2015

Run-of-River Decision Support Tool

Technical Information and Methods

Contents

I.   Executive Summary

Renewable energy technologies are being promoted around the globe to mitigate the effects of climate change. Privatized small hydropower (Run-of-River, RoR) has emerged as a key component of British Columbia's renewable energy portfolio, with presumed low site-level environmental impacts. However, the shift from few large power production locations (e.g. coal, natural gas, nuclear, large reservoir hydropower) towards many small renewable production sites poses new challenges to environmental impact assessment and strategic planning. Very few published studies have thus far evaluated biodiversity impacts from individual Run-of-River projects or the potential for their widespread adoption to create cumulative effects within biogeographic regions or political boundaries (Provinces, States). Such a knowledge gap is not unexpected for an emerging energy technology, however, investment and development decisions are happening continuously, and uncertainty surrounding environmental impacts fuels debate between promoters and opponents of widespread Run-of-River adoption. In partnership with academic institutions, governments, industry, natural resource managers, and environmental groups, our research team has tackled this problem by developing a unique decision-support tool for evaluating energy – environment trade-offs for Run-of-River development in BC. Though our understanding of potential impacts of Run-of River projects is in its infancy, our tool uses the best available science in combination with a unique dataset of thousands of potential Run-of-River development locations produced from a decade-long planning process[1] future Run-of-River projects that overlap the least with user-defined biodiversity values while prioritizing user criteria for power production, cost, and geography. By exploring a range of energy targets and biodiversity values, users can evaluate how different priorities affect the number of new Run-of-River projects required, their annual costs, and the total amount of new infrastructure (roads, powerlines, penstocks) needed to support them across the Province of British Columbia. Though the development locations are only hypothetical, the relative costs and benefits highlighted by different scenarios are realistic, and can help identify alternative ways to minimize conflicts between energy production and biodiversity conservation at broad geographic scales and over multi-decade time horizons. As a result, this value-neutral and transparent tool contributes an important missing-piece that can be used by many different groups to guide informed decisions and elevate the dialogue surrounding strategic planning for renewable energy in British Columbia and beyond.

Our web-based interactive tool identifies the suite of future Run-of-River projects that overlap the least with user-defined biodiversity values while prioritizing user criteria for power production, cost, and geography. By exploring a range of energy targets and biodiversity values, users can evaluate how different priorities affect the number of new Run-of-River projects required, their annual costs, and the total amount of new infrastructure (roads, powerlines, penstocks) needed to support them across the Province of British Columbia. Though the development locations are only hypothetical, the relative costs and benefits highlighted by different scenarios are realistic, and can help identify alternative ways to minimize conflicts between energy production and biodiversity conservation at broad geographic scales and over multi-decade time horizons. As a result, this value-neutral and transparent tool contributes an important missing-piece that can be used by many different groups to guide informed decisions and elevate the dialogue surrounding strategic planning for renewable energy in British Columbia and beyond.

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[1] https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/ror-update-report-20131115.pdf

II.   Key Assumptions

The Run-of-River Decision Support Tool is intended to provide coarse-scale, non-regulatory information on the trade-offs between fish and wildlife conservation and potential Run-of-River development at the scale of British Columbia and over long time horizons (30-50 years).

1) **No current Run-of-River projects (existing, pending approval, or in the investigative stage) are included in this tool.** This tool relies on a dataset of potential Run of River development sites identified through a decade-long process detailed in BC Hydro's Resource Options Report. We have evaluated the methods underlying the identification, capacity, and costs associated with those sites, but were not involved in their development.

2) **Run-of-River hydropower will continue to be a growing component of the renewable energy portfolio of British Columbia.** Users are asked to choose among four future energy development goals for Run-of-River hydropower (1000, 3000, 5000, 7000 GWh), and this assumes that users value additional Run-of-River development locations.

3) **The tool minimizes spatial overlap with single or multi-species occurrence as a proxy for minimizing impacts.** Few peer-reviewed studies exist on the impact of Run-of-River hydropower to particular species and ecosystem processes. Until our understanding of impacts (positive, negative, or neutral) and mitigation measures improves, we assume that minimizing overlap between Run-of-River development and single or multiple species or ecosystem attributes will minimize potential impacts.

4) **The spatial extent of the analysis is Province-wide**. This assumption means that only those datasets with Province-wide coverage, meeting minimum standards, were included in the tool.

5) **Some important species are missing.** High profile species, including caribou, moose, grizzly bear, and black bear, are missing from the tool because the publically available data for these species did not meet our minimum standards for inclusion. In the case of excluded species, datasets had limited spatial coverage (i.e., caribou habitat suitability data), very coarse resolution information, or high uncertainties in estimates (i.e., grizzly bear density aggregated to Wildlife Management Units). Thus, direct comparisons of trade-offs between these species and Run-of-River development would be misleading.

6) **Province-wide species distributions are not substitutes for local and regional assessments.** We estimated the distributions of non-fish species using between 100 and >10,000 documented occurrences per species. Where possible, we evaluated the accuracy of species distributions using regional habitat assessments conducted by BC Government biologists or independent consultants, and our predictions were similar. However, uncertainties exist, and areas predicted to have high uncertainty were given lower weight in our models.

7) **The tool is focused on the aggregate consequences of developing Run-of-River sites.** The prioritization models underlying the tool yield sets of 'best-solution' sites ranked by their ability to meet user's stated development values (e.g. cost, energy, footprint) and ecological values (single or multi-species, existing disturbance). While we provide users the ability to download the data for individual sites selected by the tool, we advise users to focus on the aggregate summaries of the set of selected sites (total new roads, powerlines, costs, power production) in order to identify the trade-offs between multiple scenarios.

III. Model Algorithm Details

- **Software:** Prioritization scenarios run using spatial conservation planning software Zonation v4, developed at University of Helsinki, Finland (http://cbig.it.helsinki.fi/software/zonation/)

- **Data types**: Zonation uses raster data; cell resolution for our analysis = 400 x 400 m (5,131,698 cells with data after glaciers and rocky barrens removed from analysis).

- **Datasets** (see **Data Inputs** for detailed information): **(1) Development Values:** potential locations of Run of River intakes and powerhouses from BC Hydro Resource Options Report (2013); of the >7200 potential locations, we used 2366 sites with Unit Energy Cost at point of interconnection <$1000/MWh. **(2) Ecological Values**: habitat suitability maps for *37 fish species* and *recreational fisheries value* from the BC Ministry of Environment (Fisheries Sensitive Watersheds initiative), distributions for *301 birds, 25 mammals, and 15 amphibian and reptiles* (predicted using ecological niche models based on actual species locality data). **(3) Existing disturbance**: linear features from the BC Digital Road Atlas, and recent logging (1990-2012) by combining data from Forest Practices Board (based on the BC Vegetation Resource Inventory, VRI) and Global Forest Change project (*http://earthenginepartners.appspot.com/science-2013-global-forest*)

- **Zonation algorithm:** The primary function of Zonation is to identify priority areas for conservation and produce a balanced ranking of conservation priorities. Zonation uses a raster for each layer (e.g., species, ecosystem service, Run of River attribute), where raster cells can contain values such as habitat suitability, species abundance, or cost of development. The ranking (0 – 1) is produced by starting with the full landscape and iteratively removing raster cells or planning units (e.g., watersheds) that lead to smallest aggregate loss of conservation value. Using a multi-species example, the least valuable cells (e.g., only few common species occurring) are removed first (rank close to 0), while the most important cells for biodiversity (e.g., high species richness and high probability species occurrence) are removed last (rank close to 1).

