

# HABITAT SUPPLY MODELING SURVEY PROJECT SUMMARY

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**October, 2000**

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## **Objective**

To provide summary data of modeling projects; which species the models have been applied to within BC, Alberta and northwestern US; and definitions, variables and applicability of models. The focus is on Habitat Supply Models that examine wildlife/habitat relationships. The intended use of the database is to support the examination of the effects of silvicultural activities on habitat and biodiversity.

## **Definition**

The definition of Habitat Supply Modeling used for the purposes of this project is **the** representation or projection of a descriptor of habitat supply. A habitat supply model takes input information about descriptors of the habitat and interprets these descriptors into an output that provides information about the value of the habitat for an organism [simplified from Jeff Stone's draft report – June, 2000].

The models included in this research examine habitat suitability in relationship to wildlife requirements, using varying levels of habitat data and biological requirements (life requisites) appropriate to the species. Scale is dependent on the species and its range.

## **Assumptions**

1. preliminary and introductory research.
2. provided a sample of the habitat modeling techniques with as many examples and sources as possible – *not an exhaustive inventory of everyone modeling in the province.*
3. the scope includes wildlife and habitat models - in reference to the relationships between them – in BC, Alberta, and the US (where available).
4. availability of information and modelers/developers.
5. resources - money and time.
6. this summary does not provide information or opinions about the quality of the model, its accuracy, its complexity, or whether or not it's been ground-truthed.

## **Methodology**

- phone conversations with wildlife biologists (Ministry of Environment, Lands and Parks and Ministry of Forests headquarters and regional staff, consultants, university modelers, and model developers)
- web searches
- habitat modeling workshop proceedings
- meetings (in Victoria)

## **Variables of Habitat Supply Modeling collected**

### **Database Structure:**

Species Name:	species for which model was applied
TEM Project ID #:	for TEM projects only
Feature:	full habitat requirements or component of habitat (specify)
Scale of Model:	sub-stand, stand, community, landscape, regional, provincial or mapping resolution (see Appendix A)
Type of Model:	belief network (expert opinion), habitat suitability, other (specify) - (see Appendix A)
Origin:	BC or other (specify)
Geographic Applicability:	what geographical area is model applicable (+ ecoregion classification)
Main use of model:	
Contact info:	name, phone, email, <b>website</b> (if available)
Regional contact:	for TEM projects only

**Results** – see attached database and definitions.

- Number of types of habitat supply modeling
- Number of wildlife species included (including list of species)
- List of contacts/modelers
- Number of sources (from BC, Alberta, and the US)

### **Recommendations**

- further research – for more detailed or follow-up information; workshop topics; and speakers.
- expanding the descriptions/definitions of the models.
- create a website – provide data and updates.
  - prepare database for website and fill in data gaps.
- workshop planning and establish an agenda.

**Descriptions expanded by Evelyn Hamilton (*additions in italics*) (Nov 10, 2000)**

## **Appendix A: Descriptions Of Habitat Models and Definition Of Terms**

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### **DESCRIPTIONS OF HABITAT MODELS**

The following are descriptions of some of the habitat supply models taken from excerpts of conversations, websites and readings. Some explanations of the models' functions are also in the *Main Use of Model* and *Comments* sections of the database.

#### **Wildlife Habitat Ratings – or Wildlife Habitat Suitability Ratings ??**

based on:

##### **Broad Ecosystem Inventory (BEI) –**

Strategic level habitat capability and suitability mapping using biological and ecosystem expertise (Delphi approach) to rate 1:250, 000 habitats – includes species accounts.

*Scale : 1:250K*

*Needs: expertise*

*Species feature (requirements):*

*Species deer, sheep, moose, mt goats, elk, caribou, black bears, grizzly bears, martin, marbled murrelets, bald eagles, n goshawk*

*Location: throughout the province for different species - often at ecoprovince level*

*Used for: strategic level*

*Contact: Tony Button BEI coordinator ???*

##### **Terrestrial Ecosystem Mapping (TEM) –**

Detailed suitability mapping linked to provincial ecosystem framework, includes species accounts. Based on field work. Terrestrial Ecosystem Mapping integrates the climatic, vegetative, and physical attributes of British Columbia's diverse ecosystems into one map product. TEM methodology emphasizes the relationship between topographic, terrain and soil features of the landscape, and the vegetation development stages of each ecosystem unit. Ecosystem mapping provides spatial data for a multitude of ecological interpretations. Since the final map is digital in a geographic information system, the data can be accessed and models developed to display or summarize interpretive information.

*Scale :(1:50K to 1:20K scale*

*Needs: TEM*

*Species feature (requirement):*

*Species many species*

*Location 54 areas (53 TEM and Fraser TSA) throughout the province (about 5% of province has TEM??*

*Used for: ???*

*Contact MoE TEM coordinator ???*

### **Predictive Ecosystem Mapping (PEM) –**

Detailed suitability mapping linked to provincial ecosystem framework, includes species accounts. Based on existing inventories such as forest cover, TRIM and localized biogeoclimatic units.

*Scale 1:20K*

*Needs sufficient ecosystem and/or forest cover data , species data*

*Species feature (requirement)*

*Species: grizzly bears, moose, mt goats, caribou, fisher (food and cover in Kispiox and Morice ) and habitat for Grizzly bears on N coast.*

*Locations : 3 studies in Kispiox, N coast, Morice District,*

*Used for : Prescriptions, FDP, LRMPs*

*Contact: Don Morgan, Andy Witt (FES Morice) #496 -498*

### **Habitat Suitability Index Model (H.S.I.) –**

Habitat Suitability Index models can be constructed from basic life history information or by modifying existing habitat models. H.S.I is defined as a numerical index that represents the capacity of a given habitat to support a selected fish or wildlife species.

*Scale : 1:20K*

*Needs:life history information or habitat models*

*Species feature (requirement):*

*Species : grizzly bears, moose, mt goats (food and cover) ,,*

*Locations : Nass Basin ,*

*Used for : FDP, LRMPs*

*Contact : Don Reid #493*

### **Other applications**

***furbearers Col***

***ruffed grouse aspen US***

***mt caribou S Purcells***

***various species FMF Alt***

***mt caribou Col Mts Will Lk***

***mammals Muskwa***

***mt caribou Kootenay Lk,***

### **Multi scalar Logistic Regression Predictor ?**

*Scale: 1:20K scale*

*Needs: forest cover and TRIM (elevation, aspect, slope) and roads and landscape simulation model*

*Species feature (requirement):*

*Species : mt. caribou :*

*Locations : Nelson Region Col Mts,*

*Used for : FDP, LRMPs*

*Contact : Bruce McLellan and Fred Hovey #504*

### **Bayesian Belief Networks –**

Represents conditional probabilities of population response, given environmental conditions. Provides consistent, testable framework by which to represent simple habitat relations of a wide array of species. Ranks quantity and quality of habitat. However it lacks inventory and population data, therefore it models habitat.

*#506*

*Scale: sub watershed*

*Needs: habitat and species information*

*Species feature (requirements): habitat requirements*

*Species : For 91 species in Col. Basin,*

*Locations : Col Basin, Wash.,*

*Used for : Evaluation of land allocation alternative, predicting species viability*

*Contact : Bruce Marcot*

*Scale: regional*

*Needs:*

*Species feature (requirement) :*

*Species : mt. caribou,*

*Locations :Mackenzie LRMP,*

*Used for : LRMPs*

*Contact : Scott McNay*

### **Cumulative Effects Model –**

A GIS-based model that models habitat effectiveness and indicates good habitat health. This model provides tools to determine thresholds for good habitat land use management policies. It layers habitat based on requirements and condition to arrive at realized habitat or threshold values.

