

Climate Change Vulnerability of BC's Fish and Wildlife: Phase 2

An excel database with comments and detailed ratings accompanies this report. Please refer to the database for further information on the 130 species assessed to date. The database is intended to be refined and expanded.

FINAL DRAFT

March 21, 2017

Report prepared by Karen Price, Ruth Lloyd and Dave Daust

For Kathy Hopkins

BC Ministry of Forests, Lands, and Natural Resource Operations

Competitiveness and Innovation Branch

Acknowledgements

Thanks to Kathy Hopkins for initiating and discussing Phase 2 of this project.

Disclaimer: Due to the short time available to complete this project, most information is drawn from existing compilations rather than from primary literature.

Pre-ample to Phase 2

Introduction

BC's climate is changing with implications for ecosystems and fish and wildlife health. Climate-change vulnerability assessments measure the susceptibility to, and ability to cope with, adverse climate change effects¹. Vulnerability depends on the level of **exposure** to changed conditions (e.g., increased temperature, decreased stream flow), the **sensitivity** of a system to change (e.g., dependence on sensitive habitats, physiological tolerance), and the **adaptive capacity** to recover or adjust following change (e.g., reproductive rate, dispersal capability).

Phase 1 of this project outlined a framework to assess climate change vulnerability for BC's fish and wildlife species and ecosystems, used the framework to assess vulnerability for 63 high-priority species, and developed a database listing detailed ratings and rationales. The report also identified high-level adaptation strategies to reduce risks associated with climate change. Please see the full Phase 1 report for methodological details, results by species grouping, ecosystem results and discussion of mitigation options.

Phase 2 continued to populate the database with an additional 67 species, including those with a high priority for conservation, keystone and characteristic species, and species likely to be sensitive to climate change. Data limitations for some species prevent reliable assessment; hence data availability provided an additional filter. As in Phase 1, the assessment groups species by climate-relevant traits to create a coarse-filter classification and to identify broadly-applicable mitigation options.

The database provides initial assessment based on easily-accessible information. Ratings should be considered preliminary hypotheses prior to expert validation and update.

Using the Database

An excel workbook with vulnerability ratings, each accompanied by a rationale, provides the structure for the database. Ratings and information describe climate-change sensitivity in relation to habitat, abiotic factors and biotic factors, sensitivity to non-climate factors, and adaptive capacity as a function of reproductive rate and dispersal potential. The spreadsheet also lists potential mitigation actions and sources of information.

Current knowledge is limited for most species. To avoid false perceptions of precision, the assessment purposely uses a coarse rating system that combines severity and likelihood; four rating classes are appropriate to classify current knowledge for most species (Table 1). Exposure, sensitivity and adaptive capacity combine to determine vulnerability of a species or ecosystem to climate change. However, integrating these factors in a robust manner is challenging². Existing vulnerability indices combine factors to derive a single value, but results across indices are inconsistent, suggesting that the challenges of integration have not yet been met³. The assessment does not sum factors due to high uncertainty associated with many factors as well as the strong likelihood of unpredictable feedbacks and cascading impacts. For climate change sensitivity, the overall rating is based on the highest rating for habitat

sensitivity, abiotic and biotic factors, based on the assumption that a high rating in one category is not reduced by a lower rating in another.

Table 1. Ratings and interpretation.

Rating	Sensitivity to climate-change pressures	Sensitivity to non-climate-change pressures	Adaptive capacity	Potential actions
1	Likely not sensitive	Likely not sensitive	Moderate-good to good	Monitor
2	Somewhat sensitive/possibly very sensitive	Somewhat sensitive/possibly very sensitive	Moderate	Decrease uncertainty by increasing knowledge
3	Likely very sensitive	Likely very sensitive	Moderate-poor	Mitigate impacts
4	Known very sensitive	Known very sensitive	Poor to very poor	Mitigate impacts

The spreadsheet lists vulnerability ratings from other sources as well as ratings completed for this project. A “table of contents” sheet within the workbook describes meta-data (simplified in Table 2).

Table 2. Information included in spreadsheet. For more details, see Table of Contents page in workbook.

