PROPOSED

Species at Risk Act
Management Plan Series
Adopted under Section 69 of SARA

Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*), British Columbia Population, in Canada

Westslope Cutthroat Trout

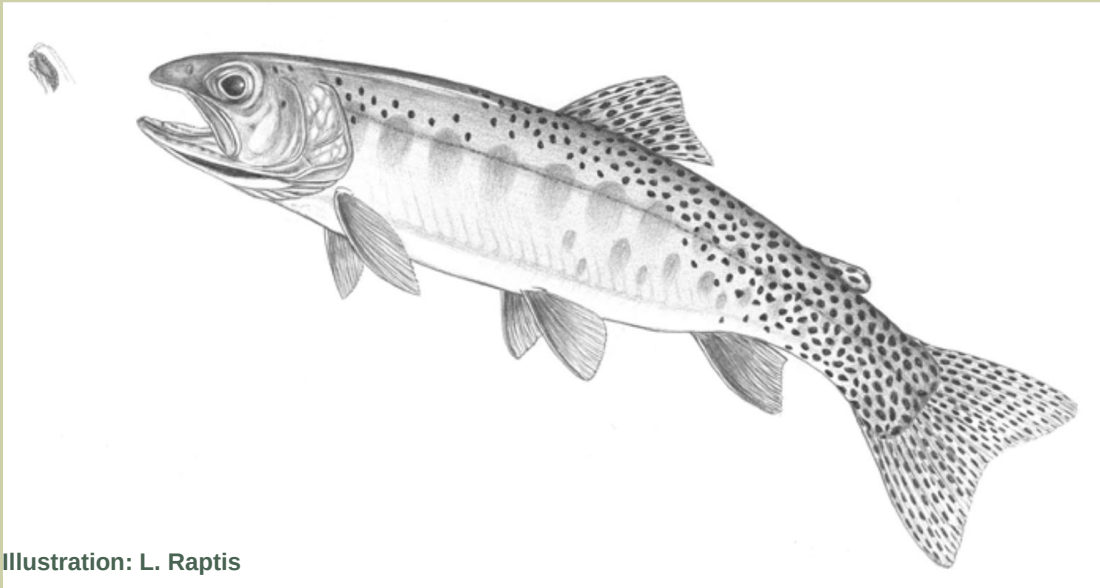

Illustration: L. Raptis

2016

Fisheries and Oceans Canada
Pêches et Océans Canada
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Important Note: British Columbia's Ministry of Environment's management plan (adopted under Section 69 of the *Species at Risk Act*) begins after page 7 of this document.

Additional copies:

Additional copies can be downloaded from the Species at Risk Public Registry.

Cover illustration: Lucas Raptis.

Également disponible en français sous le titre «Plan de gestion de la truite fardée versant de l'ouest (*Oncorhynchus clarkii lewisi*), population de la Colombie-Britannique, au Canada»

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MANAGEMENT PLAN FOR THE WESTSLOPE CUTTHROAT TROUT (*ONCORHYNCHUS CLARKII LEWISI*), BRITISH COLUMBIA POPULATION, IN CANADA [PROPOSED]

2016

Under the *Accord for the Protection of Species at Risk* (1996) the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the "Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia" (Part 2) under Section 69 of the *Species at Risk Act* (SARA). The federal Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA. A federal addition is included which completes the SARA requirements for this Management Plan.

The federal Management Plan for the Westslope Cutthroat Trout, British Columbia population, in Canada consists of two parts:

Part 1: Federal Addition to the "Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia," prepared by Fisheries and Oceans Canada

Part 2: "Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia," prepared by the British Columbia Ministry of Environment

PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for species listed as special concern. They are also required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries and Oceans and the Minister responsible for the Parks Canada Agency are the competent federal Ministers for the Westslope Cutthroat Trout (British Columbia population) as per Section 65 of SARA. In preparing this Management Plan, the competent ministers have considered, as per Section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this Management Plan has been prepared in cooperation with many individuals, organizations and government agencies, including the Province of British Columbia as per section 66(1) of SARA.

SARA Section 69 allows the Ministers to adopt all or part of an existing plan for the species if the Ministers are of the opinion that an existing plan relating to a wildlife species includes adequate measures for the conservation of the species. A provincial management plan (Part 2 of this document) for the Westslope Cutthroat Trout was provided as science advice to the jurisdictions responsible for managing the species in British Columbia. Fisheries and Oceans Canada, in cooperation with the Parks Canada Agency, has prepared a federal addition (Part 1 of this document) to meet the requirements of SARA. The federal Management Plan meets content and process requirements under SARA Sections 65, 66, 68 and 69.

As stated in the preamble to SARA, success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and measures set out in this Management Plan and will not be achieved by Fisheries and Oceans Canada, the Parks Canada Agency, or any other party alone. The cost of conserving species at risk is shared amongst different constituencies. All Canadians are invited to join in supporting and implementing this Management Plan for the benefit of the Westslope Cutthroat Trout (British Columbia population) and Canadian society as a whole.

A SARA management plan includes conservation measures to ensure that a species of special concern does not become threatened or endangered. These conservation measures support the management objectives identified in the management plan.

Implementation of this Management Plan is subject to appropriations, priorities, and budgetary constraints of participating jurisdictions and organizations.

RESPONSIBLE JURISDICTIONS

Fisheries and Oceans Canada
Parks Canada Agency
Government of British Columbia

ACKNOWLEDGMENTS

Fisheries and Oceans Canada would like to thank the British Columbia Ministry of Environment for leading the development of this Management Plan and for its close cooperation with the Department. Fisheries and Oceans Canada is also grateful to the Parks Canada Agency for cooperating in the development of the federal addition to this Management Plan.

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PART 1: Federal Addition to the "Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia," prepared by Fisheries and Oceans Canada

ADDITIONS TO THE ADOPTED DOCUMENT

Fisheries and Oceans Canada prepared the following additions to the provincial "Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia" (Part 2 of this document, hereafter the "provincial management plan") in order to address specific *Species at Risk Act* (SARA) requirements that are not fully addressed. These additions are considered part of the federal Management Plan for the Westslope Cutthroat Trout (British Columbia population) under SARA.

English Hyperlinks

The following hyperlinks in the provincial management plan are available in English only (en anglais seulement):

- Un-numbered page: http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm
- Page i: http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm
- Page 2: FRPA, OGAA, Situation de conservation, Rangs internationaux, Cadre pour la conservation de la C.-B., Groupes d'action établis en vertu du CC
- Page 59: http://a100.gov.bc.ca/pub/eswp/, http://www.env.gov.bc.ca/fw/fish/guide/#Management, http://www.env.gov.bc.ca/esd/documents/ff_program_plan.pdf, www.env.gov.bc.ca/skeena/qws/docs/SkeenaAnglingManagementPlan.pdf, http://www.env.gov.bc.ca/conservationframework/index.html, http://www.env.gov.bc.ca/wat/wq/#objectives, http://publications.gc.ca/collections/collection_2007/ec/CW69-14-506-2007F.pdf
- Page 60: www.gofishbc.com/documents/pdf/RAINBOW_TROUT_STRAINS.pdf
- Page 61: http://www.natureserve.org/publications/ConsStatusAssess_StatusFactors.pdf
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Strategic Environmental Assessment

A Strategic Environmental Assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of an SEA is to incorporate environmental considerations into the development of public policies, plans,

and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's (FSDS) goals and targets.

Management planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the Management Plan itself (Section 10), and are also supplemented by the statement below.

This Management Plan is expected to benefit the environment by promoting the long-term persistence of the Westslope Cutthroat Trout within its native range, thereby contributing to FSDS Goal 4 (Conserving and Restoring Ecosystems, Wildlife and Habitat, and Protecting Canadians). The recommended actions identified in this plan address threats such as small and large scale habitat modifications, altered flow regimes, riparian alteration, and in-stream habitat modifications, contributing to Goal 3 (Water Quality and Water Availability) of the FSDS. By addressing these threats, the recommended actions will potentially provide benefits to other species that are present, further contributing to FSDS Goal 4 (Conserving and Restoring Ecosystems, Wildlife and Habitat, and Protecting Canadians). Finally, in addressing the maintenance of wild populations at abundance levels that prevent at-risk status assessment (Objective 2) this plan contributes to FSDS Goal 5 (Biological Resources, *i.e.* sustainable production and consumption of biological resources).

Given the considerations outlined above, the benefits of this Management Plan to the environment and other species are expected to far outweigh any adverse effects that may occur.

Elk Valley Water Quality Plan

In Section 8.2.1 (Threat #3, second bullet, following the period) the following text is added:

In 2014, the British Columbia Ministry of Environment approved the Elk Valley Water Quality Plan (Teck Resources Limited, 2014). The plan was developed to address the management of water quality constituents released by mining activities throughout the Elk River watershed.

Measuring Progress

According to Section 72 of SARA, the Minister of Fisheries and Oceans must assess a management plan's implementation five years after the plan is included in the Species at Risk Public Registry, and in every subsequent five-year period, until its objectives have

been achieved. Fisheries and Oceans Canada supports the British Columbia Ministry of Environment's approach (Section 9.5) to use Essential activities (Section 9.4, Table 10) as benchmarks and performance measures to evaluate progress. This supports the achievement of Management Objectives and acknowledges that the completion of Essential activities will inform knowledge gaps currently limiting the refinement of targets (Section 6.2, Table 2) and non-Essential activities (Section 9.4, Table 10). The use of alternative benchmarks and performance measures, as well as the refinement of targets, non-Essential activities and their associated timelines may be proposed in subsequent Management Plan updates.

Record of Cooperation and Consultation

This federal Management Plan is compliant with Section 66 of SARA. The Province of British Columbia, Fisheries and Oceans Canada, and the Parks Canada Agency cooperated on the preparation of the Management Plan (Parts 1 and 2) via the regional federal-provincial Species at Risk Coordinating Committee established under the *Canada-British Columbia Agreement on Species at Risk* (2005). Part 2 has been developed by the Province of British Columbia, to the extent possible, in cooperation with multiple organizations (see Part 2: Acknowledgements) including Fisheries and Oceans Canada and the Parks Canada Agency.

The federal Management Plan for Westslope Cutthroat Trout (British Columbia population) was posted to the DFO Pacific Region Consultation Website for a public comment period from October 7 to November 24, 2014. A draft of the Management Plan, along with background information and a comment form, was made available on the website. Letters were mailed, e-mailed and faxed to First Nations organizations in the species' range requesting input on this draft Management Plan and offering an opportunity to request further discussion with Fisheries and Oceans Canada. E-mail notifications of the consultation were also sent to the Province of British Columbia, the United States Fish and Wildlife Service, regional and municipal governments, environmental interest groups, academia, industry, recreational fishery groups, and other stakeholder groups in the species' range. The general public was notified by social media tweets.

Comments were received from 7 respondents during the consultation period in the form of a hardcopy letter, emails and online comment forms. Respondents included a landowner, a recreational fishery organization, a non-government environmental organization, industrial organizations, and a municipality. Primary topics discussed include: threats; fishery enforcement; hatchery practices; knowledge gaps; provincial and federal jurisdictions; stewardship; habitat compensation; and the socio-economic impacts of implementing the Management Plan. All feedback received during the consultation period is considered in developing the final Management Plan.

References

Teck Resources Limited. 2014. Elk Valley water quality plan. Teck Resources Limited, Sparwood, British Columbia. xxxii + 256 pp.

EXCLUSIONS FROM THE ADOPTED DOCUMENT

The provincial management plan includes socio-economic considerations in multiple sections related directly to the management of the species. For this reason, the following excerpts are not considered part of the federal Management Plan for this species:

Relevant Sections of Provincial Management Plan (Part 2)	Excluded Text
• Executive Summary (paragraph 2)	"Robust, wild fish populations are the foundation of a sustainable fisheries program, which in turn provides social, economic, and recreational benefits to the province."
• Executive Summary (Vision) • Section 5 (Vision)	". . . and providing sustainable societal benefits including quality fishing opportunities . . ."
• Executive Summary (Overarching Management Goal) • Section 5 (Overarching Management Goal)	". . . at abundance levels capable of providing sustainable benefits to society, within the context of broader ecosystem values."
• Executive Summary (Management Objective #2) • Section 6 (Objective #2) • Section 6.1 (Table 2, Objective #2) • Section 6.2 (Objective #2) • Section 7.2 (Objective #2) • Appendix 2 (Objective 2)	". . . so that the populations can provide sustainable societal benefits . . ."
• Introduction (paragraph 1)	"The Province of British Columbia has a global responsibility, as well as a responsibility to its stakeholders, to ensure that this resource is protected in B.C. and continues to support a diversity of recreational opportunities."
• Introduction (paragraph 2)	All, except: "A provincial management plan for Westslope Cutthroat Trout is essential for federal and provincial government to achieve goals in natural resource management."
• Introduction (paragraph 3)	All
• Section 5.1 (Management Goal Rationale, paragraph 1)	". . . , which in turn provide social, economic, and recreational benefits to the province. Implicit in this management plan is that the conservation goal must be met first to achieve the recreational goal . . ."
• Section 5.1 (Management Goal Rationale, paragraph 2)	". . . and recreation objectives . . ."
• Executive Summary and Section 6 (Management Objectives #3 and #4)	". . . ; and 4. optimize sustainable recreational benefits."

Relevant Sections of Provincial Management Plan (Part 2)	Excluded Text
• Section 6.1 (Table 2, Objective #4)	All, except the following:[1] • Indicator: Fish Size, Measure: Length, Target: More large fish, Status – Meeting target?: YES – in the few Classified Water systems considered • Indicator: Angling regulation compliance, Measure: proportion of anglers in compliance with regulations, Target: <10% non-compliance, Status – Meeting target?: NO – exceeded for Classified Waters, unknown elsewhere
• Section 6.2 (Objective #2, Justification)	". . . that can provide sustainable societal benefits . . ."
• Section 6.2 (Objective #4 and Justification)	All, except:[2] 3. Average fish size for Classified Waters is stable or increasing. 5. Non-compliance with angling regulations on Classified Waters is <10%.
• Section 7.4	The following Sub-Sections: • 7.4.1 – All • 7.4.2 – All • 7.4.3 – Only the following excerpts are excluded: o ". . . has been reported in association with abundance estimates. While fish size contributes the quality of angling experience, it . . ." o "However, it is not clear what quantitative targets should be set for quality fisheries. For more detail, refer to Appendix 11, Fishing quality." • 7.4.4 – All • 7.4.6 – All
• Section 9.1	". . . following, at a minimum, province-wide (Province of British Columbia 2010), and Ministerial guidelines for consultation . . ."
• Section 9.4 (paragraph 1)	". . . be consistent with the B.C. Freshwater Fisheries Program Plan goals (B.C. Ministry of Environment 2007), and . . ."
• Section 9.4 (Table 10)	"Sustainable and Diverse Recreational Opportunities" and everything beneath, except rows: 4, 7, and 9.
• Section 9.4.1	". . . ; conservation is also the foundation upon which a sustainable recreational fishery can be maintained . . ."
• Section 9.4.3	All, except the following excerpts: • "Fisheries for WCT in B.C. have become increasingly conservative since the 1980s."

[1] Although Objective #4 is not part of the federal Management Plan, some activities in Table 2 associated with this objective are relevant to managing Westslope Cutthroat Trout under the mandate of SARA.
[2] Although Objective #4 is not part of the federal Management Plan, some Targets associated with this objective are relevant to managing Westslope Cutthroat Trout under SARA.

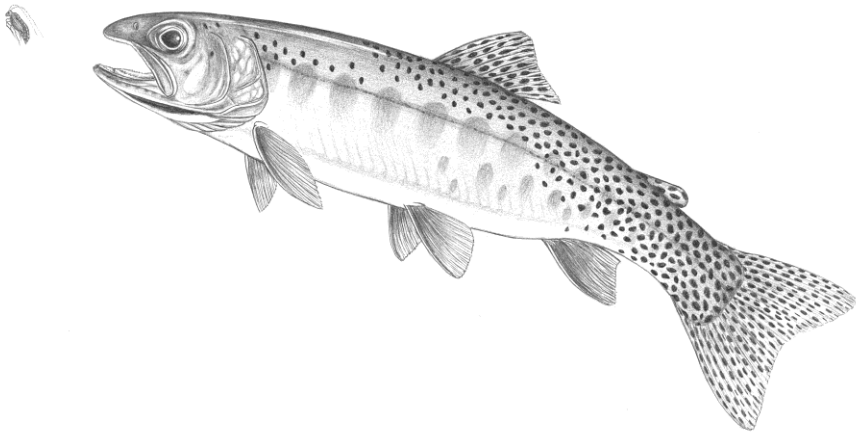
Relevant Sections of Provincial Management Plan (Part 2)	Excluded Text
	• "However, overcrowding is becoming a greater issue on some streams, and compliance is a concern for both Classified and Non-classified Waters. The extent to which harvest can be maintained is not known."
• Section 9.4.4 (paragraph 1)	• "It will take significant resources to undertake a predictive modeling exercise to spatially define all populations across the landscape."
• Section 11 (References)[3]	• Burrows, J. 2007. Kootenay Region angling management planning and performance 2003–2007. Powerpoint presentation made at the annual meeting of the Fisheries Program Rivers Committee. March 2007. • Heidt, K.D. 2004. St. Mary River Creel Survey 2003 Quality Waters Strategy (River Guardian Program). B.C. Min. Environ., Cranbrook, BC. 35 p. • Martin, A.D. 1983. Fisheries management implications of creel surveys conducted at the Elk River in Kootenay Region 1982–83. Fisheries Management Report No. 78 (1983). • Martin, A.D. 1984. Effects of a 2.5 year closure of the cutthroat fishery on the Upper St. Mary River: management implications of implementing an alternate year closure on East Kootenay trout streams. Fisheries Management Report No. 82 (1984). • Westover, W.T. 1993. Summer 1991 creel survey on the Elk River from Ladner Creek to Elko. Fisheries Project Report KO 49 (1993).

Appendices 2 and 11 make several references to socio-economic considerations; however, they remain part of the federal Management Plan (unless otherwise stated in the table above) because they contribute to the technical basis from which objectives and targets were derived.

[3] These references are cited within sections of the provincial management plan that have been omitted from the federal Management Plan.

PART 2: MANAGEMENT PLAN FOR THE WESTSLOPE CUTTHROAT TROUT (*ONCORHYNCHUS CLARKII LEWISI*) IN BRITISH COLUMBIA, PREPARED BY THE BRITISH COLUMBIA MINISTRY OF ENVIRONMENT

Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia



Prepared by B.C. Ministry of Environment

BC Freshwater Fisheries Program

BRITISH COLUMBIA | Ministry of Environment

December 2013

Updated - August 2014

About the British Columbia Management Plan Series

This series presents the management plans that are prepared as advice to the Province of British Columbia. Management plans are prepared in accordance with the priorities and management actions assigned under the British Columbia Conservation Framework. The Province prepares management plans for species that may be at risk of becoming endangered or threatened due to sensitivity to human activities or natural events.

What is a management plan?

A management plan identifies a set of coordinated conservation activities and land use measures needed to ensure, at a minimum, that the target species does not become threatened or endangered. A management plan summarizes the best available science-based-information on biology and threats to inform the development of a management framework. Management plans set goals and objectives, and recommend approaches appropriate for species or ecosystem conservation.

What's next?

Direction set in the management plan provides valuable information on threats and direction on conservation measures that may be used by individuals, communities, land users, conservationists, academics, and governments interested in species and ecosystem conservation.

For more information

To learn more about species at risk recovery planning in British Columbia, please visit the B.C. Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

Management Plan for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in British Columbia

BC Freshwater Fisheries Program

Prepared by B.C. Ministry of Environment

December 2013

Updated – August 2014

Recommended citation

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Cover illustration/photograph

Lucas Raptis

Additional copies

Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

Publication information

This is an updated version of the December 2013 first edition of this document.
See **Updates** for specific changes to the document.

Updates

Updated August 2014 - Changes to the original posting (December 2013) include: correction of FRPA and OGAA legal designation to “Species at Risk”(Section 3, pg.2); clarification of text in the “Details” column of Table 9; as well as minor formatting, grammatical and typographical corrections.

Disclaimer

This management plan has been prepared by the B.C. Ministry of Environment, as advice to the responsible jurisdictions and organizations that may be involved in managing the species.

This document identifies the management actions that are deemed necessary, based on the best available scientific and traditional information, to prevent Westslope Cutthroat Trout populations in British Columbia from becoming endangered or threatened. Management actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and management approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the management team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the management team.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this management plan.

The B.C. Ministry of Environment encourages all British Columbians to participate in the conservation of Westslope Cutthroat Trout.

ACKNOWLEDGEMENTS

This plan was prepared by Sue Pollard (B.C. Ministry of Environment) with input from an ad hoc working group during two provincial workshops for this species held in Cranbrook in January 2009 and December 2010. Workshop participation and contributions to the development of the plan came from a number of agencies, First Nations, and independent consultants including: B.C. Ministry of Environment, B.C. Ministry of Forestry, Lands and Natural Resource Operations, Parks Canada, Fisheries and Oceans Canada (Tom Brown), Canadian Columbia River Inter-Tribal Fishery Commission (Bill Green), Trout Unlimited (Jon Bisset), Freshwater Fisheries Society of BC (Doug Crawley), Alberta Fish and Wildlife (Jenny Earle), Scott Cope (Westslope Fisheries), Peter Corbett (Mirkwood Ecological Consultants), Mike Robinson (Lotic Environmental), Gerry Oliver (G.G. Oliver and Associates), and Bill Westover.

Additional reviewers included Ted Down, Leah Westereng, Greg Wilson, and the provincial Fisheries Policy Team. Staff from the Species at Risk group at Fisheries Oceans Canada provided valuable comments to better align this document with the requirements under *Species at Risk Act* (SARA).

Byron Woods provided GIS support and great maps.

Funding to support this management plan included contributions from the B.C. Ministry of Environment 2010 Habitat Conservation Trust Fund and Fisheries and Oceans Canada.

EXECUTIVE SUMMARY

The Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) was designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) due to concerns regarding introduced species (hybridization and competition), habitat loss and degradation, and increasing exploitation. It is listed as Special Concern in Canada on Schedule 1 of the *Species at Risk Act* (SARA). In British Columbia, the Westslope Cutthroat Trout is ranked S3 (vulnerable) by the Conservation Data Centre and is on the provincial Blue list. The B.C. Conservation Framework ranks the Westslope Cutthroat Trout as a priority 2 under goals 1 and 2 (contribute to global efforts for species and ecosystem conservation; and prevent species and ecosystems from becoming at risk).

In addition, Westslope Cutthroat Trout was identified as a priority native sport fish species by the BC Freshwater Fisheries Program in need of a provincial fisheries management plan. Robust, wild fish populations are the foundation of a sustainable fisheries program, which in turn provides social, economic, and recreational benefits to the province.

This document is intended to meet the needs of SARA, as well as the BC Freshwater Fisheries Program. The following are the vision, goal, and objectives of this management plan.

The Vision
Abundant and diverse populations of Westslope Cutthroat Trout capable of persisting and providing sustainable societal benefits including quality fishing opportunities.

Overarching Management Goal
Long-term persistence of the species within its native range at abundance levels capable of providing sustainable benefits to society, within the context of broader ecosystem values.

The management objectives are to:
1. maintain the native distribution and genetic diversity of populations;
2. maintain wild populations at abundance levels that prevent at-risk status assessment so that the populations can provide sustainable societal benefits;
3. maintain, or rehabilitate, the capacity of natural habitat to meet abundance targets for populations; and
4. optimize sustainable recreational benefits.

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1 INTRODUCTION

Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) arguably supports the most popular fisheries for native species in the southeast area of the province. In the past, liberal fishing regulations, in combination with other factors such as habitat degradation, have resulted in significant declines for at least some populations. Furthermore, the global distribution of the species has contracted significantly. At one time, the majority of the species' distribution was outside of Canada; competition and hybridization issues with introduced sport species, and habitat loss and degradation have resulted in a much reduced distribution with the most extant populations residing in B.C. The Province of British Columbia has a global responsibility, as well as a responsibility to its stakeholders, to ensure that this resource is protected in B.C. and continues to support a diversity of recreational opportunities.

A provincial management plan for Westslope Cutthroat Trout is essential for federal and provincial government to achieve goals in natural resource management. First, this plan will accomplish activities that were highlighted as priorities under the goals of the provincial Freshwater Fisheries Program Plan. The three goals of the Freshwater Fisheries Program Plan are to (1) establish governance approaches that are strategic, effective, and efficient; (2) conserve wild fish and their habitats; and (3) optimize recreational opportunities based on the fishery resource (B.C. Ministry of Environment 2007). Implicit in the program is that conservation goals must be met first to achieve recreational and associated economic goals.

As part of the goal to "conserve wild fish and their habitats," the need to develop species-based management plans to establish provincial-level objectives and management strategies for species that support recreation was identified. Furthermore, the goal to "optimize recreational opportunities based on the fishery resource" directs us to define objectives and establish the appropriate management approach using species-based summaries, stakeholder preferences, and resource assessments.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the B.C. population of Westslope Cutthroat Trout as Special Concern in November 2006; in 2010 the B.C. population was legally listed under the federal *Species at Risk Act* (SARA).[4] Under the SARA, species listed as Special Concern require a SARA-compliant management plan for the species and its habitat, including measures for the conservation of the species. The intent of this document is to address both federal and provincial planning needs in a single document.

[4] The Alberta population was legally listed as Threatened under SARA in 2013.

2 COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: November 2006
Common Name (population):** Westslope Cutthroat Trout
Scientific Name: ***Oncorhynchus clarkii lewisi***
COSEWIC Status: Special Concern
Reason for Designation: Populations are stressed by hybridization and competition with introduced species. Furthermore, expanding urban development, agricultural activities and resource-based industries are expected to lead to additional stresses associated with habitat loss and degradation, as well as increased exploitation. It should be noted that this assessment includes only genetically pure, native populations of the species occurring within their historical range. Any populations know to be hybridized significantly (i.e., >1%) with other trout species, or to have been introduced into a system previously free of native populations, were not assessed.
Canadian Occurrence: British Columbia
COSEWIC Status History: Designated Special Concern in May 2005. Status re-examined and confirmed November 2006. Assessment based on a new status report.

* Committee on the Status of Endangered Wildlife in Canada.
** Referred to as Cutthroat Trout, *lewisi* subspecies by the British Columbia Conservation Data Centre.