*#507*

*Scale: .*

*Needs: requires Landsat, 1:20K forest cover, DEM, generic grizzly bear polygon and point location data*

*Species feature (requirement): food, potential habitat and habitat loss*

*Species : grizzly bear*

*Locations : FMF Alta ,*

*Used for : thresholds for good habitat, land use decisions*

*Contact : Gordon Stenhouse*

*#505*

*Scale: 1:20K .*

*Needs: 1:20K forest cover, TRIM (elevation, aspect) landscape simulation model*  
*Species feature (requirement): habitat*  
*Species : grizzly bear*  
*Locations : Flathead ,*  
*Used for : land use decisions*  
*Contact : Bruce McLellan*

### **Population Viability Analysis –**

Population viability is a component of Cumulative Effects Model that links landscape condition to population numbers

### **Resource Selection Function (RSF) -**

Links landscape condition to population numbers. RSF is a predictive model examining relationships of how an animal chooses habitat, therefore forms predictive equations (regression modeling). It is a tool to interface with GIS to arrive at probability of occurrence.

#507

*Scale:*

*Needs: GIS ???*

*Species feature (requirement): population viability*

*Species : grizzly bear, black bear, Rky Mt elk, sage grouse*

*Locations : ? ,*

*Used for : habitat management , timber management*

*Contact : Mark Boyce, UoA*

### **Feenix –**

Developed by the University of Alberta. A landscape framework developing resource associations, mostly for birds.

#512

*Scale: Stand level*

*Needs: 1:20K air photos*

*Species feature (requirement):*

*Species : 16 birds (warblers, etc)*

*Locations : Boreal Alta with dominant Sb, Sw ,*

*Used for :evaluates forest management scenarios for habitat protection and various forestry practices*

*Contact : Fiona Schmieglow UoA*

### **Prognosis EI –**

*EI extension of Prognosis was developed by ESSA. Designed to assist forest management planning – detailed, quantitative environmental impact projections and expected timber flows under user-defined scenarios. There are 2 components to the model: it tracks overstory or individual trees through time (stand structure) and; tracks snag development over time. Predicts hundreds of stands at once to predict wildlife*

requirements (spatial and non-spatial indicators). An extension of Prognosis/Forest Vegetation Simulator (FVS) – FVS is the name the US uses.

*Scale : watershed level*

*Needs: tree model equations, snag and dead wood model, understory vegetation for site types, indicators of concern*

*Species feature (requirement):*

*Species : ungulates (forage and winter range), pileated woodpecker (snags, winter forage, proximity to roosting sites), grizzly bear (summer forage, denning snags and trees), bats (foraging edge and roost habitat)*

*Locations : WADF and W. Kootenay,*

*Used for : predicting impacts on wildlife of various forest practices/conditions*

*Contact : ESSA*

### **FORUM (Forest Optimization and Resource Utilization Management) –**

Developed by Hugh Hamilton Ltd. Spatial modeling and landscape analysis. Uses set objectives (Biodiversity Guidebook) to meet landscape unit planning for habitat protection. It is used for regional and landscape unit forest management planning and analysis. FORUM combines the information contained in GISs with the power of advanced optimization algorithms to provide integrated operational, tactical and strategic plans that optimize land management goals.

*Scale : 1:50K*

*Needs: sufficient habitat data and dynamic G&Y curve*

*Species feature (requirements): varies with species - forest age class and distance dependancy*

*Species : marbled murrelet, spotted owl and mt caribou*

*Locations : Arrow Forest District ,*

*Used for: integrated operational, tactical and strategic plans that optimize land management goals.*

*Contact : Hugh Hamilton*

### **Wildlife Habitat Relationships (WHR) Model –**

Links species to habitat based on vegetation characteristics using 8 matrices. The matrices were developed to characterize aspects of the wildlife species, their habitat requirements and ecological functions. This model lets animals show how species use the vegetation and habitat.

Matrices:

1. wildlife habitat
2. structural conditions
3. habitat elements
4. life history
5. key ecological functions
6. links to management activities
7. salmon/wildlife relationships

## 8. citations

*Scale : sub watershed and provincial*

*Needs: Habitat and species specific information*

*Species feature (requirements): living requirements - depends on species*

*Species : 605 species*

*Locations : Wash,*

*Used for habitat protection:*

*Contact : David Johnson Wash D F&W*

### **Atlas/SIMFOR –**

This model tracks stand structure over the landscape and habitat impacts of different harvest scenarios. Atlas inputs forest information, while SIMFOR simulates the wildlife's responses. SIMFOR links species responses to habitat changes, spatially and temporally.

*Scale : stand to landscape l*

*Needs: stand level spatial data with habitat data*

*Species feature (requirements): snags and foraging habitat, nesting habitat*

*Species : cavity nesting birds, n goshawk, songbirds*

*Locations : Invermere*

*Used for alternative timber supply scenarios*

*Contact : Ralph Wells UBC*

*Also for Grizzly bear in Flathead*

### **Habitat Suitability Index Model WITH SIMFOR –**

Using these 2 models together, enables researchers to make predictions and comparisons about what the habitat suitability could be given alternative forest management policies.

## **DEFINITION OF TERMS**

**Scale** or area over which model was developed – limits of extrapolation.

EG.	substand	< 2 ha.
	stand	2 – 200 ha.
	community	200 – 2 000 ha.
	landscape	2 000 – 150 000 ha.
	region	150 000 – 250 000 ha.
	province	1 000 000 ha.
	international	> 1 000 000 ha.

Acronyms for **Origin** and **Geographic Applicability**:

**COM** – Coast & Mountains ecoprovince

**GED** – Georgia Depression ecoprovince

**SOI** – Southern Interior ecoprovince

**SIM** – Southern Interior Mountains ecoprovince

**CEI** – Central Interior ecoprovince

**SBI** – Sub-boreal Interior ecoprovince

**BOP** – Boreal Plains ecoprovince

**TAP** – Taiga Plains ecoprovince

**NBM** – Northern Boreal Mountains ecoprovince

**Appendix B** - Ninety-one species of conservation concern (Wisdom et al., 2000) and the subset of 28 species (31 species-seasonal entries in bold-face type) selected for this analysis. From Martin Raphael's Bayesian Belief Network Modeling in the Interior Columbia River Basin.

<u>Common name</u>	<u>Scientific name</u>	<u>Terrestrial habitat family<sup>a</sup></u>
<b>Lewis' woodpecker (migrant)</b>	<i>Melanerpes lewis</i>	Low-elevation old forest (1)
White-headed woodpecker	<i>Picoides albolarvatus</i>	
White-breasted nuthatch	<i>Sitta carolinensis</i>	
<b>Pygmy nuthatch</b>	<i>Sitta pygmaea</i>	
Western gray squirrel	<i>Sciurus griseus</i>	
<b>Northern goshawk (summer)</b>	<i>Accipiter gentilis</i>	Broad-elevation old forest (2)
Blue grouse (winter)	<i>Dendrogapus obscurus</i>	
<b>Flammulated owl</b>	<i>Otus flammeolus</i>	
Great gray owl	<i>Strix nebulosa</i>	
Boreal owl	<i>Aegolius funereus</i>	
Vaux's swift	<i>Chaetura vauxi</i>	
Williamson's sapsucker	<i>Sphyrapicus thyroideus</i>	
Three-toed woodpecker	<i>Picoides tridactylus</i>	
<b>Black-backed woodpecker</b>	<i>Picoides arcticus</i>	
Pileated woodpecker	<i>Dryocopus pileatus</i>	
Olive-sided flycatcher	<i>Contopus cooperi</i>	
Hammond's flycatcher	<i>Empidonax hammondi</i>	
Chestnut-backed chickadee	<i>Poecile rufescens</i>	
Brown creeper	<i>Certhia americana</i>	
Winter wren	<i>Troglodytes troglodytes</i>	
Golden-crowned kinglet	<i>Regulus satrapa</i>	