- **Zonation algorithm applied to Run of River:** In our models, watersheds with energy potential enter Zonation the same way as species or ecosystem layers, but with a negative weight. The negative sign signals the algorithm to first identify watersheds with Run-of-River potential and start assigning the lowest conservation priority ranks (i.e., *1/number of total cells in BC*) to cells/watersheds with high Run of River development potential and low conservation value. *Thus lowest ranks indicate the top development cells/watersheds*. The algorithm continues to assign ranks to every cell in watersheds with energy potential, still seeking to balance species or ecosystems and Run of River development, then moves on to areas with no energy development. Areas of highest conservation value and no energy development are assigned the highest conservation priority ranks.

- **Weights:** Weights can be applied to all layers in the prioritization; for example, higher weights can be assigned to endangered species in order to boost its importance in the prioritization, and penalize development overlapping with endangered species. In the current web-based tool, our Ecological and Development values can be weighed both equally (1:1) and unequally (5:1 and 1:5). For example, when choosing *All Anadromous Salmon* as Ecological Value and *Cost of Development* and *Amount of Energy* per site as Development Values

o   Under an **equal** weighting scheme, each of the 6 salmon species was assigned a weight of 0.1667 (Σ weight = 1), while each of the 2 development value layers (cost, energy) was assigned a weight of –0.5 (Σ weight = –1).

o   Under an **unequal** weighting scenario focused on **Development Values**, each salmon species was assigned a weight of 0.1667 (Σ weight = 1), while each of the 2 development value layers (cost, energy) was assigned a weight of –2.5 (Σ weight = –5).

o   Under an **unequal** weighting scenario focused on **Ecological Values**, each salmon species was assigned a weight of 0.8335 (Σ weight = 5), while each of the 2 development value layers (cost, energy) was assigned a weight of –0.5 (Σ weight = –1).

- **Accounting for existing disturbance**: The 2 existing disturbance layers, *proportion forest loss 1990-2012* and *density of linear disturbance* summarized at watershed level, entered the prioritization the same way as the ecological features, and were also given a summed weight of 1. When accounting for existing disturbance, Development Values (Σ weight = –1) are balanced against a double set of species (Σ weight species + disturbance = 2). The implication of adding disturbance this way is that watersheds with least disturbance are prioritized for conservation, while Run of River development is directed in watersheds with higher disturbance.

- **Identifying best development solutions**: Using Zonation, we produced priority rank rasters for each combination of Ecological Values (single species or multi-species) and Development Values please refer to Glossary for detailed explanations). Using GIS, we extracted the priority rank values for each intake (dam) location in the Run of River dataset (2366 potential projects with Unit Energy Cost at point of interconnection <$1000/MWh). We then identified the top sites (solution) that achieve the user-specified electricity generation target (1000, 3000, 5000 or 7000 GWh/year) by sorting the sites ascending according to rank and summing their contribution to achieving the energy target.

- **Producing aggregate summaries:** for each model in the BC Run of River Decision Support Tool, (combinations of Development Values, Ecological Values and Energy Target, with or without Existing Disturbance) we calculated the aggregate annual cost of energy (annual firm energy x unit energy cost at point of interconnection), as well as the total aquatic footprint (number of projects, length of penstocks), and total terrestrial footprint (length of new roads, length of powerlines) across all sites within the solution set.

IV.   Data Inputs

1. Development Values

Run-of-River data was extracted from BC Hydro's Resource Options Report (data produced by Kerr-Wood-Leidal and BC Hydro, freely available for download from the BC Geographic Data Discovery Service, GeoBC). The methodology for identifying potential Run-of-River hydro sites, as well as modeling assumptions and caveats are described in detail in Appendix 8-A (Run-of-River Report) of the 2013 Resource Options Report Update[2]. Of a total 7281 sites with Run-of-River hydro potential, we used 2366 potential sites that can produce electricity at a cost of <$1000/MWh. For these subset of sites, we selected 4 site-level attributes that encompass the economic efficiency, energy production and potential spatial footprint.

Site-level data	Zonation optimization algorithm seeks to:
Unit Energy Cost at Point of Interconnection in $/MWh calculated in 2011 dollars based on the estimated capital and annual costs, energy production, project life, and discount rate (6% over 40 years)	**minimize** the Unit Energy Cost al Point of Interconnection = sites with lower development cost
Amount of potential Annual Firm Energy produced (electricity guaranteed to be available) in GWh/year	**maximize** Annual Firm Energy = sites with higher energy production potential
Spatial Footprint of each project and associated infrastructure (roads, powerlines) in hectares	**minimize** Spatial Footprint = sites with smaller construction footprint
Distance from town and cities in km (straight-line distance from town and cities to intake location)	**maximize** Distance = sites that are farther from towns and cities

For use in Zonation, the site-level data were summarized at the level of 1:20K Assessment Watersheds, which are the standard hydrologic subdivision of British Columbia appropriate for collecting field data, modelling aquatic impacts, reporting results, designing monitoring programs, and supporting other aquatic resource applications[3]. When multiple projects were located in the same watershed, we calculated the mean Unit Energy Cost, the summed Annual Firm Energy, the mean Footprint, and the mean Distance.

We developed models that accommodated all possible combinations of these 4 site-level attributes, to a total of 15 possible combinations. Within a given prioritization model, each of the site-level data were given equal weights.

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[2] https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/ror-update-appx-8a-20130802.pdf

[3] Carver, M., and M. Gray. 2010. Assessment watersheds for regional applications in British Columbia. Streamline Watershed Management Bulletin 13(2): 60-64
[http://www.forrex.org/sites/default/files/publications/articles/Streamline_Vol13_No2_Art7.pdf]

2. Ecological Values

This tool seeks to avoid overlap between potential Run-of-River development and high suitability habitat for aquatic and terrestrial vertebrates (fish and wildlife). The analysis of overlap is performed using single species (e.g., avoid overlap with sockeye salmon or marbled murrelet habitat) or multiple species (e.g., avoid overlap with all anadromous salmonids simultaneously). Similarly, the tool can identify sets of sites that meet specified Development values while avoiding areas that generate important ecosystem services, such as recreational fisheries.