3 SPECIES STATUS INFORMATION

Westslope Cutthroat Trout[a]			
Legal Designation:			
FRPA:[b] Species at Risk OGAA:[b] Species at Risk	B.C. *Wildlife Act:*[c] Schedule A	SARA:[d] Schedule 1 – Special Concern (2010)	
Conservation Status[e]			
B.C. List: Blue Subnational Ranks:[f] AB: S2	B.C. Rank: S3 (2004)	Global Rank: G4T3 (2003)	
B.C. Conservation Framework (CF)[g]			
Goal 1: Contribute to global efforts for species and ecosystem conservation.			Priority:[h] 2 (2009)
Goal 2: Prevent species and ecosystems from becoming at risk.			Priority: 2 (2009)
Goal 3: Maintain the diversity of native species and ecosystems.			Priority: 3 (2009)
CF Action Groups:[g]	Compile Status Report; Planning; Send to COSEWIC; Habitat Protection; Habitat Restoration; Private Land Stewardship; Species and Population Management; Review Resource Use		

[a] Data source: B.C. Conservation Data Centre (2012) unless otherwise noted.
[b] Species at Risk = a listed species that requires special management attention to address the impacts of forest and range activities on Crown land under the *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002) and/or the impacts of oil and gas activities on Crown land under the *Oil and Gas Activities Act* (OGAA; Province of British Columbia 2008) as described in the Identified Wildlife Management Strategy (Province of British Columbia 2004).
[c] Schedule A = designated as wildlife under the B.C. *Wildlife Act*, which offers it protection from direct persecution and mortality (Province of British Columbia 1982).
[d] Schedule 1 = found on the List of Wildlife Species at Risk under the *Species at Risk Act* (SARA).
[e] S = subnational; N = national; G = global; T = refers to the subspecies level; X = presumed extirpated; H = possibly extirpated; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable.
[f] Data source: NatureServe (2012).
[g] Data source: B.C. Ministry of Environment (2010).
[h] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

4 SPECIES INFORMATION

4.1 Species Description

Taxonomy
Westslope Cutthroat Trout (WCT; *Oncorhynchus clarkii lewisi*) is a strictly inland subspecies of Cutthroat Trout. In B.C., there are two subspecies of Cutthroat Trout: WCT and Coastal Cutthroat Trout (*O. clarkii clarkii*). Dymond (1931) described a third subspecies in B.C., namely Mountain Cutthroat Trout or *O. clarki alpestri,* which was found in disjunct populations in mountain lakes of the Revelstoke area. These populations are now considered a form of Westslope Cutthroat Trout (McPhail 2007). Most taxonomists currently recognize 14 allopatrically occurring subspecies of Cutthroat Trout with 4 of these subspecies, including Westslope, Coastal, Lahontan (*O. clarkii henshawi*), and Yellowstone (*O. clarkii bouvieri*) showing substantial genetic divergence and broad distribution; the remaining 10 subspecies are of limited range. Many historic records refer to WCT as the inland form of Yellowstone Cutthroat Trout. However, major genetic and chromosome differences have confirmed that these two forms are distinct subspecies (in McPhail 2007). Yellowstone Cutthroat Trout is not native to Canada.

Key Distinguishing Traits
Westslope Cutthroat Trout is one of two native subspecies of native Cutthroat Trout in B.C., the other being Coastal Cutthroat Trout. From Kookanusa Reservoir and upstream, it is one of only two native salmonids residing in southeastern B.C.; Bull Trout (*Salvelinus confluentus*) is the other species.

The main feature that distinguishes the B.C. populations of WCT from Coastal Cutthroat Trout is the pattern of spotting on the body–the spots for WCT below the lateral line are concentrated on the back half of the body and almost absent at the front. In Coastal Cutthroat Trout, irregular black spots are distributed evenly from front to back (McPhail 2007). The main feature that separates WCT from Rainbow Trout (*O. mykiss*) is the orange-red slash below the lower jaw plus a longer mouth that extends past the hind portion of the eye in WCT (COSEWIC 2006).

Ecological Role
The WCT is primarily insectivorous, typically but not exclusively feeding on drifting invertebrates and nymphs in streams, and winged insects and zooplankton while in lakes and large rivers (McPhail 2007). Therefore, they influence benthic invertebrate community structure and trophic dynamics of the habitats they inhabit.

WCT are one of the few large native fish species adapted to cold, nutrient-poor streams within their native range in British Columbia. As WCT are rather fecund, eggs, juveniles, and adults can be abundant and preyed upon by other fish (bull trout, northern pikeminnow, cottids), many mammals (river otters, mink, bears), and birds (raptors, ducks).

WCT have strict habitat requirements of cool, clean, and well-oxygenated waters, connected habitats for different life stages with various natural habitat attributes, this makes them an

indicator of ecosystem health and environmental quality indicator across the landscape. WCT were one of the first salmonids to recolonize western Canada (following glaciation). In most of their range there is only one other native species from the subfamily salmoninaes[5]; therefore, WCT play an important role in structuring north temperate ecosystems (McPhail and Carveth 1992).

WCT represent an important component of the cutthroat trout species complex. They are the subspecies at the northern periphery of the species range; inhabit a variety of extreme habitats; likely contain a number of unique specializations for cooler, less productive ecosystems; and occur in many different morphological and life-history forms (COSEWIC 2006; see section 4,3). These adaptations to marginal habitat might be necessary for reintroduction to extirpated areas, and as such constitute an important component of species biodiversity (COSEWIC 2006).

4.2 Populations and Distribution

4.2.1 Range

The historic distribution of WCT is not known with certainty (Behnke 1992; Prince 2001; McPhail 2007) but includes the upper Missouri River basin, and the Columbia River basin including the Kootenay River westward to the Cascade Mountains where it occurs as disjunct populations including those described as Mountain Cutthroat (Behnke 1992). It is thought to be one of the first post-glacial colonizers in many areas that were later extirpated except above barriers as Rainbow Trout recolonized these systems. This may explain the disjunct populations particularly in the western parts of its range in B.C. (McPhail 2007). Westslope Cutthroat Trout have experienced severe reductions in distribution in many areas of their native range in western North America owing to habitat loss, barriers, and negative interactions with introduced salmonids. In particular, their distribution is now limited to mainly cold headwater streams in most drainages in the northwest United States, as well as Alberta (Shepard *et al*. 1997; Mayhood 1999).

The core WCT range in B.C. occurs in the Kootenay, Flathead, and Pend d'Oreille systems, where WCT inhabit most major tributaries as well as smaller creeks and lakes. However, disjunct populations also occur in headwater streams and lakes of the upper Columbia River as well as a few tributaries of the South Thompson River and the Kettle River (Prince 2001; COSEWIC 2006; McPhail 2007).

Dymond (1931) described some isolated populations of Cutthroat Trout in the Revelstoke area (from both Columbia and Fraser tributaries) as a distinct subspecies: the Mountain Cutthroat Trout, *Oncorhynchus clarki alpestris*. These are undoubtedly WCT (Behnke 1992). The origins of these disjunct populations are unclear; one possibility is that the Fraser populations originated from movement from headwater Columbia tributaries nearby (McPhail 2007). However, genetic data that consider two Fraser and Columbia WCT populations in close physical proximity do not support this hypothesis as the two are genetically distinct (Taylor *et al*. 2003). The alternative is that WCT were once much more broadly distributed in the Fraser but were displaced and

[5] Subfamily salmoninaes includes salmon, trout and char.

eliminated by naturally recolonizing Rainbow Trout (Dymond 1931). In this way, similar extirpations may explain why WCT are only present above barriers in a few small tributaries of the Kettle River (McPhail 2007).

Native WCT do not occur in the Okanagan River drainage. WCT have been stocked into many additional lakes and some streams, mainly in the B.C. Southern Interior within core and peripheral areas of the native range of the species.

4.2.2 Defining Population Groups

A significant amount of literature supports the use of units below the taxonomic species level to assist in the management and conservation of species where appropriate. Particularly for widespread species with spatially variable evolutionary histories and threats such as WCT, assessing conservation status at the species level is wholly inadequate to reflect the risk of extinction. Refer to Appendix 3, Defining population groups, for more detail.

We adopted a practical compromise between the discrete population level and species level to identify units (herein called Population Group) for status and threat assessment, as well as management considerations. Specifically, two key factors were considered in defining Population Groups for WCT in B.C.: genetic population structure and major drainages. This resulted in seven Population Groups, which are used to report out on status indicators and threat assessment results. However, management activities such as abundance estimates must still be undertaken at the population level. These Population Groups are not intended to be equivalent to more robustly defined units in the literature such as Conservation Units (Wild Salmon Policy, DFO), Designatable Units (COSEWIC), or Evolutionarily Significant Units (U.S. *Endangered Species Act*). These groups fall into two categories, core range and peripheral range, reflecting the extent to which native populations occur in these areas, as follows:

Core Range:

- **Elk** - Elk lakes to Elko Dam including all tributaries
- **Flathead** - Flathead from headwaters to border
- **Upper Kootenay** - Kootenay River and tributaries from headwaters to Kookanusa Reservoir. This set excludes the Elk River except for the very lowest portion below the natural barrier at Elko Dam; thus Wigwam River is included. Includes Kootenay National Park.
- **West Kootenay** - Kootenay Lake and tributaries including inlet (to border) and outlet (to Brilliant Dam)

Peripheral Range:

- **Columbia** - entire Columbia River mainstem from headwaters to border including Pend d'Oreille. Includes Glacier and Yoho National Parks.
- **Kettle** - entire watershed
- **South Thompson** - upper portion of South Thompson watershed

The core range Population Groups represent the core or centre of distribution for WCT in B.C. while the other three Population Groups contain fairly disjunct, sparsely distributed populations considered more in the periphery of the native range. Further subdivision of Columbia Population Group into an upper and lower component (breakpoint at Mica Dam) was considered; however, WCT distribution within this area is scattered to begin with. Thus, additional groups in peripheral areas did not seem necessary. Figure 1 provides a spatial representation of these Population Groups.

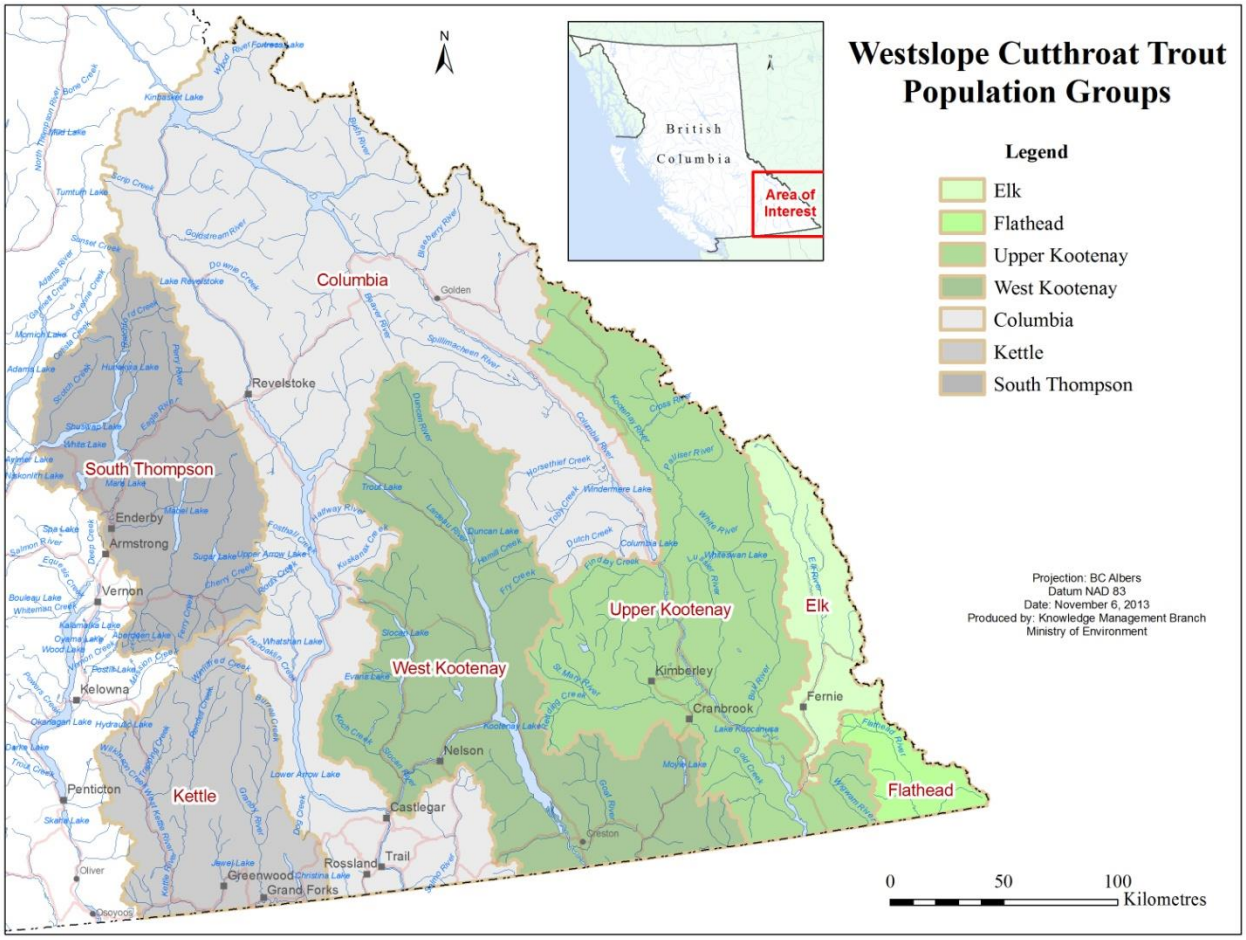

Figure 1. Spatial representation of Population Groups for Westslope Cutthroat Trout.

4.2.3 Defining Populations

Ideally, every population of WCT within each Population Group could be identified, characterized, assessed, and prioritized in terms of conservation and management objectives. This information could then be rolled up to provide an overall status evaluation and management direction at the Population Group level. However, such a detailed level of information is not, nor likely will be, available.

A total of 1,319 unique waterbodies (including both lakes and streams) at the 1:20,000 scale contain at least one WCT observation (Table 1; Figure 2). These data represent all observation

data from the Fisheries Information Summary System (FISS). The number of observations that are truly representative of original native populations versus introduced populations via hatchery releases is very difficult to determine given the extensive hatchery history for WCT in B.C. Most waterbodies with observations, approximately 928, have no hatchery release records; therefore, currently there are an estimated 928 to 1,319 waterbodies that may contain WCT populations. The numbers are probably conservative as they only includes locations for which WCT have been observed and reported. Many small headwaters and lakes capable of supporting WCT remain to be surveyed. The last COSEWIC (2006) assessment estimated a probable range of 30– to 100 mature individuals per population, considering their biology, habitat preferences, and productivity. This assumes one population per smaller lake or stream, and several independent component stocks in larger systems.

In terms of life history variation, WCT have been observed in both lakes and streams for all Population Groups in B.C. (Table 1). Based on extracted observation data, more streams than lakes have been reported to contain WCT. Larger proportions of lake observations in peripheral areas may reflect a difference in habitat types available for WCT or a stocking history in lakes in areas where native populations are not so common. The presence of isolated headwater populations has only been confirmed in limited surveys where barriers have been identified. Some studies have explicitly noted the diversity of life history variation that occurs at the watershed level. For instance, an Elk River radio-tagging study confirmed the presence of all three WCT life history forms (Westslope Fisheries Ltd. 2003). In the St. Mary River, Oliver (1990) reported that fish spent two years in nursery streams before emigration to larger, more productive systems (i.e., (ad-) fluvial life history).

With respect to genetic population structure, results indicate that populations tend to cluster geographically and are associated with watersheds, with outliers being highly isolated headwater populations (Taylor *et al*. 2003). Significant divergence among populations even where genetic exchange is possible suggests strong demographic independence and a need to manage at a local population level, despite extensive movements often observed. For more detail, refer to Appendix 3, Defining Population Groups.

It is impossible to identify all WCT populations within each Population Group with the available observation data. Furthermore, it is unlikely that all waterbodies within the native range of WCT will ever be surveyed. However, a habitat-based modeling exercise could be undertaken to assess the potential number and distribution of waterbodies capable of supporting WCT in B.C. This would enable a more detailed characterization of WCT at the population level and an assessment of rarity (e.g., based on ecotype frequency) and conservation priority (e.g., based on genetic purity, isolation from introduced Rainbow Trout). Predictive modeling will enable a more representative assessment of the number of lakes versus streams within each group likely to support WCT. In addition, modeling that considers barrier presence will help identify headwater resident populations.

Table 1. Comparison of the number of streams and lakes (as defined by blueline coding in 1:20,000 stream network data; B. Woods, pers. comm.) in which WCT have been observed, as of June 2010, across Population Groups. Overall, most WCT observations occur in stream environments.

Population Group	Streams	Lakes	Total	% Streams
Elk	134	36	170	78.8
Flathead	85	17	102	83.3
Upper Kootenay	406	114	520	78.1
West Kootenay	246	81	327	75.2
Columbia	117	54	171	68.4
Kettle	12	7	19	63.2
South Thompson	6	4	10	60.0
Total	**1006**	**313**	**1319**	**76.3**

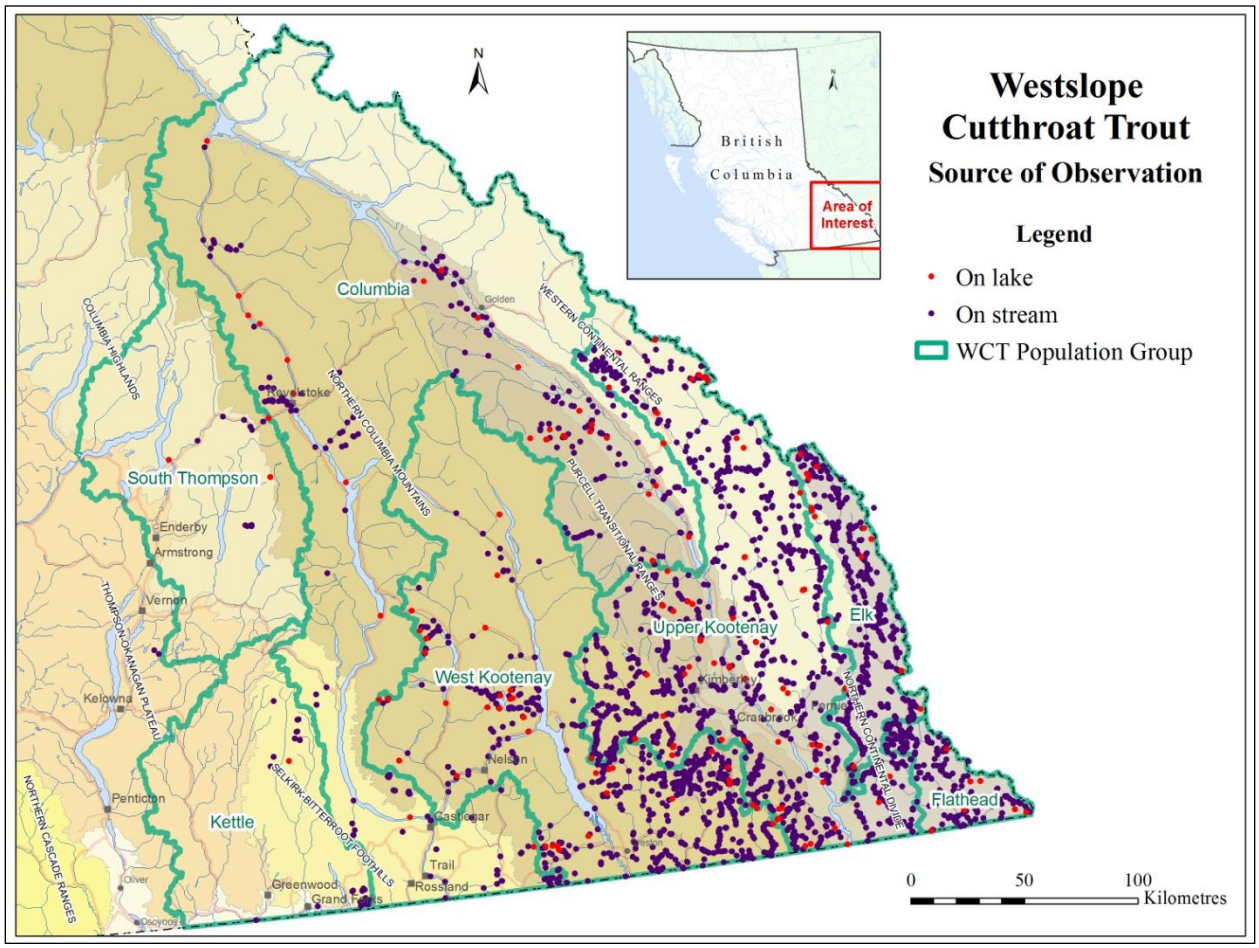

Figure 2. Distribution of WCT observation data collected from lakes and streams within each Population Group.

4.3 Needs of the Westslope Cutthroat Trout

Life History
The species typically occurs as one of three life history forms in B.C. (summarized by Oliver (2009):

1. stream-resident – typical of headwater stream populations above barriers that complete their life cycle within a very restricted distribution and remain relatively small (i.e., < 200 mm in length) due to the cold, nutrient-poor nature of these small streams;
2. fluvial – typical of migratory populations that move between small spawning/rearing tributaries and larger, more productive adult-rearing rivers and are thus generally larger as adults (i.e., > 400 mm in length); and
3. adfluvial – typical of populations that migrate between spawning/rearing tributaries and adult rearing lakes where adults can exceed 500 mm in length if productivity in lakes is high.

Resident and fluvial populations frequently co-occur in the same watersheds in B.C. although barriers may separate populations (Oliver 2009). Adfluvial populations may occur in headwater lakes with inlets and outlets, as well larger downstream lakes like Kookanusa Reservoir and Kootenay Lake.

Rising temperatures and a rising hydrograph in the spring trigger spawning migrations, and spawning in B.C. usually occurs from early May to late June (McPhail 2007). Females build the redd, usually upstream of tail-out areas of glides or riffle sections (Schmetterling 2000). Fecundity varies with size; small headwater fish are reported to have about 125–700 eggs while larger lake and river fish have 750–2000 eggs (Downs and White 1997). WCT are iteroparous (they can spawn more than once); however, frequency of repeat spawning varies across populations, from <1% to about 25% (McPhail 2007).

Resident populations may reach maturation in 3 years, but most fish mature in their fourth year with females typically maturing 1–2 years later than males (Downs and White 1997). In fluvial and adfluvial populations, maturation may occur for males after 3–4 years; in females, maturity is reached by 5 years (McPhail 2007).

Diet
Unlike other cutthroat subspecies, WCT do not appear to be highly predacious on other fish (Behnke 1992). WCT are generally insectivorous although zooplankton may be important to populations of larger lakes (McPhail 2007). This may reflect the species' co-evolution with two highly predacious species, namely Bull Trout (*Salvelinus confluentus*) and Northern Pikeminnow (*Ptychocheilus oregonensis*), such that it specialized as an insectivore to avoid competition (Behnke 1992).

Habitat Needs
Typical WCT streams are cold and nutrient poor (Liknes and Graham 1988). Specific habitat requirements vary with life history form and season including migration, spawning, incubation, rearing, and overwintering. Temperature and flow are key physical cues that trigger migrations

for spawning and overwintering (Oliver 2009). High water quality, including adequate oxygen and clean, sediment-free gravel, is essential during the incubation period (Oliver 2009). Pool-to-riffle ratios will influence availability of rearing habitat, while adequate depths and temperature regimes will strongly influence overwintering survival (Oliver 2009). In fact, Oliver (2009) suggests that the availability of suitable overwintering habitat may be most limiting particularly for fluvial or small stream populations. Refer to Habitat Use in Appendix 1 for more details specific to the Elk River.

Limiting Factors
Westslope Cutthroat trout populations are naturally limited by their specific habitat requirements relating to water temperatures, stream hydrology, connectivity and the availability of specific habitat types, as described above.

5 VISION, GOAL, AND RATIONALE

Vision
Abundant and diverse populations of Westslope Cutthroat Trout capable of persisting and providing sustainable societal benefits including quality fishing opportunities.

Overarching Management Goal
Long-term persistence of Westslope Cutthroat Trout within its native range at abundance levels capable of providing sustainable benefits to society, within the context of broader ecosystem values.

5.1 Management Goal Rationale

Westslope Cutthroat Trout is identified as a priority native sport fish species by the BC Freshwater Fisheries Program. Healthy and persistent wild fish populations are necessary for achieving conservation goals and a sustainable fisheries program, which in turn provide social, economic, and recreational benefits to the province. Implicit in this management plan is that the conservation goal must be met first to achieve the recreational goal. (One success measure in the BC Freshwater Fisheries Program is that species at risk listing decisions decline as recovery plans achieve positive outcomes.) Thus this management goal aims to maintain wild populations' integrity and at abundance levels that will not only prevent this species from becoming more at-risk but allow this species to be considered not-at-risk by COSEWIC.

Available data provide some information on genetic integrity, abundance, habitat conditions, and angling characteristics; however, at this time species/population specific targets relating to genetic integrity and abundance to meet conservation and recreation objectives cannot be quantified. A prioritized list of recommended actions along with the necessary indicators, measures, and proposed targets to meet objectives are provided in this plan. Since the COSEWIC assessment in 2006, some trend data have been collected for several rivers that show increasing abundance trends and populations over proposed abundance targets. However, the major threat of genetic introgression appears to be increasing.

6 MANAGEMENT OBJECTIVES

The following are the management objectives:
1. maintain the native distribution and genetic diversity of populations;
2. maintain wild populations at abundance levels that prevent at-risk status assessment so that the populations can provide sustainable societal benefits;
3. maintain, or rehabilitate, the capacity of natural habitat to meet abundance targets for populations; and
4. optimize sustainable recreational benefits.

6.1 Summary of Indicators, Measures, and Targets, and Status of Management Objectives

Table 2 summarizes these management objectives and associated suites of indicators, measures, and targets considered appropriate to track our success in meeting objectives for WCT as well as the status of meeting these targets. Justifications for the selection of these targets follow in Section 6.2. Details on the status of meeting these targets as they relate to the suite of indicators are provided in Sections 7.1–7.4.

Table 2. Summary of available indicators, measures, targets, and status of meeting targets for each management objective.

Objective	Indicator	Measure	Target[a]	Status - Meeting target?
1. Maintain the native distribution and genetic diversity of populations	Distribution	Proportion of native range occupied	Presence in a minimum of 80% of historic native range	YES - assumed, but does not consider genetic integrity
	Genetic integrity	Introgression	< 10% of each population group are introgressed at levels > 1%	NO - based on limited survey work
2. Maintain wild populations at abundance levels that prevent at-risk status assessment so that the populations can provide sustainable societal benefits	Abundance in wild populations[b]	Total adult abundance by population	Minimum of 80% of populations at adult abundance levels > 0.4 $N_{equilibrium}$	UNKNOWN - no appropriate metrics available
	Angling mortality	Mortality related to catch and release angling before maturity in exploited populations	< 5% catch and release related mortality in exploited populations	UNKNOWN - significance of catch and release and harvest mortality unknown
3. Maintain, or rehabilitate, the capacity of natural habitat to meet abundance targets for populations	Riparian habitat	Total stream length with undisturbed and wind-firm riparian buffers	A high proportion of stream length is undisturbed	UNKNOWN - needs detailed watershed level assessment

Objective	Indicator	Measure	Target[a]	Status - Meeting target?
	Water availability	Proportion of streams meeting or exceeding minimum flow needs	A high proportion (~80%) of streams meet minimum flow requirements	VARIED - depending on Population Group but some info missing
	Road density	Road density by watershed area (km/km^2)	Road density by watershed area is 0.4 km/km^2 or less	NO - in all Population Groups, target exceeded but more in-depth analysis required
	Habitat access	Abundance of human-made stream crossings believed to create fish passage problems	Reduced number and severity of barriers (relative to current baseline)	NO – at level of assessment considered, but could use more detailed information
	Water quality	Deleterious substances	WCT streams meeting/exceeding Water Quality guidelines for deleterious substances	VARIED - depends on criterion being measured, needs more info
4. Optimize sustainable recreational benefits	Fishing quality	Proportion of anglers rating fishing experience as "good" or "excellent"	Crowding index as negotiated in current angling management plan (B.C. Ministry of Environment 2006)	PROBABLY - but metrics need review

Objective	Indicator	Measure	Target[a]	Status - Meeting target?
	Effort	Catch per unit effort (CPUE)	River specific (e.g., 1–1.4 fish per rod-hour)	YES - in Classified Waters considered, but not particularly defensible
	Fish size	Length	More large fish	YES - in the few Classified Waters systems considered
	Harvest	Availability of harvestable fish	Sustainable harvest is maintained	UKNOWN - opportunities persist, but biologically defensible thresholds unknown
	Angling regulation compliance	Proportion of anglers in compliance with regulations	< 10% non-compliance	NO – exceeded for Classified Waters, unknown elsewhere
	Valuation	License sales	Increase in valuations associated with the fishery	UNKNOWN - analysis not conducted

[a] Unless explicitly stated, target applies to Population Group level (see Section 4.2.2).
[b] Should consider exploited and unexploited (i.e., headwater), isolated populations separately.

