COSEWIC
Assessment and Status Report

on the

Steelhead Trout
Oncorhynchus mykiss

Thompson River population
Chilcotin River population

in Canada

ENDANGERED
2020

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

COSEWIC. 2018. Technical Summaries and Supporting Information for Emergency Assessments on the Steelhead Trout *Oncorhynchus mykiss* (Thompson River and Chilcotin River populations) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 26 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Truite arc-en-ciel anadrome (*Oncorhynchus mykiss*), population de la rivière Thompson et population de la rivière Chilcotin, au Canada.

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Steelhead Trout — Cover photo courtesy of A. Goodis.

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COSEWIC
Assessment Summary

Assessment Summary – November 2020

Common name
Steelhead Trout - Thompson River population

Scientific name
Oncorhynchus mykiss

Status
Endangered

Reason for designation
This population is among the longest migrating anadromous trout in Canada. It migrates from the headwaters of the Thompson River to the Bering Sea, returning after two years to swim up the Fraser River in the fall. Within the Thompson River watershed, this population is culturally significant and was an economic and food resource for Secwépemc and Nłeʔkpmx communities for thousands of years. Dramatic population declines over the last three generations are largely a consequence of declining habitat quality and reduced survival rates while at sea, due to factors such as interception by fisheries, competition from hatchery fish, and possible predation from pinnipeds. The returning numbers of spawners are now very low and future population reductions are expected

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Endangered in an emergency assessment conducted on January 10, 2018. Status re-examined and confirmed in November 2020.

Assessment Summary – November 2020

Common name
Steelhead Trout - Chilcotin River population

Scientific name
Oncorhynchus mykiss

Status
Endangered

Reason for designation
This population is among the longest migrating anadromous trout in Canada. It migrates from the headwaters of the Chilcotin River to the Bering Sea, returning after two years to swim up the Fraser River in the fall. Within the Chilcotin River watershed, this population is culturally significant and was an important economic and food resource for Tsilhqot'in communities for thousands of years. Dramatic population declines over the last three generations are largely a consequence of declining habitat quality and reduced survival rates while at sea, due to factors such as interception by fisheries, competition from hatchery fish, and possible predation from pinnipeds. Landslides such as occurred recently at Big Bar can also cause rapid declines for this population. The returning numbers of spawners are now very low and future population reductions are expected.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Endangered in an emergency assessment conducted on January 10, 2018. Status re-examined and confirmed in November 2020.

COSEWIC
Executive Summary

Steelhead Trout
Oncorhynchus mykiss

Wildlife Species Description and Significance

Steelhead (sometimes called “Steelhead Trout”) is an anadromous (sea-run) form of Rainbow Trout (*Oncorhynchus mykiss*) that returns to fresh water to spawn. The Steelhead populations endemic to the Thompson and Chilcotin River watersheds are the two designatable units that are assessed in this report. Steelhead grows to lengths exceeding a metre and weigh up to 19.5 kg at maturity. They are metallic blue on the back and silvery on the sides with black spots. Spawning males have a pink or red band running laterally along their sides. Steelhead is widely regarded as the premier sport fish in western North America and attracts anglers from around the globe to the area in pursuit of fishing opportunities. Steelhead from each of these designatable units was historically and is currently fished by a number of First Nations for food, social, and ceremonial purposes.

Cultural Significance

Secwépemc Traditional Knowledge identified the importance of Ts’egwllníw’t (Steelhead) fishing in their traditional territory within Thompson River watershed systems for food and the continuation of their traditional knowledge on fishing practices, fishing locations, language, cultural knowledge, practices, and experience that have far-reaching implications for the well-being of Secwépemc peoples. Skeetchestn and Bonaparte (St’uxtéws) Indian Bands are identified as resource caretaker (yecwminmen) communities for Thompson Steelhead.

Members of the Nłeʔkpmx Nation fished cóʕʷɬeʔ (Steelhead) during spring, within their traditional territory as a source of fresh protein (Tmixʷ Research 2019).

Distribution

Rainbow Trout and Steelhead are reported to spawn in North America from the Kuskokwim River of Alaska to Baja California in Mexico but have also been introduced to the Laurentian Great Lakes. In Asia, native Rainbow Trout and Steelhead exist in the Kamchatka region and extend from the Bering Sea in the north, to rivers flowing into the Sea of Okhotsk in the south. The Thompson and Chilcotin Steelhead inhabit the tributaries as well as the mainstem of the Thompson and Chilcotin Rivers as part of the interior Fraser River watershed.

Habitat

Steelhead freshwater habitat is characterized by clear, cold water, a silt-free rocky substrate in riffle-run areas with sections of slower, deep water. It should include well-vegetated stream banks, sufficient cobble and boulder cover, and relatively stable water flow and temperature regimes. They spend relatively little time in the Fraser River estuary migrating out of the Strait of Georgia into the broader Pacific Ocean. After spending two or three summers in the ocean they migrate back to their river of origin.

Biology

Steelhead has evolved a variety of life history forms. Spawning migrations can occur in most months of the year. However, Thompson and Chilcotin Steelhead populations migrate into the Fraser River from September to late November and hold in the Fraser mainstem until March. These fish move into tributaries for spawning which occurs from March to June. Thompson River Steelhead are larger and more fecund than other Fraser River populations averaging 12,600 eggs. Spawning is typically nocturnal, and females choose the sites and dig redds. Unlike salmon, Steelhead do not all die following spawning although repeat spawning is low, typically less than 5% for the Thompson and Chilcotin populations and repeat spawners are mostly female.

Eggs hatch in five to eight weeks depending on water temperature. Fry emerge from the gravel between mid-June to early July. Residence in freshwater lasts from 1 to 5 years with most Thompson Steelhead spending two and Chilcotin Steelhead three years before migrating to the sea. Transformation to smolts occurs at about 160 mm at which point they migrate to the ocean. There is a rapid downstream movement of Thompson River smolts to the Fraser River estuary of 10-20 days followed by a quick exit from the Strait of Georgia travelling some 400 km in 22 days. Most smolts from the Fraser River exit via the Strait of Juan de Fuca but some also head north through Johnstone Strait. Generally, less than 50% of the smolts survive these migrations out of the straits and recent return rates of adults back to home rivers are 1 to 4%. In the freshwater and marine environment Steelhead are preyed on by a number of fish, birds, and marine mammals.

Population Sizes and Trends

Estimates of spawning adults in the Thompson watershed are based on automated fish counters at the Deadman and Bonaparte rivers while visual boat counts in combination with radio tagging are used in the Nicola River. The Chilcotin spawning escapement is estimated visually from a series of helicopter overflights. The average number of Steelhead spawning from 2018 to 2020 is 216 mature individuals for the Thompson and 78 for the Chilcotin River. The number of mature individuals has declined by over 80% for each of these populations during the most recent three generations.

Threats and Limiting Factors

The threat to Thompson and Chilcotin Steelhead from fishing was rated as high impact. Natural systems modifications were also rated as a high impact threats in both freshwater and marine habitat.

Biological, physical, and chemical oceanographic conditions have affected carrying capacity as reflected in reduced productivity, growth, and survival. Reduced survival while at sea is considered an important factor in population declines since the early 1990s due to factors such as interception by fisheries, competition from hatchery fish, and possible predation from pinnipeds, and improvements in marine survival are essential to recovery.

The Thompson watershed has greater physical habitat degradations than the Chilcotin watershed. The Thompson River watershed has been affected by forestry, agriculture, water extraction, and urban development. The catastrophic infestation of Lodgepole Pine by Mountain Pine Beetle and the potential for forest fires is exacerbating the habitat threat in both systems.

Protection, Status and Ranks

The Thompson and Chilcotin Steelhead populations were emergency assessed by COSEWIC as Endangered in January 2018. However, in 2019 the Government of Canada elected not to list either Thompson or Chilcotin Steelhead under the *Species at Risk Act*. Instead, the Government of Canada and the Province of British Columbia (BC) developed the Interior Fraser Steelhead: BC/Canada Action Plan. The BC Government via BC Sport Fishing Regulations under the federal *Fisheries Act* controls sport harvest and closed the fishery indefinitely in 2018. Southern BC protections covering fishery and habitat are also in place through a federal Integrated Fisheries Management Plan, BC *Water Sustainability Act*, and the *Forest and Range Practices Act*.

A large number of United States Steelhead populations have been listed under the *Endangered Species Act*. Organizations such as NatureServe (2018) and the BC Conservation Data Centre have listed Thompson and Chilcotin Steelhead as S1.

TECHNICAL SUMMARY – Thompson River population

Oncorhynchus mykiss

Steelhead Trout (Thompson River population)

Truite arc-en-ciel anadrome (Population de la rivière Thompson)

Ts’egwllníw’t (Secwépemctsin)

cóʕʷłeʔ (NłeʔkpmxcinI)

Range of occurrence in Canada (province/territory/ocean): British Columbia, Pacific Ocean

Demographic Information

Generation time (usually average age of parents in the population)	5 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Estimated 71% continuing decline in total number of mature individuals in last 2 generations.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Estimated 82% reduction in total number of mature individuals over the last 3 generations
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Project an 82% reduction in the total number of mature individuals over the next 3 generations
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Estimated 82% reduction in total number of mature individuals during the last 3 generations and into the future.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No, although decline may be ameliorated by reduction in incidental fishing mortality and pinniped predation. b. No, primary factor is fishing mortality and possibly pinniped predation neither of which are clearly understood. Reduced survival in the marine environment also plays a poorly understood role in the decline. c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	>20,000 km² in the Pacific Ocean 9332 km² in freshwater
Index of area of occupancy (IAO) (Always report 2x2 grid value).	<500 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations" (use plausible range to reflect uncertainty if appropriate)	<=5
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Thompson River, includes spawning in the following tributaries: Deadman, Bonaparte, Coldwater rivers and Spius Creek and Nicola River in most recent survey year (2018) but these do not represent sub-populations.	216 (average from 2018-2020)
Total	216

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not calculated

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes. i. Biological resource use (High) • Fishing & harvesting aquatic resources (H) ii. Natural system modifications (High) • Dams & water management/use (L) • Other ecosystem modifications (H) iii. Invasive & other problematic species & genes (High-medium) • Problematic native species/diseases (H-M) iv. Pollution (Medium) • Domestic & urban waste water (L) • Industrial & military effluents (L) • Agricultural & forestry effluents (M) v. Geologic events (Low) • Avalanches/landslides What additional limiting factors are relevant? Limiting factors are defined as activities and processes that may not cause a population level decline, but limit growth, resilience, or recovery of the Wildlife Species. Limiting factors can become threats if a species has lost its resilience due to other threats and thus is prone to decline. The Thompson DU has high decline rates, small distributions, and small numbers of mature individuals. Hence, they can be considered to have lost resilience due to other threats and are prone to decline. As a result, several activities that might otherwise be described as limiting factors, such as, altered ocean and freshwater conditions, predation, competition and reduced prey in the ocean are described as threats

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Thompson Steelhead are endemic to this watershed and rescue is not possible from other Steelhead populations.
Is immigration known or possible?	NA
Would immigrants be adapted to survive in Canada?	NA
Is there sufficient habitat for immigrants in Canada?	NA
Are conditions deteriorating in Canada?+	NA
Are conditions for the source population deteriorating?+	NA
Is the Canadian population considered to be a sink?+	NA
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status History

COSEWIC: Designated Endangered in an emergency assessment conducted on January 10, 2018. Status re-examined and confirmed in November 2020.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** A2bcde+3bcde+4bcde; B2ab(iii,v); C1+2a(i,ii); D1
Reasons for designation: This population is among the longest migrating anadromous trout in Canada. It migrates from the headwaters of the Thompson River to the Bering Sea, returning after two years to swim up the Fraser River in the fall. Within the Thompson River watershed, this population is culturally significant and was an economic and food resource for Secwépemc and Nłeʔkpmx communities for thousands of years. Dramatic population declines over the last three generations are largely a consequence of declining habitat quality and reduced survival rates while at sea, due to factors such as interception by fisheries, competition from hatchery fish, and possible predation from pinnipeds. The returning numbers of spawners are now very low and future population reductions are expected	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A2bcde+3bcde+4bcde. The number of mature individuals has declined by 82% over the past 3 generations and it is inferred that this decline will continue into the future.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B2ab(iii,v). IAO is <= 500 km^2 and the number of locations is <=5. The quality of the freshwater and marine habitats and numbers of mature individuals are declining.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered, C1+2a(i,ii). The estimated continuing decline in total number of mature individuals over the next two generations is 71% and there is a projected continuing decline in the number of mature individuals. The number of mature individuals is 216 (average from 2018-2020) and consist of one subpopulation.
Criterion D (Very Small or Restricted Population): Meets Endangered D1. The number of mature individuals in the population is 216 (average from 2018-2020).
Criterion E (Quantitative Analysis): Not applicable. Not done.

TECHNICAL SUMMARY – Chilcotin River population

Oncorhynchus mykiss

Steelhead Trout (Chilcotin River population)

Truite arc-en-ciel anadrome (Population de la rivière Chilcotin)

Secwépemc: Ts’egwllníw’t

Nłeʔkpmxa: cóʕʷłeʔ

Range of occurrence in Canada (province/territory/ocean): British Columbia, Pacific Ocean

Demographic Information

Generation time (usually average age of parents in the population)	6 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Estimated 68% continuing decline in total number of mature individuals in last 2 generations.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Estimated 80% reduction in total number of mature individuals over the last 3 generations
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Project an 80% reduction in the total number of mature individuals over the next 3 generations
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Estimated 80% reduction in total number of mature individuals over any 3-generation period in the past and the future.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No, although declines may be ameliorated by reduction in incidental fishing mortality and pinniped predation. b. No, primary factor is fishing mortality and possibly pinniped predation neither of which are clearly understood. Reduced survival in the marine environment also plays a poorly understood role in the decline. c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	>20,000 km² in the Pacific Ocean 6634 km² in freshwater
Index of area of occupancy (IAO) (Always report 2x2 grid value).	<500 km²

Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations" (use plausible range to reflect uncertainty if appropriate)	<= 5
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Chilcotin River, including the following spawning tributaries: Taseko, Chilko and Little Chilcotin rivers in the most recent survey year (2018) but these do not represent subpopulations.	78 (average from 2018-2020
Total	78

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not calculated

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes. i. Biological resource use (High) • Fishing & harvesting aquatic resources (H) ii. Natural system modifications (High) • Dams & water management/use (L) • Other ecosystem modifications (H) iii. Invasive & other problematic species & genes (High-medium) • Problematic native species/diseases (H-M) iv. Pollution (Low) • Domestic & urban waste water (L) • Industrial & military effluents (L) • Agricultural & forestry effluents (L) v. Geologic events (Low) • Avalanches/landslides What additional limiting factors are relevant? Limiting factors are defined as activities and processes that may not cause a population level decline, but limit growth, resilience, or recovery of the Wildlife Species. Limiting factors can become threats if a species has lost its resilience due to other threats and thus is prone to declines. The Chilcotin DU has high decline rates, small distributions, and small numbers of mature individuals. Hence, they can be considered to have lost resilience due to other threats and are prone to decline. As a result, several activities that might otherwise be described as limiting factors, such as altered ocean and freshwater conditions, predation, competition and reduced prey in the ocean, are described as threats.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Chilcotin Steelhead are endemic to this watershed and rescue is not possible from other Steelhead populations.
Is immigration known or possible?	NA
Would immigrants be adapted to survive in Canada?	NA
Is there sufficient habitat for immigrants in Canada?	NA
Are conditions deteriorating in Canada?+	NA
Are conditions for the source population deteriorating?+	NA
Is the Canadian population considered to be a sink?+	NA
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

+ See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status History

COSEWIC: Designated Endangered in an emergency assessment conducted on January 10, 2018. Status re-examined and confirmed in November 2020.

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes:** A2bcde+3bcde+4bcde; B2ab(iii,v); C1+2a(i,ii); D1
Reasons for designation: This population is among the longest migrating anadromous trout in Canada. It migrates from the headwaters of the Chilcotin River to the Bering Sea, returning after two years to swim up the Fraser River in the fall. Within the Chilcotin River watershed, this population is culturally significant and was an important economic and food resource for Tsilhqot'in communities for thousands of years. Dramatic population declines over the last three generations are largely a consequence of declining habitat quality and reduced survival rates while at sea, due to factors such as interception by fisheries, competition from hatchery fish, and possible predation from pinnipeds. Landslides such as occurred recently at Big Bar can also cause rapid declines for this population. The returning numbers of spawners are now very low and future population reductions are expected.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered, A2bcde+3bcde+4bcde. The number of mature individuals has declined by 80% over 3 generations and it is inferred that this decline will continue into the future.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered, B2ab(iii,v). IAO is <= 500 km^2 and the number of locations is <=5. The quality of the freshwater and marine habitats and numbers of mature individuals are declining.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered, C1+2a(i,ii). The estimated continuing decline in total number of mature individuals over the next two generations is 68% and there is a projected continuing decline in the number of mature individuals. The number of mature individuals is 78 (average from 2018-2020) and consist of one subpopulation.
Criterion D (Very Small or Restricted Population): Meets Endangered D1. The number of mature individuals in the population is 78 (average from 2018-2020).
Criterion E (Quantitative Analysis): Not applicable. Not done.

PREFACE

The Thompson and Chilcotin populations were first assessed using an Emergency Assessment in February 2018 (COSEWIC 2018). The status for both populations was endangered. This report fulfills the requirement to update the 2018 Emergency Assessment with a full assessment. It also incorporates Aboriginal Traditional Knowledge (ATK), information from a Fisheries and Oceans Recovery Potential Assessment (DFO 2018), and recent BC provincial information. Data from 2019 and 2020 have been added to the 2018 COSEWIC assessment.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2020)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Steelhead Trout
Oncorhynchus mykiss

Thompson River population
Chilcotin River population

in Canada

2020

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Rainbow Trout (*Oncorhynchus mykiss*) is a polytypic salmonid species native to cold-water rivers of the Pacific Ocean in Asia and North America. It is widespread in both coastal and interior drainages in a range of habitats, from lakes and headwater streams, to estuaries and large rivers. Steelhead (sometimes called "Steelhead Trout") is an anadromous (sea-run) form of Rainbow Trout that returns to fresh water to spawn after typically spending two or more years in the ocean although a form known as "half-pounders" return within a few months of entering the marine environment. Freshwater forms that have been introduced into the Laurentian Great Lakes and migrate into tributaries to spawn are also called Steelhead.

Order:	Salmoniformes
Family:	Salmonidae, subfamily Salmoninae (salmon, trout, char)
Genus:	*Oncorhynchus* (formerly *Salmo*)
Species:	*Oncorhynchus mykiss* (formerly *Salmo gairdnerii*)

Common name:

English:	Steelhead Trout
French:	Truite arc-en-ciel anadrome
Secwépemc:	Ts'egwllníw't
Nłeʔkpmxa:	cóʕʷłeʔ
Other:	Anadromous Rainbow Trout, Steelhead

The species was originally named in 1792 by the German taxonomist Johann Walbaum based on type specimens from the Kamchatka Peninsula in Siberia. Walbaum's original species name, *mykiss*, was derived from the local Kamchatkan name for the fish, *mykizha*. The genus name is from the Greek *onkos* ("hook") and *rynchos* ("nose"), referring to the "kype" or hooked jaws of the male in breeding season (Behnke 2002). In 1989, morphological and genetic studies indicated that trout of the Pacific basin were genetically more similar to Pacific Salmon (*Oncorhyncus* spp.) than to the Salmos, Brown Trout (*Salmo trutta*) or Atlantic Salmon (*Salmo salar*) of the Atlantic basin (Smith and Stearley 1989). Accordingly, taxonomic authorities moved Rainbow, Cutthroat, and other Pacific basin trout into the genus *Oncorhynchus*. Walbaum's name had precedence, so the scientific name for the species became *Oncorhynchus mykiss*. The previous species names *irideus* and *gairdneri* were adopted as subspecies names for the anadromous Coastal Rainbow Trout (*O. m. irideus*) and Columbia River Redband Trout (*O. m. gairdneri*), respectively, that are commonly known as Steelhead (Behnke 2002). However, McCusker *et al.* (2000) provide mtDNA and other evidence suggesting that these are not valid subspecies. For the purposes of this report we will refer to the Thompson and Chilcotin River populations as Steelhead *Oncorhynchus mykiss.*

Secwépemc people from the Skeetchestn and St'uxtéws communities know Steelhead as Ts'egwllníw't, a name that applies specifically to Thompson River anadromous Steelhead due to the bright stripe on its side during freshwater and spawning phases (Ignace *et al*. 2019). *Sgwigwle* is the name used for the large lake resident Rainbow Trout in the South Thompson and Shuswap Lakes area and by Secwépemc on the Fraser River (Ignace *et al*. 2019). Steelhead are known as cóʕʷłeʔ in the NłeʔkpmxA language (S. Crowley pers. comm. 2019).

COSEWIC (2014) has previously assessed the Athabasca River population of non-anadromous Rainbow Trout (*Oncorhynchus mykiss*) as Endangered.

Morphological Description

Rainbow Trout vary widely in size from 300 to 450 mm in resident populations to more than 1000 mm in anadromous Steelhead (Figure 1) and up to 19.5 kg (Hart 1973; Scott and Crossman 1973). The body is elongated, compressed and body depth is variable. The maxilla extends to the posterior of the eye and teeth and are absent at the base of the tongue. The dorsal fin has 10 to 12 rays, anal fin 8 to 12 rays, pectoral fin about 15 rays, and the caudal fin is shallowly forked with 19 rays (Hart 1973). They have 16-17 gill rakers and 115-130 scales in the mid-lateral row. Colour is variable with habitat, size, and sexual condition but generally metallic blue on the dorsal surface, silvery on the sides, and with black spots on the back, dorsal, and caudal fins. Spawning males have a pink or red band running laterally along their sides and below the lower jaw. Young Steelhead vary from blue to green on the dorsal surface, to white on the sides and below. They have 5 to 10 dark oval parr marks on the back between the head and dorsal fin (Scott and Crossman 1973). The dorsal fin has a white to orange tip and a dark leading edge, and the caudal fin has few or no black spots.

Figure 1. Steelhead Trout (photo courtesy United States National Park Service).

Secwépemc Knowledge from Skeetchestn and St'uxtéws fishers interviewed indicates that the body condition and colour of anadromous Steelhead changed during the last 30 years when the fish were firmer and more silver in colour (Ignace *et al*. 2019). Bellies are now greener in colour and there has been an observable decrease in body length, girth size, and weight (Ignace *et al*. 2019). They have a more 'fishy' smell and there is an increase in reports of belly worms (Ignace *et al*. 2019). The weight of anadromous Steelhead in the Thompson River decreased from around 13.6 kg (30 lbs.) during the 1960-70s to about 9 -10 kg (20-22 lbs.) in the early 1990s (Ignace *et al*. 2019). Members of the Nłeʔkpmx Nation observed the average body length of Steelhead decreased over time, from 1.2 – 2.4 m (4-8 ft) (including head and tail) to 0.3 m (1 foot long) (not including head and tail) (Tmix^{w} Research 2019). Body size has also been found to decline since the mid-1980s using gillnet test fishery data (Bison 2012).

Population Spatial Structure and Variability

The taxon *O. mykiss* exhibits two broad life-history types: a lake- and stream-resident form known as Rainbow Trout and an anadromous (sea-run) form known as Steelhead (McPhail 2007). Depending on the geographic context (e.g., distance from the sea, presence of migration barriers, presence of lakes within a watershed), the forms may exist separately, co-exist at the same place and time as juveniles and spawning adults, or their ranges may be adjacent to one another (McPhail 2007). Secwépemc nomenclature identified anadromous Steelhead as a kind of salmon (*sqlélten*), rather than their '*stay at home cousins'*, trout (*pisell*), prior to taxonomic re-classification of Steelhead from *Salmo* to *Oncorhynchus* (Pacific salmon) in the 1980s (Ignace *et al*. 2019).

A variable degree of demographic and genetic interaction occurs between the forms where they co-exist. In some instances, there is little detectable genetic differentiation between the forms and in other instances they may represent genetically distinct populations (Docker and Heath 2003; McMillan *et al.* 2007; Pearse *et al.* 2009). Also, there is evidence that in some systems, Steelhead may be produced from Rainbow Trout mothers, while some Steelhead offspring may remain permanently in fresh water (termed "residuals"), especially when they experience faster growth as juveniles, e.g., in hatchery supplemented populations (Viola and Schuck 1995; Zimmerman and Reeves 2000; Thrower *et al.* 2004). These variable life history forms between Steelhead and Rainbow Trout are also found in other salmonid species such as *O. nerka* where there are freshwater ("Kokanee") and anadromous forms ("Sockeye Salmon"), and *S. salar* with freshwater ("Ouananiche") and anadromous ("Atlantic Salmon") forms (COSEWIC 2018). In the context of Thompson and Chilcotin River Steelhead, there is no information on the genetic relationship between the two life history forms. While there is some evidence that Steelhead in these systems may be produced from Rainbow Trout mothers (R. Bison pers. comm. 2019), the spatial and temporal extent of this phenomenon is not well understood; therefore, consistent with recent status assessments for Atlantic Salmon (COSEWIC 2010) and Sockeye Salmon (COSEWIC 2017), this assessment of interior Fraser River *O. mykiss* concerns only Steelhead life-history. The COSEWIC approach is also consistent with that of United States fisheries management agencies where anadromous and freshwater-resident forms of *O. mykiss* are assessed separately (Hard *et al*. 2015).

Steelhead and Rainbow Trout exhibit a myriad of life history forms (Kendall *et al.* 2015). Among these, two distinct seasonal patterns of returns of spawning Steelhead to their natal streams are evident. So-called summer and winter run populations are a special case of distinct and independent populations within a stream. Winter run populations typically enter coastal rivers from November to April with early individuals holding in or near natal streams for up to 4 months. Winter run fish usually enter the stream mature (fully developed gonads) or almost mature (Quinn *et al*. 2016). Coastal summer run populations return in late April through July and spawn the following spring. Interior summer run populations enter freshwater in late August through November and mature over the winter in larger rivers such as the Skeena, Thompson, and Fraser. Typically, these fish move into their natal streams the following spring to spawn. The Thompson and Chilcotin Steelhead are interior populations that follow the late summer run pattern and spawn in the Fraser River watershed upstream of the Coast Mountain Range.

British Columbia contains a myriad of Steelhead Trout (anadromous *O. mykiss*) populations from south coastal areas to northwestern BC with perhaps 1,200 or more watersheds potentially supporting Steelhead populations (Figure 2). There are 11 spatially discrete watersheds with extant late summer run Steelhead populations in the interior Fraser watershed (Bison 2012). The populations in the Nahatlatch watershed downstream of Hannah Lake, the Stein watershed, the Seton watershed downstream of Seton Lake, and the Bridge watershed downstream of Terzaghi Dam are genetically distinct from Thompson and Chilcotin Steelhead and are not included in this assessment.

The Thompson River Steelhead population encompasses fish spawning in the Nicola watershed downstream of Nicola and Mamit lakes, the Bonaparte watershed downstream of Young Lake, and the Deadman watershed downstream of Mowich Lake (Figure 3). The Chilcotin Steelhead population encompasses fish spawning in the Chilko River downstream of Chilko Lake, the Taseko watershed downstream of Taseko Lake (including Elkin Creek), and the Little Chilcotin River (Figure 3). Further upstream in the Fraser River is a population in the Quesnel River, which includes the Cariboo River, tributary of the Quesnel River downstream of Quesnel Lake. The Cariboo River is the furthest confirmed upstream occurrence of Steelhead spawning in the Fraser watershed. However, the consistency of Steelhead spawning in the Cariboo River is unknown (Bison 2012) and is not included in this assessment. Interestingly, Steelhead do not occur further upstream such as the Stuart and Bowron watersheds below Stuart and Bowron Lakes in the Fraser River, as both produce salmon. The freshwater migration distance to the Stuart and Bowron lake outlets, about 950 and 1200 km respectively, is less than for Snake River Steelhead in the Columbia River watershed that migrate over 1500 km. The presence of Steelhead in most watersheds appears to be constrained by the occurrence of a lake that limits their upstream colonization (Levy and Parkinson 2014).