Terrestrial Vertebrate Species

For >341 terrestrial species, we developed species distribution models using occurrence locations from two open-access online databases: Global Biodiversity Information Facility (data.gbif.org) and Nature Counts (www.birdscanada.org/birdmon). For some species, such as the coastal tailed frog, we augmented the data with occurrences from BC government sources. We manually screened occurrence points to remove uncertain records, or records that were spatially autocorrelated (e.g., telemetry data). We also excluded large, wide-ranging mammal species from our analysis on the basis that their habitat associations vary widely across populations, and are therefore poorly modelled using conventional SDM methods. Species with fewer than 100 occurrence points within British Columbia were discarded to ensure that data paucity did not interfere with model performance, which resulted in 341 native vertebrate species modeled using ensemble models implemented in program R via the *BIOMOD2* library.

For modeling species distributions, we used a set of bioclimatic and topographic variables. We extracted bioclimatic data (annual precipitation, isothermality (mean diurnal range/annual temperature range), precipitation seasonality (coefficient of variation of monthly precipitation), temperature seasonality, mean temperature of the coldest quarter, and mean temperature of the warmest quarter) from the WorldClim database (*www.worldclim.org*, (Hijmans *et al.*, 2005)).We also used elevation data from USGS Global Multi-resolution Terrain Elevation Data model (topotools.cs.usgs.gov/gmted_viewer), and slope derived from the DEM using ArcGIS 10.

Fish Species

Habitat models for 37 fish species in British Columbia, including anadromous salmonids, were produced by ESSA Technologies Ltd. in collaboration with BC's Ministry of Environment[4]. Please see the metadata file included with the Fish Species Distributions shapefile on the Downloads page for a full description of their methods and results.

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[4] Porter, M., D. Pickard, K. Wieckowski and K. Bryan. 2008. Developing Fish Habitat Models for Broad-Scale Forest Planning in the Southern Interior of B.C. Draft report prepared by ESSA Technologies Ltd. and B.C. Ministry of the Environment (MOE) for B.C. Forest Science Program, PricewaterhouseCoopers, Vancouver, B.C. 92 pp.

Existing Landscape Disturbance

The province of BC has a relatively short (<100 years), but intensive history of landscape disturbance, mainly as a result of resource extraction activities, including logging, mining, and oil and gas (and to a lesser extent from conversion to agriculture and urban land uses). As a result, certain areas of the province have dense infrastructure networks (roads, powerlines, pipelines), while other, less accessible and remote regions, are still relatively undisturbed by human activities. To account for legacies of past human disturbance, we used two landscape disturbance indicators summarized at watershed level: **density of linear fragmentation** (km/km^2), and **recent forest cover changes** (<20 years-old) from logging, wild fires, and pests (i.e., pine beetle) (proportion of watershed). We used the Digital Road Atlas of British Columbia (http://geobc.gov.bc.ca/base-mapping/atlas/dra/), along with existing distribution and transmission lines to create a dataset of all linear infrastructure in the province. We created the forest cover loss layer from two spatial data sources: the Vegetation Resources Inventory (VRI, http://www.for.gov.bc.ca/hts/vri/) which contains data on forest cover and logging activities in BC (compiled by M. Eng at the BC Forest Practices Board), and Global Forest Change project (http://earthenginepartners.appspot.com/science-2013-global-forest). Thus, by combining the two datasets we were able to obtain the most complete dataset of forest cover change in BC between early 1990's and 2012.

3. Species used in the models

To identify potential Run-of-River sites that avoid overlap with Ecological Values, we considered species individually (hereafter Single Species), and in groups (hereafter Multi Species). The difference between the Single and Multi Species prioritizations is how the weighting schemes are assigned. For Single Species, the weight for that particular species is on par with Development Values (e.g., under a *balanced scenario*, weight of species S = 1, and weight of Development Values = 1). For Multi Species, the weight for a given species is a fraction of the weight of Development Values (e.g., under a balanced scenario, the weight of a species in a group of 10 species = 1/10, and weight of Development Values = 1). This means that under Multi Species, the Zonation algorithms tries to identify the optimal solution for all the species in the group, while considering the Development Values of potential Run-of-River development.

Single Species

Because of the large number of fish and wildlife species with habitat or distribution models available, we selected a subset of 44 species for which we considered overlaps with potential Run-of-River individually. These 44 species are either (1) listed as *endangered or threatened* in British Columbia, or (2) have *high overlap* with potential Run-of-River development. A species was classified as having high overlap with potential Run-of-River development if more than 20% of watersheds (for terrestrial species) or 10% of watersheds (for fish species) in the species range had potential for Run-of-River hydro development.

Multi Species

We considered 5 groups of species for which we developed prioritization models (some species can occur in more than one group), and 1 ecosystem service:

(1) *Anadromous salmonids* (6 species)

(2) *Endangered fish and wildlife species* (10 species)

(3) *Endangered and Threatened fish and wildlife species* (23 species)

(4) *Fish and wildlife species with highest overlap with potential Run-of-River sites* (26 species)

(5) *All fish and wildlife species* (37 fish and 341 wildlife species)

(6) *Recreational fisheries value* (derived by the BC Ministry of Environment as part of the Fisheries Sensitive Watersheds initiative; http://www.env.gov.bc.ca/wld/frpa/fsw/)

Anadromous Salmonids

Common Name	Latin Name
Coho salmon	*Oncorhynchus kisutch*
Steelhead	*Oncorhynchus mykiss*
Chum salmon	*Oncorhynchus keta*
Pink salmon	*Oncorhynchus gorbuscha*
Chinook salmon	*Oncorhynchus tshawytscha*
Sockeye salmon	*Oncorhynchus nerka*

Endangered Species

	Common Name	Latin Name
Fish	Coho salmon	*Oncorhynchus kisutch*
	Kokanee	*Oncorhynchus nerka*
	Sockeye salmon	*Oncorhynchus nerka*
Terrestrial and Riparian Vertebrates	Horned lark	*Eremophila alpestris*
	Yellow-breasted chat	*Icteria virens*
	Red crossbill	*Loxia curvirostra*
	Little brown bat	*Myotis lucifugus*
	Sage thrasher	*Oreoscoptes montanus*
	Vesper sparrow	*Pooecetes gramineus*
	Williamson's sapsucker	*Sphyrapicus thyroideus*