Species Description
<ul style="list-style-type: none"> • Phylogeny (unique number for sorting) • Habitat-based grouping • Scientific name (and alternatives) • Common name (and alternatives)
Ratings from a variety of assessments
<ul style="list-style-type: none"> • Sensitivity rating from the PNW Climate Sensitivity Database⁴ • Vulnerability rating from the NatureServe Climate Change Vulnerability Index for species in Alberta⁵ • Climate-change-based threat from recent COSEWIC reports (using IUCN threat calculator)⁶ • Intrinsic vulnerability rating from BC Conservation Status Reports⁷ • Vulnerability rating developed for this project
Sensitivity factors
<ul style="list-style-type: none"> • Dependence on sensitive habitats (rating and rationale) • Sensitivity to abiotic factors affected by climate change (rating and rationale) • Sensitivity to biotic factors affected by climate change (rating and rationale) • Sensitivity to non-climate factors (rating and rationale)
Adaptive capacity factors
<ul style="list-style-type: none"> • Reproductive capacity (rating and rationale) • Dispersal capacity (rating and rationale based on distance)

- Barriers to dispersal
- Adaptive capacity (summary of reproductive rating and dispersal rating, with added information on genetic diversity and phenotypic plasticity as available)

Summary, adaptation options and information sources

- Summary of climate change vulnerability
- Key mitigation options (= climate adaptation)
- Information sources
- Source certainty

Conservation Framework Priorities

- Highest priority rating for conservation framework goals 1 to 3⁸
- Priority rating for goal 1
- Priority rating for goal 2
- Priority rating for goal 3

Results

Phase 2 doubled the number of assessed fish from 10 to 20 species, completed assessment of all 20 of BC’s amphibians, assessed the first 5 reptiles, considerably expanded the number of assessed birds from 5 to 33 species (including sub-species in the cases where variation in vulnerability is likely high), and increased the number of assessed mammals from 34 to 52 species, for a total of 130 taxa.

Results found similar patterns to those in Phase 1. Some generalist species, and those adapted to unpredictable environments, will likely benefit; most specialised species will likely face stressors. Even species able to migrate to newly-suitable climates will likely be challenged by atypical ecosystems arising from changed disturbance patterns, increased variability, invasive species and new patterns of disease. Although some changes are predictable (e.g., loss of small wetlands, increased water temperature), surprises will be unavoidable. Disease outbreaks and ecosystem regime shifts may change conditions rapidly. Most amphibians, alpine birds and mammals, aerial insectivores, marine-interface birds, and anadromous and cold-water fish are highly sensitive to climate change (Table 3).

Table 3. Climate change sensitivity and adaptive capacity of 130 assessed taxa (Phase 1 and 2).

<i>Assessed Species</i>	<i>Climate Change Sensitivity</i> ¹	<i>Non-Climate Stressors</i>	<i>Adaptive Capacity</i> ²
AMPHIBIANS			
Stream dwelling			
Rocky Mountain Tailed Frog	M-H	H	V Poor
Coastal Tailed Frog	M-H	H	V Poor
Coastal Giant Salamander	M-H	M-H	V Poor
Small wetland breeding			
Western Toad	M-H	H	Poor
Great Basin Spadefoot	H	M-H	Mod-poor
Northern Leopard Frog	M-H	H	Mod-poor
Wood Frog	M-H	M	Poor
Northern Red-legged Frog	M-H	M-H	Mod-poor

<i>Assessed Species</i>	<i>Climate Change Sensitivity¹</i>	<i>Non-Climate Stressors</i>	<i>Adaptive Capacity²</i>
Boreal Chorus Frog	M-H	H	Poor
Northern Pacific Treefrog	M	M-H	Poor
Roughskin Newt	M-H	M	Poor
Long-toed Salamander	M-H	M	Mod-poor
Blotched Tiger Salamander	M-H	H	V Poor
Northwestern Salamander	M-H	M	NA
Large wetland frogs			
Columbia Spotted Frog	M	M-H	Mod-poor
Oregon Spotted Frog	M	H	Poor
Terrestrial salamanders			
Wandering Salamander	M-H	M-H	V Poor
Ensatina	M	M	NA
W Red-backed Salamander	M	M	Poor
Coeur d'Alene Salamander	H	H	V Poor
REPTILES			
Snakes and lizards			
Northern Rubber Boa	M	M-H	V Poor
North American Racer	M	M-H	Mod-poor
Western Rattlesnake	M	H	V Poor
Western Skink	M	M-H	V Poor
Turtles			
Painted Turtle	M-H	M-H	Mod-poor
BIRDS			
Aerial insectivores			
Black Swift	H	M-H	Mod-poor
Common Nighthawk	M-H	M-H	Moderate
Barn Swallow	M-H	M	Mod-good
Olive-sided Flycatcher	M-H	M-H	Mod-poor
Alpine/subalpine			
Red-necked Phalarope	M-H	M	Moderate
White-tailed Ptarmigan	H	L	Mod-poor
White-tailed Ptarmigan, saxatilis	H	L	Mod-poor
Clark's Nutcracker	H	H	Moderate
Snowy Owl	M-H	M	Mod-good
Brewer's Sparrow, taverni	M-H	L	Mod-good
Forest birds			
Red Crossbill	M	L	Mod-good
Northern goshawk	H	H	Moderate
Grasslands			
Swainson's Hawk	L	H	Mod-good
Long-billed Curlew	M	M-H	Moderate
Grasshopper Sparrow	M-H	H	Mod-good
Brewer's Sparrow, breweri	M-H	M-H	Mod-good
Mountain Bluebird	M	M-H	Mod-good