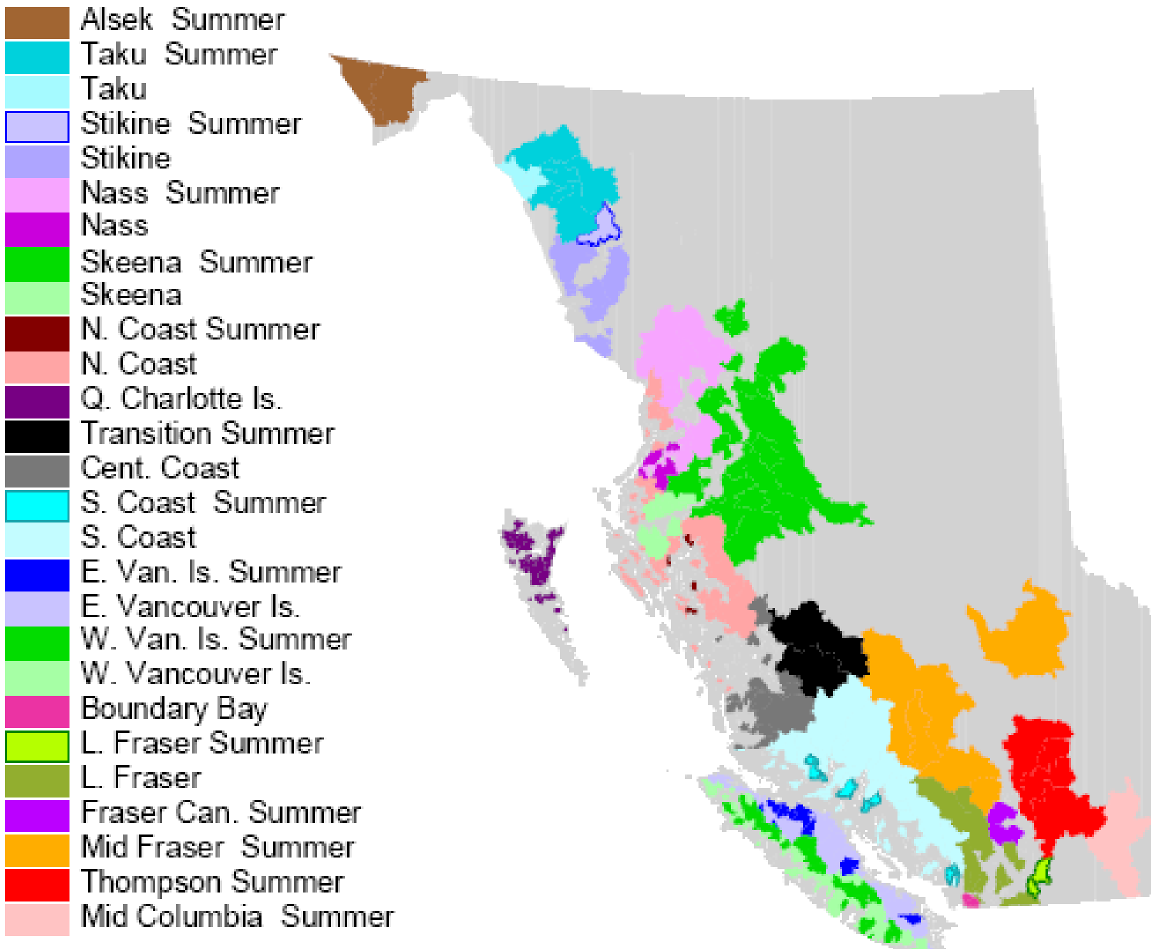


Figure 2. Steelhead populations in British Columbia (reproduced from Parkinson *et al.* 2005). Chilcotin Steelhead is included within the Mid-Fraser Summer population.

Figure 3. Distribution of the Thompson and Chilcotin Rivers Steelhead Trout populations in Canada.

Steelhead in the Thompson and Chilcotin Rivers are discrete from other Canadian Steelhead based on genetic data, and also differ from each other. Thompson and Chilcotin Steelhead likely evolved from fish isolated in the Columbia refugium to the south during the last glaciation while other Canadian Steelhead may have arisen from a Haida Gwaii refugium (COSEWIC 2018).

Designatable Units

The Thompson and Chilcotin River Steelhead constitute two designatable units (DUs) within this assemblage with no subpopulations and satisfy both the discreteness and significance criteria for recognizing DUs (COSEWIC 2016, 2018). Subpopulations are defined by COSEWIC as: “Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less” (COSEWIC 2016).

ATK is in general agreement with the DU structure proposed for the Thompson River, but the Elkin system was identified as a potential DU within the Chilcotin River Steelhead DU (Toth and Tung 2013; Levy and Parkinson 2014). There was, however, no additional information provided to pursue the delineation as a DU using the COSEWIC perspective.

Discreteness

Thompson and Chilcotin Steelhead spawn within the mainstem and tributaries of the Thompson and Chilcotin Rivers of the Fraser River drainage and thus are spatially discrete from other Steelhead populations in BC. Given the well-documented homing to natal streams for spawning of most anadromous salmonids like Steelhead (Keefer and Caudill 2014), there is a high degree of spatial genetic population structure in interior Fraser River Steelhead. For instance, Beacham *et al.* (2004) assayed 14 microsatellite DNA loci and demonstrated that Thompson and Chilcotin Steelhead, and a group of Steelhead from the mid-Fraser River (Stein, Nahatlatch, and Bridge rivers), formed a well-defined cluster of populations (75% bootstrap support) distinct from 46 other populations from northwestern BC to United States portions of the upper Columbia River. In fact, the Thompson, Chilcotin (Chilko River) and the mid-Fraser Steelhead were more similar genetically to Steelhead from the upper Columbia River than they were to Steelhead from the lower Fraser River (e.g., Chilliwack and Coquihalla rivers), possibly reflecting their origins from different refugia. In addition, the Thompson River Steelhead are discrete from the mid-Fraser Steelhead as well as from the Chilcotin River Steelhead when assayed using these same microsatellite loci (COSEWIC 2018).

Beacham *et al.* (2004) clearly (i.e., with 98% bootstrap support) identified Thompson River Steelhead as a genetic cluster distinct from other Steelhead including the Chilcotin River Steelhead. Genetic distance (FST) between Thompson River Steelhead and Chilcotin River Steelhead at microsatellite loci accounted for between 6.2% and 8.3% of the total variation when assaying those two samples (COSEWIC 2018). Parkinson’s (1984) data also showed that Chilcotin River Steelhead had multilocus genotypes across four allozyme loci (SOD, LDH, MDH, and AGP) that were distinct from samples of Thompson, and mid-Fraser River Steelhead.

The Thompson and Chilcotin Steelhead are part of the admixed south coast/interior group as inferred from mtDNA that reflects deep intraspecific phylogenetic divergence unique in BC (McCusker *et al.* 2000). The microsatellite and mtDNA data both suggest that the Thompson and Chilcotin Steelhead have had a unique glacial and postglacial history in BC in that they share a close affinity with Steelhead from the south coast (mtDNA) as well as from the upper Columbia River (microsatellites). This history suggests that the Thompson and Chilcotin Steelhead may be the result of colonization of the current waterscape from two glacial refugia, a situation that appears to be unique within the evolutionary legacy of BC Steelhead (McCusker *et al.* 2000).

Thompson and Chilcotin Steelhead are also spatially discrete, occupying different joint adaptive zones as identified by Holtby and Ciruna (2007) that are assumed to foster local adaptation and have permitted the persistence of the discrete populations in these unique environments. They also differ in life history characteristics being phenotypically discrete from each other, most notably in terms of adult age at maturation, migration timing and behaviour, and smolt age (Renn *et al*. 2001; Bison 2012).

Evolutionary Significance

In addition to genetic differences, Thompson and Chilcotin Steelhead differ from other Fraser River Steelhead and from each other in a number of life history characters. Differences in several aspects of migration timing, speed, and behaviour that can be plausibly interpreted as adaptations to the different locations of their spawning areas are evident (Renn *et al*. 2001). Genetic mixture and telemetry studies indicate that Chilcotin Steelhead enter the Fraser River earlier, migrate upriver faster, and exhibit less “milling” behaviour than Thompson Steelhead (i.e., “milling” occurs when fish remain relatively stationary in an area enroute to the spawning or overwintering sites). Bison (unpubl. data) found a mean difference in the date of migration past river km 235 (near the Nahatlatch River) of 13.8 days (i.e., these fish arrived almost 14 days earlier than the average date across all populations entering the Fraser River) for Chilcotin Steelhead, compared to 0.2 to -4.3 days for Thompson Steelhead, and -1.6 to -8.3 days for the later-arriving mid-Fraser fish. The differences may result from selection for earlier and more direct migration in Chilcotin Steelhead because they must pass three migration hurdles prior to the onset of winter (two in the lower Fraser River Canyon at river kms 185 and 210, and one at Bridge River rapids at river km 340). Thompson Steelhead must only bypass two hurdles in the lower Fraser River Canyon. Between Fall 2018 and Spring 2019, a landslide at Big Bar introduced an additional hurdle for Chilcotin Steelhead just above the confluence of the Thompson with the Fraser River, sparing the Thompson Steelhead population from this obstacle. Chilcotin Steelhead also travel further to their overwintering sites which are at least 522 river km in the Chilcotin River or 510 km in the Fraser River (~100 km upstream of the Chilcotin-Fraser confluence; Renn *et al.* 2001). In comparison, Thompson Steelhead overwinter only as far upstream as the outlet of Kamloops Lake at river km 375 from the mouth of the Fraser River while latest-arriving Nahatlatch River (mid-Fraser) fish travel only 238 km.

Thompson and Chilcotin River Steelhead differ from each other both in smolt age and adult age of return to fresh water; the majority of Thompson Steelhead smolts are age two years when they migrate to sea (93%), while the majority of Chilcotin Steelhead smolts are age three years (83%, Bison 2012). The age at first spawning is typically five years (rarely six or seven) for Thompson Steelhead, but age six years (rarely seven or eight) for Chilcotin Steelhead (Bison 2012).

Finally, Thompson and Chilcotin Steelhead occur in different climates – as demonstrated by the distribution of the DU streams in the biogeoclimatic zones and subzones of BC. Significant portions of both DUs occur in the Bunchgrass and Interior Douglas-fir zones. However, 72% of the Thompson DU is in warm to hot subzones of Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones. Whereas more of the Chilcotin DU (67%) is in the slightly cooler subzone of the interior Douglas-fir zone. These values were determined by adding up the distance of stream segments within each biogeoclimatic unit (Meidinger, D., pers. comm. 2020).

The higher temperature Thompson DU may result in greater growth opportunity for Steelhead smolts in this DU and partly explains their younger average age at smolting relative to Chilcotin Steelhead. Several studies provide evidence of divergence in thermal tolerance physiology in *O. mykiss* from non-BC populations along a similar desert-montane environmental gradient (Rodnick *et al.* 2004; Narum *et al.* 2010, 2013) and it is plausible that similar differences exist between Thompson and Chilcotin Steelhead.

Additional evidence for the evolutionary significance of the discreteness of Thompson and Chilcotin Steelhead from other populations comes from studies of allozyme differentiation and its apparent association with swimming stamina. Thompson and Chilcotin Steelhead, represented by samples from the Thompson River, have higher frequencies of lactate dehydrogenase phenotypes that are associated with substantially greater prolonged swimming performance compared to fish from the lower Fraser River (Tsuyuki and Williscroft 1977). Such physiological differences are also apparent between coastal and interior populations of Coho Salmon (*O. kisutch*) and point to the actual and potential adaptive characteristics of salmonid fishes with long upstream migrations in the Fraser River (Taylor and McPhail 1985). Other differences between Thompson and Chilcotin Steelhead and south coast Steelhead include their fall-season run timing and the immature state of gonads during migration, a phenomenon known as “premature migration”. In contrast, other south coast Steelhead typically migrate through the lower Fraser River after Thompson and Chilcotin Steelhead and with gonads in more advanced states of maturity. The premature migration phenotype appears to have a relatively simple genetic basis, to be under strong positive selection, and is considered critical for the persistence of Steelhead biodiversity in other portions of its range (Prince *et al.* 2017).

Cultural Significance

Indigenous Knowledge Systems include detailed information on laws and protocols for human relationships with the environment, on events on the land, on ecological relationships and on characteristics of species, that are passed on through teachings and parables *stsptekwll* (oral narrative), based on long-term observations (Ignace *et al.* 2019). Place names provide information about harvesting areas, ecological processes, or the products of harvest, while Indigenous taxonomic nomenclature identifies life history characteristics of a species or distinct differences between similar species (Ignace *et al.* 2019).

Secwépemc Knowledge of Ts'egwllníw't was gathered by Secwépemc Fisheries Commission staff from only two Secwépemc communities, due to limited funding (Matthew *et al.* 2019). Most members of the nine communities generally "believe inclusion of ATK is essential in the decision to list process" (Matthew *et al.* 2019). Nłeʔkpmx Nation Elders shared their knowledge of Steelhead (Tmixʷ Research 2019) but identified that younger generations lack knowledge about Steelhead and Steelhead fishing practices which was attributed to a reduction in fishing effort since the early 1980s, as a result of a declining Steelhead population (Tmixʷ Research 2019).

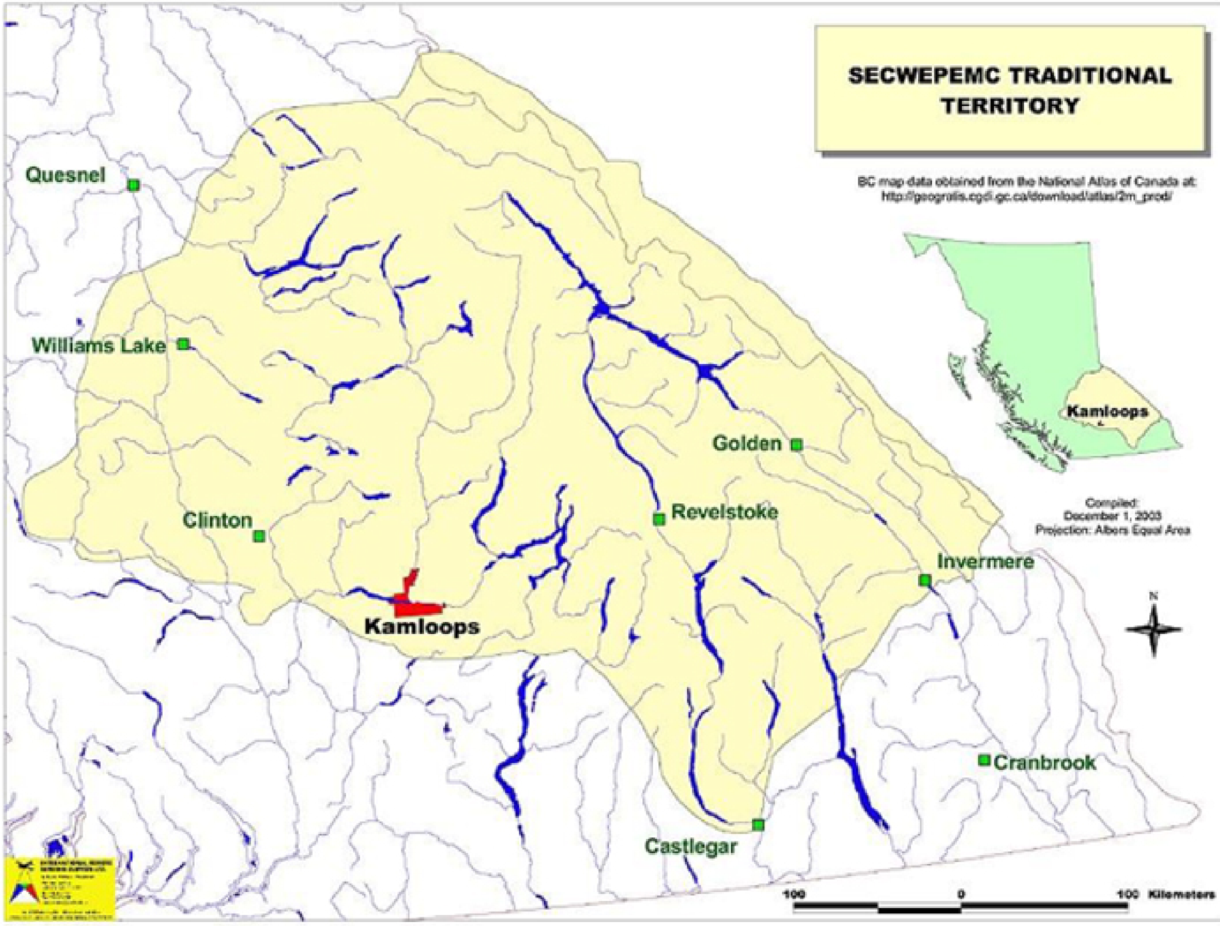
Thompson River DU

Steelhead was an important economic and food resource for Secwépemc people for thousands of years, within their traditional territory (Figure 4), until fish populations recently collapsed, removing an important fresh source of protein during early to mid-winter months when dried, stored provisions were diminishing (Ignace *et al.* 2019). If Steelhead disappear Secwépemc people will be harmed through loss of specific harvesting technologies, skills and practices, and cultural values associated with this species:

"Steelhead salmon [harvesting] … included an important set of cultural practices, skills and values connected to human interactions with living resources in Secwepemcul'ecw, the stewardship and caretakership of resources, and the Indigenous laws of reciprocal accountability with fishery resources (Ignace *et al.* 2019)."

Archaeological evidence shows that Secwépemc people have been harvesting Steelhead since runs became established throughout the Fraser and Columbia watersheds between 5,000 to 7,000 years ago (Ignace *et al.* 2019). Salmon are regarded as close relatives to humans as acknowledged by the late Secwépemc Elder Laura Harry *"salmon are our first children"* which includes the responsibility of caretaker to the resource (Ignace *et al.* 2019).

The importance of anadromous salmon (Ts'egwllníw't) for Secwépemc people was documented following contact with Europeans in the early 1800s, in the correspondence of early explorers, Journals of the Hudson's Bay Company, ethnographic and archaeological reports and publications, and more recently, from a report commissioned by the Department of Fisheries and Oceans and the Union of BC Indian Chiefs (Ignace *et al.* 2019). Secwépemc stories identify protocols and laws for interactions between humans and species within their environment and the loss of Steelhead would have a negative impact on the interdependence of the ecosystem (Ignace *et al.* 2019). Ignace *et al*. (2019) recognize that "Loss of a species as it connects to environment, language, cultural knowledge, practices and experience, thus has far -reaching implications for the well-being of Secwépemc peoples".



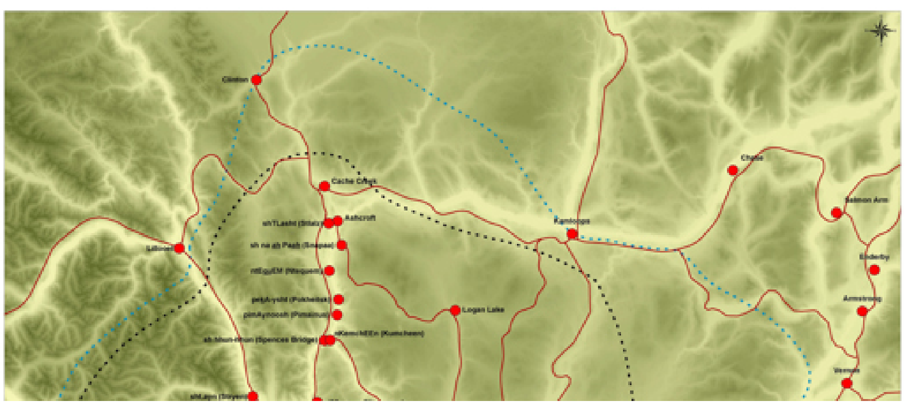


Figure 4. Map of Secwépemc Traditional Territory (upper) and map of Nłeʔkpmx Nation Traditional Territory (lower).

Secwépemc Traditional Knowledge from Skeetchestn and St'uxtéws Indian Bands (southern Secwépemc communities located in the Thompson River watershed) is included in this report from a project conducted by the Secwépemc Fisheries Commission (Ignace *et al*. 2019). Secwépemc Traditional and contemporary Knowledge of Steelhead was gathered during group interviews and later, during follow-up interviews with individual fishers (Ignace *et al*. 2019; Matthew *et al.* 2019). Included in the project report was Secwépemc knowledge gathered during the 1980s from interviews with Skeetchestn and St'uxtéws Elders on fishing practices, fishing locations, and other relevant information that identified the importance of salmon fishing and the continuation of their traditional knowledge on Steelhead (Ignace *et al.* 2019). Skeetchestn and St'uxtéws Indian Bands are identified as resource caretaker (yecwminmen) communities for Thompson Steelhead (Ignace *et al*. 2019).

Members of the Nłeʔkpmx Nation historically fished Steelhead for food during spring as the bland taste aided the human body to adjust from the dried food sources of winter to a fresh, oil rich diet (Tmix^{w} Research 2019). Elders reported that, as a result of a decline in abundance of Thompson River Steelhead, since the early 1980s, the fish are no longer considered a main food source for the Nłeʔkpmx Nation, resulting in a gap in Steelhead knowledge between Elders and younger generations, and suggesting contemporary Nłeʔkpmx Nation Steelhead knowledge and fishing practices will not persist over time within their Traditional Territory (Figure 4) (Tmix^{w} Research 2019).

<u>Chilcotin River DU</u>

The Tsilhqot'in Nation fish for Steelhead during fall and spring (Toth and Tung 2013; Levy and Parkinson 2014).

Special Significance

Rainbow Trout and particularly Steelhead are widely regarded as the premier sport fish in western North America and attract anglers from around the globe to the Thompson and Chilcotin River watersheds in pursuit of fishing opportunities. Thompson River Steelhead is recognized as being among the largest Steelhead in BC and represents a unique genetic heritage. The variety of life history tactics that have evolved in Rainbow Trout, particularly anadromy and associated residency, remain poorly understood concepts generating scientific interest and inviting further study.

DISTRIBUTION

Global Range

Rainbow Trout and Steelhead, *O. mykiss,* are endemic to northeastern Siberia and North America (McPhail 2007; Figure 5). Steelhead is reported to spawn in North America from the Kuskokwim River of Alaska to Baja California in Mexico and includes coastal and interior regions of British Columbia, Washington, Oregon and California (Scott and

Crossman 1973; Behnke 1992; McPhail 2007). Rainbow Trout also occur east of the continental divide in three Arctic drainages. Rainbow Trout are found in both lakes and rivers and occur as freshwater resident and anadromous populations. In North America, the anadromous Steelhead populations are restricted to the west coast but have also been introduced to the Laurentian Great Lakes. In Asia, native Rainbow Trout and Steelhead exist in the Kamchatka region and extend from the Bering Sea in the north to rivers flowing into the Sea of Okhotsk in the south (McPhail 2007). However, Rainbow Trout have been introduced successfully throughout every continent except for Antarctica (MacCrimmon 1971) resulting in at least one anadromous Steelhead population (Riva Rossi *et al.* 2004; Liberoff *et al*. 2014).

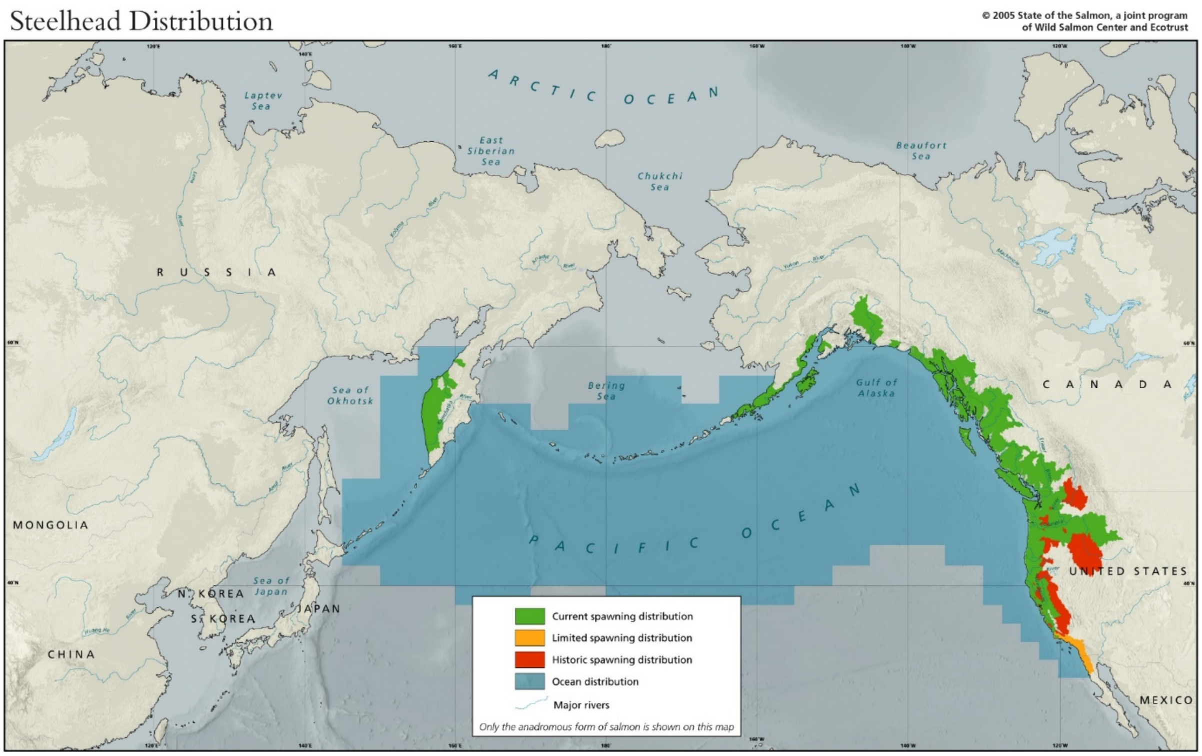


Figure 5. Global native range of Steelhead Trout indicating the current and historical extent of spawning sites as well as their marine distribution (map courtesy of the wildsalmoncenter.org). It does not include the introductions to the Laurentian Great Lakes and Argentina.

Canadian Range

The native range of Steelhead within Canada includes many of the coastal streams and rivers of BC as well as the interior watersheds of the Fraser, Nass, and Skeena Rivers (Figure 5). Steelhead has also been introduced widely throughout the Laurentian Great Lakes region that now supports many self-sustaining populations. These populations are among the longest migrating anadromous trout in Canada. They migrate from the headwaters of the Thompson and Chilcotin Rivers to the Bering Sea, returning after two years to swim up the Fraser River in the fall.

Search Effort

The distribution of Steelhead within the two DUs is known from biological surveys undertaken by government researchers, students, and anglers (e.g., Bell 1980; McGregor 1986; Parkinson *et al.* 2005). Annual monitoring programs collect information on distribution of spawning adult Steelhead within each of the major river systems in the two DUs (Chilcotin, Chilko, Bonaparte, Deadman, Nicola). The methods used include visual surveys from land and air, telemetry and mark recapture, counting fences, video devices, and electronic fish counters and are described in detail below (e.g., Spence 1981; Braun and Bison 2016a,b). Additionally, annual electrofishing surveys to monitor distribution and abundance of juvenile Steelhead are conducted (Decker *et al*. 2015).

Indigenous fishers within the Thompson and Chilcotin systems interacted with Steelhead historically and continue to do so through fishing practices, assessment, management, and restoration activities (S. Crowley pers. comm. 2019).

Nicola Valley First Nations community members now only fish ‘at times of hardship’, due to observed declines since the 1980s (Tmix^{w} Research 2019).

HABITAT

Habitat Requirements

Steelhead freshwater habitat is characterized by clear, cold rivers and streams; a silt-free rocky substrate in riffle-run areas with sections of slower, deep water although they also occur in turbid waters such as the Chilcotin River. It should include well-vegetated streambanks, sufficient cobble and boulder cover (Raleigh *et al*. 1984; Rosenau and Angelo 1999). Canopy cover is important in maintaining shade to control stream temperature and provision of allochthonous materials. Secwépemc Knowledge indicated that adult Ts’egwllníw’t were observed in swift water and deep pools 3.6 – 4.6 m (12 – 15 feet) deep downstream from river eddies, following freshwater migration (Ignace *et al*. 2019). Steelhead fry and juveniles residing in streams require riffles, rapids, and cascades and prefer a maximum stream velocity of less than 30 cm/sec. Fry have a preferred temperature range of 13 to 18°C (Raleigh *et al.* 1984). Steelhead juveniles in streams have a preferred temperature range from 4 to 13°C (optimal 7 to 10° C) from March until June for normal smoltification to occur. Adult Steelhead prefer water temperatures between 4 and 18°C (Raleigh *at al*. 1984) although it is reported that migration slowed or ceased at temperatures below 7°C (Renn *et al*. 2001). Lee and Rinne (1980) report an adult upper lethal temperature of approximately 27°C. Spawning typically occurs in a redd dug in gravel substrate at water temperatures ranging between 3.9 and 9.4°C. Spawning is nocturnal and occurs in flowing water of 0.4 to 1.5 m/sec in depths from 20 cm to more than 2 m (Moore and Olmstead 1985).

After spending their first two to four years in freshwater, juvenile Steelhead in Fraser River watersheds begin a rapid spring migration to the marine environment. They spend relatively little time in the estuary before rapidly migrating out of the Strait of Georgia into the broader Pacific Ocean (Welch *et al.* 2011). The distribution of Steelhead in the North Pacific changes seasonally: in the spring the highest density occurs between 42°N and 52°N, and from the North American coastline to 155°W in the Gulf of Alaska (Burgner *et al.* 1992). By summer, fish have moved north and west in the eastern North Pacific to south of the Aleutian Islands. The southern limit also shifts north from about 38°N to near 40°N. Sutherland (1973) determined from research catches that the majority of Steelhead (61%) were found in surface waters between 8 and 11.4°C, and all were constrained by water temperatures between 5 and 15°C (Burgner *et al.* 1992; Welch *et al.* 2000). Steelhead occurred near the surface with the highest catches in the upper 7 m of the water column (Burgner *et al.* 1992).

