Non-game animals in the Skagit Valley of British Columbia: literature review and research directions

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prepared for Ministry of Environment and Parks

January 1987

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ACKNOWLEDGEMENTS

I am indebted to Fred Bunnell for reviewing this manuscript. Thanks to Dave Dunbar for supplying valuable information and necessary literature.

To the Vertebrate Zoology Division of the British Columbia Provincial Museum, particularly Mike McNall and Dave Nagorsen, I am grateful for the access provided me to the wildlife record scheme and the reprint collections. Thanks also to Richard Cannings of the Vertebrate Museum of the Department of Zoology of the University of British Columbia for access to wildlife sighting records.

Thanks to Anthea Farr and Barry Booth for their first hand observations of non-game wildlife in the Skagit. Thanks also to Fred Bunnell, Andrew Harcombe, Alton Harestad, Brian Nyberg, and Steve Wetmore for their input into potential research directions for non-game animals in the Skagit Valley.

ABSTRACT

Extant data on the abundance, distribution, and diversity of non-game animals of the Skagit Valley (specifically, small mammals, non-game avifauna, cavity-using species, and waterfowl) are reviewed. Principal sources include Slaney (1973), wildlife records of the British Columbia Provincial Museum Vertebrate Division, University of British Columbia Vertebrate Museum records, and naturalist field trip records. Totals of 24 small mammal and 186 avian species have been recorded in the Skagit Valley to date.

General research directions are presented based on management objectives expressed in provincial preliminary management plans for non-game species. A means of coordinating several research directions is suggested. Specific research questions for small mammals, cavity-using species, non-game avifauna, and waterfowl are listed.

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1. INTRODUCTION

Barnard (1986) identified deficiencies in baseline data for specific groups of wildlife species inhabiting the Skagit River Watershed. Among these deficiencies was the lack of updated species presence lists for avifauna and small mammals in the watershed. Updated species lists indicating species diversity, abundance, and distribution would provide the necessary data base to develop comprehensive research proposals and management plans.

This report has two objectives. First, to review the literature to determine the presence and status of non-game wildlife (specifically non-game birds, cavity-us ing species, waterfowl, and small mammals) within the Skagit River Watershed of British Columbia and particularly within the Skagit Valley Recreational Area. Second, to suggest broad research directions exploring the potential for management of non-game wildlife in the Skagit River Watershed.

2. STUDY AREA

The principal study area is the Skagit Valley Recreational Area which occupies 328 km^2 within the Skagit River Watershed. The watershed itself consists of 8144 km^2, 1086 km^2 of which is located in British Columbia. The watershed has been described in detail by Slaney (1971, 1973).

Major tributaries of the Skagit River include the Sumallo River, Klesilkwa River, and Nepopekum (Muddy) Creek (Fig. 1). Portions of the valleys of all these tributaries lie within the Skagit Recreational Area. The Skagit River flows in a westerly direction from its source in the Hozameen Range of Manning Park to the confluence of the Skagit and Sumallo Rivers. The valleys in this northern portion of the watershed are characterized by steep walls and narrow valley bottoms. Below the confluence of the Skagit and Sumallo Rivers the Skagit flows south for 39 km to the international boundary into Washington State. Below the confluence of the Skagit and Klesilkwa Rivers, the Skagit Valley bottom becomes flat and broad. The Skagit River Valley is one of the few flat-bottomed valleys in British Columbia not inundated by a lake.

The Skagit River lies in a rain shadow created by the Pickett mountain range. The valley bottom is therefore unusually dry for watersheds west of the crest of the cascades. Six biogeoclimatic zones occur within the watershed including: 1) Alpine Tundra and Mountain Hemlock 2) Alpine Tundra and

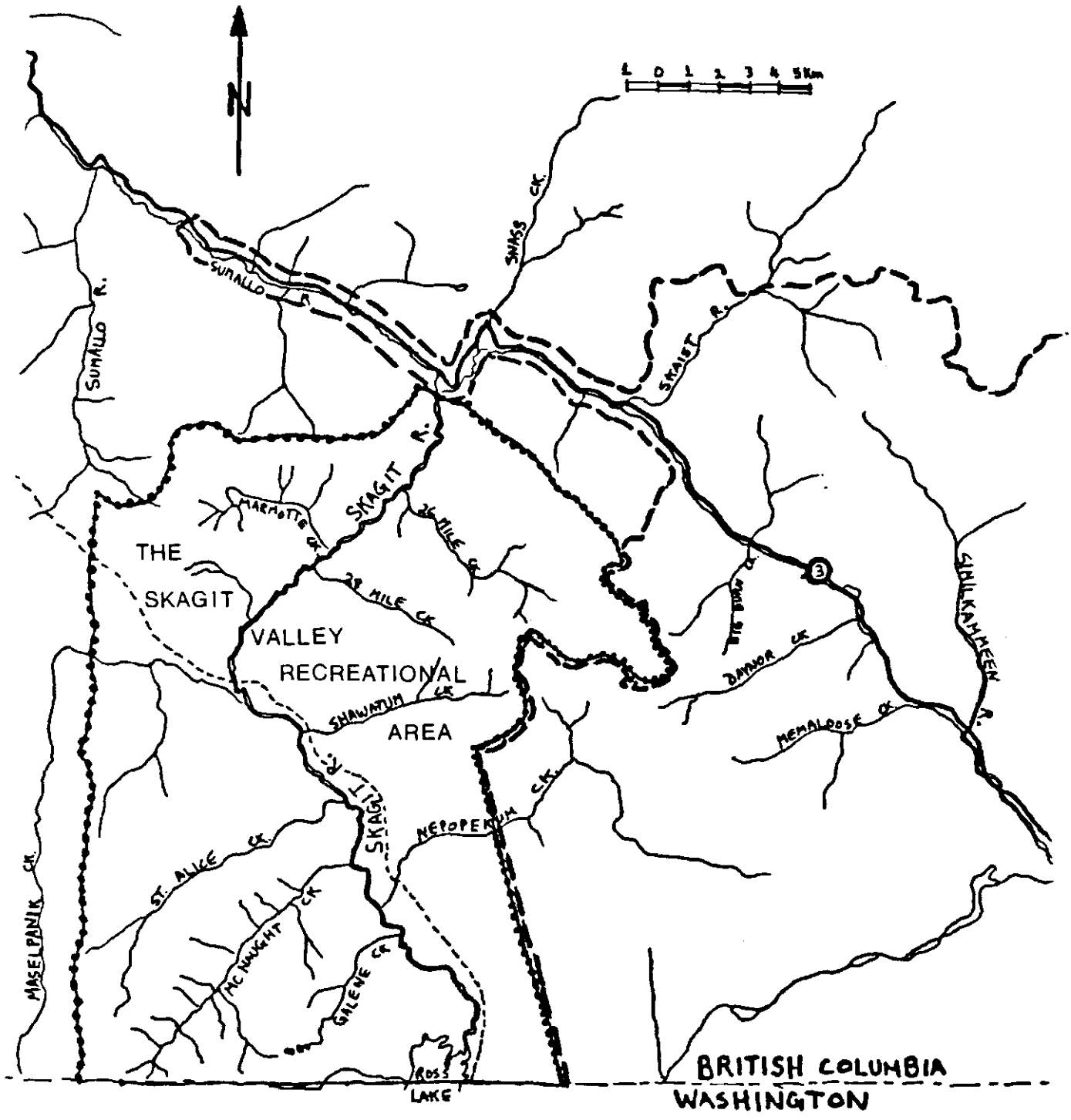

Figure 1. The Skagit Valley Recreational Area

Englemann Spruce- Subalpine Fir 5) Coastal Western Hemlock and 6) Interior Douglas-fir. The classification of these zones is presently being modified by Fuhr (pers. comm.). The intermixing of zones characteristic of coastal and interior British Columbia results in diverse small mammal and avifauna populations.

3. PART ONE "Species Present"

Two principal sources were examined to aggregate available information on avifauna and small mammal presence, abundance, and distribution. One source was written documents about the Skagit River Watershed. Most of these reports were prepared during investigations of the impact of the proposed High Ross Reservoir. The other source included sighting and breeding records of the Vertebrate Division of the British Columbia Provincial Museum and of the Vertebrate Museum of the Department of Zoology of The University of British Columbia, and field trip records of local naturalists.

Limited wildlife research has been carried out in the Skagit River Watershed of British Columbia. The most comprehensive and reliable study was done by Slaney (1971, 1973). Studies completed prior to Slaney's report do not contain additional information. Moreover, papers containing data on non-game wildlife in the Skagit valley written after 1971 seem to draw entirely on information collected by Slaney (e.g. Adams et al. 1971, Gates 1974). Furthermore, other potential sources of information on non-game wildlife were omitted from this paper

because of undisclosed methods of acquiring species presence or abundance estimates (e.g. Robichaud et al. 1971).

In addition to Slaney (1971,1973) two other sources of information on non-game wildlife were deemed valuable. These sources were museum and naturalist records. However, historically the Skagit River has not received a high level of recreational use; consequently sighting and breeding records are scarce and often dated.

Barnard (1986) has reviewed existing literature containing data on avifauna and small mammals. This report contains a more detailed summary of existing literature primarily to provide a more complete base for the proposed research directions. Also, museum records and naturalist records augment the literature review done by Barnard.

3.1 Methods

Barnard (1986) noted that little or no data supplementary to Slaney (1973) exists. The literature review completed during this study supports Barnard's statement. Presence-absence lists of avifauna and small mammal species using the Skagit Recreational Area were developed primarily from museum records and the work of Slaney (1971, 1973). Additional information on species diversity was obtained from notes of naturalist field trips. I considered these sources to be the most reliable information available. Slaney's results are summarized and updated where possible to provide a relatively complete picture of the status of

knowledge of non-game mammals and avifauna in the Skagit Valley.

The terms of reference of the contract for this report identified four specific groups of species to be reviewed. These groups were 1) non-game mammals, 2) non-game avifauna, 3) cavity-nesting avifauna, and 4) waterfowl. Because additional information on some small mammal furbearers and game birds, is included in this report, however, the four groups of species reviewed have been altered to include:

1) small mammals,
2) non-game avifauna,
3) cavity-using species, and
4) waterfowl.

These four groups are not mutually exclusive as, for example, non-game avifauna includes some cavity-using species and waterfowl includes both non-game and game birds and cavity-using species.

3.2 Small Mammals

Small mammal species diversity and density data from Slaney (1973), the Vertebrate Division of the British Columbia Provincial Museum, and the Vertebrate Museum of the University of British Columbia, are summarized in Table 1. Because of the dearth of museum records, no calculation of species density was attempted; instead, the number of observations for each species is recorded. Distribution maps and tables associating animal density and habitat type are presented in Appendix 1 for those

Table 1: Abundance of small mammals in the Skagit Valley

Scientific Name	Average density Slaney (1973)	Number of Observations (B.C.P.M.[1], U.B.C.[2])
Insectivora		
Neurotrichus gibbsi	0.26/ acre	1
Sorex cinereus	0.21/ acre	0
Sorex monticolus	0 records	4
Sorex palustris	1 record	0
Sorex vagrans	0.70/ acre	2
Chiroptera		
Eptesicus fuscus	0 records	2
Lasionycteris noctivagans	0 records	2
Myotis lucifugus	2 records	0
Lagomorpha		
Lepus americanus	0-2/ acre depending on habitat (Appendix 1)	0
Ochotona princeps	large nubers in one location	0
Rodentia		
Clethrionomys gapperi	not calculated	3
Microtus longicaudus	not calculated	2
Microtus oregoni	not calculated	1
Microtus townsendi	not calculated	1
Peromyscus maniculatus	not calculated	10
Peromyscus maniculatus austerus	0 records	20
Citellus saturatus	2 records	0
Glaucomys sabrinus	5 records	1
Glaucomys sabrinus fuliginosus	0 records	1
Tamias amoenus	0.04/ acre	0
Tamias townsendi	0.11/ acre	3
Tamiasciurus douglasi	0.63/ acre	4
Tamiasciurus hudsonicus	0.12/ acre	1
Zapus trinotatus	not calculated	1

1 B.C.P.M.= British Columbia Provincial Museum records
2 U.B.C.= Records from The University of British Columbia Vertebrate Museum

species investigated by Slaney (1973). Records obtained from both museums were insufficient to determine species distribution. Methods employed by Slaney to determine species presence, density, and distribution are summarized in Appendix 2.

Slaney's records of species presence for varying hare, douglas squirrel, white-footed deer mouse, townsend chipmunk, and unknown species of bats have been corroborated (Booth pers. comm. Farr pers. comm., Howie et al. 1981, and Weber 1972,1973,1974).

A total of 24 small mammal species have been recorded in the Skagit Valley Recreational Area. Portions of the watershed within the boundaries of Manning Park have been surveyed and documented by Carl et al. (1952). Appendix 3 documents all small mammal species inhabiting the Skagit Valley Watershed and adjacent areas (including Manning Park and the Chilliwack Valley).

No other reliable data pertaining to small mammal presence, abundance, or distribution were located.

3.3 Non-game avifauna

Slaney (1973) provides the most reliable, comprehensive assessment of the avifauna of the Skagit River Watershed in British Columbia. Slaney recorded 177 bird species. Appendix 4 records these species with annotations as to seasonal occurrence, breeding status, and habitat preference. Of the 177 species, 82 were considered to breed there. A total of 25 species were

resident in the study area throughout the year; 130 species were estimated to use the valley during migration. Slaney reported 20 species utilizing the Skagit River Watershed that were uncommon to coastal British Columbia and 7 species found only in extreme southwestern British Columbia (Appendix 5). The remaining 150 species occur regularly along the coast. The apparent diversity of avifauna is thought to be a result of the intermixing of coastal and interior habitat types.

Slaney (1973) developed a habitat rating for breeding birds based on diversity and density data (Figure 2). Generally, he found dry sites and those with closed canopies were low in avifauna density and diversity; mesic habitats supported moderate bird density and diversity; moist open habitats supported high avian density and diversity. Fuhr (pers. comm.) is presently developing a new habitat classification.

Weber (1972,1973,1974) recorded 3 species in addition to those recorded by Slaney. McGrenere et al. (1986) recorded a further 3 new species. Sighting records at the Vertebrate Division of the British Columbia Provincial Museum add yet a further 3 new species to bring the total number of species recorded in the Skagit Recreational Area to 186 (see Appendix 6). Unfortunately, the breeding and migratory status of these newly added species has not been determined.

Stevens et al. (1972) recorded 13 potential additions (Appendix 6) to the bird species listed by Slaney (1973) in the

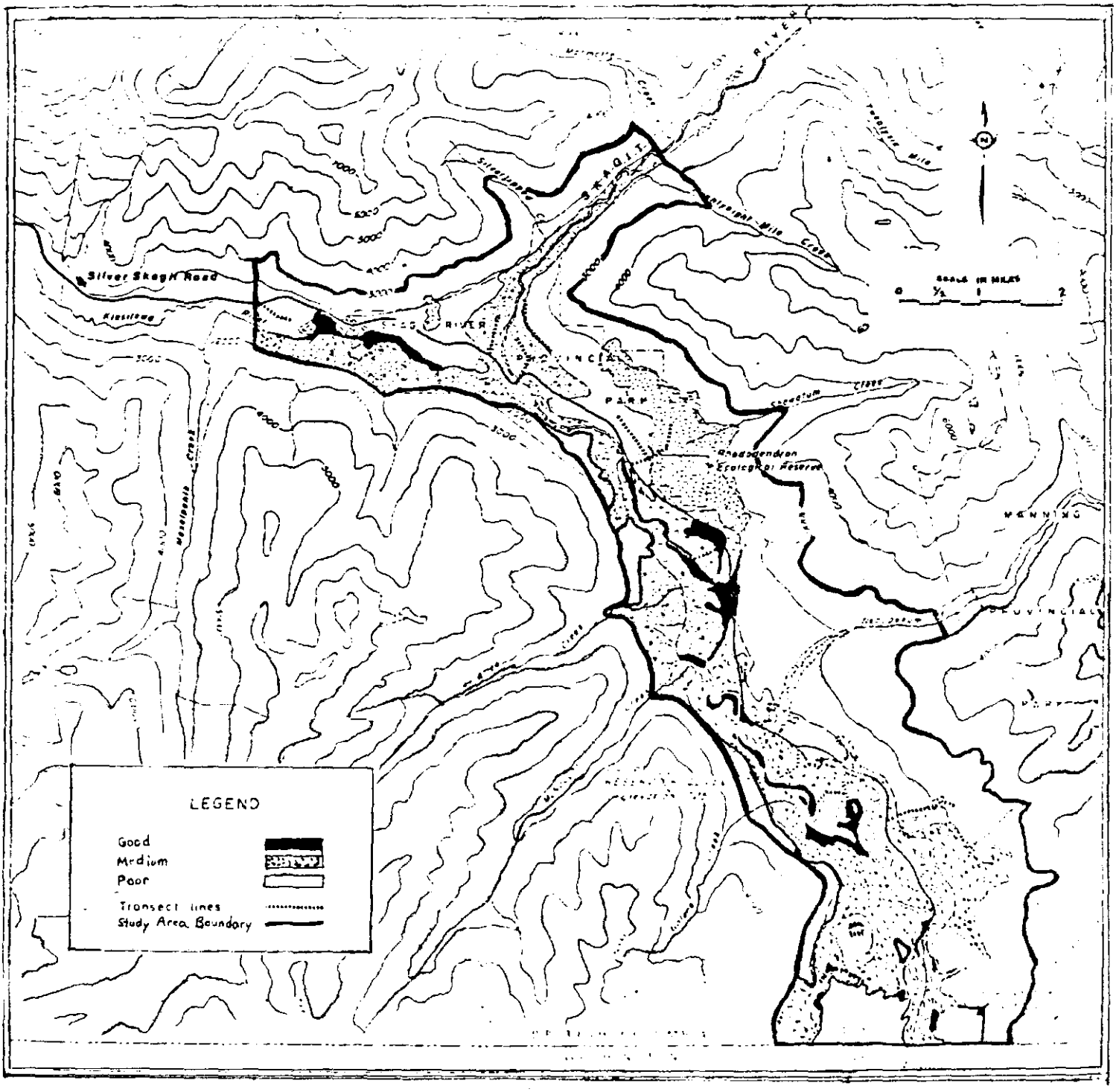

Figure 2. Habitat rating for breeding birds (from Slaney 1973)

Ross Lake Basin of Washington State. Check lists prepared for Manning Park and North Cascades National Park indicate that more than 50 other species could be expected to occur occasionally within the Skagit River Watershed.