Endangered and Threatened Species

	Common Name	Latin Name
Fish	Coho salmon	*Oncorhynchus kisutch*
	Kokanee	*Oncorhynchus nerka*
	Sockeye salmon	*Oncorhynchus nerka*
	Chinook salmon	*Oncorhynchus tshawytscha*
	Coastrange sculpin	*Cottus aleuticus*
Terrestrial and Riparian Vertebrates	Horned lark	*Eremophila alpestris*
	Yellow-breasted chat	*Icteria virens*
	Red crossbill	*Loxia curvirostra*
	Little brown bat	*Myotis lucifugus*
	Sage thrasher	*Oreoscoptes montanus*
	Vesper sparrow	*Pooecetes gramineus*
	Williamson's sapsucker	*Sphyrapicus thyroideus*
	Northern saw-whet owl	*Aegolius acadius*
	Marbled murrelet	*Brachyramphus marmoratus*
	Common nighthawk	*Chordeiles minor*
	Olive-sided flycatcher	*Contopus cooperi*
	Bobolink	*Dolichonyx oryzivorus*
	Barn swallow	*Hirundo rustica*
	American marten	*Martes Americana*
	Western screech owl	*Megascops kennicottii*
	Lewis' woodpecker	*Melanerpes lewis*
	Short-tailed weasel	*Mustela erminea*
	Sand martin	*Riparia riparia*

High Overlap with Run-of-River potential

	Common Name	Latin Name
Fish	Westslope cutthroat trout	*Oncorhynchus clarki lewisi*
	Coastal cutthroat trout	*Oncorhynchus clarki clarki*
	Coho salmon	*Oncorhynchus kisutch*
	Steelhead	*Oncorhynchus mykiss*
	Chum salmon	*Oncorhynchus keta*
	Bull trout	*Salvelinus confluentus*
	Kokanee	*Oncorhynchus nerka*
	Pink salmon	*Oncorhynchus gorbuscha*
	Dolly varden	*Salvelinus malma*
	Chinook salmon	*Oncorhynchus tshawytscha*
	Rainbow trout	*Oncorhynchus mykiss*
	Coastrange sculpin	*Cottus aleuticus*
	Sockeye salmon	*Oncorhynchus nerka*
Terrestrial and Riparian Vertebrates	Northwest salamander	*Ambystoma gracile*
	Wandering salamander	*Aneides vagrans*
	Coastal tailed frog	*Ascaphus truei*
	Sooty grouse	*Dendragapus fuliginosus*
	Townsend's vole	*Microtus townsendii*

	Band-tailed pigeon	*Patagioenas fasciata*
	Western red-backed salamander	*Plethodon vehiculum*
	Chestnut-backed chickedee	*Poecile rufescens*
	Red-legged frog	*Rana aurora*
	Black-throated gray warbler	*Setophaga nigrescens*
	Rough-skin newt	*Taricha granulosa*
	Northwestern garter snake	*Thamnophis ordinoides*
	Hutton's vireo	*Vireo huttoni*

All Species

Fish and wildlife species included in the *All Species* model (BC Conservation Status ranks: 1 = critically imperiled, 2 = imperiled, 3 = special concern, vulnerable to extirpation of extinction, 4 = apparently secure, 5 = demonstrably widespread, abundant, and secure, NA = not applicable, NR = unranked).

Species Name	Common Name	Taxon	Habitat Classification	Provincial Conservation Status
Oncohynchus gorbuscha	Pink salmon	Anad. Salmon	Aquatic	5
Oncorhynchus keta	Chum salmon	Anad. Salmon	Aquatic	5
Oncorhynchus kisutch	Coho salmon	Anad. Salmon	Aquatic	4
Oncorhynchus mykiss	Steelhead	Anad. Salmon	Aquatic	5
Oncorhynchus nerka	Sockeye salmon	Anad. Salmon	Aquatic	4
Oncorhynchus tshawytscha	Chinook salmon	Anad. Salmon	Aquatic	4
Accipiter cooperii	Cooper's hawk	Bird	Forest generalist	4
Accipiter gentilis	Northern goshawk	Bird	Forest generalist	2
Accipiter striatus	Sharp-shinned hawk	Bird	Forest generalist	5
Actitis macularius	Spotted sandpiper	Bird	Non-forest	5
Aechmophorus clarkii	Clark's grebe	Bird	Non-forest	1
Aechmophorus occidentalis	Western grebe	Bird	Non-forest	1
Aegolius acadicus	Northern saw-whet owl	Bird	Forest generalist	5
Aegolius funereus	Boreal owl	Bird	Forest generalist	4
Aeronautes saxatalis	White-throated swift	Bird	Non-forest	4
Agelaius phoeniceus	Red-winged blackbird	Bird	Non-forest	5
Aix sponsa	Wood duck	Bird	Forest generalist	4
Ammodramus savannarum	Grasshopper sparrow	Bird	Non-forest	1
Anas acuta	Northern pintail	Bird	Non-forest	4
Anas americana	American widgeon	Bird	Non-forest	5
Anas clypeata	Northern shoveler	Bird	Non-forest	5
Anas crecca	Green-winged teal	Bird	Non-forest	5
Anas cyanoptera	Cinnamon teal	Bird	Non-forest	4
Anas discors	Blue-winged teal	Bird	Non-forest	4
Anas penelope	Eurasian widgeon	Bird	Non-forest	NA

Anas platyrhynchos	Mallard	Bird	Non-forest	5
Anas strepera	Gadwall	Bird	Non-forest	5
Anser albifrons	Greater white-fronted goose	Bird	Non-forest	4
Anthus rubescens	American pipit	Bird	Non-forest	5
Aquila chrysaetos	Golden eagle	Bird	Forest generalist	4
Archilochus alexandri	Black-chinned hummingbird	Bird	Forest generalist	4
Ardea herodias	Great blue heron	Bird	Forest generalist	3
Arenaria melanocephala	Black turnstone	Bird	Non-forest	4
Asio flammeus	Short-eared owl	Bird	Non-forest	3
Asio otus	Long-eared owl	Bird	Forest generalist	4
Aythya affinis	Lesser scaup	Bird	Non-forest	4
Aythya americana	Redhead	Bird	Non-forest	4
Aythya collaris	Ring-necked duck	Bird	Forest generalist	5
Aythya marila	Greater scaup	Bird	Non-forest	4
Aythya valisineria	Canvasback	Bird	Non-forest	4
Bombycilla cedrorum	Cedar waxwing	Bird	Forest generalist	5
Bombycilla garrulus	Bohemian waxwing	Bird	Forest generalist	5
Bonasa umbellus	Ruffed grouse	Bird	Forest specialist	4
Botaurus lentiginosus	American bittern	Bird	Non-forest	3
Brachyramphus marmoratus	Marbled murrelet	Bird	Forest specialist	3
Branta bernicla	Brant	Bird	Non-forest	3
Branta canadensis	Canada goose	Bird	Non-forest	5
Branta hutchinsii	Cackling goose	Bird	Non-forest	3
Bubo scandiacus	Snowy owl	Bird	Non-forest	3
Bubo virginianus	Great-horned owl	Bird	Forest generalist	5
Bucephala albeola	Bufflehead	Bird	Forest generalist	5
Bucephala clangula	Common goldeneye	Bird	Forest generalist	4
Bucephala islandica	Barrow's goldeneye	Bird	Forest generalist	4
Buteo jamaicensis	Red-tailed hawk	Bird	Forest generalist	5
Buteo lagopus	Rough-legged hawk	Bird	Non-forest	2
Buteo platypterus	Broad-winged hawk	Bird	Forest generalist	3
Buteo swainsoni	Swainson's hawk	Bird	Forest generalist	2
Butorides virescens	Green heron	Bird	Non-forest	3
Calcarius lapponicus	Lapland longspur	Bird	Non-forest	NA
Calidris alba	Snaderling	Bird	Non-forest	4
Calidris alpina	Dunlin	Bird	Non-forest	4
Calidris bairdii	Baird's sandpiper	Bird	Non-forest	UN
Calidris himantopus	Stilt sandpiper	Bird	Non-forest	NA
Calidris mauri	Western sandpiper	Bird	Non-forest	4
Calidris melanotos	Pectoral sandpiper	Bird	Non-forest	5
Calidris minutilla	Least sandpiper	Bird	Non-forest	4
Calidris pusilla	Semipalmated sandpiper	Bird	Non-forest	NA
Calypte anna	Anna's hummingbird	Bird	Forest generalist	4