Habitat Trends

Trends in habitat are discussed under the **Habitat Trends** and **Threats** subheadings in each of the Thompson and Chilcotin DU sections.

BIOLOGY

Information on the biology of Steelhead is often interspersed with descriptions that apply to freshwater Rainbow Trout. Shapovalov and Taft (1954) provide a thorough treatment of Steelhead freshwater biology, while Sutherland (1973) and Burgner *et al.* (1992) provide comprehensive summaries of the large volume of data collected on the offshore marine distribution and biology. Brannon *et al*. (2004) provide a thorough summary of what is known about Steelhead in the Columbia River watershed. The thesis by McGregor (1986) provides a good summary of a number of aspects of the reproductive biology of Steelhead in the Thompson River watershed, supplemented by an array of internal publications by BC government researchers on the key rivers in the two DUs, all accessible through the BC CLIR (2019) website. There are numerous recent publications on smoltification and residualism, aspects of reproductive success, migratory and spawning behaviour, but no concise summary of this material. However, see Scott and Crossman (1973) and Hart (1973) for summaries of earlier research on the species.

Life Cycle and Reproduction

Steelhead has evolved a variety of life history forms encompassing an array of reproductive strategies. However, Thompson and Chilcotin Steelhead populations migrate into the Fraser River from September to late November and hold in the Fraser mainstem until March. These fish move into tributaries for spawning which occurs from March to June. Steelhead that return to the interior BC watersheds are virtually all summer-run populations. Summer-run Thompson and Chilcotin Steelhead populations begin their migration into the Fraser River from late August to late November. Summer-run Steelhead have immature gonads at this time and will overwinter in the mainstem of the Fraser or Thompson and

Chilcotin Rivers near their natal streams. Spawning occurs the following spring from February to early June. The spawning adults begin to ascend the tributary streams to spawn as river temperatures and stream flow from freshets increases (McGregor 1986). Secwépemc Knowledge from experienced fishers noted pairing up of Ts'egwllníw't in the Thompson River, indicating that some Steelhead spawn in the main river where they are present from December to March, often near stands of Juniper (*Juniperus scopulorum*) (Ignace *et al*. 2019). Some fishers reported catching males and females in pairs, one after the other, in the same fishing areas (Ignace *et al*. 2019). Steelhead were observed spawning in slough areas with slow moving water and a gravelly substrate (Ignace *et al*. 2019). It was noted that the slough areas in the Thompson River have declined over time (Ignace *et al*. 2019). Homing to natal streams by Steelhead is believed to be quite high with reported rates of straying to non-natal areas ranging from 1.9 to 2.9 % (Shapovalov and Taft 1954). Average length of returning spawners increases latitudinally from central California to southern BC, likely reflecting the longer period of ocean residency for growth. Steelhead that return to the Thompson River are larger and more fecund but with smaller eggs than other runs into the Fraser River (McGregor 1986). Fecundity of Thompson Steelhead varies between 5,900 and 18,400 eggs with a mean of 12,600. Spawning is initiated by the female choosing the redd site, in which she digs several nests (Burgner *et al.* 1992). Generally, a dominant male attends the nest and fertilizes the eggs, but no guarding of the nest occurs. Females typically leave the spawning area immediately after completing egg deposition and covering while the males may remain in the area spawning with several females (Shapovalov and Taft 1954). Unlike salmon, Steelhead are iteroparous and do not necessarily die following spawning. Repeat spawners are mostly females and McGregor (1986) reports rates of 2 to 7.1% for the Thompson River and Spence (1978) estimated a rate of 1.4% for the Chilcotin River population, a return rate lower than for many other BC, Oregon, and California populations (Busby *et al*. 1996). Busby *et al*. (1996) speculate that lower repeat spawning rates may be a function of longer migrations requiring greater energy expenditures. However, McGregor (1986) notes that some marked emigrating 'kelts' (fish that had spawned) were captured in "Fraser River native nets, by sport anglers in Georgia Strait, and by the commercial fleet in Johnstone Strait", and may contribute to the apparent low rate of repeat spawning.

Incubation of the eggs lasts between five and eight weeks depending on water temperature. Peak fry emergence from the gravel at a body length of about 23-26 mm occurs from mid-June to early July and the yolk is absorbed in 3-7 days before the alevins become free-swimming (Scott and Crossman 1973). Residence in the stream is 2 years for Thompson, and 3 years for Chilcotin Steelhead juveniles, before emigrating to the sea (Spence 1978; McGregor 1986). In their first year Steelhead grow to about 100 mm reaching 150 mm or more by the end of the second winter in the stream, at which size they transform into smolts and migrate to the ocean (Burgner *et al.* 1992). Smolt size at outmigration is consistently near 160 mm and size more than age determines smolting (the physiological change that allows them to live in salt water). Size at emigration appears to affect the number of years at sea and therefore the size at return (Burgner *et al*. 1992). Larger smolts return as mature adults sooner than those produced from smaller smolts (Shapovalov and Taft 1954). Emigration of smolts peaks between mid-April and mid-May co-incident with spring runoff. Typically, Steelhead will spend 2 to 4 years in the North

Pacific Ocean feeding and growing before migrating back to their natal stream to spawn. The majority of both Thompson and Chilcotin Steelhead return to spawn after only 2 years in the ocean.

In many watersheds, including the Thompson and Chilcotin DUs, both anadromous Steelhead and resident Rainbow Trout occur together. The interactions between these life history phenotypes are not well understood and the factors that determine whether an individual fish smolts and becomes anadromous or residualizes and matures in freshwater are complex (Kendall *et al.* 2015). The available evidence suggests that there is interplay between genetics and environmental factors that determines the accumulation of lipids in juvenile trout, which ultimately determines whether anadromy or residency becomes the life history choice. However, the empirical evidence indicates that there is a substantial variation in its manifestation in different river systems. Recent genetic studies found that selection appears to favour the resident phenotype to the detriment of anadromy (Phillis *et al.* 2016), but that detectable genetic differences exist between the two forms in some systems but not others (Docker and Heath 2003; McMillan *et al.* 2007; Pearse *et al.* 2009). There is no information specific to the Thompson and Chilcotin Rivers on the genetic distinctiveness of Rainbow Trout and Steelhead. Evidence from otolith microchemistry from the nearby Babine River (Zimmerman and Reeves 2000) indicates that Steelhead may be produced from Rainbow Trout females and would limit genetic differentiation between the two forms. Male Steelhead tend not to spawn with resident Rainbow Trout females (McMillan *et al.* 2007; Christie *et al.* 2011) because of size-assortative mating behaviour (Seamons 2004). When interbreeding occurs, female Steelhead can produce resident male offspring, but generally not resident female offspring (Liberoff *et al.* 2013; Berejikian *et al.* 2014). The fitness of these hybrids is unclear, although they appear to have an intermediate likelihood of smolting (Ruzycki *et al.* 2009). Declining Steelhead abundance is expected to increase the rate of interbreeding and further diminish the productivity of these Steelhead populations. Simulation studies indicate that a declining population of Steelhead in a watershed may be enhanced if reduced density dependence and environmental conditions favour a shift towards an anadromous phenotype (Araki *et al.* 2007; Phillis 2014, Kendall *et al.* 2015). The potential benefits of inter-breeding between anadromous and resident phenotypes depend on many unknown parameters, such as the extent of selection against the anadromous phenotype, and heritability of resident and anadromous traits. However, the relative magnitude of this effect is unknown but does not appear to have contributed significantly to the productivity of Thompson and Chilcotin Steelhead.

Physiology and Adaptability

Rainbow Trout and by inference Steelhead have been successfully introduced worldwide confirming that habitats and environmental conditions suitable for this species are widespread. However, perhaps the most dramatic adaptation is that of anadromy in Steelhead whereby they transform from being adapted to a life in freshwater to that of a marine existence. The parr to smolt transformation of anadromous salmonids includes a suite of behavioural, morphological, and physiological changes that prepare them for downstream migration and entry into seawater. In many species including Steelhead, the transformation is size dependent and occurs in spring, mediated through photoperiod and temperature cues. The resulting smolt has an increased capacity to secrete salt, increased growth and swimming performance in seawater, and higher marine survival (McCormick 2013).

The other important physiological process that is initiated during the Steelhead's freshwater residency is that of imprinting on their birthplace. Specific olfactory receptors increase during smolt development, resulting in greater sensitivity of the olfactory epithelium. During smolting, exposure to river-specific amino acids results in formation of a peripheral memory in the olfactory bulb. The memories are stimulated again at the time of upstream migration (possibly by reproductive hormones), leading to high-fidelity homing to the natal stream or site of imprinting (McCormick 2013).

Dispersal and Migration

Steelhead undertake two major migrations during their lives, the initial downstream migration as smolts to saltwater and the subsequent return migration to their spawning grounds. Inference on the direction and timing of these migrations has come from various tagging studies. Recent telemetry studies using acoustic tags implanted into Steelhead smolts have demonstrated a rapid downstream movement of Thompson River fish to the Fraser River estuary of 10-20 days after release from the tagging site (Melnychuk *et al.* 2010). Indications are that the tagged Steelhead (2004-2007) also rapidly exited the Strait of Georgia travelling some 400 km in 22 days (Welch *et al.* 2011). The majority of Steelhead smolts from the Fraser River exited via the southern Strait of Juan de Fuca route except for those from the Deadman River in 2006 that exited via Johnstone Strait (Melnychuk *et al.* 2010). All the tagged Steelhead smolts from the Cheakamus River and those from Vancouver Island populations left the Strait of Georgia through Johnstone Strait from 2004 to 2006. Early freshwater survival of Thompson Steelhead (about 20 to 60%) exceeded that of Chinook Salmon (*O. tshawytscha*) but was lower than for Coho Salmon or coastal Steelhead populations (Figure 6). However, apparent early marine survival rates (about 15 to 50%) were similar to or exceeded those for coastal Steelhead and Sockeye (*O. nerka*) during this period of migration (Welch *et al*. 2011). Subsequent survival rate in the Pacific Ocean from juvenile to returning adult spawners for many salmonid populations including Steelhead were substantially lower at 1 to 4% since the 1990s (Welch *et al*. 2000, 2011).

Steelhead migration throughout the northeast Pacific has been monitored through recaptures of externally tagged fish in extensive research surveys over several decades (Sutherland 1973; Light *et al.* 1989; Burgner *et al.* 1992; Welch *et al.* 2000). Fish from North American rivers enter the ocean near the coast in spring gradually moving west and north before reaching the western Gulf of Alaska. In the fall they move back toward the North American coast. Movement through the winter is not well understood but apparently a westward movement resumes approaching the eastern Aleutian Islands by late summer when eastward movement repeats with a portion entering their spawning streams (Light *et al.* 1989; Burgner *et al.* 1992). Fish tagged offshore migrated an average of 50 km/day ranging between 15 to 85 km/day (Burgner *et al.* 1992). Few if any Steelhead have been found in the Bering Sea and distribution appears to be constrained within the 5 and 15°C isotherms (Light *et al.* 1989). Typically, females are slightly more common than males in offshore waters and this is especially so for repeat spawners (McGregor 1986; Burgner *et al.* 1992).

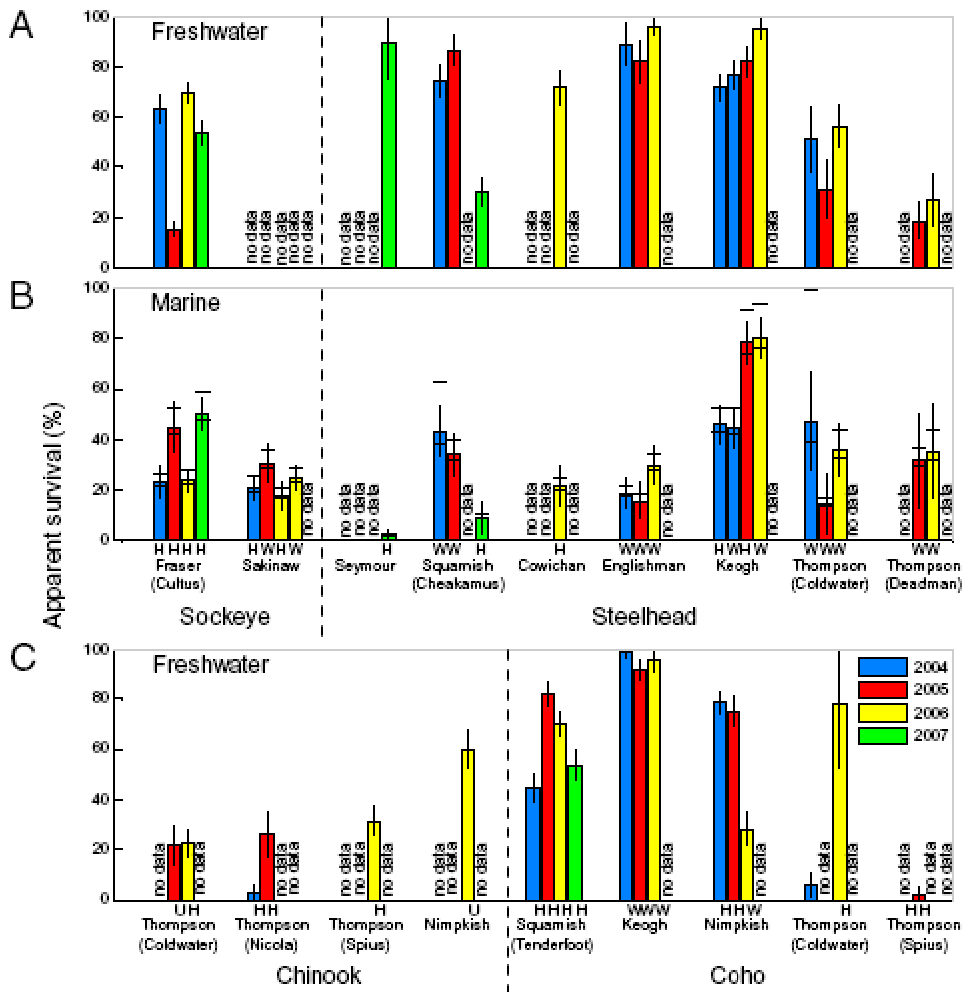


Figure 6. Freshwater and early marine survival estimates for Sockeye and Steelhead populations (A and B) and for Chinook and Coho (C). Freshwater survival is from the release site to the river mouth sub-array and early marine survival is from the river mouth to exit from Georgia Strait, either the Juan de Fuca or Queen Charlotte Sound detector. Error bars are one standard error. Rearing origin (H, hatchery; W, wild; U, unknown). No data indicates that tagging didn't occur in that year (reproduced with permission from Welch *et al.* 2011).

McGregor (1986) reports that Thompson and Chilcotin Steelhead enter the Fraser River in late August at the earliest and peak in the last week of September and first three weeks of October. They migrate rapidly to the Thompson River peaking between mid-October and mid-November, with a portion holding in the Fraser River overwinter. Similarly, for the Chilcotin River with fish holding overwinter in-river as well as in the Fraser mainstem. Spence (1981) found that some fish remained stationary in a section of the Chilcotin River, BC for up to six months. The fish did not hold in the same location but were spread over 60 km in the lower Chilko and Chilcotin rivers. Rising temperatures and flow rates in spring (March and April) initiate final migration into tributary streams where spawning occurs.

Stsptekwll (oral narrative) refers to the story of Ts'egwllníw't's fall migration into the Thompson River from the ocean to freshwater and upriver habitats, moving upstream between November and February from Cooks Ferry to places that include Basque, Spatsum, Oregon Jack, Ashcroft, MacAbees, Rocky Point, Walhachin, Skeetchestn, Sk'emqin, and into Kalmoops Lake (Ignace *et al*. 2019). Steelhead then migrate up Skeetchestn and Bonaparte Rivers during May (Ignace *et al*. 2019). Anadromous Steelhead were identified in an older ethnographic report from as far south as Chase on the South Thompson River (Ignace *et al*. 2019).

Interspecific Interactions

Interspecific interactions include prey items consumed during various parts of the life history, predation of juvenile and adult Steelhead in the rivers and ocean, competition effects of hatchery introductions of Steelhead within the natal stream, and global hatchery production of other salmonids and resulting in potential competition in the ocean.

Aggressive behaviour by Rainbow Trout, i.e*.,* hitting the side of female Steelhead in an attempt to dislodge eggs, observed by experienced fishers from Skeetchestn and St'uxtéws Indian Bands, was interpreted as attempted interbreeding (Ignace *et al*. 2019). Oral narrative of Ts'egwllníw't indicates a potential for Thompson Steelhead jacks (Ignace *et al*. 2019). Interviewer clarified they would not be kelts because the fish in the story are migrating upstream (Ignace *et al*. 2019).

Young Steelhead are primarily insectivores. Shapovalov and Taft (1954) report that caddisflies (*Trichoptera*) were the main food item consumed by Steelhead up to 50 cm during the spring and summer in Waddell Creek, California and the Cowichan River, BC. Over the winter the main food item was the eggs of other salmonids, caddisfly larvae and Chironomids (Shapovalov and Taft 1954). Predation on young Steelhead in streams is probably highest from other Steelhead and freshwater sculpins, but Bull Trout (*Salvelinus confluentus*), Whitefish (*Coregonus clupeaformis*), Cutthroat Trout (*O. clarkia)*, juvenile Coho and Chinook Salmon, and Northern Pikeminnow (*Ptychocheilus oregonensis*) are also known predators. Small numbers of juveniles may be eaten by crayfish, giant water bugs, snakes, fish-eating birds (kingfishers, mergansers, herons), and some are also taken by various terrestrial mammals. Once young Steelhead enter the ocean, they become available to another suite of predators, particularly Harbour Seals (*Phoca vitulina*), and uncertainty remains regarding the extent of their impact both in Puget Sound (Moore *et al.* 2015; Berejikian *et al.* 2016) and in the Strait of Georgia (Thomas *et al.* 2017). Acoustic tagging of Steelhead smolts and DNA testing of seal scats indicates that they are targeted during migration into the Pacific Ocean. Although the proportion of Steelhead in the Harbour Seal diet is small, given their abundance and the decline of most Steelhead populations the impact of this predation may be significant. Secwépemc Knowledge identified Otter (*Lontra canadensis*) predation as a recent (since 2005) threat to a declining

Steelhead population in the Thompson River (Ignace *et al*. 2019). A Nłeʔkpmx Nation community member reported sea otters (*Enhydra lutris*) in the Fraser River as far as Kwoiek area (Tmixʷ Research. 2019). Marine birds such as Caspian Terns (*Hydroprogne caspia*), Western Gulls (*Larus occidentalis*), and Double-crested Cormorants (*Phalacrocorax auritus*) also are capable of predating Steelhead smolts in the ocean. In the Pacific Ocean, Steelhead feed on a variety of prey but mostly various fish, gonatid squids, and to a small degree euphausiids (Burgner *et al.* 1992). Relatively little is known of predation once the Steelhead move offshore in the Pacific. Christensen and Trites (2011) summarize the major offshore predators of Sockeye Salmon that include Humboldt Squid (*Dosidicus gigas*), 17 species of fish, seven species of marine mammals, and a range of coastal and marine birds many of which likely also consume Steelhead.

Introductions of hatchery-raised fish have sometimes been intended to augment the wild population in aid of conservation or recovery, but the efficacy of this management approach has been questioned for Steelhead in BC (Ward 2011; Pollard 2013). Local hatchery Steelhead fry and parr were introduced at a few sites in the Chilcotin River watershed in the early 1980s (Tredger 1985) and in Thompson River watershed from 1979 to 1995 (Bison 2009). However, they were discontinued because of the apparent low returns of mature adults. Studies of both Steelhead and other salmonids indicate that hatchery augmentation, while increasing the overall survival rate of the combined population (Kostow 2004, 2009), negatively impacts the long-term viability of the run, because the population becomes dominated by hatchery fish (Chilcote *et al.* 2011). Another issue with hatchery Steelhead is the tendency for a portion of the juveniles to fail to smolt and residualize in the river thereby competing with wild Steelhead juveniles in the system. Steelhead also co-occur with Chinook Salmon throughout their range and competitive interactions between them in freshwater may limit the efficacy of Steelhead hatchery introductions (Brannon *et al*. 2004). Introductions of other hatchery salmonids to the total population of wild and hatchery fish in the broader Pacific Ocean also appear to have reached carrying capacity for the North Pacific (Ruggerone and Irvine 2018), leading to reductions in growth rate of some salmonids (Pink (*O. gorbusha*), Chum (*O. keta*), and Sockeye). If this also applies to Steelhead, it would contribute to reduced survival and escapements of Steelhead populations.

POPULATION SIZES AND TRENDS

THOMPSON STEELHEAD TROUT DU

Extent of Occurrence and Area of Occupancy

Extent of Occurrence (EOO)

Steelhead from the Thompson River DU typically reside in freshwater for the first two or three years of their lives and then migrate down the Fraser River to the Strait of Georgia and then rapidly into the North Pacific Ocean where they reside for another two years with an estimated extent of occurrence exceeding 20000 km^2. The estimated extent of occurrence in freshwater is 9332 (Appendix 1). Descriptions of anadromous Steelhead in the South Thompson in the early part of the twentieth century suggests they may once have occurred as far upstream as the South Thompson (Ignace *et al*. 2019).

Index of Area of Occupancy (IAO)

The IAO should represent an estimate of habitat necessary to completing the organism's life cycle. This necessary habitat has been defined as the area used for redd construction within cumulative 2 x 2 km^2 grids (COSEWIC 2016). For Sockeye Salmon spatial data on spawning distribution were used to estimate IAO (COSEWIC 2017). Chinook Salmon IAO was based on length of known spawning habitat, number of watersheds, and the total watershed area (COSEWIC 2019). Estimates of spawning distribution and habitat were not available for Steelhead. Instead, an estimate of the maximum IAO for Steelhead was estimated based on number of females in a population and redd construction characteristics.

Steelhead trout females produce on average 1.4 – 1.6 redds per year (Jacobs *et al.* 2002; Berejikian *et al*. 2018). A completed redd occupies about 5.57 m^2 (~60 ft^2) (Shapovalov and Taft 1954). An additional assumption was made that the redds constructed by each female would exclusively be confined to one 2 x 2 km^2 grid. The percentage of females in a Steelhead population estimated in studies ranging from 2 – 20 years and four rivers from 1976 to 2020 ranges from 59% to 68% (Moore and Olmstead 1985; Morris 2002, R. Bison pers. comm. 2020). Using these figures, a maximum estimate of IAO was based on the number of expected females in each DU and estimating a maximum IAO assuming redds from each female occupy exclusively a 2x2 km^2 square. IAO values for Thompson over the most recent generation were 345 – 397 km^2 and for Chilcotin were 211-243 km^2.

Sampling Effort and Methods

The geographical extent of the Thompson River proper (125 km) and its tributaries: Nicola River (99 km), Skuhun Creek (19 km), Spius Creek (30 km), Maka Creek (15 km), Coldwater River (63 km), Deadman River (49 km), and the Bonaparte River (122 km) represents a logistical monitoring challenge requiring significant annual resourcing.

Historical and current interactions between Indigenous groups and Steelhead populations, within the Thompson and Chilcotin systems, include fishing practices, assessment, management, and restoration activities (S. Crowley pers. comm. 2019). St'uxtéws fishers, interviewed in 2019, reported declines in catch effort over the past 30 years in the mainstem Thompson River (Ignace *et al*. 2019). In the 1970s 7-8 Steelhead were taken in a night, while schools of 100-200 Steelhead were observed in the river during the 1980s (Ignace *et al*. 2019). Beginning in 1990s, a member of the community angled to catch and release Steelhead in the Thompson River in an effort to monitor the Steelhead population (Ignace *et al*. 2019). He reported catching a Steelhead every time he fished during the 1990s, but more effort was required to catch the same numbers starting about 2004/5 and by 2012 he had a hard time catching Steelhead and discontinued the monitoring in 2016 due to conservation concerns (Ignace *et al*. 2019). A member of the St'uxtéws Indian Band fished with his great grandpa at Ashcroft and downstream of Ashcroft when Steelhead were observed everywhere throughout the river (Ignace *et al*. 2019). He reported lines of sport fishers along the Thompson River bank, back when there was a 10 Steelhead/day quota for anglers and also observed thousands of freezer burned Steelhead discarded at the dump (Ignace *et al*. 2019). An experienced fisher from St'uxtéws Indian Band observed a 'massive Steelhead' upstream of Bonaparte Lake, in 2006, in an area he frequently checked while hunting and fishing (Ignace *et al*. 2019).

Spawning Population Estimates

The spawning population estimate for the Thompson DU consists of the combination of Steelhead returning to the Nicola, Deadman, and Bonaparte rivers and their tributaries (Appendix 2). Data on the number of mature adult Steelhead for the Nicola watershed are available since 1983, although the reliability varies with year. Up until 1999, estimates were based on peak counts from limited helicopter and ground surveys that were ineffective for the Coldwater River where turbid freshet conditions often precluded visual surveys. Since 1999, escapement estimates have been based on periodic visual counts for Spius Creek and estimates for other streams of the Nicola system (Bison 2006). Nicola River Steelhead congregate and overwinter in the Thompson River, migrating into the Nicola during spring freshets and spawning in the lower Nicola mainstem, Skuhun, Shakan, Nuaitch, Spius, and Maka Creeks and the Coldwater River (Figure 3). Some spawning has also been observed in Guichon, Prospect, and Clapperton creeks and the Nicola mainstem between the Coldwater confluence and Nicola Lake (Webb *et al.* 2000).

Steelhead spawning in the Deadman River were enumerated using a full river fish fence located below Highway 1 from 1978 to 1998. High flows from Criss Creek often flooded the downstream portion of the Deadman River mainstem leading to movement of the fence upstream of Criss Creek in recent years (Braun and Bison 2016a). A resistivity counter was installed, and a weir was built in 1999 to enumerate Steelhead and Rainbow Trout and has been the only method used subsequently. Since 1978, Steelhead abundance has varied over 15-fold from 48 to 1,260 individuals. The mean Steelhead abundance is 324 with a standard deviation of 229 (1978 to 2016). The accuracy of the resistivity counter spawner estimates is affected by correctly discriminating Steelhead from Rainbow Trout due to partial size overlap, occasional malfunction of the counter due to power failure, and determining the date of the end of upstream migration of Steelhead and the date when downstream movement of kelts begins (Braun and Bison 2016a). The effect of these factors on abundance estimates is unknown.

The Bonaparte River is the other major tributary of the Thompson River and has a length of 122 km. Prior to the construction of a fishway in 1988, an impassable waterfall restricted anadromous salmonid migration to the lower 2.6 km of the river (Braun and Bison 2016b). The monitoring of Steelhead spawner abundance in the Bonaparte River has been continuous for 27 years beginning in 1989. From 1989 to 2001, Steelhead were enumerated manually by capturing them in a conventional adult fish trap housed within a fishway located 4 km upstream of the confluence of the Bonaparte and Thompson Rivers.

In 2001, the trap was modified to accommodate the installation of a resistivity fish counter (Bison 2013). The efficiency of detecting Steelhead with the counter and tube array set-up was determined using video monitoring (Bison 2013). In a sample of 29 upstream moving Steelhead detected by video, counter efficiency was 100% with peak signal sizes for each detection ranging from 111 to the upper limit of 127. In a sample of 55 upstream moving Rainbow Trout, counter efficiency was also 100% with peak signal sizes ranging from 35 to 109 thus confirming the accurate separation of Steelhead and Rainbow Trout. The counter has operated annually from 2002 to the present although in 2018 the Bonaparte fishway ceased operating due to structural damage caused by erosion.

The automated fish counters are used in the Deadman and Bonaparte rivers and for some tributaries of the Thompson River. Periodic boat-based visual counts are used in a major tributary of the Nicola River watershed. These visual counts are combined in a maximum likelihood estimation model with observer efficiency, timing and spatial distribution estimates from external and radio tagging to estimate abundance of Steelhead in the Nicola River watershed, which includes estimates for the Coldwater River, Spius Creek and the lower Nicola River (Bison and Phelps 2017). The estimates from the fish counters and visual surveys are summed to determine total spawning population abundance. Although non-anadromous Rainbow Trout co-occur with Steelhead in many of these systems there is sufficient size difference that bias due to mis-identification appears to be insignificant.

Pre-fishery Abundance

A variety of fisheries intercept Thompson Steelhead during their migration to the ocean, in the ocean, and during the return to their natal stream to spawn (e.g., Figure 7, Appendix 3 (1995 examples). Estimates of the mortality resulting from these fishery interceptions are critical to determining the survival of the population from emigrating smolt to returning adult. Annual monitoring information is available from the Albion test fishery conducted in the Fraser River about 60 km upstream from the ocean (near Fort Langley, BC). Steelhead entering the Fraser River and destined for the Thompson River migrate past Albion from late August to November (Bison and Renn 1997). The run timing overlaps with that of the five Fraser River salmon species. Gillnet and purse seine fisheries timed to target late-run Sockeye, Pink, and Chum Salmon incidentally catch Steelhead belonging to the populations further upstream in the Fraser River including Thompson and Chilcotin Steelhead and the other Interior Fraser Steelhead populations. The test fishery consisted of one gillnet vessel operating near Fort Langley beginning September 1 using a 20 cm (8-inch) mesh gillnet for the Chinook test fishery and a 15.3 cm (6.75 inch) mesh gillnet for Chum test fishing on alternate days prior to October 21 (Bison 2016). Thereafter, only the Albion Chum Test Fishery (ACTF) operated daily. Bison and Renn (1997) demonstrated that the ACTF provided statistically sound forecasts of Steelhead escapement to the Nicola, Deadman, and Bonaparte Rivers but it does not account for any intervening overwinter mortality in the holding areas. In the past, these forecasts have been used to determine the opening date for the sport fishery targeting Thompson Steelhead.