Varied thrush	<i>Ixoreus naevius</i>	
White-winged crossbill	<i>Loxia leucoptera</i>	
Silver-haired bat	<i>Lasionycteris noctivagans</i>	
<b>Hoary bat</b>	<i>Lasiurus cinereus</i>	
Northern flying squirrel	<i>Glaucomys sabrinus</i>	
<b>American marten</b>	<i>Martes americana</i>	
Fisher	<i>Martes pennanti</i>	
<b>Woodland caribou</b>	<i>Rangifer tarandus caribou</i>	
<b>Blue grouse (summer)</b>	<i>Dendrogapus obscurus</i>	Forest mosaic (3)
Mountain quail (summer)	<i>Oreortyx pictus</i>	
Hermit warbler	<i>Dendroica occidentalis</i>	
Pygmy shrew	<i>Sorex hoyi</i>	
<b>Wolverine</b>	<i>Gulo gulo</i>	
<b>Lynx</b>	<i>Lynx canadensis</i>	
<b>Lazuli bunting</b>	<i>Passerina amoena</i>	Early-seral montane and lower montane (4)
Long-eared owl	<i>Asio otus</i>	Forest and range mosaic (5)
<b>Gray wolf</b>	<i>Canis lupus</i>	
<b>Grizzly bear</b>	<i>Ursus arctos</i>	
Mountain goat	<i>Oreamnos americanus</i>	
California bighorn sheep	<i>Ovis canadensis californiana</i>	
<b>Rocky Mountain bighorn sheep (summer)</b>	<i>Ovis c. canadensis</i>	
<b>Rocky Mountain bighorn sheep (winter)</b>	<i>Ovis c. canadensis</i>	
Sharptail snake	<i>Contia tenuis</i>	Forests, woodlands, and

California mountain kingsnake	<i>Lampropeltis zonata</i>	montane shrubs (6)
<b>Northern goshawk (winter)</b>	<i>Accipiter gentilis</i>	
<b>Rufous hummingbird</b>	<i>Selasphorus rufus</i>	
Black-chinned hummingbird	<i>Archilochus alexandri</i>	
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>	
Pine siskin	<i>Carduelis pinus</i>	Forests, woodlands, and
Yuma myotis	<i>Myotis yumanensis</i>	sagebrush (7)
<b>Long-eared myotis</b>	<i>Myotis evotis</i>	
Fringed myotis	<i>Myotis thysanodes</i>	
Long-legged myotis	<i>Myotis volans</i>	
Western small-footed myotis	<i>Myotis ciliolabrum</i>	
Spotted bat	<i>Euderma maculatum</i>	
Pale western big-eared bat	<i>Corynorhinus townsendii pallescens</i>	
Pallid bat	<i>Antrozous pallidus</i>	
<b>Western bluebird</b>	<i>Sialia mexicana</i>	Rangeland and early- and late-seral forest (8)
<b>Ash-throated flycatcher</b>	<i>Myiarchus cinerascens</i>	Woodland (9)
Bushtit	<i>Psaltriparus minimus</i>	
Mojave black-collared lizard	<i>Crotaphytus bicinctores</i>	Range mosaic (10)
Longnose leopard lizard	<i>Gambelia wislizenii</i>	
<b>Striped whipsnake</b>	<i>Masticophis taeniatus</i>	
Longnose snake	<i>Rhinocheilus lecontei</i>	
Ground snake	<i>Sonora semiannulata</i>	
Ferruginous hawk	<i>Buteo regalis</i>	

Burrowing owl	<i>Athene cunicularia</i>	
<b>Short-eared owl</b>	<i>Asio flammeus</i>	
Vesper sparrow	<i>Pooecetes gramineus</i>	
Lark sparrow	<i>Chondestes grammacus</i>	
Western meadowlark	<i>Sturnella neglecta</i>	
Preble's shrew	<i>Sorex preblei</i>	
White-tailed antelope squirrel	<i>Ammospermophilus leucurus</i>	
<b>Washington ground squirrel</b>	<i>Spermophilus washingtoni</i>	
Wyoming ground squirrel	<i>Spermophilus elegans nevadensis</i>	
Uinta ground squirrel	<i>Spermophilus armatus</i>	
<b>Pronghorn</b>	<i>Antilocapra americana</i>	
<b>Sage grouse (summer)</b>	<i>Centrocercus urophasianus</i>	Sagebrush (11)
<b>Sage grouse (winter)</b>	<i>Centrocercus urophasianus</i>	
Sage thrasher	<i>Oreoscoptes montanus</i>	
Loggerhead shrike	<i>Lanius ludovicianus</i>	
<b>Brewer's sparrow</b>	<i>Spizella breweri</i>	
Black-throated sparrow	<i>Amphispiza bilineata</i>	
Sage sparrow	<i>Amphispiza belli</i>	

Lark bunting	<i>Calamospiza melanocorys</i>	
Pygmy rabbit	<i>Brachylagus idahoensis</i>	
Sagebrush vole	<i>Lemmyscus curtatus</i>	
Kit fox	<i>Vulpes macrotis</i>	
<b>Columbian sharp-tailed</b>	<i>Tympanuchus phasianellus</i>	Grassland and open-
<b>grouse (summer)</b>	<i>columbianus</i>	canopy
Clay-colored sparrow	<i>Spizella pallida</i>	sagebrush (12)
<b>Grasshopper sparrow</b>	<i>Ammodramus savannarum</i>	
Idaho ground squirrel	<i>Spermophilus brunneus</i>	
Black rosy finch	<i>Leucosticte atrata</i>	None <sup>b</sup>
Gray-crowned rosy finch	<i>Leucosticte tephrocotis</i>	
Lewis' woodpecker (resident)	<i>Melanerpes lewis</i>	
<b>Brown-headed cowbird</b>	<i>Molothrus ater</i>	

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<sup>a</sup> Terrestrial family number, as referred to in the text, follows the family name; see Wisdom et al. (2000) for further details about vegetation and elevational ranges associated with terrestrial families.

<sup>b</sup> These four species were

**Appendix C** – 605 wildlife species included in David Johnson and Thomas O’Neil’s Wildlife Habitat Relationships Modeling in Oregon and Washington.

**Amphibians and Reptiles (N = 63)**

<i>Ambystoma gracile</i>	Northwestern salamander
<i>Ambystoma macrodactylum</i>	Long-toed salamander
<i>Ambystoma tigrinum</i>	Tiger salamander
<i>Dicamptodon copei</i>	Cope's giant salamander
<i>Dicamptodon tenebrosus</i>	Pacific giant salamander
<i>Rhyacotriton cascadae</i>	Cascade torrent salamander
<i>Rhyacotriton kezeri</i>	Columbia torrent salamander
<i>Rhyacotriton olympicus</i>	Olympic torrent salamander
<i>Rhyacotriton variegatus</i>	Southern torrent salamander
<i>Taricha granulosa</i>	Roughskin newt
<i>Plethodon dunni</i>	Dunn's salamander
<i>Plethodon elongatus</i>	Del Norte salamander
<i>Plethodon larselli</i>	Larch Mountain salamander
<i>Plethodon stormi</i>	Siskiyou Mountains salamander
<i>Plethodon vandykei</i>	Van Dyke's salamander
<i>Plethodon vehiculum</i>	Western red-backed salamander
<i>Ensatina eschscholtzii</i>	Ensatina
<i>Aneides ferreus</i>	Clouded salamander
<i>Aneides flavipunctatus</i>	Black salamander
<i>Batrachoseps attenuatus</i>	California slender salamander
<i>Batrachoseps wrighti</i>	Oregon slender salamander
<i>Ascaphus truei</i>	Tailed frog
<i>Scaphiopus intermontanus</i>	Great Basin spadefoot
<i>Bufo boreas</i>	Western toad
<i>Bufo woodhousii</i>	Woodhouse's toad
<i>Pseudacris regilla</i>	Pacific treefrog
<i>Rana aurora</i>	Red-legged frog
<i>Rana boylei</i>	Foothill yellow-legged frog
<i>Rana cascadae</i>	Cascades frog
<i>Rana catesbeiana</i>	Bullfrog
<i>Rana luteiventris</i>	Columbia spotted frog
<i>Rana pipiens</i>	Northern leopard frog
<i>Rana pretiosa</i>	Oregon spotted frog
<i>Clemmys marmorata</i>	Western pond turtle
<i>Chrysemys picta</i>	Painted turtle