Cardellina pusilla	Wilson's warbler	Bird	Forest generalist	4
Carduelis flammea	Common redpoll	Bird	Forest generalist	4
Carduelis hornemanni	Hoary redpoll	Bird	Non-forest	NA
Carduelis pinus	Pine siskin	Bird	Forest generalist	4
Carduelis tristis	American goldfinch	Bird	Forest generalist	4
Carpodacus cassinii	Cassin's finch	Bird	Forest generalist	5
Carpodacus mexicanus	House finch	Bird	Forest generalist	5
Carpodacus purpureus	Purple finch	Bird	Forest generalist	4
Cathartes aura	Turkey vulture	Bird	Forest generalist	4
Catharus fuscescens	Veery	Bird	Forest generalist	4
Catharus guttatus5	Hermit thrush	Bird	Forest generalist	5
Catharus ustulatus	Swainson's thrush	Bird	Non-forest	3
Catherpes mexicanus	Canyon wren	Bird	Non-forest	3
Cepphus columba	Pigeon guillemot	Bird	Non-forest	4
Cerorhinca monocerata	Rhinoceros auklet	Bird	Non-forest	4
Certhia americana	Brown creeper	Bird	Forest specialist	4
Chaetura vauxi	Vaux's swift	Bird	Forest specialist	4
Charadrius semipalmatus	Semipalmated plover	Bird	Non-forest	4
Charadrius vociferus	Killdeer	Bird	Non-forest	4
Chen caerulescens	Snow goose	Bird	Non-forest	4
Chlidonias niger	Black tern	Bird	Non-forest	4
Chondestes grammacus	Lark sparrow	Bird	Non-forest	2
Chordeiles minor	Common nighthawk	Bird	Non-forest	4
Chroicocephalus philadelphia	Bonaparte's gull	Bird	Forest generalist	5
Cinclus mexicanus	American dipper	Bird	Forest generalist	5
Circus cyaneus	Northern harrier	Bird	Non-forest	4
Cistothorus palustris	Marsh wren	Bird	Non-forest	5
Clangula hyemalis	Long-tailed duck	Bird	Non-forest	2
Coccothraustes vespertinus	Evening grosbeak	Bird	Forest generalist	5
Colaptes auratus	Northern flicker	Bird	Forest generalist	5
Contopus cooperi	Olive-sided flycatcher	Bird	Forest generalist	3
Contopus sordidulus	Western wood pewee	Bird	Forest generalist	4
Corvus brachyrhynchos	American crow	Bird	Forest generalist	5
Corvus caurinus	Northwestern crow	Bird	Forest generalist	5
Corvus corax	Common raven	Bird	Forest generalist	5
Cyanocitta cristata	Blue-jay	Bird	Forest generalist	4
Cyanocitta stelleri	Steller's jay	Bird	Forest generalist	5
Cygnus buccinator	Trumpeter swan	Bird	Non-forest	4
Cygnus columbianus	Tundra swan	Bird	Non-forest	3
Cygnus olor	Mute swan	Bird	Non-forest	NA
Cypseloides niger	American black swift	Bird	Non-forest	4
Dendragapus fuliginosus	Sooty grouse	Bird	Forest generalist	3
Dendragapus obscurus	Dusky grouse	Bird	Forest generalist	4

Dendroica petechia	American yellow warbler	Bird	Forest generalist	4
Dendroica townsendi	Townsend's warbler	Bird	Forest generalist	5
Dolichonyx oryzivorus	Bobolink	Bird	Non-forest	3
Dryocopus pileatus	Pileated woodpecker	Bird	Forest specialist	5
Dumetella carolinensis	Gray catbird	Bird	Non-forest	5
Empidonax alnorum	Alder flycatcher	Bird	Forest generalist	5
Empidonax difficilis	Pacific-slope flycatcher	Bird	Forest generalist	4
Empidonax flaviventris	Yellow-bellied flycatcher	Bird	Forest generalist	4
Empidonax hammondii	Hammond's flycatcher	Bird	Forest generalist	5
Empidonax minimus	Least flycatcher	Bird	Forest generalist	5
Empidonax oberholseri	American dusky flycatcher	Bird	Forest generalist	5
Empidonax occidentalis	Cordilleran flycatcher	Bird	Forest generalist	NA
Empidonax traillii	Willow flycatcher	Bird	Forest generalist	4
Empidonax wrightii	Gray flycatcher	Bird	Forest specialist	3
Eremophila alpestris	Horned lark	Bird	Non-forest	4
Euphagus carolinus	Rusty blackbird	Bird	Forest generalist	3
Euphagus cyanocephalus	Brewer's blackbird	Bird	Forest generalist	5
Falcipennis canadensis	Spruce grouse	Bird	Forest generalist	5
Falco columbarius	Merlin	Bird	Forest generalist	5
Falco mexicanus	Prairie falcon	Bird	Non-forest	1
Falco peregrinus	Peregrine falcon	Bird	Non-forest	3
Falco rusticolus	Gyrfalcon	Bird	Non-forest	3
Falco sparverius	American kestrel	Bird	Forest generalist	4
Fulica americana	American coot	Bird	Non-forest	4
Gallinago delicata	Wilson's snipe	Bird	Non-forest	4
Gavia immer	Common loon	Bird	Non-forest	5
Gavia pacifica	Pacific loon	Bird	Non-forest	4
Gavia stellata	Red-throated loon	Bird	Non-forest	4
Geothlypis tolmiei	MacGillivray's warbler	Bird	Forest generalist	4
Geothlypis trichas	Common yellowthroat	Bird	Non-forest	5
Glaucidium gnoma	Northern pygmy owl	Bird	Forest generalist	4
Glaucomys sabrinus	Northern flying squirrel	Bird	Forest generalist	5
Grus canadensis	Sandhill crane	Bird	Non-forest	4
Haematopus bachmani	Black oystercatcher	Bird	Non-forest	4
Haliaeetus leucocephalus	Bald eagle	Bird	Forest generalist	5
Himantopus mexicanus	Black-necked stilt	Bird	Non-forest	NA
Hirundo rustica	Barn swallow	Bird	Non-forest	3
Histrionicus histrionicus	Harlequin duck	Bird	Non-forest	3
Hydroprogne caspia	Caspian tern	Bird	Non-forest	3
Icteria virens	Yellow-breasted chat	Bird	Forest generalist	1
Icterus bullockii	Bullock's oriole	Bird	Forest generalist	5
Icterus galbula	Baltimore oriole	Bird	Forest generalist	4
Ixoreus naevius	Varied thrush	Bird	Forest generalist	5