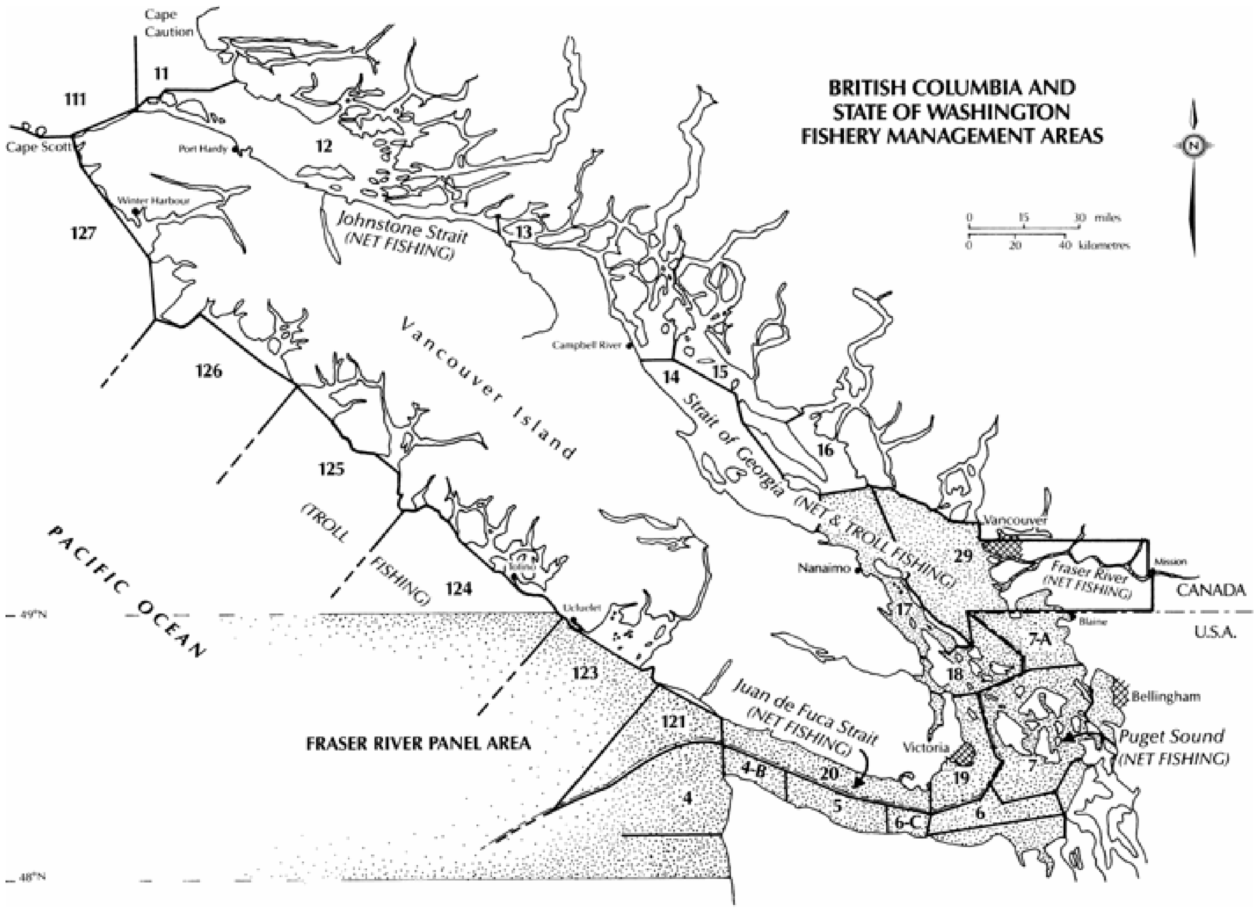


Figure 7. Map of fishery management regions where Steelhead and Salmon species are caught. Reproduced from Bison (2007).

Catch (and release) in the sport fishery (closed in 2018) was estimated by random stratified on-the-ground angler surveys, where about one-third of the total effort was surveyed (Bison and Phelps 2017). A secondary estimate was based on an annual post-season angler questionnaire survey conducted province-wide by the BC Fish & Wildlife Branch (Bison and Phelps 2017). Incidental catch in the commercial Pacific Salmon fisheries is estimated indirectly, using trends and level of encounter rates and fishing mortality rates that are estimated with the use of a simulation model based on the timing, location, duration, and catches in these fisheries and the test fishery described above (Bison 2016; Figure 8). However, there is considerable uncertainty about the estimated exploitation rates, particularly in recent years, due to limited data on the diversion rate of returning Steelhead (Johnstone versus Juan de Fuca Strait); uncertainty in run timing due to low Steelhead returns; incidental catch of Steelhead prior to reaching the ACTF; and absence of reliable data from First Nations winter fisheries.

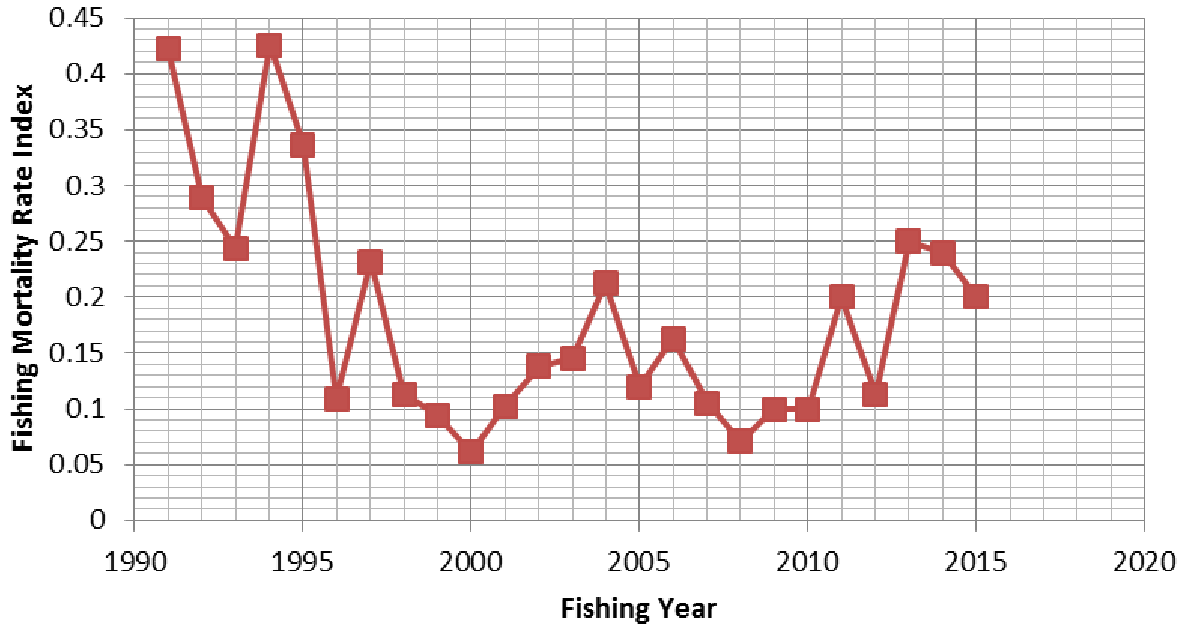


Figure 8. Estimates of relative mortality rate of Thompson River Steelhead from bycatch in salmon fisheries based on Bison (2007) but extended through 2015. Estimates do not include First Nation fisheries targeting Steelhead in the Fraser and Thompson Rivers but do include losses from non-retention sport fisheries (reproduced from Bison 2016).

To determine pre-fishery abundance, the most plausible fishing mortality rate estimates from incidental catch in salmon fisheries are applied to the sum of escapements, plus sport harvest (limited to early years when harvest was permitted), plus catch and release mortality. Directed First Nation harvest in terminal areas has not been monitored continuously and constitutes an unknown level of mortality to Thompson Steelhead.

Secwépemc Knowledge indicates that a night of pitch lamp fishing between the 1940s to the early 1990s resulted in a harvest of between 60-70 Steelhead and fishing from shore was almost as successful as pitch lamp fishing (Ignace *et al*. 2019). Secwépemc Knowledge on fishing success corroborates the observed collapse of the Ts'egwllníw't population between the early 1990s and mid-2010s (Ignace *et al*. 2019).

Members of the Nłeʔkpmx Nation reported a decline in numbers of Steelhead observed in watersheds throughout the Nicola Valley since the early 1980s (Tmix^{w} Research 2019).

Rescue Effect

There are no Steelhead DUs that could potentially provide rescue for the Thompson Steelhead. As noted earlier, freshwater-resident Rainbow Trout may produce offspring that become anadromous (e.g., Zimmerman and Reeves 2000; Kendall *et al.* 2015). However, it appears to be a watershed-specific phenomenon, and the extent to which this occurs within the Thompson River watersheds is unknown and is not rescue per se.

Similarly, hatchery supplementation of Steelhead in the Thompson DU has been practised in the past but does not constitute rescue (Ward 2011; Pollard 2013). However, hatchery production is widely used in the states of Washington, Oregon, and California to supplement or maintain otherwise endangered Steelhead populations (e.g., NWFSC 2015; NMFS 2016).

Habitat Trends

Habitat in the Thompson River watershed has been impacted to a considerable degree as a result of human activities including agriculture, forestry, and significant urbanization. Keeley *et al.* (2005) provide information on broad habitat types, Porter and Rosenfeld (1999) for fry requirements, and Beamish (2018) for ocean habitat and range requirements. Nelitz *et al*. (2011) also provide an extensive summary of habitat in the region pertaining to Sockeye but also relevant to Steelhead. Some of this material is summarized below.

Secwépemc Knowledge identified numerous impacts to habitat within the Thompson River watershed due to: logging (erosion, stream clogging, silt deposit), an increase in farming (water use, fertilizer effluents), cattle ranching and 2017 wildfires (erosion, changes of freshet) that resulted in changes in riparian areas and Steelhead spawning beds (Ignace *et al*. 2019). The flow of water in the Bonaparte River was described as higher and faster than normal (Ignace *et al*. 2019).

<u>Freshwater habitat</u>

Productive freshwater habitats maximize the production of smolts per spawner and can help sustain salmon and Steelhead populations during periods of adverse marine conditions or excessive fishing. Juvenile Coho Salmon and Steelhead spend at least two full years in freshwater making them susceptible to freshwater habitat perturbation. Bradford and Irvine (2000) found that the rate of decline of Coho Salmon escapements to 40 streams in the North and South Thompson River watersheds was related to the extent of human impact during 1988-1998. Rate of decline was correlated with agricultural land use, road density, and a qualitative index of stream habitat status. Steelhead habitat in the interior Fraser River watersheds has been impacted by logging of many valley bottoms that have since supported agriculture (mainly livestock, dairy, and animal feed crops) for over 50 years. Some spawning streams within the Thompson River watershed have been impacted by this activity. Riparian vegetation has been removed, livestock have destabilized stream banks, and off-channel habitats and wetlands have been destroyed in some locations (Brown 2002). Forest harvesting in the headwaters of many watersheds leads to degradation of the stream channel, increased summer stream temperatures, and altered seasonal hydrographs. The Mountain Pine Beetle (*Dendroctonus ponderosae*) infestation in the interior Fraser River watershed has resulted in the loss of large tracts of mature forest in important spawning drainages for Thompson Steelhead populations (Nelitz *et al*. 2011).

The southern and western portions of the Thompson River watershed are semi-arid, experiencing significant surface water withdrawal in summer for irrigation resulting in low flows and high water temperatures (Rood and Hamilton 1995; Walthers and Nener 2000). Demand for surface water and groundwater to support agriculture peaked about 40 years ago in the Thompson River watershed when surface water licencing was fully allocated. Groundwater extraction has been increasing since that time in some parts of the DU. However, water licence clawback and building of reservoirs in the 1980s (Nicola Lake Dam, Bonaparte Lake Dam, Snohoosh Dam) have had counteracting effects. Nevertheless, recent increases in water demand for agriculture and population growth are exceeding the available water resources leaving inadequate rearing habitat for salmonids in some systems (Nicola WUMP 2010).

Estuary and marine habitat

The area around the lower Fraser River is heavily populated and an estimated 70 to 90% of estuarine habitats have been lost, including 99% of seasonally flooded habitats (Birtwell *et al.* 1988; Langer *et al.* 2000; Levings 2000). The Fraser River watershed drains about one quarter of the British Columbia land area and as a consequence has been heavily inundated by various pollutants, including sewage, agricultural runoff, and mine and mill waste resulting in elevated levels of aluminum, iron, zinc and phosphorus (MacDonald *et al*. 2011). As well, elevated fecal coliform and turbidity in the lower river and its estuary occur, particularly during the spring freshet when Steelhead and Salmon smolts from the interior BC Fraser River watersheds are undertaking their seaward migration.

The extent to which Steelhead utilize estuarine habitats in the lower Fraser River is not well understood but they appear to rapidly transit out of the Strait of Georgia (Welch *et al.* 2011). Marine areas used by Steelhead from the Fraser River watersheds are less impacted than the Fraser estuary, but localized impacts from pulp mills, sewage effluent, and fish farms are difficult to quantify. Early ocean residence has been suggested as a critical survival period for Pacific Salmon and Steelhead particularly in southern inshore waters of BC and Puget Sound (Thomas *et al.* 2017). Indications are that predation from marine mammals, particularly pinnipeds are an important factor in determining survival (Thomas *et al.* 2017; Nelson *et al.* 2019). Other studies suggest that changing climate has negatively impacted marine survival of Pacific Salmon and Steelhead (Beamish and Bouillon 1993; Hare and Francis 1995; Mantua *et al.* 1997). Reduced survival appears to be related to changes in the timing of zooplankton blooms and species composition (less lipid rich) resulting from increasing water temperatures (Mackas *et al.* 2007, 2012). As well, competition for food among the increasing numbers of salmonids present in the north Pacific due to hatchery augmentation appears to have impacted the survival and growth of Sockeye, Chum, and Pink Salmon, as well as Steelhead (DFO 2018; Ruggerone and Irvine 2018).

Abundance

The spawning population in the Thompson DU is comprised mostly of the Nicola watershed. Estimates of spawning Steelhead suggest modest abundances in the Nicola watershed of 1000 adults in the 1970s, but pre-fishery estimates in that time period appear to be about 3000 (R. Bison pers. comm. 2019). Subsequently, the number of spawning Steelhead increased during the early to mid-1980s, exceeding 3000 (estimated 3284) in 1985 followed by decline. Steelhead returns in the Nicola in the late 1990s improved and were highly variable ranging from 288 to 2576 until 2007 when variability diminished and returns ranged between 690 (in 2009) and 93 (in 2018). In the past 11 years, Spius Creek and tributaries have been a dominant component of the returns into the Nicola watershed (average 39%, range 29-52%) followed almost equally by Coldwater and its tributaries (average 31%, range 14-45%) and lower Nicola and its tributaries (average 30%, range 13-50%).

The average number of mature spawners returning to the entire Thompson River watershed prior to 2000 was estimated at 1859 (Appendix 2). The decade from 2000 to 2009 averaged 1559 mature spawners and the period from 2010 to 2020 has averaged just 602 adult fish. The estimate of abundance for 2020 is 257 spawning adults.

Fluctuations and Trends

The trend in annual abundance of spawning fish for major tributaries of the Thompson River shows a dramatic decline since the early 2000s (Figure 9). The estimated rate of decline using only the most recent three generations (2006 - 2020) is 82% for the Thompson DU. The decline rate projected for two generations into the future is 71%. Applying the rate of decline determined over the available time series (1978 – 2020), to the most recent three generations suggests a 40% decrease over the most recent three generations.

The longer time series 1978 – 2020) is representative of a time-period that includes ocean and habitat conditions that were more favourable for Steelhead. Using only the most recent three generations (2006-2020) better reflects the increased risk from declining habitat quality both in marine and freshwater environments, and bycatch mortality from Pacific salmon fisheries (DFO 2018).

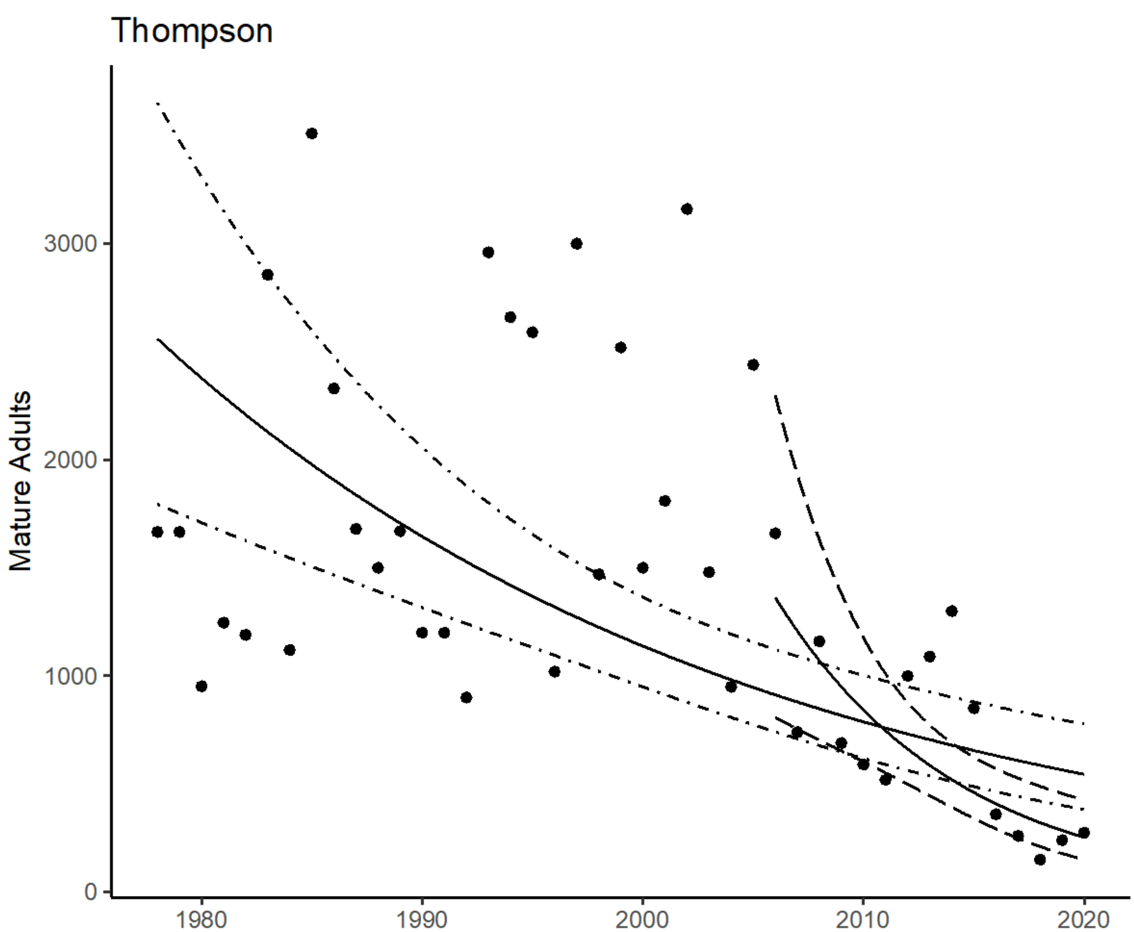


Figure 9. Trend in the number of mature adults (spawners) in the Thompson River Steelhead DU, 1978-2020, and the fitted log-linear regression through the most recent 3 generations (2006-2020) and to the entire time series (1978-2020). Data provided by R. Bison, Province of BC. Solid line are regression fits, dashed line 95% confidence interval for most recent 3 generations, dot -dashed line 95% confidence interval for the entire time series converted to arithmetic scale from log-linear regressions. Slope for most recent 3 generations = -0.12 and is -0.037 for the entire time series. P-values <0.005 for both regressions.

Members of First Nations within the Nłeʔkpmx Nation observe fewer Steelhead spawn in Skuhun Creek compared to 10 years ago (Tmix^w Research 2019). The fish used to travel 4.8 km (3 miles) up the creek but are now observed spawning only 0.8 km (½ mile) into the creek (Tmix^w Research 2019). ATK from Nłeʔkpmx Nation members reported Steelhead are rarely observed in the Coldwater River where they have been declining steadily since the 1960s and less than 10 Steelhead spawn today in Tank Creek compared to 60-70 observed in the past (Tmix^w Research 2019).

The Recovery Potential Assessment identified an abundance target for Thompson Steelhead of 938 spawners (DFO 2018) very similar to the conservation concern threshold of 1187 and above the limit reference point of 431 recommended by Johnston (2013). However, population simulations under average productivity indicate that the probability of recovery within 10 years is 17% or less (DFO 2018). A doubling of productivity over the next 10 years indicates a greater than 90% probability of achieving the recovery target.

Threats

The IUCN Threats Calculator was used to assess the scope and severity of risk to the population from current and imminent threats (Master *et al*. 2012). Scope of a threat is defined as the percentage of the population expected to be impacted by the threat within 10 years if current circumstances and trends continue. Severity is the level of damage (percent population loss) to the population within the scope identified for the threat that can reasonably be expected if current circumstances and trends continue over the next 10 years or three generations, whichever is longer. Threat Timing depends on when the threat is expected to occur (COSEWIC 2016). An IUCN Threat Calculator is provided for the Thompson DU (Appendix 7). The threats calculator was completed by a COSEWIC facilitator, the report writer, the Co-chair and members of the Marine Fishes Subcommittee of COSEWIC, and external experts via a conference call, December 10, 2018. Note: this call was completed prior to knowledge of the extent of the Big Bar slide.

A variety of threats affect the survival and productivity of Thompson River Steelhead throughout their life history (Appendix 7). Agriculture results in effects on stream hydrology through water withdrawal for irrigation, loss of riparian zones, fertilizer seepage into the waterways, sedimentation, and increases in water temperature, all reducing suitable rearing habitat. These effects may impact fry and juvenile growth and survival. Predation of Steelhead smolts and exposure to pollutants during downstream migration as they approach the Fraser River estuary and enter the marine environment are additional sources of mortality. Food availability and quality together with predation in the ocean seem to be important factors in explaining the recent reduced survival rates. Incidental capture in various fisheries for other salmonids and marine mammal predation of adults returning to the natal spawning sites have also contributed to population decline.

Secwépemc Knowledge identified numerous impacts on habitat within the Thompson River watershed due to logging watersheds (erosion, stream clogging, silt deposit), an increase in farming (increased water use, fertilizer effluents), cattle ranching and 2017 wildfires (erosion, changes of freshet) that resulted in changes in riparian areas and Steelhead spawning beds (Ignace *et al*. 2019). In Deadman Creek deforestation for firewood since 1950s – 1960s and logging of agricultural land to stream banks, resulted in reduction of riparian areas (Ignace *et al*. 2019). In the Deadman watershed, impacts were from clearcutting in mountains and mountain top erosion following the 2017 Elephant Hill wildfire (Ignace *et al*. 2019). Hydrology and water flow were impacted as a result of roadbuilding for logging and fire control; wetlands were affected from reduction in beaver populations and water levels affected by increased housing and ranching developments (Ignace *et al*. 2019). Climate change was recognized as a factor: winters were colder prior to the 1990s, with longer cold-snaps and rain fall patterns shifted. [Now] “we also get so much rain in shorter periods of time, even in the winter” (Ignace *et al*. 2019).

Secwépemc Knowledge identified threats in the mainstream Thompson River from the twinning of the CN rail track and from pollution from the Kamloops pulp mill, located upstream of the Lower Thompson River and from predation on Steelhead by otters (Ignace *et al*. 2019).

Potential threats and concerns identified by NłeʔkpmxNation Elders include changes in mesh size of nets that permit smaller fish to pass through and may have, over time, unintentionally changed the gene pool resulting in the smaller size of Steelhead observed today; rock festival events in the Merritt area associated with the Coldwater River are contributing to water pollution; rally races that course through fish streams damage and/or destroy fry or alevin, spawning habitats and eggs; habitat destruction from an increase in flooding and water temperatures and decrease in water levels as a result of increased access to rural areas, logging, mining, and spraying of "unknown" substances; observed increased year-round activities for farming, ranching, and housing developments, at higher elevations, contribute to changes in water levels through overdrawing of water from tributaries and leaching of fertilizers and pesticides, sewers and livestock manure (Tmixʷ Research 2019). It was noted that a previous requirement to ensure livestock avoided areas where leaching could occur is no longer in effect (Tmixʷ Research 2019). Other perceived threats include leaching in the Nicola valley from bio-solid plants and sewage from cities located along the Fraser and Thompson Rivers (Tmixʷ Research 2019). Cyanobacteria (blue-green) algae blooms and *e-coli* have been reported from water systems throughout the valley along with changes in spring melt that used to take months but is now occurring over two weeks, resulting in major flooding, land erosion and leaching from septic systems (Tmixʷ Research 2019). An increase in commercial fishing by Indigenous and non-Indigenous fishers and lack of net monitoring were identified by Nłeʔkpmx Nation Elders as causes of the decrease in Steelhead travelling up the Fraser and Thompson Rivers and the Nicola watershed, along with extensive harvesting using small mesh size nets and waste with deceased fish left in nets (Tmixʷ Research 2019). Abandoned ghost nets in big rivers and oceans were a concern for Nłeʔkpmx Nation Elders as is the Nicola River dam that may be preventing Steelhead from travelling upriver towards Douglas Lake (Tmixʷ Research 2019). Community members reported a lack of collaboration between government agencies regarding control of the mountain beetle epidemic in BC forests and parks that suggested to them there is a general disinterest in thinking in ways that would benefit the ecosystem (Tmixʷ Research 2019). Sport fishing is a concern for some Nłeʔkpmx Nation Elders that feel the potential for a Steelhead being caught several times decreases its chance of spawning success (Tmixʷ Research 2019). Nłeʔkpmx Nation Elders observed changes in water levels over generations, with recent high water now reaching levels of what were normal summer levels (Tmixʷ Research 2019). Water temperatures have increased in the Coldwater and Nicola Rivers and water quality has been adversely affected by climate change and extensive logging resulting in increased erosion and debris along creeks and rivers that limit access to spawning areas upstream (Tmixʷ Research 2019). Additional factors that are thought to limit Steelhead survival include predation by Killer Whales (*Orcinus orca*) and sealions, thriving invasive predatory species (i.e., yellow perch (*Perca flavescens*) and observations of ocean otters as far as Kwoiek area on the Fraser River (Tmixʷ Research 2019).

Nłeʔkpmx Nation Elders observed changes in water levels, quality and temperatures over generations. Shackan Creek is reported to be silt free, but in other areas of the valley, Nłeʔkpmx Nation Elders have observed a decline in food sources such rock bugs or mayflies since slime began to appear on rocks in creeks and river bottoms (Tmix^{w} Research 2019). Water temperatures that exceed natural variation affect physiological processes in fish and create stressful, sometimes lethal, conditions for juveniles and adults. Groundwater is essential for juveniles rearing in smaller rivers to avoid temperature extremes. Wildfires in combination with land use practices can increase sedimentation and exacerbate degradation of freshwater conditions. The extent and degree of altered freshwater conditions is localized to sub-areas of the Thompson DU.

5. Biological Resource Use (High Impact)

5.4 Fishing & harvesting aquatic resources (High Impact)

The threat and impact to Thompson Steelhead from fishing was rated as high. Fishing affects adults returning to spawning grounds from the sea (late August to late November) and migration to the sea after spawning (1 year). Migration from the sea coincides with troll, gillnet, and seine fisheries for one or more other salmon species (Figure 7). First Nations fisheries also occur on post-spawning Steelhead returning to the sea. There are no directed commercial fisheries for Steelhead in BC. All fish returning to the Fraser River from the sea to spawn must pass through some of these fisheries as do fish returning to the sea post-spawning. The Government of Canada has introduced a series of commercial, FSC, and sport fishery closure windows to protect migrating Thompson and Chilcotin Steelhead in recent years (DFO 2019). Fishery related mortality of Steelhead cannot be estimated directly because of inadequate incidental catch data and is based instead on simulation estimates of run timing and migration speed of returning Steelhead and timing of the salmon fisheries (Bison 2007). The estimated mortality rate from all Steelhead incidental catch in commercial salmon fisheries has been on an increasing trend since about 2008 to recent levels in 2013-2015 of 20 to 25% annually (Bison 2016). First Nations in the Thompson Valley have declared a Steelhead fishery closure, but some angling still occurs. The impact of this activity has been assessed recently and appears to add 5 to 10% mortality depending on the stock (Phelps and Bison 2017). Steelhead are iteroparous and fish surviving spawning, usually females, return to the sea where they may be intercepted by a First Nations gillnet fishery in the Thompson and Fraser Rivers. The impact of these fisheries on kelt mortality is not well understood.