<i>Dermochelys coriacea</i>	Leatherback
<i>Elgaria coerulea</i>	Northern alligator lizard
<i>Elgaria multicarinata</i>	Southern alligator lizard
<i>Crotaphytus bicinctores</i>	Mojave black-collared lizard
<i>Gambelia wislizenii</i>	Long-nosed leopard lizard
<i>Sceloporus graciosus</i>	Sagebrush lizard
<i>Sceloporus occidentalis</i>	Western fence lizard
<i>Uta stansburiana</i>	Side-blotched lizard
<i>Phrynosoma douglassii</i>	Short-horned lizard
<i>Phrynosoma platyrhinos</i>	Desert horned lizard
<i>Eumeces skiltonianus</i>	Western skink
<i>Cnemidophorus tigris</i>	Western whiptail
<i>Cnemidophorus velox</i>	Plateau striped whiptail
<i>Charina bottae</i>	Rubber boa
<i>Diadophis punctatus</i>	Ringneck snake
<i>Contia tenuis</i>	Sharptail snake
<i>Coluber constrictor</i>	Racer
<i>Masticophis taeniatus</i>	Striped whipsnake
<i>Pituophis catenifer</i>	Gopher snake
<i>Lampropeltis getula</i>	Common kingsnake
<i>Lampropeltis zonata</i>	California mountain kingsnake
<i>Thamnophis atratus</i>	Pacific Coast aquatic garter snake
<i>Thamnophis elegans</i>	Western terrestrial garter snake
<i>Thamnophis ordinoides</i>	Northwestern garter snake
<i>Thamnophis sirtalis</i>	Common garter snake
<i>Hypsiglena torquata</i>	Night snake
<i>Sonora semiannulata</i>	Western ground snake
<i>Crotalus viridis</i>	Western rattlesnake

**Loons, Grebes, and Waterfowl (N = 46)**

<i>Gavia adamsii</i>	Yellow-billed loon
<i>Gavia immer</i>	Common loon
<i>Gavia pacifica</i>	Pacific loon
<i>Gavia stellata</i>	Red-throated loon
<i>Podilymbus podiceps</i>	Pied-billed grebe
<i>Podiceps auritus</i>	Horned grebe
<i>Podiceps grisegena</i>	Red-necked grebe
<i>Podiceps nigricollis</i>	Eared grebe
<i>Aechmophorus clarkii</i>	Clark's grebe
<i>Aechmophorus occidentalis</i>	Western grebe

Cygnus buccinator	Trumpeter swan
Cygnus columbianus	Tundra swan
Cygnus olor	Mute swan
Anser albifrons	Greater white-fronted goose
Chen caerulescens	Snow goose
Chen rossii	Ross' goose
Branta bernicla	Brant
Branta canadensis	Canada goose
Aix sponsa	Wood duck
Anas acuta	Northern pintail
Anas americana	American wigeon
Anas clypeata	Northern shoveler
Anas crecca	Green-winged teal
Anas cyanoptera	Cinnamon teal
Anas discors	Blue-winged teal
Anas penelope	Eurasian wigeon
Anas platyrhynchos	Mallard
Anas rubripes	American black duck
Anas strepera	Gadwall
Aythya affinis	Lesser scaup
Aythya americana	Redhead
Aythya collaris	Ring-necked duck
Aythya marila	Greater scaup
Aythya valisineria	Canvasback
Histrionicus histrionicus	Harlequin duck
Clangula hyemalis	Oldsquaw
Melanitta fusca	White-winged scoter
Melanitta nigra	Black scoter
Melanitta perspicillata	Surf scoter
Bucephala albeola	Bufflehead
Bucephala clangula	Common goldeneye
Bucephala islandica	Barrow's goldeneye
Lophodytes cucullatus	Hooded merganser
Mergus merganser	Common merganser
Mergus serrator	Red-breasted merganser
Oxyura jamaicensis	Ruddy duck

**Pelicans, Herons, Cranes (N = 19)**

Pelecanus erythrorhynchos	American white pelican
Pelecanus occidentalis	Brown pelican
Phalacrocorax auritus	Double-crested cormorant
Phalacrocorax pelagicus	Pelagic cormorant
Phalacrocorax penicillatus	Brandt's cormorant
Botaurus lentiginosus	American bittern

<i>Ixobrychus exilis</i>	Least bittern
<i>Ardea alba</i>	Great egret
<i>Ardea herodias</i>	Great blue heron
<i>Egretta thula</i>	Snowy egret
<i>Bubulcus ibis</i>	Cattle egret
<i>Butorides virescens</i>	Green heron
<i>Nycticorax nycticorax</i>	Black-crowned night heron
<i>Plegadis chihi</i>	White-faced ibis
<i>Coturnicops noveboracensis</i>	Yellow rail
<i>Rallus limicola</i>	Virginia rail
<i>Porzana carolina</i>	Sora
<i>Fulica americana</i>	American coot
<i>Grus canadensis</i>	Sandhill crane

**Shorebirds (N = 43)**

<i>Pluvialis dominica</i>	American golden-plover
<i>Pluvialis fulva</i>	Pacific golden-plover
<i>Pluvialis squatarola</i>	Black-bellied plover
<i>Charadrius alexandrinus</i>	Snowy plover
<i>Charadrius semipalmatus</i>	Semipalmated plover
<i>Charadrius vociferus</i>	Killdeer
<i>Haematopus bachmani</i>	Black oystercatcher
<i>Himantopus mexicanus</i>	Black-necked stilt
<i>Recurvirostra americana</i>	American avocet
<i>Tringa flavipes</i>	Lesser yellowlegs
<i>Tringa melanoleuca</i>	Greater yellowlegs
<i>Tringa solitaria</i>	Solitary sandpiper
<i>Catoptrophorus semipalmatus</i>	Willet
<i>Heteroscelus incanus</i>	Wandering tattler
<i>Actitis macularia</i>	Spotted sandpiper
<i>Bartramia longicauda</i>	Upland sandpiper
<i>Numenius americanus</i>	Long-billed curlew
<i>Numenius phaeopus</i>	Whimbrel
<i>Limosa fedoa</i>	Marbled godwit
<i>Limosa haemastica</i>	Hudsonian Godwit
<i>Limosa lapponica</i>	Bar-tailed Godwit
<i>Arenaria interpres</i>	Ruddy turnstone
<i>Arenaria melanocephala</i>	Black turnstone
<i>Aphriza virgata</i>	Surfbird
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper
<i>Calidris alba</i>	Sanderling
<i>Calidris alpina</i>	Dunlin
<i>Calidris bairdii</i>	Baird's sandpiper
<i>Calidris canutus</i>	Red knot

Calidris himantopus  
Calidris mauri  
Calidris melanotos  
Calidris minutilla  
Calidris ptilocnemis  
Calidris pusilla  
Tryngites subruficollis  
Philomachus pugnax  
Limnodromus griseus  
Limnodromus scolopaceus  
Gallinago gallinago  
Phalaropus fulicaria  
Phalaropus lobatus  
Phalaropus tricolor

**Seabirds (N = 40)**

Phoebastria immutabilis  
Phoebastria nigripes  
Fulmarus glacialis  
Puffinus bulleri  
Puffinus carneipes  
Puffinus creatopus  
Puffinus griseus  
Puffinus tenuirostris  
Oceanodroma furcata  
Oceanodroma leucorhoa  
Stercorarius longicaudus  
Stercorarius parasiticus  
Stercorarius pomarinus  
Catharacta maccormicki  
Larus argentatus  
Larus californicus  
Larus canus  
Larus delawarensis  
Larus glaucescens  
Larus heermanni  
Larus hyperboreus  
Larus occidentalis  
Larus philadelphia  
Larus pipixcan  
Larus thayeri  
Rissa tridactyla  
Xema sabini  
Sterna caspia