<i>Assessed Species</i>	<i>Climate Change Sensitivity¹</i>	<i>Non-Climate Stressors</i>	<i>Adaptive Capacity²</i>
Short-eared Owl	M	M-H	Mod-good
Insectivore			
Canada Warbler	M-H	H	Mod-good
Wilson's Warbler	M	M	Mod-good
Dusky Flycatcher	M	M	Mod-good
Marine Interface			
Marbled murrelet	M-H	H	Mod-poor
Black-belled Plover	H	M	Mod-good
Black Oystercatcher	H	M	Mod-poor
Great Blue Heron, fannini	H	H	Mod-poor
Double-crested Cormorant	M-H	M	Mod-poor
Brandt's Cormorant	M-H	M	Moderate
Wetland			
Canvasback	M-H	M	Mod-good
Barrow's goldeneye	M	M-H	Mod-good
Great Blue Heron, Herodias	M	M	Moderate
American bittern	M	M-H	NA
Western Grebe	L	M-H	Mod-good
MAMMALS			
Generalist			
Elk	M	M	Mod-good
White-tailed Deer	M	M	Mod-good
Mule Deer	M	M	Mod-good
Coyote	L	L	Mod-good
Grey Wolf	L	M	Mod-good
Red Fox	L	M	Mod-good
Canada Lynx	M	M	Mod-good
Ermine	M	L	Mod-poor
American Black Bear	L	M	Moderate
Grizzly Bear	M-H	H	Mod-poor
Snowshoe Hare	M	M-H	Mod-good
Bushy-tailed Woodrat	L	L	Mod-good
North American Porcupine	L	L	Moderate
Woodchuck	M	M	Mod-poor
Red-tailed Chipmunk	M	L	Mod-poor
Alpine specialists			
Hoary Marmot	H	L	Mod-poor
Yellow-bellied Marmot	H	L	Moderate
Vancouver Island Marmot	H	H	Mod-poor
Collared Pika	H	L	Poor
American Pika	H	L	Mod-poor
Northern Bog Lemming	H	NA	Mod-poor
Mountain Goat	H	M-H	Mod-poor
Wolverine	H	M_H	Mod-poor
Grassland specialists			
Wood and Plains Bison	M	H	Poor
Bighorn Sheep	M	M-H	Moderate

<i>Assessed Species</i>	<i>Climate Change Sensitivity¹</i>	<i>Non-Climate Stressors</i>	<i>Adaptive Capacity²</i>
Thinhorn Sheep	M	M	Moderate
American Badger	M	H	Moderate
Nuttall's Cottontail	M	M	Mod-good
Hibernators			
Western Jumping Mouse	M-H	L	Mod-poor
Old forest specialists			
Caribou	M-H	H	Moderate
American Marten	M-H	H	Mod-poor
Pacific Marten	M-H	H	Mod-poor
Southern Red-backed Vole	M	M	Moderate
Northern Flying Squirrel	M	M-H	Mod-poor
Red Squirrel	M	M	Moderate
Riparian specialists			
Moose	M-H	M-H	Mod-good
North American River Otter	M	M	Mod-good
Fisher	M	H	Moderate
Mountain Beaver	M-H	H	Poor
American Beaver	M	M	Moderate
North American Water Vole	M-H	M	Moderate
American Water Shrew	M	M	Mod-poor
Pacific Water Shrew	M	H	Mod-poor
Bats			
Hoary Bat	M	M	Mod-good
Pallid Bat	M	M-H	Moderate
Townsend's Big-eared Bat	M	M-H	Moderate
Spotted Bat	M	M	Poor
Little Brown Myotis	M	H	Moderate
Northern Myotis	M	H	Moderate
Keen's Myotis	M	M-H	Mod-poor
Northern Myotis	M	H	Moderate
Fossorial			
Townsend's Mole	M	H	Poor
FISH			
Anadromous			
Green Sturgeon	M-H	H	Moderate
Eulachon	H	M-H	Moderate
Coho Salmon	H	M-H	Mod-good
Chinook Salmon	H	M-H	Moderate
Sockeye Salmon	H	M-H	Mod-good
Cold water			
Mountain Sucker	H	H	Mod-poor
Rainbow Trout/Steelhead	H	M-H	Mod-good
Bull Trout	H	M-H	Moderate
Dolly Varden	H	H	Moderate
Arctic Grayling	M-H	M-H	Moderate
Shorthead Sculpin	M-H	M-H	Mod-poor
Columbia Sculpin	M-H	M-H	Mod-poor