The Province of BC closed the sport catch and release fishery for Chilcotin Steelhead in 2008. The Thompson Steelhead sport fishery and all other interior Fraser Steelhead sport fisheries were closed in 2018. In recent years leading up to pre-season closure, the fishery operated on a catch-and-release basis with closures if in-season abundance estimates are below pre-determined limits. The fishery was also implemented with various restrictions to maximize survival of released Steelhead. Depending on the duration of the fishery, the fishing mortality rate by the catch and release fishery in those years added an additional 0.5-1% to fishing mortality rates accumulated in salmon fisheries downstream (Bison and Phelps 2017).

New fishery regulations are intended to reduce fishing mortality. However, if fisheries occur annually in a similar manner to the past over the next decade, they would be expected to affect between 71-100% of the population with a severe impact resulting in serious population decline (31-70%). Fishing mortality, predominantly incidental catch of Steelhead, poses a significant and ongoing threat to the population. Hence, the continued monitoring of fishing mortality will be an essential part of determining the role of fishing in any future declines.

7. Natural System Modifications (High Impact)

7.3 Other ecosystem modifications (High Impact)

The threat and impact from other ecosystem modifications was rated as high. Conditions in the offshore marine environment have shown marked changes that appear to be related to warming temperatures and changing climate. Mantua (2009) found correspondence between salmon production and environmental indices such as the Pacific Decadal Oscillation and the North Pacific Gyre. More recent studies provide evidence for reduced growth and survival of salmonids associated with warming ocean conditions (Atcheson *et al.* 2012; Friedland *et al.* 2014; Debertin *et al.* 2017). The effects of these changes in the ocean ecosystem have been magnified by competition for food due to the extensive introductions of hatchery salmon throughout the North Pacific Ocean. It has resulted in a reduction in growth rates in some salmon species (Sockeye, Chum, Pink) as well as Steelhead (Chasco *et al.* 2017, DFO 2018; Ruggerone and Irvine 2018) possibly leading to reduced survival.

Within the Thompson watershed there is little evidence that there is spatial contraction of freshwater rearing area. In addition, declines in body weight and length suggest that factors associated with ocean rearing environments are of prime importance in assessing the effects of ecosystem modifications (Bison 2012). Other studies indicate the importance of marine environments in assessing ecosystem modification effects. For example, the unintended consequences created by human actions affecting interspecific interactions in the marine environment (predation and competition) will be important to monitor in order to assess the threat from biological ecosystem modifications (Chasco *et. al*. 2017; Thomas *et al.* 2017).

In freshwater, Steelhead is threatened by sedimentation and thermal stress resulting from loss of riparian vegetation as a result of logging and water extraction for irrigation (Figure 10). Logging in the Thompson River watershed has occurred historically and is ongoing with associated impacts on Steelhead throughout their life history (Appendix 4). Rosenau and Angelo (1999) note that at least 40 % of provincial forests have been logged without adequate controls on impacts to fish habitat since the mid-1800s. How significant these effects were in the Thompson drainage prior to the Mountain Pine Beetle infestation (Figure 11) is unknown. However, logging can affect the thermal regime, hydrology, flow pathways, sediment transfer, water temperatures, nutrient budgets, and wood recruitment of streams (Rosenau and Angelo 2009). Forest harvesting can increase rates and timing of snowmelt, and the size of the peak of the hydrograph. Where the logging is extensive, such as it is for some of the beetle-kill salvage areas in central BC, the peak snowmelt water levels can be both earlier and greater with associated effects on salmonids (Rosenau and Angelo 2009). The Mountain Pine Beetle infestation peaked in 2004 but cumulatively has affected 18.3 million hectares (more than five times the area of Vancouver Island). It was projected that by 2015 about 76 percent of the Lodgepole Pine (*Pinus contorta*) volume in the interior of BC might be dead and the action plan called for harvesting as much of the dead wood as possible before it rots or is burned in forest fires (Mountain Pine Beetle Action Plan 2006-2011 Progress Report 2008). The ongoing removal of the trees will have significant impacts in the watersheds with increased erosion, landslides, and resulting sedimentation, loss of riparian vegetation, increasing water temperatures and potential reduction in stream productivity.

MacGregor (1986) reported rates of repeating spawning for Thompson Steelhead ranging from 2 to 7.1%. Repeat spawning in this population was lower than for other Steelhead in the Columbia River and for other areas of BC (Busby *et al*. 1996). However, Renn *et al*. (2001) report that almost half the radio tagged Steelhead were observed moving downstream in 1998 and 1999 after spawning. Apparently, other factors inflicting mortality in the river or in the ocean are reducing the repeat spawning of this population.

A comparison of predicted juvenile Steelhead recruitment with and without including covariates of summer drought and winter flow did not add any predictive power of recruitment than including only adult brood abundance. It was cautioned that these results are based on insufficient sample size combined with the low explanatory power associated with using environmental variables collected for other purposes. Additional work from studies focusing on this issue are required to provide a better test of the relationship between drought and recruitment (Schick *et al*. 2016).

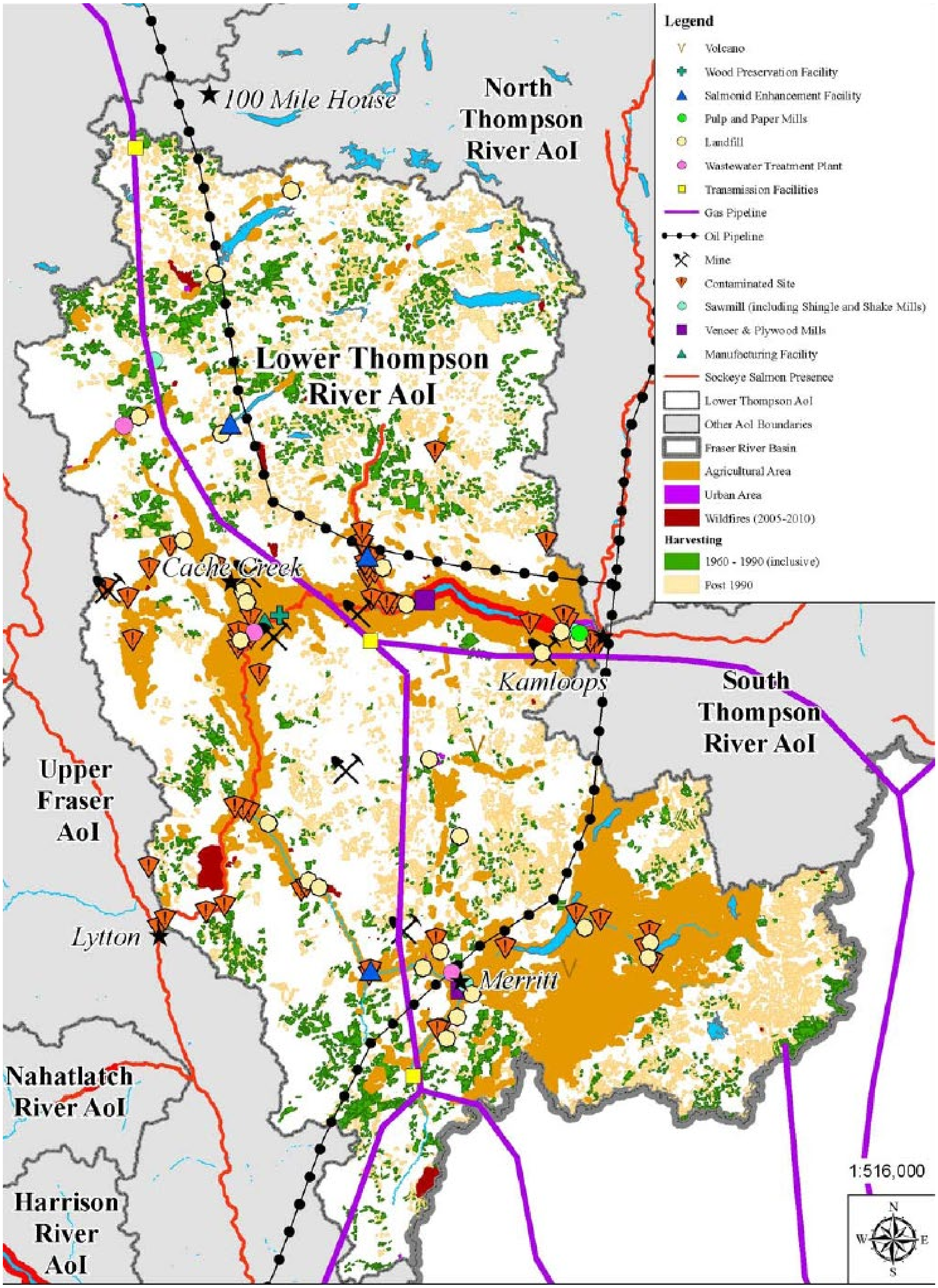


Figure 10. Map of the lower Thompson River watershed showing location of all land uses (reproduced from MacDonald *et al.* 2011).

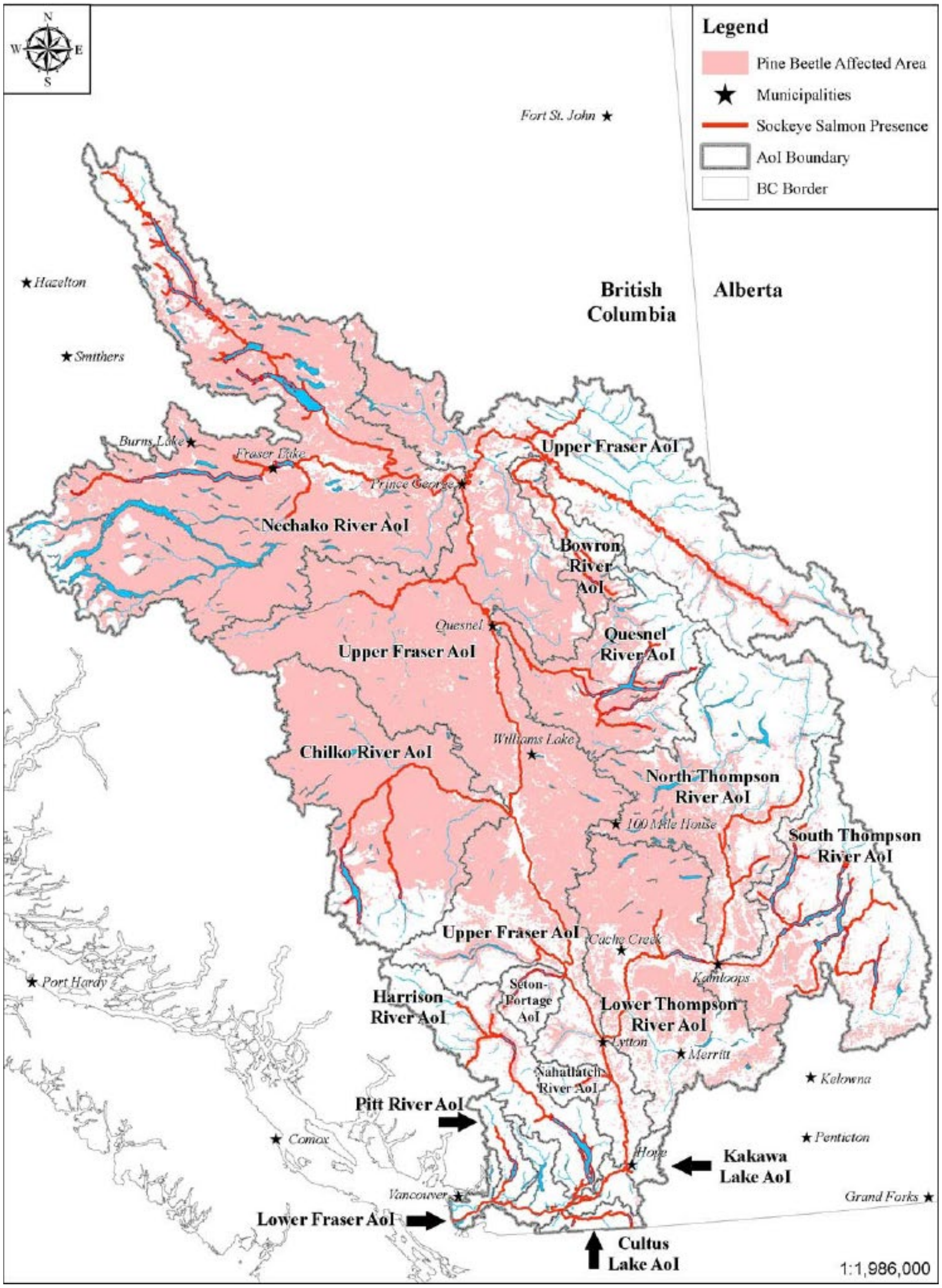


Figure 11. Map of the Fraser River watershed showing the distribution of Mountain Pine Beetle infestation (reproduced from MacDonald *et al*. 2011). The Chilko River AOI (Area of Interest) encompasses the Chilcotin DU while the lower Thompson River AoI includes the Thompson DU.

Nłeʔkpmx Nation Elders observed changes in water levels, quality and temperatures over generations. Shackan Creek is reported to be silt free, but in other areas of the valley, Nłeʔkpmx Nation Elders have observed a decline in food sources such rock bugs or mayflies since slime began to appear on rocks in creeks and river bottoms (Tmixʷ Research 2019). Water temperatures that exceed natural variation affect physiological processes in fish and create stressful, sometimes lethal, conditions for juveniles and adults. Groundwater is essential for juveniles rearing in smaller rivers to avoid temperature extremes. Wildfires in combination with land use practices can increase sedimentation and exacerbate degradation of freshwater conditions. The extent and degree of altered freshwater conditions is localized to sub-areas of the Thompson DU.

These threats in the freshwater and marine environment were expected to continue over the next 10 years and are pervasive affecting 71-100% of the Steelhead population with an expected impact of 31-70% population decline. The consensus is that mortality might be near the upper end of the range.

7.2 Dams & water management/use (Low Impact)

The threat and impact from dams and water management were rated as low. The Thompson Plateau experiences a continental climate with temperatures ranging from minus 30°C in winter, to plus 40°C in summer. The annual precipitation in the Nicola River basin varies from 15 to 75 cm (Rosenau and Angelo 2003). The drainages can be quite moist in the spring and fall and have a considerable snow pack by the end of winter in most years. The snow accumulations in the higher areas are important in maintaining flows for many of the basin's streams during dry and hotter periods of the year. However, because of the naturally dry conditions throughout much of the Nicola River drainage, significant changes to the flows within this watershed during low-discharge periods directly impact fish-production capacity. Water removal from the streams in this basin, especially during late summer, affects salmon and Steelhead juvenile rearing, and during the winter when embryos and alevins are incubating in the gravel (Rosenau and Angelo 2003). Water extraction in the Nicola River basin also impacts water temperature. Low flow events exacerbated by high rates of withdrawal result in high water temperatures during the summer. For a number of the streams in the watershed, including the Nicola and Coldwater rivers, empirical observations indicate highly elevated water temperatures during the very warm and low-flow periods of summer (Walthers and Nener 2000). Loss of riparian vegetation on ranchland areas and removal of shade trees along the stream banks have exacerbated the problem, resulting in temperatures at lethal, or near-lethal, levels for juvenile salmon and Steelhead on a number of occasions (Nelitz *et al.* 2007). However, the main concern regarding water use and fish in the Nicola River basin is that extraction of water from many of the streams has been excessive during low flow periods. Inadequate flows have occurred for either instream rearing juvenile fish, adult migration or the incubation of embryos and alevins. Flow issues have been worsened on occasion by non-compliance by water licence holders, intentional or otherwise, and in the absence of comprehensive compliance monitoring. The problem relating to low flows and salmon and Steelhead is the ongoing growth in demand for water due to an expanding population in the basin. Increasingly more water was sought and allocated, with little regard for habitat capability or the environmental stresses and consequences for fish (Rosenau and Angelo 2003). Further impacts on environmental flow needs from new water licence demands will be mitigated by the requirement to consider fish under new provincial legislation.

The threat is expected to affect alevin emergence and growth (mid-June to early July), and juvenile growth in tributaries (zero to 2-3 years). It affects a large (31-70%) portion of the population, impacting all of the Nicola and Coldwater and at least half of the Bonaparte and Deadman Rivers. The consensus opinion was that population decline from reduced water availability (due to withdrawal) would be less than 10%. Water management activities are an annual occurrence expected to proceed similarly or become more restrictive over the next 10 years.

7.1 Fire & fire suppression (Negligible Impact)

The threat and impact from fire and fire suppression was rated as negligible and primarily refers to water withdrawal for fire suppression (Figure 10). Removal of water from some or all of the streams in the DU to assist in suppression of forest fires potentially affects all life history stages depending on the timing and severity of the forest fire season. Fire and fire suppression were determined by consensus to be negligible as there is a low probability of multiple fires occurring in one area.

<u>8. Invasive and Other Problematic Species & Genes (High-Medium Impact)</u>

8.2 Problematic native species/diseases (High-Medium Impact)

The threat and impact from problematic native species or diseases was rated as high-medium. The reduced population abundance of Thompson Steelhead makes predation particularly by pinnipeds a threat, not only in the inshore, but also in the offshore by Harbour Porpoises (*Phocoena phocoena*) and White-sided Dolphins (*Lagenorhychus obliquidens*). Adults migrating to overwintering areas of the Thompson River from the sea (late August to late November), smolts migrating to sea (mid-April to mid-May, once they have smolted after 2 or 3 years), and smolt offshore migration (June to September) are all vulnerable. Estimates of loss rates for tagged smolts between estuaries and departure from inshore marine waters is about 70% over a 3-week smolt migration period (Melnychuk 2007; Troffe *et al.* 2007). Berejikian *et al.* (2016) also suggested that predation by Harbour Seals is contributing to mortality of migrating juvenile Steelhead off Washington State, and they hypothesized that changes in the Puget Sound ecosystem may currently put them at greater risk of predation. Thomas *et al.* (2017) reported Steelhead in Harbour Seal diets in the Strait of Georgia and Nelson *et al.* (2019) conducted a broad analysis of survival in hatchery enhanced Chinook Salmon in the Pacific northwest concluding that Harbour Seal predation was largely responsible for a 74 % decline in their maximum sustainable yield since the 1970s. A number of other studies have investigated the reduced survival of salmonids in recent decades and linked the mortality to Harbour Seal and other predation (e.g., Moore *et al.* 2015; Chasco *et al.* 2017). The effects appear to be most pronounced on the downstream migrating smolts when they first enter the estuary (Melnychuk *et al.* 2014) but may also be a function of other species such as Dolly Varden Char (*Salvelinus malma*), Bull Trout (*S. confluentus*), Staghorn Sculpins (*Leptocottus armatus*), Common Mergansers (*Mergus merganser*), and Glaucus-winged Gulls (*Larus glaucescens*) present in the watershed (Melnychuk *et al.* 2007). The scope is pervasive potentially affecting the entire smolt outmigration. Harbour Seals also can prey on the returning adult spawners as they enter the Fraser River potentially targeting the entire spawning population (Wright *et al*. 2007; Naughton *et al*. 2011). The impact of sea lice on Steelhead smolts and adults during migration past fish farms in northern Johnstone Strait are a current and future threat with uncertain impact.

Another threat to Thompson Steelhead is the potential for interbreeding particularly between Steelhead females and resident Rainbow Trout males due to size assortative mating (Seamons *et al.* 2004). Courter *et al.* (2013) investigated the maternal origin of repeat spawning Steelhead and found considerable spatial and inter-annual variation ranging between 2 and 26% between 2010 and 2011 in the Naches sub-basin of the Yakima River and between 13 to 19% in another section being the product of Rainbow Trout mothers. As Thompson Steelhead abundance has declined the potential impact of the interbreeding becomes more significant. In addition, indication from hatchery crosses of Steelhead and Rainbow Trout is that their offspring had lower incidences of smolting (Ruzycki *et al.* 2009) potentially leading over the longer term to greater residualization and production of fewer Steelhead smolts.

The suite of threats from these species is expected to continue over the next 10 years and was rated as high-medium impact potentially affecting the entire population (71-100%) generating a serious to moderate (11-70%) population decline.

9. Pollution (Medium Impact)

9.3 Agricultural & forestry effluents (Medium Impact)

The threat and impact from agricultural and forestry effluents could affect all life history stages and was rated as medium (Figure 10). Pollutants include agricultural runoff, sedimentation, and pesticides in both the Thompson and lower Fraser River watersheds (MacDonald *et al*. 2011). The Bonaparte River, Nicola River, and some of its tributaries have been particularly affected by runoff following logging and fire damage contributing to soil erosion and siltation (R. Bailey pers. comm. 2018). As a consequence, there has been loss of pool/riffle area and habitat complexity. Conversion of the lower Coldwater River area to agriculture and ranching is believed to have reduced carrying capacity for salmonids significantly. The entire population (71-100%) is potentially exposed to the pollutants and the effects are expected to result in moderate (11-30%) population decline over the coming decade.

9.1 Domestic & urban wastewater (Low Impact)

Wastewater effluent potentially affects all life stages as smolts and adults transit through the Thompson and lower Fraser Rivers and it was rated as having a low impact (Figure 10). In particular, the area around the lower Fraser River is heavily populated and it drains about one quarter of the British Columbia land area. It has been heavily inundated by various pollutants including sewage, discharge from treatment plants, leaking septic, oil or sediment from roads, domestic fertilizers and pesticides, and road salt (MacDonald *et al*. 2011; Nelitz *et al*. 2011). As well, elevated fecal coliform and turbidity in the lower Fraser River and its estuary occur, particularly during the spring freshet when Steelhead and salmon smolts from the Interior Fraser watersheds are undertaking their seaward migration. The extent to which Steelhead utilize estuarine habitats in the lower Fraser River is not well understood but it appears that they rapidly transit out of the Strait of Georgia (Welch *et al*. 2011) so exposure to this pollutant would be minimal. The threat potentially affects the entire population (71-100%) but the severity was rated as producing a slight (1-10%) population decline.

9.2 Industrial & military effluents (Low Impact)

The threat affects smolts and adults migrating through the Thompson and lower Fraser Rivers and was rated as having a low impact (Figure 10). Industrial and military effluents such as mine and mill waste that result in elevated levels of aluminum, iron, and zinc have differing effects depending on time of year and extent of exposure (MacDonald *et al.* 2011). All Steelhead in the area of the spill or effluent would be affected. For example, toxic spills from train derailments are known along the Fraser River and may affect the Thompson River from Kamloops Lake to the confluence with the Fraser River. A sodium hydroxide spill in 2005 in the Cheakamus River travelled downstream as a pulse killing over 90% of free-swimming fish in the mainstem river (Melnychuk *et al.* 2014) thus impacting 2 to 3 years of wild production. Similarly, the breach of the Polley Mine tailings pond, in 2014, released toxicants into Quesnel Lake in the Mid/Upper Fraser watershed and represents a potential future threat to Steelhead should the chemicals reach the Fraser River and impact downstream and upstream migrations. Similar threats may exist around other mine sites with tailing ponds and, while such events are rare, could have significant localized or widespread impact on the population. The lower Fraser River and estuary are heavily industrialized and subject to a variety of effluents of variable toxicity (Brown 2002). The threat is ongoing and smolts and adults are exposed as they transit the lower reaches of the Fraser River. Steelhead are exposed to industrial effluents in freshwater, the Fraser River estuary and Strait of Georgia. Estimating direct effects of the pollutants is difficult but consensus is that although the threat is pervasive potentially affecting the entire population (71-100%), population decline was believed to be slight (1-10%).

10. Geological Events (Low Impact)

10.3 Avalanches/landslides (Low Impact)

The threat and impact to the Thompson DU from avalanches or landslides was rated as low but ongoing. The rapid and extensive removal of dead and dying trees from the Mountain Pine Beetle infestation (Figure 11) will have significant impacts in the watersheds with increased potential for landslides depending on the local terrain (Nelitz *et al*. 2011). The effect of landslides is typically to increase downstream turbidity and potentially produce changes in the streambed as waters circumnavigate any blockage. There have been immediate impacts on the Bonaparte River watershed as a result of forest fires and subsequent landslides (Figure 10). Depending on the timing of the landslides, effects could occur on various life history stages, but eggs, alevins, and juveniles would be most affected. However, if significant they could block upstream passage of adult spawners. For example, the Big Bar slide of 2018 occurred just upstream from this DU. Occurrences are expected to be infrequent and have minimal effects (1-10% decline) on a portion of the population (1-10%).

2. Agriculture & Aquaculture (Negligible Impact)

2.3 Livestock farming & ranching (Negligible Impact)

The threat and impact to Thompson Steelhead from direct physical harm due to livestock farming and ranching was rated as negligible. Trampling of eggs by animals or vehicles accessing the streambeds was considered to affect a small (1-10%) portion of the population and population decline would be negligible (<1%).

4. Transportation & Service Corridors (Negligible Impact)

4.2 Utility & service lines (Negligible Impact)

The threat and impact from maintenance activities associated with utilities and service lines was rated as negligible (<1% mortality). It includes current maintenance work along the Trans Mountain Pipeline where it crosses streams. Portions of the pipeline are exposed and need to be re-armoured. The effect is primarily in the Coldwater River watershed affecting 11-30% of the population and could impact all life history stages. Any future linear developments (e.g., highways, railways, pipelines) would threaten portions of the DU. Risks to Steelhead from linear developments include catastrophic spills of deleterious substances (e.g., McCubbing *et al.* 2006) and habitat losses associated with stream crossings, stream channelization, erosion, and removal of riparian vegetation. Future development of the Trans Mountain Pipeline will include many stream crossings and disruption and represents a potential ongoing threat particularly to the Nicola River watershed (Decker and Irvine 2013).

4.3 Shipping lanes (Negligible Impact)

The threat and impact from shipping lanes includes dredging in the lower Fraser River for channel maintenance and was rated as negligible (<1% decline). All adult and smolt Steelhead (71-100%) traverse the area and would be potentially affected but it was felt that with proper mitigation they would be negligible as fish move through the area rapidly.

6. Human Intrusions and Disturbance (Negligible Impact)

6.1 Recreational activities (Negligible Impact)

The threat and impact from recreational activities was rated as negligible. The threat affects alevin emergence and fry growth (mid-June to early July) in rearing streams. A small percentage of rearing areas are affected by physical disturbance from human activity (e.g., gold panning, horse, bike, and ATV incursions into rearing habitat, beach parties, music festivals). The effect is expected to be pervasive, but severity would be negligible. Timing of disturbance is typically following emergence and doesn't directly affect redds and eggs. These activities are ongoing and expected to continue for the next 10 years.

8. Invasive & Other Problematic Species & Genes

8.1 Invasive non-native/alien species/diseases (not scored)

The introduction of invasive fishes is a recent occurrence in the Thompson DU. Runciman and Leaf (2009) reviewed the distribution of four alien species throughout BC. Yellow Perch (*Perca flavescens*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*M. salmoides*), and Pumpkinseed Sunfish (*Lepomis gibbosus*) have been introduced, either intentionally or illegally, into a number of water bodies mostly in southern BC, including the Thompson River drainage. At this point, none are directly accessible to salmon bearing waterbodies in the DU, but they pose a potential future threat. However, these species are resident in the lower Fraser River watershed and could feed on Steelhead smolts during their migration to the sea.

11. Climate Change & Severe Weather (Unknown Impact)

Climate warming is also producing habitat shifts and alterations affecting both the freshwater and marine ecosystems. Over the past century in BC, minimum temperature has increased by about 1.7°C and precipitation by 22%. The largest increases in precipitation have occurred in interior BC (Hinch and Martins 2011). The highest increases in both temperature and precipitation have occurred during the winter and spring causing earlier snowmelt and advancing the spring freshet by 1 to 4 weeks. In the Fraser River, the dates for one third and one half of the cumulative annual flow have been occurring progressively earlier at the rate of 1.1 and 0.9 days per decade since the 1950s (Hinch and Martins 2011).

Despite the earlier onset of the spring freshet, the total summer flow of the Fraser River has not changed significantly. However, the water temperature in the summer has increased at a rate of 0.33°C per decade since the 1950s and the river is now ~ 2.0°C warmer than 60 years ago and water temperatures in 13 of the last 20 summers have been the warmest on record. The highest rate of increase in water temperature during the summer has occurred in June and July (Hinch and Martins 2011).

Similar changes are occurring in the marine environment, but effects are more difficult to detect. Welch *et al*. (2000) were among the first to speculate that warming ocean conditions would produce a northward shift in distribution resulting in a reduction in the available ocean-rearing habitat for Steelhead. Climate and competitive interaction effects have also been observed in Sockeye Salmon and will be important to consider in evaluations of climate change effects on Steelhead in the marine environment (Connors *et al*. 2020).