6.2 Targets and Justifications for Management Objectives

Objective 1. Maintain the native distribution and genetic diversity of populations

Targets:
1. Self-sustaining wild populations occur in a minimum of 80% of each population group's historic native range.
2. Less than 10% of all populations are introgressed at levels > 1%.[6]

Justification:
The long-term persistence of a species depends on the spatial distribution of populations,[7] their genetic composition, the movement of individuals among populations, and the physical and biological factors within their immediate environments that influence population abundances. Implicit in the distribution target is that genetic and phenotypic (i.e., life history) diversity are retained. We assume that for the most part the current range approximates the historic, post-glacial native range except in cases where obvious habitat losses have occurred (e.g., migration barriers, lake conversion to tailings pond), but this can be informed with further investigation similar to Prince (2001), and gathering of aboriginal traditional knowledge (ATK). A target of 80% occupancy is somewhat arbitrary but represents a reasonable interim target for this objective, particularly as the historic distribution cannot be determined with certainty, and should avoid a declining distribution, which could contribute to a COSEWIC at-risk assessment (COSEWIC 2010).

The degree to which populations are physically connected influences gene flow (i.e., via exchange or migration of individuals) among populations. When physical connectivity is reduced or eliminated, populations may become fragmented into small, genetically and physically isolated subpopulations that are more vulnerable to local extinction through stochastic events (due to reduced or no recolonization potential) and inbreeding. Loss of migratory life history types will also result, further eroding resistance to extinction. On the other hand, increasing physical connectivity beyond what naturally occurs is not necessarily beneficial as it can result in increased levels of migration and gene flow among populations, resulting in the loss of local adaptive traits (including co-evolved gene complexes) and, in some cases, increased hybrid presence. Life history variability maintains adaptive options under different environmental conditions to increase the likelihood of survival within population and as a species, allowing higher exploitation of different niches and contributing to spatial diversity.

Current hatchery programs do not contribute to this objective (i.e., they primarily support objective 4). In fact, hatchery practices can create challenges to achieving Objective 1 in some situations, and hybridization and competition with invasive fish species were the foremost reasons for the recent COSEWIC assessment and SARA designation of Special Concern. To maintain the genetic integrity and associated unique characteristics associated with distinct

[6] As recommended in Allendorf *et al*. (2004).
[7] For the purpose of the management plan, a population is defined as an interbreeding, demographically similar group of individuals reproductively isolated from other such groups by time and/or space.

populations within the species (including species-specific behaviour adapted to the extreme conditions they may be exposed to), protecting wild, non-introgressed WCT is of the upmost importance. Those populations containing significant levels (i.e., > 1%) of introgression with other salmonid species may pose a threat to pure populations (where inter-breeding is possible) although they may be of some conservation value under a scenario where no or few pure populations remain. In particular, WCT appear to be particularly vulnerable to introgression with Rainbow Trout in watersheds outside of the native range of Rainbow Trout where the two species have not co-evolved or developed mechanisms to minimize inter-breeding. The maintenance of genetically pure WCT populations is not just a philosophical argument; hybridization between WCT and non-native trout can result in outbreeding depression and the loss of co-adapted gene complexes, leading to the loss of local adaptations (Barton and Hewitt 1989). A recent study indicates that even low levels of hybridization between WCT and Rainbow Trout that are only detectable via genetic testing (i.e., no morphological differences apparent) can result in markedly reduced reproductive success; at 20% admixture, there was a 50% decrease in reproductive success (Muhlfeld *et al*. 2009). This study suggests that protecting populations with even low levels of admixture could facilitate further expansion of hybridization. Hybridization also interferes with homing behaviour and increases straying rates, further homogenizing populations (Boyer *et al*. 2008).

Objective 2. Maintain wild populations at abundance levels that prevent at-risk status assessment so that the populations can provide sustainable societal benefits

Targets:

1. 80% of exploited wild populations in each population group are at adult abundance levels greater than $0.4 \cdot N_{equilibrium}$[8] averaged over a one-generation time interval where one generation is about 10 years.
2. 80% of unexploited isolated headwater populations persist at adult abundance levels greater than $0.4 \cdot N_{equilibrium.}$[9]
3. Angling mortality of exploited populations is < 5% before maturity.

Justification:

Indicators associated with abundance enable fisheries managers to: (1) evaluate the capacity of the particular system to support fisheries and thus the ability to establish targets; and (2) track trends in conservation status to report out to the public and to assist with setting regulations. We propose to manage WCT populations using an abundance-based precautionary management framework in which a series of abundance thresholds and control rules guide changes in

[8] $N_{equilibrium}$ has been proposed to be ≈ 45 fish > 30 cm fork length per km for large, productive streams but it is not clear if any single target can be selected given variability observed even within Classified Waters (e.g., Michel vs. St. Mary vs. Elk).

[9] The goal of $0.2N_{equilibrium}$ for headwater populations was originally selected because the management goal for these stocks is assumed to be persistence rather than the ability to sustain a fishery. For small populations in situations where there are no management controls to influence the population trajectory (other than habitat protection) and natural variability may be high, it may not be realistic to define management goals as high proportions of an equilibrium abundance because we would have no effective way of increasing abundance. However, we decided that the goal should be higher because while we will not permit human-caused mortality, we will not have many options to achieve it if the population is below the target.

management actions. These actions are designed to maintain a population (and population group) at or near a desired target abundance level that can provide sustainable societal benefits with little risk of severe population decline and associated at-risk conservation determinations (COSEWIC, SARA, or British Columbia Red or Blue list). The framework uses three abundance thresholds to define abundance ranges within which management objectives and management actions differ. Stock assessment standards and tools will be required to evaluate the status of populations from the perspective of the targets described above. Refer to Appendix 2 for a detailed description outlining the framework and derivation of abundance targets.

Mortality is also a useful indicator as it helps explain the mechanism of decline; this, of course, assumes that we can control fishing mortality. Two types of mortality may be associated with WCT fisheries: hooking mortality associated with catch and release zones, and harvest mortality.

Objective 3. Maintain, or rehabilitate, the capacity of natural habitat to meet abundance targets for populations

Targets:

1. A high proportion of stream length has undisturbed and wind-firm riparian buffers.
2. A high proportion of streams meets minimum flow requirements.
3. Road density by watershed area is 0.4 km/km^2 or less.[10]
4. The number and severity of human-made barriers to fish movement such as culverts and dewatering events decreases significantly.
5. WCT streams meet B.C. Water Quality Guidelines for key deleterious substances.

Justification:

The quantitative relationships between both local and landscape-scale habitat characteristics and the capacity of stream ecosystems to maintain productive populations of WCT are uncertain, although the qualitative linkages are well known. The interim targets listed above are based on professional judgment and relate to the general health of aquatic ecosystems, with WCT being a focal element of those ecosystems. The interim targets may be modified by the requirements of higher-level regional land and resource use plans or by improved information. These objectives should all apply at the defined Population Group level (defined in next section).

The general intent of this objective is to maintain the productive capacity of relatively undisturbed streams to produce WCT by ensuring suitable habitat is maintained and accessible (i.e., not fragmented), supported by adequate water flows and water quality (e.g., selenium is maintained below recommended levels). There may also be limited opportunities available to increase the productive capacity of degraded streams. The B.C Ministry of Environment provides relevant water quality guidelines (criteria) and waterbody specific objectives (B.C Ministry of Environment 2013).

[10] As recommended in Stalberg *et al.* (2009).

Objective 4. Optimize sustainable recreational benefits[11]

Targets:
1. Current angling quality standards[12] established in the Angling Management Plan for Kootenay Quality Waters (B.C. Ministry of Environment 2006) are maintained or improved for crowding index.
2. Catch is stable or improving.
3. Average fish size for Classified Waters is stable or increasing.
4. Harvest opportunities are maintained where sustainable.
5. Non-compliance with angling regulations on Classified Waters is < 10%.
6. Valuations associated with the fishery increase.

Justification:
This management plan defers to the fishing quality targets negotiated in the East Kootenay Angling Management Plan (B.C. Ministry of Environment 2006) for the seven rivers identified as East Kootenay Quality Waters. These include legally mandated caps on total angler days, as well as guided angler days and guide allocations, mainly in response to overcrowding concerns.

We consider a number of factors indicative of our ability to optimize recreational opportunities that are considered sustainable. Once conservation objectives are met, we intend to maintain angling quality and client satisfaction, as well a diversity of recreational opportunities. Fishing quality is also a function of compliance. Efforts to increase valuation of the fishery should not only focus on increasing license sales but also on increasing public appreciation of the resource and support of management decisions.

7 STATUS OF MEETING MANAGEMENT OBJECTIVES

The following section describe the status of meeting the management objectives as they relate to the suite of indicators identified in Table 2 for WCT based on whether the targets are being met. Discussion is limited to a brief overview of information available, status (to the extent possible based on available data), and information gaps (refer to appendices for more detailed information). See Recommended Management Actions and Priorities (Section 9.3) as to the priorities and extent to which these knowledge gaps will be addressed.

[11] Implicit with this objective is that we have already considered First Nations traditional use requirements.
[12] An average CPUE of 1.0–1.4 fish per rod-hour for Classified Waters was proposed based on observed CPUE values where fishing was considered excellent. However, these values may be too high for some systems.

7.1 Objective 1. Maintain the Native Distribution and Genetic Diversity of Populations

7.1.1 Distribution

Overview – The native range of WCT in B.C. is concentrated along the western slope of the Rocky Mountains, but limited to the southeastern portion of the province (McPhail 2007). At present, the data determining the extent to which WCT still occupy their original native range within B.C. are limited to the observations captured in the provincial FISS (Fisheries Information Summary System) database and population-specific studies where they occur.

Status – The current status of WCT in B.C. is thought to persist throughout their historical range in all major watersheds of core and peripheral areas in B.C. However, this status is complicated by two main factors:

a) The extensive stocking history of WCT in the province makes it difficult to determine whether some occurrences represent historical distribution or introductions particularly in the peripheral range; and
b) Hybridization with introduced, non-native Rainbow Trout has been documented in B.C. and will reduce the distribution of WCT populations that are still genetically pure (see Section 7.1.2 Genetic Integrity). The extent to which this reduction has occurred, and will continue to occur, is difficult to quantify given limited genetic analyses. However, preliminary modeling suggests that reductions may continue as long as a source of RBT is available and can access WCT populations (Bennett 2007).

Information Gaps – The biggest information gap at this broad level is the lack of clarity as to the extent to which native range has been reduced by hybridization leading to introgression and the loss of genetically pure WCT populations. The section on Genetic Integrity (Section 7.1.2) addresses this to some extent, but given the limited screening of populations (N = 88 waterbodies) and lack of consistent molecular markers applied, some spatial gaps in information exist. It would be valuable to identify genetically pure populations for conservation prioritization purposes. Another uncertainty is the extent to which populations in the peripheral range can be considered viable.

7.1.2 Genetic Integrity

Overview – While hybrid assessments of WCT populations in B.C. have not been extensive, they provide some indication of how significant the problem might be and suggest "hot spots" for further spread of hybridization. The main sources of molecular genetic data are provided by Bennett (2007), Muhlfeld (unpublished data), Boyer *et al*. (2008), and Parks Canada (Shelley Humphries, unpublished data). For more detail, refer to Appendix 4, Introgression.

Status – A total of 114 sites representing 88 waterbodies (both streams and lakes) were assessed for hybrid presence (Figure 3). What is immediately obvious is the extensive degree of hybridization occurring in two of the four central Population Groups, namely the Elk and Upper Kootenay Population Groups. In particular, it appears that any WCT-inhabited waters accessible

from the Kookanusa Reservoir (i.e., in the lower portions of tributaries below barriers) contain significant levels of Rainbow Trout genes. Three additional "hotspots" for hybrids include (1) lower and mid-sections of tributaries in the lower Elk River above Elko Dam (i.e., Michel Creek area); (2) streams (e.g., White River) near Whiteswan Lake in the Upper Kootenay group; and (3), to a slightly lesser degree, upstream tributaries of Kootenay National Park in the Upper Kootenay group.

For planning purposes, note that the level of hybridization is not static and may require different management responses depending on the rate and direction of hybridization. The Kookanusa Reservoir appears to have an established Rainbow Trout population, providing an ongoing source of Rainbow Trout genes. The result is ongoing upstream movement of Rainbow Trout genes, likely associated with higher straying rates of hybrids. Without eliminating the Rainbow Trout source, expansion is expected to continue. At Whiteswan Lake, Rainbow Trout have successfully evaded containment in the lake, with spawning rainbow WCT hybrids found downstream (Heidt 2007, 2009). In contrast, there is no naturalized Rainbow Trout population associated with Michel Creek area and movement of Rainbow Trout genes is primarily downstream. Rainbow Trout genes are expected to become increasingly diluted in time and there is evidence that F_1s and F_2s are decreasing with pure WCT numbers not declining (P. Corbett, pers. comm., 2010). Kootenay National Park has a few hybrid populations but very few pure Rainbow Trout sources. In contrast, Yoho National Park has well-established Rainbow Trout populations in several lakes with no WCT evident.

The Canadian portion of the Flathead group appears to remain a stronghold for pure WCT; however, south of the international border, hybridized populations are scattered throughout the lower portions of the Flathead River and its tributaries (Boyer *et al.* 2008). It is not clear if some environmental factors (e.g., temperature) prevent further northward spread of hybrids into the B.C. portion (as there are no obvious physical barriers) or if it is a matter of time before this occurs. Survey work has been too limited to draw conclusions about the status of peripheral Population Groups.

In conclusion, for the central Population Groups where WCT distribution is concentrated, only the Flathead was within target of 10% hybrid populations; Elk and Upper Kootenay both exceeded this value significantly (for stream counts, refer to Table A5.1 in Appendix 5, Abundance). Across all sites considered (N = -113 in 88 waterbodies), only 61.4% contained pure WCT populations.

Information Gaps – Only a small portion of all WCT-containing watersheds have been evaluated for the presence of hybrids; whether this is representative of the issue throughout B.C. is unknown. Particularly in peripheral range, it is not clear if the absence of hybrids is an artifact of limited sampling or truly reflects the current status. A proper hybrid assessment would require the application of a standard set of appropriate molecular genetic markers across B.C. (E. Taylor, pers. comm., 2010); this has not been done.

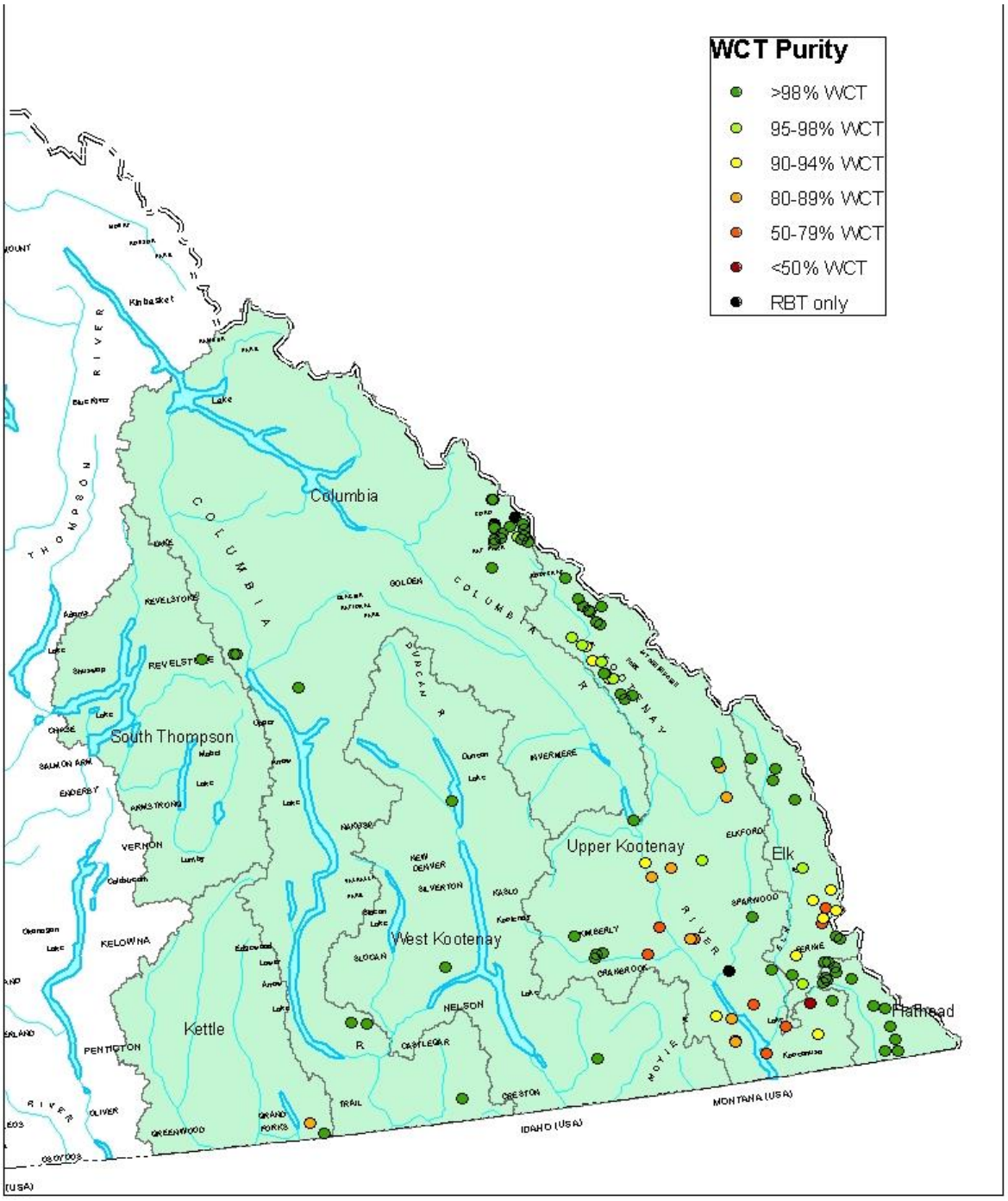

Figure 3. Distribution of hybridized WCT populations in southeast B.C. watersheds.
Note that percent values indicate percent WCT genotypes present. RBT = only Rainbow Trout observed, no WCT. Other genotypes include hybrids (F_1s, F_2s), backcrosses, and unknowns.

7.2 Objective 2. Maintain wild populations at abundance levels that prevent at-risk status assessment so that the populations can provide sustainable societal benefits

7.2.1 Abundance in Wild Populations

Overview – Information on population abundance is extremely limited for WCT in B.C. Some short-term monitoring has been undertaken in the East Kootenays in an attempt to estimate abundance in some high priority streams. However, these values cannot be compared against a target value; at best, they may be useful to monitor trends with no established reference points.

Status – Abundance and density data have been collected for a very few high priority WCT streams in the Upper Kootenay and Elk Population Groups including the Elk mainstem, Wigwam, Michel, St. Mary, and Bull rivers. Estimates tend to reflect higher abundance and densities in the warmer, more productive sections of the rivers, and the presence of large fish in all cases, but it is difficult to evaluate the status of these populations. If we assume that 45 fish > 30 cm/km (from systems that are almost entirely catch and release; Hagen and Baxter 2009) approximates the unfished equilibrium abundance $N_{equilibrium}$ for large productive systems, application of $0.4N_{equilibrium}$ as the target for large productive systems results in a numerical target of about 18 fish > 30 cm/km in fished populations. In 2008 and 2010 surveys, Michel Creek, Elk, Upper Bull, Wigwam, and lower St. Mary rivers exceeded this target; White River did not. However, we would expect if catch and release resulted in insignificant mortality then the fish densities observed should represent $N_{equilibrium}$, thus estimates in these systems should actually be for $N_{equilibrium}$. Clearly, this requires resolution. For more detail, refer to Appendix 5, Abundance.

Trend data are available for only two rivers, the Wigwam and St. Mary. These trends are mostly linked with changes in regulations with a general improvement in catch per unit effort (CPUE) since the implementation of more conservative regulations. Similarly, the increased presence of large fish in recent years indicates a positive response to more conservative regulations. No studies have attempted to determine minimum or target abundance or density values. Furthermore, headwater fluvial populations have not been assessed at all. For more detail, refer to Appendix 5, Abundance.

Information Gaps – There are no metrics of abundance for WCT that consider a target, only scattered surveys of adults from a few priority WCT systems that are not calibrated against the carrying capacity of the system. It is not clear if these locations are representative of the situation throughout the WCT range. The application of a single target across a broad range of habitats where capacities could vary to some degree may also not be appropriate. Estimates of abundance are difficult and costly to generate; given this, we need to determine if we should focus on estimators of abundance (e.g., fish per kilometre) or on an alternative option like mortality (i.e., catch and release related mortality) to assess impact of fishery on abundance (see Angling Mortality, next section).

7.2.2 Angling Mortality

Overview – WCT are highly vulnerable to overexploitation. Regulations for WCT in the East Kootenays have become increasingly restrictive in response to reduced CPUEs in the early 1990s with a strong positive response in CPUEs. Post-hooking mortality for catch and release WCT fisheries on Classified Waters is assumed to be 5–10% but this remains to be rigorously tested (Heidt 2010). Some concerns for fish survival have been expressed where catch and release regulations are in place, as well as for incidental catch in winter fisheries.

Status – Angling pressure is increasing in a number of Classified Waters (Tepper 2008b). Heidt (2003) estimated that 92,635 WCT had been angled from Sparwood to Elko in the Elk River in 2002; undoubtedly, many of these fish represent recaptured fish. Even with relatively low angling mortality rate (typically 3–5% estimated per capture) and apparent high catch and release rate (99.8%; Heidt 2003), injury and mortality from catch and release angling could be significant (26–94% of WCT > 400 mm long observed to have injuries consistent with hooking; see Appendix 6), on the total number of fish captured within one season or across multiple seasons. Recent snorkel surveys have also documented increasing frequency of angling-related injuries as fish get bigger; mortality may also be increasing as stream size decreases and fish vulnerability increases (Hagen and Baxter 2009). In addition, WCT in overwintering habitats are highly vulnerable, and an increase in WCT numbers has been observed recently during winter fisheries (Heidt, unpublished data). Angler surveys in 2009 and 2010 during these fisheries suggest that most anglers are targeting Bull Trout even though up to 55% of catch was composed of WCT (Heidt, unpublished data). For more detail, refer to Appendix 6, Angling mortality.

Information Gaps – It is unclear how significant angling-related mortalities are for WCT persistence at the population level. The current angling restrictions for WCT are considered conservative but are mainly to provide angler satisfaction rather than meet abundance targets although conservation needs still are assumed to be met. The following questions remain: (1) Is catch and release related mortality too high in streams where fish are recaptured numerous times within a season? (2) Are there other factors like temperature that may increase mortality rates beyond an acceptable level? (3) What are the best options to reduce mortality? (4) While river fisheries appear to be 99% catch and release in Classified Waters even where harvest is permitted, how much mortality do these same adfluvial populations endure during winter bait fisheries where harvest is permitted? Given that harvest is still important to some anglers (i.e., mandatory catch and release throughout the region is not a palatable option), it is important to understand the significance of harvest rates.

7.3 Objective 3. Maintain, or Rehabilitate, the Capacity of Natural Habitat to Meet Abundance Targets for Populations

7.3.1 Riparian Habitat

Overview – A number of land use activities have the potential to degrade riparian habitat buffers within the range of WCT populations including mining, urban development, agriculture, and forestry, as well as roads and railways (Oliver 2009). The challenge is to evaluate the extent to which existing and past activities have altered these habitats. Ideally, each WCT watershed

would be examined to determine how much riparian habitat remains intact; this would be a hugely onerous task and not currently possible although application of remote tools (e.g., satellite imagery) may be of assistance. Available information to evaluate this indicator is very limited.

Status – No particular activity has had wide-ranging impacts to riparian habitats within the WCT range in B.C. Cumulatively, the combined alterations associated with forestry, agriculture, road and rail crossings, mining, and urban development have undoubtedly compromised the riparian buffers for some smaller WCT streams particularly in the upper Columbia, Elk, and Upper Kootenay (southern portion) Population Groups. The extent to which this has occurred is not available. For sector-by-sector breakdown, refer to Appendix 7, Riparian habitat buffers.

Information Gaps – Without a detailed watershed-level analysis of land use and associated impacts to riparian habitats, it is impossible to quantify the amount of intact riparian habitat by stream length. In particular, sensitivities to forestry have only been conducted for a fraction of the watersheds within WCT range, and it is not clear to what extent cattle are able to access streams, particularly in smaller streams. Furthermore, there appears to be some question as to whether there are ongoing riparian impacts associated with forestry, or if the impacts are largely residual based on impacts to small streams that occurred before the Forest Practices Code, which was enabled in 1996.

7.3.2 Water Availability

Overview – A recent analysis of natural flow sensitivity was conducted at the ecosection level, which included the range of WCT in B.C. (Ptolemy 2010). This assessment used water gauge data from specific streams within the region to calculate percent mean annual discharge at various times of the year. Results were then used to characterize each ecosection for natural flow sensitivity. For more detail, refer to Appendix 8, Natural flow conditions.

Status – WCT streams within the key range with potential flow sensitivity concerns are concentrated in the Southern Rocky Mountain Trench (i.e., the southern portion of the Upper Kootenay Population Group), and particularly for the East Kootenay Trench and McGillivary Range ecosections (Ptolemy 2010). Lowest baseflows actually occur during winter months, affecting winter survivorship of WCT. Outside of this key range, similar concerns also exist for tributaries of the lower Columbia and lower Kootenay rivers, as well as Kettle River (see Figure 4).

The Flathead and Elk Population Groups are generally not susceptible to drought conditions, similar to the upper portion of the Upper Kootenay Population Group, which occurs in the Rocky Mountains and receives adequate flows in general. In terms of meeting the interim target of 80% of streams meeting minimum flows, information is limited to the streams that are monitored. Specific failures to provide adequate fish flows have been reported for two creeks (Wolfe and Joseph creeks). Refer to Threats Assessment (Section 8.3) on water use for more details.

Information Gaps – Minimum fish flow needs for WCT will vary according to stream and season. In particular, spawning, rearing/overwintering, and passage requirements will undoubtedly differ; these have yet to be defined for WCT. Another remaining gap is the analysis

of existing baseflow data on a stream-specific basis in terms of current water allocation (R. Ptolemy, pers. comm., 2010). Natural baseflows may already be below minimum fish flow needs in some cases. Finally, the relationship between groundwater and surface flows remains unknown.