3.4 Cavity-using species

Most cavity users are avifauna, however, some small mammals are included in this classification. A list of cavity-using avifauna and small mammals in the Skagit River Watershed is presented in Table 2. Little is known concerning the distribution of nesting and feeding habitat for these species.

The spotted owl is the only species listed in Table 2 that is considered endangered. Forsman and Booth (1986) conducted a survey of the spotted owl in the watersheds of the Skagit River and its associated tributaries; methods of the survey are summarized in Appendix 7. They found 3 spotted owls in the Skagit River Watershed and also recorded 27 barred owls, 18 saw-whet owls, 1 great -horned owl, and 2 pygmy owls. The distribution of these owls is shown in Figure 3. The 3 spotted owls recorded included a male near the mouth of McNaught Creek, a male on Nepopekum Creek in Manning Park (outside of the Skagit Recreational Area), and a male near the Sumallo Grove, also in Manning Park (just slightly outside of the Skagit Recreational Area). All three of these sites consisted of old-growth Douglas-fir, western red cedar, western hemlock, or silver fir. Fuhr (pers. comm.) has developed a habitat suitability map for spotted owls in the Skagit Valley.

Forsman and Booth (1986) concluded that spotted owls are extremely rare in the Skagit River Watershed and that barred owls are relatively common for a bird of prey. Spotted owls rely on old-growth forests (Forsman et al. 1972); Forsman and Booth

Table 2. Cavity-using species in the Skagit Valley (adapted from Millar 1985).

COMMON NAME	SCIENTIFIC NAME
Cavity-dependent species	
* Wood duck	*Aix sponsa*
* Common goldeneye	*Bucephala clangula*
* Bufflehead	*Bucephala albeola*
* Hooded merganser	*Lophodytes cucullatus*
Screech owl	*Otus asio*
Pygmy owl	*Glaucidium gnoma*
Barred owl	*Strix varia*
Spotted owl	*Strix occidentalis*
Boreal owl	*Aegolius funereus*
Saw-whet owl	*Aegolius acadicus*
Common flicker	*Colaptes auratus*
* Pileated woodpecker	*Drycopus pileatus*
* Lewis woodpecker	*Melanerpes lewis*
* Yellow-bellied sapsucker	*Sphyrapicus varius*
* Hairy woodpecker	*Picoides villosus*
* Downy woodpecker	*Picoides pubescens*
* Black-backed three-toed woodpecker	*Picoides arcticus*
* Northern three-toed woodpecker	*Picoides tridactylus*
* Violet-green swallow	*Tachycineta thalassina*
* Tree swallow	*Iridoprocne bicolor*
* Boreal chickadee	*Parus hudsonicus*
* Chestnut-backed chickadee	*Parus rufescens*
* Black-capped chickadee	*Parus atricapillus*
* Red-breasted nuthatch	*Sitta canadensis*
* Brown creeper	*Certhia familiaris*
* Western bluebird	*Sialia mexicana*
* Mountain bluebird	*Sialia currucoides*
Cavity-using species	
* Barrow's goldeneye	*Bucephala islandica*
* Common merganser	*Mergus merganser*
* Western flycatcher	*Empidonax difficilis*
* House wren	*Troglodytes aedon*
* Winter wren	*Troglodytes troglodytes*
* Bewick's wren	*Thryomanes bewickii*
Starling	*Sturnus vulgaris*
Little brown myotis	*Myotis lucifugus*
Big brown bat	*Eptesicus fuscus*
Raccoon	*Procyon lotor*
Red squirrel	*Tamiasciurus hudsonicus*
Chickaree	*Tamiasciurus douglasi*
Northern flying squirrel	*Glaucomys sabrinus*

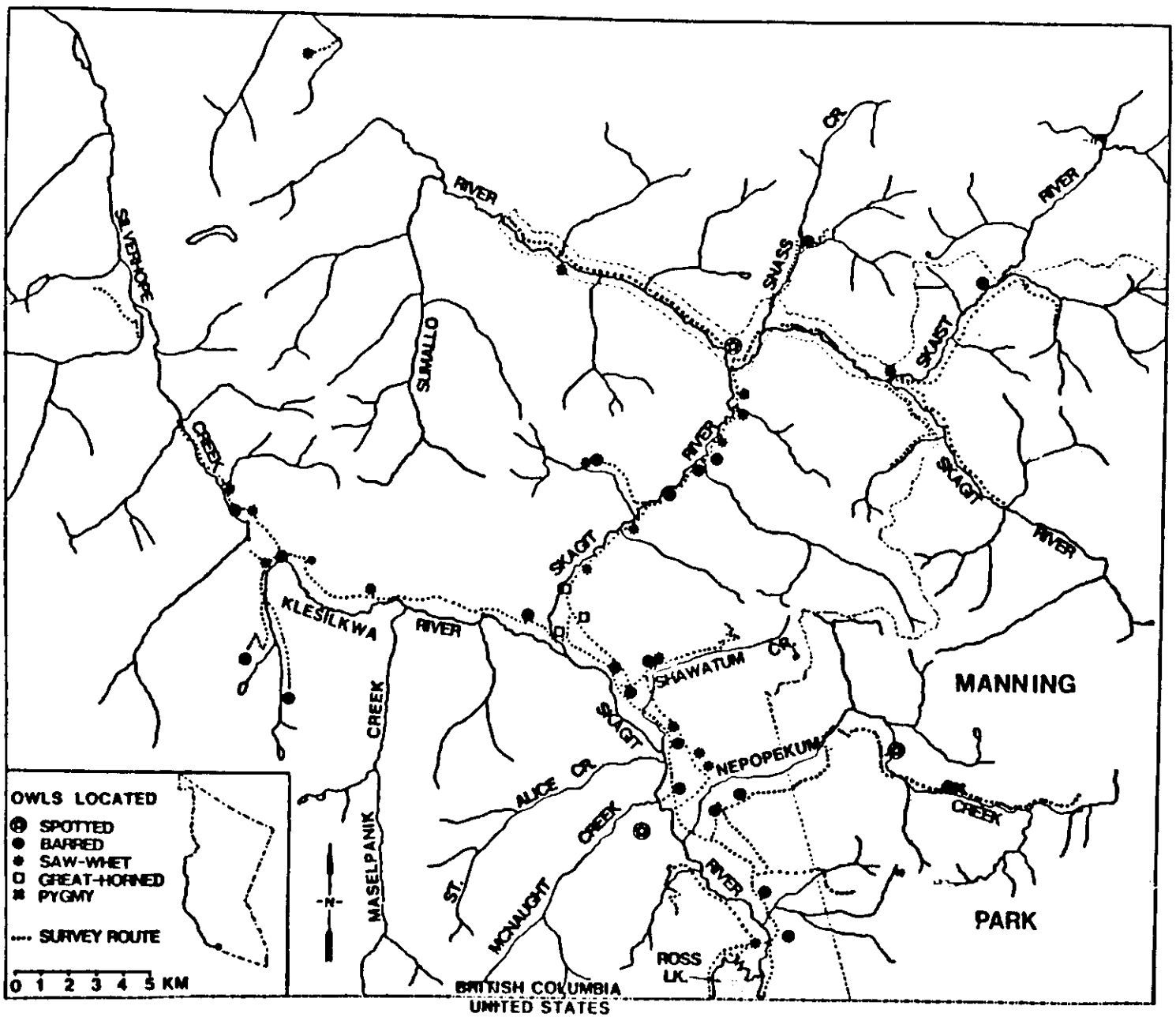

Figure 3. Distribution of owls located by Forsman and Booth (reproduced from Forsman and Booth 1986).

suggested that the only way to manage for spotted owls is to protect as much of the remaining old-growth and mature forest as possible. Forsman and Booth noted that there is no guarantee that reserving old-growth will be sufficient to ensure the survival of the spotted owl population as barred owls may be displacing spotted owls throughout a large portion of their overlapping ranges.

3.5 Waterfowl

Slaney (1973) identified 22 species of waterfowl in the Skagit River Watershed. Weber et al. (1972,1973,1974), and McGrenere et al. (1986) corroborated many of the sightings reported in Slaney (1973) but did not record any additional species. Similarly, museum records supported Slaney's observations but did not add further species.

Slaney inventoried migratory and resident waterfowl by three methods: 1) direct counts during fall migration, 2) brood counts by species and habitat type during spring and summer, and 3) census counts throughout the year by boat of Ross Lake and the Skagit River. These inventory methods indicated that 200 to 300 ducks and occasional geese were associated with Ross Lake, which provided 500 acres (202 ha) of open water. About 500 coots were observed during migration, resting and feeding along the shallow shores of the reservoir. About 50 dabbling ducks utilized beaver ponds within the study area. These beaver ponds supported 2 mallard broods and 1 golden-eye brood.

Slaney (1973) reported that seepages provide 40 acres (16 ha) of waterfowl habitat in fall and approximately 5 acres (2 ha) in winter. These seepages allowed waterfowl to overwinter in the Skagit Watershed. Common snipe frequented seepage areas as well as the fringes of beaver ponds and the drawdown area. Wetlands near Whitworth ranch, along the Klesilkwa River, and near 26 mile bridge provided habitat for Virginia rail. The Skagit river itself provided 15 miles of waterfowl habitat; along the lower skagit 8 pairs of mergansers and 2 pairs of harlequin ducks raised broods.

3.6 Upland Game Birds

Upland game birds in the Skagit River Watershed include the ruffed grouse, blue grouse, Franklin's (spruce) grouse, and white-tailed ptarmigan. Quantitative information on upland game bird density and distribution is available only from Slaney (1973). Slaney's methods of cencusing upland game birds is summarized in Appendix 2.

Ruffed grouse exhibited seasonal habitat preferences. In winter, birds frequented open habitats (logged land, roads, bluffs) from valley bottom to well over 3000 ft (915 m) elevation. Preferred vegetation types seemed to be Douglas-fir, cedar and hemlock overstories with alder, vine maple, or service berry understory.

In the spring and early summer, 75% of the ruffed grouse

observed were located in the valley bottom. Preferred habitats seemed to be dominated by cottonwoods and willows.

In the fall, young ruffed grouse dispersed widely and were occasionally found in pure coniferous forests, but still seemed to favour deciduous forests or regenerating young conifer stands.

Slaney reported a low density of ruffed grouse. Other sources, however, indicate that the population may be relatively dense in comparison with other south-western British Columbian areas (Adams et al. 1971, Farr pers. comm.)

Slaney (1973) found blue grouse to be abundant above 1800 ft (549 m) elevation in semi-mature Douglas-fir stands.

Franklin grouse were observed in lodgepole pine stands scattered with spruce above 1725 feet (525 m) elevation. Slaney noted that habitat appeared to limit the population of Franklin grouse.

Slaney reported 4 white-tailed ptarmigan among clumps of willow and cottonwood near the drawdown area of Ross Lake. In spite of the low number of ptarmigan recorded, Slaney felt that white-tailed ptarmigan populations were not habitat limited in the Skagit Valley.

4. PART TWO "Research Opportunities"

4.1 Introduction

An environmental endowment fund has been established to enhance recreation and environmental concerns in the Skagit River Watershed. Among the objectives to which the fund can be addressed are: 1) protecting scarce habitat or threatened wildlife species, 2) furthering the understanding of the dynamic ecological relationships of plants, animals, and the physical environment, and, 3) promoting cooperation in the wise use and management of natural resources. The fund is to exist for 80 years, consequently there exists a rare opportunity for long-term research.

The Skagit Valley Recreational Area is to maintain recreation and wildlife conservation as principal land uses - all other land uses are secondary. Because there are few competing land uses and because obtaining monies from the fund does not require developing exclusively management-oriented research proposals as would be expected with industry related funding, research possibilities are vast.

The Minister of the Environment is required to "manage, protect, and conserve all provincial animal life" (B.C.M.O.E 1979a. Two principal goals for wildlife management are identified for British Columbia in the Proposed Wildlife Management Plan for British Columbia (B.C.M.O.E. 1979b) :

1) to maintain the diversity of species representative of the major biophysical zones of the province, and

2) to ensure that, within the constraints of land capability and biological limits of each species, wildlife is available in sufficient abundance to meet the recreational and economic needs of society.

These principal policy goals can not be met over the long-term without managing for non-game avifauna, cavity-using species, waterfowl, and small mammals.

Policies and objectives more specific to raptors, non-game mammals, and non-game birds, have been identified in 3 preliminary management plans (B.C.M.O.E. 1979c, 1981a, and 1981b respectively).

4.1.1 Proposed management objectives for non-game mammals

Most non-game mammals (mice, moles, chipmunks, etc.) are not yet declared wildlife under law. In spite of this, non-game mammals fall completely under provincial jurisdiction and management objectives have been developed for these species. Commonly recognized (though not necessarily recognized by law) non-game mammals are described in B.C.M.O.E. (1981a). No legislative protection is yet afforded non-game mammals except for a few species considered threatened or endangered. The status of non-game mammals in Region 2 has not yet been studied.

Among the management objectives for non-game mammals is to identify and preserve areas of habitat particularly rich in non-game mammals and of habitat of mammals of specialized systems (B.C.M.O.E. 1981a). Furthermore the management of non-game

mammals is to be primarily for recreational use other than hunting. Public involvement in management is encouraged (B.C.M.O.E. 1981a). Interagency cooperation to preserve habitat diversity is also suggested as management for non-game mammals focuses largely on habitat management.

4.1.2 Proposed management objectives for non-game avifauna

Non-game avifauna includes all birds other than ducks, geese, upland game birds, and raptors. Jurisdiction is shared between federal and provincial governments for migratory and insectivorous birds; all other birds fall exclusively under provincial jurisdiction. Most non-game birds are protected by provincial legislation. Federal legislation protects both migratory and insectivorous birds. Article 1, section 2 of The Convention for the Protection of Migratory Birds of 1916, declares that migratory insectivorous birds, migratory game birds, and migratory non-game birds be protected. Article 2, section 2 establishes a year round closed season on taking of migratory insectivorous birds and most migratory non-game birds, and establishes partial seasons on migratory game birds. Article 4 protects migratory bird eggs and nests from destruction. The Migratory Bird Convention Act of 1917 empowers the Governor in Council to make regulations necessary to protect the habitat of all migratory birds inhabiting Canada during any part of the year.

Provincially, the Preliminary Non-game Bird Management Plan

for British Columbia (B.C.M.O.E. 1981b) identifies 4 principal objectives. Among these are to:

1) cooperate with other agencies and groups to establish a system of surveys to determine population trends in numbers of non-game birds, and
2) identify and preserve areas of habitat particularly rich in avifauna fauna or habitat of birds of specialized systems.

Non-game birds are to be managed primarily for their aesthic values and recreational use other than hunting. To meet the above objectives, habitats critical to any species are to be identified and protected, interagency cooperation is to be sought to maintain or enhance habitat diversity, and public involvement is to be encouraged. Several problems hinder the immediate achievement of these objectives. Among these problems are 1) critical habitat requirements for some bird species are not known, and, 2) information on population distribution and density is inadequate (B.C.M.O.E. 1981b).

In Region 2 proposed management objectives for non-game birds include maintaining the present diversity and distribution of non-game birds in addition to the above mentioned provincial objectives. The objective "to identify and preserve areas especially rich in avifauna or habitats of birds of specialized systems" is designed to protect the diversity of bird life and to provide areas for the public to observe birds in their habitat.

4.1.3 Proposed management objectives for raptors

Raptors include hawks, falcons, harriers, eagles, owls, ospreys, and vultures; all are under the exclusive jurisdiction of the provincial government and all are protected.

The Preliminary Raptorial Bird Management Plan for British Columbia (B.C.M.O.E.1979c) has among its objectives to:

1) maintain viable populations within historical ranges of all species of raptorial birds occurring in British Columbia, and
2) enhance populations of species which have seriously declined.

Proposed management objectives in Region 2 for raptors are identical to provincial objectives with priority given to maintaining viable populations of raptors known to breed in the region.

Raptors are to be managed primarily for public viewing in the wild. To meet the above objectives, several management prescriptions are suggested, among these are:

1) Protect critical nesting areas and key prey of those species which have declined or which are of public concern.
2) Monitor all species with emphasis on species which have declined or for which there is a public demand, and
3) Encourage private groups and individuals to report nesting sites and major migrations of all species.

Several problems have been identified impeding the attaining of the management objectives, among these problems are:

1) inventory of most species is lacking and obtaining the information is difficult. and,
2) habitat of prey species is being destroyed.

4.1.4 Proposed management objectives for ducks

Separate preliminary management plans have been prepared for ducks and geese. Legal jurisdiction for all waterfowl is shared between federal and provincial governments.

Provincially, management objectives include:

1) protecting, and where desirable, enhancing wetlands of major importance to ducks, and
2) providing an opportunity for people to observe ducks in their natural habitat.

However, ducks are to be managed primarily as game birds. Management prescriptions to meet the above objectives include:

1) protecting critical wetland and enhancing wetlands where desirable,
2) encouraging participation of private groups in the protection and enhancement of wetlands, and
3) developing a wetland system of Wildlife Management Areas throughout the province for the protection of ducks and public viewing.

4.2 Research Directions

The Skagit Valley Recreational Area provides habitat for a diversity of non-game mammals and birds. The diversity of vegetation types resulting from the mixture of coastal and interior habitats supports fauna of both coastal and interior British Columbia. Because the Skagit Valley is a unique habitat and because it supports an abundance of diverse wildlife close to an urban center, provincial preliminary management objectives and prescriptions indicate that it is a strong candidate for intensive management of non-game mammals and birds.