The carrying capacity of the Steelhead niche in the Pacific Ocean varies inter-annually with environmental conditions and limits the abundance and productivity of Thompson Steelhead. Long-term decrease in the available niche space for Steelhead would result in the decline and limited recovery observed for these populations since the early 1990s (Welch *et al*. 2000; Kendall *et al.* 2017). Similar ocean survival-based declines have been reported in recent COSEWIC reports for Sockeye and Coho Salmon. Predicting trends in the North Pacific Ocean is uncertain because of inter-annual and inter-decadal modes of climate variability (Hinch and Martins 2011). Short-term variability is related to El Niño Southern Oscillation (ENSO) events, which occur every 2-7 years and persist for up to 1.5 years. Typically, El Niño events lead to warm SST (sea surface temperature) in the waters off the west coast of North America and have become more common since the 1970s. Inter-decadal variability in the North Pacific Ocean climate has been described by several indices, the most common being the Pacific Decadal Oscillation (PDO). PDO events typically last for 20-30 years and are characterized by variations in SST over the North Pacific Ocean (Mantua *et al.* 1997). Warm SST over the western and eastern North Pacific Ocean characterizes the warm or positive phase of the PDO, and cool SST the negative phase. The PDO was predominantly in the positive phase from 1925-1946 and 1977-1997, and in the negative phase from 1900-1924 and 1947-1976. Since 1998, the PDO has alternated more frequently between the positive and negative phases, which have lasted from 3-4 years (Hinch and Martins 2011). Salmonid productivity has been shown to correlate broadly with the PDO but the underlying mechanism driving the response is unclear (Mantua *et al*. 1997; Mantua 2009). In addition, SST has increased between 0.5 and 1.5°C over the past six decades while salinity and pH have decreased. These changes in ocean conditions have also been manifest in the zooplankton community (Mackas *et al.* 2007, 2012) and either changes in timing of peak productivity or lipid content have resulted in poorer growing conditions for a number of species including Steelhead (Atcheson *et al.* 2012). Steelhead survival rate is dependent on growth during the first few months in the ocean and future increases in SST may result in reduced prey availability and quality and reduction in ocean habitat (Welch *et al*. 2000; Abdul-Aziz *et al.* 2011; Atcheson *et al.* 2012; Friedland *et al.* 2014). Steelhead are known to migrate furthest to the south in the eastern Pacific relative to other salmonids and so may be more susceptible to warming conditions in the marine environment as a result of PDO or climate change. Steelhead feed mainly on fish and squid during their offshore migration and availability of these prey species may also be altered or reduced by food limitations associated with warming waters and a changing marine environment.

The impact level of physical habitat degradation from climate shifts on Steelhead populations, while they are currently uncertain and unknown, do not appear to be dominant at this time.

CHILCOTIN STEELHEAD TROUT DU

Extent of Occurrence and Area of Occupancy

Steelhead from the Chilcotin DU typically reside in freshwater for the first three or four years and then migrate down the Fraser River to the Strait of Georgia. Subsequently, they move rapidly into the North Pacific Ocean where they reside for another two years with an estimated extent of occurrence exceeding 20000 km^2. The estimated extent of occurrence in freshwater is 6634 km^2 (Appendix 5). Using the method described for the Thompson DU the IAO for Chilcotin was 211-243 km^2.

Sampling Effort and Methods

The Chilcotin River stretches for 306 km although it is believed that Steelhead do not occur upstream of Chilcotin Lake, 162 km from the Fraser River (Riley *et al*. 1998) and radio telemetry indicates that few Steelhead enter the river past the confluence of the Chilko River (Spence 1981). Most Steelhead spawn in 85 km of the Chilko River below Chilko Lake. The Taseko River is accessible for 99 km from the confluence with the Chilko River with another 22 km in Elkin Creek but few fish have been observed there (Spence 1981; Riley *et al*. 1998). The expanse and remoteness of the area make this DU a monitoring challenge.

Historical Chilcotin Steelhead systems include the Chilko, Taseko/Elkin systems, Chilcotin, and little Chilcotin Rivers (Toth and Tung 2013; Levy and Parkinson 2014). Presently Steelhead are known to spawn in the Chilko River, upper Chilcotin and Taseko/Elkin systems (S. Crowley pers. comm.). There was, however, no additional information to pursue the pursue the delineation as a DU using the COSEWIC criteria.

Spawning Population Estimates

Estimates of the abundance of mature spawning adults (escapement) come primarily from aerial survey counts. For 1964 and 1973 to 2006, counts of individual fish were conducted annually over an index section of the Chilko River. Prior to 1998, single flights were conducted, and subsequently multiple flights have been used. The index section is 23.8 km extending from the Brittany Creek confluence upstream to Chilko Lake. It was identified as an important spawning area through radio telemetry studies (Spence 1980, 1981; Hagen 2001). Data from multiple periodic surveys provide enough information to conduct the area-under-the-curve (AUC) analysis to estimate abundance (Williston 2006). Prior to 2006, escapement estimates were calculated by expanding the peak count from aerial surveys by a factor of 4.8 based on the comparison of the 1980 aerial count to the estimate from a mark-recapture study (Spence 1981). The bias and precision of the escapement using the peak count depend on the consistency in the ratio of observed peak count to total escapement which has uncertainty in annual variability of: 1) observer efficiency; 2) run timing dynamics; and 3) spatial distribution of spawners relative to the index area (Williston 2006). The first source of variability is minimal in the Chilcotin River as viewing conditions are generally very good and consistent inter-annually (Hagen 2001). However, variability in run timing and spatial distribution are problematic for the peak count method. It is also difficult to schedule surveys to consistently overlap with the date of peak abundance in the index area. However, typically four surveys per year are conducted which always capture the temporal variation in spawner numbers from which a peak spawning abundance can be estimated (Bison pers. comm. 2019).

The AUC method relies on periodic counts of spawners in a stream. The number of fish observed is plotted against date and the residency of a fish in the index area is estimated from other information. The number of spawners is determined from the cumulative days of residency by all fish divided by the mean residency of an individual determined from telemetry. Counts are done periodically rather than daily but uncertainty increases as the time between surveys increases (Williston 2006). The other variable is an estimate of observer efficiency. For the Chilcotin River Steelhead, Hagen (2001) calculated observer efficiency for 1980 at 0.71 for the aerial survey abundance relative to that from a combination of mark-recapture, radio telemetry, and sex ratio data. He also estimated residency from radio telemetry studies in 1998 and 1999 of 8.04 days for females and 22.8 days for males. Based on a sex ratio of 2.65 females to males an aggregate residency of 12.1 days was determined. Unfortunately, the estimates of residency were based on only three males and two females (Hagen 2001). Finally, it is necessary to estimate the proportion of the population within the index area, which based on telemetry studies from 1979, 1980, 1998, and 1999 averaged 50.3 percent (Hagen 2001). Williston (2006) compared expanded peak count estimates with AUC and found that they produced similar trends in escapement, but the AUC for 1998 to 2006 was 0.9 of the peak count. Escapement estimates for 1964 and 1972 to 1997 were adjusted to align them with the later AUC estimates. Williston (2006) also found that the escapement estimates were sensitive to the parameters for observer efficiency and residency in the index area and there was some concern about the extent of spawning in the Taseko River rather than the Chilko index area.

As in the Thompson DU, the estimate of total adult spawners is summed with an estimate of mortalities from all fisheries to determine total population abundance.

Rescue Effect

No Steelhead DU is known that could potentially provide rescue to the Chilcotin Steelhead. Freshwater-resident Rainbow Trout may produce offspring that become anadromous (e.g., Zimmerman and Reeves 2000; Kendall *et al.* 2015) and contribute to the population but this is not rescue per se. It appears that this phenomenon is watershed-specific, and the extent to which this occurs within the Chilcotin River watershed is unknown.

Habitat Trends

Freshwater habitat

Habitat in the Chilcotin River watershed has been impacted to a lesser degree by human activities than the Thompson River (Figure 12). Quantitative data on trends in habitat are limited. A portion of the watershed was impacted by forest fires in the early 2000s and resulting impact to the habitat from changed hydrology have been exacerbated more recently by the effects of the Mountain Pine Beetle infestation in the interior Fraser River watershed (Figure 11). The resulting damage and loss of large tracts of mature forest in spawning drainages for Chilcotin Steelhead are expected to result in longer term impacts on the quality and quantity of both spawning and juvenile rearing habitat.

The Chilcotin DU has not been affected by hydroelectric development. Natural channel morphology at various sites in the Fraser River combined with flow and temperature conditions have been factors that have driven the evolution of the unique migration timing and behaviour of Chilcotin Steelhead. Human alterations of channel morphology in the Fraser River have occurred to facilitate easier migration conditions for salmon. Fish passage restoration at Hell's Gate and subsequent improvement is the earliest type of restoration and enhancement during the commercial history of Fraser River salmon. Fishways have been constructed near Yale, at Bridge Rapids, and multiple fishways were built at Hell's Gate (Roos 1991). Despite the amelioration of migration conditions for salmon, Chilcotin Steelhead as well as other interior Fraser Steelhead may be unable to reach overwintering areas due to early onset of winter as migration ceases when temperatures fall below 7°C (Renn *et al*. 2001). Telemetry studies illustrating these events highlight the forces that maintain run timing and migration behaviour for Chilcotin Steelhead, even when channel morphology is altered to facilitate migration (Renn *et al*. 2001).

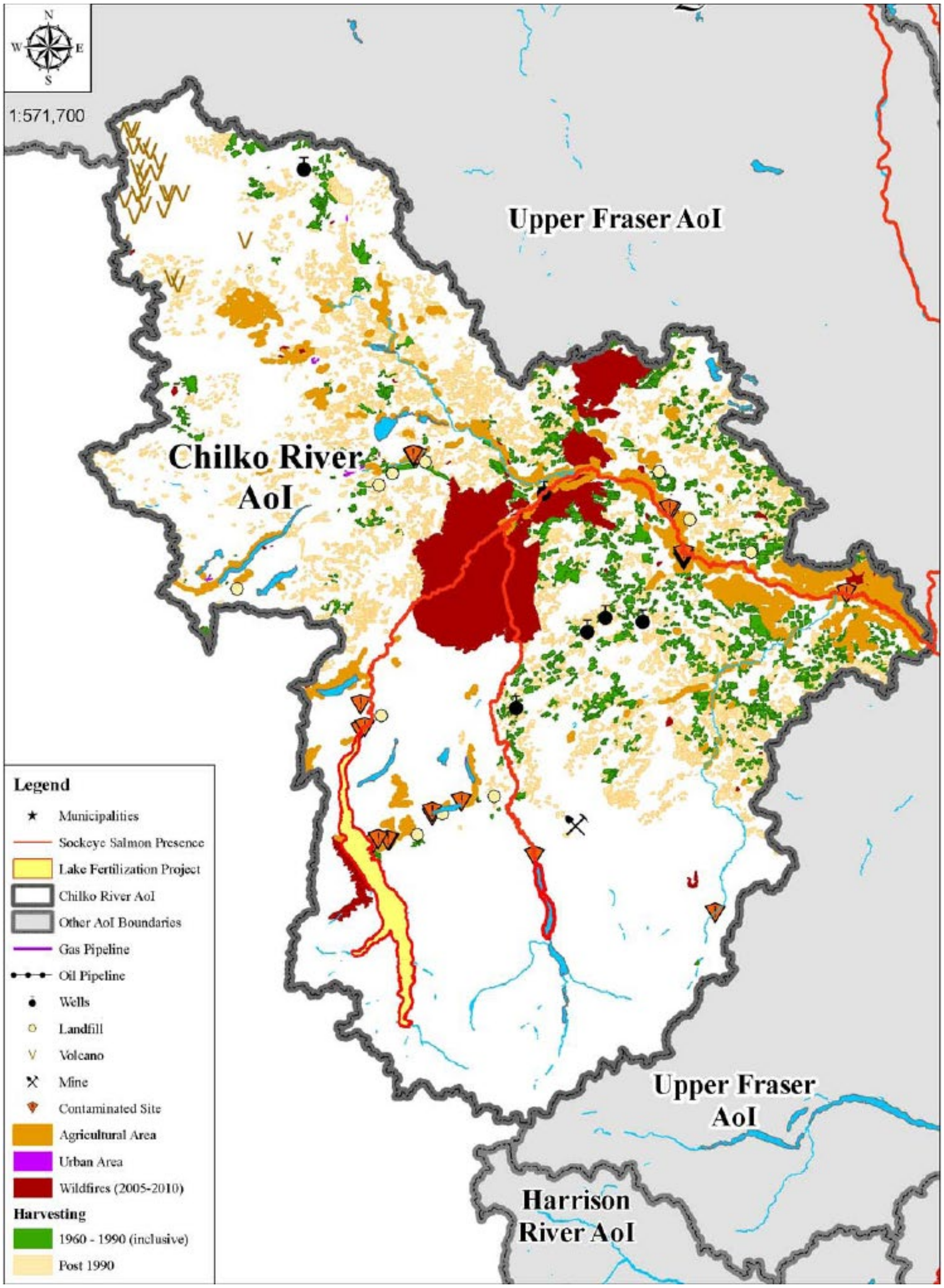


Figure 12. Map of the Chilcotin River watershed showing the location of all land uses (reproduced from MacDonald *et al*. 2011).

Estuary and marine habitat

Chilcotin Steelhead is subject to the same habitat trends and associated issues in the Fraser River and its estuary, and in the marine environment, as reported above for Thompson Steelhead.

Abundance

The pre-fishery abundance of Chilcotin Steelhead is determined as the sum of the predicted harvest across all fisheries and the estimated escapement (Appendix 6). Fishery exposure is identical to that reported above for Thompson Steelhead. The sport fishing mortality was monitored annually with a creel survey program (e.g., MacPherson 2006) until the fishery was closed in 2018. The harvest simulation model developed by Bison (2007) is also used for Chilcotin Steelhead to determine an exploitation rate for the population. The average number of mature spawners returning to the Chilcotin DU prior to 2000 was estimated at 1091. The decade from 2000 to 2009 averaged 610 mature spawners and the period from 2010 to 2020 has averaged 284 adult fish. The estimated abundance of mature spawning fish in 2020 was 38 individuals.

Fluctuations and Trends

The trend in annual abundance of spawning fish for major tributaries of the Chilcotin River shows a dramatic decline since the early 2000s (Figure 13). The estimated rate of decline using only the most recent three generations (2003 - 2020) is 80% for the Chilcotin DU. The decline rate projected for two generations into the future is 68%. Applying the rate of decline determined over the available time series (1972 – 2020), to the most recent three generations suggests a 51% decrease over the most recent three generations (2003 – 2020).

The longer time series is representative of a time-period that includes ocean and habitat conditions that were more favourable for Steelhead. Using only the most recent three generations better reflects the increased risk from declining habitat quality both in marine and freshwater environments, and bycatch mortality from Pacific salmon fisheries (DFO 2018).

The Recovery Potential Assessment identified an abundance target for Chilcotin Steelhead of 629 spawners (DFO 2018), very similar to the conservation concern threshold of 763 and above the limit reference point of 296 recommended by Johnston (2013). However, population simulations under average productivity indicate a 33% or less probability of achieving the recovery target within 10 years (DFO 2018). A doubling of productivity over the next 10 years indicates a greater than 74% probability of achieving the recovery target.

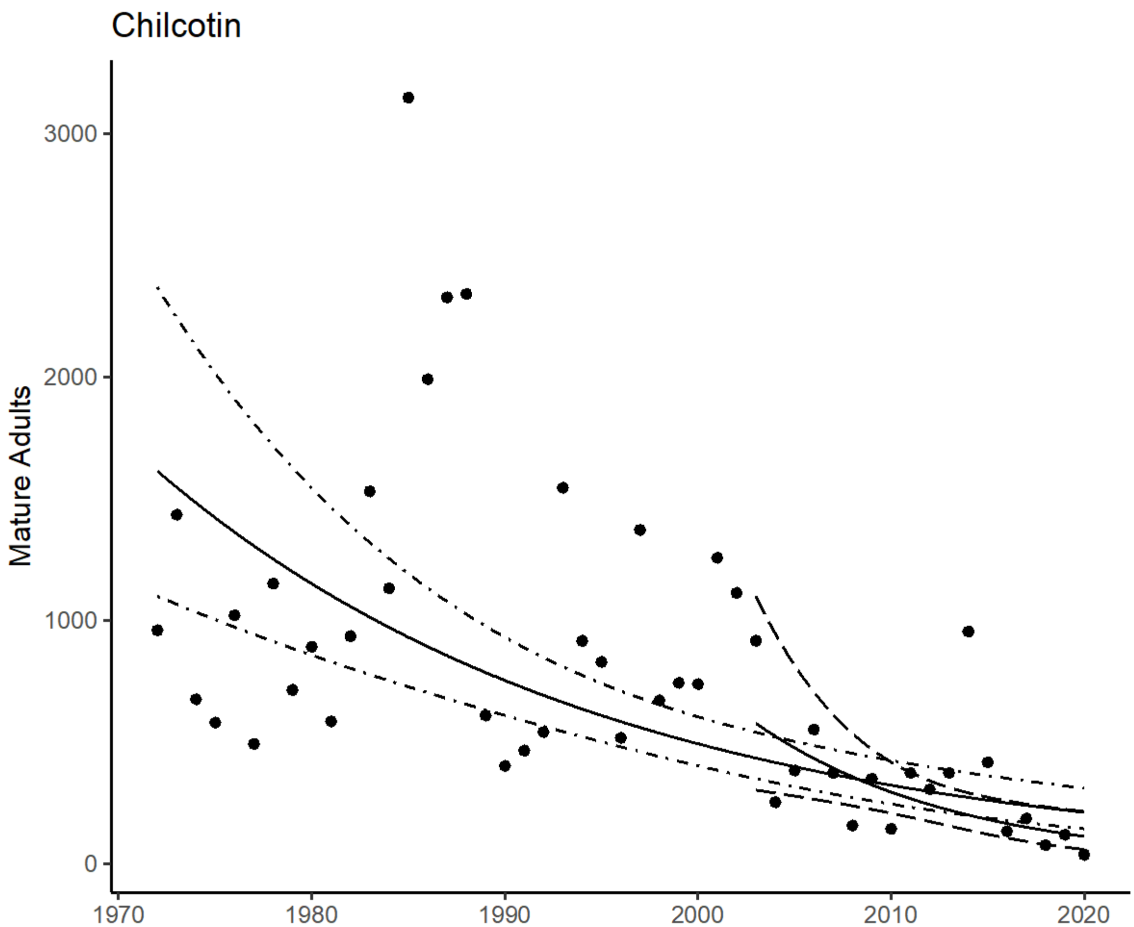


Figure 13. Trend in the number of mature individuals (spawners) in the Chilcotin River Steelhead DU, 1972-2020, and the fitted log-linear regression through the most recent three generations (2003-2020) and for the entire time series (1972 – 2020). Data provided by R. Bison, Province of BC. Solid line is regression fits, dashed line 95% confidence interval for most recent 3 generations, dot -dashed line 95% confidence interval for the entire time series converted to arithmetic scale from log-linear regressions. Slope for most recent 3 generations = -0.096 and is -0.042 for the entire time series. P-values <0.01 for both regressions.

Threats

A number of access roads have been built primarily by mining companies in the existing generally intact wilderness areas within the Xeni Gwet'in Caretaker Area (McCRory 2014). The Pellaire Mine in Falls River is the only commercial mine developed within the upper Dasiqox-Taseko watershed, although historical and modern mining tenures occur in the area, including one within the boundaries of the Aboriginal/wild horse preserve at Teztan Biny (Fish Lake) (McCrory 2014).

An IUCN Threat Calculator is provided for the Chilcotin DU (Appendix 8). The threat calculator was completed by a COSEWIC facilitator, the report writer, the Co-chair and members of the Marine Fishes Subcommittee of COSEWIC, and external experts via a conference call, December 10, 2018.

The following threats were identified as being an ongoing concern to the survival and recovery of Steelhead in the Chilcotin DU. They are ranked from highest to negligible threat impact within each category.

<u>5. Biological Resource Use (High Impact)</u>

5.4 Fishing & harvesting aquatic resources (High Impact)

The threat impact from fishing was rated as high. Steelhead returning to the Chilcotin DU is subject to all of the fisheries impacting the Thompson DU. The sport fishery for Steelhead was monitored by an annual creel survey and mail questionnaire prior to its closure in 2018. Mortality from incidental capture in various salmon fisheries is inferred from a simulation model that assumes typical Steelhead migration rate and timing in relation to salmon fishery openings (Bison 2007, 2016). Incidental catch of Chilcotin Steelhead in various salmon fisheries conducted in approaches to and in the lower Fraser River is expected to continue for the next decade and affect 71-100% of the population, potentially resulting in a serious population decline (31-70%), and poses an ongoing threat to the DU. While new fishery regulations are intended to reduce fishing mortality, the continued monitoring of fishing mortality will be an essential part of determining the role of fishing in any future declines.

<u>7. Natural System Modifications (High Impact)</u>

7.3 Other ecosystem modifications (High Impact)

The threat impact from other ecosystem modifications was rated as high. Chilcotin Steelhead experience the same ocean conditions as Thompson Steelhead and are affected by warmer surface waters and predation impacting growth and survival (Mantua 2009; Debertin *et al*. 2017). Chilcotin Steelhead is also subject to the competitive influence of extensive introductions of hatchery salmonids throughout the North Pacific Ocean (Ruggerone and Irvine 2018). In freshwater large lakes in the watershed (Chilko and Taseko) buffer temperature and sedimentation effects.

Within the Chilcotin watershed there is little evidence that there is spatial contraction of freshwater rearing area. In addition, declines in body weight and length suggest that factors associated with ocean rearing environments are of prime importance in assessing the effects of ecosystem modifications (Bison 2012). Other studies indicate the importance of marine environments in assessing ecosystem modification effects. For example, the unintended consequences created by human actions affecting interspecific interactions in the marine environment (predation and competition) will be important to monitor in order to assess the threat from biological ecosystem modifications (Chasco *et. al*. 2017; Thomas *et al.* 2017).

The rate of repeat spawning in Chilcotin Steelhead is lower than for the Thompson DU, perhaps because of the longer, more arduous migration and also limits the productivity of the population.

The threats in the marine environment, are the primary ecosystem modification effect expected to continue over the coming 10 years and are pervasive, affecting 71-100% of the population with an anticipated impact of 31-70% population decline. These marine effects will be exacerbated by any additional freshwater threats which develop.

7.2 Dams & water management/use (Low Impact)

The threat impact associated with dams and water management was rated as low. Water availability for alevin emergence and juvenile rearing is less of an issue than in the Thompson DU because the rearing areas are in larger rivers less susceptible to low flow and sedimentation. The rearing streams are fed by large lakes that naturally flatten the hydrograph minimizing forestry related effects on stream hydrology (Bison pers. comm. 2019). The Chilcotin SRMP (2007) states that a comprehensive water management strategy is needed for the Cariboo Region, to address impacts on water resources from agriculture, residential development, roads, industrial activity, and forest harvesting. These effects are most pronounced in the Quesnel area but are also of concern to the Chilcotin DU. Minor issues related to allocation of stream flows to agriculture and ranching affect the Elkin, Chilko, and Chilcotin Rivers. The threat impact was anticipated to continue in a similar manner for the next decade and estimated to affect a small portion of the DU (1-10%) with an expected slight (1-10%) mortality of the population.

7.1 Fire & fire suppression (Negligible Impact)

The threat impact from fire and fire suppression was rated as negligible and primarily refers to water withdrawal for fire suppression. Removal of water from some or all of the streams in the DU to assist in suppression of forest fires potentially affects all life history stages depending on the timing and severity of the forest fire season. Scope and severity of the impact are dependent on local terrestrial habitat and fire history, but the consensus opinion was that they are negligible.

<u>8. Invasive & Other Problematic Species & Genes (High-Medium Impact)</u>

8.2 Problematic native species/diseases (High-Medium Impact)

The threat impact from problematic native species and diseases was rated as high to medium. As in the Thompson DU, impacts on both adult spawners and outmigrating smolts from pinniped predation appear to be a significant source of mortality threatening survival and recovery of Chilcotin Steelhead and is an ongoing and pervasive threat. Invasive species have not been detected in the DU but outmigrating smolts are exposed to invasive predators in the lower Fraser River. As in the Thompson DU, Chilcotin Steelhead are susceptible to interbreeding with native Rainbow Trout with potentially negative impacts on the production of anadromous offspring. Chilcotin Steelhead smolts are also subject to the same parasite and pathogen impacts associated with aquaculture facilities on the migration route to the Pacific Ocean as Thompson Steelhead smolts. The impact of these factors will be ongoing annually for the next decade and may impose serious - moderate decline (11-70%) on the population.

<u>9 Pollution (Low Impact)</u>

9.1 Domestic & urban wastewater (Low Impact)

The threat impact from domestic and urban wastewater was rated as low. It could potentially affect all smolts and adults in the DU as they transit through the Fraser River, similarly to Thompson Steelhead. The threat potentially affects the entire population (71-100%) but the severity was rated as producing a slight (1-10%) population decline.

9.2 Industrial & military effluents (Low Impact)

The threat impact affects smolts and adults migrating through the Chilcotin and lower Fraser Rivers and was rated as having a low impact. Industrial and military effluents such as mine and mill waste that result in elevated levels of aluminum, iron, and zinc have differing effects depending on time of year and extent of exposure (MacDonald *et al.* 2011). All Steelhead in the area of the spill or effluent would be affected. The Chilcotin River watershed also contains a number of landfills and contaminated sites that may contribute additional toxicants (Figure 12). These threats are an annual and ongoing occurrence as smolts and adults transit the lower reaches of the Fraser River. Chilcotin Steelhead are exposed to industrial effluents in freshwater, the Fraser River estuary and Strait of Georgia. Estimating direct effects of the toxicants is difficult but consensus is that, although the threat is pervasive potentially affecting the entire population (71-100%), the decline in abundance would be slight (1-10%).

9.3 Agricultural & forestry effluents (Low Impact)

The threat impact from agricultural and forestry effluents could affect all life history stages and was rated as low. Pollutants include agricultural runoff, sedimentation, and pesticides both in the Chilcotin and lower Fraser River watersheds (MacDonald *et al*. 2011). Agricultural activity is concentrated in the Chilcotin River adjacent to the confluence with the Fraser River while forest harvesting is widely distributed in the watershed (Figure 12). A large segment of the population (31-70%) is potentially exposed to the pollutants but the effects are expected to result in a slight decline (1-10%) in abundance over the next ten years.

10 Geological Events (Low Impact)

10.3 Avalanches/landslides (Low Impact)

The threat impact to the Chilcotin DU from avalanches or landslides was rated as low but is ongoing. The rapid and extensive removal of dead and dying trees from the Mountain Pine Beetle infestation (Figure 11) will have significant impacts in the watersheds with increased potential for landslides (Nelitz *et al*. 2011). Landslides typically increase downstream turbidity and potentially produce changes in the streambed as waters circumnavigate any blockage. The larger flow in these rivers is likely to buffer the effects but the degree of Mountain Pine Beetle infestation is much more severe than in the Thompson DU. Depending on the timing of the landslides, effects could occur on various life history stages, but eggs, alevins, and juveniles would be most affected. Landslides such as occurred recently at Big Bar can also cause rapid declines for this population. However, the Threat Calculator was completed prior to the Big Bar slide and such occurrences were expected to be infrequent and have minimal effect (1-10% decline) on a portion of the population (1-10%).

2. Agriculture and Aquaculture (Negligible Impact)

2.3 Livestock farming & ranching (Negligible Impact)

The threat impact to Chilcotin Steelhead from direct physical harm due to livestock farming and ranching was rated as negligible. The Cariboo-Chilcotin area accounts for about 20% of BC beef production (Chilcotin SRMP 2007). However, trampling of eggs by animals or vehicles accessing the streambeds was considered to affect a negligible portion of the population and decline in abundance would be negligible (<1%).

4. Transportation and Service Corridors (Negligible Impact)

The threat impact from maintenance activities associated with utilities and service lines was rated as negligible (<1% decline). There are currently no pipelines or major roads transiting the DU. Any future linear developments (e.g., highways, railways, pipelines) would threaten portions of the DU.

6. Human Intrusions and Disturbance (Negligible Impact)

6.1 Recreational activities (Negligible Impact)

The threat impact from recreational activities was rated as negligible. The threat affects alevin emergence and fry growth (mid-June to early July) in rearing streams. A small percentage of rearing areas are affected by physical disturbance from human activity (e.g., gold panning, horse, bike, and ATV incursions into rearing habitat, beach parties, music festivals). The consensus is that decline from physical disturbance of the spawning and rearing habitat is negligible. Timing of disturbances is typically following emergence and doesn't directly affect redds and eggs. These activities are ongoing and expected to continue for the next 10 years.

8.1 Invasive non-native/alien species/diseases (not scored)

The introduction of invasive fishes is a recent occurrence in the Thompson DU. Runciman and Leaf (2009) reviewed the distribution of four alien species throughout BC. Yellow Perch (*Perca flavescens*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*M. salmoides*), and Pumpkinseed Sunfish (*Lepomis gibbosus*) have been introduced, either intentionally or illegally, into a number of water bodies mostly in southern BC, including the Thompson River drainage. At this point, none are directly accessible to salmon bearing waterbodies in the DU, but they pose a potential future threat. However, these species are resident in the lower Fraser River watershed and could feed on Steelhead smolts during their migration to the sea.

<u>11. Climate Change & Severe Weather (Unknown Impact)</u>

The threats to Chilcotin Steelhead from climate change and severe weather are anticipated to be similar to those noted above for the Thompson DU.