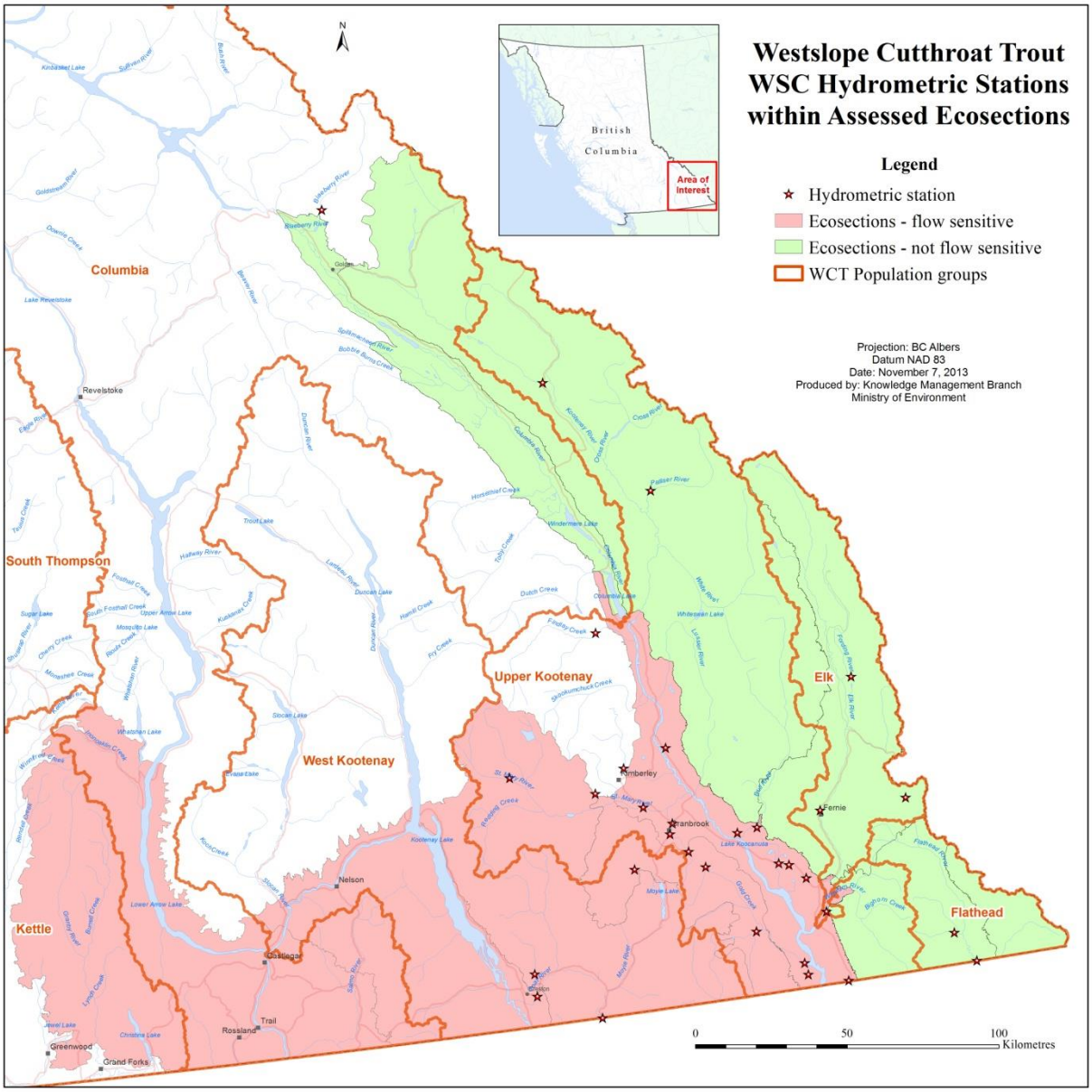

Figure 4. Landscape-level assessment of flow sensitivity in different ecosections within assessed ecosections within the native range of WCT in B.C.

7.3.3 Road Density

Overview – Roads have been identified since road density has been negatively related to Pacific salmon (Bradford and Irvine 2000) and WCT abundance (Valdal and Quinn 2010). Road data are

currently available in two databases: the digital road atlas, which includes most road developments in the province and most forestry roads; and the forestry roads, both available in the Land and Resource Data Warehouse (LRDW). As the digital road atlas provides a more complete coverage of all roads (though some forestry roads are not connected), a road density analysis was limited to these data.

Status – Based on a target value of 0.4 km/km^2 (Stalberg *et al.* 2009), every Population Group exceeds the target significantly, suggesting even at this very broad level that we might expect to see a higher risk of negative effects to habitat (Table 3). The distribution of roads within the various groups will undoubtedly depend to some degree on topography, as well as development.

Table 3. Summary of road density by Population Group.

Population Group	Watershed group area (km^2)	Road length (km)	Road density (km/km^2)
Elk	3,565	4,406	1.24
Flathead	1,579	1,634	1.03
Upper Kootenay	16,566	18,122	1.09
West Kootenay	17,563	15,373	0.88
Columbia	36,707	27,798	0.76
Kettle	8,165	13,776	1.69
South Thompson	10,483	13,049	1.24

[a] Analysis provided by Byron Woods.
[b] Road data were derived from provincial digital road atlas (WHSE_BASEMAPPING.DRA_DIGITAL_ROAD_ATLAS_LINE_SP).

Information Gaps – This analysis was conducted at a very broad scale considering groups of watersheds rather than individual (e.g., third-order) watersheds. A more detailed watershed-by-watershed assessment may better focus where the greatest risks occur. This also does not consider where in the watershed WCT are distributed or the types of roads (paved, unpaved) involved.

7.3.4 Habitat Access

Overview – Natural migration corridors enable WCT populations to access a breadth of habitats necessary to support the various life stages although migratory distances will vary according to life history type and habitat availability (Appendix 9, Site fidelity). Loss of connectivity reduces resilience in several ways: it increases threat of extinction associated with stochastic events; it prevents natural recolonization should local extirpation occur; it results in the loss of life history variation (i.e., only headwater fluvial populations persist); and it increases small-population issues like inbreeding and loss of variability. The number of stream crossings within each WCT Population Group is staggering; however, these crossings vary greatly in form (open-bottom structure to small enclosed culvert), which will influence their ability to pass fish (Figure 5). The actual number of crossings that have been assessed from a fish passage perspective is limited to less than 5% (C. Mount, pers. comm., 2011).

Status – Relative to populations in other jurisdictions (e.g., Shepard *et al.* 1997), some studies suggest that WCT in B.C. have experienced much less habitat fragmentation and destruction at a broad level. For the most part, they continue to persist as interconnected populations throughout much of their core range in the Upper Kootenay drainage (Hagen and Baxter 2009). This is probably the case for Flathead and Elk populations as well. In fact, a radio-tagging study conducted in the Elk River demonstrated that large adult WCT (i.e., FL > 330 mm) are able to ascend barriers 2 m high (e.g., cascade falls, beaver dams) under low and high water conditions (Westslope Fisheries Ltd. 2003). Clearly, numerous major hydro-electric dam developments on the Columbia, Lower Kootenay, and Pend d'Oreille mainstems have altered the degree to which tributaries can maintain connectivity. However, at least in the Columbia Population Group, it is not clear how broadly distributed WCT may have been before the dams. These rivers all contain native populations of Rainbow Trout. It is possible that the WCT in these regions may already have been naturally restricted to colder headwater tributaries as Rainbow Trout recolonized mainstems and lower, warm sections of tributaries.

That being said, a recent GIS-based modeling exercise (see Appendix 10, Stream crossings) estimated that a total of 69,131 stream crossings associated with forestry roads occured within the WCT range, of which about two-thirds (42,483) of these are modelled to be on fish habitat (C. Mount, unpublished data). A total of 2017 (< 5%) of these crossings have been assessed on the ground for fish passage problems (excludes Flathead and Elk Population Groups where no assessments have been conducted), about half of which are closed-bottom structures that are more likely to be barriers than open-bottom structures (C. Mount, pers. comm., 2011). Closed-bottom structures in the form of round culverts had significantly higher rates of failure, approaching or surpassing 50% in all Population Groups in which they were assessed. For the most part, all other structures had 0% failure rates to provide passage. Although this analysis needs further resolution in terms of its representation of the overall issue, it does suggest that stream crossing associated with culverts could represent a signficant problem for migratory populations.

Information Gaps – This recent analysis is the first of its kind to undertake a landscape-level assessment of barriers to fish movement for WCT. The results should be unbiased in terms of representation (C. Mount, pers. comm., 2011). Thus, extrapolation of the results suggests that barriers associated with road crossings may be a much larger habitat threat than previously known. A key next step would be a more detailed GIS-based analysis to determine highest priority barriers where removal would enable access to significant lengths of stream. As mentioned, this analysis was limited to forestry road crossings. It is impossible to gauge the extent to which fish passage associated with road and rail crossings is a concern for the various Population Groups. However, this issue should be investigated particularly along the floodplains of the Elk, Kootenay, and Columbia rivers (Oliver 2009).

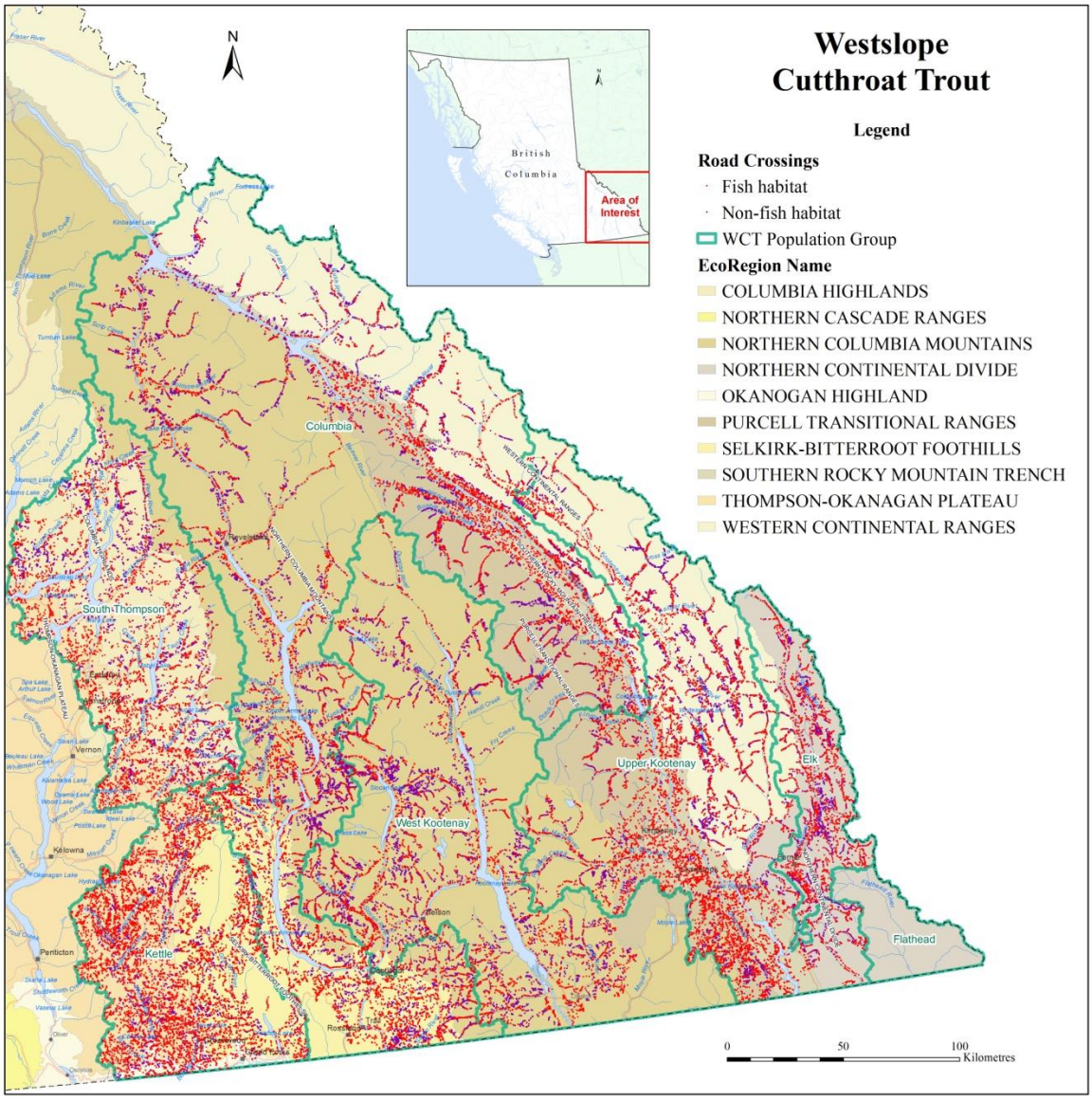

Figure 5. Known stream crossings based on intercept analysis of road/rail x stream, within the WCT range in B.C. Crossings differentiated according to stream sections identified as fish-bearing or non-fish-bearing.

7.3.5 Water Quality

Overview – Coal mining, urban runoff, and agriculture are associated with elevated levels of several chemical contaminants including selenium, calcite, and nitrogen. Some chemicals related to nutrient loading may be considered either positive or negative depending on the system; however, others are considered deleterious substances.

Status – Michel Creek drainage actually appears to have benefited from elevated levels of nitrogen in combination with naturally high background concentrations of phosphorus; increased

benthic productivity has improved food resources for foraging WCT, which has downstream effects on WCT in the mainstem Elk River as well (Oliver 2009).

Elevated selenium (Se) levels in Fording River associated with coal extraction continue to be a concern although a recently convened panel of experts could not agree on whether population-level effects for WCT have or will occur in the Elk Valley (Oliver 2009). Levels will continue to be monitored, but the response has been to minimize selenium input rather than trying to establish cause and effect. Finally, the deposition of leached minerals like calcite downstream of some rock drain facilities associated with coal mining in the Elk Valley represents a potential loss of fish habitat. Specifically, these minerals cement loose river bottom gravel, essentially infilling all interstitial spaces (D. Martin, pers. comm., 2011).

Information Gaps – We still do not know how great an impact selenium may have on WCT populations in the Elk River, or on fish growth, reproduction, and survival in general. The deposition of minerals resulting in the calcification of river gravel is a potentially growing concern in the Elk Valley but it is not clear how water chemistry influences the extent of depositions or the amount of fish habitat.

7.4 Objective 4. Optimize Sustainable Recreational Benefits

7.4.1 Fishing Quality

Overview – Once the conservation Objectives (#1–3) are met, there should be substantial recreational opportunities to be optimized consistent with the Fisheries Program Plan. Fishing pressure for WCT in B.C. appears to have increased significantly in recent years, partly in response to rebuilding stocks and partly due to expanding human development in the region (B.C. Ministry of Environment 2006). Guides and regional fisheries biologists have observed degradation in the quality of angling experience or expect to see it due to high fishing pressure on some streams (EKAMPC 2003; Hagen and Baxter 2009).

Status – In response to perceived or expected degradation of the angling experience, seven streams in the East Kootenay Region were designated as Classified Waters in 2005–2006 with special management regimes including: the upper Kootenay River, White River, Elk River, Wigwam River, Bull River, St. Mary River, and Skookumchuck Creek. Regulatory changes were implemented to address overcrowding concerns. Angler day quota limits were established for each Classified Water by the Angling Management Plan Committee (B.C. Ministry of Environment 2006), with quotas allocated among eligible guides. A number of other objectives and issues were identified throughout the process in a status report (B.C. Ministry of Environment 2006) but they were not implemented as part of the Angling Management Plan. Follow-up assessments were conducted by regional staff and the River Guardian program on these seven streams to evaluate quality. In summary, angling quality was considered good to excellent on 100% of these rivers but crowding appeared to be increasing in almost all cases, which may reduce quality in the future. The WCT management plan will defer to the Angling Management Plan process for all targets associated with crowding. However, as the East Kootenay Angling Management Plan is a living document, there is an opportunity to work within

the process the make revisions over time. For river-specific details, refer to Appendix 11, Fishing quality.

Information Gaps – Outside of the River Guardian Program, the quality of the angling experience on unclassified waters is not monitored and unknown.

7.4.2 Effort

Overview – A significant increase in angler days has been observed in response to improved fisheries, based on repeated creel surveys completed on selected waterbodies. Catch per unit effort (CPUE) has been used as an alternative metric of quality fisheries.

Status – Long-term CPUE trend data are available for only two WCT rivers in B.C., namely the Elk and St. Mary rivers. In both cases, historical estimates were well below the proposed target of 1.0–1.4 fish per rod-hour but recent estimates exceed this target (Table 4). CPUEs have been tracked over the past 5 years for the Bull, Michel, White (Elk), Skookumchuck, St. Mary, and Wigwam (East Kootenay) rivers. In all cases, the target is almost met or exceeded. However, for both the St. Mary and Wigwam rivers, a recent downward trend was also observed. For specific CPUEs, refer to Appendix 11, Fishing quality.

Information Gaps – The proposed 1.0–1.4 fish per rod-hour target is not based on a well-defined biological reference point but rather what appears to be associated with Quality Waters rivers considered "excellent quality." Given the variability of productivity capacity of WCT streams, even this target may be too high in some cases. The significance of angling-related mortality associated with increasing effort is unknown (see Objective 2). No CPUE information is available for unclassified rivers.

Table 4. Summary of WCT CPUE on Quality Waters where effort has been reported over time.

River	Date	Angler effort - days (hr)	Fish caught	CPUE (fish per hour)	% WCT released
Elk River (Elko Dam to Sparwood)	1982/83 (Martin 1983) - summer/fall	6,493 (6,686)	2,824	0.37	?
	1991 (Westover 1993) - 1.3 months	2,705	4,100	0.46	82.6
	2002 (Heidt 2003) - 4 months	10,719 (66,025)	98,031	1.48	99.7
Upper St. Mary River	1979 (Martin 1984) - July/August	? (5,000)	4,000	0.71	?
Lower St. Mary River	1992 (Heidt 2003) - July/August	? (4,421)	?	1.7 (not extrapolated)	?
Upper and Lower St. Mary	2003 (Heidt 2004) – July to September	2,469 (15,233)	28,694	1.88	99.6

7.4.3 Fish Size

Overview – Fish size has been reported in association with abundance estimates. While fish size contributes to the quality of the angling experience, it is also used as a crude estimator of population health, usually considered in connection with age structure.

Status – WCT usually recruit to the fishery at a fork length 300 mm. Oliver (2009) reported that 50% of fish captured for a tagging study in 2008 on the Elk River were > 300 mm in length. Similarly, estimates of numbers of fish exceeding 300 mm appear to have recently increased in the Wigwam River and the lower St. Mary River (although this river had historically higher estimates). However, it is not clear what quantitative targets should be set for quality fisheries. For more detail, refer to Appendix 11, Fishing quality.

Information Gaps – No quantitative target is available. Established targets should be in relation to size at age and size distribution.

7.4.4 Harvest

Overview – There is still strong support from a small sector of the recreational angling community for harvestable opportunities for WCT, once conservation goals are met.

Status – Harvest is limited to five trout per day with only one WCT over 50 cm in non-Classified Waters of the Kootenay management region. Limited harvest is permitted in some sections of Classified Waters; however, even in these sections, catch and release practices are estimated to be 99% (Heidt 2003, 2009). Harvest rate on non-Classified Waters is unknown.

Information Needs – It is impossible to determine what sustainable harvest levels are for any systems because there is no information on carrying capacity.

7.4.5 Angling Regulation Compliance

Overview – Status data for compliance regarding licensing and other regulations have only be collected for Classified Waters.

Status – For the seven Classified Waters, the River Guardian program encountered 17% non-compliance and 24% infractions (i.e., actual number of violations, which could be more than one per angler) based on interviews with 608 anglers in the summer and fall of 2008. This is considered high compared to the benchmark of 10% used by the Conservation Officer Service as a general provincial target for anglers (Tepper 2008b). Angling license infractions appeared to increase disproportionately from 2006 to 2008 compared to other infractions, although barbed hook concerns remain high. The highest rate of infractions occurred in non-resident Canadian angler group with lowest being from the United States. The highest infraction rates occurred on the Bull, Skookumchuck, and White systems (38%, 38%, and 35%, respectively), whereas the lowest occurred on the Elk (15%). This appears to be consistent over the past 3 years monitored (2006–2008). Compliance is related to the number of people fishing on the river, and the River Guardian program plays a key role in communicating the regulations to anglers.

Information Needs – There is no information regarding compliance in WCT waters outside of the Quality Waters program.

7.4.6 Valuation

Overview – This indicator speaks to maintaining benefits associated with generating license sales, a key driver of the provincial Fisheries Program. The focus of this indicator is on Classified Waters where most revenue for WCT is generated. However, valuation should also consider the "attraction" of the fisheries experience, which is much more difficult to quantify.

Status – Based on the 2005 Fishing Survey of Canada, the total number of angler days for the Kootenay region is 645,000. Allocated guided angler days are approximately 5,000 (for all species), but the actual used days are probably only 60–70% of this (J. Burrows, pers. comm., 2011). Thus, the total percentage of angler days represented by guided angler days is about 0.62% (J. Burrows, pers. comm., 2011). How this relates to the percent of total angler days specifically on Classified Waters is unknown.

With respect to license sales for Classified Waters in the East Kootenays, an analysis of Angler Management Plan (AMP) sales targets (B.C. Ministry of Environment 2006) versus counterfoil counts in 2005–2006 indicates that sales fell short of targets for 5 of the 7 Classified Waters; however, sales exceeded targets for both Wigwam and Elk rivers (Table 5).

In terms of actually monetary value of the WCT fishery, a 2005–2006 evaluation of license sales for Classified Waters (3,363 residents; 2,444 non-resident Canadian; 5,489 non-resident alien) plus angling guide rod day fees approximated $285,000 (J. Burrows, pers. comm., 2011). However, the 2005 federal angler survey indicated that direct expenditures per day (including license and other) were about $107 per angler. For out-of-province anglers, this equates to approximately $1 million while a conservative estimate for B.C. resident anglers (5 days each at about $20 per day) equals about $300,000. Thus, a reasonable estimate for 2005–2006 is $1.5 million but this does not include non-classified waters. Given that there are 40,000 to 50,000 active anglers in the Kootenay region, many of whom undoubtedly fish for WCT, a conservative total estimate is probably more than $2 million per year for WCT (J. Burrows, pers. comm., 2011).

Anecdotal information suggests that non-resident anglers value the WCT fisheries in the Kootenays, not only for the fish but also for the full "wilderness experience."

Information Gaps – It is very difficult to identify a measurable WCT-specific metric for this objective. It is not clear to what extent this objective can be assessed quantitatively.

Table 5. Comparison of license counterfoils with East Kootenay Angling Management Plan targets for Kootenay (B.C. Ministry of Environment 2006; Burrows 2007)

Watershed	Unguided non-resident AMP[a] target	Guided AMP target	Total target	2005–2006 Counterfoils
Bull River	600	500	1100	349
Elk River	3540	2950	6490	6740
Kootenay River	275	0	275	38
Skookumchuck Creek	180	150	330	260

Watershed	Unguided non-resident AMP[a] target	Guided AMP target	Total target	2005–2006 Counterfoils
St Mary River	1500	1250	2750	941
White River	425	0	425	71
Wigwam River	180	150	330	**1091**

[a] AMP: Angler Management Plan.

8 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational) (Salafsky *et al.* 2008). For purposes of threat assessment, only present and future threats are considered.[13] Threats do not include limiting factors which are presented in Section 4.3.[14]

Key threats to WCT are described in this section using categories found in Hatfield and Long (2010). With this approach, threat mechanism[15] and threat source (i.e., what is responsible for the threat) are recorded independently as proposed by Balmford *et al.* (2009). Section 8.2 details the threat assessment completed for each population group.

8.1 Threat Sources

The threats to WCT in B.C. associated with land use, water use, fishing, and hatchery stocking are summarized in Oliver (2009) and Costello (2007). Thus, the following is limited to a brief description of the threat sources to WCT following categories used by Hatfield and Long (2010).

8.1.1 Forest Harvest

Oliver (2009) compared equivalent clearcut areas (ECAs) to evaluate potential impacts of logging and related activities on WCT. He considered 50 WCT tributaries (large and small) of the upper Kootenay and Columbia rivers, although he acknowledged that these are limited in terms of representation of entire WCT range. He concluded that although harvest effects are variable in terms of changes to peak flow, harvesting has largely occurred within acceptable levels without producing large imbalances in hydrologic stability. Sensitivities may be most evident at the micro-scale (i.e., sub-basin) where disturbance to basin area ratios are bigger. Furthermore, he summarized the outcome of a study assessing fish habitat condition downstream associated with different riparian treatments upstream (Johnston 2001). Where riparian buffers

[13] Past threats may be recorded but are not used in the calculation of Threat Impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2009).
[14] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation; or likelihood of regeneration or recolonization for ecosystems).
[15] The mechanism is the process– often anthropogenic – that is having (or has had) a directly negative effect on the state of the conservation target (population, species, community, or ecosystem).

were provided, summer temperatures were not elevated. He indicates that practices have improved significantly over the past 30 years, and current operations are not perceived to be as detrimental as past practices. Impacts to riparian habitats are mostly residual based on practices before the implementation of the Forest Practices Code in 1996. The most significant impact related to forestry may be the road development and associated stream crossings (see discussion below on Linear Projects), as well as stream access for anglers. However, recent discussions indicate that some ongoing concerns persist particularly related to small WCT streams, salvage logging, ongoing sedimentation, and inadequate riparian buffers in the lower Columbia unit (C. Legebokow, pers. comm., 2010).

8.1.2 Mining

For the most part, mineral mines within the WCT range are small-scale operations and considered relatively benign from an environmental aspect; coal mining is by far the biggest mining concern in the region (Oliver 2009). Principal changes are physical and chemical in nature, involving fish passage, habitat loss, and water nutrification and contamination. Of particular concern in the Elk Valley is the link between coal extraction and selenium introduction into the aquatic environment. Selenium has been linked with defects in reproduction and growth, as well as mortality and deformity in WCT (summarized in Oliver 2009). However, studies in the Elk Valley have been inconclusive in terms of population-level impacts to WCT, and the issue remains unresolved. In general, potential impacts may range from localized habitat losses (e.g., rock drain construction, mine footprint) to downstream concerns associated with water quality. The Population Group with the greatest ongoing concern of these threats is in the Elk Valley, due to elevated selenium levels.

8.1.3 Linear Projects

Roads may impact WCT populations in two ways: they increase access to vulnerable populations and they can interrupt fish passage at stream crossings. The issue is mainly historic in nature; new road development is sensitive to fish passage and standards have been developed to minimize impacts (Oliver 2009). However, a number of railway crossings (e.g., in the Elk Valley) that have been in place for years may be problematic. Although a few examples are known (e.g., Dalzell Creek in the Elk Valley), the extent to which crossings may impact WCT passage remains unknown. A recent analysis indicates that up to 50% or more of culverts assessed in the region would likely present a fish barrier (C. Mount, unpublished data).

Valdal and Quinn (2010) identified an additional factor, namely road density, which may be an indicator of WCT abundance although this is complicated by potentially cumulative effects of development activity type. Specifically, a significant negative relationship was observed between WCT density and cumulative effects of forestry-related activities as measured by road density, roads on erodible soils, roads within near-stream zones, and two measures of logging to the stream bank. This study considered reconnaissance level fish abundance data collected between 1996 and 2000 via electroshocking for six river basins within the upper Kootenay River. In particular, proximity of roads to streams (i.e., within 100 m of streams) was a significant factor. Furthermore, a significant correlation suggested logging of non-fish bearing perennial and

ephemeral streams can be a key factor in WCT abundance downstream, whereas consideration of all stream reaches did not demonstrate a significant relationship. This may reflect the management practices associated with logging in non-fish bearing versus fish-bearing streams in B.C. Equivalent clearcut area did not appear to be a useful predictor of habitat quality, as reflected by WCT density.