Junco hyemalis	Dark-eyed junco	Bird	Forest generalist	5
Lagopus lagopus	Willow ptarmigan	Bird	Non-forest	5
Lagopus leucura	White-tailed ptarmigan	Bird	Non-forest	5
Lagopus muta	Rock ptarmigan	Bird	Non-forest	5
Lanius excubitor	Norhtern shrike	Bird	Forest generalist	4
Larus argentatus	Herring gull	Bird	Non-forest	4
Larus californicus	California gull	Bird	Non-forest	3
Larus canus	Common gull	Bird	Non-forest	5
Larus delawarensis	Ring-billed gull	Bird	Non-forest	4
Larus glaucescens	Glaucous-winged gull	Bird	Non-forest	5
Larus hyperboreus	Glaucous gull	Bird	Non-forest	NR
Larus occidentalis	Western gull	Bird	Non-forest	4
Larus thayeri	Thayer's gull	Bird	Non-forest	5
Leucophaeus pipixcan	Fanklin's gull	Bird	Non-forest	4
Leucosticte tephrocotis	Gray-crowned rosy finch	Bird	Non-forest	5
Limnodromus griseus	Short-billed dowitcher	Bird	Non-forest	2
Limnodromus scolopaceus	Long-billed dowticher	Bird	Non-forest	5
Limosa haemastica	Hudsonian godwit	Bird	Non-forest	1
Lophodytes cucullatus	Hooded merganser	Bird	Forest generalist	5
Loxia curvirostra	Red crossbill	Bird	Forest generalist	4
Loxia leucoptera	Two-barred crossbill	Bird	Forest generalist	5
Megaceryle alcyon	Belted kingfisher	Bird	Forest generalist	4
Megascops kennicottii	Western screech-owl	Bird	Forest generalist	4
Melanerpes lewis	Lewis's woodpecker	Bird	Forest generalist	2
Melanitta fusca	Velvet scooter	Bird	Non-forest	4
Melanitta nigra	Common scoter	Bird	Non-forest	4
Melanitta perspicillata	Surf scoter	Bird	Non-forest	3
Melospiza georgiana	Swamp sparrow	Bird	Non-forest	4
Melospiza lincolnii	Lincoln's sparrow	Bird	Non-forest	5
Melospiza melodia	Song sparrow	Bird	Non-forest	5
Mergus merganser	Common merganser	Bird	Non-forest	5
Mergus serrator	Red-breasted merganser	Bird	Non-forest	5
Mniotilta varia	Black and white warbler	Bird	Forest generalist	4
Molothrus ater	Brown-headed cowbird	Bird	Forest generalist	5
Myadestes townsendi	Townsend's solitaire	Bird	Forest generalist	4
Nucifraga columbiana	Clark's nutcracker	Bird	Forest generalist	5
Numenius americanus	Long-billed curlew	Bird	Non-forest	3
Numenius phaeopus	Whimbrel	Bird	Non-forest	4
Oreoscoptes montanus	Sage thrasher	Bird	Non-forest	1
Oreothlypis celata	Orange-crowned warbler	Bird	Forest generalist	5
Oreothlypis peregrina	Tennessee warbler	Bird	Forest generalist	5
Oreothlypis ruficapilla	Nashville warbler	Bird	Forest generalist	5
Otus flammeolus	Flammulated owl	Bird	Forest specialist	3

Oxyura jamaicensis	Ruddy duck	Bird	Non-forest	5
Pandion haliaetus	Osprey	Bird	Forest generalist	5
Parkesia noveboracensis	Northern waterthrush	Bird	Forest generalist	5
Passerculus sandwichensis	Savannah sparrow	Bird	Forest generalist	4
Passerella iliaca	Fox sparrow	Bird	Forest generalist	5
Passerina amoena	Lazuli bunting	Bird	Non-forest	5
Patagioenas fasciata	Band-tailed pigeon	Bird	Forest generalist	3
Pelecanus erythrorhynchos	American white pelican	Bird	Non-forest	1
Perisoreus canadensis	Gray jay	Bird	Forest generalist	5
Petrochelidon pyrrhonota	Cliff swallow	Bird	Non-forest	4
Phalacrocorax auritus	Double-crested cormorant	Bird	Forest generalist	3
Phalacrocorax pelagicus	Pelagic cormorant	Bird	Non-forest	4
Phalacrocorax penicillatus	Brandt's cormorant	Bird	Non-forest	4
Phalaenoptilus nuttallii	Common poorwill	Bird	Non-forest	4
Phalaropus lobatus	Red-necked pharalope	Bird	Non-forest	3
Phalaropus tricolor	Wilson's pharalope	Bird	Non-forest	4
Pheucticus ludovicianus	Rose-breasted grosbreak	Bird	Forest generalist	4
Pheucticus melanocephalus	Black-headed grosbeak	Bird	Forest generalist	5
Pica hudsonia	Black-billed magpie	Bird	Forest generalist	5
Picoides arcticus	Black-backed woodpecker	Bird	Forest generalist	5
Picoides dorsalis	American three-toed woodpecker	Bird	Forest specialist	5
Picoides pubescens	Downy woodpecker	Bird	Forest generalist	5
Picoides villosus	Hairy woodpecker	Bird	Forest generalist	5
Pinicola enucleator	Pine grosbeak	Bird	Forest generalist	5
Pipilo maculatus	Spotted towhee	Bird	Forest generalist	5
Piranga ludoviciana	Western tanager	Bird	Forest generalist	5
Plectrophenax nivalis	Snow bunting	Bird	Non-forest	4
Pluvialis dominica	American golden plover	Bird	Non-forest	3
Pluvialis squatarola	Black-bellied plover	Bird	Non-forest	5
Podiceps auritus	Horned grebe	Bird	Non-forest	4
Podiceps grisegena	Red-necked grebe	Bird	Non-forest	4
Podiceps nigricollis	Eared grebe	Bird	Non-forest	4
Podilymbus podiceps	Pie-billed grebe	Bird	Non-forest	4
Poecile atricapillus	Black-capped chickadee	Bird	Forest generalist	5
Poecile gambeli	Mountain chickadee	Bird	Forest generalist	5
Poecile hudsonica	Boreal chickadee	Bird	Forest generalist	5
Poecile rufescens	Chestnut-backed chickadee	Bird	Forest generalist	4
Pooecetes gramineus	Vesper sparrow	Bird	Non-forest	4
Porzana carolina	Sora	Bird	Non-forest	4
Progne subis	Purple martin	Bird	Forest generalist	2
Psaltriparus minimus	American bushtit	Bird	Forest generalist	5
Quiscalus quiscula	Common grackle	Bird	Forest generalist	5