Stilt sandpiper  
Western sandpiper  
Pectoral sandpiper  
Least sandpiper  
Rock sandpiper  
Semipalmated sandpiper  
Buff-breasted Sandpiper  
Ruff  
Short-billed dowitcher  
Long-billed dowitcher  
Common snipe  
Red phalarope  
Red-necked phalarope  
Wilson's phalarope

Laysan albatross  
Black-footed albatross  
Northern fulmar  
Buller's shearwater  
Flesh-footed shearwater  
Pink-footed shearwater  
Sooty shearwater  
Short-tailed shearwater  
Fork-tailed storm-petrel  
Leach's storm-petrel  
Long-tailed jaeger  
Parasitic jaeger  
Pomarine jaeger  
South polar skua  
Herring gull  
California gull  
Mew gull  
Ring-billed gull  
Glaucous-winged gull  
Heermann's gull  
Glaucous gull  
Western gull  
Bonaparte's gull  
Franklin's gull  
Thayer's gull  
Black-legged kittiwake  
Sabine's gull  
Caspian tern

*Sterna elegans*  
*Sterna forsteri*  
*Sterna hirundo*  
*Sterna paradisaea*  
*Chlidonias niger*  
*Uria aalge*  
*Cepphus columba*  
*Brachyramphus marmoratus*  
*Synthliboramphus antiquus*  
*Ptychoramphus aleuticus*  
*Cerorhinca monocerata*  
*Fratercula cirrhata*

Elegant tern  
Forster's tern  
Common tern  
Arctic tern  
Black tern  
Common murre  
Pigeon guillemot  
Marbled murrelet  
Ancient murrelet  
Cassin's auklet  
Rhinoceros auklet  
Tufted puffin

**Raptors (N = 35)**

*Cathartes aura*  
*Pandion haliaetus*  
*Elanus leucurus*  
*Haliaeetus leucocephalus*  
*Circus cyaneus*  
*Accipiter cooperii*  
*Accipiter gentilis*  
*Accipiter striatus*  
*Buteo jamaicensis*  
*Buteo lagopus*  
*Buteo lineatus*  
*Buteo regalis*  
*Buteo swainsoni*  
*Aquila chrysaetos*  
*Falco columbarius*  
*Falco mexicanus*  
*Falco peregrinus*  
*Falco rusticolus*  
*Falco sparverius*  
*Tyto alba*  
*Otus flammeolus*  
*Otus kennicottii*  
*Bubo virginianus*  
*Nyctea scandiaca*  
*Glaucidium gnoma*  
*Athene cunicularia*  
*Strix nebulosa*  
*Strix occidentalis*  
*Strix varia*  
*Asio flammeus*

Turkey vulture  
Osprey  
White-tailed kite  
Bald eagle  
Northern harrier  
Cooper's hawk  
Northern goshawk  
Sharp-shinned hawk  
Red-tailed hawk  
Rough-legged hawk  
Red-shouldered hawk  
Ferruginous hawk  
Swainson's hawk  
Golden eagle  
Merlin  
Prairie falcon  
Peregrine falcon  
Gyr Falcon  
American kestrel  
Barn owl  
Flammulated owl  
Western screech-owl  
Great Horned owl  
Snowy owl  
Northern pygmy-owl  
Burrowing owl  
Great gray owl  
Spotted owl  
Barred owl  
Short-eared owl

Asio otus	Long-eared owl
Aegolius acadicus	Northern saw-whet owl
Aegolius funereus	Boreal owl
Lanius excubitor	Northern shrike
Lanius ludovicianus	Loggerhead shrike

**Gallinaceous Birds, Pigeons, Doves (N = 16)**

Perdix perdix	Gray partridge
Alectoris chukar	Chukar
Phasianus colchicus	Ring-necked pheasant
Falcapennis canadensis	Spruce grouse
Dendragapus obscurus	Blue grouse
Lagopus leucurus	White-tailed ptarmigan
Bonasa umbellus	Ruffed grouse
Centrocercus urophasianus	Sage grouse
Tympanuchus phasianellus	Sharp-tailed grouse
Meleagris gallopavo	Wild turkey
Colinus virginianus	Northern bobwhite
Callipepla californica	California quail
Oreortyx pictus	Mountain quail
Columba fasciata	Band-tailed pigeon
Columba livia	Rock dove
Zenaida macroura	Mourning dove

**“Passerines” 1 (N = 76)**

Coccyzus americanus	Yellow-billed cuckoo
Chordeiles minor	Common nighthawk
Phalaenoptilus nuttallii	Common poorwill
Cypseloides niger	Black swift
Chaetura vauxi	Vaux's swift
Aeronautes saxatalis	White-throated swift
Archilochus alexandri	Black-chinned hummingbird
Calypte anna	Anna's hummingbird
Stellula calliope	Calliope hummingbird
Selasphorus platycercus	Broad-tailed hummingbird
Selasphorus rufus	Rufous hummingbird
Selasphorus sasin	Allen's hummingbird
Ceryle alcyon	Belted kingfisher
Melanerpes formicivorus	Acorn woodpecker
Melanerpes lewis	Lewis' woodpecker
Sphyrapicus nuchalis	Red-naped sapsucker
Sphyrapicus ruber	Red-breasted sapsucker
Sphyrapicus thyroideus	Williamson's sapsucker
Picoides albolarvatus	White-headed woodpecker
Picoides arcticus	Black-backed woodpecker

<i>Picoides pubescens</i>	Downy woodpecker
<i>Picoides tridactylus</i>	Three-toed woodpecker
<i>Picoides villosus</i>	Hairy woodpecker
<i>Colaptes auratus</i>	Northern flicker
<i>Dryocopus pileatus</i>	Pileated woodpecker
<i>Contopus cooperi</i>	Olive-sided flycatcher
<i>Contopus sordidulus</i>	Western wood-pewee
<i>Empidonax difficilis</i>	Pacific-slope flycatcher
<i>Empidonax hammondi</i>	Hammond's flycatcher
<i>Empidonax minimus</i>	Least flycatcher
<i>Empidonax oberholseri</i>	Dusky flycatcher
<i>Empidonax occidentalis</i>	Cordilleran flycatcher
<i>Empidonax traillii</i>	Willow flycatcher
<i>Empidonax wrightii</i>	Gray flycatcher
<i>Sayornis nigricans</i>	Black phoebe
<i>Sayornis saya</i>	Say's phoebe
<i>Myiarchus cinerascens</i>	Ash-throated flycatcher
<i>Tyrannus tyrannus</i>	Eastern kingbird
<i>Tyrannus verticalis</i>	Western kingbird
<i>Alauda arvensis</i>	Sky lark
<i>Eremophila alpestris</i>	Horned lark
<i>Progne subis</i>	Purple martin
<i>Tachycineta bicolor</i>	Tree swallow
<i>Tachycineta thalassina</i>	Violet-green swallow
<i>Stelgidopteryx serripennis</i>	Northern rough-winged swallow
<i>Riparia riparia</i>	Bank swallow
<i>Petrochelidon pyrrhonota</i>	Cliff swallow
<i>Hirundo rustica</i>	Barn swallow
<i>Perisoreus canadensis</i>	Gray jay
<i>Cyanocitta cristata</i>	Blue jay
<i>Cyanocitta stelleri</i>	Steller's jay
<i>Aphelocoma californica</i>	Western scrub jay
<i>Gymnorhinus cyanocephalus</i>	Pinyon jay
<i>Nucifraga columbiana</i>	Clark's nutcracker
<i>Pica pica</i>	Black-billed magpie
<i>Corvus brachyrhynchos</i>	American crow
<i>Corvus caurinus</i>	Northwestern crow
<i>Corvus corax</i>	Common raven
<i>Poecile atricapillus</i>	Black-capped chickadee
<i>Poecile gambeli</i>	Mountain chickadee
<i>Poecile hudsonicus</i>	Boreal chickadee
<i>Baeolophus inornatus</i>	Oak titmouse
<i>Baeolophus ridgwayi</i>	Juniper titmouse
<i>Poecile rufescens</i>	Chestnut-backed chickadee