8.1.4 Agriculture

Most agriculture is restricted to hay production and cattle, and follows irrigation water license distribution along the valley bottoms in the Elk, Kootenay, Upper Columbia, Slocan, Kettle, and Shuswap rivers (Figure 6; Oliver 2009). One significant issue related to agriculture within the native range of WCT is water extraction for irrigation during the summer months (Oliver 2009). As storage facilities are limited or non-existent in most cases, removal is on an as-needed basis. In particular, the smaller streams with naturally low summer base flows are most vulnerable during July and August, particularly in the dry Southern Interior Mountain Trench ecosection in which much of the Upper Kootenay Population Group occurs (Ptolemy 2010). Riparian habitat damage is another significant concern in much of the core range where cattle are able to access small (possibly important spawner) streams, leading to sedimentation and increased water temperatures. Grazing leases are extensive but impacts associated with access to small streams are more localized. Nutrient loading associated with feedlot runoff may occur in some instances. There is some suggestion that increased nutrient levels may benefit introduced Rainbow Trout populations in the Upper Kootenay area (M. Robinson, pers. comm., 2010).

8.1.5 Residential, Recreational, and Commercial Development

Probably the best documented example of how urban development may impact WCT in B.C. is represented by Joseph Creek, a WCT stream that runs through the city of Cranbrook. This stream has suffered a multitude of impacts related to urban development including water quality degradation (reduced oxygen levels, elevated contaminants, sedimentation, nutrient loading, and increased temperatures) associated with altered runoff patterns and storm sewer inputs (Oliver 2009). Similar impacts likely occur in receiving waters of all communities within WCT range. This degradation impacts spawning habitat and fish health. Water use is also a major concern but is discussed below.

8.1.6 Water Use - Permanent Water Withdrawal (Consumptive)

This category includes domestic and irrigation water licenses (Figure 6). Removal of water associated with irrigation has been discussed in the status section to some extent already. Water use associated with storage facilities (i.e., reservoirs) has not. Joseph Creek, for example, is influenced by water storage in Phillips Reservoir in two ways: (1) discontinuity in the natural flow pattern both above and below the reservoir; and (2) delay in timing of peak flow, which affects spawning cues. In 1998, WCT spawner entry was delayed as much as one month, which probably affected egg, emergence, and winter survival of offspring in the following year (Oliver 2009). In addition, lower reaches experienced summer temperatures that exceeded published

optimum juvenile cutthroat rearing temperatures, which can cause stress and reduce survival (Oliver 2009). Impacts will affect reaches downstream of community reservoir outflows.

8.1.7 Water Use - Temporary Diversions/Dams (Non-Consumptive)

Numerous large- and small-scale hydro facilitates operate on rivers within the native WCT range in B.C. The large dams on the Columba River downstream of Mica Dam have influenced historic WCT distributions. Within the upper Kootenay River, dams tend to be placed on natural barriers (e.g., Elko Dam on the lower Elk River). However, the completion of the Libby Dam in 1972 and Kookanusa Reservoir likely had the greatest hydro-related impacts to WCT distribution, displacing riverine populations with the inundation of habitat (Oliver 2009). Independent Power Producer (IPP) operations tend to be fairly small due to the size and location of the streams used (upper reaches with high gradients) but may pose a threat where resident populations occur (Oliver 2009). The most vulnerable season for WCT associated with IPPs may be during overwintering if water is diverted when flows are naturally low at this time (Oliver 2009).

Figure 6 provides an overview of the number of current water licenses associated with irrigation, communities, and IPPs within the native WCT range, as well as those that are pending. Water withdrawal tends to be concentrated in the valley bottoms were agriculture and urban development are most prevalent. A current license does not necessarily indicate if and to what extent water is being extracted.

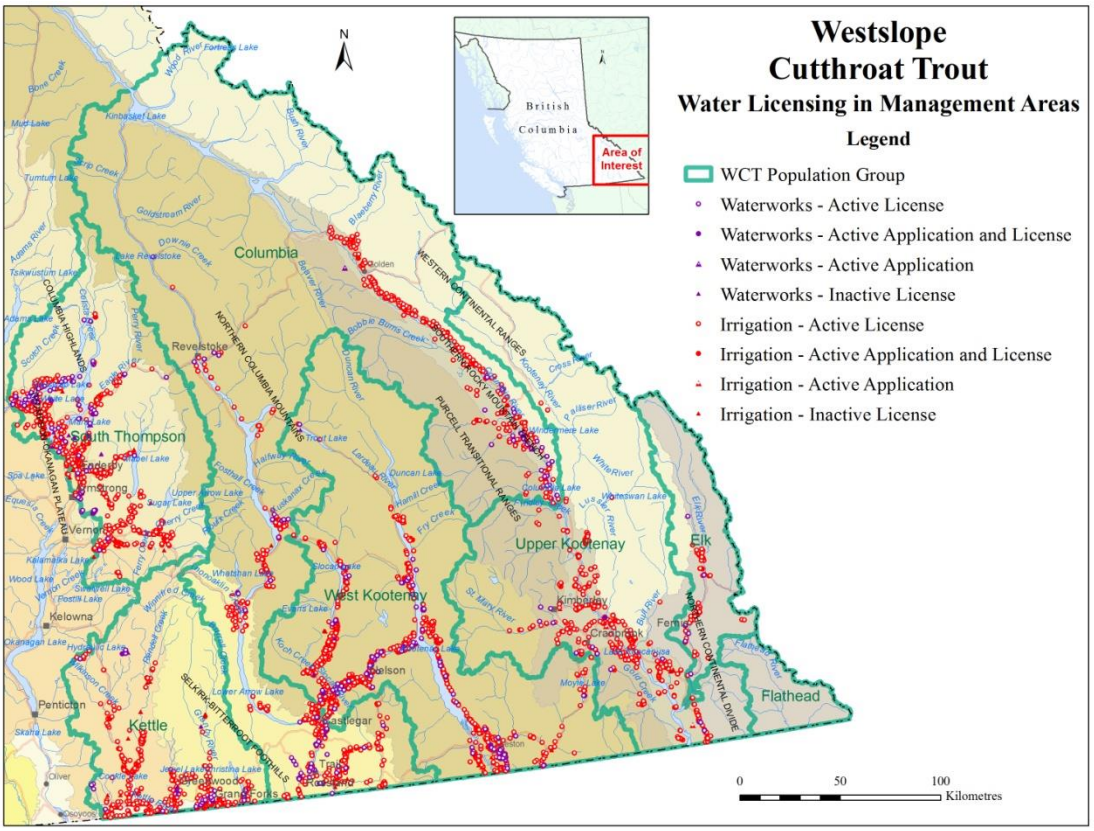

Figure 6. Overview of all current and pending water licenses within the WCT range in B.C.

8.1.8 Fishing

Records are largely limited to the Elk and St. Mary systems in the Kootenay River where public appeal and interest in the species are likely greatest. In the early 1980s, it became apparent that quality of fishing had decreased on the Elk River with only a small percentage of the catch being WCT, and mostly of smaller, younger age groups. This resulted in a shift in regulations in 1984. Since this time, both quality and angler use have increased significantly. The St. Mary River was virtually unfished in the 1980s because of the perception that it was highly polluted from the Sullivan Mine in Kimberly. Water quality was poor during the 1960s and 1970s, and extremely toxic conditions were noted including the complete absence of macro-invertebrate and fish communities (summarized in Oliver 2009). The mine was improved in the 1970s, and fish communities began to return. A creel survey in the 1990s indicated very high angling use of the river and excellent quality (Oliver 2009).

Angling interest continues to increase in response to the excellent quality of WCT fishing in the region. During 1991, for example, just 81 guided days were recorded on the Elk River. By 2000, that number had jumped to 1458 (COSEWIC 2006). The threat associated with angling is related to catch and release post-hooking mortality, as well as incidental catches in winter fisheries and compliance. While catch and release is considered to produce very low mortality (i.e., < 5%), the cumulative impact of multiple catch and release occurrences for individual fish may become significant throughout a summer season. For example, it is estimated that catchable trout in the

Elk River may be recycled 11 times in a single season. Hooking mortality associated with a fly and lure caught fish range from 4 to 6% (Wydoski 1979). Mortality could be significantly higher, particularly associated with warm water temperatures and poor handling by some anglers. Where fishing pressure on WCT populations continues to increase, the risk associated with catch and release mortality may become a greater concern.

8.1.9 Aquaculture, Hatcheries, and Stocking

Several observed or potential impacts to WCT are associated with the long history of fish stocking in B.C. The three greatest impacts are:

1. hybridization leading to introgression,
2. competition and displacement, and
3. outbreeding depression.

Refer to Appendix 12, Fish stocking, for more detail on these impacts.

Hatchery stocking records occurring within the native range of WCT in B.C. go back to the early 1900s (Table 7). Over 200 identified waterbodies within the core native range have been stocked with Rainbow Trout or WCT. Over 100 waterbodies have been stocked with Eastern Brook Trout. Finally, 20 waterbodies in the Kootenays region were stocked with Rainbow Trout and Cutthroat Trout (RBT x CT) crosses from 1929 to 1940. Most of these fish were from the Monroe "strain" produced at the Cranbrook Hatchery, but Peavine, Rosebud, and Kiakho "strains" were also used occasionally. It is unclear what subspecies of Cutthroat Trout were used in these crosses. The use of sterile strains has only been implemented fully for Eastern Brook Trout and Rainbow Trout in the past 10 years; all WCT released remain fertile and, in recent years, all originate from the Connor Lake of the upper Elk system. Clearly, many of these waterbodies were originally fishless lakes. Recent fisheries management policy requires that only lakes should be stocked, preferably those with no outlet. However, it is not clear to what extent stocked lakes can be considered isolated.

In considering waterbodies where WCT have been observed (based on FISS records), the Upper Kootenay Population Group has seen most introductions of the central groups. Only one lake and one stream received Rainbow Trout in the Flathead. Only 8 waterbodies in the Elk River reported to contain WCT received Rainbow Trout. Note that Summit Lake (in Elk group), Joseph Creek, and Bull River (both in Upper Kootenay group), which all contain native WCT populations, also directly received hatchery Rainbow Trout 10 or more times. Refer to Appendix 12, Fish stocking, for a breakdown of stocking records by waterbodies where WCT have been observed.

In summary, at least two of the main threats identified above occur to varying degrees in the Population Groups in the core WCT range in B.C. The issue of introgression has been discussed already; competition/displacement is a concern for at least one system (i.e., Joseph Creek; Oliver 2009). The potential for homogenization and outbreeding depression has not been considered. The source of WCT for stocking has a varied history. Most recently, all broodstock has come from Connor Lake but it is generally thought that Connor Lake was originally fishless. It was stocked a single time in 1950 with Kiakho Lake WCT, which in turn had been stocked with

various sources of fish since 1929 including Munroe Lake, Peavine Creek, Loon Lake, and Beaver Creek. These systems themselves have been stocked. Thus, it is unlikely that the original source of Connor Lake WCT can be determined.

Table 6. Summary of all stocking records for WCT, Rainbow Trout (RBT), Eastern Brook Trout (EBT), and Rainbow Trout x Cutthroat Trout crosses (RBT x CT) in the core range of WCT until 2008.

Species stocked	Region[a]	Years stocked	Number of waterbodies stocked[b]	Frequency	Ploidy[c]
WCT	4E	1923–2008	187	Up to 50+ times	Still all 2N in 2008
	4W	1924–2007	57	Up to 50+times	Still all 2N in 2008
RBT	4E	1915–2008	151	Up to 100+ times	Still some 2N in 2008
	4W	1911–2008	120	Up to 100+ times	All AF, AF3N, and 3N after 2005
EBT	4E	1924–2008	81	Up to 50+ times	All AF3N or 3N after 2003
	4W	1911–1999	31	Up to 100+ times	All AF3N or 3N after 1999
RBT x CT	4E	1938–1949	13	1 to 2 times	All diploid
	4W	1929–1968	8	1 to 2 times	All diploid

[a] Management region 4E = Upper Kootenay (upstream of Kootenay Lake) and Flathead; 4W is Lower Kootenay and Columbia systems.
[b] Only those waterbodies with a unique waterbody ID number were counted. A number of records did not have any associated ID code.
[c] Ploidy indicates if and when some form of sterile strain was used. Ploidy levels of released hatchery fish: 2N = diploid, all fertile; 3N = triploid, all sterile, AF = all female, fertile; AF3N = all female, all sterile.

8.1.10 Climate Change and Severe Weather

In B.C., a number of trends associated with a changing climate are relevant to WCT. B.C. Interior snowmelt systems continue to experience earlier snowmelt runoff followed by longer and drier summers (Oliver 2009). This is reflected in reduced mean annual discharge observed in southern B.C. drainages. This trend in combination with increasing water demands could be catastrophic for WCT in some small streams were naturally dry conditions already exist. A number of related impacts are associated with these low flows including: increased water temperatures; reduced oxygen levels; reduced riffle habitat; and in the winter, reduced refuge areas. Such conditions will result in increased physiological stress and mortalities.

8.2 Threats Assessment

A spreadsheet-based threats assessment tool was developed for MOE to assist in identifying key threats to WCT according to mechanism and source of threat (Hatfield and Long 2010). This tool uses a ranking system similar to NatureServe (Master *et al.* 2009) to assess both the scope[16] and severity[17] of a threat to come up with a combined score for rating each threat that represents the

[16] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).
[17] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or 3-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

threat impact[18]. The immediacy or timing[19] of each threat is recorded to provide context for each threat, but it is not used in the calculation to determine the threat rating. Threats for the WCT were assessed for the entire province to identify the key provincial-level threats (see text below and Appendix 13 for details).[20]

The following text highlights moderate to high rated threats identified for each Population Group (Table 8), to focus attention on threats that are both understood and currently affecting populations. Descriptions list threat mechanisms[21] and the sources associated with these threat mechanisms.

While the use of a threat assessment tool is valuable in identifying primary threats to species at risk, lower ranking threats, which may include wide-ranging threats and threats with significant data gaps, may play an important role in exacerbating other factors already threatening WCT, or accumulate for a larger impact. See Appendix 13 for a further description and the complete list of identified and potential threats.

8.2.1 Elk

1. The highest ranking threats were associated with aquaculture, hatcheries, and stocking, namely:
    - Introgression – associated with invasive Rainbow Trout is the highest threat.
    - Altered community dynamics – is considered a medium threat associated with this source.

2. Fish passage associated with linear projects is a medium threat throughout the range of the Elk Population Group.

3. Two mechanisms associated explicitly with coal mining were identified:
    - Riparian clearing and alteration – rock drains.
    - Water quality – selenium and calcite.

4. Mechanisms related to forest harvest similar to that for Upper Kootenay were identified. In particular, mountain pine beetle salvage operations were highlighted as an ongoing source of this threat.

5. Altered flow regimes associated with water use (permanent withdrawal-consumptive) are considered a serious threat although localized.

[18] **Threat impact -** The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest (Master *et al.* 2009). This combined score is based on the interaction between assigned scope and severity values, and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. (Very High; High; Medium; Low; Negligible; Unknown; Blank).

[19] **Timing** –Timing categories are different than those provided by Master *et al.* (2009) and follow Hatfield and Long (2010), in an attempt to better describe trends. (Residual only, i.e., threat is no longer occurring but residual effects continue; Ongoing but diminishing; Ongoing and stable; Ongoing but increasing; and Future only (Hatfield and Long 2010).

[20] Local experts were asked to individually complete a spreadsheet to rate threats. Assessment outcomes were then refined based on discussions at a provincial workshop held in December 2010. There was some concern that significant localized threats may not get highlighted. However, the purpose of this exercise was to identify the highest priority provincial-level threats.

[21] Threat Mechanisms are indicated by underlined text in Sections 8.2.

A number of other lower rated and localized threats were also identified. For example, land clearing, the mechanism identified with urban development (recreational and residential), is limited mainly to the Fernie area.

8.2.2 Flathead

No high or medium threats were identified for this population group. Historically, forestry heavily impacted this watershed, along with a major pine beetle infestation in the 1980s. However, forests appear to be recovering and WCT populations appear to be healthy. Finally, introgression downstream in the U.S. portion of the Flathead watershed should be monitored as there are no physical upstream barriers and it could spread northward.

8.2.3 Upper Kootenay

1. The highest ranking threats and only non-habitat mechanisms identified were both associated with aquaculture, hatcheries, and stocking as follows:
    - Introgression – Is the single greatest threat within lower sections of tributary streams accessible by Rainbow Trout from the Kookanusa Reservoir, which likely contains some level of hybridization.
    - Altered community dynamics – The presence of kokanee in the Kookanusa Reservoir is thought to be influencing predation by Bull Trout on WCT. Elsewhere, Eastern Brook Trout and Rainbow Trout are thought to be displacing WCT. In Kootenay National Park, WCT in all lakes (i.e., adfluvial form) have been lost due to the introduction of Eastern Brook Trout.

2. Two mechanisms related to forest harvest were identified as medium threats, and might be considered residual to some extent (i.e., cutblocks associated with practices before the Forest Practices Code implementation in 2004):
    - Riparian clearing and alteration – Vegetation removal can increase peak flows and decrease summer low flows. This results in high temperatures and decreased dissolved oxygen, promoting other fish species such as invasive species. Riparian buffers are not providing a functioning riparian area. This is an ongoing issue (i.e., not just residual) as proper protection is still not occurring, especially in non-fish (first and second order) streams. However, given sufficient time substrate, distribution and invertebrate communities are recovering naturally. Salvage logging post-fire is an ongoing concern. Sedimentation may still be a concern, as is the largely deciduous forest that generally replaces lost forest.
    - Water quality – considered ongoing, associated with above issue.

3. Altered flow regime associated with water use (permanent withdrawals) is a medium threat – this relates to water storage (water use permanent withdrawal) on Mark and Joseph creeks.

4. Linear projects were an identified source, related to the following mechanisms:
    - Fish passage – the greatest threat associated with bridge and culvert crossings.

- Large-scale habitat modifications – particularly in Kootenay National Park, there has been a direct loss of habitat associated with the conversion of channel to culverts (~ 7 km).

Other points of discussion included some localized threats related to agriculture (i.e., riparian issues with cattle access to spawning streams); climate change related impacts to flow regime and water; quality; and whirling disease, which was considered a greater threat for Rainbow Trout.

8.2.4 West Kootenay

1. Altered community dynamics and altered flow regimes associated with permanent water withdrawal for irrigation and consumption on private land and by communities are considered to be fairly widespread, particularly downstream of diversion and a medium threat.

2. Fish passage associated with irrigation dams (water use – permanent withdrawal, consumptive) and culvert crossings for forest harvest roads on small streams (linear projects) may be a significant widespread issue, though it requires additional ground-truthing.

3. Water quality, altered flow regime, and riparian clearing and alteration associated with forest harvest are threats, though may be diminishing or residual only with the onset of the Forest Practices Code.

4. Instream mechanical disturbance associated with linear projects is an ongoing concern throughout this group.

8.2.5 Columbia

1. Yoho and Glacier National Parks have been considered separately from the remainder of this Population Group. As such, the greatest issues are mechanisms associated with the introduction of invasive trout species associated with aquaculture, hatcheries, and stocking as the source. In particular, both introgression and altered community dynamics have heavily impacted these areas. Outside of the parks, it is not clear to what extent these mechanisms have occurred. Road crossings that restrict fish passage are a concern but conflicting perceptions suggest more work is required to determine the extent of this threat.

2. Altered flow regime associated with water use (non-consumptive – Independent Power Projects) is a significant threat throughout the tributaries of this group. Furthermore, ground water effects from IPPs are an issue and are likely to expand in the future as more projects get underway.

3. Altered flow regime associated with water use (permanent withdrawal, consumptive) was also identified as a medium threat.

4. Instream mechanical disturbance associated with linear projects is an ongoing threat throughout this group.

5. Mechanisms related to forestry harvest are one of the most significant concerns in this group. Although mostly residual in nature, several ongoing concerns were also identified, including:
   - Fish passage – associated with culvert crossings: identified as unknown in the assessment (Appendix 13), however more investigation is needed as it is thought to be a significant threat.
   - Water quality – especially sedimentation.
   - Riparian clearing and alteration

Hydroelectric impacts associated with the Mica area are probably not a concern for WCT because it is not known to occur in mainstem rivers in this geographic area.

8.2.6 Kettle

There is too little information regarding the presence and distribution of WCT within the Kettle Population Group to assess threats at this time.

8.2.7 South Thompson

There is too little information regarding presence and distribution of WCT within the South Thompson Population Group to assess threats at this time.

8.3 Threat Summary

Table 8 summarizes medium- to high-rated threats for each assessed Population Group. The threat with the highest threat impact is introgression associated with historic releases of reproductively capable hatchery Rainbow Trout, as well as the ongoing spread of Rainbow Trout genes associated with established Rainbow Trout populations and hybrid movement. This threat is considered ongoing, increasing in some areas, but potentially decreasing (genetic dilution) where Rainbow Trout gene source no longer exists. This threat is evident in two of the three Core Ranges for WCT: the Elk and Upper Kootenay, as well as Glacier, Yoho, and Kootenay National Parks. Related to this are the mostly residual impacts of releasing Eastern Brook Trout, particularly in the National Parks where stocked Eastern Brook Trout have replaced all adfluvial populations of WCT.

Several threats, all habitat-related, were identified as having a medium threat rating across many Population Groups. One key mechanism is altered flow regime associated with consumptive water use (irrigation, community), non-consumptive water use (IPPs), and forest harvest (riparian and water quality impacts). Fish passage, another identified mechanism, requires some significant additional ground-truthing, especially with respect to road crossings, which are confirmed to be the greatest habitat threat in the National Parks (S. Humphries, pers. comm.,

2010). Mining-related mechanisms (water quality and riparian impacts) are restricted to the Elk Valley where coal mining persists.

Several threat mechanisms could be of significant concern but are currently ranked low or unknown based on lack of information. These included two key non-habitat mechanisms—harvest-related mortality, and altered community dynamics associated with introduced salmonids (in Kookanusa Reservoir) and climate change—as well as habitat mechanisms including climate change related changes to water flows and quality, and impacts of IPPs in particular on flows and passage.

While significant uncertainty is associated with threats to WCT, some general conclusions can be drawn in terms of how various threats may influence the level of conservation concern of each Population Group (Table 9). Level of conservation concern was determined by "rolling up" the factors listed in Table 9 and the key threats for each for each Population Group.

Table 7. Summary of medium and high rating threats for each Population Group.

Threat mechanism[a]		Threat source[a]	Threat impact by Population Group[b, c]				
Level 1	**Level 2**		**Elk**	**Flathead**	**Upper Kootenay**	**West Kootenay**	**Columbia**
Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	L	L	L	**M**	L
Habitat	Altered flow regime	Forest Harvest	L	L	L	**M**	L
Habitat	Altered flow regime	Water Use – permanent withdrawal – consumptive	**M**	L	**M**	**M**	**M**
Habitat	Altered flow regime	Water Use – temporary diversions/dams, non-consumptive	L	L	L	L	**M**
Habitat	Fish passage	Linear Projects	**M**	L	**M (H[d])**	**M**	**M (H[d])**
Habitat	Fish passage	Water Use – permanent withdrawal – consumptive	**M**	L	**M**	**M**	**M**
Habitat	Instream mechanical disturbance	Linear Projects	L	L	L	**M**	**M**
Habitat	Riparian clearing and alteration	Forest Harvest	**M**	L	**M**	**M**	**M**
Habitat	Riparian clearing and alteration	Mining	**M**	L	L	L	L
Habitat	Water quality	Forest Harvest	**M**	L	**M**	**M**	**M**
Habitat	Water quality	Mining	**M**	L	L	L	L
Non-Habitat	Altered community dynamics	Aquaculture, Hatcheries, and Stocking	**M**	L	**M (H[d])**	L	? [d]
Non-Habitat	Introgression	Aquaculture, Hatcheries, and Stocking	**H**	L	H	?	? [d]

[a] Mechanisms and sources are based on the assessment tool described in Hatfield and Long (2010).

[b] Threat Impact - The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Negligible: when scope or severity is negligible..

[c] Note that neither Kettle nor South Thompson groups were assessed.

[d] High in National Parks.

Table 8. Summary of Population Groups with respect to trends, key threat mechanisms, and level of conservation concern.

Population Group	Area (km^2)	Trends			Key threat mechanisms	Level of conservation concern
		Abundance	**Distribution**	**Habitat**		
Core						
Elk	3,565	Stable to increasing	Stable, but if genetic integrity considered, decreasing	Local losses and impacts	Introgression and altered flow regime, fish passage, water quality	**High** – While still considered abundant and able to support a quality fishery, significant concerns regarding introgression and localized habitat impacts exist
Flathead	1,579	Assumed stable	Assumed stable	Local concerns but low overall	Mechanisms related to forest harvest, introgression in U.S.	**Low** – Concerns relate to habitat impacts and potential introgression should U.S. fish move upstream
Upper Kootenay	16,566	Stable to increasing	Stable, but if genetic integrity considered, decreasing	Local losses and impacts	Introgression, altered flow regime, fish passage, water quality	**High** – While still considered abundant and able to support a quality fishery, significant concerns regarding introgression and localized habitat impacts exist **High in Kootenay National Park** – Introgression and culvert issues
West Kootenay	17,563	Assumed stable but unknown	Assumed stable but unknown	Local impacts	Altered flow regime, fish passage, riparian clearing and alteration, water quality	**Low-Medium** – Survey information limited, introgression not apparent but populations scattered
Peripheral						
Columbia	36,707	Historically more, now assumed stable but unknown	Historically more, now assumed stable but unknown	Historically more, residual forestry issues	Altered flow regime, fish passage, riparian clearing and alteration, water quality Introgression, altered community dynamics	**Medium** – Survey information limited, introgression not apparent outside of park, but populations scattered and some habitat concerns exist **High in Yoho**– Pure WCT now limited to isolated streams, lake form lost; reverse situation in **Glacier National Park** – population in Schuss Lake only
Kettle	8,165	Unknown	Unknown	Unknown	Unknown	**Unknown** – Status of native versus introduced WCT difficult to determine
South Thompson	10,483	Unknown	Unknown	Unknown	Unknown	**Unknown** – Status of native versus introduced WCT difficult to determine

9 CURRENT MANAGEMENT FRAMEWORK

The current management framework is outlined here as it applies to people and habitat management.

9.1 First Nations Interests

Shared stewardship of B.C.'s shared fisheries resource and support of the food, social, and ceremonial needs of First Nations are critical to the recognition of established First Nation rights and entitlements. For WCT management, this means a need to consult on management issues that may affect First Nations culture. At all times, First Nations will be appropriately consulted following, at a minimum, province-wide (Province of British Columbia 2010), and Ministerial guidelines for consultation. Effective delivery of this management plan depends on relationship building and engaging First Nations in all activities, such as habitat restoration, as there is always the potential for information sharing and cost effective implementation. In addition, the collection of traditional knowledge, as begun in Prince (2001), should continue and could help clarify baseline data on distribution, for example.