Limiting Factors – Thompson and Chilcotin

Limiting factors are defined as activities and processes that may not cause a population level decline, but limit growth, resilience, or recovery of the Wildlife Species. Limiting factors can become threats if a species has lost its resilience due to other threats and thus is prone to decline (COSEWIC 2016). Thompson and Chilcotin DUs both have high decline rates, small distributions, and small numbers of mature individuals. Hence, they can be considered to have lost resilience due to other threats and are prone to decline. As a result, several activities that might otherwise be described as limiting factors, such as altered ocean and freshwater conditions, predation, competition and reduced prey in the ocean are described as threats (see previous threat sections).

Number of Threat Locations – Thompson and Chilcotin

The term ‘location’ is based on the IUCN definition as a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat (IUCN 2001, 2012).

The method employed for estimating locations followed three criteria of the IUCN (2012) and COSEWIC O&P guidance (COSEWIC 2016).

1. Justification for number of locations should consider all areas whether under threat or not.
2. Areas under threat should include reference to the most plausible threat.

3. Threat calculator impacts with a High impact are identified for each area.

Using these criteria, the sum of area with high threat impacts would equal the number of locations.

Fish from more than one spawning year are exposed to an area threat in any single calendar year and over the lifespan of a spawning year cohort, all fish are exposed to the threat. This implies that cohort separation in time can be eliminated from adding to the location count.

Thompson and Chilcotin each have four areas to consider. Each area had a threat with high impact:

Estuary:

4. Fishery (5.4 High) – Mid-Aug to end of November
5. Pinniped (8.2 Problematic native species (High-Medium) – predation (adult return mid – Aug to November,) (smolts leaving April – May)

Coastal:

6. Pinniped predation (8.2 Problematic native species High-Medium): June to September smolts at sea migration
7. Fishery (5.4 High) – Mid-Aug to end of November

High Seas – Year round:

8. Competition from other salmonids from ocean ranching (7.3 Other ecosystem modifications High)
9. Ocean productivity ranching (7.3 Other ecosystem modifications High)

Freshwater:

10. Fishery (5.4 High) Fall winter
11. Habitat degradation (7.3 Oher ecosystem modifications High)
12. Landslides (10.3, considered low when the Threats calculator was done, prior to the Big Bar slide)

The above scenario identifies four locations to consider for determining in which a single threatening event can rapidly affect all individuals of the taxon present. Of these four locations, only the estuary and freshwater represent areas where Steelhead would be concentrated in a way that a threat could rapidly affect all individuals present. Hence, it was concluded that locations were <= 5 for both the Thompson and Chilcotin DUs.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

The Thompson and Chilcotin Steelhead DUs were both proposed for listing under the *Species at Risk Act* as Endangered following an emergency assessment by COSEWIC in January 2018. However, the Government of Canada decided against listing and has partnered with the Province of British Columbia on the Interior Fraser Steelhead: BC/Canada Action Plan. Other existing legal protections to Steelhead are encompassed in a number of acts and policies. The Province of BC has a delegated authority via the BC Sport Fishing Regulation under the federal *Fisheries Act* to manage sport fishing of Steelhead in freshwater.

Legal protections are provided through the BC *Water Act* and *Fish Protection Act* which both focus on the regulation of water flow and stream habitat protection. In 2016, the BC *Water Act* was replaced by the *Water Sustainability Act* which added new protections for aquatic ecosystems including water rights and licensing for non-domestic groundwater users, fees and rentals for use of surface and groundwater, new requirements for well construction and maintenance. The *Forest and Range Practices Act* through Temperature Sensitive Stream and Fishery Sensitive Watershed designations are also intended to provide habitat protections. In 1997, the BC Fisheries Strategy was introduced with the objective of renewing the Pacific Salmon fishery by incorporating a number of initiatives including Fisheries Renewal BC, the Forest Practices Code, the Protected Areas Strategy, Forest Renewal BC, the Urban Salmon Habitat Program, the Canada/BC Agreement on the Management of Pacific Salmon Fisheries Issues, and the *Fish Protection Act* (Rosenau and Angelo 1999). Taken together, these initiatives are intended to conserve and protect Salmon and Steelhead and their habitat. In addition, the *Land Title Act* is provincial legislation with important implications regarding fish and fishery habitat. Under the *Land Title Act* the Minister of Environment, Lands and Parks can designate flood plain areas for the purpose of minimizing potential damage. In other words, the province can refuse development or subdivision of an area near to a river and fish habitat if water normally inundates that area.

The federal Integrated Fisheries Management Plan for Salmon in southern BC is supported by federal policies on Wild Salmon, By-Catch, and Selective Fishing that result in mixed stock, mixed species salmon fisheries that attempt to minimize impacts on Steelhead.

Non-Legal Status and Ranks

NatureServe (2018) does not differentiate between Rainbow Trout and Steelhead and listed *O. mykiss* as globally secure (G5) in 2008. However, it recognizes a large number of United States Steelhead populations that have been listed under the *Endangered Species Act*. Similarly, the BC Conservation Data Centre have listed Thompson and Chilcotin Steelhead Trout as S1.

Habitat Protection and Ownership

There are no specific habitat protection provisions for Thompson and Chilcotin Steelhead. However, the BC government has enacted a variety of legislation with fish habitat protection as one goal. For example, the *Ministry of Environment Act* provides the authority of the Ministry of Environment, Lands and Parks to plan and set standards for, and to manage, protect and conserve all water, land, air, plant life and animal life, with regard to the economic and social benefits they confer on the province (Rosenau and Angelo 1999). Also, legislated authority to deal with some fish habitat issues is included under the *British Columbia Wildlife Act*, and responsibility lies with the Regional Manager of Fish, Wildlife and Habitat Protection Management. The Act also provides for the acquisition of land or improvements for the management and protection of fish.

First Nations communities are actively working with British Columbia's Fish and Wildlife Branch and with the Department of Fisheries and Oceans on recovery, restoration and educational initiatives, to reverse the decline of their traditional fishery with the goal of recovering and maintaining Steelhead population levels for food, social and ceremonial harvest.

Nłeʔkpmx Nation Elders recommended a number of mitigating strategies for consideration by fisheries managers and community members: decrease or ban commercial fishing and close fish farms to prevent the spread of farm-fish diseases (Tmixʷ Research 2019). Elders recommended Nłeʔkpmx Nation community members work with others to clean up waterways of clogging debris that impedes Steelhead spawning and, increase the number of fish hatcheries throughout the province to increase numbers of fish that make it back to their spawning areas (Tmixʷ Research 2019). Nłeʔkpmx Nation Elders recommended monitoring of *all* fish stocks (not just those of concern) and require that farmers/ranchers restrict livestock access to creek systems (Tmixʷ Research 2019). An observed lack of beavers, needed for building small dams along tributaries, was identified as a problem for water control that could be ameliorated by building spillways (Tmixʷ Research 2019). Restriction of water use to night hours only by farmers and ranchers would also aid water control efforts throughout Coldwater, Nicola, and Spius Creeks (Tmixʷ Research 2019).

St'uxtéws and Skeetchetstn Indian Bands implemented extensive measures to restore habitat (Ignace *et al*. 2019). Skeetchetstn Indian Band bought over 12 km^2 (3000 acres) of ranchland between 2004 and 2015 to protect the Deadman Creek watershed ground water and Steelhead spawning areas (Ignace *et al*. 2019). They obtained Marshy Lake in mid-1990s as a specific claim settlement (Ignace *et al*. 2019). Deadman Creek was fenced off for 30 km. along the length of the Skeetchetstn Indian Reserve, the local ranches mentioned above and non-First Nations neighbours properties north of the Indian Reserve to restrict cattle and horse access (Ignace *et al*. 2019). The Band established a bank stabilization program, stream habitat restoration, ongoing since the 1990s, and riparian planting along with improved beaver control. They manage selective logging, fire control, and grazing (Ignace *et al*. 2019).

Other measures have been undertaken by the Skeetchetstn Indian Band since the mid-1990s to protect the Deadman Creek watershed Steelhead spawning and rearing habitats: cryopreservation of Steelhead salmon milt, production of a map of Sensitive Habitat Inventory (SHIM) for Deadman River (which can be accessed online through community mapping network), and participation on the water management board (Ignace *et al*. 2019). In 1985 the Skeetchetstn community passed a by-law to voluntarily close the Deadman River Food, Ceremonial, and Social salmon fishery (Ignace *et al*. 2019).

St'uxtéws Indian Band fishers reported switching to catch and release angling in the 1990s and established a community policy in 2012 that advocates respectful, sustainable use of fish and wildlife (Ignace *et al*. 2019). Past practices included offering tobacco after releasing the first two Steelhead they caught, keeping fishing sites clean, and sustainably managing their fishery based on community common law (Ignace *et al*. 2019). Habitat restoration projects have been implemented by St'uxtéws Indian Band along with working with local stewardship groups (Ignace *et al*. 2019). A community technician will be collecting data for the Secwepemc Fisheries Commission SHIM mapping project, detailing stream and riparian habitat for salmon, and for monitoring water temperature in the Bonaparte River and tributaries (Ignace *et al*. 2019).

The *Agricultural Land Reserve Act* is designed to protect farmland from conversion to non-agricultural use and to maintain the size of plots to ensure that they remain economically viable. A significant portion of BC's agricultural land is adjacent to water sources for fish in valley bottoms, and typically the lands rely on availability of the water to irrigate crops and water cattle (Rosenau and Angelo 1999). While agriculture impacts fish habitat by changing the vegetation, sediment mobilization, drainage and contaminants, benefits of maintaining a "greenbelt" often outweigh the alternative development of the land. Thus, property within the Agricultural Land Reserve can often result in significant benefits to fish and fish habitat versus that resulting from urbanization.

The majority of the Thompson and Chilcotin River watersheds are privately held either by forestry interests or as farm or Crown land. The Nuntsi Provincial Park protects part of the Taseko River, Tunkwa Provincial Park protects part of Guichon Creek, Arrowstone Provincial Park protects part of the Bonaparte River watershed and Bonaparte Provincial Park protects parts of the Deadman River watershed.

In 2014 the Supreme Court of Canada granted the Aboriginal title to lands described in Tsilqot'in Nation v. British Columbia (McCRory 2014).

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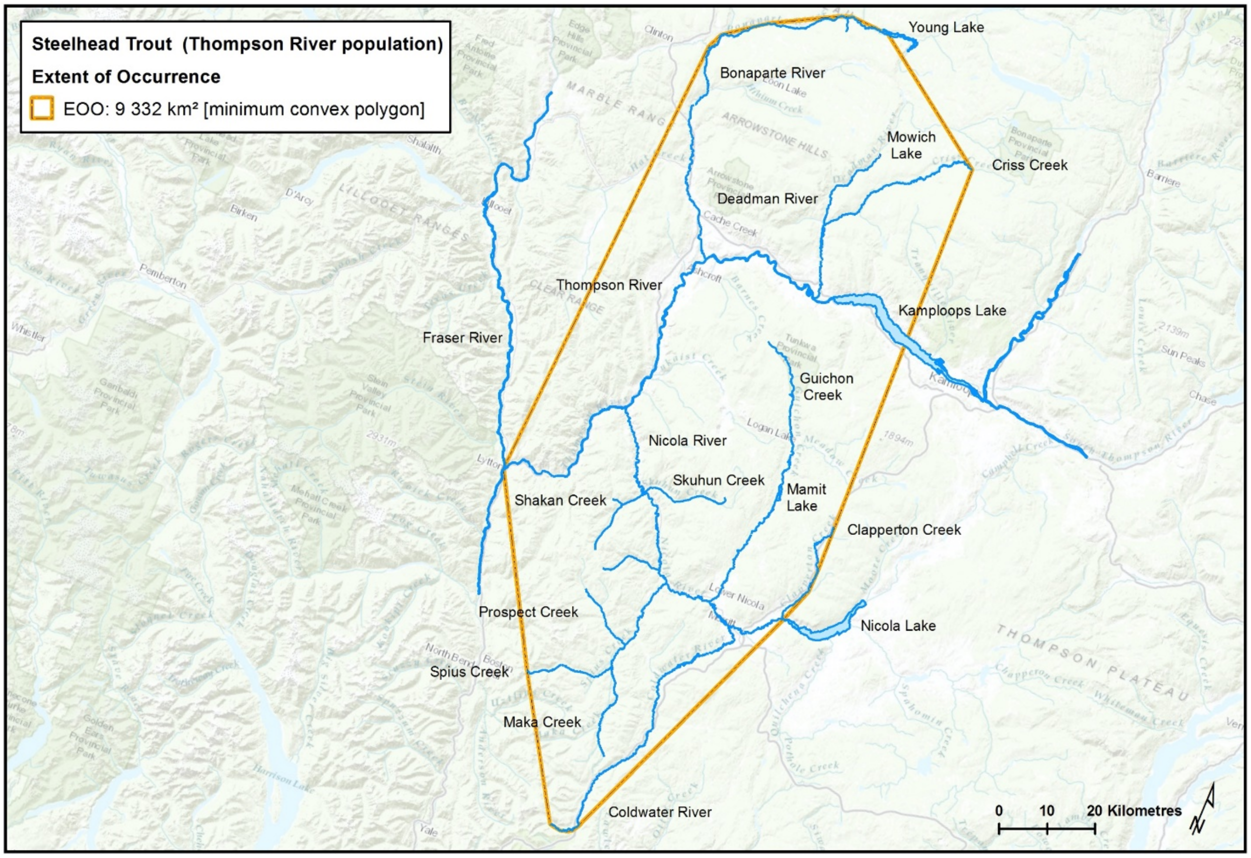
Appendix 1. Estimated extent of occurrence (EOO) for the Thompson River Steelhead population.



Appendix 2. Abundance, age composition and recruitment for Thompson River Steelhead Trout. Data provided by R. Bison. Annual bycatch fishing mortality rate includes impacts of salmon commercial and sport fisheries.

					Age Composition						
Brood Year	Adult Spawners	Sport Fishing Mortalities	Annual Bycatch Fishing Mortality Rate	Pre-fishery Abundance	Age 4	Age 5	Age 6	Age 7	Age 8	Sample Size	Total Adult Recruitment*
1972											
1973											
1974											
1975											
1976											
1977					0.01	0.77	0.20	0.01	0.01	96	
1978	1666	747	0.42	4182	0.05	0.78	0.13	0.04	0.01	165	6664
1979	1666	581	0.42	3894	0.00	0.93	0.07	0.00	0.00	14	2839
1980	952	1008	0.42	3398	0.38	0.62	0.00	0.00	0.00	21	10416
1981	1247	661	0.42	3307	0.00	1.00	0.00	0.00	0.00	20	4593
1982	1190	959	0.42	3725	0.00	0.97	0.03	0.00	0.00	35	2924
1983	2857	1032	0.42	6740	0.00	0.95	0.05	0.00	0.00	100	3742
1984	1120	839	0.42	3395	0.15	0.77	0.08	0.00	0.00	143	3359
1985	3510	1350	0.42	8423	0.03	0.95	0.03	0.00	0.00	37	2098
1986	2330	1142	0.42	6018	0.02	0.66	0.32	0.00	0.00	50	2180
1987	1680	81	0.42	3052	0.00	0.89	0.11	0.00	0.00	38	1980
1988	1500	559	0.42	3569	0.06	0.90	0.02	0.02	0.00	49	4223
1989	1670	268	0.42	3358	0.00	0.84	0.16	0.00	0.00	50	4254
1990	1200	78	0.42	2215	0.02	0.84	0.14	0.00	0.00	215	3842
1991	1200	36	0.42	2143	0.00	0.89	0.11	0.00	0.00	79	1434
1992	900	37	0.42	1623	0.00	0.89	0.11	0.00	0.00	65	3367
1993	2960	130	0.29	4346	0.00	0.89	0.09	0.02	0.00	66	2152
1994	2660	129	0.24	3690	0.00	0.89	0.07	0.04	0.00	27	3244
1995	2590	134	0.43	4741	0.00	0.78	0.21	0.01	0.00	73	1489
1996	1020	70	0.34	1644	0.04	0.87	0.09	0.00	0.00	47	2414
1997	3000	115	0.11	3498	0.06	0.94	0.00	0.00	0.00	78	3233
1998	1470	99	0.23	2041	0.06	0.93	0.01	0.00	0.00	89	1728
1999	2520	54	0.11	2903	0.03	0.97	0.00	0.00	0.00	91	1247
2000	1500	37	0.09	1698	0.04	0.75	0.19	0.01	0.00	69	3376
2001	1810	37	0.06	1968	0.00	0.96	0.04	0.00	0.00	48	1627
2002	3160	75	0.10	3604							944
2003	1480	34	0.14	1758							1247
2004	950	14	0.15	1128							825
2005	2440	26	0.21	3130	0.00	0.92	0.08	0.00	0.00	51	526
2006	1660	34	0.12	1925	0.00	0.76	0.24	0.00	0.00	51	725
2007	740	19	0.16	907	0.02	0.83	0.14	0.00	0.00	42	1510
2008	1160	19	0.11	1317	0.04	0.81	0.13	0.02	0.00	53	1141

					Age Composition						
Brood Year	Adult Spawners	Sport Fishing Mortalities	Annual Bycatch Fishing Mortality Rate	Pre-fishery Abundance	Age 4	Age 5	Age 6	Age 7	Age 8	Sample Size	Total Adult Recruitment*
2009	690	0	0.07	743	0.02	0.75	0.21	0.02	0.00	52	1732
2010	590	20	0.10	678	0.06	0.63	0.31	0.00	0.00	48	971
2011	520	0	0.10	578	0.02	0.83	0.13	0.01	0.00		376
2012	1000	28	0.20	1285							318
2013	1090	34	0.11	1267	0.02	0.61	0.33	0.04	0.00	57	NA
2014	1300	23	0.25	1764	0.04	0.83	0.13	0.00	0.00	54	NA
2015	850	14	0.24	1136	0.00	0.71	0.21	0.08	0.00	38	NA
2016	360	2	0.20	452	0.05	0.74	0.21	0.00	0.00	43	NA
2017	260	1	0.20	327							NA
2018	150	1	0.20	184							NA
2019	240		265								
2020	257		284								

*Estimated size of the brood year production including returns over multiple years from the spawning in the given year.

Appendix 3. Summary of non-selective net fisheries conducted in 1995 that occurred during times and locations where Thompson and Chilcotin Steelhead are known to migrate (reproduced from Bison 1996).

Geographic Location	Statistical Area	Allocation Sector/ Gear Type	Date/Time Opening	Date/Time Closing	Duration (hours)
Strait of J. de Fuca	Area 20	Commercial seine	Aug 22/0700 hrs	Aug 22/1900 hrs	12 hrs
Strait of J. de Fuca	Area 20	Commercial seine	Aug 28/0700 hrs	Aug 29/1900 hrs	2- 12 hr periods
Strait of J. de Fuca	Area 20	Commercial seine	Sept 5 /0700 hrs	Sept 6/1900 hrs	2- 12 hr periods
Strait of J. de Fuca	U.S. Areas 4B, 5,6C	Treaty Indian gillnet	Aug 21/1200 hrs	Aug 26/1200 hrs	5 days
Strait of J. de Fuca	U.S. Areas 4B, 5,6C	Treaty Indian gillnet	Oct 15/1200 hrs	Nov 11	27 days
Johnstone Strait	Area 12/13	Commercial seine	Aug 22/0700 hrs	Aug 22/1900 hrs	12 hrs
Johnstone Strait	Area 12/13	Commercial seine	Aug 28/0700 hrs	Aug 29/1900 hrs	2- 12 hr periods
Johnstone Strait	Area 12/13	Commercial gillnet	Aug 27/1800 hrs	Aug 29/0800 hrs	38 hrs
Johnstone Strait	Area 12/13	Commercial seine	Sept 4/0700 hrs	Sept 5/1900 hrs	2- 12 hr periods
Johnstone Strait	Area 12/13	Commercial gillnet	Sept 3/1800 hrs	Sept 5/0800 hrs	38 hrs
Johnstone Strait	Area 12/13	Commercial seine	Sept 12/0700 hrs	Sept 12/1900 hrs	12 hrs
Johnstone Strait	Area 12/13	Commercial gillnet	Sept 11/1800 hrs	Sept 13/0800 hrs	38 hrs
Johnstone Strait	Area 12/13	Commercial seine	Sept 25/1600 hrs	Sept 26/1600 hrs	24 hrs
Johnstone Strait	Area 12/13	Commercial gillnet	Sept 25/1600 hrs	Sept 26/1600 hrs	24 hrs
Nitinat	Area 21	Commercial gillnet	Oct 2/0800 hrs	Oct 3/1900 hrs	35 hrs
Nitinat	Area 21	Commercial gillnet	Oct 3/1900 hrs	Oct 5/1900 hrs	48 hrs
Nitinat	Area 21	Commercial gillnet	Oct 9/0800 hrs	Oct 11/1900 hrs	59 hrs
Nitinat	Area 21	Commercial gillnet	Oct 16/0800 hrs	Oct 19/1800 hrs	82 hrs
Nitinat	Area 21	Commercial gillnet	Oct 23/0800 hrs	Oct 23/1800 hrs	10 hrs
San Juan Islands	U.S. Area 7	Commercial gillnet	Aug 31/2100 hrs	Sept 1/0900 hrs	12 hrs
San Juan Islands	U.S. Area 7	Commercial seine	Aug 3 1/0500 hrs	Aug 31/2100 hrs	16 hrs
San Juan Islands	U.S. Areas 6,7	Treaty Indian gn & sn	Aug 28/0500 hrs	Aug 29/0900 hrs	16 hrs
San Juan Islands	U.S. Areas 7,7A	Commercial gillnet	Sept 5/2000 hrs	Sept 7/0700 hrs	12 hrs & 11 hrs
San Juan Islands	U.S. Areas 7,7A	Commercial seine	Sept 5/0500 hrs	Sept 6/2100 hrs	2- 16 hr periods
San Juan Islands	U.S. Areas 6,7,7A	Treaty Indian gn & sn	Sept 2/1800 hrs	Sept 4/2100 hrs	51 hrs
San Juan Islands	U.S. Areas 7,7A	Commercial gillnet	Nov 2/0600 hrs	Nov 3/1800 hrs	2- 12 hr periods
San Juan Islands	U.S. Areas 7,7A	Commercial gillnet	Nov 7/0600 hrs	Nov 10/1800 hrs	4-12 hr periods
Fraser River	Area 29	Commercial gillnet	Oct 31/0800 hrs	Oct 31/1800 hrs	10 hrs
Fraser River	Sawmill to Steveston	AFS gillnet	Sept 1	Sept 13	13 days
Fraser River	Sawmill to Steveston	AFS drift gillnet	Oct 27	Oct 28	34 hrs
Fraser River	Sawmill to Steveston	AFS set gillnet	Oct 27	Oct 27	24 hrs
Fraser River	Sawmill to Steveston	AFS drift gillnet	Nov 4	Nov 4	12 hrs
Fraser River	Sawmill to Steveston	AFS set gillnet	Nov 3	Nov 5	48 hrs
Fraser River	Sawmill to Steveston	AFS drift gillnet	Nov 9	Nov 9	10 hrs

Geographic Location	Statistical Area	Allocation Sector/ Gear Type	Date/Time Opening	Date/Time Closing	Duration (hours)
Fraser River	Sawmill to Steveston	AFS set gillnet	Nov 10	Nov 13	48 hrs
Fraser River	Sawmill to Steveston	AFS set gillnet	Nov 13	Nov 13	10 hrs

Appendix 4. Summary of essential functions, area or type of site, and biophysical attributes of Steelhead Trout in Canada by life stage. References are in the habitat sections of this report and Ptolemy and Wilson (pers. comm. 2020).

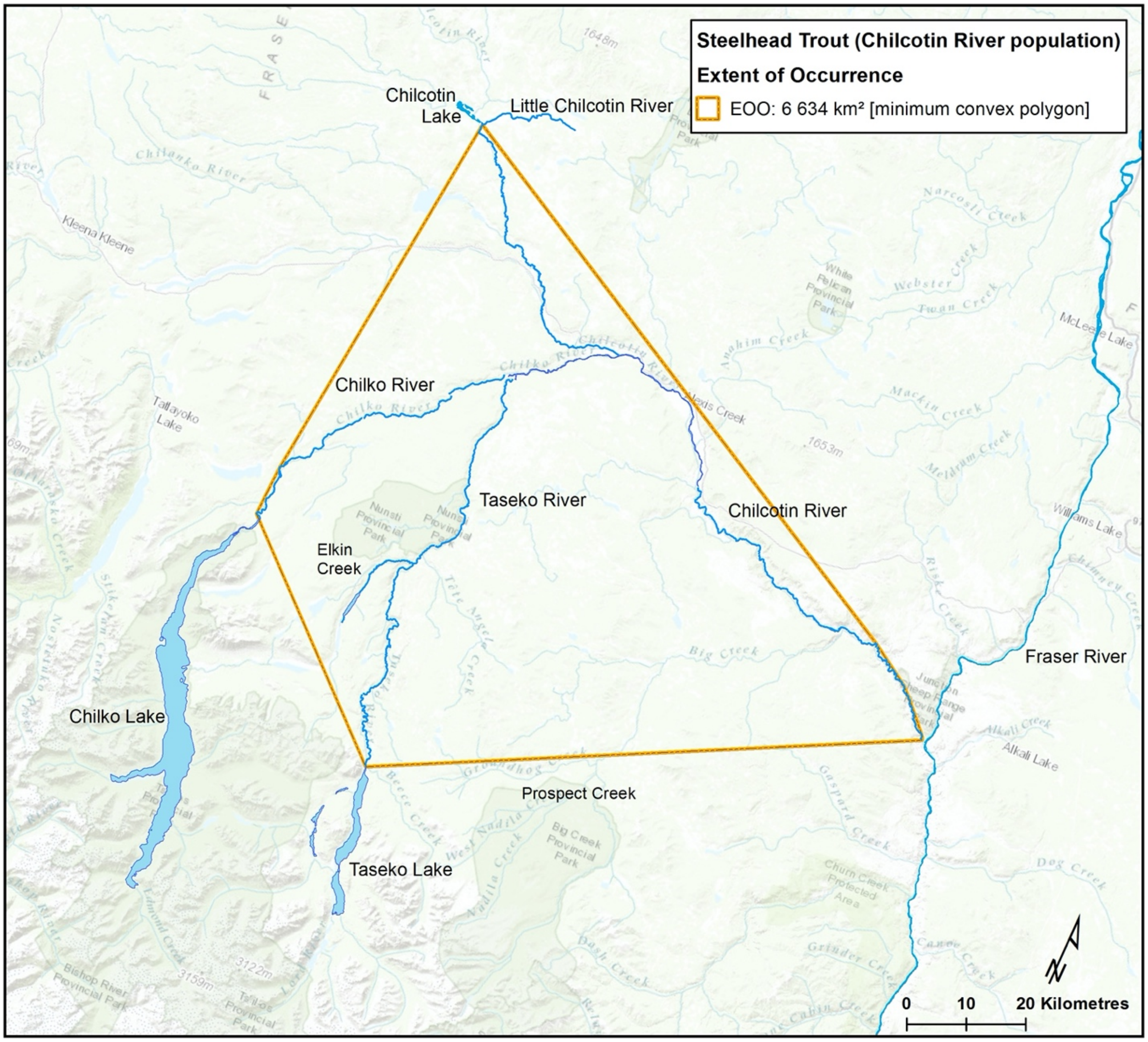
Life Stage	Function[a]	Area or Type of site[b]	Biophysical Attributes
Egg - Alevin	Egg development (May – June, 5 – 8) Alevin: emergence and fry growth. Yolk sac absorbed 3 – 7 days and become alevins. (mid-June – early July)	Redds in river tributaries or mainstems such as Chilcotin River	Gravel substrate at water temperatures ranging between 3.9 and 9.4°C. Optimal temperature 7 -12 °C. Velocities 40 cm/sec to 90 cm/sec. <10% fines Suitable incubation gravel 0.6 to 10.2 cm in diameter. Water depths greater 24 to and less than 100cm.
Juvenile (0+, fry or YoY)	Growth (fry to parr)	Stream margins	In streams: • small gravel/rubble with cover • depths of <20cm, velocities of <0.01m/s • some move to midchannel later in summer • lacustrine populations move to lakes, shallow water near shore and cover
Juvenile (parr)	Growth (parr to presmolt in river tributaries and mainstem) (0 to 3 years Thompson, 0 to 4 years in Chilcotin)	River tributaries and mainstem Often move to slower water on emergence but move to deeper faster water as they grow. Overwinter in river bottom below cobble-boulder surface In lakes, near cover, forage over sand and gravel substrate	Freshwater: • riffles, runs rapids, and cascades with cobble-boulder substrate and prefer a maximum stream velocity of less than 30 cm/sec for fry and <100cm/sec for parr • preferred temperature range of 13 to 18°C • pool area 40 – 60% of stream area in small tributaries • cover: aquatic vegetation, debris, rock interstices • substrate overwinter 10 - 150 cm in diameter • overwinter: fines >-10% reduces value

Life Stage	Function[a]	Area or Type of site[b]	Biophysical Attributes
Smolts	Migration to sea early April to late-May once they have smolted after 2 or 3 years for Thompson and 3 or 4 years for Chilcotin	Fraser River and estuary	Freshwater, estuary: • 4 to 13°C (optimal 7 to 10° C) from March until June for normal smoltification
Smolts	Offshore migration (June to September)	Fraser River estuary to Strait of Georgia to Johnstone or Juan de Fuca straits	Marine • spring the highest density occurs between 42°N and 52°N, and from the North American coastline to 155°W in the Gulf of Alaska • summer, fish have moved north and west in the eastern North Pacific to south of the Aleutian Islands.
Adults	Feeding and growth (2 – 3 years)	Gulf of Alaska then return to spawning grounds	Marine: • surface waters between 8 and 11.4°C, and all were constrained by water temperatures between 5 and 15°C • Steelhead occurred in the upper 7 m of the water column
Adults	Return to river of origin from sea and migrate towards spawning rivers. Thompson and Chilcotin are late summer runs. (Late August-late-November)	Coastal zone and estuaries, spawning rivers Overwinter in the mainstem of Fraser, Thompson, or Chilcotin rivers near natal streams.	Freshwater: • swift water and deep pools (12 – 15 feet deep) downstream from river eddies • prefer water temperatures between 4 and 18°C (Raleigh *et al*. 1984) although it is reported that migration slowed or ceased at temperatures below 7°C • upper lethal temperature of approximately 27°C
Adults	Nov-Feb, overwintering, pre-spawn (Thompson and Chilcotin)	Fraser River mainstem pools	Deep, stable pools

Life Stage	Function[a]	Area or Type of site[b]	Biophysical Attributes
Adults	Spawning, egg deposition Spawning February-early June. Most die after spawning or move to Migration to the sea after spawning followed by adults return to river	Chilcotin River and tributaries. Ascend tributary streams as temperatures and stream flow increase. Spawning has not been observed in the Thompson River mainstem.	Freshwater: • Spawning typically occurs in a redd dug in gravel substrate at water temperatures ranging between 3.9 and 9.4°C. • Spawning is nocturnal and occurs in flowing water of 0.4 to 1.5 m/sec in depths from 20 cm to more than 2 m
Adults (kelting)	Post-spawn migration to the sea after spawning (One year)	Fraser River estuary to Strait of Georgia to Johnstone or Juan de Fuca straits, Gulf of Alaska then return to spawning grounds	See previous adult descriptions, repeat spawners are mostly females

[a] Function: a life-cycle process of the species
[b] Area or Type of Site: The area or type of site where the listed species naturally occurs.