4.2.1 Species with limited distributions in British Columbia

Because of the geographic location of the Skagit Valley in British Columbia and because of the special habitats comprising the Skagit Valley, the Skagit Valley supports certain species having limited distributions in British Columbia. These species are of particular interest because of their addition to the diversity of fauna in B.C., the legislative mandate to protect species with limited distributions, and the limited geographic area within which to do research. The Skagit Valley may provide an opportunity to study the spotted owl, flying squirrel, trowbridge shrew, and mountain beaver, all species which have limited distributions in B.C.. Of these species, research of the spotted owl is of the most importance. Mountain beaver and trowbridge shrew have been identified in areas adjacent to the Skagit Valley, but although they likely inhabit the Skagit Valley, they have not yet been sighted there.

The spotted owl is currently being considered for listing as "endangered" in British Columbia. Management objectives concerning raptorial birds propose protecting critical habitats and prey species and monitoring species which have declined or are of public concern. The spotted owl is both of public concern and declining over its historical range; its present range in British Columbia is thought to occur entirely within Region 2. Studies into critical amounts of nesting and feeding habitat to support a population are necessary to formulate a comprehensive management plan. Forsman and Booth (1986) suggest that the remaining old-growth habitat in the Skagit Valley be reserved for spotted owls in spite of the uncertainty as to the effects of barred owl populations on the long-term viability of spotted owl populations.

Trowbridge shrew inhabits a limited area of southwestern British Columbia; little is known about its habitat requirements or preferences. Hooven (1973) suggested that the trowbridge shrew prefers drier habitats than does the vagrant shrew. The distribution and habitat requirements of trowbridge shrew must be determined before it can be successfully managed in the Skagit Valley.

The mountain beaver has not been identified in the Skagit Valley, however, populations exist in neighbouring areas and are therefore also likely to exist in the Skagit Valley (Nyberg pers. comm.). Mountain beaver has been studied extensively in Washington and Oregon where it is a major forest pest. It

causes only localized damage in British Columbia where its distribution is very limited (Cosco 1980). Nevertheless, this limited distribution makes mountain beaver of interest to the Ministry of Environment and Parks as indicated by there non-game mammal management proposal. Information on their present distribution, range extensions or depletions, and population density is necessary to propose any management plans for mountain beaver; much of this information is available in Cosco (1980).

4.2.2 Species with wide distributions in British Columbia

The Skagit Valley Recreational Area provides habitat for many species that enjoy a wide distribution throughout British Columbia. The ecology of some of these species is poorly understood, particularly of bats (Chiropterans) and several small rodents. The Skagit Endowment Fund provides the means for researching the ecology of these species, identifying the roles of bats and rodents in controlling forest pests, determining critical habitats, identifying the importance of some small mammals as a food source for raptors and furbearers, and suggesting management options that could be applicable throughout British Columbia.

Management objectives for non-game mammals, non-game birds, waterfowl, and raptors suggest managing for species diversity close to urban centers so as to provide public access and involvement in wildlife recreation and public participation in

non-game animal surveys. These management objectives suggest that the Skagit Valley, because of its proximity to the lower mainland and its wildlife species richness, is a prime candidate for intensive non-game mammal and avifauna research, management, and development of public viewing programs. Although the Skagit Valley is not a major migratory route for waterfowl, wetland management could create areas valuable for waterfowl viewing. Small mammal enhancement in these wetland areas could further increase the potential for public viewing of wildlife.

4.2.3 Species-habitat relationships

In addition to offering the opportunity to investigate the natural history of several species, the Skagit Valley provides the opportunity to explore the relationships between habitat manipulations and species population responses. Non-game mammal and bird management focuses largely on habitat management. Thus understanding the relationships between non-game species and their habitats is vital. Proposed management objectives for habitat of non-game species (B.C.M.O.E. 1979c, 1981a, 1981b) include promoting interagency cooperation to ensure the maintenance of habitat diversity and habitats critical for particular species. Examining the effects of various habitat manipulations on non-game species populations is necessary to achieve this objective. Results from such process-level studies will have relevance to non-game management in other areas of British Columbia.

Because recreation and wildlife conservation are principal priorities in the Skagit Valley, novel habitat manipulations may be implemented to examine process-level questions. Preliminary management plans indicate that interagency cooperation will be sought to maintain habitat diversity and species diversity. Process-level studies can involve both Ministry of Forests and Lands and Ministry of Environment and Parks in forest manipulations. Demonstration forests could incorporate manipulations to improve avifauna habitat and small mammal habitat. Forest manipulations for deer winter range can be concomitant with studies investigating the effects of cover removal, by slashburning or scarification, on small mammal populations and ultimately on furbearer and raptor distributions and densities. Forest inventories can include investigations into the rates of renewal and mortality of wildlife trees in different habitats. Riparian zones can be examined for species diversity and density, and wildlife tree production rates, with views to the management of riparian zone leave strips for non-game wildlife. Critical amounts of habitats for each species of concern must be identified.

Of special concern at the process-level of species-habitat relationships, is the management of wildlife trees for cavity-using species. Insectivorous birds and raptors are non-game birds of primary importance to the forest industry; to date, however, wildlife tree management has not been an issue in Region 2 of the Ministry of Environment and Parks. The Skagit

Valley provides the opportunity to propose and test wildlife tree management goals and objectives. Millar (1985) suggested that the primary objective should be to maintain the production of wildlife trees in forested areas. Efforts directed at merely saving snags are inadequate, continued production of wildlife trees is necessary. Research directed at maintaining wildlife tree production should include investigations into the feasibility of:

1) maintaining clumps of seed trees, live culls, and sound trees to provide wildlife trees over ensuing rotations,
2) utilizing riparian management areas, deer winter range, or other forest reserves for snag production and enhancement, and
3) maintaining snags and live culls during thinning and other silvicultural operations.

A certain amount of basic knowledge is necessary to effectively manage wildlife trees for cavity-using wildlife. This basic knowledge includes habitat requirements, life histories, and population distributions for each cavity-using species, as well as characteristics of wildlife trees. Millar (1985) suggested that determining the distribution of cavity-using wildlife by habitat type and elevation is a top priority. Of equal importance is research into techniques to artificially create wildlife trees that might replace existing wildlife trees felled to reduce safety and fire hazards. Creating wildlife trees from seed trees, sound culls, or other leave trees through methods such as topping

live trees to promote rot, routing holes in trees to simulate nest cavities, innoculating trees with heart rot, and girdling trees to promote rot should be explored. Girdling trees may kill trees in such a manner so as to make them unsuitable for excavation (Miller and Miller 1980).

Forest inventories could provide information on wildlife tree densities by tree species, habitat, elevation, and aspect. Wildlife tree decay and recruitment rates may also be determined from existing forest inventory data. Modified forest inventory could collect information about which wildlife trees (species, size, state of decay, habitat) are most useful to wildlife. The Skagit Valley provides an opportunity to develop the information sources and data bases.

4.2.4 Integrated research

It is recommended that a system be put in place to allow research and inventories done in the Skagit Valley to be fitted together to provide a cohesive body of knowledge. Research in many areas could be inter-related by this system.

Much of non-game wildlife management depends on habitat management. Habitat management is also a common ground for considering any wildlife needs in areas managed for renewable resources. Thus, a system that involved a common habitat classification to allow easy comparison of the needs of many species and the compatibility of different management

prescriptions for different species (in the same general area) would be of enormous benefit. A habitat classification for the Skagit Valley is being developed by Fuhr (1986) that includes a detailed 1:20 000 map with units delineated by biogeoclimatic zones, surficial geology, site moisture and nutrient regimes, and present successional stage. Habitat suitability maps for spotted owl and mule deer have also been developed. Valuable research should be directed at validating these suitability maps. All these maps are on an automated computer mapping system so interpretive maps could easily be derived. Habitat suitability maps for additional species could easily be added to the system. All species inventories could relate distribution and habitat requirements to such a habitat classification.

After inventorying species in the Skagit Valley, target species for relatively intensive management should be identified. Habitat requirements for these target species and other species of importance should be documented. Relationships could then be developed that would rate the value of different successional stages and forest manipulations to the life requisites of these species. Such models are presently being developed for several species (Harcombe pers. comm.). Habitat requirements have already been 'guessed at' for species with distributions east of the Cascades in the interior of British Columbia (Harcombe pers. comm.) Several of these species also inhabit the Skagit Valley. Habitat requirements for some species inhabiting the Skagit Valley could be extracted from Brown (1985). Field research may

be necessary to obtain habitat requirements for a few species in the Skagit Valley. Research will also be necessary to validate the models and monitor species-habitat relationships to see if habitat manipulations result in the projected impacts on the species of interest. Validation and monitoring of predicted relationships are necessary to obtain reliable knowledge.

If species diversity for non-consumptive use is a primary goal for the Skagit Valley then the proposed system of relating species inventories and research to a common habitat classification, then developing models to predict the effects of habitat manipulations, and testing these models, would be highly valuable. This system would be broad enough to include mammals, birds and herptiles; it would promote a common method for ranking habitats, a means of identifying and ranking information needs to be met by research, and a means of assessing the impact of habitat changes on the wildlife resource. Species of particular concern might include flying squirrels, mountain beaver, trowbridge shrew, barred owls, spotted owls, bald eagles, osprey, and cavity-using species.

4.3 Research Priorities

The following discussion assigns priorities to information needs for small mammals, non-game avifauna, cavity-using species, and waterfowl. The priority ranking system discussed was adapted from McNay and Davies (1985). Major research or management topics are listed in Table 3; criteria used to assess the priority of these topics are listed in Table 4. The first 6 criteria reflect mandates and proposed management objectives of the Ministry of Environment And Parks as reviewed in section 4.1 of this report. The remaining criteria reflect the degree of difficulty associated with implementing, conducting, and applying the research or management actions.

Table 5 indicates the ranking of potential research topics for each criterion listed in Table 4. Table 6 summarizes the relative ranks of each research topic.

In this system, Topic 5, investigating the potential for public viewing of avifauna and small mammals, is ranked top priority, primarily because of the importance of promoting public involvement in 'wilderness' areas close to urban centers. Furthermore, little research is required to develop successful public viewing opportunities; excellent examples already exist within British Columbia.

Topic 1, the production of habitat suitability models for important species and topic 7, exploring methods of wildlife tree maintenance and development, are ranked second in priority.

Identifying habitat suitability is a first step towards habitat manipulations to improve existing habitats. Moreover, the framework for habitat suitability models is already in place and much of the necessary research has been initiated. Wildlife tree management is of extreme importance to ensure successful management of cavity- using species. Implementing a successful wildlife tree management program would require considerable cooperation between the Ministry of Environment and Parks and the Ministry of Forests and Lands.

Topics 3 and 6, investigating the responses of small mammals to structural diversity (topic 3) and improving habitats in wetlands (topic 6), are ranked third. Understanding the responses of animals to habitat structural diversity is of great importance for successful habitat manipulation. Although topic 3 ranks below topic 1 (developing habitat suitability models) some research into topic 3 will be necessary to successfully complete topic 1. Some new research is required to more fully understand the effects of structural diversity on small mammals and avifauna. There is, however, a substantial body of research already completed on the effects of vertical structural diversity on non-game avifauna. Topic 6, habitat improvement in wetlands, is ranked third - primarily because the Skagit Valley is not an important breeding area or migration route for waterfowl. Some wetland management is desirable, however, to provide high quality public viewing of avifauna. Wetland improvement would involve little new research

or technical transfer.

Topic 2, determining how habitat juxtaposition effects small mammals and avifauna, ranks fourth. The low ranking is a result of a large amount of new research necessary and the relatively long-term nature of the research. As with topic 3, some research into topic 2 is necessary to successfully complete topic 1 (developing habitat suitability models). Topic 2 should not be ignored in the Skagit Valley; resources are available for new and long-term research.

Topic 4), investigating the effects of security cover and thermal cover manipulations on small mammal populations, is ranked fifth. The results of such research could suggest management practices to increase small mammal populations and indirectly increase furbearer and raptor populations.

Specific research questions relating to each of these topics are listed in Appendix 8.

Table 3. Potential broad research topics.

1) Developing habitat suitability models for important species.

2) Determining how habitat juxtaposition effects small mammals and avifauna.

3) Determining the effects of horizontal and vertical structural diversity on small mammal and avifauna populations.

4) Investigating how manipulations of security and thermal cover affect small mammal and avifauna populations.

5) Developing public viewing opportunities for a variety of animals.

6) Exploring habitat improvement in wetlands.

7) Creating a program for wildlife tree maintenance and development.

Table 4. Criteria used to assess priority of information needs.

Is the topic within the realm of the organization?
1) What are the agency's legislative responsibilities?
2) What are the agency's priorities and policy?
3) Is there substantial public concern?

Is the topic of major concern to the organization?
4) What is the extent of the applicability of the topic (ie. local or widespread)?
5) What are the wildlife values involved?
6) Are there opportunities to cooperate with other land use management agencies?

Are there current management or research actions available to address the topic?
7) Is new information essential?
8) What are the implications of no research?
9) How are public attitudes and the management climate?
10) What amount of demonstration and technical transfer is needed?
11) Are there models available to generate effective research?

What are the cost-benefit details?
12) What is the cost of research?
13) What is the probability of success; what are the associated risks?
14) What is the time frame of research activities and associated benefits?
15) Can the results of research can be implemented as management action?

Table 5. Ranking of potential research topics

Criteria consideration	Research topics[a]						
	1	2	3	4	5	6	7
Is the topic within the realm of the organization?							
1) Legislative responsibilities	H[b]	H	H	H	H	H	H
2) Agency's priorities and policy	H	H	H	M	H	H	H
3) Public concern	M	M	H	L	H	H	H
Is the topic of major concern to the organization?							
4) Extent of applicability of the topic	H	H	H	H	H	H	H
5) Wildlife values involved	H	H	H	H	H	H	H
6) Opportunities to cooperate with land use management agencies	H	H	H	H	M	L	H
Are there current management or research actions available to address the topic?							
7) Little new information essential[c]	M	L	M	L	H	H	M
8) Important implications of no research	H	M	M	L	H	L	H
9) Beneficial public attitudes and management climate	M	M	M	L	H	M	H
10) Small amount of demonstration and technical transfer needed[c]	M	M	M	L	H	L	M
11) Models available to generate effective research	H	L	M	L	M	M	M
What are the cost-benefit details?							
12) Low cost of research[c]	M	L	M	M	M	M	M
13) High Probability of success	H	M	M	H	H	H	H
14) Short time frame of research activities and benefits?	H	M	M	H	H	H	M
15) Results of research can be implemented	H	H	M	H	H	H	H

a Research topics are identified in Table 3

b Ranks are H=high, M=medium, L=low

c The ranking in this table considers little new information requirements, small amounts of technical transfer, and low cost of research, to be beneficial to research and thus these conditions receive a high priority rank. Note, however, that important research topics may require considerable effort in any of these three areas.

Table 6. Priority ranking of research topics.

Priority ranking[1]	Topic number[2]
1	5
2	1, 7
3	3, 6
4	2
5	4

1 Overall priority is based on totals accumulated for each project, where points of priority (High=3, Medium=2, Low=1) were assigned to each of the criteria considered for every project (see Table 5).

2 For project descriptions see Table 10.

5. CONCLUSION

Insufficient knowledge regarding non-game bird and mammal species distributions, life histories, and habitat requirements impedes development and implementation of progressive management plans in the Skagit Valley.

The Skagit Valley provides the area and funding over a sufficient time interval for managers and researchers to improve the data bases and clarify management directions for several non-game species including species with limited distributions in the province and those species with distributions ranging throughout the province. Furthermore, the Skagit Valley provides the opportunity to explore species-habitat relationships, primarily the effects of habitat manipulations (forestry practises or enhancement practises) on non-game species population responses.

Data collection and habitat suitability assessment can be guided by a common habitat classification and species habitat models. These models can help rank target species and research concerns, and help predict effects of forest practises or habitat enhancement manipulations on the non-game wildlife resource.

The Skagit Valley provides the opportunity to explore important management questions for several species of British Columbia. Clarifying data bases and management directions may enhance the ability of provincial and regional wildlife managers to obtain the cooperation of the Ministry of Forests in achieving

wildlife resource objectives throughout the province.

6. LITERATURE CITED

Adams, P.T.B., Byrne, T., Duguid, A.G., Howie, F.G., Landeen, B. Lemarquand, D.G., Perry, T.L.Jr., Turner, M. 1971. The future of the Skagit Valley. Institute of Resource Ecology, Univ. British Columbia. 187 pp.

Barnard, T. 1986. Skagit environmental endowment area status of wildlife data. Ministry of Environment and Parks. 33 pp.

B.C. Ministry of Environment. 1979a. Wildlife act. R.S. chapter 433, 21 pp.

B.C. Ministry of Environment. 1979b. Proposed wildlife management plan for B.C. Fish and Wildlife Branch, Victoria. 89 pp.

B.C. Ministry of Environment. 1979c. Preliminary raptorial bird management plan for B.C. Fish and Wildlife Branch, Victoria. 17 pp.

B.C. Ministry of Environment. 1981a. Preliminary non-game mammal management plan for B.C. Fish and Wildlife Branch, Victoria. 9 pp.

B.C. Ministry of Environment. 1981b. Preliminary non-game bird management plan for B.C. Fish and Wildlife Branch, Victoria. 13 pp.

Brown, E.R., 1985. Management of wildlife and fish ahbitats in forests of western Oregon and Washington. U.S. Dep. Agric. For. Serv. Pac. Northwest region, Part 1, 332 pp.

Canada. 1985. Office consolidation: Migratory Birds Convention Act. Ministry of Supply and Services, Ottawa. 51 pp.

Carl, C.C., Guiget, C.J., Hardy, G.A. 1952. A natural history survey of the Manning Park area, B. C. Brit. Col. Prov. Museum. Occ. paper #9. Victoria. 130 pp.

Cosco, J. 1980. Mountain Beaver (Aplodontia rufa): Its biology and implications to forestry in British Columbia. B.S.F. Thesis, Faculty of Forestry, U.B.C. 108 pp.

Forsman, E.D., Horn, K.M., Neitro W.A. 1972. Spotted owl research and management in the Pacific Northwest. Trans. N. Amer. Wildl. and Natur. Resour. Conf. 47: 323-331.

Forsman. E.D., Booth, B. 1986. A survey of spotted owl in the Skagit River region of British Coumbia. Ministry of Environment and Parks. Surrey, B.C. 18 pp.