9.2 Habitat Management

The following legislative tools may protect various aspects of fish habitat within WCT range:

Table 9. Legislative tools that may protect various aspects of fish habitat within WCT range

Legislation	Details
Federal	
Fisheries Act	The Fisheries Protection and Pollution Prevention provisions of the *Fisheries Act* provide protection to WCT.
Canada National Parks Act	Enables the Governor in Council or the Minister responsible for the Parks Canada Agency to make regulations regarding management of parks including flora, fauna, and fisheries.
Species at Risk Act (SARA)	One goal of SARA is to manage species of special concern to prevent them from becoming endangered or threatened. SARA requires the development and subsequent reporting on implementation of a management plan which includes measures for the conservation of the species. If a project is subject to an assessment under the Canadian Environmental Assessment Act 2012, measures must be taken to avoid or lessen any adverse effects of the project on the species.
Provincial	
B.C. *Wildlife Act*	Wildlife Management Areas (not used for fish in general, but may provide indirect benefits.
Forest and Range Practices Act (FRPA)	Identified Wildlife Management Strategy – WCT is on the schedule of species at risk that may be affected by forest and range practices and may require additional protection measures. An account for WCT lays out habitat needs and sensitivities, as well as appropriate measures for protection. Fisheries Sensitive Streams can also be designated under FRPA where fish values are high and sensitive to forest and range practices. To date, a single WCT stream, Palliser Creek, has been designated, indicating it requires special management to maintain key stream characteristics. Under FRPA, temperature-sensitive streams may also be designated to highlight the need to maintain water temperatures but to date no streams have been

Legislation	Details
	designated and no official procedure is in place to do so (L. Reese-Hansen, pers. comm., 2010). Wildlife Habitat Areas (only been used for Bull Trout so far) are another possibility.
Protected Areas related	*Park Act, Ecological Reserve Act, Reserve Act, Environment, Land Use Act* – general intent is to maintain intact ecosystems
B.C. *Fish Protection Act*	Riparian Areas Regulation – RAR only applies to local governments within the regional districts of Columbia/Shuswap and Thompson/Nicola. Both of these regions lie in the peripheral areas of the WCT range in B.C.
B.C. *Water Act*	Water Act Modernization (in progress), the new proposed *Water Sustainability Act* and Living Water Smart program. Section 9 regarding "changes in and about a stream" – incorporating stream health and instream flow needs into water allocations.
B.C. *Environmental Management Act*	Came into force in 2004 – especially Waste Discharge Regulation

9.3 Fisheries Management

9.3.1 Regulatory Framework

Both federal and provincial legislation provides a framework for managing WCT fisheries:

- Federal *Fisheries Act* – B.C. Sport Fishing Regulations (aggregate daily quota of 6 for CT) – regulates provincial quotas for all sport species
- Provincial *Wildlife Act* – responsible for regulation of sport fish licenses for freshwater sport species
- *Canada National Parks Act* and National Parks of Canada Fishing Regulations

9.3.2 Regional WCT Regulations

Increasingly conservative regulations have been put in place to improve angling quality in East Kootenay streams since the 1980s, in response to complaints over declines in abundance and fish size. In particular, these regulations have been geared to restoring a balanced age structure in WCT and reducing harvest (Oliver 2009). To this end, management has been effective in achieving these goals at least in the heavily angled waters of the Elk and St. Mary's rivers. Seasonal angler catch has increased by 30-fold, WCT now make up 95% of the total catch, CPUEs have increased significantly (up to 3.5 times), and large fish (> 30 cm) are much more common (Oliver 2009). In addition, guided angling has increased significantly.

Furthermore, the East Kootenay Angling Management Plan (EKAMP) was completed in 2006 (B.C. Ministry of Environment 2006) as a response to overcrowding issues on what were considered premier WCT streams. Implicit in the EKAMP is that conservation needs have already been met.

The current angling regulations include (from 2009 to 2011 Freshwater Fishing Regulations Synopsis):

- designation of Classified Waters (Class II) – Seven watersheds (including tributaries) have been classified including the Wigwam, Elk, Bull, St. Mary, and White rivers;

Skookumchuck Creek; and Kootenay River upstream of White River confluence. All require purchase of a supplemental Classified Waters License.
- single barbless hook on all East Kootenay waters
- catch and release only on all streams from Nov. 1 to March 31; may apply year round to some WCT rivers such as catch and release only zones on several sections of the Elk River
- no fishing on any streams from April 1 to June 14
- daily catch quota is 5, but only 2 from streams and no more than 1 > 50 cm; may be more restrictive on some rivers (or some zones within rivers) where catch is reduced to one or zero fish
- bait ban on many WCT rivers

9.3.3 Quality Waters Strategy

As previously discussed, the EKAMP lays out specific angler day quotas and guide number caps for each of seven Quality Waters streams. While these Quality Waters include all species, wild WCT is generally the targeted species by guided and non-guided anglers alike, although Bull Trout may also be targeted in the Wigwam River, and is a close "second" target in some other rivers (J. Burrows, pers. comm., 2011). The implementation of the River Guardians Program as part of the Quality Waters Strategy occurred to monitor status of the WCT fishing quality.

9.3.4 Fisheries Enhancement

Enhancement for recreational opportunities associated with WCT is currently limited to stocking of diploid F_1 hatchery fish, fish originating from Connor Lakes broodstock. WCT stocking is now limited to mainly lakes, all within the native range of WCT. It remains unclear as to whether stocking occurs in systems with wild populations of WCT. Egg collections from wild broodstock in Connor Lake occur every 2 years. The Columbia Basin Fish and Wildlife Compensation Program may be initiating enhancement on some streams in the next 5 years.

9.3.5 Safeguarding/Refugia

No framework or policy is in place regarding the identification or creation of refuge populations of pure WCT but some have been considered recently including fishing closures, designation of headwater populations above barriers (COSEWIC 2006), and translocations to isolated areas above barrier locations. For example, a transplant from Cupola Creek to previously fishless Ventigo Creek has been initiated as part of an IPP project to provide an insurance population. While refugia can contribute to conservation goals, a full evaluation of effectiveness and potential impacts on other species needs to be considered in advance, in consideration of emerging policy and new biological/genetic information.

9.3.6 Provincial Parks

The *Fish Stocking in Provincial Protected Areas Guideline* is available for Protected Areas in B.C. However, Whiteswan Lake in Whiteswan Provincial Park represents a particularly challenging situation. The park was designated as a Class A park in 1978 (D. Biffard, pers. comm., 2011). The lake supports a regionally significant sport fishery and has been stocked regularly with Rainbow Trout from various strains from 1964 to 2009 (most recently Gerrard). Historically, stocking may have occurred as early as 1931 to 1957 but the lake was treated with toxaphene at this time to eliminate native non-sport species (J. Burrows, pers. comm., 2011). Diploid fish (1.5 million Rainbow Trout from various strains) were stocked up to 2003. A naturalized Rainbow Trout population became established in the lake and efforts were shifted to encourage natural spawning; such efforts included beaver control to maintain stream access. Most recently, native species control and enhancement of an invasive species were determined to be inconsistent with the Conservation Program Policy under the *Park Act* but permissible if expressly approved by the Regional Manager of Parks and Protected Areas. Currently, the Regional Manager approves a strategy to discontinue beaver control, monitor angler use, and stock to maintain the fishery with sterile Rainbow Trout (D. Biffard, pers. comm., 2011), but enhancement of spawning habitats has been discontinued since 2009. However, the situation remains challenging as rainbow are continuing to migrate out of the lake despite attempted containment with a barrier fences (Heidt 2007, 2009), and other preventative measures. Spawning rainbow are regularly found downstream of the lake and falls (Bell and Chirico (2007), as have numerous WCT hybrids (Rubidge and Taylor 2004, 2005).

9.3.7 National Parks

Angling in the mountain national parks is managed through the *Canada National Parks Act* and the National Parks of Canada Fishing Regulations. In addition to the act and fishing regulations, Superintendent's Orders at each park can be used for short-term management or to bridge the times between regulatory amendments. WCT have zero possession limits in Yoho and Kootenay. Streams and rivers are closed to angling in Mount Revelstoke and Glacier. Beyond this there is little information available for fisheries. They support very few anglers, waters tend to be fairly unproductive, and no enhancement or fertilization has been conducted since the 1970s. Regardless, the Eastern Brook Trout originally stocked throughout much of Kootenay and Yoho National Parks have now become the dominant species (S. Humphries, pers. comm., 2011).

9.4 Recommended Management Actions and Priorities

Recommended management actions for WCT in B.C. ensure that the Management Objectives (see Section 6) can be met, are intended to be consistent with the B.C. Freshwater Fisheries Program Plan goals (B.C. Ministry of Environment 2007), and return the species' conservation status to not at risk. As evidence is unclear or lacking in many cases, actions are included as necessary to address key gaps in information, to address priority threats, and to directly address targets and objectives.

The full list of recommended actions is summarized in Table 10. Actions were prioritized according to immediacy of need. Actions that should be initiated immediately are noted as Essential. Most of these actions consist of inventory and monitoring, or habitat restoration and protection focused activities. This focus emphasizes the current lack of information available to describe population structure and distribution, as well as highlights the need for some immediate policy and planning to improve protection of WCT populations.

Recommendations for management on a *provincial scale* that can be used by government, partners, and interest groups to aid in determining resource priorities and to develop appropriate policy statements are summarized in the following sections.

Table 10. Summary of recommended actions[22] considered critical in implementing the WCT management plan.

Recommended Actions	Objective[a] and Concern Addressed	Priority[b]
Population Conservation		
Define populations using predictive model: • Confirm status in unknown areas including peripheral areas • Consider data on range of movement, barrier data, hydrological units, genetics, threats, stocking records • Ground-truth species composition, logical hydrological units, genetics, demography, barrier surveys, habitat disturbances using standardized approaches	1; Knowledge Gap	Essential
Describe genetic structure of B.C. WCT populations.	1; Knowledge Gap	Beneficial
Establish status of introgression in WCT populations: • Complete a genetic inventory update and gap analysis • Where hybridization is occurring, determine direction and rate of change	1; Knowledge Gap	Essential
Identify naturalized Rainbow Trout spawning locations focusing on locations where they are likely to concentrate (e.g., in lower elevation creeks), prioritize areas where there is potential cross-breeding with WCT.	1; Threat: Introgression	Essential
Identify naturalized Eastern Brook Trout populations.	1; Threats: Altered Community Dynamics	Necessary
Monitor upstream movement of U.S. hybrids within Flathead Population Group.	1; Threats: Introgression	Necessary
Determine if kokanee enhancement in Kookanusa could be a detriment to WCT production.	1; Threats: Altered community dynamics	Beneficial
Define "pure WCT population" and establish thresholds to trigger appropriate management responses.	1; Threats: Introgression	Necessary
Prioritize WCT populations for restoration action based on genetic purity.	1; Threats: All	Necessary
Gather aboriginal traditional knowledge, and other historic accounts of occurrence and unique characteristics to help clarify historical distribution, relative abundance, and fish community structure	1, 2; Knowledge Gap	Necessary
Develop policy and regulations for protection and restoration of wild WCT populations including consideration of: • Regulations: opportunistic removal in areas of high hybridization and naturalize Rainbow Trout populations (listed in Appendix 4) • Policies: refugium/transplantation; barrier use; nutrient supplementation; and hatchery supplementation. Note that B.C. currently does not use hatchery supplementation to restore salmonid populations thus it would first have to be considered in an experimental/evaluation context (Province of British Columbia 2005). • "Habitat banking" – explore as a compensation option and determine if/when using this might be appropriate.	1; Threats: Introgression; Fish passage; large-scale habitat modifications	Essential
Review recreational stocking programs for WCT, Rainbow Trout, and Eastern Brook Trout to ensure risks to WCT are minimized:	1; Threat: Introgression	Necessary

[22] Recommended management actions for WCT in B.C. were generated largely based on the output of a provincial workshop held in Cranbrook, BC., on December 8–9, 2010.

Recommended Actions	Objective[a] and Concern Addressed	Priority[b]
• WCT stocking in Connor Lake – review stocking plan to ensure no stocking into wild WCT waters • Eastern Brook Trout stocking – confirm plan meets current stocking policy • Rainbow Trout stocking – confirm all current stocking in WCT range is in isolated lakes and uses sterile fish; reduce Rainbow Trout stocking in key WCT range and consider stocking with native species as an alternative		
Support stewardship initiatives by local governments, angling groups, and stream stewardship groups, by helping prepare the following for a wider distribution than the regulations synopsis: • species identification tools; • education material to reduce hooking injury mortality; • education materials for schools/angling clubs on biology, threats (especially invasive species and introgression), such as brochures, Powerpoint presentations, and relevant signage; and • promote stewardship agreements/conservation covenants.	1-4; all	Beneficial
Develop Whiteswan Lake management plan for WCT due to confirmed hybrid status (WCT x RBT) in watershed. Plan should include stocking recommendations, naturalized Rainbow Trout population management, barrier use, etc.	1, 2; Threats: Introgression	Essential
For wild, unexploited WCT populations, use threat analysis to identify at risk populations and assess carrying capacity of a random subset of these populations.	1, 2; Knowledge Gap	Beneficial
Identify wild, exploited stream and lake WCT populations (include subgroups if necessary) for individual stock assessment including Classified Waters and non-Classified Waters: • Classified Waters: Bull, Wigwam, Elk, St. Mary, Skookumchuck, White, and Upper Kootenay rivers • Non-Classified Waters: Flathead, Akolkolex, Goat, Findlay, and Lussier rivers • Other small populations	2; Knowledge Gap	Essential
Develop a measure of carrying capacity for each exploited WCT population using: • the empirical approach (preferred) on as many populations as possible to measure total abundance and harvest rate; or • the modeling approach (as needed) which requires considerable demographic information.	2; Knowledge Gap	Necessary
Develop and implement standard protocols to determine WCT total abundance. • Consider the following methods: ○ Snorkeling – adult count of entire river ○ Mark recapture – watershed or reach scale ○ Catch per unit effort (could be hyper-stable, needs investigation before use) ○ Genetic analysis (needs investigation to determine if plausible). • Determine fry/parr densities (e.g., night-time snorkeling). • Determine if the different methods produce equivalent results. • Document, test, and prioritize each protocol. • Develop long-term sampling strategy to obtain data for carrying capacity.	2; Knowledge Gap	Essential
Establish a periodic schedule of WCT stock re-assessments that is prioritized around relative threat risk and	2; Knowledge Gap	Necessary

Recommended Actions	Objective[a] and Concern Addressed	Priority[b]
availability of occurrences.		
Determine if a single $N_{equilibrium}$ value for large, productive systems and its associated WCT Objective 2 target is appropriate given variability in productivity observed even among Classified Waters rivers.	2; Knowledge Gap	Necessary
Based on application of abundance-related reference points, develop a summary of WCT manage actions for each management zone (as adapted from Johnston *et al*. 2002).	2; Knowledge Gap	Necessary
For wild, unexploited WCT populations manage threats to keep populations above the Limit Reference Point (0.2 equilibrium or higher in very small populations).	2; Threats: All	Beneficial
Determine if the "persistence" goal for wild, unexploited (headwater) WCT populations of $0.2 \cdot N_{equilibrium}$ (Limit Reference Point) needs adjusting (may not be high enough). Adjust as needed.	2; Knowledge Gap	Necessary
Determine how to assess angling mortality, and obtain direct measures of catch and release mortality for each fishery (e.g., fly fishing only in catch and release zone, gear in catch and release zone, fly fishing in kill zone, gear in kill zone).	2; Knowledge Gap; Threat: Direct mortality	Necessary
Evaluate physiological impacts of catch and release: condition factor, age at size, post-release mortality (24- to 48-hr mortality standard).	2; Knowledge Gap; Threat: Direct mortality	Necessary
Habitat Protection/Restoration		
Identify key habitats for migratory and resident WCT populations.	3; Knowledge Gap	Necessary
Review fish barrier information and further investigate to confirm significance of threat (e.g., reduction in carrying capacity) to WCT.	3; Threats: Fish passage; Small-scale habitat modifications	Essential
Support *Water Act* modernization including: • establishing fish flow needs for WCT and identify priority watersheds with persistent deficiencies, • strengthen provisions regarding release of damaging substances to high risk streams, and • support/develop water management plans in priority streams.	3; Knowledge Gap; Threat: Altered flow regime	Beneficial
Explore the possibility of extending Riparian Area Regulations in Kootenays beyond Revelstoke, toward the goal of identify opportunities for regulating minimum riparian protection widths in areas of the province where they do not currently exist.	3; Threats: Small/large-scale habitat modifications	Beneficial
Complete stream restoration activities in streams with identified habitat deficiencies, impacts, or high fishing pressures	1-4; all; Threats: riparian alteration, altered flow regimes, instream habitat modifications	Essential
Sustainable And Diverse Recreational Opportunities		
Obtain use information for priority non-Classified Waters: Goat, Lussier, Findlay, and Wildhorse rivers.	4; Knowledge Gap	Beneficial
Determine linkage between catch per unit effort and fish abundance.	2, 4; Knowledge Gap	Necessary
Determine advantage of a catch per unit effort target for Classified Waters.	4; Knowledge Gap	Beneficial
Determine if commercial activities are adequately regulated on non-Classified Waters.	4; Knowledge Gap	Necessary

Recommended Actions	Objective[a] and Concern Addressed	Priority[b]
Determine benefits of small lakes recreation associated with WCT and consider ways to optimize sustainable recreation including stocking, lake enrichment, etc.	4; Knowledge Gap	Beneficial
Determine information needed to better understand and define WCT harvest opportunities. Develop a plan to explore potential harvest opportunities.	4; Knowledge Gap	Beneficial
Expand the River Guardian program to priority non-Classified Waters, including data gathering on compliance monitoring (including small streams), and harvest rate determination.	4; Threats: several	Beneficial
Consider Skeena approach (Dolan 2008) to deal with oversubscription issues for Wigwam River and Elk River.	4; Threat: Direct mortality	Necessary
Advertise WCT status via appropriate bulletin/poster program to educate public on its conservation status and required management.	1, 2, 3, 4; Threats: several	Beneficial

[a] Objectives are described in Section 6.

[b] Essential (urgent and important, needs to start immediately); Necessary (important but not urgent, action can start in 2–5 years); or Beneficial (action is beneficial and could start at any time that was feasible).

9.4.1 Population Conservation (Objectives 1 and 2)

Population protection and recovery for WCT are the top priorities for this management plan; conservation is also the foundation upon which a sustainable recreational fishery can be maintained. To date, the conservation of wild WCT populations has been mainly ad hoc and reactive, in response to declining angling quality, with a few one-off initiatives such as translocations associated with water and land use. Angling regulations have become increasingly restrictive resulting in a positive response in terms of more, larger fish observed in the few rivers tracked. Introgression and altered communities associated with past stocking initiatives have only been recently considered in stocking changes; specifically limiting stocking to sterile Rainbow Trout (3N RBT) in the East Kootenays and sterile (all female) Eastern Brook Trout (AF3N EBT) province wide (see FFSBC 2003 for a detailed description of stocked fishes). The extent to which hybridization exists and is ongoing remains unknown but potential for impact appears greatest in Upper Kootenay and Elk Population Groups. Furthermore, reference points for population abundance have not been determined and it is unclear if angling-related mortality is a significant issue in any of the fisheries (e.g., Classified Waters, non- Classified Waters summer, non- Classified Waters winter).

9.4.2 Habitat Protection/Restoration (Objective 3)

Habitat protection and restoration are fundamental components of conservation. Few landscape-level assessments have considered habitat availability and quality specifically for WCT in B.C., although several location-specific assessments have been conducted. Forestry-related concerns are thought to be mainly residual (i.e., from pre-Forest Practices Code days) although some concerns exist under the current results-based framework and require increased compliance monitoring on behalf of government and industry. Agricultural and urban development, mainly related to riparian issues and water diversions, need to ensure WCT needs are met. Furthermore, the extent that stream crossings represent a significant barrier to upstream habitats needs to be determined. Finally, water quality concerns related to coal mining are significant in the Elk Population Group and need to be monitored.

9.4.3 Sustainable and Diverse Recreational Opportunities (Objective 4)

Assuming conservation needs are met, the provision of recreational opportunities is fundamental to the Fisheries Program. Fisheries for WCT in B.C. have become increasingly conservative since the 1980s. At least in Quality Waters, the response is generally positive with quality of angling experience considered very good to high. However, overcrowding is becoming a greater issue on some streams, and compliance is a concern for both Classified and Non-classified Waters. The extent to which harvest can be maintained is not known. Similarly, there may be additional opportunities on small lakes of which we are currently unaware. Actions to be taken include exploring additional potential recreational fishing opportunities and working within the AMP process for Quality Waters to ensure that high quality opportunities are maintained. The WCT Management Plan defines WCT usable surplus; this surplus (i.e., harvest opportunities) will be addressed via an independent regulation setting process.

9.4.4 Recommended Approach

A number of initiatives and projects were recommended to provide protective measures and address key knowledge gaps for WCT (Table 10). One of the highest priority items involves defining populations and prioritizing them for conservation. It is recommended that this be undertaken at the population level as watershed-level evaluation is considered to be too coarse a filter. To do this, discrete populations will need to be identified and their abundance level and associated management approach determined (see Appendix 2). It will take significant resources to undertake a predictive modeling exercise to spatially define all populations across the landscape. However, exploited populations are readily identified, and status can be in part assessed using stock assessment tools to evaluate abundance. Angling activity will need to be taken into account as angling pressures are increasing (along with improved harvest and compliance monitoring and fishing regulation assessments). Once populations have been assessed, a methodology to prioritize conservation efforts will need to be identified and applied.

Thus, in terms of activities that can be undertaken immediately, two high priority activity areas are apparent. First, a comprehensive stock assessment plan that establishes standardized methodologies to evaluate abundance in exploited systems should be initiated as soon as possible. This approach will not only evaluate existing and new methodologies available to estimate abundance and track trends, but will also identify priority populations for trend assessment. Such a plan will enable limited resources to be appropriately allocated. Second, in terms of protective and restoration measures to address hybridization, few additional resources are required to develop two policy-related pieces: a broader piece regarding barriers- and the Swan Lake Management Plan. As well, the development of a regulatory strategy to address Rainbow Trout presence where they co-occur with WCT should be initiated.

9.5 Management Plan Updates and Implementation Monitoring

The long time span required to document population recovery and ongoing management required for exploited populations necessitates a management plan that evolves over time. There are continuing advances in our understanding of the biology of native WCT (e.g., life history determination, population biology and genetics), stock assessment methodology and results, in addition to changes in the interest and concerns of anglers, First Nations and the general public. The landscape also changes, with rapidly developing anthropogenic changes altering the threats to the species, and the structure, jurisdictions, and capacity of management agencies are in a period of uncertainty and great flux. An effective management plan must be informed by these changes and the management objectives and priorities evolve to reflect them. To be current and effective this plan should be evaluated every 5 years and updated as necessary (a SARA requirement). The goal is to provide at least one up-to-date version to inform each COSEWIC reassessment, which currently occurs approximately every 10 years (next 2016).

The Essential activities prioritized in Table 10 should be completed over the next 5–10 years, and can serve as benchmarks and performance measures to evaluate progress towards meeting the Plan objectives. These activities directly relate to the COSEWIC reasons for designation (i.e.,

hybridization and competition with introduced species, development, agricultural, and resource-based industries), and provide the stock assessment information necessary to evaluate progress toward conservation and recreation objectives.

10 EFFECTS ON OTHER SPECIES

Implementation of actions consistent with the objectives in this plan is intended to prevent WCT from becoming further at-risk and return the species' conservation status to "not at risk," and meet our global responsibility for the species' conservation. Additional outcomes of actions to maintain or improve the capacity of natural habitats and ecosystem function will benefit many other fish, mammal, and bird species. Several potentially affected SARA-listed aquatic species include Umatilla Dace (*Rhinichthys umatilla*), Shorthead (*Cottus confuses*) and Columbia (*Cottus hubbsi*) sculpins, Painted Turtle (*Chrysemys picta*), Rocky Mountain Tailed Frog (*Ascaphus montanus*), White Sturgeon (*Acipenser transmontanus*), and Bull Trout. The potential for the plan to inadvertently lead to effects on other species was considered. This plan will clearly benefit the environment and will not entail any significant adverse effects.

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Personal Communications

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Jeff Burrows. Senior Fish Biologist, B.C. Ministry of Forests, Lands and Natural Resource Operations, Nelson, BC. January 2011.

Peter Corbett. Mirkwood Ecological Consultants Ltd, Winlaw, BC. December 2010.

Kevin Heidt. Fisheries Technician. B.C. Ministry of Forests, Lands and Natural Resource Operations, Cranbrook, BC. December 2011.

Shelley Humphries. Parks Canada Aquatics Specialist, Lake Louise, Yoho and Kootenay National Parks. December 2010.

Cory Legebokow. Ecosystems Specialist. B.C. Ministry of Environment, Revelstoke, BC. December 2010.

Doug Martin. Senior Ecosystem Specialist, B.C. Ministry of Environment, Cranbrook, BC. Email correspondence. January 2011.

Craig Mount. Aquatic Habitat Geomorphologist, B.C. Ministry of Environment, Victoria, BC. January 2011.

Ron Ptolemy. Instream Flow Specialist, B.C. Ministry of Environment, Victoria, BC. December 2010.

Lars Reese-Hansen. Ecosystem Planning Biologist, B.C. Ministry of Natural Resource Operations, Victoria, BC. January 2010.

Mike Robinson. Independent Consultant, Cranbrook, BC. December 2010.

Dr. Eric Taylor. Professor, Department of Zoology, University of British Columbia, Vancouver, BC. November 2010.

Byron Woods. GIS Coordinator, B.C. Ministry of Environment, Victoria, BC. Ongoing.

APPENDIX 1. HABITAT USE IN THE ELK RIVER

The following summary describes more specifically habitat use by WCT in the Elk River; this information is useful in understanding the need for intact migration routes, as well as the extent to which WCT use different habitats at different times. This recent radio-tagging study on the Elk River conducted in 2001–2002 identified important habitats for WCT (Westslope Fisheries Ltd. 2003).

Overwintering habitat was characterized by deeper river sections with glides and pools, in both iced over and open sections of river. Fish tended to aggregate in these sections starting in October, where they remained until the following April. Most notably, the fish in the upper sections migrated twice the distance that fish in the lower sections of the Elk River did to access overwintering sites, namely the Elk Lakes. Once there, the fish remained fairly sedentary. Elk Lakes are undoubtedly one of the few areas in the headwater section of the watershed with adequate depth to support adult WCT during the winter. In the lower river sections, fish tended to move frequently throughout the winter, possibly to avoid ice movement. Fish moved both upstream and downstream to access overwintering habitat in this lower section. The longest distance traveled between spawning and overwintering habitats during the study was 60 km.

Spawning habitat was documented in both tributaries and mainstem areas where gravels have been freshly deposited post-freshet. Tributary spawners in the lower Elk River exhibited the longest migrations to spawning grounds of up to 20 km. Although macro-habitats selected for spawning varied from main channel margins to side channels and perennial creeks, the specific characteristics were fairly similar among them. Redds tended to be clumped, and found in areas with an abundance of large woody debris and undercut banks. The dominant substrate used was gravel (1.8–3.3 cm diameter). Spawning occurred in late May and June when temperatures reached 7–11^{o}C, but specific timing depended on elevation and snow pack runoff.

Conclusions from this study indicate for WCT in the Elk River:

1. A range of overwintering and spawning migrations (extensive vs. short distances) is observed, reflecting different life histories and habitat availability.
2. Spawning habitats include a range of locations (mainstem margin, offchannel, ephemeral, and perennial tributaries). While most fish spawned in the mainstem, some spawned in Morrissey, Lizard, Hartley, Michel, and Fording creeks, as well as the outlet of lower Elk Lake.
3. Spawn time appeared to be linked to key stream conditions including temperature and flow (downward limb of hydrograph after fresh gravels are deposited).
4. Microhabitat selection appears to be fairly invariable, regardless of location.

APPENDIX 2. DETAILED DESCRIPTION OF FRAMEWORK AND DERIVATION OF ABUNDANCE TARGETS (TO MEET OBJECTIVE 2)

Objective 2. *Maintain wild populations at abundance levels that prevent at-risk status assessment so that the populations can provide sustainable societal benefits*

Management framework

The three abundance thresholds are illustrated in Figure A2.1. The framework assumes that managers can alter either mortality rates or stock productivity through management actions. For populations that support recreational fisheries, the management actions will often be changes in fishing mortality rates.