*Psaltriparus minimus*  
*Sitta canadensis*  
*Sitta carolinensis*  
*Sitta pygmaea*  
*Certhia americana*  
*Salpinctes obsoletus*  
*Catherpes mexicanus*  
*Thryomanes bewickii*  
*Troglodytes aedon*  
*Troglodytes troglodytes*  
*Cistothorus palustris*  
*Cinclus mexicanus*

**Passerines 2 (N = 86)**

*Regulus calendula*  
*Regulus satrapa*  
*Poliophtila caerulea*  
*Sialia currucoides*  
*Sialia mexicana*  
*Myadestes townsendi*  
*Catharus fuscescens*  
*Catharus guttatus*  
*Catharus ustulatus*  
*Turdus migratorius*  
*Ixoreus naevius*  
*Chamaea fasciata*  
*Dumetella carolinensis*  
*Mimus polyglottos*  
*Oreoscoptes montanus*  
*Anthus rubescens*  
*Bombycilla cedrorum*  
*Bombycilla garrulus*  
*Sturnus vulgaris*  
*Vireo gilvus*  
*Vireo huttoni*  
*Vireo olivaceus*  
*Vireo cassinii*  
*Vermivora celata*  
*Vermivora ruficapilla*  
*Dendroica coronata*  
*Dendroica nigrescens*  
*Dendroica occidentalis*  
*Dendroica petechia*  
*Dendroica townsendi*

Bushtit  
Red-breasted nuthatch  
White-breasted nuthatch  
Pygmy nuthatch  
Brown creeper  
Rock wren  
Canyon wren  
Bewick's wren  
House wren  
Winter wren  
Marsh wren  
American dipper

Ruby-crowned kinglet  
Golden-crowned kinglet  
Blue-gray gnatcatcher  
Mountain bluebird  
Western bluebird  
Townsend's solitaire  
Veery  
Hermit thrush  
Swainson's thrush  
American robin  
Varied thrush  
Wrenit  
Gray catbird  
Northern mockingbird  
Sage thrasher  
American pipit  
Cedar waxwing  
Bohemian waxwing  
European starling  
Warbling vireo  
Hutton's vireo  
Red-eyed vireo  
Cassin's vireo  
Orange-crowned warbler  
Nashville warbler  
Yellow-rumped warbler  
Black-throated gray warbler  
Hermit warbler  
Yellow warbler  
Townsend's warbler

<i>Setophaga ruticilla</i>	American redstart
<i>Seiurus noveboracensis</i>	Northern waterthrush
<i>Oporornis tolmiei</i>	MacGillivray's warbler
<i>Geothlypis trichas</i>	Common yellowthroat
<i>Wilsonia pusilla</i>	Wilson's warbler
<i>Icteria virens</i>	Yellow-breasted chat
<i>Piranga ludoviciana</i>	Western tanager
<i>Pheucticus melanocephalus</i>	Black-headed grosbeak
<i>Passerina amoena</i>	Lazuli bunting
<i>Pipilo chlorurus</i>	Green-tailed towhee
<i>Pipilo crissalis</i>	California towhee
<i>Pipilo maculatus</i>	Spotted towhee
<i>Spizella arborea</i>	American tree sparrow
<i>Spizella atrogularis</i>	Black-chinned sparrow
<i>Spizella breweri</i>	Brewer's sparrow
<i>Spizella pallida</i>	Clay-colored sparrow
<i>Spizella passerina</i>	Chipping sparrow
<i>Poecetes gramineus</i>	Vesper sparrow
<i>Chondestes grammacus</i>	Lark sparrow
<i>Amphispiza belli</i>	Sage sparrow
<i>Amphispiza bilineata</i>	Black-throated sparrow
<i>Passerculus sandwichensis</i>	Savannah sparrow
<i>Ammodramus savannarum</i>	Grasshopper sparrow
<i>Passerella iliaca</i>	Fox sparrow
<i>Melospiza georgiana</i>	Swamp sparrow
<i>Melospiza lincolni</i>	Lincoln's sparrow
<i>Melospiza melodia</i>	Song sparrow
<i>Zonotrichia albicollis</i>	White-throated sparrow
<i>Zonotrichia atricapilla</i>	Golden-crowned sparrow
<i>Zonotrichia leucophrys</i>	White-crowned sparrow
<i>Zonotrichia querula</i>	Harris' sparrow
<i>Junco hyemalis</i>	Dark-eyed junco
<i>Calcarius lapponicus</i>	Lapland longspur
<i>Plectrophenax nivalis</i>	Snow bunting
<i>Dolichonyx oryzivorus</i>	Bobolink
<i>Agelaius phoeniceus</i>	Red-winged blackbird
<i>Agelaius tricolor</i>	Tricolored blackbird
<i>Sturnella neglecta</i>	Western meadowlark
<i>Xanthocephalus xanthocephalus</i>	Yellow-headed blackbird
<i>Euphagus cyanocephalus</i>	Brewer's blackbird
<i>Molothrus ater</i>	Brown-headed cowbird
<i>Icterus bullockii</i>	Bullock's oriole
<i>Leucosticte atrata</i>	Black rosy-finch
<i>Leucosticte tephrocotis</i>	Gray-crowned rosy-finch

Pinicola enucleator  
Carpodacus cassinii  
Carpodacus mexicanus  
Carpodacus purpureus  
Loxia curvirostra  
Loxia leucoptera  
Carduelis flammea  
Carduelis pinus  
Carduelis psaltria  
Carduelis tristis  
Coccothraustes vespertinus  
Passer domesticus

Pine grosbeak  
Cassin's finch  
House finch  
Purple finch  
Red crossbill  
White-winged crossbill  
Common redpoll  
Pine siskin  
Lesser goldfinch  
American goldfinch  
Evening grosbeak  
House sparrow

**Bats (N = 16)**

Myotis californicus  
Myotis ciliolabrum  
Myotis evotis  
Myotis keenii  
Myotis lucifugus  
Myotis thysanodes  
Myotis volans  
Myotis yumanensis  
Lasionycteris noctivagans  
Pipistrellus hesperus  
Eptesicus fuscus  
Lasiurus cinereus  
Corynorhinus townsendii  
Euderma maculatum  
Antrozous pallidus  
Tadarida brasiliensis

California myotis  
Western small-footed myotis  
Long-eared myotis  
Keen's myotis  
Little brown myotis  
Fringed myotis  
Long-legged myotis  
Yuma myotis  
Silver-haired bat  
Western pipistrelle  
Big brown bat  
Hoary bat  
Townsend's big-eared bat  
Spotted bat  
Pallid bat  
Brazilian free-tailed bat

**Small Mammals (N = 79)**

Sorex bairdi  
Sorex bendirii  
Sorex cinereus  
Sorex hoyi  
Sorex merriami  
Sorex monticolus  
Sorex pacificus  
Sorex palustris  
Sorex preblei  
Sorex sonomae  
Sorex trowbridgii  
Sorex vagrans  
Neurotrichus gibbsii

Baird's shrew  
Pacific water shrew  
Masked shrew  
Pygmy shrew  
Merriam's shrew  
Dusky shrew  
Pacific shrew  
Water shrew  
Preble's shrew  
Fog shrew  
Trowbridge's shrew  
Vagrant shrew  
Shrew-mole