Gates, B.R., 1974. Possible effects upon wildlife and associated recreational values in British Columbia if Ross reservoir were increased by 25 feet rather than 125 feet. Environmental and land use committee. 5 pp.

Hall, E.R. 1981. The Mammals of North America. New York, Wiley. 2 vols. 1181 pp.

Howie, R., Stirling, D., Baldwin, J., 1981, Skagit Valley field trip. unpubl. 6 pp.

Hooven, E.F., The effects of vegetational changes on small forest mammals. In Hermann,R.K. and D.P. Lavender (eds.) 1973. Symposium proceedings on "even-aged management" . Oregon State Univ. School of Forestry. 250 pp.

McGrenere, M., McGrenere, B., Ross, G. 1986. Vancouver Natural History Society field trip to Skagit Valley. Unpubl. 1 pp.

Mc Nay, R.S., Davies, R. 1985. Interactions between black-tailed deer and intensive forest management: problem analysis. Res., Ministries of Environment and Forests. Victoria. 110 pp.

Millar, J.W. 1985. Managing wildlife trees in British Columbia: a problem analysis. MRM report #22 Simon Fraser Univ., Vancouver. 178 pp.

Miller, E. and Miller, D.R. 1980. Snag use by birds. In Management of western forests and rangelands for nongame birds, Proc. Workshop (Salt Lake City, Utah, Feb. 11-14, 1980). p. 337-356. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-86. Intermountain For. Exp. Stn., Ogden, Utah. 535 pp.

Robichaud, L.J., Herter, C.A., Scott, A.D., Weber, E.W., Beaupre, B., Ross, C.R., MacCallum, J.L., Chance, D.G., Bullard, W.A. 1971. Environmental and ecological consequences in Canada of Raising Ross Lake in the Skagit Valley to elevation 1725. International Joint Commission Canada and United States. 191 pp.

Stevens, W. F., Gilbert, S., and Nellis, C.H. 1973. Appendix E: Birds of Ross Lake Basin In Taber, R.D. Biotic survey of Ross Lake basin. Univ. of Washington. 23 pp.

Slaney, F. F. and Co. Ltd. 1971. Environmental investigations Skagit Valley in Canada and indication of consequences from raising the level of Ross Lake. City of Seattle, Dept. of Lighting. 66 pp.

Slaney, F. F. and Co. Ltd. 1973. Environmental investigations

proposed high Ross reservoir- Volumes 1-10. City of Seattle, Dept. of Lighting. unnumbered.

Weber, W. 1972. Birds recorded in the Skagit Valley, B.C. Unpubl. 1 pp.

Weber, W. 1973. Birds recorded in the Skagit Valley, B.C. Unpubl. 1 pp.

Weber, W. 1974. Birds recorded in the Skagit Valley, B.C. Unpubl. 1 pp.

Personal Communication

Booth, B. Research assistant to E. Forsman

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Appendix 1: Estimated small mammal densities by habitat type and distributions of small mammals in the Skagit Valley as determined by Slaney (1973).

1a) Estimated shrew densities by habitat type.
b) Wandering shrew distribution.
c) Cinereus shrew distribution.

2a) Estimated shrew-mole densities by habitat type.
b) Shrew-mole distribution.

3a) Seasonal hare distribution by habitats.
b) Lagomorpha habitat distribution.

4a) Estimated chipmunk densities by habitat types.
b) Townsend chipmunk distribution.
c) Northwestern chipmunk distribution.

5a) Potential ground squirrel habitat distribution.

6a) Estimated tree squirrel densities by habitat types.
b) Tree squirrel distribution.

7a) Estimated densities of mouse-like animals by habitat types.
b) Deer mouse distribution.
c) Creeping vole distribution.
d) Long-tailed vole and townsend vole distribution.
e) Boreal redback vole distribution.
f) Northwestern jumping mouse distribution.

Note:

The poor quality of the available copy of Slaney (1973) made some of the habitat rating and animal distribution maps unreadable; these maps are not included in Appendix 1. A thorough search to obtain a better copy of Slaney (1973) was fruitless. The following persons and agencies were contacted:

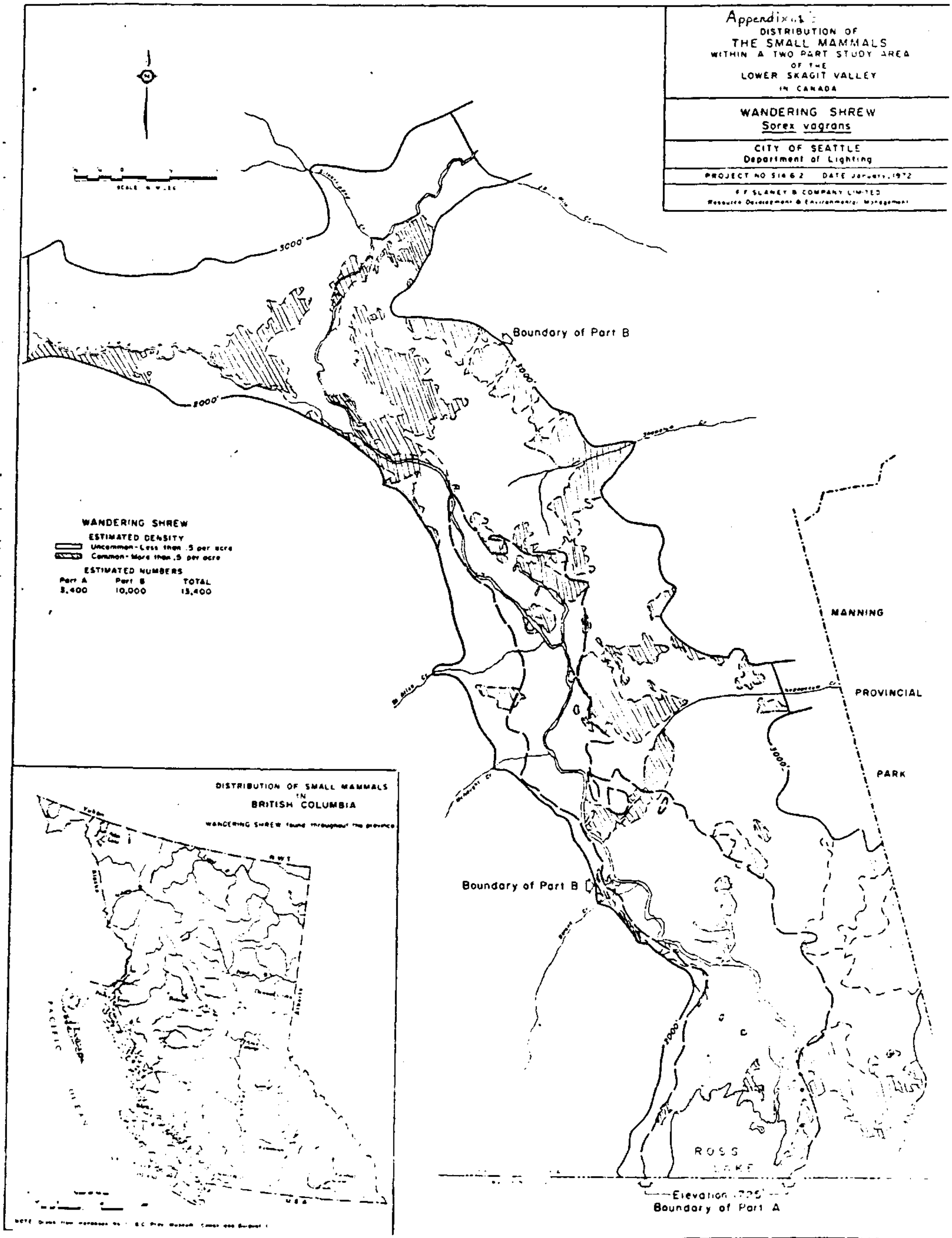
1) British Columbia Provincial Museum Vertebrate Division,
2) British Columbia Provincial Museum Archives,
3) Ministry of Environment; Surrey and Victoria,
4) LGL Consulting, Sidney,
5) City of Seattle, Department of Lighting (they possessed a copy of the rough draft),
6) John Foster of Mac Laren Plansearch Corp., Vancouver, and
7) Tim Slaney of Aquatic Resources Limited, Vancouver.

Appendix 11a - ESTIMATED SHREW DENSITIES BY HABITAT TYPES

Habitat	Wandering Shrew (Sv) Average Density	Wandering Shrew (Sv) Density Class	Cinereus Shrew (Sc) Average Density	Cinereus Shrew (Sc) Density Class
	Animals/Acre		Animals/Acre	
A) Ground Cover Density Types in Mature Forests				
1. Coniferous forest				
a) open-light ground cover	.07	I	.07	I
b) medium ground cover	.88	II	.22	-
c) dense ground cover	.69	II	.29	I
2. Coniferous-deciduous forest				
a) open-light ground cover	.79	II	0.0	I
b) medium ground cover	.76	II	.30	I
c) dense ground cover	.18	I	.18	I
B) Ground Cover Species Type				
3. Regeneration (cut-over)				
a) deciduous	.89	II	.14	I
b) mixed	1.22	II	.25	I
c) coniferous	.70	II	0.0	-
d) 1970-71 slash	1.26	II	.36	I
4. Pond riparian	1.18	II	.36	I
5. River riparian	.22	I	.05	I
6. Meadows	.31	I	.11	I
7. Drawdown	-	-	-	-

Density Classes

I. Low = less than .5 animals per acre.
II. High = more than .5 animals per acre.



Appendix
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA
WANDERING SHREW
Sorex vagrans
CITY OF SEATTLE
Department of Lighting
PROJECT NO 514.6.2 DATE January, 1972
F F SLANEY & COMPANY LIMITED
Resource Development & Environmental Management
WANDERING SHREW
ESTIMATED DENSITY
Uncommon - Less than .5 per acre
Common - More than .5 per acre
ESTIMATED NUMBERS
Part A Part B TOTAL
3,400 10,000 13,400
3000'
Boundary of Part B
Boundary of Part B
MANNING
PROVINCIAL
PARK
ROSS
LAKE
Elevation 1725'
Boundary of Part A
DISTRIBUTION OF SMALL MAMMALS
IN
BRITISH COLUMBIA
WANDERING SHREW found throughout the province
PACIFIC

Appendix IC

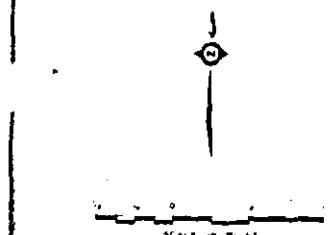
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA

CINEREUS SHREW
Sorex cinereus

CITY OF SEATTLE
Department of Lighting

PROJECT NO 514 6 2 DATE January, 1972

E.P. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management



CINEREUS SHREW
ESTIMATED DENSITY
None found
Uncommon - Less than 5 per acre

ESTIMATED NUMBER

Part A	Part B	TOTAL
900	2700	3600

Boundary of Part B

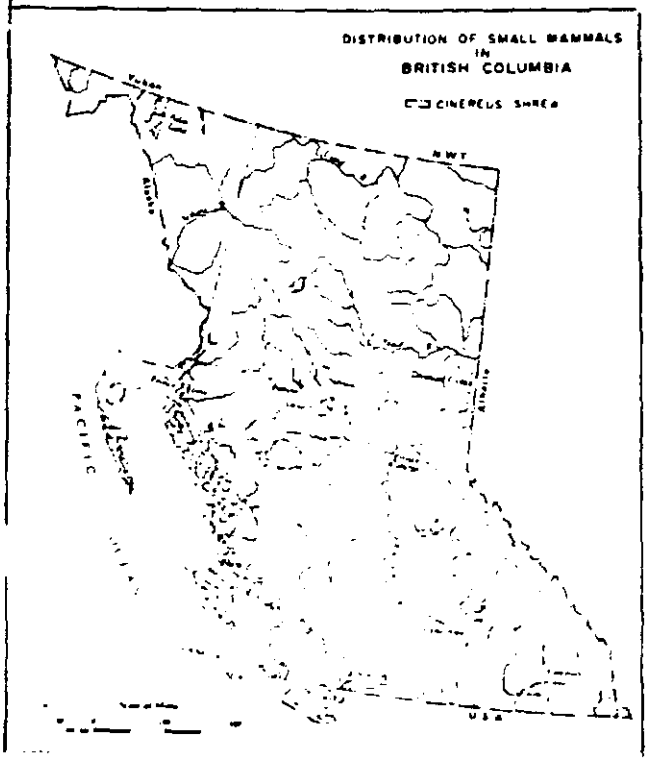
Boundary of Part B

MANNING PROVINCIAL PARK

ROSS

Elevation

Boundary of Part A



Appendix 1.2 a

ESTIMATED SHREW-MOLE DENSITIES BY HABITAT TYPES

	Habitat	Shrew-Mole (Ng) Average Density	Density Class
		animals/acre	
A)	Ground Cover Density Types in Mature Forests		
	1. Coniferous forest		
	a) open-light ground cover	0.0	-
	b) medium ground cover	0.0	-
	c) dense ground cover	.18	I
	2. Coniferous-deciduous forest		
	a) open-light ground cover	.09	I
	b) medium ground cover	.05	I
	c) dense ground cover	.27	I
B)	Ground Cover Species Type		
	3. Regeneration (cut-over)		
	a) deciduous	.05	I
	b) mixed	0.0	-
	c) coniferous	0.0	-
	d) 1970-71 slash	0.0	-
	4. Pond riparian	.9	II
	5. River riparian	0.0	-
	6. Meadows	0.0	-
	7. Drawdown	-	-

Density Classes

I. Low = less than .5 animals per acre.
II. High = more than .5 animals per acre.

Appendix 1.2 b

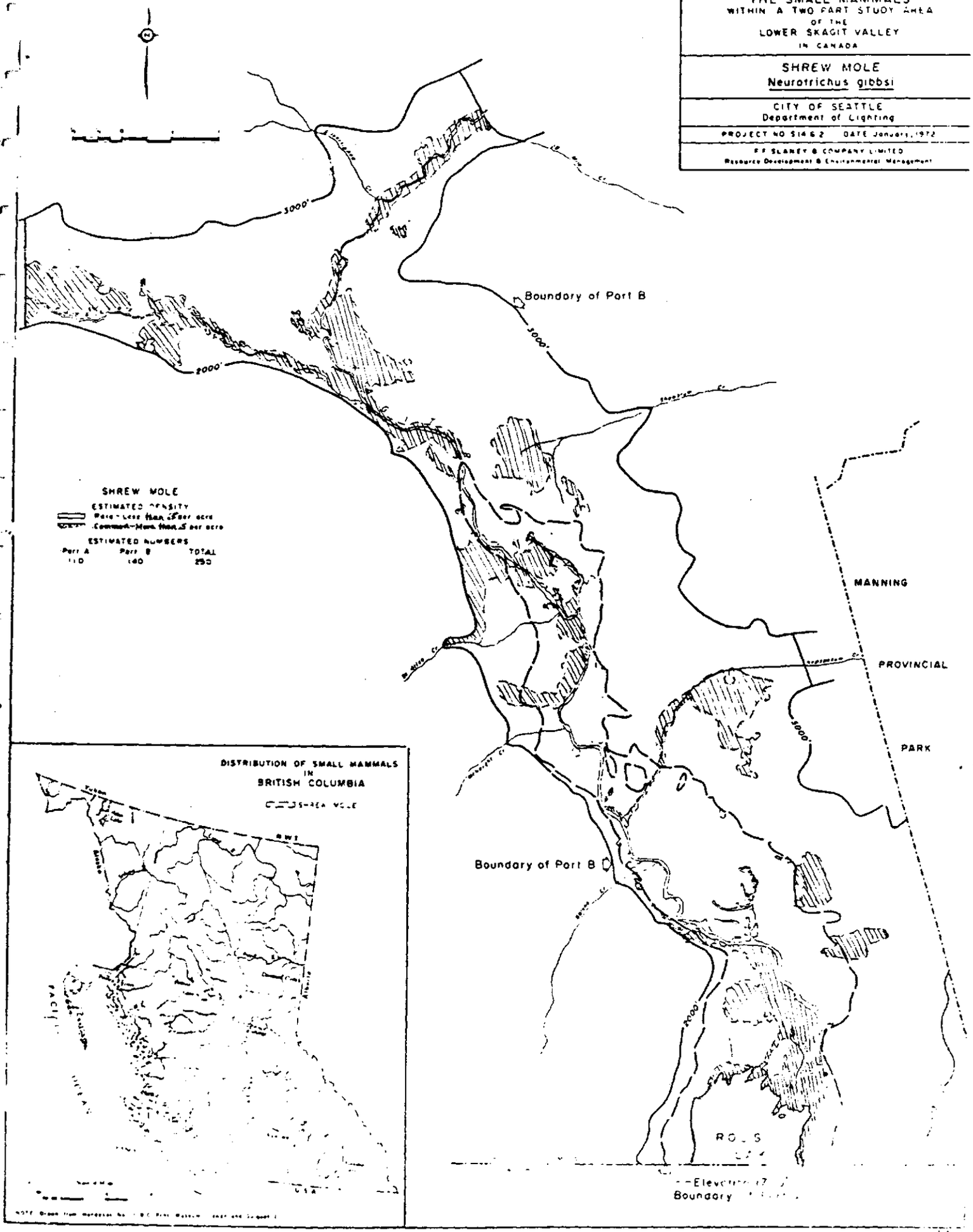
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA

SHREW MOLE
Neurotrichus gibbsi

CITY OF SEATTLE
Department of Lighting

PROJECT NO 5146.2 DATE January, 1972

R.F. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management



Appendix 1.3 a

SEASONAL HARE DISTRIBUTION BY HABITATS

Arbitrary Density Classes	*Winter	**Spring	***Summer
Abundant (2 or more/ acre)	-mixed mature deciduous-coniferous -mixed deciduous-coniferous regeneration.	-mixed mature -mixed deciduous coniferous regeneration. -immature cottonwood.	-mixed mature deciduous-coniferous -immature cottonwood -deciduous regenerotion
Common (1-2/acre)	-mature conifers -immature cottonwoods -conifer regeneration	-mature conifers -deciduous regenerations	-mixed deciduous-coniferous regeneration -mature conifers
Rare (0-1/acre)	-deciduous regeneration. -open conifers	-conifer regeneration -open conifers	-conifer regeneration -open conifers