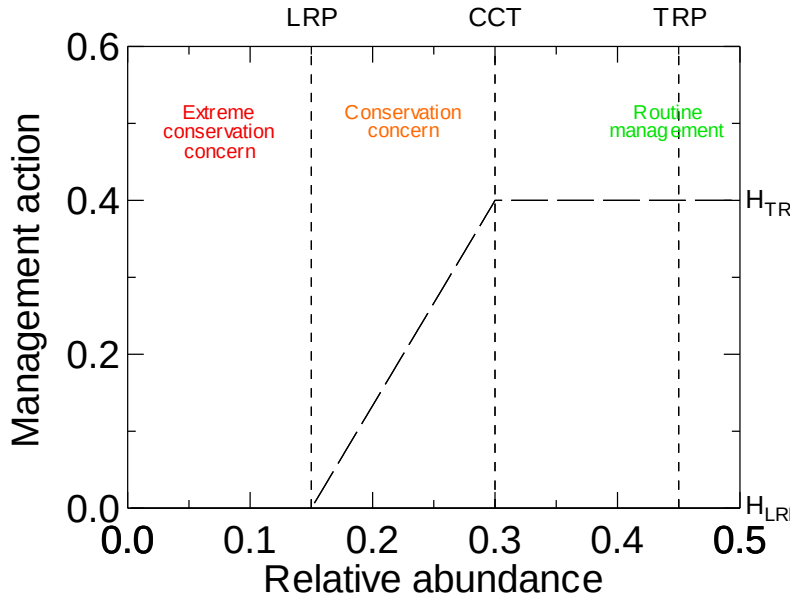

Figure A2.1. The elements of an abundance-based precautionary management framework. Three abundance thresholds (the limit reference point, LRP; the conservation concern threshold, CCT; and the target reference point, TRP) force mandatory changes in management actions that are intended to maintain a population within the routine management zone, where sustainable societal benefits are optimized. Within the conservation concern and extreme conservation concern zones of abundance, management actions are increasingly directed towards promoting population recovery (e.g., by reducing harvest rates from H_{TR} to H_{LR}), and potential societal benefits are correspondingly reduced. Population abundance is measured relative to the asymptotic maximum abundance (see below).

The key abundance threshold is the "conservation concern threshold" (CCT on Figure A2.1). The CCT identifies an abundance level below which the ability of the population to provide sustainable benefits is reduced and the likelihood of long-term decline is increased. The conservation concern threshold is used as a precautionary threshold to force mandatory management actions (such as reductions in harvest rates or other anthropogenic sources of mortality) that are intended to arrest population declines and return populations to desired abundance levels quickly under average environmental conditions. The intensity of management

actions increases as the difference between current abundance and the conservation concern threshold increases. For example, permitted fishing mortality rates would be decreased at lower population abundance (Figure A2.1). A population whose abundance is below the conservation concern threshold may still be capable of providing sustainable societal benefits such as fish harvest, but at a reduced level. Operationally, we define the conservation concern threshold to be the adult abundance at maximum sustainable yield, N_{MSY}, below which a population is considered to be overfished. This usage conforms to the FAO *Code of Conduct for Responsible Fisheries*, which considers a minimum management objective to be to "maintain or restore stocks at levels capable of producing maximum sustainable yield."

The limit reference point (LRP on Figure 1) marks an abundance level below which the risk of non-recovery to the routine management zone within a predetermined time under average environmental conditions is deemed to be unacceptable. As abundance declines below the LRP, the long-term viability of the population and its ability to provide desired societal benefits in the future are increasingly threatened. For small populations, the risk of extinction will increase greatly at abundances below the LRP. The LRP is intended to force management actions to restore a depressed population before population viability is imperiled. Management actions could include extraordinary measures such as the elimination of all anthropogenic sources of mortality, the reduction of controllable sources of natural mortality, and measures to increase stock productivity. Operationally, we define the LRP for moderately productive salmonid populations such as WCT to be the abundance from which a population is expected to recover to the conservation concern threshold within 1–2 generations under average environmental conditions. Simulations of the dynamics of a well-studied steelhead population indicate that this definition will usually avoid extirpation for small stocks when combined with mortality reductions (Johnston *et al*. 2000). Because the rate of recovery of a depressed population depends on stock productivity, which is usually known imprecisely, it is desirable to define the LRP such that it remains effective despite this uncertainty.

Abundance levels above the conservation concern threshold define a "routine management zone" (Figure A2.1) where the risk of an irreversible decline in abundance is low and the population can be managed to optimize societal benefits. The target reference point (TRP in Figure A2.1) is the abundance level at which the chosen measure of societal benefit is maximized. The location of the TRP will vary with the management objectives for the stock and with the factors that are included in the metric of societal benefit that is to be maximized. Stakeholder consultations may help define the factors to be considered. For harvest fisheries, the TRP may be close to N_{MSY} to maximize yields, whereas for catch and release fisheries the TRP may be close to the unfished equilibrium abundance to maximize expected catch rates. Specific analyses to determine the TRP may be required if economic criteria or other non-fishery measures of societal benefit are to be considered, but in no circumstances will the TRP be permitted to be below the conservation concern threshold.

Abundance thresholds and benchmarks for WCT

Defining management reference points for WCT and other species that may exist as numerous small, discrete populations is difficult because normally there is little or no quantitative abundance information available for a given population. In particular, there are few data on stock productivity, which determines the rate of recovery at low abundance. Even where reliable data

exist, estimates of the parameters that are needed to establish reference points can be very imprecise. Establishing effective limit reference points is particularly important, however, because the small size of many populations increases their vulnerability to extirpation. Because of the data limitations, effective reference points that do not require stock productivity information are desirable. Our approach is to use a simple analytical method to determine limit reference points and conservation concern thresholds. The method is appropriate for demographically independent populations of territorial, stream-rearing salmonids whose stock-recruit relationships often approximate a Beverton-Holt model (Figure A2.2). Although there are other alternatives, this model is reasonable and gives thresholds that can be estimated from limited abundance data for unexploited populations. For a Beverton-Holt stock-recruit relationship, the CCT (defined to be N_{MSY}) is:

$$CCT = N_{MSY} = B \cdot a^{-0.5} - B \cdot a^{-1}$$

(Johnston *et al*. 2002).

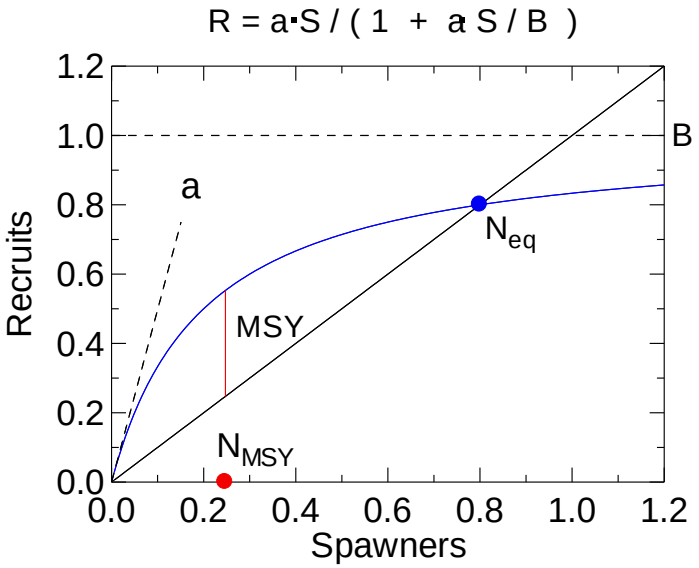

Figure A2.2. A Beverton-Holt stock-recruitment relationship (blue line): Recruits = a·Spawners / (1 + a·Spawners / B), where a is the stock productivity and B is the asymptotic maximum abundance. Stock productivity is the rate of population increase at very low abundance (diagonal dashed line, labelled "a"). The asymptotic maximum abundance, B, is the expected recruitment at very high spawner abundance; it is estimated from a time-series of spawner-recruit data. An unfished population will fluctuate about the equilibrium population size, $N_{equilibrium}$, which is always less than B for a Beverton-Holt model. The solid black line is the 1:1 line where recruits equal spawners. The difference between the 1:1 line and the stock-recruit relationship is the (potentially) harvestable surplus. N_{MSY} is the spawner abundance which produces the largest harvestable surplus. In this example, a = 5, spawners and recruits are both given in units of B, $N_{MSY} = 0.247 \cdot B$ and $N_{eq} = 0.80 \cdot B$.

Although the conservation concern threshold depends on stock productivity, it is a slowly varying function of stock productivity within the range typically seen for salmonids, and has an upper bound of 0.25·B (Figure A2.3). While we lack estimates of stock productivity for most populations of WCT, we can nevertheless define the conservation concern threshold as 0.25·B

(we will later modify this value slightly to account for environmental variability). This value will be a very good approximation to the exact value over the range of stock productivity that is likely for small populations of salmonids (Figure A2.3, left panel) and it will provide significant protection to populations with very low stock productivity, which is a desirable outcome for small populations that are especially vulnerable to extirpation. If the conservation concern threshold is defined as a constant proportion of the asymptotic maximum abundance, the limit reference point for one-generation return can easily be determined. The LRP is:

$$LRP = B \cdot CCT / a \cdot (B - CCT).$$

The limit reference point depends strongly on stock productivity but is bounded by 0.13·B for recovery to N_{MSY} within one generation (Figure A2.3, left panel). Recovery to 0.25·B requires a slightly higher limit reference point at very low stock productivity (Figure A2.3, left panel).

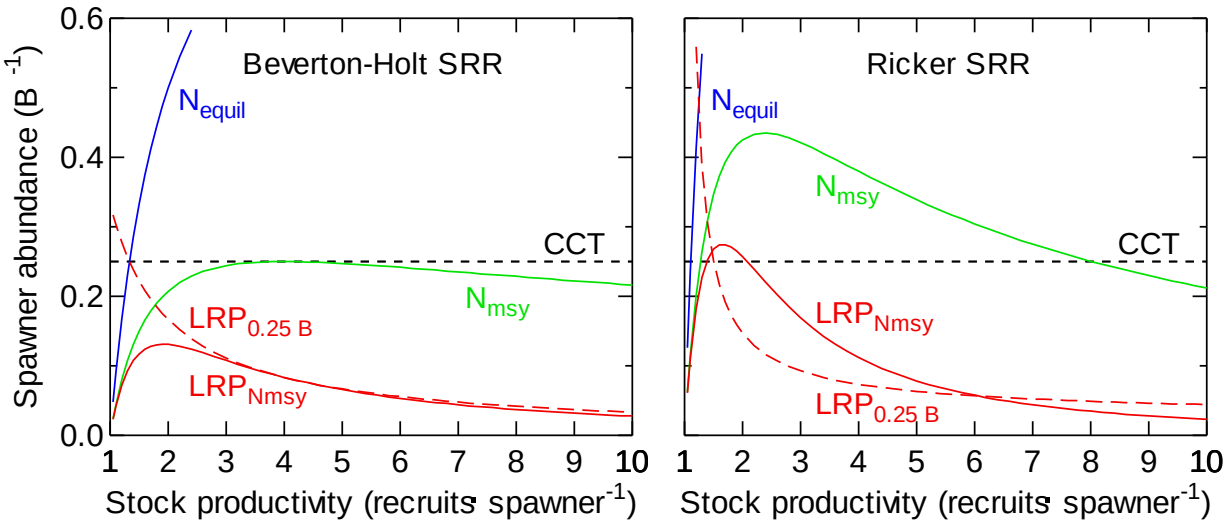

Figure A2.3. Abundance-based management thresholds may vary with stock productivity. The spawner abundance at maximum sustainable yield (N_{MSY}, solid green line) for a Beverton-Holt type stock-recruitment relationship (left panel) is a slowly-varying function of stock productivity that approximates (and is bounded by) 0.25·B (CCT, dashed black line) where B is the asymptotic maximum recruitment. The spawner abundances from which a stock can recover to N_{MSY} (solid red line) or to 0.25·B (dashed red line) within one generation define possible limit reference points (LRP). For a Ricker-type stock-recruitment relationship, N_{MSY} varies more strongly with stock productivity and is a greater proportion of the asymptotic maximum abundance than N_{MSY} for a Beverton-Holt SRR with the same stock productivity. $N_{equilibrium}$ (blue line) is the equilibrium abundance about which an unfished population will fluctuate.

In the absence of population-specific stock productivity information, defining management thresholds as fixed proportions of the asymptotic maximum abundance (e.g., LRP ≈ 0.13·B and CCT ≈ 0.25·B) is a justifiable approximation that will be operationally effective in many cases. There are two potential pitfalls inherent in this approach, however. The first is uncertainty about the "true" structural form of the stock-recruitment relationship. The management thresholds suggested for a Beverton-Holt type stock-recruitment relationship are apparently less effective for a Ricker model (Figure A2.3, right panel) or for a hockey-stick model (Johnston *et al*. 2002). The second pitfall is the fact that the asymptotic maximum abundance is not directly observable for a Beverton-Holt model; it is estimated from stock-recruitment analyses. Unexploited

populations will fluctuate about their equilibrium abundances, which are considerably lower that the asymptotic maxima (Figure A2.2).

The potential management thresholds can be re-expressed as proportions of the observable equilibrium abundance (Figure A2.4). It is apparent that management thresholds for unproductive stocks must be large fractions of their equilibrium population sizes, e.g., CCT ≈ $0.4 \cdot N_{equilibrium}$ to $0.5 \cdot N_{equilibrium}$ and LRP ≈ $0.3 \cdot N_{equilibrium}$ to $0.4 \cdot N_{equilibrium}$ independent of the form of the stock-recruitment relationship. For moderately productive stocks, say $a \geq 3$ recruits·spawner^{-1}, CCT values should be roughly $0.35 \cdot N_{equilibrium}$ to $0.4 \cdot N_{equilibrium}$ and LRP ≈ $0.1 \cdot N_{equilibrium}$ to $0.2 \cdot N_{equilibrium}$. In general, the effect of parameter uncertainty and environmental variability is to increase the required management thresholds, although this depends on the variance of the stochastic process error and the nature of the control rules applied between the conservation concern threshold and the limit reference point (Johnston *et al*. 2000); an example of the effectiveness of various LRP definitions in altering the risk of "extinction" is given in Figure A2.5. Unfortunately, we currently lack the demographic information to perform similar analyses for WCT. In the absence of stock productivity information, we propose that the conservation concern threshold should be assumed to be $0.4 \cdot N_{equil}$ and the limit reference point to be $0.2 \cdot N_{equilibrium}$.

The equilibrium abundance from which population-specific management abundance thresholds can be established can be approximated as the average density measured for unexploited populations in undisturbed habitat or estimated from habitat capacity models. For a salmonid species whose life-history can be separated into a juvenile stage with density-dependent mortality and an older stage with density-independent mortality, the appropriate density for setting management thresholds must occur after the density-dependent stage, which is often the smolt stage. For WCT, the best current estimates of habitat capacity are likely the densities of catchable fish (i.e., those fish > 30 cm fork length) estimated from snorkel surveys on lightly fished populations (e.g., Oliver 1990) or on classified waters with mandatory catch and release regulations where fishing mortality may be low (e.g., Hagen and Baxter 2009). Data for the lower St. Mary River, a large and productive system, suggest an equilibrium abundance near 75 fish > 30 cm fork length per river km (Oliver 1990). Densities on other Classified Waters currently range from about 15 to 45 fish·km^{-1} (Hagen and Baxter 2009); however, it is not clear whether these values can be considered as estimates of the equilibrium densities of the various populations.

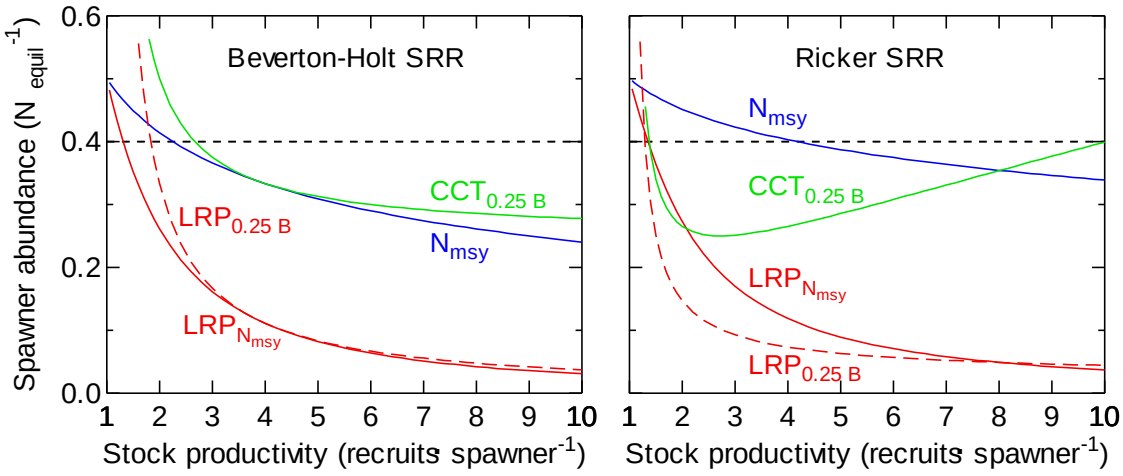

Figure A2.4. Management thresholds expressed in terms of the equilibrium abundance, $N_{equilibrium}$, for Beverton-Holt (left panel) and Ricker (right panel) stock-recruitment relationships. N_{MSY} is the spawner abundance at maximum sustainable yield, $CCT_{0.25B}$ is 0.25 of the asymptotic maximum abundance, LRP_{Nmsy} is the abundance from which a population can recover to N_{MSY} within one generation under average conditions, and $LRP_{0.25B}$ is the abundance from which a population can recover to 0.25 of the asymptotic maximum abundance within one generation under average conditions.

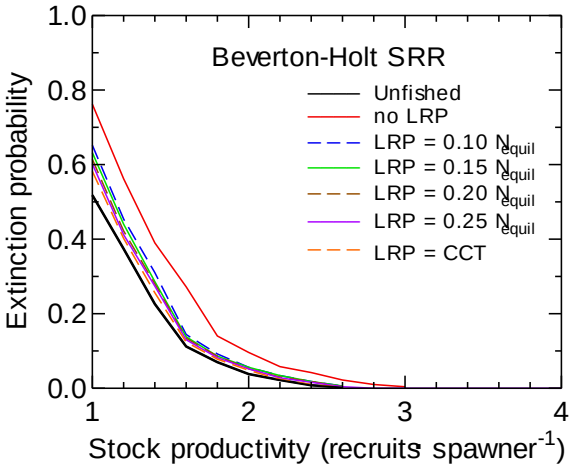

Figure A2.5. The probability of quasi-extinction (N < 10 adults averaged over a generation) of low-productivity stocks under an abundance-based management framework with a constant exploitation rate of 0.1 in the routine management zone that declines linearly to zero between a conservation concern threshold at $0.4 \cdot N_{equilibrium}$ and a limit reference point as indicated. The simulation incorporates realistic levels of temporally autocorrelated process error and implementation error. The example is for populations with an equilibrium abundance of 1000 adult fish and is based on the demographics of the Keogh River steelhead stock; see Johnston *et al.* (2000) for details. The simulations suggests that small, very unproductive stocks in variable environments with runs of good and poor survival have a high risk of extinction but that limit reference points in the range of $0.1 \cdot N_{equilibrium}$ to $0.2 \cdot N_{equilibrium}$ give results that approach that of an unexploited population. Moderately productive populations (stock productivity > 2.5 recruits per spawner) have a low extinction risk under any management framework that enforces a conservation concern threshold and a limit reference point, although at a cost in terms of access to the

fishery. The simulation results allow policy comparisons but the estimated extinction risks should not be considered to be accurate.

APPENDIX 3. DEFINING POPULATION GROUPS

The U.S. *Endangered Species Act* provides for the very formally described Evolutionarily Significant Units, whereas COSEWIC, designated under SARA to assess wildlife conservation status, defines Designatable Units (DUs). Two WCT DUs were defined, coinciding with the two provincial jurisdictions in which the species occurs in Canada, namely Alberta and B.C.

Steelhead Trout (*Oncorhyncus mykiss*) in B.C. are managed as discrete, reproductively-isolated populations (or stocks) at the scale of third-order or larger watersheds (Johnston *et al*. 2002; Parkinson *et al*. 2005). Populations at this spatial scale appear to be sufficiently isolated, based on genetic data and related assumptions, to have independent population dynamics. Johnston *et al*. (2002) propose the watershed-scale level as the appropriate one to describe "stocks" or "stock aggregates" to which operational objectives for management should be applied. Furthermore, they support finer-scale management where appropriate to conserve specific ecotypes. They recognize however, that this may prove not practical because of the lack of information and resources available to manage individual stocks.

Rationale

This section describes the rationale for using genetic structure and drainages to define Population Groups:

1. Genetic structure (summarized from Costello 2008)

Molecular genetic data are widely accepted as one descriptor of within-species diversity; namely, this data provides an estimate as to what degree reproductive isolation occurs. The more isolated populations are, the greater the likelihood for locally adaptive traits to evolve independently from other populations.

Taylor *et al*. (2003) noted that an unusually high degree of genetic variance based on microsatellite analysis was attributed to differences among populations (32%), emphasizing the need to consider "management units" at fairly small geographic scales (compare with anadromous salmonid populations where this variation is typically < 10%). This degree of differentiation suggests significant contemporary population structure with fairly limited gene flow even at localized levels. Limited gene flow means that populations cannot rely on regular immigration for recolonization or to bolster numbers. Furthermore, many isolated populations have very little genetic variation reflecting small population sizes and no gene flow with other populations (e.g., Taylor *et al*. 2003). For example, B.C. populations above migratory barriers tend to have significantly fewer alleles per microsatellite locus compared to those below barriers (Taylor *et al*. 2003). Low variation within populations does not necessarily suggest inbreeding; however, it does emphasize the need to maintain many populations to ensure adequate conservation of genetic diversity across the species. Furthermore, these isolated populations frequently express high frequencies of alleles rare or non-existent elsewhere again emphasizing to need to maintain as many populations as possible across the landscape (Taylor *et al*. 2003). Overall, these results indicate that populations tend to cluster geographically and are associated with watersheds, with outliers being highly isolated headwater populations. Significant divergence among populations even where genetic exchange is possible suggests strong

demographic independence and a need to manage at a local population level, despite extensive movements often observed (Taylor *et al*. 2003).

Three main population clusters were apparent from these genetic analyses: (1) mainstem and tributary populations in the upper Kootenay River; (2) mainstem and tributary populations in the Elk River; (3) mainstem and tributary populations from upper Fording River (above the barrier). In addition, a heterogeneous set of above barrier headwater populations from locations west of the confluence of Kootenay and Columbia rivers did not cluster with any of the other groups suggesting much greater isolation and higher potential for divergence associated with these isolated habitats. However, significant variation among populations lacking any obvious barriers suggests significant isolation even among adjacent populations (Taylor *et al*. 2003).

2. Major drainages

Hierarchical structure as reflected by drainage organization is considered an appropriate way to classify freshwater systems according to key spatial and temporal processes (see Ciruna *et al*. 2007 and references therein). B.C. has adopted such a freshwater classification framework to describe systems at three spatial scales; Freshwater Ecoregions (of which there are 5), Ecological Drainage Units (EDUs, of which there are 36) and finally at the most detailed level River and Lake Ecosystem Types. We roughly followed the second tier of this classification framework to identify major drainages within the native range for WCT. These EDUs are intended to capture both historic (i.e., zoogeography) and contemporary (i.e., physiographic and hydrologic) processes influencing species distribution (Ciruna *et al.* 2007). The original EDUs include Upper Columbia, Columbia-Arrow Lakes, Upper Kootenay, Lower Kootenay, Kettle, Flathead and Thompson; all of which reflect different zoogeographic, physiographic and hydrologic traits (Ciruna *et al*. 2007). Parkinson *et al*. (2005) also considered major drainages in considering hierarchical organization of diversity for steelhead, rationalizing that populations evolving in a similar geographic regions likely share adaptive traits.

Six major drainage basins fall within WCT native range in B.C. including the Upper Kootenay (above the original location of Kootenai Falls below Kookanusa Reservoir), Elk (including tributaries above Elko Dam), West Kootenay (Kootenay Lake and downstream), Columbia (including Arrow Lakes, Pend d'Oreille), Kettle and South Thompson.

Population Groups

In combining the identified six watershed units and three genetic groupings, seven Population Groups were defined (Table A3.1). Given that Upper Fording genetic group occurred above a natural barrier, it will be treated as other "headwater" isolated populations but it is included in the Elk Population Group. Headwater populations will be treated as "special cases" within their Population Group, given their highly isolated, vulnerable nature.

Table A3.1. Defined Population Groups based on genetic data and delineated major drainages within native WCT range

Drainages	**Additional genetic groups within drainages**	**Population Group**	**Range status**
Elk	Elk River and tributaries	Elk	Core
Elk	Upper Fording River and associated tributaries (above barrier)	Elk	Core
Flathead	N/A (not well represented)	Flathead	Core
Upper Kootenay	Mainstem Upper Kootenay and tributaries	Upper Kootenay	Core
West Kootenay	N/A (not well represented)	West Kootenay	Core/Peripheral
Columbia	N/A (not well represented)	Columbia	Peripheral
Kettle	Above barrier set	Kettle	Peripheral
South Thompson	Above barrier set	South Thompson	Peripheral

APPENDIX 4. INTROGRESSION

Hybridization with non-native trout species leading to introgression and hybrid swarms is persistently identified as one of the greatest threats to WCT throughout its North American range. In fact, it is estimated that non-hybridized populations of WCT now persist in less than 10% of their historic range, and those are frequently restricted to isolated headwater systems highly vulnerable to extinction associated with stochastic events (Trotter 2008).

A total of 114 sites (some including lower, upper, and in some cases middle sections of the same river) representing 88 waterbodies (both streams and lakes) were assessed for hybrid presence (see Table A4.2). As it is very difficult to differentiate between very low levels of hybridization and polymorphisms within the species (i.e., < 1% admixture) (Allendorf *et al*. 2001), any populations with WCT genotypes representing 99% or more of the population are considered pure WCT.

Several studies considered patterns of hybridization spread and potential mechanisms that facilitate or limit spread in B.C. WCT populations (Hitt *et al*. 2003; Rubidge and Taylor 2005; Boyer *et al*. 2008; Bennett and Kershner 2009). Key conclusions from these studies include:

1. Backcrosses (i.e., beyond F_1 hybrids) are the most common form of hybrid in the B.C. populations studied, indicating an ongoing ability to interbreed among the various hybrid and pure forms.
2. Some populations are approaching hybrid swarm status where no pure WCT genotypes remain.
3. Admixture with Rainbow Trout decreases with upstream distance from Rainbow Trout source or hybrid swarm.
4. Populations above migration barriers contain fewer hybrids than below barriers.
5. The role of environmental factors in limiting the spread of hybridization may not be as important as demographic factors.
6. Hybrids appear to facilitate further spread of Rainbow Trout genes to neighbouring populations via increased straying rates compared to pure WCT.
7. Much of the core B.C. range is not the stronghold for remaining pure WCT populations we had thought it to be.
8. Although all B.C. stocking of Rainbow Trout into native WCT range is now conducted using sterile fish which will prevent further hybridization at new locations, introgressed populations can persist indefinitely (although can be diluted through time), making the protection of non-introgressed populations the highest priority.

In summary, these studies indicate that two main Population Groups are seriously compromised by non-native Rainbow Trout introgression. Some pure WCT populations still exist in these groups but these populations tend to be located in upstream portions of tributaries. The Flathead River appears to be the only group with no hybridization present, at least in the Canadian portion of the river. Survey work has been too limited to draw conclusions about the status of peripheral Population Groups. WCT appear to be naturally limited to tributaries while native Rainbow Trout tend to dominate downstream mainstems in these areas suggesting natural reproductive isolation has prevented extensive introgression here.