Appendix 5. Estimated extent of occurrence (EOO) for the Chilcotin River Steelhead population.



Appendix 6. Abundance, age composition and recruitment for Chilcotin River Steelhead Trout. Data provided by R. Bison. Annual bycatch fishing mortality rate includes impacts of salmon commercial and sport fisheries.

					Age Composition						
Brood Year	Adult Spawners	Sport Fishing Mortalities	Annual Bycatch Fishing Mortality Rate	Pre-fishery Abundance	Age 4	Age 5	Age 6	Age 7	Age 8	Sample Size	Total Adult Recruitment*
1972	960	202	0.42	2014							2247
1973	1435	159	0.42	2763							2034
1974	677	533	0.42	2097							1813
1975	581	278	0.42	1489							1612
1976	1022	179	0.42	2083							1277
1977	494	487	0.42	1701							2312
1978	1152	365	0.42	2629							2872
1979	715	142	0.42	1485							3993
1980	893	21	0.42	1584	0.00	0.06	0.69	0.31	0.00	32	4089
1981	586	49	0.42	1100	0.00	0.00	0.80	0.20	0.00	15	3969
1982	936	20	0.42	1657	0.00	0.00	0.55	0.36	0.09	11	3680
1983	1531	23	0.42	2693							1825
1984	1133	41	0.42	2035	0.00	0.00	0.71	0.29	0.00	14	905
1985	3149	43	0.42	5533							893
1986	1992	53	0.42	3545							1150
1987	2328	31	0.42	4090							1807
1988	2342	14	0.42	4085							1487
1989	610	87	0.42	1207							1322
1990	403	37	0.42	764							1054
1991	466	46	0.42	887							1282
1992	542	33	0.42	998							1030
1993	1546	40	0.29	2230							859
1994	917	5	0.24	1219							906
1995	830	6	0.43	1456							1216
1996	518	4	0.34	787							1246
1997	1373	4	0.11	1546							1011
1998	672	2	0.23	877							520
1999	744	2	0.11	841							473
2000	739	2	0.09	819							569
2001	1258	6	0.06	1347							455
2002	1114	8	0.10	1251							270
2003	917	8	0.14	1074							300
2004	254	11	0.15	310							228
2005	384	2	0.21	490							424
2006	552		0.12	627							240
2007	374	2	0.16	449							261
2008	158		0.11	177							846

					Age Composition						
Brood Year	**Adult Spawners**	**Sport Fishing Mortalities**	**Annual Bycatch Fishing Mortality Rate**	**Pre-fishery Abundance**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8**	**Sample Size**	**Total Adult Recruitment***
2009	350	0	0.07	377							1096
2010	144	0	0.10	160							322
2011	374	0	0.10	416	0.00	0.03	0.87	0.10	0.00	71	209
2012	307	0	0.20	384	0.03	0.32	0.59	0.06	0.00	69	NA
2013	374		0.11	420	0.00	0.72	0.28	0.00	0.00	46	NA
2014	955		0.25	1273	0.02	0.57	0.40	0.02	0.00	63	NA
2015	418		0.24	550	0.00	0.28	0.67	0.05	0.00	38	NA
2016	134		0.20	168	0.00	0.32	0.68	0.00	0.00	33	NA
2017	187		0.20	234							NA
2018	77			96							NA
2019	120			133							
2020	38			42							

*Estimated size of the brood year production including returns over multiple years from the spawning in year

Appendix 7. Threats Calculator for Thompson River Steelhead DU.

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	*Oncorhyncus mykiss* Steelhead Trout Thompson River Population		
Element ID		**Elcode**	
Date:	10/01/2019		
Assessor(s):	D. Lepitzki (facilitator), R. Claytor (Co-chair), J. Schweigert (report writer), T. Davies, J. Neilson, M. Treble, S. Tucker, K. Campbell, R. Bailey, J. Shaw, B. Leaman, P. Nicklin, R. Bison, G. Wilson, I. Fleming, R. Boles, R. Vennesland, S. Feinman, S. Decker		
References:	Draft status report, draft calculator provided by J. Schweigert, comparison spreadsheet Thompson River vs. Chilcotin River DUs.		

Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	3	2
	C	Medium	1	2
	D	Low	1	1
Calculated Overall Threat Impact:			Very High	Very High
Assigned Overall Threat Impact:			**A = Very High**	
Impact Adjustment Reasons:				
Overall Threat Comments			Generation time = 5 years (therefore timeframe for severity and timing is 15 years into the future). The population has declined (82%) over the last three generations and it is now the lowest on record. The number of mature individuals is 216 (average from 2018-2020) and consist of one subpopulation. The effects of low population size on severity of threats were recognized during the call. These effects would tend to push the severity likelihood to the higher range of the decline estimates. See Threats section in the report for additional discussion regarding how small population size influences extinction risk.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						Threats from human settlements or other non-agricultural land uses with a substantial footprint. Includes any physical modification of habitat.
1.1	Housing & urban areas						Not relevant for this DU.
1.2	Commercial & industrial areas						Not relevant for this DU.
1.3	Tourism & recreation areas						Not relevant for this DU.
2	Agriculture & aquaculture		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture
2.1	Annual & perennial non-timber crops						Not relevant for this DU.
2.2	Wood & pulp plantations						Not relevant for this DU.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	The consensus was that a small amount of trampling occurred in the rivers with severity near the low end of the range.
2.4	Marine & freshwater aquaculture						A proportion of the emigrating smolts pass fish farms in Johnstone Strait and would be exposed to sea lice. Threats from sea lice and other increased parasite loads caused by aquaculture are scored under 8.2.
3	Energy production & mining						Threats from production of non-biological resources. There are no energy production and mining threats in this DU.
3.1	Oil & gas drilling						Not relevant for this DU.
3.2	Mining & quarrying						Not relevant for this DU.
3.3	Renewable energy						Not relevant for this DU.
4	Transportation & service corridors		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality
4.1	Roads & railroads						Not relevant for this DU.
4.2	Utility & service lines		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Includes current maintenance work along pipeline where it crosses streams. Portions of the pipeline are exposed and need to be re-armoured. Effects primarily in the Coldwater watershed and would impact all life history stages. Future development of the Trans Mtn Pipeline will include many stream crossings and disruption and would be scored here.
4.3	Shipping lanes		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Includes dredging in the lower Fraser River for channel maintenance. All adult and smolt Steelhead traverse the area and would be affected. Effects were unknown but it was felt that with proper mitigation they would be negligible as fish move through the area rapidly.
4.4	Flight paths						Not relevant for this DU.
5	Biological resource use	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Threats from consumptive use of “wild” biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species
5.1	Hunting & collecting terrestrial animals						Not relevant for this DU
5.2	Gathering terrestrial plants						Not relevant for this DU
5.3	Logging & wood harvesting						Not relevant for this DU

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Fishing affects adults returning to spawning grounds from the sea (late Aug. to late November) and migration to the sea after spawning (1 year). Migration from the sea coincides with fisheries for one or more other Salmon species. First Nations fisheries also occur on post-spawning Steelhead returning to the sea. All fish returning from sea to rivers to spawn must pass through the fishery as do fish returning to the sea post-spawning. Mortality cannot be estimated directly but is based on simulation estimates of run timing and migration speed of returning Steelhead and timing of the Salmon fisheries. Fisheries are planned to occur annually in a similar manner to the past for the next 10 years. Estimated annual mortality ranges between 15 and 25% based on the simulator but varies depending on the timing of fisheries and Steelhead migration. The fisheries appear to have an impact on a population that has been in decline for decades. Includes direct FSC harvest and catch and release mortality from sport fisheries, bycatch in other fisheries (uncertain), and illegal harvest between ocean and spawning grounds (uncertain). Direct and incidental lethal scientific collecting also scored here. Recent data indicate an additional 10% mortality in the Nicola and 5% in the Coldwater. General agreement that severity exceeded 30% but considerable uncertainty about higher levels. However, low population effects increase the extinction risk. Suggestion that properly enforced mitigations could lead to significant reductions in mortality.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Threats from human activities that alter, destroy, and disturb habitats and species associated with non-consumptive uses of biological resources.
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Threat affects alevin emergence and fry growth (mid-June to early July) in rearing streams. A small percentage or rearing areas are affected by physical disturbance from human activity (gold panning, horse, bike and ATV in rearing habitat, beach parties, music festivals). Mortality from physical disturbance of the spawning and rearing habitat is difficult to assess, likely small. Timing is typically following emergence and doesn't directly affect redds and eggs. These activities are an annual occurrence expected to proceed for the next 10 years.
6.2	War, civil unrest & military exercises						Not relevant for this DU

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.3	Work & other activities						Threat from Albion Salmon test fishery included under 5.4. Some other research studies conducted in Nicola but not expected to affect Steelhead.
7	Natural system modifications	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare
7.1	Fire & fire suppression		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Includes water withdrawal for fire suppression. Removal of water from some or all of the streams in the DU to assist in suppression of forest fires potentially affects all life history stages depending on the timing and severity of the forest fire season. Scope and severity are dependent on local terrestrial habitat and fire history, but the impact is negligible as not expecting multiple fires in one location.
7.2	Dams & water management/use	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Threat expected to affect alevin emergence and growth (mid-June to early July), and Juvenile growth in tributaries (zero to 2-3 years). Affects all of the Nicola and Coldwater and at least half of the Bonaparte and Deadman. Direct mortality from reduced water availability (due to withdrawal) is difficult to assess but felt to be less than 10%. Water management activities are an annual occurrence expected to proceed similarly or become more serious over the next 10 years. Issues include over allocation of stream flows to agriculture, industry and municipal requirements, unregulated and poorly monitored groundwater pumping, poor control of stream levels during spawning or incubation periods, and alteration of natural flow patterns by storage facilities.
7.3	Other ecosystem modifications	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Includes reduced ocean productivity and competition from other salmonids resulting from ocean ranching in the high seas, and offshore predation on smolts and adults. In freshwater includes riprap of stream banks, sedimentation and thermal problems due to loss of riparian vegetation and water extraction. Severity felt to be towards the higher end of the range.
8	Invasive & other problematic species & genes	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species/diseases						Invasive species can affect the deposited eggs, newly hatched alevins and fry rearing in the tributaries, and even juveniles and migrating smolts. Depending on the species of invader a substantial proportion of the population could be affected, and mortality depends on the species and its biological proclivities that may be simply predation or food competition but could include habitat alteration and disturbance of the substrate and could be significant. Once established invasive species would have annual impact for the next 10 years. Currently no Invasives in the DU are impacting Steelhead or resident Rainbow Trout. However, migrating smolts may be affected to limited degree by established species in the lower Fraser River.
8.2	Problematic native species/diseases	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	The reduced population abundance of Steelhead makes predation particularly by pinnipeds in the inshore as well as by Harbor Porpoises and White-sided Dolphins in the offshore a threat. Adults migrating to overwintering areas of Thompson River from sea (late Aug. to late Nov.), smolts migrating to sea (mid-April to mid-May, once they have smolted after 2 or 3 years), and smolt off-shore migration (June to September) are all vulnerable. Mortality from threat is uncertain but up to 50% of smolts are lost during transit from freshwater out of Georgia Strait. Diet data indicate that Steelhead are consumed by seals in the Fraser estuary and in the Strait of Georgia and Puget Sound. In freshwater, otters may be a predation threat at current reduced abundance. Interbreeding of Steelhead and resident Rainbow Trout is also an increasing threat at current abundance. Impact of sea lice on smolts and adults during migration past fish farms in northern Johnstone Strait is a current and future threat with uncertain impact.
8.3	Introduced genetic material						Not applicable to this DU but any future hatchery introductions would be considered here.
8.4	Problematic species/diseases of unknown origin						Not relevant for this DU
8.5	Viral/prion-induced diseases						Not relevant for this DU
8.6	Diseases of unknown cause						Not relevant for this DU
9	Pollution	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Affects all life stages as smolts and adults passage through the Thompson and lower Fraser. In particular, the area around the lower Fraser River is heavily populated and it drains about one quarter of the British Columbia land area. It has been heavily inundated by various pollutants including sewage, discharge from treatment plants, leaking septic, oil or sediment from roads, domestic fertilizers and pesticides, and road salt. As well, elevated fecal coliform and turbidity in the lower river and its estuary occur, particularly during the spring freshet when Steelhead and Salmon smolts from the Interior Fraser are undertaking their seaward migration. The extent to which Steelhead utilize estuarine habitats in the lower Fraser River is not well understood but it appears that they rapidly transit out of the Strait of Georgia. Pollution potentially affects the entire population, but the impacts appear to be minimal.
9.2	Industrial & military effluents	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Affects smolts and adults migrating through the Thompson and lower Fraser rivers. Industrial and military effluents such as mine and mill waste that result in elevated levels of aluminum, iron, zinc have differing effects depending on time of year and extent of exposure. All Steelhead in the area of the spill or effluent would be affected. An annual occurrence as smolts and adults transit the lower reaches of the Fraser River. Steelhead are exposed to industrial effluents in freshwater, the Fraser estuary and Strait of Georgia. There is also the possibility of contaminant spills from train derailments into the tributaries or Thompson River proper. Estimating direct effects of the pollutants is difficult but consensus was that they were slight.
9.3	Agricultural & forestry effluents	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	All life history stages potentially impacted by this threat. Pollutants include agricultural runoff, sedimentation, pesticides both in the Thompson and lower Fraser watersheds. The Bonaparte, Nicola and some of its tributaries have been particularly affected by runoff following logging and fire damage contributing to soil erosion and siltation. Loss of pool/riffle and habitat complexity. Conversion of lower Coldwater to agriculture and ranching reduced carrying capacity significantly. The entire population is potentially exposed to the pollutants and the effects were rated as moderate.
9.4	Garbage & solid waste						Not relevant for this DU
9.5	Air-borne pollutants						Not relevant for this DU
9.6	Excess energy						Not relevant for this DU

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10	Geological events	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Threats from catastrophic geological events.
10.1	Volcanoes						Not relevant for this DU
10.2	Earthquakes/tsunamis						Not relevant for this DU
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	The rapid and extensive removal of dead and dying trees will have significant impacts in the watersheds with increased potential for landslides depending on the local terrain. Typically result in downstream turbidity and potentially result in changes in the stream bed as waters circumnavigate the blockage. Depending on the timing of the landslides effects could occur on various life history stages but eggs, alevins and juveniles would be most affected. Occurrences are expected to be infrequent and have minimal effect on the population. There have been immediate impacts on the Bonaparte watershed.
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Threats from long-term climatic changes that may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat.
11.1	Habitat shifting & alteration						Evidence of earlier and larger spring freshets, pine beetle infestation, higher summer air and stream temperatures. Changes in hydrographs caused by a variety of factors (e.g., snow melt, rain on snow, etc.).
11.2	Droughts						Increasing number of years with reduced precipitation resulting in contraction in available rearing habitat.
11.3	Temperature extremes						Increases in either or both marine and freshwater temperatures.
11.4	Storms & flooding						Increase in winter precipitation resulting in rapid runoff, scouring of some streambeds and loss of eggs, flooding in some areas especially where widespread removal of dead trees has occurred.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).							

Appendix 8. Threats Calculator for Chilcotin River Steelhead DU.

THREATS ASSESSMENT WORKSHEET			
Species or Ecosystem Scientific Name	*Oncorhyncus mykiss* Steelhead Trout Chilcotin River Population		
Element ID		**Elcode**	
Date:	10/01/2019		
Assessor(s):	D. Lepitzki (facilitator), R. Claytor (Co-chair), J. Schweigert (report writer), T. Davies, J. Neilson, M. Treble, S. Tucker, K. Campbell, R. Bailey, J. Shaw, B. Leaman, P. Nicklin, R. Bison, G. Wilson, I. Fleming, R. Boles, R. Vennesland, S. Feinman, S. Decker		
References:	Draft status report, draft calculator provided by J. Schweigert, comparison spreadsheet Thompson River vs. Chilcotin River DUs.		

Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	3	2
C	Medium	0	1
D	Low	2	2
Calculated Overall Threat Impact:		Very High	Very High
Assigned Overall Threat Impact:		**A = Very High**	
Impact Adjustment Reasons:			
Overall Threat Comments		Generation time = 6 years (therefore timeframe for severity and timing is 18 years into the future). The population has declined (80%) over the last three generations and it is now the lowest on record. The number of mature individuals is 78 (average from 2018-2020) and consist of one subpopulation. The effects of low population size on severity of threats were recognized during the call. These effects would tend to push the severity likelihood to the higher range of the decline estimates. See Threats section in the report for additional discussion regarding how small population size influences extinction risk.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						Threats from human settlements or other non-agricultural land uses with a substantial footprint. Includes any physical modification of habitat.
1.1	Housing & urban areas						Not relevant for this DU.
1.2	Commercial & industrial areas						Not relevant for this DU.
1.3	Tourism & recreation areas						Not relevant for this DU.
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture
2.1	Annual & perennial non-timber crops						Not relevant for this DU.
2.2	Wood & pulp plantations						Not relevant for this DU.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	The consensus was that because the rivers were large they would be less accessible and any trampling would be negligible.
2.4	Marine & freshwater aquaculture						A proportion of the emigrating smolts pass fish farms in Johnstone Strait and would be exposed to sea lice. Threats from sea lice and other increased parasite loads caused by aquaculture are scored under 8.2.
3	Energy production & mining						Threats from production of non-biological resources. There are no energy production and mining threats in this DU.
3.1	Oil & gas drilling						Not relevant for this DU.
3.2	Mining & quarrying						Not relevant for this DU.
3.3	Renewable energy						Not relevant for this DU.
4	Transportation & service corridors		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality
4.1	Roads & railroads						Not relevant for this DU.
4.2	Utility & service lines						Includes any construction of maintenance work along a pipeline where it crosses streams. Future development of the Trans Mtn Pipeline will include many stream crossings and disruption and would be scored here.
4.3	Shipping lanes		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	Includes dredging in the lower Fraser River for channel maintenance. All adult and smolt Steelhead traverse the area and would be affected. Effects were unknown but it was felt that with proper mitigation they would be negligible as fish move through the area rapidly.
4.4	Flight paths						Not relevant to this DU.
5	Biological resource use	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Threats from consumptive use of “wild” biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species
5.1	Hunting & collecting terrestrial animals						Not relevant to this DU.
5.2	Gathering terrestrial plants						Not relevant to this DU.
5.3	Logging & wood harvesting						Not relevant to this DU.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Fishing affects adults returning to spawning grounds from the sea (late Aug. to late November) and migration to the sea after spawning (1 year). Migration from the sea coincides with fisheries for one or more other Salmon species. First Nations fisheries also occur on post-spawning Steelhead returning to the sea. All fish returning from sea to rivers to spawn must pass through the fishery as do fish returning to the sea post-spawning. Mortality cannot be estimated directly but is based on simulation estimates of run timing and migration speed of returning Steelhead and timing of the Salmon fisheries. Fisheries are planned to occur annually in a similar manner to the past for the next 10 years. Estimated annual mortality ranges between 15 and 25 percent based on the simulator but varies depending on the timing of fisheries and Steelhead migration. The fisheries appear to have an impact on a population that has been in decline for decades. Includes direct FSC harvest and catch and release mortality from sport fisheries (5-10%), bycatch in other fisheries (uncertain), and illegal harvest between ocean and spawning grounds (uncertain). Direct and incidental lethal scientific collecting also scored here. General agreement that severity exceeded 30% but considerable uncertainty about higher levels. However, low population effects increase the extinction risk. Suggestion that properly enforced mitigations could lead to significant reductions in mortality.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Threats from human activities that alter, destroy, and disturb habitats and species associated with non-consumptive uses of biological resources.
6.1	Recreational activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Threat affects alevin emergence and fry growth (mid-June to early July) in rearing streams. A small percentage of rearing areas are affected by physical disturbance from human activity (gold panning, horse, bike, and jet boats in rearing habitat). Mortality from physical disturbance of the spawning and rearing habitat is difficult to assess, likely small. Timing is typically following emergence and doesn't directly affect redds or eggs. These activities are an annual occurrence expected to proceed for the next 10 years.
6.2	War, civil unrest & military exercises						Not relevant to this DU.
6.3	Work & other activities						Threat from Albion Salmon test fishery included under 5.4. Some other research studies conducted in Nicola but not expected to affect Steelhead.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7	Natural system modifications	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare
7.1	Fire & fire suppression		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Includes water withdrawal for fire suppression. Removal of water from the streams in the DU to assist in suppression of forest fires potentially affects all life history stages depending on the timing and severity of the forest fire season. Scope and severity are dependent on local terrestrial habitat and fire history, but the impact is negligible as not expecting multiple fires in one location.
7.2	Dams & water management/use	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Threat expected to affect alevin emergence and growth (mid-June to early July), and Juvenile growth in tributaries (zero to 2-3 years). Direct mortality from reduced water availability (due to withdrawal) is difficult to assess but felt to be less than 10%. Water management activities are an annual occurrence expected to proceed similarly or become more serious over the next 10 years. Issues include over allocation of stream flows to agriculture, industry and municipal requirements, unregulated and poorly monitored groundwater pumping, poor control of stream levels during spawning or incubation periods, and alteration of natural flow patterns by storage facilities. The Elkin, Chilco, and Chilcotin rivers are thought to be most affected but possibly also Little Chilcotin (needs verification). Any future run of the river hydro development would be included here.
7.3	Other ecosystem modifications	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Includes reduced ocean productivity and competition from other salmonids resulting from ocean ranching in the high seas, and offshore predation on smolts and adults. In freshwater includes sedimentation and thermal problems due to loss of riparian vegetation from logging and water extraction. However, the lakes in the watershed buffer the temperature and sedimentation to some degree.
8	Invasive & other problematic species & genes	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species/diseases						Invasive species can affect the deposited eggs, newly hatched alevins and fry rearing in the tributaries, and even juveniles and migrating smolts. Depending on the species of invader a substantial proportion of the population could be affected and mortality depends on the species and its biological proclivities that may be simply predation or food competition but could include habitat alteration and disturbance of the substrate and could be significant. Once established invasive species would have annual impact for the next 10 years. Currently no Invasives in the DU are impacting Steelhead or resident Rainbow Trout. However, migrating smolts may be affected to limited degree by established species in the lower Fraser River.
8.2	Problematic native species/diseases	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	The reduced population abundance of Steelhead makes predation particularly by pinnipeds in the inshore as well as by Harbor Porpoises and White-sided Dolphins in the offshore a threat. Adults migrating to overwintering areas of Thompson River from sea (late Aug. to late Nov.), smolts migrating to sea (mid-April to mid-May, once they have smolted after 2 or 3 years), and smolt off-shore migration (June to September) are all vulnerable. Mortality from threat is uncertain but up to 50% of smolts are lost during transit from freshwater out of Georgia Strait. Diet data indicate that Steelhead are consumed by seals in the Fraser estuary and in the Strait of Georgia and Puget Sound. In freshwater, otters, whitefish, and Bull Trout may be a predation threat at current reduced abundance. Interbreeding of Steelhead and resident Rainbow Trout is also an increasing threat at current abundance. Impact of sea lice on smolts and adults during migration past fish farms in northern Johnstone Strait are a current and future threat with uncertain impact.
8.3	Introduced genetic material						Not applicable to this DU but any future hatchery introductions would be considered here.
8.4	Problematic species/diseases of unknown origin						Not relevant to this DU.
8.5	Viral/prion-induced diseases						Not relevant to this DU.
8.6	Diseases of unknown cause						Not relevant to this DU.
9	Pollution	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.1	Domestic & urban waste water	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Affects all life stages as smolts and adults passage through the Chilcotin and lower Fraser rivers. In particular, the area around the lower Fraser River is heavily populated and it drains about one quarter of the British Columbia land area. It has been heavily inundated by various pollutants including sewage, discharge from treatment plants, leaking septic, oil or sediment from roads, domestic fertilizers and pesticides, and road salt. As well, elevated fecal coliform and turbidity in the lower river and its estuary occur, particularly during the spring freshet when Steelhead and Salmon smolts from the Interior Fraser are undertaking their seaward migration. The extent to which Steelhead utilize estuarine habitats in the lower Fraser River is not well understood but it appears that they rapidly transit out of the Strait of Georgia. Pollution potentially affects the entire population, but the impacts appear to be minimal.
9.2	Industrial & military effluents	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Affects smolts and adults migrating through the Chilcotin and lower Fraser rivers. Industrial and military effluents such as mine and mill waste that result in elevated levels of aluminum, iron, zinc have differing effects depending on time of year and extent of exposure. All Steelhead in the area of the spill or effluent would be affected. An annual occurrence as smolts and adults transit the lower reaches of the Fraser River. Steelhead are exposed to industrial effluents in freshwater, the Fraser estuary and Strait of Georgia. Estimating direct effects of the pollutants is difficult but consensus was that they were slight.
9.3	Agricultural & forestry effluents	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	All life history stages potentially impacted by this threat. Pollutants include agricultural runoff, sedimentation, pesticides both in the Chilcotin and lower Fraser watersheds. Agriculture is concentrated near the confluence of the Chilco and Chilcotin rivers but much reduced from that in the Thompson DU. The entire population is potentially exposed to the pollutants, but the effects were felt to be diluted by larger flows in the Chilcotin River watershed and rated as slight.
9.4	Garbage & solid waste						Not relevant to this DU.
9.5	Air-borne pollutants						Not relevant to this DU.
9.6	Excess energy						Not relevant to this DU.
10	Geological events	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Threats from catastrophic geological events.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.1	Volcanoes						Not relevant to this DU.
10.2	Earthquakes/tsunamis						Not relevant to this DU.
10.3	Avalanches/landslides	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	The rapid and extensive removal of dead and dying trees in combination with forest fire damage is having significant impacts in the watersheds with increased potential for landslides. Typically result in downstream turbidity and potentially result in changes in the stream bed as waters circumnavigate the blockage. Depending on the timing of the land slides effects could occur on various life history stages but eggs, alevins and juveniles would be most affected. Occurrences are expected to be infrequent and have minimal effect on the population. These scores do not include the 2018 Big Bar slide.
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Threats from long-term climatic changes that may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat.
11.1	Habitat shifting & alteration						Evidence of earlier and larger spring freshets, pine beetle infestation, higher summer air and stream temperatures. Changes in hydrographs caused by a variety of factors (e.g., snow melt, rain on snow, etc.).
11.2	Droughts						Little evidence of drought in the Chilcotin relative to the Thompson watersheds. Buffering by the lakes at the head of the watershed.
11.3	Temperature extremes						Increases in either or both marine and freshwater temperatures. Freshwater temperatures buffered by the lakes.
11.4	Storms & flooding						Storm effects are less pronounced than in the Thompson due to the buffering effect of the lakes that stabilize discharge and minimize flooding risk.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).							