* Based on 32 card records, November 1970 - April 1971

** Based on 20 card records, April 1971 - June 1971

*** Based on four complete road censuses and six card records, June 1971 - July 1971.

Appendix ... C

DISTRIBUTION OF THE SMALL MAMMALS WITHIN A TWO PART STUDY AREA OF THE LOWER SKAGIT VALLEY IN CANADA

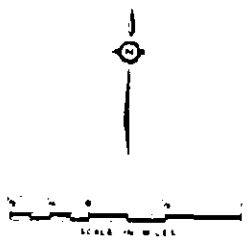
LAGOMORPHA HABITAT

HARE	PIKA
Lepus americanus	Ochotona princeps

CITY OF SEATTLE
Department of Lighting

PROJECT NO 5146 2 DATE January, 1972

R. F. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management



Boundary of Part B

3000'

LAGOMORPHA HABITAT

HARE HABITAT
Good Spring and Summer

POTENTIAL PIKA HABITAT
Good (open talus)
Poor (semi-open rocky areas)

MANNING

PROVINCIAL

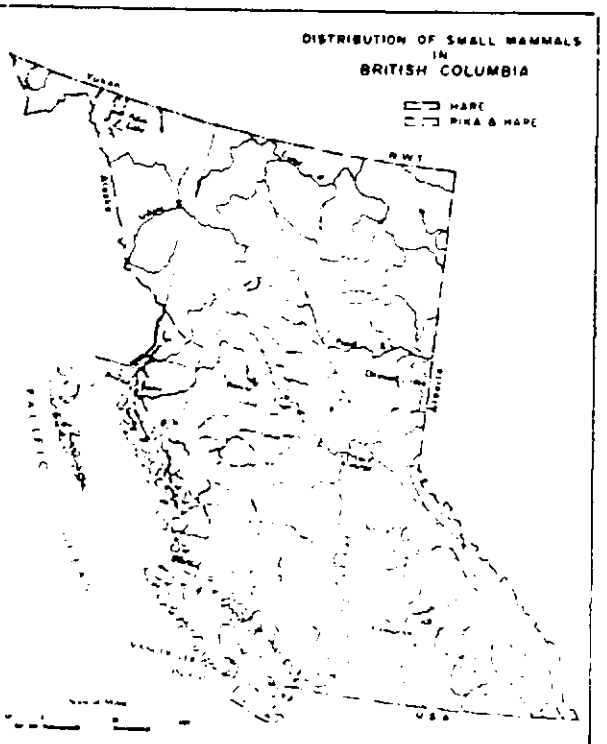
PARK

Boundary of Part B

ROSS LAKE

Elevation 1725'

Boundary of Part A



Appendix 1.4 a

ESTIMATED CHIPMUNK DENSITIES BY HABITAT TYPES

Habitat	Number Per Acre: Eutamias townsendi	Eutamias amoenus
A) Ground Cover Density Types in Mature Forests		
1. Coniferous forest		
a) light ground cover	.04	---
b) medium ground cover	.07	.02
c) dense ground cover	.08	---
2. Deciduous-coniferous forest		
a) light ground cover	.35	---
b) medium ground cover	.34	---
c) dense ground cover	.41	---
B) Ground Cover Species Type		
3. Cutover areas		
a) deciduous regeneration	.03	.42
b) mixed regeneration	.31	.13
c) coniferous regeneration	.34	---
d) 1970-71 slash	.13	.39
4. Pond Riparion	.02	.05
5. River Riparian	.56	---
6. Meadows	.11	.07
Average Density	.11	.04

Appendix 4b

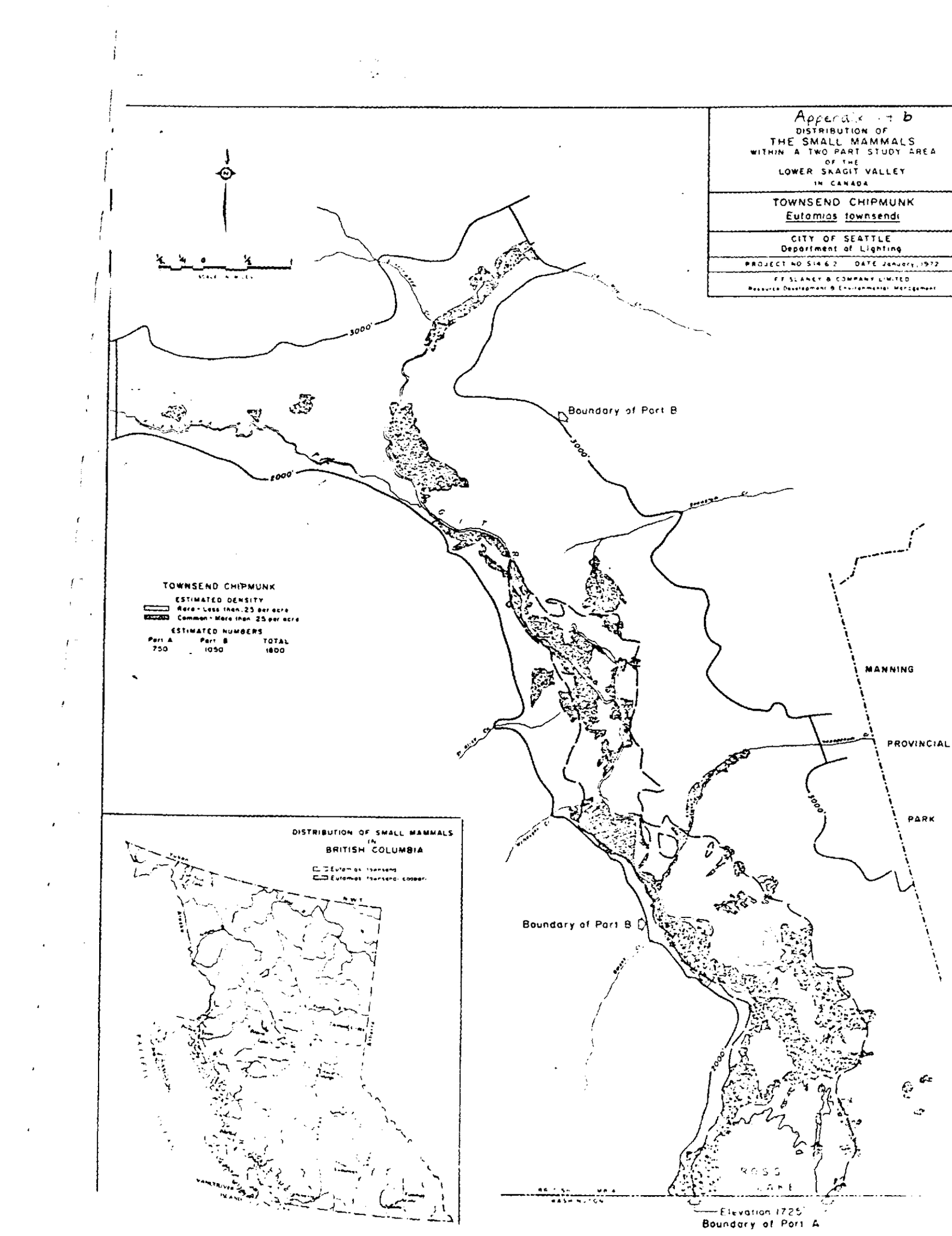
DISTRIBUTION OF THE SMALL MAMMALS WITHIN A TWO PART STUDY AREA OF THE LOWER SKAGIT VALLEY IN CANADA

TOWNSEND CHIPMUNK
Eutamias townsendi

CITY OF SEATTLE
Department of Lighting

PROJECT NO 5146.2 DATE January, 1972

R.F. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management



Appendix C

DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA

NORTHWESTERN CHIPMUNK
Eutamias amoenus

CITY OF SEATTLE
Department of Lighting

PROJECT NO. 514.6.2 DATE January, 1972

R. W. SLAGER & COMPANY, LTD.
Resource Development & Environmental Management

SCALE IN MILES

NORTHWESTERN CHIPMUNK

ESTIMATED DENSITY

None found

Rare - Less than .25 per acre

Common - More than .25 per acre

ESTIMATED NUMBERS

Part A	Part B	TOTAL
450	300	750

Boundary of Part B

Boundary of Part B

SKAGIT R.

MANNING PROVINCIAL PARK

ROSS LAKE

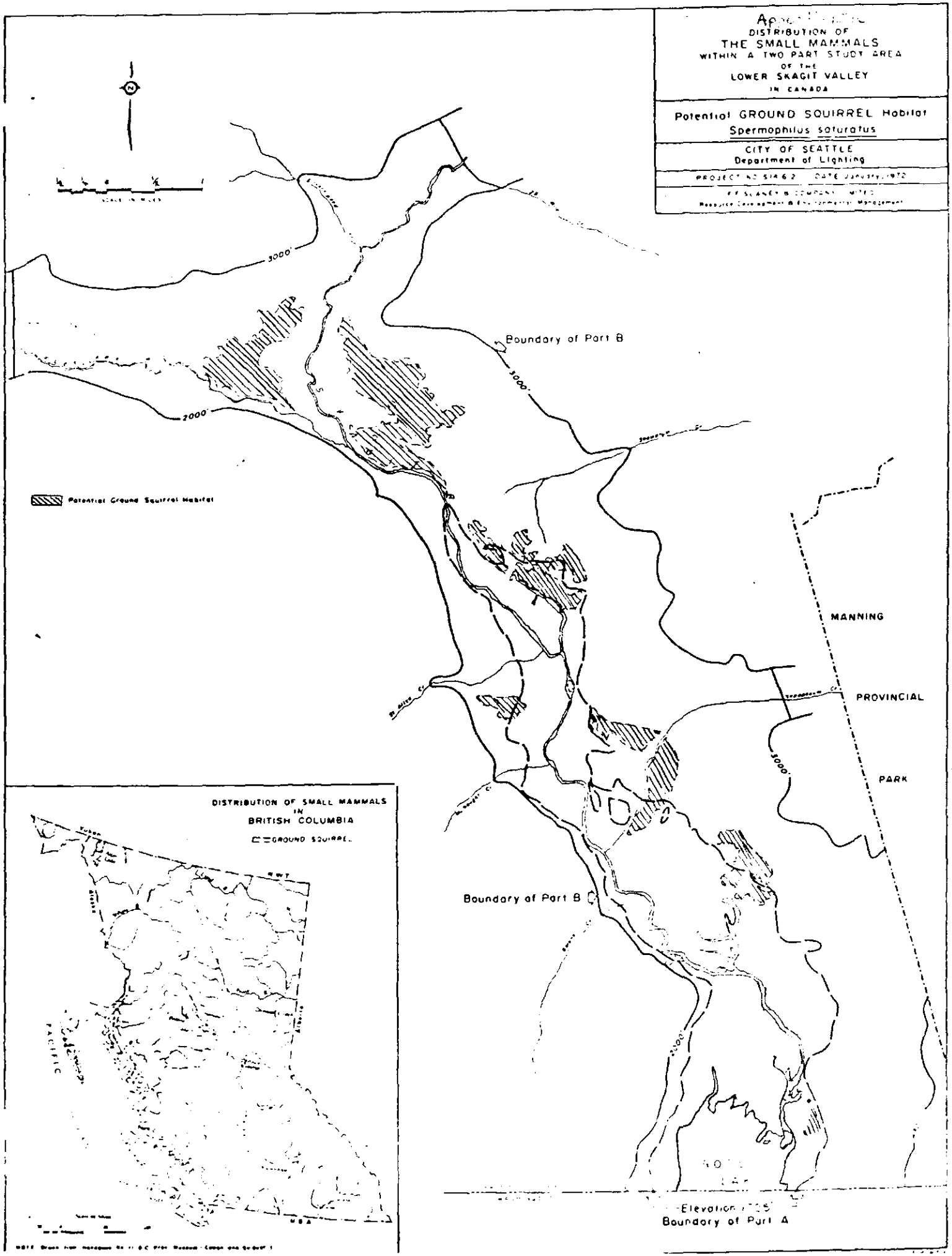
Elevation 1725'

Boundary of Part A

DISTRIBUTION OF SMALL MAMMALS
IN
BRITISH COLUMBIA

NORTHWESTERN CHIPMUNK

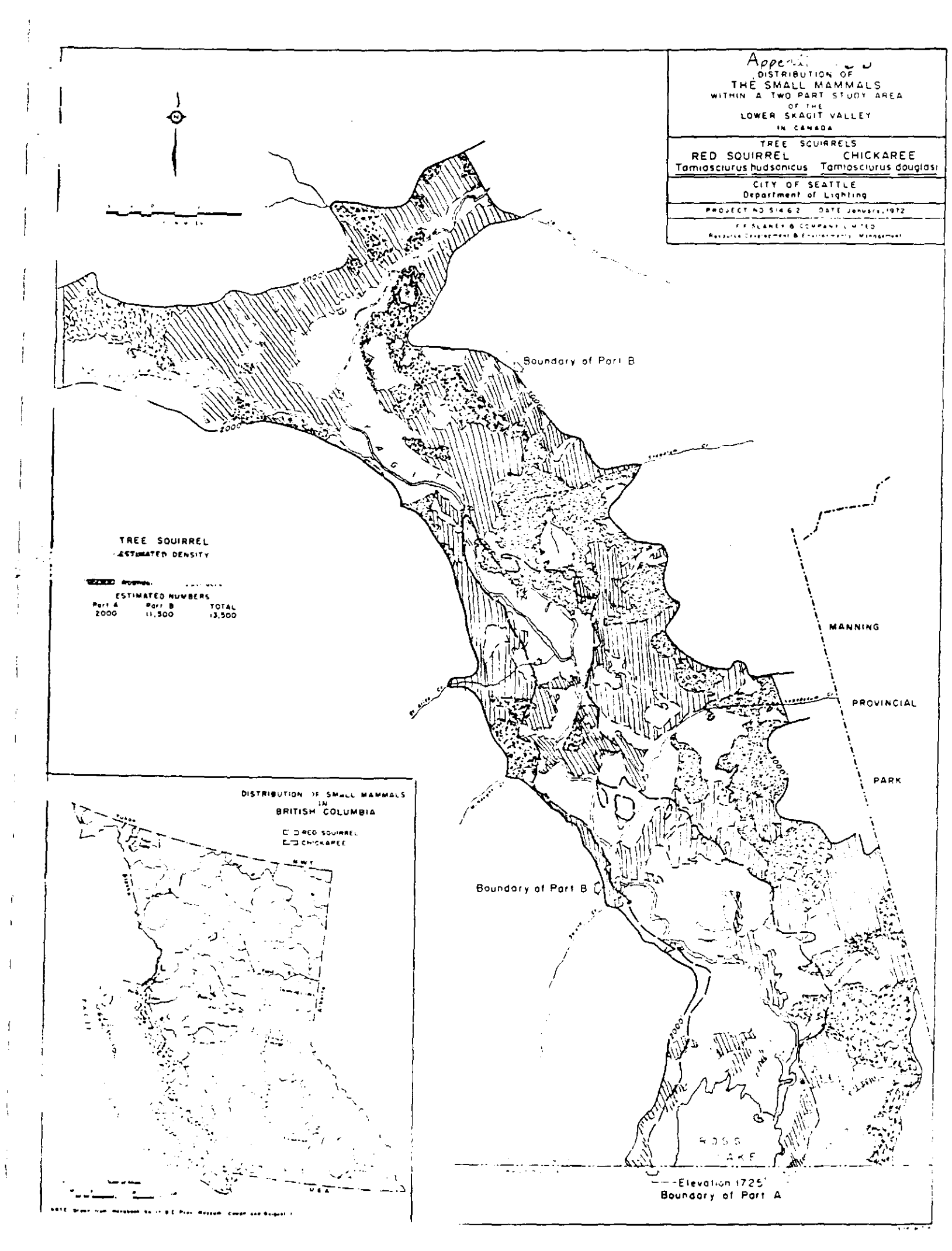
NOTE: Drawn from [illegible]


DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA
Potential GROUND SQUIRREL Habitat
Spermophilus saturatus
CITY OF SEATTLE
Department of Lighting
Boundary of Part B
Potential Ground Squirrel Habitat
MANNING
PROVINCIAL
PARK
Boundary of Part B
Boundary of Part A
DISTRIBUTION OF SMALL MAMMALS
IN
BRITISH COLUMBIA
GROUND SQUIRREL

Appendix 1.6 a

HABITAT DENSITY ESTIMATES OF SQUIRRELS

Habitat Type	No. Observed per 1000 Feet	Estimated Density	Density Class
a) Large and small Douglas fir	23+	1.0-1.5/acre	1 - abundant
b) Douglas fir with scattered pine, cedar or balsam	11-22	.5-1.0/acre	11 - common
c) Douglas fir with cedar, pine or cottonwood; cottonwood-cedar; cottonwood and all deciduous types; pine, cedar or balsam stands; all regeneration areas; meadows and riparian.	0-10	0-.5/acre	111 - uncommon
Average Estimated Density -		.75/acre	


Appendix
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA
TREE SQUIRRELS
RED SQUIRREL
Tamiosciurus hudsonicus
CHICKAREE
Tamiosciurus douglasi
CITY OF SEATTLE
Department of Lighting
PROJECT NO 5146.2 DATE January, 1972
F.F. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management
Boundary of Part B
TREE SQUIRREL
ESTIMATED DENSITY
ESTIMATED NUMBERS
Part A
2000
Part B
11,500
TOTAL
13,500
MANNING
PROVINCIAL
PARK
Boundary of Part B
ROSS
LAKE
Elevation 1725'
Boundary of Part A
DISTRIBUTION OF SMALL MAMMALS
IN
BRITISH COLUMBIA
RED SQUIRREL
CHICKAREE
N.W.T.
U.S.A.