<i>Scapanus latimanus</i>	Broad-footed mole
<i>Scapanus orarius</i>	Coast mole
<i>Scapanus townsendii</i>	Townsend's mole
<i>Aplodontia rufa</i>	Mountain beaver
<i>Tamias amoenus</i>	Yellow-pine chipmunk
<i>Tamias minimus</i>	Least chipmunk
<i>Tamias ruficaudus</i>	Red-tailed chipmunk
<i>Tamias senex</i>	Allen's chipmunk
<i>Tamias siskiyou</i>	Siskiyou chipmunk
<i>Tamias townsendii</i>	Townsend's chipmunk
<i>Ammospermophilus leucurus</i>	White-tailed antelope squirrel
<i>Spermophilus beecheyi</i>	California ground squirrel
<i>Spermophilus beldingi</i>	Belding's ground squirrel
<i>Spermophilus canus</i>	Merriam's ground squirrel
<i>Spermophilus columbianus</i>	Columbian ground squirrel
<i>Spermophilus lateralis</i>	Golden-mantled ground squirrel
<i>Spermophilus mollis</i>	Piute ground squirrel
<i>Spermophilus saturatus</i>	Cascade golden-mantled ground squirrel
<i>Spermophilus townsendii</i>	Townsend's ground squirrel
<i>Spermophilus washingtoni</i>	Washington ground squirrel
<i>Sciurus carolinensis</i>	Eastern gray squirrel
<i>Sciurus griseus</i>	Western gray squirrel
<i>Sciurus niger</i>	Fox squirrel
<i>Tamiasciurus douglasii</i>	Douglas' squirrel
<i>Tamiasciurus hudsonicus</i>	Red squirrel
<i>Glaucomys sabrinus</i>	Northern flying squirrel
<i>Thomomys bottae</i>	Botta's (Pistol River) pocket gopher
<i>Thomomys bulbivorus</i>	Camas pocket gopher
<i>Thomomys mazama</i>	Western pocket gopher
<i>Thomomys talpoides</i>	Northern pocket gopher
<i>Thomomys townsendii</i>	Townsend's pocket gopher
<i>Perognathus longimembris</i>	Little pocket mouse
<i>Perognathus parvus</i>	Great Basin pocket mouse
<i>Microdipodops megacephalus</i>	Dark kangaroo mouse
<i>Dipodomys californicus</i>	California kangaroo rat
<i>Dipodomys microps</i>	Chisel-toothed kangaroo rat
<i>Dipodomys ordii</i>	Ord's kangaroo rat
<i>Neotoma cinerea</i>	Bushy-tailed woodrat
<i>Neotoma fuscipes</i>	Dusky-footed woodrat
<i>Neotoma lepida</i>	Desert woodrat
<i>Onychomys leucogaster</i>	Northern grasshopper mouse
<i>Reithrodontomys megalotis</i>	Western harvest mouse
<i>Peromyscus crinitus</i>	Canyon mouse
<i>Peromyscus keeni</i>	Columbian mouse

Peromyscus maniculatus	Deer mouse
Peromyscus truei	Pinon mouse
Clethrionomys californicus	Western red-backed vole
Clethrionomys gapperi	Southern red-backed vole
Phenacomys albipes	White-footed vole
Phenacomys intermedius	Heather vole
Phenacomys longicaudus	Red tree vole
Microtus californicus	California vole
Microtus canicaudus	Gray-tailed vole
Microtus longicaudus	Long-tailed vole
Microtus montanus	Montane vole
Microtus oregoni	Creeping vole
Microtus pennsylvanicus	Meadow vole
Microtus richardsoni	Water vole
Microtus townsendii	Townsend's vole
Lemmiscus curtatus	Sagebrush vole
Synaptomys borealis	Northern bog lemming
Rattus norvegicus	Norway rat
Rattus rattus	Black rat
Mus musculus	House mouse
Zapus princeps	Western jumping mouse
Zapus trinotatus	Pacific jumping mouse

**Meso-Mammals (N = 40)**

Didelphis virginiana	Virginia opossum
Ochotona princeps	American pika
Brachylagus idahoensis	Pygmy rabbit
Sylvilagus bachmani	Brush rabbit
Sylvilagus floridanus	Eastern cottontail
Sylvilagus nuttallii	Nuttall's cottontail
Oryctolagus cuniculus	European rabbit
Lepus americanus	Snowshoe hare
Lepus californicus	Black-tailed jackrabbit
Lepus townsendii	White-tailed jackrabbit
Marmota caligata	Hoary marmot
Marmota flaviventris	Yellow-bellied marmot
Marmota olympus	Olympic marmot
Castor canadensis	Beaver
Ondatra zibethicus	Muskrat
Erethizon dorsatum	Porcupine
Myocastor coypus	Nutria
Vulpes velox	Kit or swift fox
Vulpes vulpes	Red fox
Urocyon cinereoargenteus	Gray fox

Canis latrans	Coyote
Canis lupus	Gray wolf
Ursus americanus	Black bear
Ursus arctos	Grizzly bear
Bassariscus astutus	Ringtail
Procyon lotor	Raccoon
Mustela erminea	Ermine
Mustela frenata	Long-tailed weasel
Mustela vison	Mink
Martes americana	American marten
Martes pennanti	Fisher
Gulo gulo	Wolverine
Taxidea taxus	American badger
Spilogale gracilis	Western spotted skunk
Mephitis mephitis	Striped skunk
Lutra canadensis	Northern river otter
Enhydra lutris	Sea otter
Lynx canadensis	Lynx
Lynx rufus	Bobcat
Felis concolor	Mountain lion

**Marine Mammals (N = 15)**

Callorhinus ursinus	Northern fur seal
Eumetopias jubatus	Northern (Steller) sea lion
Zalophus californianus	California sea lion
Mirounga angustirostris	Northern elephant seal
Phoca vitulina	Harbor seal
Eschrichtius robustus	Gray whale
Balaenoptera acutorostrata	Minke whale
Megaptera novaeangliae	Humpback whale
Lagenorhynchus obliquidens	Pacific white-sided dolphin
Grampus griseus	Risso's dolphin
Orcinus orca	Killer whale
Lissodelphis borealis	Northern right whale dolphin
Phocoena phocoena	Harbor porpoise
Phocoenoides dalli	Dall's porpoise
Physeter macrocephalus	Sperm whale

**Ungulates (N = 11)**

Equus asinus	Wild burro
Equus caballus	Feral horse
Sus scrofa	Feral pig
Cervus elaphus	Elk
Odocoileus hemionus	Mule and black-tailed deer
Odocoileus virginianus	White-tailed deer

*Alces alces*  
*Rangifer tarandus*  
*Antilocapra americana*  
*Oreamnos americanus*  
*Ovis canadensis*

Moose  
Mountain caribou  
Pronghorn antelope  
Mountain goat  
Bighorn sheep

**Appendix D: List of types of model included in the database.**

**N = 15**

<b>Type of Model</b>
Wildlife Habitat Ratings - Broad Ecosystem Inventory (BEI)-based
Wildlife Habitat Ratings - Terrestrial Ecosystem Mapping (TEM)-based
Habitat Suitability Index (H.S.I.) Model
Wildlife Habitat Ratings - Predictive Ecosystem Mapping (PEM)-based
Multi-Scalar Logistic Regression Predictor
Cumulative Effects Model (GIS-based)
Bayesian Belief Network (BBN) Models
Resource Selection Model (RSF) regression modeling (predictive)
Feenix (developed in-house)
Prognosis EI
FORUM
Wildlife Habitat Relationships Model (WHR)
Habitat Suitability Index Model
Wildlife Habitat Ratings
Atlas/SIMFOR

**Appendix E: list of species included in the database.**

N = 130 (not including species from Appendices B and C)

