simpson, K. Hebert, and G.P. Woods. February 1987. 13pp.

WR-24 Impacts of a hydro-electric reservoir on populations of caribou and grizzly bear in southern British Columbia. K. Simpson. February 1987. 40pp.

WR-25 The effects of snowmobiling on winter range use by mountain caribou. K. Simpson. February 1987. 15pp.

WR-26 Quesnel Highlands wolf control project. D. Hebert. January 1987. 10pp.

WR-27 Muskwa Wolf Management Project of northeastern B.C. 1986-87 annual report. J.P. Elliott. April 1987. 20pp.

WR-28 Vancouver Island wolf control project. Year 1 progress report. D. Janz. July 1987. 11pp.

WR-29 Habitat survey of the Mackenzie Heritage Trail corridor. V. Hignett. June 1987. 21pp + 5 maps.

WR-30 A proposal to manage coyote and cougar populations of the Junction Wildlife Management Area. D. Hebert. September 1987. 11pp.

WR-31 Wildlife habitat suitability of the Mackenzie Heritage Trail corridor. V. Hignett. May 1988. 16pp + 6 maps.

WR-32 Research priorities for furbearers in British Columbia. D. Blood. June 1988. 49pp.

WR-33 Electrically triggered drop net to capture wild sheep. J.W. Hirsch. January 1988. 18pp.

WR-34 A lynx management strategy for British Columbia. D.F. Hatler. July 1988. 121pp.

WR-35 Causes of bighorn sheep mortality and dieoffs - literature review. H.M. Schwantje. April 1988. 54pp.

WR-36 Explanatory legend for vegetation maps of the Kamloops Lake bio-physical study area. E.C. Lea. December 1988. 78pp.

Continued from inside back cover

WR-37 Bio-physical habitat units and interpretations for moose use of the upper Cariboo River Wildlife Management Area. E.C. Lea, T. Vold, J. Young, M. Beets, D. Blower, J. Youds, A. Roberts. December 1988. 24pp.

WR-38 Grizzly bear habitat of the Flathead River area: expanded legend. E.C. Lea, B.L. Fuhr, and L.E.H. Lacelle. December 1988. 24pp.

WR-39 Managing habitat through guidelines: How far can you go? M. Fenger and V. Stevens, eds. February 1989. 48pp.

WR-40 Wolf-prey dynamics. Proceedings of a symposium sponsored by B.C. Ministry of Environment, Wildlife Branch, Faculty of Forestry, University of British Columbia and the Northwest Wildlife Preservation Society. February 1989. 188pp.

WR-41 Caribou research and management in B.C.: proceedings of a workshop. R.Page, ed. November 1988. 275pp. (Also printed as WHR-27)

WR-42 Trapping in British Columbia - a survey. R. Reid. January 1989. 55pp.

WR-43 Biophysical habitat units of the Lower Halfway study area: expanded legend. E.C. Lea and L.E.H. Lacelle. December 1989. 33pp.

WR-44 Long range habitat planning: proceedings. M. Fenger and V. Stevens, eds. March 1990. 49pp.

WR-45 Biophysical habitat units of the Mosley Creek study area: expanded legend and interpretations. E.C. Lea and R.C. Kowall. March 1990. 33pp.

WR-46 Habitat Management Section. Annual General Meeting. Yellowpoint Lodge - 1989 April 25-27. Wildlife and Recreational Fisheries Branches, Ministry of Environment. July 1990. 107pp.

WR-47 Working plan — Khutzeymateen Valley grizzly bear study. A.N. Hamilton and J.A. Nagy. September 1990. 35pp. (Also printed as WHR-28).

WR-48 Khutzeymateen Valley grizzly bear study. Annual progress report - year 1 (1989/90), annual working plan - year 2 (1990/91). J.A. Nagy and A.G. MacHutchon. January 1991. 44pp. (Also printed as WHR-29).

WR-49 Fort Nelson and area average winter maximum snowpack mapping. R. Chilton. July 1990. 12pp.

WR-50 Marten habitat suitability research project - working plan. E.C. Lofroth and V. Banci. January 1991. 31pp.

WR-51 Khutzeymateen Valley grizzly bear study. Annual progress report - year 2 (1990/91), annual working plan - year 3 (1991/92). A.G. MacHutchon and S. Himmer. March 1992. 36pp. (Also printed as WHR-30)

WR-52 Abundance, Distribution and Conservation of Birds in the Vicinity of Boundary Bay, B.C. R.W. Butler, ed. 1992. 132pp. (Also printes as Technical Report Series No. 155, Pacific and Yukon Region, Can. Wildlife Service).

WR-53 Status of the Clouded Salamander in British Columbia. T.M. Davis and P.T. Gregory. March 1993. 19pp.

WR-54 Status of the Northern Pacific Rattlesnake in British Columbia. M.B. Charland, K.J. Nelson, P.T. Gregory. March 1993. 23 pp.

WR-55 Status of the Shrew-mole in British Columbia. L. Kremsater, L. Andrusiak, F.L. Bunnell. March 1993. 26 pp.

WR-56 Status of the Nuttall's Cottontail in British Columbia. D.W. Carter, A. Harestad, F.L. Bunnell. March 1993. 33 pp.

WR-57 Status of the Sharp-tailed Snake in British Columbia. D.J. Spalding. March 1993. 15pp.

WR-58 Guidelines for Technical Publications of the Wildlife Program. E. Stanlake. March 1993. 57pp.

WR-59 Status of Keen's Long-eared Myotis in British Columbia. M. Firman, M. Getty, and R.M.B. Barclay. March 1993. 29pp.

WR-60 Biophysical Habitat Units for the Tatlayoko Lake Study Area: expanded legend and interpretations. E.C. Lea and R.C. Kowall. March 1993. 22pp.

WR-61 Status of the Pallid Bat in British Columbia. K. Chapman, K. Mc Guinness, R.M. Brigham. February 1994. 32pp.

WR-62 Status of the Bald Eagle in British Columbia. D.A. Blood and G. G. Anweiler. February 1994. 92pp