Appendix 1.7 a

ESTIMATED DENSITY OF MYOMORPHS BY HABITAT TYPES

Average Estimated Density, (Numbers per acre)

Habitat	Deer Mouse	Oregon Vole	Long-tailed Vole	Townsend Vole	Redback Vole	Jumping Mouse
A) Ground Cover Density Types in Mature Forests						
1. Coniferous forest						
a) light ground cover	.6	.5	-	-	-	-
b) medium ground cover	1.6	.4	-	-	.4	-
c) dense ground cover	1.5	1.3	-	.7	.4	-
2. Mixed forest						
a) light ground cover	5.4	-	-	-	.3	-
b) medium ground cover	2.7	-	-	-	.4	-
c) dense ground cover	6.8	.7	3.9	.8	-	-
B) Ground Cover Species Type						
3. Cutover Areas						
a) deciduous	1.8	-	-	-	-	.8
b) mixed	2.8	-	-	-	-	.7
c) coniferous	2.3	-	-	-	-	-
d) 1970-71 slash	1.1	-	-	-	-	-
4. Pond Riparian	4.3	3.2	3.9	-	-	.8
5. River Riparian	4.0	.7	-	-	-	-
6. Meodows	1.0	.4	-	-	-	.7
7. Drawdown Areo	2.1	-	-	-	-	-

Appendix F-b

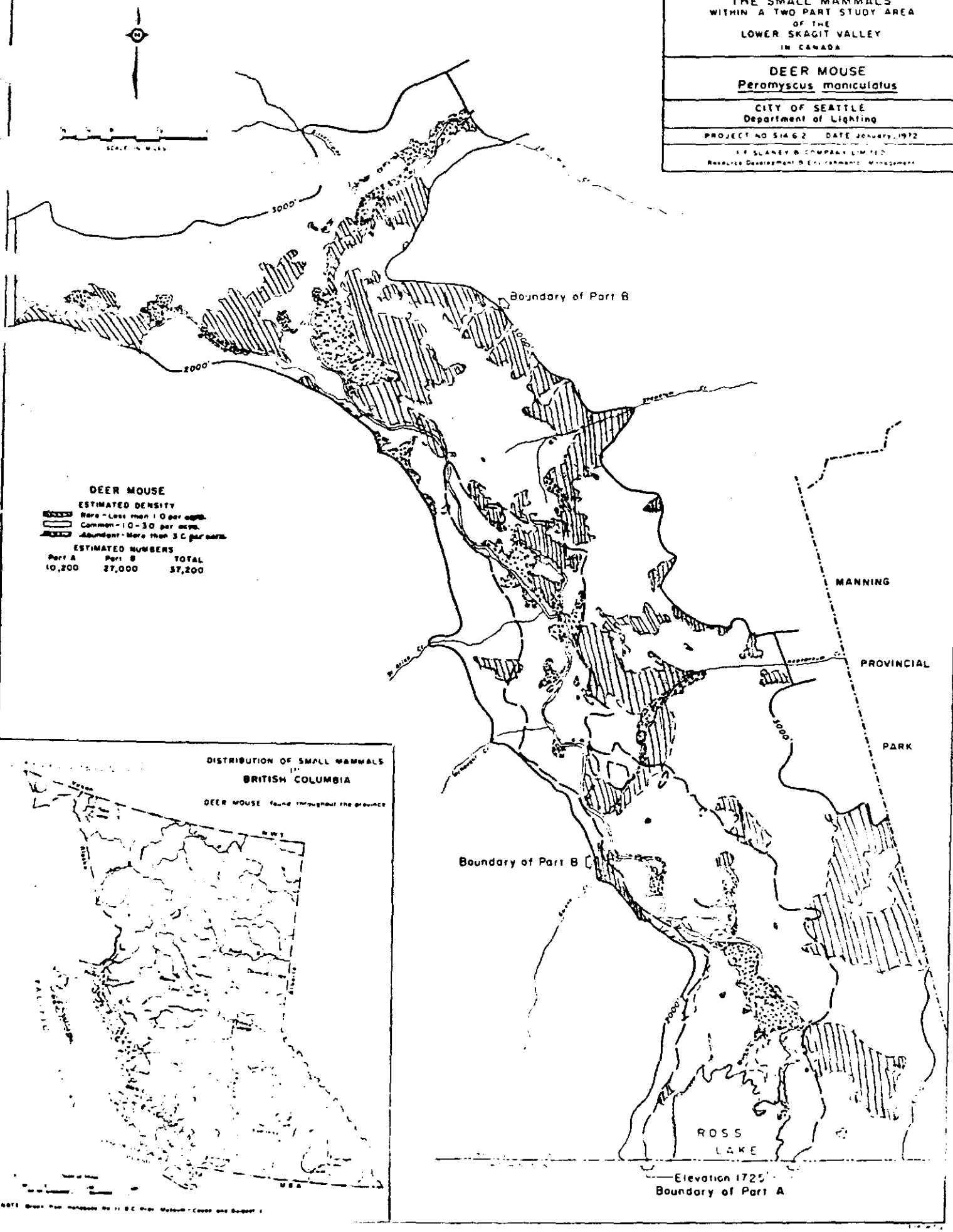
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA

DEER MOUSE
Peromyscus maniculatus

CITY OF SEATTLE
Department of Lighting

PROJECT NO 5146.2 DATE January, 1972

T.P. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management



Appendix 1.7.2

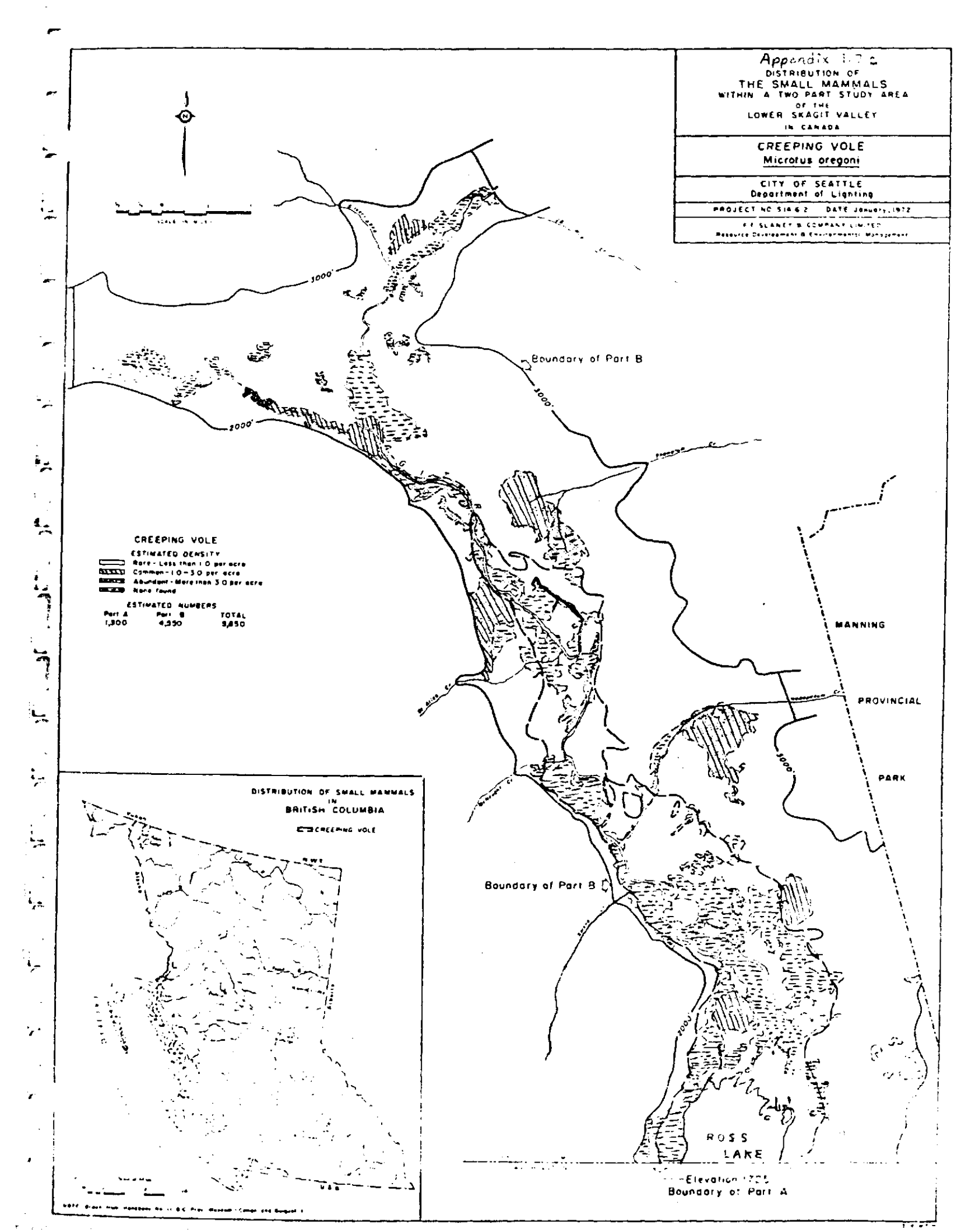
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA

CREEPING VOLE
Microtus oregoni

CITY OF SEATTLE
Department of Lighting

PROJECT NO. 516 & 2 DATE January, 1972

R. J. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management



Appendix 1.7 d

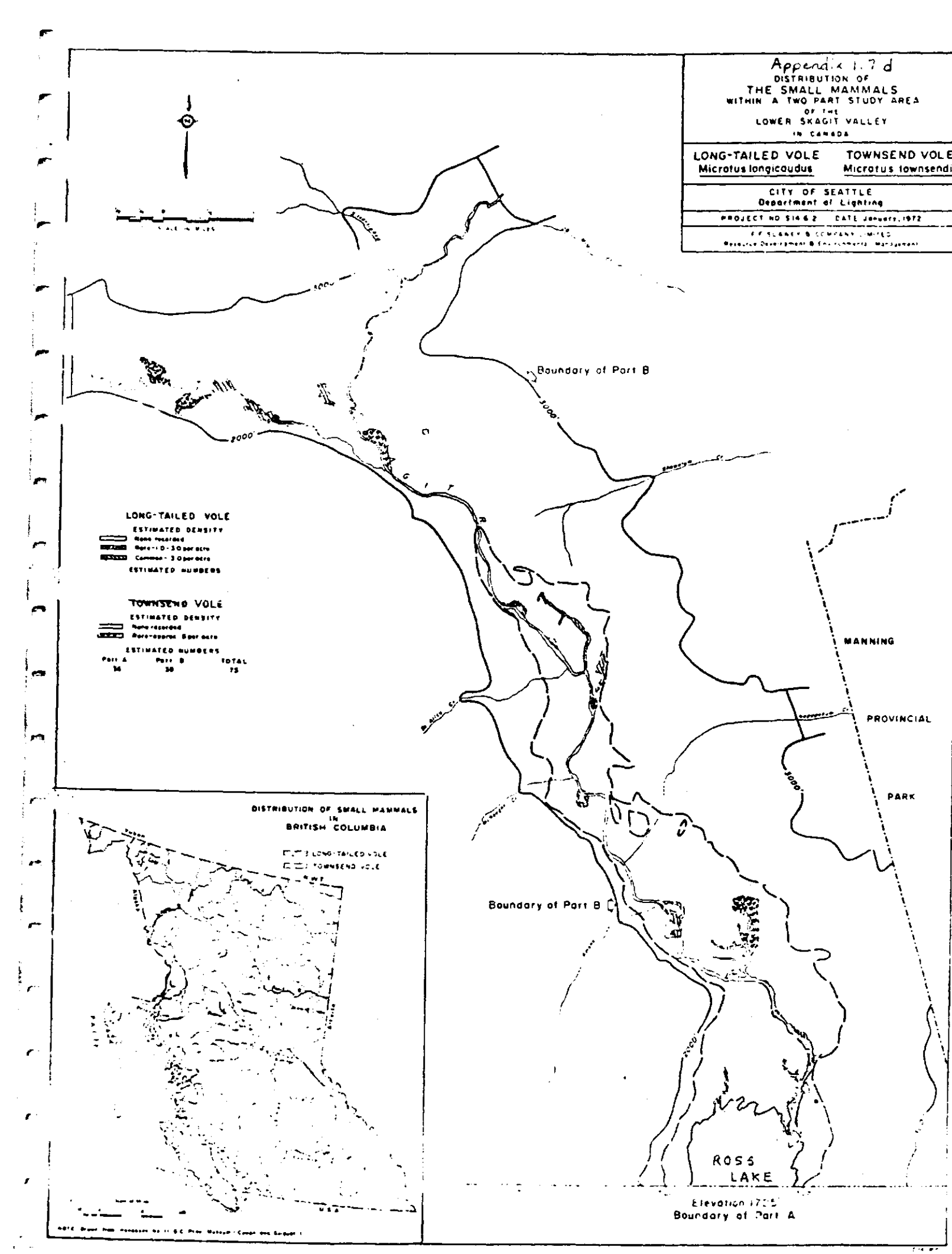
DISTRIBUTION OF THE SMALL MAMMALS WITHIN A TWO PART STUDY AREA OF THE LOWER SKAGIT VALLEY IN CANADA

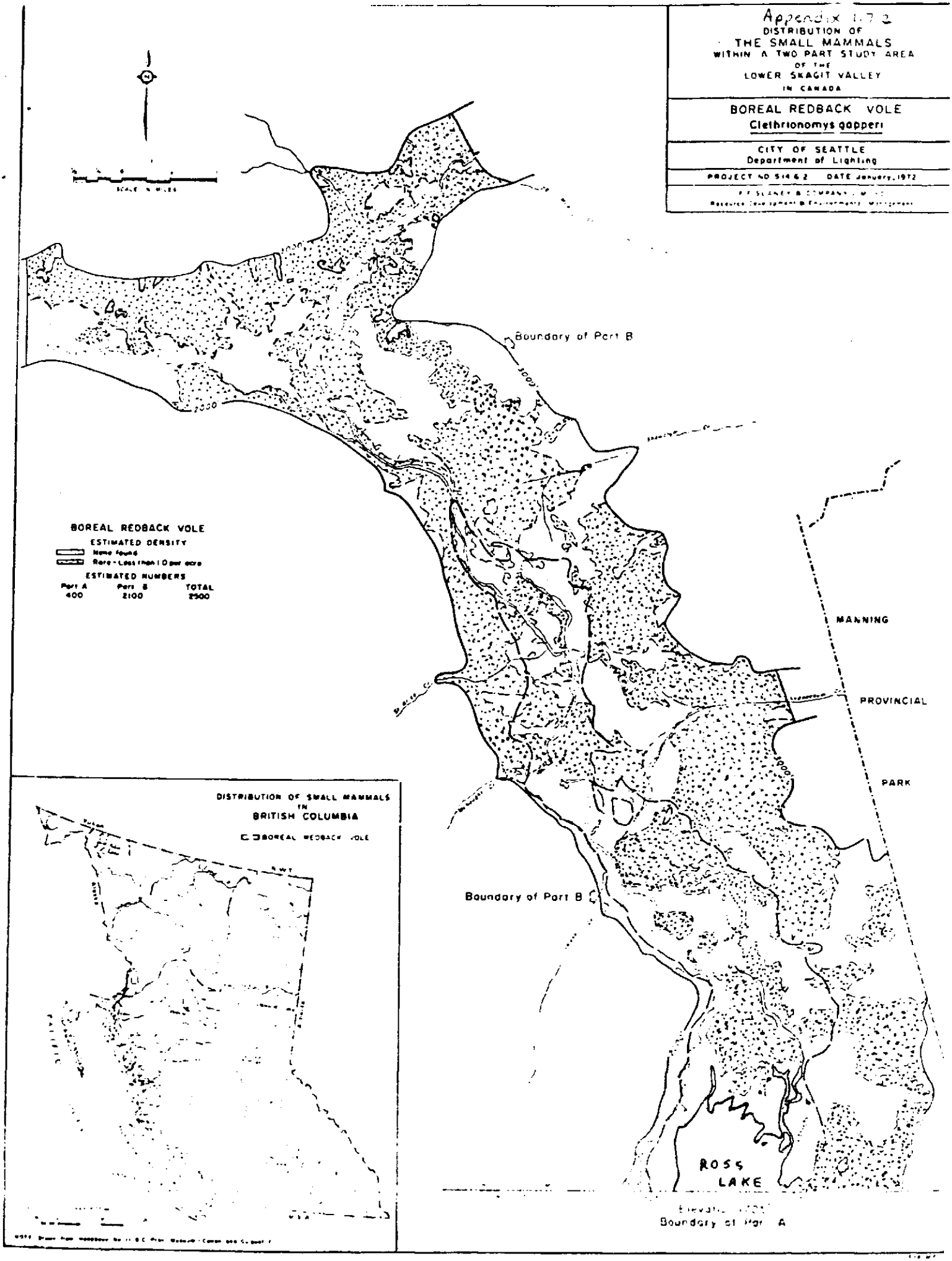
LONG-TAILED VOLE	TOWNSEND VOLE
Microtus longicaudus	Microtus townsendi