Rallus limicola	Virginia rail	Bird	Non-forest	4
Recurvirostra americana	American avocet	Bird	Non-forest	2
Regulus calendula	Ruby-crowned kinglet	Bird	Forest specialist	5
Regulus satrapa	Golden-crowned kinglet	Bird	Forest specialist	5
Riparia riparia	Sand martin	Bird	Non-forest	4
Salpinctes obsoletus	Rock wren	Bird	Non-forest	4
Sayornis phoebe	Eastern phoebe	Bird	Forest generalist	4
Sayornis saya	Say's phoebe	Bird	Non-forest	5
Seiurus aurocapilla	Ovenbird	Bird	Forest generalist	4
Seiurus noveboracensis	Northern waterthrush	Bird	Forest generalist	5
Selasphorus calliope	Calliope hummingbird	Bird	Forest generalist	5
Selasphorus rufus	Rufous hummingbird	Bird	Forest generalist	4
Setophaga auduboni	Audobon's warbler	Bird	Forest generalist	NA
Setophaga coronata	Yellow-rumped warbler	Bird	Forest generalist	5
Setophaga magnolia	Magnolia warbler	Bird	Forest generalist	4
Setophaga nigrescens	Black-throated gray warbler	Bird	Forest generalist	4
Setophaga ruticilla	American redstart	Bird	Forest generalist	5
Setophaga striata	Blackpoll warbler	Bird	Forest generalist	5
Sialia currucoides	Mountain bluebird	Bird	Non-forest	4
Sialia mexicana	Western bluebird	Bird	Forest generalist	4
Sitta canadensis	Red-breasted nuthatch	Bird	Forest generalist	5
Sitta carolinensis	White-breasted nuthatch	Bird	Forest generalist	5
Sitta pygmaea	Pygmy nuthatch	Bird	Forest specialist	4
Sphyrapicus nuchalis	Red-naped sapsucker	Bird	Forest specialist	5
Sphyrapicus ruber	Red-breasted sapsucker	Bird	Forest generalist	5
Sphyrapicus thyroideus	Williamson's sapsucker	Bird	Forest generalist	3
Sphyrapicus varius	Yellow-bellied sapsucker	Bird	Forest generalist	5
Spizella arborea	American tree sparrow	Bird	Forest generalist	5
Spizella breweri	Brewer's sparrow	Bird	Non-forest	4
Spizella pallida	Clay-colored sparrow	Bird	Forest generalist	4
Spizella passerina	Chipping sparrow	Bird	Forest generalist	5
Stelgidopteryx serripennis	Northern rough-winged swallow	Bird	Non-forest	4
Stercorarius parasiticus	Parasitic jaeger	Bird	Non-forest	1
Sterna forsteri	Foster's tern	Bird	Non-forest	1
Sterna hirundo	Common tern	Bird	Non-forest	4
Sterna paradisaea	Arctic tern	Bird	Non-forest	4
Strix nebulosa	Great gray owl	Bird	Forest specialist	4
Strix varia	Barred owl	Bird	Forest generalist	5
Sturnella neglecta	Western meadowlark	Bird	Non-forest	4
Surnia ulula	Northern hawk-owl	Bird	Forest generalist	4
Synthliboramphus antiquus	Ancient murrelet	Bird	Forest generalist	2
Tachycineta bicolor	Tree swallow	Bird	Forest generalist	4

Tachycineta thalassina	Violet-green swallow	Bird	Forest generalist	4
Thryomanes bewickii	Bewick's wren	Bird	Forest generalist	4
Tringa flavipes	Lesser yellowlegs	Bird	Non-forest	5
Tringa incana	Wandering tattler	Bird	Non-forest	3
Tringa melanoleuca	Greater yellowlegs	Bird	Non-forest	5
Tringa solitaria	Solitary sandpiper	Bird	Non-forest	5
Troglodytes aedon	House wren	Bird	Forest generalist	5
Troglodytes hiemalis	Winter wren	Bird	Forest specialist	5
Troglodytes pacificus	Pacific wren	Bird	Forest generalist	5
Turdus migratorius	American robin	Bird	Forest generalist	5
Tympanuchus phasianellus	Sharp-tailed grouse	Bird	Non-forest	4
Tyrannus tyrannus	Eastern kingbird	Bird	Forest generalist	4
Tyrannus verticalis	Western kingbird	Bird	Forest generalist	4
Tyto alba	Barn owl	Bird	Non-forest	3
Uria aalge	Common murre	Bird	Non-forest	2
Vireo cassinii	Cassin's vireo	Bird	Forest generalist	5
Vireo gilvus	Warbling vireo	Bird	Forest generalist	5
Vireo huttoni	Hutton's vireo	Bird	Forest generalist	4
Vireo olivaceus	Red-eyed vireo	Bird	Forest generalist	4
Vireo solitarius	Blue-headed vireo	Bird	Forest generalist	4
Xanthocephalus xanthocephalus	Yellow-headed blackbird	Bird	Non-forest	4
Zenaida macroura	Mourning dove	Bird	Forest generalist	4
Zonotrichia albicollis	White-throated sparrow	Bird	Forest generalist	5
Zonotrichia atricapilla	Golden-crowned sparrow	Bird	Non-forest	5
Zonotrichia leucophrys	White-crowned sparrow	Bird	Forest generalist	5
Zonotrichia querula	Harris's sparrow	Bird	Forest generalist	NA
Achrocheilus alutaceus	Chiselmouth	Fish	Aquatic	3
Acipenser transmontanus	White sturgeon	Fish	Aquatic	2
Catostomus catostomus	Longnose sucker	Fish	Aquatic	5
Catostomus columbianus	Bridgelip sucker	Fish	Aquatic	5
Catostomus commersonii	White sucker	Fish	Aquatic	5
Catostomus macrocheilus	Largescale sucker	Fish	Aquatic	5
Coregonus clupeaformis	Lake whitefish	Fish	Aquatic	5
Cottus aleuticus	Coastrange sculpin	Fish	Aquatic	5
Cottus asper	Prickly sculpin	Fish	Aquatic	5
Cottus cognatus	Slimy sculpin	Fish	Aquatic	5
Couesius plumbeus	Lake chub	Fish	Aquatic	5
Esox lucius	Northern pike	Fish	Aquatic	5
Gasterosteus aculeatus	Threespine stickleback	Fish	Aquatic	5
Lota lota	Burbot	Fish	Aquatic	4
Mylocheilus caurinus	Peamouth chub	Fish	Aquatic	5
Oncorhynchus clarkia clarkii	Coastal cutthroat trout	Fish	Aquatic	3
Oncorhynchus clarkia lewisi	Westslope cutthroat trout	Fish	Aquatic	3