<i>Assessed Species</i>	<i>Climate Change Sensitivity¹</i>	<i>Non-Climate Stressors</i>	<i>Adaptive Capacity²</i>
Cold water, lakes			
Burbot	H	M-H	Moderate
Lake Trout	H	M	Moderate
Warmer, gentler streams and rivers			
White Sturgeon	M-H	H	Poor
Chiselmouth	M	M	Mod-good
Umatilla Dace	M	H	Moderate
Coastal Cutthroat Trout	H	H	Mod-poor
Western Brook Lamprey	M	H	Mod-poor
Lake and/or stream residents			
Threespine stickleback	M	M	Mod-good

1. The highest value for sensitivity based on habitat, abiotic and biotic factors
2. Based on reproductive and dispersal capacity.

Discussion

Doubling the number of species assessed confirmed the potential of the framework. Habitat groupings developed in Phase 1 worked reasonably well, although not all species fit easily into boxes. For example, grassland/shrubland species generally rate as moderately sensitive to climate change, but some are more sensitive due to particular dependence on habitat structure or species composition—elements that might change with invasive species. We found that some bird sub-species have sufficiently different needs that they needed to be assessed separately.

Phase 2 included a new assessor with expertise related to birds. Becoming proficient in the framework took about two days of discussion and joint assessments. For the first 10 species, two assessors rated species independently. In all but one case, ratings were no more than one class apart, and two-thirds of ratings were the same. We found that creating a written summary of information (about one page per species) helped the team discuss ratings. The new assessor spent considerably longer on each species out of interest and to increase her confidence. We conclude that the extra eyes and experience helped, and that discussion was particularly helpful, but length of time required is higher. Future assessment would benefit from an assessor with expertise related to fish.

More than in Phase 1, we found that information sources varied tremendously in detail and reliability. We abandoned assessments of several species due to sparse data. It would be possible to use sparse data as an initial hypothesis; however, we decided to focus on summarising species with better information first.

Recommended Next Steps

Continue assessment

Current information exists to provide preliminary assessment for a total of 200-250 species, although information detail and reliability will decline for most groups. Birds are most amenable to expansion as knowledge is good for many species yet unassessed. An additional 30-50 species of birds could be

completed fairly readily. The list of mammals could be increased, although information for remaining species is fairly sparse. An additional 20 species of mammals could be assessed, though reliability would be considerably lower than for completed species. Reptiles could be expanded by at least 5 species. Fish could be expanded with additional sources. Increased fish expertise would be useful on an assessment team. Amphibians are completed.

We suggest that new assessors or assessment teams should communicate with previous assessors to ensure consistency in approach.

Review approach and ratings

Expert review and validation will be an important next step. Achieving consensus among large groups of experts on precise species ratings could be time-consuming. We suggest two routes: first, broad review of the utility of the approach and the ratings would be useful; second, workshops with small groups of specialists could discuss and document relative ratings and information reliability for a class. Group discussion could minimise the challenges associated with gathering individual expert opinions.

Develop process for updating and editing database

As knowledge improves and as the climate continues to change, it will be important to be able to add information to the database and update assessments appropriately. Establishing a structured process for updating and editing the database will help ensure that information represents consensus knowledge.

References

- ¹ Intergovernmental Panel on Climate Change. 2007. Climate Change 2007 Synthesis Report. P. 48
- ² Williams SE, Shoo LP, Isaac JL, Hoffmann AA, Langham G 2008. Towards an integrated framework for assessing the vulnerability of species to climate change. PLoS Biol 6(12): e325. doi:10.1371/journal.pbio.
- ³ Lankford AJ, Svancara LK, Lawler JJ, Vierling K. 2014 Comparison of climate change vulnerability assessments for wildlife. Wildlife Society Bulletin. 38:386-94.
- ⁴ Case MJ, Lawler JJ, Tomasevic JA. 2015. Relative sensitivity to climate change of species in northwestern North America. Biological Conservation. 187:127-33 <http://dx.doi.org/10.1016/j.biocon.2015.04.013>
- ⁵ Shank CS and Nixon A. 2014. Climate change vulnerability of Alberta's terrestrial biodiversity: a preliminary assessment. Biodiversity Management and Climate Change Adaptation Project. Alberta Biodiversity Monitoring Institute, Edmonton AB
- ⁶ COSEWIC homepage: <http://www.cosewic.gc.ca/default.asp?lang=En&n=A9DD45B7-1>
- ⁷ BC Species and Ecosystems Explore homepage: <http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/species-and-ecosystems-explorer>
- ⁸ From BC Species and Ecosystem Explorer