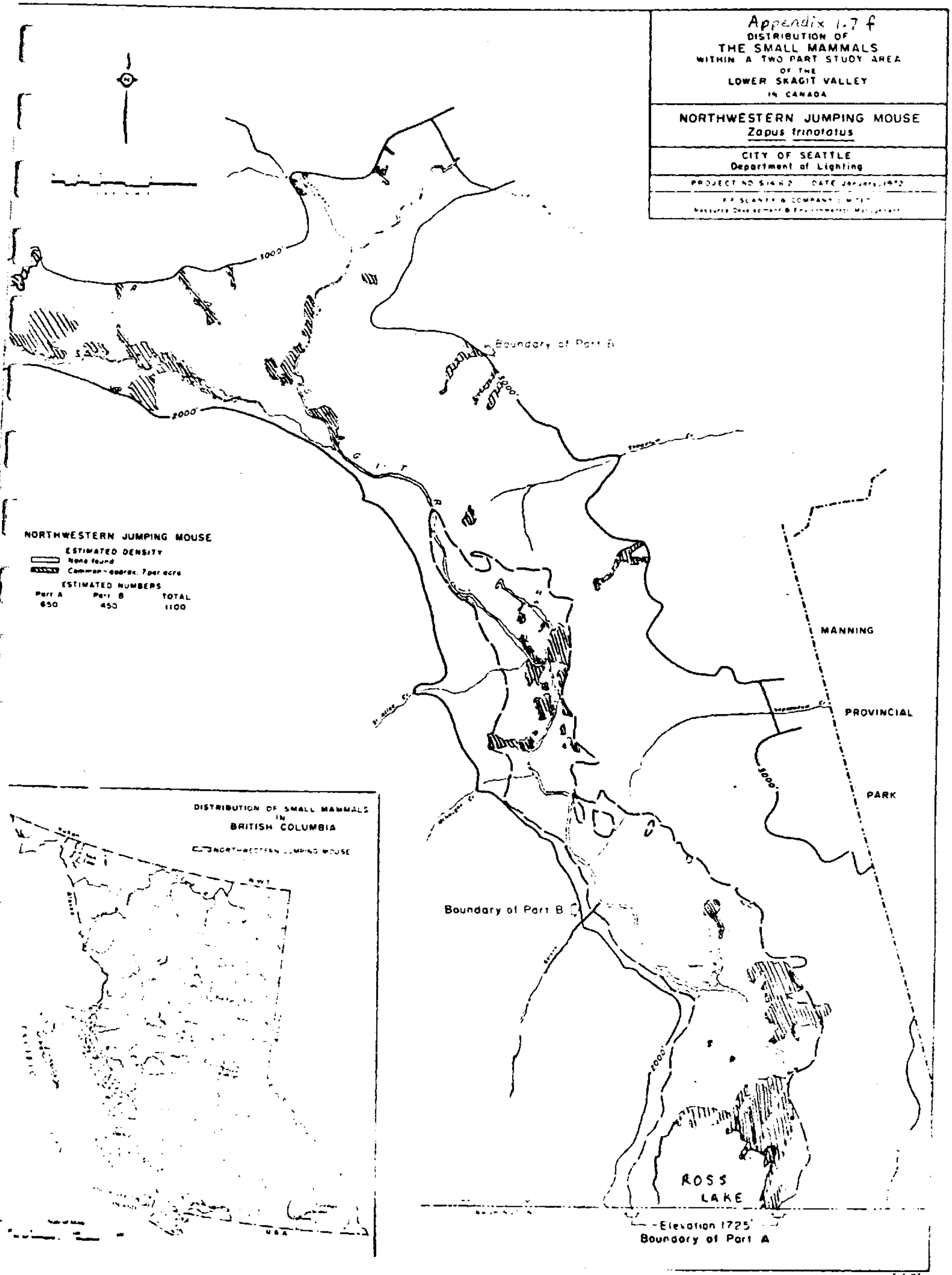
CITY OF SEATTLE
Department of Lighting

PROJECT NO S14 6 2 DATE January, 1972

F F SLANEY & COMPANY LIMITED
Resource Development & Environmental Management




Appendix 1.7.2
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA
BOREAL REDBACK VOLE
Clethrionomys gapperi
CITY OF SEATTLE
Department of Lighting
PROJECT NO 514 & 2 DATE January, 1972
SCALE IN MILES
Boundary of Part B
BOREAL REDBACK VOLE
ESTIMATED DENSITY
None found
Rare - Less than 10 per acre
ESTIMATED NUMBERS
Part A 400
Part B 2100
TOTAL 2500
MANNING
PROVINCIAL
PARK
Boundary of Part B
ROSS
LAKE
Boundary of Part A
DISTRIBUTION OF SMALL MAMMALS
IN
BRITISH COLUMBIA
BOREAL REDBACK VOLE
N.W.T.
U.S.A.



Appendix 1.7 f
DISTRIBUTION OF
THE SMALL MAMMALS
WITHIN A TWO PART STUDY AREA
OF THE
LOWER SKAGIT VALLEY
IN CANADA
NORTHWESTERN JUMPING MOUSE
Zapus trinotatus
CITY OF SEATTLE
Department of Lighting
NORTHWESTERN JUMPING MOUSE
ESTIMATED DENSITY
None found
Common - approx. 7 per acre
ESTIMATED NUMBERS
Part A 650
Part B 450
TOTAL 1100
Boundary of Part B
Boundary of Part B
3000'
2000'
MANNING
PROVINCIAL
PARK
ROSS
LAKE
Elevation 1725'
Boundary of Part A
DISTRIBUTION OF SMALL MAMMALS
IN
BRITISH COLUMBIA
NORTHWESTERN JUMPING MOUSE

APPENDIX 2: Methods of data collection of Slaney (1973)

1) Small mammals

Insectivores, chipmunks, mice, and voles were censused by 66 lines of snap-traps set up over the study area between June 2, 1971 and July 23, 1971. The traplines varied in length from 450 to 750 feet (137 to 229 m). Stations were set 30 m apart on each line; 2 traps at each station. Traplines were checked every morning and left in the same location for 3 nights before moving. 7500 trapnights were recorded.

Squirrels were censused using 3 methods. First, transects were established through each habitat and indications of squirrel presence recorded. The length of the transect depended on the extent of the habitat type. Second, all squirrels observed while running these same transects were recorded along with total distance travelled and total time spent on the transect. Third, a listening-observation plot was established within each habitat type and all squirrels heard or seen during 15 minute periods were recorded.

Hare densities were estimated from road censuses conducted between 8:00 and 10:00 pm. Sightings were recorded with exact locations and habitat descriptions.

Incidental observations between November 1970 and October 1971 were the only data collected for the northern flying squirrel, cascade mantled ground squirrel, pika, and little brown bat.

Methods of data analysis are described in Slaney (1973).

2) Non-game avifauna

Slaney (1973) recorded bird species abundance, diversity, and distribution during spring (April 1- June 15), summer (June 15- August 15), autumn (August 15- Dec 1), and winter (December 15- April 1). These seasonal definitions were meant to correspond to known migration periods (spring and autumn) and intermigration periods. Both spring and summer were included in the breeding season.

During the breeding season, 22 transects and 2 ponds were censused in the early morning. All birds heard or seen within 150 feet of the transect line were recorded. Birds were classified according to species, sex, and migration or breeding status. Transects varied in length from 270 to 4540 feet (82 to 1384 m) and censused each major habitat type.

During winter, bird species, numbers, and locations were recorded from transect lines. The relative occurrence of each

species was rated as:

Classification	Relative occurrence of species
A- abundant	observed daily and in large numbers
F- frequent	observed daily but in small numbers
R- rare	seen irregularly although resident
C- casual	seen once or twice per season
T- transient	migrating through study area

3) Upland game birds

A census route was established along roads within the study area. This route was travelled twice by vehicle during the breeding season with listening stops made every quarter mile. Further locations of drumming grouse were supplied by fisheries biologists working on the Skagit River.

Appendix 3: Mammals of the Skagit Valley and Environs

Scientific Name[1]	Common Name	Source
Marsupialia		
Didelphidae		
Didelphis virginiana	Opposum	B.C.P.M.[2]
Insectivora		
Talpidae		
Neurotrichus gibbsi	Shrew-mole	B.C.P.M.
Soricidae		
Sorex bendirii	Pacific water shrew	B.C.P.M.
Sorex cinereus	Masked shrew	B.C.P.M.
Sorex monticolus		B.C.P.M.
Sorex obscurus obscurus[5]	Dusky shrew	U.B.C.V.M.[3]
Sorex palustris	Northern water shrew	U.B.C.V.M.
Sorex trowbridgii	Trowbridge shrew	B.C.P.M.
Sorex vagrans	Vagrant shrew	B.C.P.M.
		U.B.C.V.M.
Chiroptera		B.C.P.M.
Vespertilionidae		B.C.P.M.
Eptesicus fuscus	Big brown bat	B.C.P.M.
Lasionycteris noctivagans	Silver-haired bat	B.C.P.M.
Myotis evotis	Long-eared myotis	B.C.P.M.
Myotis lucifugus	Little brown myotis	Carl et al.[4]
Myotis yumanensis	Yuma myotis	B.C.P.M.
Plecotus townsendii	Western big-eared bat	B.C.P.M.
Phyllostomidae		
Leptonycteris nivalis	Long-nosed bat	Carl et al.
Carnivora		
Procyonidae		
Procyon lotor	Raccoon	Carl et al.
Mustelidae		
Spilogale gracilis	Spotted skunk	Carl et al.
Mephitis mephitis	Striped skunk	Carl et al.
Lagomorpha		
Leporidae		
Lepus americanus	Snowshoe hare	B.C.P.M.
Ochotonidae		
Ochotona princeps	Pika	B.C.P.M.
Rodentia		
Aplodontiidae		
Aplodontia rufa	Mountain beaver	B.C.P.M.
Cricetidae		
Clethrionomys gapperi	Boreal redbacked vole	B.C.P.M.

Microtus longicaudus	Longtail vole	B.C.P.M.
Microtus longicaudus macroucus	Longtail vole	U.B.C.V.M.
Microtus oregoni	Oregon vole	B.C.P.M.
Microtus richardsoni	Richardson vole	B.C.P.M.
Microtus townsendi	Townsend vole	B.C.P.M.
		U.B.C.V.M.
Phenacomys intermedius	Mountain phenacomys	B.C.P.M.
Neotoma cinerea	Bushytail woodrat	B.C.P.M.
Peromyscus maniculatus	Deer mouse	B.C.P.M.
		U.B.C.V.M.
Geomyidae		
Thomomys talpoides	Northern pocket gopher	B.C.P.M.
		U.B.C.V.M.
Muridae		
Rattus rattus	Black rat	B.C.P.M.
Sciuridae		
Marmota flaviventris	Yellowbelly marmot	Carl et al.
Citellus columbianus columbianus	Columbian ground squirrel	U.B.C.V.M.
Citellus parryi	Arctic ground squirrel	B.C.P.M.
Citellus saturatus	Golden-mantled squirrel	B.C.P.M.
Glaucomys sabrinus	Northern flying squirrel	B.C.P.M.
Glaucomys sabrinus columbiensis	Northern flying squirrel	U.B.C.V.M.
Glaucomys sabrinus fuliginosus	Northern flying squirrel	U.B.C.V.M.
Tamias amoenus	Yellow pine chipmunk	B.C.P.M.
		U.B.C.V.M.
Tamias towmsendi	Townsend chipmunk	B.C.P.M.
Tamiasciurus douglasi	Chickaree	B.C.P.M.
Tamiasciurus douglasi mollipilosus	Chickaree	U.B.C.V.M.
Tamiasciurus hudsonicus	Red squirrel	B.C.P.M.
Tamiasciurus hudsonicus streatori	Red squirrel	U.B.C.V.M.
Zapodidae		
Zapus princeps	Western jumping mouse	B.C.P.M.
Zapus trinotatus	Pacific jumping mouse	B.C.P.M.
Zapus trinotatus trinotatus	Pacific jumping mouse	U.B.C.V.M.

1 Source is Hall (1981)
2 B.C.P.M.= British Columbia Provincial Museum wildlife records
3 U.B.C.V.M.= University of British Columbia Vertebrate Museum wildlife records
4 Carl et al.= Carl et al. (1952)
5 Sorex obscurus obscurus is noe called Sorex monticolus.

Appendix 4: Avifauna observed in the Skagit Valley by Slaney (1973) with annotations as to habitat type, seasonal occurrence, and breeding status.

APPENDIX 1.4(5)

BIRD CHECK LIST – STUDY AREA LOWER SKAGIT VALLEY, CANADA

LEGEND

SEASON: Fall August 15 to December 1
Winter December 1 to April 1
Spring April 1 to June 15
Summer June 15 to August 15

OCCURRENCE: A Abundant, seen daily in large numbers.
F Frequent, seen daily but in low numbers.
R Rare, seen irregularly although resident.
C Casual, seen only once or twice per season.
T Migrate through Study Area.

STATUS: B Recorded as a breeding bird.

HABITAT TYPES: 1a. River. 1b Lake. 1c Pond. 1d Riparian.
2a. Sedge Meadow. 2b. Grass Meadow.
3. Willow–Birch.
4a. Mature Cottonwood. 4b Immature Cottonwood.
5. Mixed Deciduous–Coniferous.
6. Cedar–Hemlock
7a. Mature Douglas Fir. 7b Immature Douglas Fir.
8. Fir–Pine or Pine
9. Alpine, Sub–Alpine.

Species	Seasonal Occurrence: Fall	Winter	Spring	Summer	Habitat Type	Breeding Status
Common Loon	-	-	CT	R	1b	
Red-necked Grebe	-	-	-	CT	1b	
Eared Grebe	RT	-	CT	-	1b	
Horned Grebe	CT	-	-	-	1b	
Western Grebe	AT	-	-	-	1b	
Pied-Billed Grebe	CT	-	-	CT	1b	
Great Blue Heron	RT	R	R	C	1a, 1b	
Whistling Swan	CT	-	-	-	1b	
Canada Goose	CT	-	-	-	1b	
White-fronted Goose	CT	-	-	-	1b	
Mallard	AT	F	RT	R	1b, 1c, 1e	B
Pintail	RT	-	RT	-	1b, 1e	
Green-winged Teal	RT	F	RT	R	1b, 1c, 1e	B
Cinnamon Teal	-	-	CT	-	1c	
Blue-winged Teal	-	-	CT	R	1b, 1c	B
American Widgeon	CT	-	CT	-	1b, 1c	
Shoveler	CT	-	-	-	1b	
Wood Duck	-	-	CT	-	1a,	
Ring-necked Duck	-	C	-	-	1c, 1b	
Canvasback	CT	-	-	-	1b	
Greater Scaup	C	C	CT	-	1b, 1c	
Lesser Scaup	CT	C	CT	-	1c, 1b	
Common Goldeneye	RT	F	RT	R	1a, 1b, 1c	B
Barrow's Goldeneye	-	-	CT	-	1c	
Bufflehead	FT	F	C	-	1a, 1b, 1c	
Harlequin Duck	-	-	-	R	1a	B
White-winged Scoter	-	-	CT	-	1b	
Ruddy Duck	CT	-	-	-	1b	
Hooded Merganser	CT	R	-	-	1a, 1c, 1b	
Common Merganser	RT	-	FT	R	1a, 1b, 1c	B
Red-breasted Merganser	-	-	CT	-	1b	
Goshawk	-	R	R	R	6, 7a, 5	B
Sharp-shinned Hawk	RT	-	R	R	4b	B
Cooper's Hawk	RT	-	R	R	7a, 5	B
Red-tailed Hawk	RT	C	R	R	1b, 6, 7a	B
Golden Eagle	CT	CT	CT	-	—	
Bald Eagle	-	CT	CT	-	—	
Marsh Hawk	RT	-	CT	-	1d, 2b	
Osprey	-	-	CT	-	1b	
Pigeon Hawk	RT	-	CT	-	2b, 7a	
Sparrow Hawk	RT	-	R	R	1b, 2b, 4a	B
Blue Grouse	-	F	-	F	7a	B
Spruce Grouse	-	C	-	C	8	B
Ruffed Grouse	-	F	-	F	1d, 3, 4a, 5, 6, 7a, b	B
White-tailed Ptarmigan	-	C	-	-	9	
Sandhill Crane	CT	-	-	-	1b	
Virginia Rail	CT	-	-	C	3, 2a	B
American Coot	AT	-	CT	-	1b	
Semipalmated Plover	CT	-	-	-	1b	
Killdeer	C	R	F	R	1b, 1e	B
Golden Plover	CT	-	-	-	1b	
Common Snipe	R	R	R	R	2a, 1c,	B
Long-billed Curlew	-	-	CT	-	1b	
Spotted Sandpiper	CT	-	FT	R	1b, 1a	B
Greater Yellowlegs	-	-	CT	-	1b	
Lesser Yellowlegs	-	-	CT	-	1b	
Pectoral Sandpiper	CT	-	-	-	1b	
Short-billed Dowitcher	CT	-	-	-	1b	
Semipalmated Sandpiper	-	-	CT	-	1b	
Glaucous-winged Gull	-	-	CT	RT	1b	
California Gull	-	-	RT	RT	1b	
Ring-billed Gull	-	-	RT	-	1b	
Band-tailed Pigeon	RT	-	CT	R	7a, b, 6	B
Rock Dove	-	-	CT	-	—	
Mourning Dove	CT	-	FT	R	4b, 2b	B
Screech Owl	C	-	-	-	7b	
Horned Owl	-	R	R	R	7a, 4a	B
Pygmy Owl	C	R	R	R	5, 7a, b, 4b	B
Spotted Owl	C	R	-	C	7a, b, 6	B
Short-eared Owl	-	-	CT	-	4a, 2b	
Saw-whet Owl	-	C	-	-	7a	
Poor-will	-	-	CT	-	2b	
Common Nighthawk	-	-	FT	F	1a, b,	B
Black Swift	-	-	AT	F	—	
Vaux's Swift	-	-	AT	F	—	B
Rufous Hummingbird	-	-	AT	F	4b, 7a, b, 2b, 1d	B
Calliope Hummingbird	-	-	FT	F	2b, 5	B
Belted Kingfisher	FT	R	RT	R	1a, 1b,	B
Red-shafted Flicker	R	-	FT	R	1b, 4a, b, 6, 7a, b	B
Pileated Woodpecker	R	F	FT	F	4a, 5, 6, 7a, b	B
Yellow-Bellied Sapsucker	CT	-	F	R	2a, b, 3, 4b, 5, 6, 7a, 7b.	B
Red-breasted Sapsucker	C	-	R	R	-	B
Hairy Woodpecker	R	R	R	R	3, 4a, b, 5, 6, 7b,	B
Downy Woodpecker	R	F	C	C	1d, 3, 4a, b, 5,	B
Black-backed Three-toed Woodpecker	-	-	CT	-	4b, 7b	
Northern Three-toed Woodpecker	CT	-	R	C	6, 7b	
Eastern Kingbird	-	-	RT	R	1c, 2b, 7b	
Western Kingbird	-	-	RT	R	2b, 7b	
Say's Phoebe	-	-	CT	-	2b	
Traill's Flycatcher	-	-	CT	C	1d, 5	B
Hammond's Flycatcher	-	-	AT	A	7a, b, 8	B
Dusky Flycatcher	-	-	RT	R	5, 7a	B
Western Flycatcher	-	-	RT	-	7b	B
Western Wood Peewee	-	-	RT	R	4a, b, 5, 7a, b, 8	B
Olive-sided Flycatcher	-	-	RT	R	5, 7a, b, 8	
Horned Lark	RT	-	RT	-	1b	
Violet-green Swallow	-	-	AT	F	—	B
Tree Swallow	-	-	AT	F	—	B
Bank Swallow	-	-	CT	-	1b	
Rough-winged Swallow	-	-	FT	R	1a, 1b, 2a	B
Barn Swallow	-	-	R	R	—	B
Cliff Swallow	-	-	RT	-	1b	
Gray Jay	R	R	C	C	6, 7b, 9	B
Steller's Jay	R	R	R	R	1d, 4a, b, 5, 6, 7a, b, 8	
Black-billed Magpie	R	R	-	-	4a, 4b	
Common Raven	F	R	R	R	—	B
Common Crow	F	R	R	R	1b	B
Northwestern Crow	R	R	-	-	1b	
Clark's Nutcracker	R	R	-	C	7a	B
Chestnut-backed Chickadee	A	A	A	A	5, 6, 7a, b, 8	B
Black-capped Chickadee	RT	R	C	C	5, 6, 7a, b, 8	B
Red-breasted Nuthatch	F	F	F	F	5, 6, 7a, b, 8	B
Brown Creeper	R	R	R	R	5, b, 7a, b, 8	B
American Dipper	FT	F	RT	R	1a	B
House Wren	-	-	R	R	5, 7a	B
Winter Wren	FT	R	R	R	3, 8	B
American Robin	FT	-	AT	A	1d, 8	B
Varied Thrush	FT	C	FT	R	5, 8	B
Hermit Thrush	-	-	RT	-	4a, 5, 7a, 8	
Swainson's Thrush	-	-	FT	F	1d, 3, 5, 7a	B
Veery	-	-	?	?	1a, 3, 4a, b, 5	B
Western Bluebird	-	-	CT	-	2b	
Mountain Bluebird	RT	-	AT	-	1b, 2b	
Townsend's Solitaire	CT	-	RT	C	3, 5	
Golden-crowned Kinglet	AT	F	R	R	4, 8	B
Ruby-crowned Kinglet	AT	-	FT	-	2b, 3, 4b, 5, 7b	
Water Pipit	FT	-	RT	-	1b, 2b	
Cedar Waxwing	-	-	-	F	3, 4a, b, 5, 7b	B