605 species - see Appendix C	Fisher	Red Squirrel
91 species - see Appendix B	Flammulated Owl	Red-breasted nuthatch
Accipiters	Furbearers	River Otter
American Bittern	Golden-crowned Kinglet	Rocky Mountain bighorn sheep
Amphibians	Goshawk	Rocky Mountain elk
bald eagle	Great Blue Heron	Roosevelt elk
barred owl	great gray owl	Rough-legged Hawk
Barrow's Golden-eye	great horned owl	ruffed grouse
Bat	Green-winged Teal	sage grouse
Bay-breasted Warbler	grizzly bear	Sandhill Crane
Beaver	hairy woodpecker	savannah sparrow
Bighorn sheep	Hares	Sharp-tailed Grouse
Birds	Harlequin Duck	Short-eared Owl
Bison	hermit thrush	Sitka black-tailed deer
black bear	hoary bat	Snowshoe Hare
Black-capped Chickadee	Lewis' Woodpecker	songbirds
Black-tail Deer	Long-billed Curlew	southern red-backed vole
Black-throated Green Warbler	long-toed salamander	Spotted Bat
Blue Grouse	Lynx	Spotted Owl
Bobcat	Magnolia Warbler	Spruce Grouse
Bobolink	mammals	Squirrel
boreal caribou	marbled murrelet	Stone's sheep
boreal owl	marten	Swainson's thrush
Brown Creeper	Mink	Tailed Frog
Bufflehead	Montane Vole	Three-toed Woodpecker
California bighorn sheep	moose	Townsend's Big-eared Bat
Canada Warbler	mountain caribou	Trumpeter Swan
Cape May Warbler	mountain goat	ungulates
Caribou	mule deer	varied thrush
Cattle	Muskrat	warbling vireo
Cavity Nesting Birds	northern caribou	Western Tanager
chipping sparrow	Northern Flying Squirrel	Whitebark Pine
clay-coloured sparrow	northern goshawk	white-tailed deer
Coastal Black-tailed Deer	Otter	White-throated Sparrow
Columbia black-tailed deer	Ovenbird	White-throated Swift
Common Garter Snake	Owls	White-winged crossbill
Common Goldeneye	Palm Warbler	Winter Wren
common yellowthroat	Peregrine Falcon	Wolf
Connecticut Warbler	Philadelphia Vireo	Wolverine
Cougar	Pileated Woodpecker	wood bison
Dall's sheep	Pine Marten	Woodland Caribou
Deer	Prairie Flacon	Yellow Warbler
Eared Grebe	R&B Listed Species	Yellow-bellied Flycatcher
Elk	Raptors	Yellow-rumped Warbler

Habitat Supply Modeling – Contact Information

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**Appendix F: list of contacts included in the database.**

Government biologists

<b>Name</b>	<b>Position</b>	<b>Ministry Office</b>	<b>Address</b>	<b>Phone</b>	<b>Email</b>
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Bruce McLellan	Senior Wildlife Habitat Ecologist	MOF – Forest Practices Research Station	PO Box 9158, RPO#3 Revelstoke, BC V0E 3K0	250-837-7767	Bruce.McLellan@gems9.gov.bc.ca
Carla Lenihan	Wildlife Biologist	MELP – Fish, Wildlife and Habitat Protection	2 <sup>nd</sup> Floor – 10470 152 St. Surrey, BC V3R 0Y3	604-582-5336	Carla.Lenihan@gems7.gov.bc.ca
Mike Seper	Regional Information Technical Coordinator	MELP – Planning and Assessment	2 <sup>nd</sup> Floor – 10470 152 St. Surrey, BC V3R 0Y3	604-582-5369	Mike.Seper@gems2.gov.bc.ca
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## Habitat Supply Modeling – Contact Information

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Mike Panian	Wildlife Inventory Biologist	MELP – Fish, Wildlife and Habitat Protection	401 – 333 Victoria St. Nelson, BC V1L 4K3	250-354-6584	Mike.Panian@gems7.gov.bc.ca
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Tom Braumandl	Research Ecologist	MOF – Nelson Forest Region, Research	518 Lake St. Nelson, BC V1L 4C6	250-354-6703	Tom.Braumandl@gems5.gov.bc.ca

### Other (consultants, universities, Alberta and the US)

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ECO-concepts Ecological Services	Carol Thompson	Suite 4, 1960 Springfield Rd. Kelowna, BC V1Y 5V7	(250) 860-3554	(250) 860-2103	ecoconcept@silk.net
Environmental Insight	Jim Poriz / Clint Smythe	P.O. Box 1530 Blairmore, Alta. T0K 0E0	Clint (403) 562-7083 / Jim -7080	(403) 562-7082	Insight@AGT.NET

## Habitat Supply Modeling – Contact Information

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## Habitat Supply Modeling – Contact Information

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**Appendix G: project locations and provinces/states where they originated.**

BC – N = 71

Alberta – N = 3

US – N = 5

<b>Origin (location of study)</b>	
BEI	BC
Germansen, Wolverine, Klawli (118073), Manson, Discovery, Lower Osilinka, Tenakihi and Gaffney Lus	BC
North Stuart Lake	BC
Takla-East Operating Area	BC
Kirbyville Cr.	BC
Swift River	BC
Ahbou Creek	BC
Wolverine/Johnson	BC
Little Swift Rv./Lightning Ck.	BC
Churn Creek	BC
Upper Dala River, Kitimat drainage - Kalum FD	BC
Willow River	BC
Brewer Creek	BC
Jamieson Creek	BC
Bowron Valley	BC
N. Quesnel Lake/Penfold	BC
Kimball Ck./Pine Valley	BC
Hawks Cr./McLeese Lk.	BC
Chetwynd	BC
Akie, Pesika, Buffalo Head and Lower Ingenika (118075)	BC
Hugh Allan, Blackman and Camkp, Canoe drainages	BC
Hellroar Cr. (Thompson Cr.)	BC
Diorite Cr./Premier	BC
Nilkitkwa drainage - Bulkley FD	BC
Upper Kitimat River	BC
Knewstubb Lk./West Road R.	BC
Westerly exposure of Galton Range from Montana/B.C. border to the Elk River. Border Ranges Ecosection and small part of East Kootenay Trench Ecosection.	BC
Steamboat Mtn.	BC
Williams Lake	BC
Wood River	BC
Sukunka/Carbon	BC
Quesnel River	BC
Gosnell Creek and Thautil river drainages in the Morice Forest District	BC
Morrison IRM of the Morice Forest district	BC
Mount Coronation drainage	BC
Upper Qualicum Low Intensity Area	BC
Gerimi/Nyland	BC
Itchas/Ilgachus	BC

Ellerslie Lake	BC
Big Valley North	BC
Cunningham	BC
Ts'yl-os Provincial Park	BC
Bordered by Liard River and Beaver River	BC
Alexis Cr./Chilcotin R.	BC
Itcha-Ilgachuz	BC
S. of Anahim Lk/SW of Itcha project	BC
Horsefly	BC
Sandy Cr.	BC
Dunedin R.	BC
Smith R./Fishing Cr.	BC
Snake R./Sahtenah R.	BC
NW of Williams Lk.	BC
Besa R./Prophet R.	BC
Lignum IFPA area southwest of Williams Lake	BC
Nass Basin	BC
Kispiox Forest District	BC
north coast of BC	BC
Morice Forest District	BC
Nelson Forest Region - Columbia Mountains	BC
Columbia River Basin, Washington	BC
Foothills Model Forest - Hinton AB.	BC
Alberta	AB
boreal ecosystems with dominant white and black spruce in Alberta	AB
West Arm Demonstration Forest (Kootenay Lake)	BC
Arrow Forest District.	BC
Washington State	US
MacKenzie Forest District	BC
Invermere Forest District	BC
boreal coniferous forests of the western US	US
throughout the range of the beaver	US
inland wetland habitats throughout the range of this species	US
the region where aspen is a predominant component of the forest ecosystem	US
southern Purcell Mountains, BC	BC
Foothills Model Forest - west-central Alberta	AB
Columbia Highlands and North Columbia Mountains ecoregions	BC
Fraser Timber Supply Area (TSA)	BC
Muskwa-Kechika	BC
Kootenay Lake Forest District	BC
Flathead	BC