Oncorhynchus mykiss	Rainbow trout	Fish	Aquatic	5
Oncorhynchus nerka	Kokanee	Fish	Aquatic	4
Percopsis omiscomaycus	Trout-perch	Fish	Aquatic	4
Prosopium coulterii	Pygmy whitefish	Fish	Aquatic	4
Prosopium williamsoni	Mountain whitefish	Fish	Aquatic	5
Ptychocheilus oregonensis	Northern pikeminnow	Fish	Aquatic	5
Rhinichthys cataractae	Longnose dace	Fish	Aquatic	5
Rhinichtys falcatus	Leopard dace	Fish	Aquatic	4
Richardsonius balteatus	Redside shiner	Fish	Aquatic	5
Salvelinus confluentus	Bull trout	Fish	Aquatic	3
Salvelinus malma	Dolly varden	Fish	Aquatic	4
Salvelinus namaycush	Lake trout	Fish	Aquatic	4
Sander vitreus	Walleye	Fish	Aquatic	4
Thymallus arcticus	Arctic grayling	Fish	Aquatic	5
Ambystoma gracile	Northwestern salamander	Herpetile	Forest generalist	4
Ambystoma macrodactylum	Long-toed salamander	Herpetile	Forest generalist	4
Anaxyrus boreas	Western toad	Herpetile	Forest generalist	3
Aneides vagrans	Wandering salamander	Herpetile	Forest generalist	3
Ascaphus truei	Coastal Tailed Frog	Herpetile	Forest specialist	3
Lithobates sylvaticus	Wood frog	Herpetile	Forest generalist	4
Plethodon vehiculum	Western redback salamander	Herpetile	Forest generalist	4
Pseudacris regilla	Pacific tree frog	Herpetile	Forest generalist	5
Rana aurora	Northern red-legged frog	Herpetile	Forest generalist	3
Rana luteiventris	Columbia spotted frog	Herpetile	Non-forest	4
Spea hammondii	Western spadefoot	Herpetile	Non-forest	NA
Taricha granulosa	Rough-skinned newt	Herpetile	Forest generalist	4
Thamnophis elegans	Western garter snake	Herpetile	Forest generalist	5
Thamnophis ordinoides	NW garter snake	Herpetile	Non-forest	4
Thamnophis sirtalis	Common garter snake	Herpetile	Forest generalist	5
Lemmus sibiricus	Siberian brown lemming	Mammal	Non-forest	5
Lepus americanus	Snowshoe hare	Mammal	Forest generalist	5
Martes americana	American marten	Mammal	Forest specialist	4
Martes pennanti	Fisher	Mammal	Forest generalist	2
Microtus longicaudus	Long-tailed vole	Mammal	Forest generalist	5
Microtus pennsylvanicus	Meadow vole	Mammal	Non-forest	5
Microtus townsendii	Townsend's vole	Mammal	Non-forest	5
Mustela erminea	Stoat	Mammal	Forest generalist	5
Myodes gapperi	Southern red-backed vole	Mammal	Forest generalist	5
Myodes rutilus	Northern red-backed vole	Mammal	Forest generalist	5
Myotis lucifugus	Little brown bat	Mammal	Forest generalist	4
Neotoma cinerea	Bushy-tailed woodrat	Mammal	Forest generalist	5
Neovison vison	American mink	Mammal	Forest generalist	5
Ochotona princeps	American pika	Mammal	Forest specialist	5

Peromyscus keeni	Northwestern deer mouse	Mammal	Forest specialist	5
Peromyscus maniculatus	Deer mouse	Mammal	Forest generalist	5
Phenacomys intermedius	Western heather vole	Mammal	Forest generalist	5
Sorex cinereus	Cinereus shrew	Mammal	Forest generalist	5
Sorex monticolus	Montane shrew	Mammal	Forest generalist	5
Sorex vagrans	Vagrant shrew	Mammal	Forest generalist	5
Tamias amoenus	Yellow-pine chipmunk	Mammal	Forest generalist	5
Tamias minimus	Least chipmunk	Mammal	Forest generalist	5
Tamiasciurus hudsonicus	American red squirrel	Mammal	Forest generalist	5
Thomomys talpoides	Northern pocket gopher	Mammal	Non-forest	5
Zapus princeps	Western jumping mouse	Mammal	Non-forest	5

Glossary

Model	Series of steps in which users choose the Energy Target, Development Values, and Ecological Values (with or without Existing Disturbance) to generate a set of Run of River sites which meets specified constraints
Ecological Values	Fish habitat suitability models (37 species) and wildlife species distributions (341 species) and ecosystem services (recreational fisheries) with province-wide coverage
Development Values	Site-level data for potential Run of River project sites (from BC Hydro's Resource Options Report) • **Unit Energy Cost at Point of Interconnection** in $/MWh calculated in 2011 dollars based on the estimated capital and annual costs, energy production, project life, and discount rate (6% over 40 years) • **Amount of potential Annual Firm Energy** produced (electricity guaranteed to be available) in GWh/year • **Spatial Footprint** of each project and associated infrastructure (roads, powerlines) in hectares • **Distance** from town and cities in km (straight-line distance from town and cities to intake location)
Existing disturbance	Density of existing linear infrastructure (roads, powerlines, pipelines, railroads) and recent logging (1990-2012) with province-wide coverage; data used to constrain new development to watersheds with existing disturbance ('Yes')
Energy target	Amount of firm energy to be generated from potential Run of River projects (1000, 3000, 5000 and 7000 GWh/year); used to identify the top sites that meet user-specified model constraints. For reference, 5000 GWh/year represents ¼ to ½ of the BC electricity deficit forecasted for 2031
Model summary	Aggregate measures of Cost of Development, Aquatic Footprint (number of dams, length of penstocks), and Terrestrial Footprint (length of roads and powerlines) in graphical and table form for the set of Run of River sites identified in the model
Conservation planning	A form of assessment that relies on quantitative techniques to generate priorities for conservation and environmental planning problems, aimed at informing decision-making

Probability of occurrence	Probability of a species being present in a particular location predicted based on a set of habitat and/or climatic conditions. Probabilities are calculated using habitat suitability modeling (for fish) or ecological niche modeling (for mammals, birds, reptiles and amphibians) using actual species localities. The maps show the actual data used in the prioritization process. For multiple species, the map is a visualization of the summed individual probabilities
Model weights	How important the model determines each attribute to be when it runs that algorithm. Model weights of 1:1 indicate that attributes are weighted equally, with no mathematical emphasis given to either attribute. Model weights of 4:1 means that the first attribute is considered 4 times more important by the algorithm when choosing sites – for example it may consider avoiding a species 4 times more important than choosing a cheap site.