Species	Seasonal Occurrence: Fall	Winter	Spring	Summer	Habitat Type	Breeding Status
[illegible] Shrike	-	-	C	C	2a, 4b	
[illegible] Starling	R	-	R	R	2b, 5, 7b	B
[illegible]'s Vireo	-	-	CT	-	3	
[illegible] Vireo	-	-	RT	R	1d, 4a, 4b	
[illegible]oyed Vireo	-	-	R	R	1d, 4a, b,	B
[illegible]ding Vireo	-	-	F	R	1d, 4a, b,	B
[illegible]nge-crowned Warbler	-	-	RT	C	4b, 5	
[illegible]tsville Warbler	-	-	RT	R	7a	
[illegible]low Warbler	-	-	AT	A	1d, 3, 4a,	B
Audubon's Warbler	FT	-	AT	F	1b, 1d, 3, 8,	B
Black-throated Gray [illegible]arbler	-	-	RT	R	4b, 5, 7b	
[illegible]unsend's Warbler	-	-	RT	F	5, 7a, b, 8	B
[illegible]rthern Waterthrush	-	-	-	CT	1b,	
MacGillivray's Warbler	-	-	R	F	1d, 4b, 7b, 5, 6,	B
Common Yellow-throat	-	-	R	R	1c, d, 3,	B
[illegible]lson's Warbler	-	-	RT	R	3, 5, 7b,	
[illegible]erican Redstart	-	-	CT	R	1d, 3, 4a, b,	B
[illegible]ackbird	-	-	CT	-	2b, 4a,	
Western Meadowlark	RT	-	RT	-	2b	
[illegible]low-headed Blackbird	-	-	CT	R	1b, 1c, 3,	
[illegible]d-winged Blackbird	RT	-	F	R	1b, 1c, 3	B
[illegible]llock's Oriole	-	-	CT	C	4b, 5, 7b	
Brewer's Blackbird	RT	-	RT	R	1b, c, 3, 2b	B
Brown-headed Cowbird	-	-	FT	F	1b, 2b, 3, 5	B

Species	Seasonal Occurrence: Fall	Winter	Spring	Summer	Habitat Type	Breeding Status
Western Tanager	-	-	FT	F	2b, 3, 4a, 5, 8	B
Black-headed Grosbeak	-	-	R	R	1d, 4b, 7b	B
Lazuli Bunting	-	-	CT	-	2b	
Evening Grosbeak	F	F	R	R	3, 5, 7a, b,	
Purple Finch	A	F	RT	R	4b, 5, 6, 7a, b	B
Pine Grosbeak	-	C	C	-	4a, 5, 6, 7a, b	
Pine Siskin	F	A	A	F	1a, 8	B
American Goldfinch	-	C	RT	R	1d, 3, 7b, 1b, 4b	
Red Crossbill	C	F	R	R	1d, 4b, 5, 7a, b	B
White-winged Crossbill	-	-	C	-	7b	
Rufous-sided Towhee	C	C	RT	R	1d, 3, 4a, b, 5, 6, 7b	B
Savannah Sparrow	-	-	CT	-	1b, 2b	
Vesper Sparrow	RT	-	RT	-	1b, 2b, 1a	
Lark Sparrow	-	-	CT	-	1b	
Slate-colored Junco	CT	C	CT	-	5, 7b	
Oregon Junco	RT	R	AT	F	1d, 2b, 4b, 5, 8	B
Tree Sparrow	C	-	C	-	5,	
Chipping Sparrow	-	-	AT	F	1b, 2b, 7b,	B
Harris' Sparrow	CT	-	-	-	2b	
White-crowned Sparrow	AT	-	FT	R	1d, 2a, b, 4b, 7b	B
Golden-crowned Sparrow	-	-	FT	-	4b, 3, 7b, 2b	
Fox Sparrow	-	-	CT	-	2b	
Lincoln's Sparrow	-	-	RT	-	1d, 2b	
Song Sparrow	R	F	F	F	1d, 3	B
Snow Bunting	CT	-	-	-	2b	

BIRD SPECIES NOT OBSERVED BUT WHICH MAY UTILIZE THE CANADIAN SKAGIT VALLEY

Arctic Loon
Double-crested Cormorant
Green Heron

American Bittern
Gadwall
Redhead

Surf Scoter
Turkey Vulture
Swainson's Hawk

Rough-legged Hawk
Peregrine Falcon
Sora Rail

Black-bellied Plover
Solitary Sandpiper
Baird's Sandpiper

Least Sandpiper
Dunlin
Short-billed Dowitcher

Western Sandpiper
Sanderling
Wilson's Phalarope

Northern Phalarope
Western Gull
Herring Gull

Mew Gull
Bonaparte's Gull
Common Tern

Arctic Tern
Caspian Tern

Black Tern
Snowy Owl
Hawk Owl

Long-eared Owl
Black-chinned Hummingbird
Lewis' Woodpecker

Lapland Longspur
Purple Martin
Mountain Chickadee

Boreal Chickadee
Common Bushtit
White-breasted Nuthatch

Bewick's Wren
Long-billed Marsh Wren
Catbird

Bohemian Waxwing
Northern Shrike
Magnolia Warbler

Myrtle Warbler
Yellow-breasted Chat
House Sparrow

Cassin's Finch
House Finch
Gray-crowned Rosy Finch

Common Redpoll
Lark Bunting
White-throated Sparrow

SPECIES WITH RESTRICTED NESTING DISTRIBUTIONS IN THE TWO PART STUDY AREA

Observed Nesting in Part B only

Spotted Owl
Goshawk
Red-tailed Hawk

Blue Grouse
Band-tailed Pigeon
Raven

Clark's Nutcracker
Gray Jay

Observed Nesting in Part A only

Mallard
Green-winged Teal
Common Goldeneye

Killdeer
Common Snipe
Sparrow Hawk

Mourning Dove
Barn Swallow
Common Crow

House Wren
Brewer's Blackbird
White-crowned Sparrow

LIST OF BIRD SPECIES GROUPED ON BASIS OF HABITAT ASSOCIATIONS & BREEDING STATUS

Group A

Species Associated with Wetland Habitats

Status: Breeding	Status: Non-Breeding
* Mallard	Common Loon
* Green-winged Teal	Red-necked Grebe
* Blue-winged Teal	Eared Grebe
* Common Goldeneye	Horned Grebe
* Common Snipe	Western Grebe
* Spotted Sandpiper	Pied-billed Grebe
* Virginia Rail	Great Blue Heron
* Killdeer	Whistling Swan
	Canada Goose
	White-fronted Goose
	Pintail
	Cinnamon Teal
	American Widgeon
	Shoveler
	Wood Duck
	Ring-necked Duck
	Canvasback
	Greater Scaup
	Lesser Scaup
	Barrow's Goldeneye
	Bufflehead
	White-winged Scoter
	Ruddy Duck
	Hooded Merganser
	Red-breasted Merganser
	Bald Eagle
	Osprey
	Semipalmated Plover
	American Coot
	Semipalmated Plover
	Golden Plover
	Long-billed Curlew
	Greater Yellowlegs
	Lesser Yellowlegs
	Pectoral Sandpiper
	Long-billed Dowitcher
	Semipalmated Sandpiper
	Glaucous-winged Gull
	California Gull
	Ring-billed Gull

Group B

Species Associated with Conifer Habitats

Status: Breeding	Status: Non-Breeding
* Goshawk	Golden Eagle
* Sharp-shinned Hawk	Pigeon Hawk
* Cooper's Hawk	White-tailed Ptarmigan
* Red-tailed Hawk	Rock Dove
* Blue Grouse	Screech Owl
* Spruce Grouse	Saw-whet Owl
* Band-tailed Pigeon	Black Swift
* Horned Owl	Black-backed Three-toed Woodpecker
* Spotted Owl	Northern Three-toed Woodpecker
* Vaux's Swift	Olive-sided Flycatcher
* Pileated Woodpecker	Bank Swallow
* Yellow-bellied Sapsucker	Cliff Swallow
* Red-breasted Sapsucker	Steller's Jay
* Hairy Woodpecker	Townsend's Solitaire
* Hammond's Flycatcher	Ruby-crowned Kinglet
* Gray Jay	Nashville Warbler
* Common Raven	Black-throated Grey Warbler
* Clark's Nutcracker	Pine Grosbeak
* Chestnut-backed Chickadee	White-winged Crossbill
* Red-breasted Nuthatch	Fox Sparrow
* Brown Creeper	
* Golden-crowned Kinglet	
* Audubon's Warbler	
* Purple Finch	
* Pine Siskin	
* Red Crossbill	
* Townsend's Warbler	

Group C

Species Associated with Meadowland Habitats

Status: Breeding	Status: Non-Breeding
* Sparrow Hawk	Short-eared Owl
* Mourning Dove	Marsh Hawk
* Common Crow	Poor-will
* Chipping Sparrow	Eastern Kingbird
	Western Kingbird
	Say's Phoebe
	Horned Lark
	Black-billed Magpie
	Northwestern Crow
	Western Bluebird
	Water Pipit
	Bobolink
	Western Meadowlark
	Lazuli Bunting
	Northern Waterthrush
	Savannah Sparrow
	Vesper Sparrow
	Lark Sparrow
	Harris' Sparrow
	Golden-crowned Sparrow
	Lincoln's Sparrow
	Snow Bunting
	Mountain Bluebird

Group D

Species Associated with Riparian Habitats

Status: Breeding	Status: Non-Breeding
* Harlequin Duck	Yellow-headed Blackbird
* Common Merganser	
* Belted Kingfisher	
* Traill's Flycatcher	
* Rough-winged Swallow	
* American Dipper	
* Red-eyed Vireo	
* Common Yellowthroat	
* Western Wood Pewee	
* Tree Swallow	
* Barn Swallow	
* Red-winged Blackbird	
* Brewer's Blackbird	
* American Redstart	
* Song Sparrow	

Group E

Species Associated with Deciduous Habitats

Status: Breeding	Status: Non-Breeding
* Ruffed Grouse	Tree Sparrow
* Pygmy Owl	Hermit Thrush
* Common Nighthawk	Loggerhead Shrike
* Rufous Hummingbird	Hutton's Vireo
* Calliope Hummingbird	Solitary Vireo
* Red-shafted Flicker	Orange-crowned Warbler
* Downy Woodpecker	Wilson's Warbler
* Dusky Flycatcher	Bullock's Oriole
* Western Flycatcher	Slate-colored Junco
* Violet-green Swallow	Evening Grosbeak
* House Wren	American Goldfinch
* Winter Wren	
* American Robin	
* Veery	
* Swainson's Thrush	
* Cedar Waxwing	
* Common Starling	
* Warbling Vireo	
* Yellow Warbler	
* MacGillivray's Warbler	
* Black-headed Grosbeak	
* Brown-headed Cowbird	
* Rufous-sided Towhee	
* Oregon Junco	
* Black-capped Chickadee	
* Varied Thrush	
* Western Tanager	
* White-crowned Sparrow	

Appendix 5: Avifauna recorded by Slaney (1973) utilizing the Skagit Valley and uncommon to either coastal or interior British Columbia.

SPECIES UNCOMMON TO COASTAL FORESTS

Breeding	Transient
Dusky Flycatcher	Black-backed Three-toed Woodpecker
Yellow-bellied Sapsucker	Lark Sparrow
Calliope Hummingbird	Lazuli Bunting
Common Crow	Harris' Sparrow
Veery	Bullock's Oriole
American Redstart	Poor-will
	Northern Waterthrush
	Bobolink
	Bank Swallow
Winter Resident Only	Slate-coloured Junco
Black-billed Magpie	Vesper Sparrow
	Long-billed Curlew
	Loggerhead Shrike

SPECIES UNCOMMON TO BRITISH COLUMBIA INTERIOR

Breeding	Transient
Spotted Owl	Red-breasted Merganser
Red-breasted Sapsucker	Glaucous-winged Gull
Western Flycatcher	Northwestern Crow
	Hutton's Vireo

Appendix 6: Avifauna additions to those recorded by Slaney (1973)

Species	Source
northern flicker	Weber 1972
northern shrike	Weber 1972, B.C.P.M.
common redpoll	Weber 1972, B.C.P.M.
Bonaparte's gull	McGrenere et al. 1986
barred owl	McGrenere et al. 1986, B.C.P.M.
Bewick's wren	McGrenere et al. 1986
grey catbird	B.C.P.M.
merlin	B.C.P.M.
semi-palmated plover	B.C.P.M.

1 B.C.P.M. = British Columbia Provincial Museum Ornithology Records.

In addition, Scott (1973) surveyed the american portion of the Ross Lake Basin and found 14 potential additions to the avifauna list compiled by Slaney (1973). Species seen in Scott's survey as yet not recorded in the canadian Skagit Valley were:

green heron,
redhead,
oldsqua,
Swainson's hawk,
peregrine falcon,
pomarine jaeger,
mew gull,
Lewis' woodpecker,
mountain chickadee,
boreal chickadee,
bohemian waxwing,
myrtle warbler, and
Cassin's finch.

Appendix 7: Methods of Forsman and Booth's (1986) spotted owl survey

To survey spotted owls, continuous transects along forest roads or trails were walked at night while alternately playing tape-recorded spotted owl calls and listening for responses. All surveys were conducted between 20 minutes after sunset and 30 minutes before sunrise on days having little precipitation or wind. Surveys were conducted between May 9 and June 6, 1986. Only areas below 1250 metres elevation were surveyed.

Appendix 8. Specific research questions

Topic 5:

- Are ecological reserves for species of limited distribution a viable option to meet management objectives? (for spotted owl, flying squirrel, mountain beaver, trowbridge shrew, and the shrew mole)
- Is establishing a wildlife viewing area together with enhancement for non-game a viable option for meeting management objectives?
- What is the optimum habitat structure to ensure presence of birds yet have adequate visibility for viewing?
- Can birds be "brought to the people" by enhancing bird viewing opportunities close to recreational developments in the Skagit Valley.
- Can birding spots in unique birding areas be developed to attract public viewing?
- Can wildlife viewing areas be established in wetlands concurrently with habitat enhancement for non-game mammals and birds?

Topic 1: Developing habitat suitability models

- What species of bats inhabit the Skagit Valley?
- What species are present in the Skagit Valley? What is there density and distribution?
- What are the management objectives for avifauna? What are the key species? How do these management objectives effect

research priorities?

- additional questions under topics 2 and 3.

Topic 7: Developing a wildlife tree management program

- What are the distributions of cavity-using wildlife by habitat and elevation?
- What are the winter habitats of cavity-using species?
- What is the current impact of forestry practises on cavity-using species?
- What is the current size distribution and state of decay of wildlife trees in the Skagit Valley? How does size and state of decay of wildlife trees correlate with wildlife use?
- How do the rates of wildlife tree recruitment and loss differ between habitats?
- What are the possibilities of enhancing wildlife tree production?
- How can forest practises be modified to safely generate or maintain wildlife trees?
- Can creation of old-growth wildlife trees be simulated in second-growth forests. Can creation of wildlife trees be incorporated into programs creating deer winter range?
- What is the value of erecting nest boxes? What is the rate of nest box use in areas where wildlife trees are left standing as compared to the rate of use of nest boxes in area where wildlife trees have been felled?

Topic 3: Investigating the effects of structural diversity

- What are the relationships between small mammal diversity and density and habitat structure?
- Can bat populations be enhanced by the construction of bat houses?
- Can flying squirrel numbers be increased by supplying nest boxes?

Topic 6: Habitat improvement in wetlands

- Can waterfowl populations be enhanced by enhancing wetlands? eg. seeding forage plants, creating year-round shallow water.

Topic 2: Exploring the effects of habitat juxtaposition

- How do the shapes, sizes, and arrangement of different forest seral stages affect small mammals and avifauna?

Topic 4: Determining the effects of cover

- How do silvicultural practices influence small mammal populations ? Specifically, how does the removal of cover by burning or scarification affect small mammal densities after logging?
- How does small mammal productivity influence furbearer and raptor densities?