Table A4.2. Percent of populations considered to be pure WCT based on genotypic data by Population Group. Note that in some cases, the approximate location within the stream was reported by researchers (L = lower, M = Mid, U = upper), otherwise location was reported as "unknown." (WCT = Westslope Cutthrout Trout, RBT=Rainbow Trout)

Population Group	**Location in stream**	**>98% WCT**	**95 – 98% WCT**	**<95% WCT**	**Pure RBT**	**% Pure WCT populations**
Elk	L	1	2	5	0	12.5
	M	1	0	1	0	50.0
	U	3	0	2	0	60.0
	unknown	2	0	0	0	100.0
Elk Total (11 waterbodies)		7	2	8	0	41.2
Flathead	L	1	0	0	0	100.0
	U	2	0	0	0	100.0
	unknown	11	0	0	0	100.0
Flathead Total (8 waterbodies)		14	0	0	0	100.0
Upper Kootenay	L	3	1	13	0	17.7
	M	3	0	4	0	42.9
	U	5	1	2	0	62.5
	unknown	12	4	2	0	66.7
Upper Kootenay Total (45 waterbodies)		23	6	21	0	48.0
West Kootenay Total (3 waterbodies)		3	0	0	0	100.0
Columbia	L	2	0	0	0	100.0
	M	1	0	0	0	100.0
	U	2	0	0	0	100.0
	unknown	16	1	2	3	72.7
Columbia Total (18 waterbodies)		21	1	2	3	77.8
Kettle Total (2 waterbodies)		1	0	1	0	50.0
South Thompson Total (1 waterbody)		1	0	0	0	100.0
Grand total (88 waterbodies)		70	9	32	2	61.4

APPENDIX 5. ABUNDANCE

Information on population abundance is extremely limited for WCT in B.C. Some short-term monitoring has been undertaken in the East Kootenays to estimate abundance in some high priority streams.

Snorkel surveys have been conducted at a number of index sites for several popular WCT streams to estimate abundance and densities. Snorkel surveys appear to be fairly efficient (i.e., snorkelers are able to observe most fish) for adult and sub adult WCT (reviewed in Hagen and Baxter 2009). Table A5.1 summarizes abundance estimates and trends for WCT rivers for which surveys have been conducted.

Table A5.1. Summary of abundance and density estimates for WCT in a small set of streams from the Elk and Upper Kootenay Population Groups.

System	Abundance			Conclusion
	Year	Estimate	Fish/km	
Wigwam River[a, b] - between Desolation and Lodgepole creeks - 42.1 km length	2008	> 300 mm = 701 > 400 mm = 189	12–24 4–6	Shift in densities upstream over time, but overall abundance appears to be fairly stable, 2008 estimate for large fish was higher than for 2001 or 2002 upstream of Bighorn Creek; 2008 estimate for large fish was lower than for 2001 or 2002 downstream of Bighorn Creek
	2002	> 300 mm = 341 > 400 mm = 95	5–32 2–9	
	2001	> 300 mm = 295 > 400 mm = 64	10–33 2–7	
Michel Creek[a] - three sections surveyed (upper, middle, and lower) - total length is 36.7 km	2008	> 300 mm = 1704 > 400 mm = 611	46 17	A highly productive population with a large proportion of very large fish
Lower St. Mary River[a] - 54.1 km	2008	> 300 mm = 2360	44	Recovery from low abundance in late 1980s/early 1990s evident but highest density was in 1982 suggesting carrying capacity is greater than what is currently observed. Note also a clear reduction in fork length from a mean of 342 mm in 1981 to 271 mm in 1989 was observed[c]
	1994	> 300 mm = 1731	32	
	1990	> 300 mm = 920	17	
	1989	> 300 mm = 1082	20	
	1984	> 300 mm = 2435	45	
	1982	> 300 mm = 4166	77	
Upper St. Mary River[e] 3.9 km (Mud Hole Rd. to Meachen Bridge)	2010	> 300 mm = 493	17	
Upper St. Mary River[a, e] - 2.8 (km 43.5 to Pyramid Cr.)	2010 2008	> 300 mm = 493 > 300 mm = 49 > 400 mm = 10	21 14 3	Fairly limited in extent of coverage
Elk River[a] - 4.9 km	2008	> 300 mm = 192* > 400 mm = 108*	39* 22*	Feasibility study only but observed 192 trout > 300 mm, over half of which were > 40 mm; *note that these are unadjusted counts
Upper Bull River - between Van Creek and Aberfeldie headpond[c] – 11 km	2006	> 300 mm = 538 > 400 mm = ?	33 4	WCT are widely distributed except for first km up stream/s of headpond, with densities similar to those viewed elsewhere in river
Upper Bull River[d] - between Sulphur Creek and Van Creek - 17.5 km	Year?	> 300 mm = 860 > 400 mm = ?	39 3	Included both a catch and release section and an adjacent harvest section;

System	Abundance			Conclusion
	Year	Estimate	Fish/km	
White River (N. Fork)[e] Goat Camp to Colin Cr. - 2.7 km	2010	> 300 mm = 260	10.2	
White River (N. Fork)[e] - Nilksuka upstream - 2.3 km	2010	See above	6.5	

From [a]Hagen and Baxter 2009, [b]Baxter and Hagen 2003, [c]Baxter 2006, [d]Baxter 2004, [e]K. Heidt, pers. comm., 2011.

Densities vary with stream with the upper St. Mary and Wigwam rivers clearly less productive than Michel Creek and lower St. Mary River. Wigwam's unexpanded estimate suggests densities that are even higher than the other streams surveyed (Hagen and Baxter 2009).

Catch per unit effort data (CPUE) can also provide an index of fish abundance. A recent radio-tagging study in the lower Elk River indicated that CPUE values for fish 350 mm long or greater were considerably larger in the lower Elk River (Elko Dam to Sparwood, catch and release and harvest sections combined = 2.36 fish per hour) compared to the upper Elk River (Sparwood to lower Elk Lake, catch and release and harvest sections combined = 0.97 fish per hour) (Westslope Fisheries Ltd. 2003).

With respect to headwater fluvial populations, a modeling exercise considered population responses to carrying capacity of habitat in terms of likelihood of extinction (Hilderbrand 2003). Results indicated that likelihood of extinction declined significantly as carrying capacity increased, even if these increases were very modest. This reflects a general negative relationship between extinction rate and population size. The conclusion was that we should maintain as large a population size as possible for small isolated populations and maintain supporting habitat. Big gains can be made through habitat length increase (and removing non-native species) and habitat quality. Furthermore, this study noted that immigration to small isolated systems can reduce extinction risk without risk to source population. Thus we should maintain natural connectivity between core populations as peripheral populations. However, this benefit decreases as population dynamics between large migratory and small isolated populations become increasingly synchronized.

APPENDIX 6. ANGLING MORTALITY

During snorkel survey studies in 2008 (Hagen and Baxter 2009) hooking injury was documented. Only Wigwam and Michel systems could be adequately assessed due to visibility limitations in other systems. In both systems, the proportion of fish with injuries increased significantly with size as follows: 0–54% for fish < 200 mm long, 5–76% for fish 200–300 mm long, 15–92% for fish 300–400 mm long to 26–94% for fish > 400 mm long. Michel Creek in general had higher frequencies of injuries for all size groups, likely owing to its small stream size and vulnerability of fish.

Given that hooking mortality is typically 3–5%, cumulative hooking mortality over an entire season may be significantly more. This is a particular concern for a species like WCT, which may be caught multiple times in one season.

A radio-tagging study that tracked adults for 2 years in the Elk River estimated rates of mortality associated with various sources as follows: 12.5% (spawning), 5% (avian), and (17.5%) angler harvest (Westslope Fisheries Ltd. 2003).

APPENDIX 7. RIPARIAN HABITAT BUFFERS

Forestry-related Issues

Oliver (2009) considered the impact of forestry-related activities to WCT habitat and found that in an evaluation of 50 watersheds within the Upper Kootenay and Columbia Population Groups, only 5 exceeded sensitivity guidelines and greatest sensitivities were in smaller basins. Higher hazard ratings for surface erosion and mass wasting were consistent for basins with equivalent clearcut area greater than 10%. It is uncertain how representative this small portion of streams is for WCT in B.C. Forestry practices have generally improved dramatically over the past 30 years, and current practices under the B.C. *Forest and Range Practices Act* (FRPA, implemented in 2004) are intended to provide adequate riparian habitat buffer zones for fish-containing streams. Palliser Creek is currently the only stream within the range of WCT identified as a Fisheries-Sensitive Stream under FRPA to which more stringent management guidelines are applied to protect fisheries values. Section 7.3.4, Habitat Access (also see Appendix 10) discusses road crossings more specifically.

Agriculture-related Issues

Of the 52 Crown range units identified in the Southern Rocky Mountain Trench and Elk Valley, 22 are considered active and 8 may be of particular concern to WCT due to cattle access to streams (Oliver 2009). Sensitivity is greatest where streams are small.

Mining-related Issues

There are a few examples within the range of WCT of where rock drains have permanently eliminated fish habitat and passage (e.g., Line and Kilmarnock creeks), and temporary diversions may also affect fish passage (Oliver 2009). Numerous off-channel areas and wetlands have been compromised or eliminated in the Elk Valley by tailings and settling ponds (Oliver 2009). The extent to which this has compromised riparian habitat within WCT range has not been calculated; impacts are likely only significant for a limited number of streams.

Urban Development Issues

Impacts to riparian habitats have probably best been described for Cranbrook where the WCT stream, Joseph Creek, flows through the city. Altered surface run-off patterns associated with paved surfaces and storm sewer inputs have resulted in elevated sediment loads entering the stream at certain high water times (Oliver 2009). This issue is undoubtedly repeated in all communities within the WCT range (i.e., Kimberley, Fairmont, Golden, Revelstoke, Castelgar, Invermere, and Trail) but is probably greatest where receiving waters involve relatively small streams rather than large mainstems (like the Columbia and Elk rivers) were impacts are diluted (Oliver 2009).

Roads and Transportation Line Issues

Probably the greatest concern is related to the number of highway and railway crossings on smaller WCT streams, affecting passage to other habitats (Oliver 2009). The actual impact associated with riparian habitat is probably very localized and associated more with construction.

APPENDIX 8. NATURAL FLOW CONDITIONS

Almost all of the native WCT range in B.C. falls within the Southern Interior Mountains Ecoprovince, a region characterized by two distinct climate regimes: one occurs in the mountainous areas and the other in the Southern Rocky Mountain Trench. The Trench is naturally flow-sensitive, and a recent analysis indicated that unit run-off was generally low in all ecosections within the ecoprovince but very low (i.e., dry) within the East Kootenay Trench, as well as the McGillivary Range (Ptolemy 2010). These two ecosections contain two tributaries with known fish-flow conflicts, Wolfe and Joseph creeks. In particular, it is estimated that adult trout upstream passage and spawning flows of near 124% mad (mean annual discharge) are required for days to weeks during May-June on small streams such as Joseph Creek (Ptolemy 2010). Spring flows in 1977 averaged 136 $L \bullet s^{-1}$ or 8.5% mad with resultant spawning failures. Failures also likely occurred in 1992 and 2001 (Oliver 2003).

APPENDIX 9. SITE FIDELITY

WCT in the Elk River demonstrate site fidelity to both summer feeding areas and spawning locations, not only at the population level (i.e., using genetic data) but also at the individual fish level as demonstrated by a 2-year radio-tagging study (Westslope Fisheries Ltd. 2003). In fact, 25% of the tagged adults migrated to the same site in 2 consecutive years. The average length of stream used by WCT in this study to winter and spawn was 11.2 km, and ranged from 1.8 to 35.9 km. Furthermore, fish in the upper portion of the Elk River used twice as much river habitat over the course of a year than those in the lower river, undoubtedly reflecting availability of suitable habitat particularly ice-free habitats for overwintering (Westslope Fisheries Ltd. 2003).

This fidelity is clearly expressed in the significant genetic population structure evident among B.C. populations where a considerable amount of genetic variation is attributed to differences among populations (i.e., 32% of total variation; Taylor *et al*. 2003). Although WCT may range considerably throughout a year using various habitats to feed, rear, spawn, and overwinter; local population structure indicates that homing in this species is very strong. From a conservation perspective, these results indicate that a breadth of habitats and migratory corridors must be maintained for this species.

APPENDIX 10. STREAM CROSSINGS

Table A10.1. The estimated number of crossings associated with forestry roads in seven WCT Management Group areas that have been assessed as being a problem for fish passage.

A total of 69,131 crossings associated with forestry roads in seven WCT Management Group areas were estimated based on a modeling exercise, of which about two-thirds (42,483) of these are modelled to be on fish habitat (C. Mount, pers. comm., 2011). A total of 2017 (< 5%) of these crossings have been assessed for fish passage problems. Of that subset, roughly half are Closed Bottom Structures (CBS). Data provided by C. Mount. Assessed systems are all assumed to be fish habitat.

			Assessed					Modelled	
WCT Population Group	Crossing Type	Crossing Subtype	n Total	n Barrier	n Potential Barrier	Pct Barrier	Pct Barrier or Potential Barrier	n Crossings (Fish Habitat)	n Crossings (non Fish Habitat)
Columbia	CBS	OVAL CULVERT	2	2		100%	100%		
Columbia	CBS	ROUND CULVERT	233	108	11	46%	51%		
Columbia	NCS		57			0%	0%		
Columbia	NCS	FORD	7			0%	0%		
Columbia	OBS		8			0%	0%		
Columbia	OBS	BRIDGE	82			0%	0%		
Columbia	OBS	PIPE ARCH	3	1		33%	33%		
Columbia	OBS	WOOD BOX CULVERT	24			0%	0%		
Columbia	OTHER		6			0%	0%		
Columbia Sub Total (all)	all	all	422	111	11	26%	29%	12,416	10,243
Columbia Sub Total (CBS only)	CBS	all CBS	235	110	11	47%	51%		
Kettle	CBS	OTHER	2	1		50%	50%		
Kettle	CBS	ROUND CULVERT	174	62	32	36%	54%		
Kettle	NCS		34			0%	0%		
Kettle	NCS	FORD	11			0%	0%		
Kettle	OBS	BRIDGE	4			0%	0%		
Kettle	OBS	PIPE ARCH	7	3		43%	43%		
Kettle	OBS	WOOD BOX CULVERT	5			0%	0%		
Kettle Sub Total (all)	all	all	237	66	32	28%	41%	9,018	2,126
Kettle Sub Total (CBS only)	CBS	all CBS	176	63	32	36%	54%		
South Thompson	CBS	ROUND CULVERT	344	147	23	43%	49%		
South Thompson	NCS		105			0%	0%		
South Thompson	NCS	FORD	2			0%	0%		
South Thompson	OBS	BRIDGE	105			0%	0%		
South Thompson	OBS	PIPE ARCH	4			0%	0%		
South Thompson	OBS	WOOD BOX CULVERT	1			0%	0%		
South Thompson	OTHER		115			0%	0%		
South Thompson Sub Total (all)	all	all	676	147	23	22%	25%	4,447	2,636
South Thompson (CBS only)	CBS	all CBS	344	147	23	43%	49%		
Upper Kootenay	CBS	ROUND CULVERT	101	71	11	70%	81%		
Upper Kootenay	NCS		85			0%	0%		
Upper Kootenay	NCS	FORD	62			0%	0%		
Upper Kootenay	OBS	BRIDGE	7			0%	0%		
Upper Kootenay	OBS	WOOD BOX CULVERT	8	2	2	25%	50%		
Upper Kootenay	OTHER		7	1	1	14%	29%		
Upper Kootenay Sub Total (all)	all	all	270	74	14	27%	33%	9,350	4,295
Upper Kootenay Sub Total (CBS only)	CBS	all CBS	101	74	11	73%	84%		
West Kootenay	CBS	ROUND CULVERT	151	96	6	64%	68%		
West Kootenay	NCS		124			0%	0%		
West Kootenay	NCS	FORD	9			0%	0%		
West Kootenay	OBS	BRIDGE	97			0%	0%		
West Kootenay	OBS	PIPE ARCH	1			0%	0%		
West Kootenay	OBS	WOOD BOX CULVERT	22			0%	0%		
West Kootenay	OTHER		8	1		13%	13%		
West Kootenay Sub Total (all)	all	all	412	97	6	24%	25%	4,083	5,499
West Kootenay Sub Total (CBS only)	CBS	all CBS	151	96	6	64%	68%		
Elk Sub Total (all)	all	all	0					2251	1536
Elk Sub Total (CBS only)	CBS	all CBS	0						
Flathead Sub Total (all)	all	all	0					918	313
Flathead Sub Total (CBS only)	CBS	all CBS	0						
TOTAL (all assesments)	all	all	**2017**	495	86	25%	29%	**42,483**	26,648
TOTAL (CBS only)	CBS	all CBS	**1007**	490	83	**49%**	**57%**		

Crossing Type: CBS = closed bottom structure; NCS = no crossing structure (a ford crossing); OBS = open bottom structure

APPENDIX 11. FISHING QUALITY

Table A11.1 summarizes the status of angler use on the seven Classified Waters and comes directly from Tepper (2008a). It summarizes data collected from River Guardians Program from Elk in 2002, St. Mary in 2003, and all seven rivers in 2004–2008.

Table A11.1. Catch per unit effort (CPUE) and fishing quality comments for several Quality Waters systems

River	CPUE	Comment on quality
Upper Kootenay	N/A	High – based on limited information
White	1.0 (2007) 0.8 (2008)	Good to excellent but based on low interview numbers, light angler use but may be increasing
Skookumchuck	0.9–1.9 (2004–2008), no trend	Quality improving, slightly crowded, assuming guides reporting properly, non-guided non-resident anglers over target allocation of 180 angler days by 27%
St. Mary	0.8–1.8 (2003–2007), lower recently	Quality improved to 2006, dropped slightly in 2007 and 2008, but still considered high to excellent; CPUE lower in 2007 and 2008 compared to previous years; non-resident (guided and non-guided) considered well below target allocation of 2750 angler days, considered not crowded
Bull	0.9–1.5 (2004–2008), no trend	Quality improving and considered high, crowding may be increasing, non-resident (guided and non-guided) considered well below target allocation of 1100 angler days
Elk	0.9–1.5 (2002–2008), no trend	Quality improved until 2007 and 2008 when a slight drop was noted, possibly due to more crowding but still considered high to excellent, non-resident and non-resident, non-guided anglers over target allocation of 3540 angler days by 57%
Michel (tributary of Elk not separately classified)	1.2–2.0 (2004–2008), no trend	Quality improved and considered high to excellent, crowding may be increasing (particularly as perceived by local resident anglers)
Wigwam	0.8–1.4 (2004–2008), trending downward	Quality was improving until 2007 and 2008 but still considered high to excellent; CPUE lower in 2007 and 2008 compared to previous years, non-resident non-guided angler days exceeded target allocation of 180 angler days by 444% in 2006, crowding may be increasing with “very crowded” considered by local residents, guides, and non-residents

APPENDIX 12. FISH STOCKING

Threat Associated with Fish Stocking
Several observed or potential impacts to WCT are associated with the long history of fish stocking in B.C. The three greatest impacts are:

1. Hybridization leading to introgression - WCT interbreed with non-native closely related trout species like Rainbow Trout, resulting in fertile hybrids that continue to back cross with WCT, Rainbow Trout, or other hybrids. WCT are particularly susceptible to this where they have evolved in isolation of other closely related species and have not therefore evolved reproductive isolation mechanisms (i.e., upstream of Kootenai Falls). The result if allowed to continue is a hybrid swarm where neither parental genotype remains within the population. Hybrids and backcrossed individuals may be intermediate in phenotype and adaptive abilities. They have also been shown to stray more. The result from an ecological perspective is a loss of local population structure and local adaptive traits. These traits may be precisely why WCT have continued to persist for thousands of years in conditions considered too harsh for many other freshwater fish species. Clearly this is a major threat to populations in the core native range in B.C., and has also been identified as one of the leading causes for the precipitous declines in pure WCT populations in Montana and Alberta.

2. Competition and displacement - Species like Rainbow Trout and Eastern Brook Trout are more productive (i.e., reproduce at an earlier age, produce more offspring) than native WCT, and tend to be more resilient to fishing pressure. Furthermore, these salmonids may fare better in degraded conditions (increased water temperatures, increased siltation) to which WCT are more sensitive, and may have a competitive advantage as they emerge earlier as fry (summarized in Costello 2008). This combination of factors may explain the predominance of Eastern Brook Trout in Joseph Creek (Oliver 2009).

3. Outbreeding depression - Although this threat has not been evaluated for WCT in B.C. or elsewhere, it is worth considering. Hatchery-origin WCT have been released in watersheds of southeastern B.C. for decades. Since the early 1970s, all fish have originated from a single-source population in Connor Lakes. This source has been genetically confirmed to be pure WCT but all releases continue to be diploid. Given the significant localized substructuring apparent in wild populations, there is some risk associated with releasing a non-local (i.e., not same watershed) fish capable of reproducing.

Stocking History in B.C.
The stocking of non-native trout species into waters containing native WCT has been one of the greatest threats to the persistence of the species throughout much of its original range.

To attempt a more focused consideration of WCT waterbodies, Table A12.1 considers only stocked waterbodies in which WCT have also been observed based on the provincial FISS database records. Predictive modelling to identify those waterbodies likely to support WCT will enable a more thorough analysis of hatchery practices throughout the native WCT range in B.C.

In the central groups, over 50% of the lakes in which WCT have been observed are also stocked with WCT. Most of the recent stocking initiatives are limited to lake stocking within these areas but some WCT stocking appears to be continuing in riverine situations. While this may not affect genetic integrity at the species level, it may act to genetically homogenize populations where the non-local hatchery stock interbreeds with local wild populations, particularly given the unclear origins of the Connor Lakes hatchery fish.

With respect to Rainbow Trout stocking within the core range of WCT outside of native Rainbow Trout range, the Upper Kootenay Population Group has seen most introductions. Only one lake and one stream received Rainbow Trout in the Flathead. Only 8 waterbodies in the Elk River reported to contain WCT received Rainbow Trout. Note that Summit Lake (in Elk group), Joseph Creek, and Bull River (both in Upper Kootenay group), which all contain native WCT populations, also directly received hatchery Rainbow Trout 10 or more times.

Table A12.1. Number of streams and lakes (as defined by unique "blueline number" up until 2008; B. Woods, pers. comm. Ongoing) where WCT has been observed at least once for which at least one stocking event has also occurred for CS (Cutthroat x Rainbow Trout cross), CT (Cutthroat Trout, probably coastal), EBT (Eastern Brook Trout), RBT (Rainbow Trout), and WCT. Total WCT = the total number of streams and lakes were WCT have been observed.

Population Group	Waterbody type	Total WCT	CS	CT	EBT	RBT	WCT	Total stocked
Elk	Stream	134	0	0	4	3	22	**29**
	Lake	36	0	0	0	5	20	**25**
Flathead	Stream	85	0	0	0	1	6	**7**
	Lake	17	0	0	0	1	12	**13**
Upper Kootenay	Stream	406	0	3	5	15	43	**66**
	Lake	114	0	1	7	21	53	**82**
West Kootenay	Stream	246	1	2	4	21	30	**58**
	lake	81	0	0	2	16	47	**65**
Columbia	Stream	117	0	0	2	9	19	**30**
	Lake	54	0	1	0	11	29	**41**
Kettle	Stream	12	0	0	0	0	3	**3**
	Lake	7	0	0	0	0	7	**7**
South Thompson	Stream	6	0	0	0	1	5	**6**
	Lake	4	0	0	0	3	1	**4**
Total	**Stream**	**1006**	**1**	**5**	**15**	**40**	**128**	**189**
	Lake	**313**	**0**	**2**	**9**	**54**	**169**	**234**

APPENDIX 13. THREATS ASSESSMENT

While the moderate to high rated threats identified for each Population Group are discussed in detail in the main body of the document, lower ranking threats, which may include wide-ranging threats and threats with significant data gaps, may play an important role in exacerbating other factors already threatening WCT. For example, it is suspected that invasive species (COSEWIC 2007) such as spiny-rayed fishes, and zebra and quagga mussels, may play a role in competition for shared resources. However, due to knowledge gaps, we cannot be certain how strong of a role they play. Although fishing pressure was not listed as a high ranking threat for at-risk populations, it is widespread across WCT's entire range, and population reductions have the potential to enhance vulnerability to stochastic events (e.g., epizootics; COSEWIC 2007). Mayhood (2009) highlights that WCT are most vulnerable to overharvest in small-stream populations in part due to their vulnerability to increased road access to these areas. Finally, although not identified as a single threat, habitat degradation is a recurring theme across most threats to WCT. For example, forest harvest, mining, linear projects, agriculture, development, and water use all potentially affect WCT habitat quality and quantity. In particular, carrying capacity is diminished significantly by habitat degradation via fine sedimentation, barrier creation, and climate warming in Albertan populations of WCT (Mayhood 2009); details on equivalent effects in B.C. are lacking. Trends suggest significant amounts of habitat degradation over the last 100 years, in part due to recent increases in access to waterbodies, and with formal protection measures only recently coming into force (COSEWIC 2006). Consideration of the influence of invasive species, fishing pressure, and habitat degradation is thus important when interpreting results of the threat assessment tool.

The following table contains the entire ranked list of threat mechanisms and associated sources.[23] Refer to Hatfield and Long (2010) for more information on the threat assessment process used.

Table A13.1. Output from threats assessment tool with all threats considered. Threats sorted by Population Group, then by threat mechanisms.

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Columbia	Habitat	Altered community dynamics	Invasive Species	Unknown	Unknown	unknown	Unknown
Columbia	Habitat	Altered community dynamics	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Columbia	Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Restricted	Moderate	Ongoing, stable	Low
Columbia	Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered community dynamics	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered flow regime	Climate Change & Severe Weather	Large	Unknown	Ongoing, increasing	Unknown
Columbia	Habitat	Altered flow regime	Water Use – permanent withdrawal – consumptive	Restricted	Serious	Ongoing, increasing	Medium
Columbia	Habitat	Altered flow regime	Water Use - temporary diversions/dams, non-consumptive	Large	Moderate	Ongoing, increasing	Medium

[23] Outputs were generated based on preliminary responses from four local experts, as well as follow-up discussion at the December 2010 provincial workshop.

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Columbia	Habitat	Altered flow regime	Agriculture	Restricted	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered flow regime	Forest Harvest	Restricted	Moderate	Ongoing, stable	Low
Columbia	Habitat	Altered flow regime	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered flow regime	Mining	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered flow regime	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Altered flow regime	Oil and Gas	Negligible	Negligible	0	Negligible
Columbia	Habitat	Altered flow regime	Linear Projects	Negligible	Negligible	0	Negligible
Columbia	Habitat	Fish passage	Forest Harvest	Large	Unknown	Ongoing, diminishing	Unknown
Columbia	Habitat	Fish passage	Climate Change & Severe Weather	Unknown	Unknown	Ongoing, stable	Unknown
Columbia	Habitat	Fish passage	Water Use – permanent withdrawal – consumptive	Restricted	Serious	Ongoing, stable	Medium
Columbia	Habitat	Fish passage	Linear Projects	Large	Moderate	Ongoing, stable	Medium
Columbia	Habitat	Fish passage	Water Use - temporary diversions/dams, non-consumptive	Large	Slight	Ongoing, stable	Low
Columbia	Habitat	Fish passage	Mining	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Fish passage	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Columbia	Habitat	Fish passage	Oil and Gas	Negligible	Negligible	0	Negligible
Columbia	Habitat	Instream mechanical disturbance	Agriculture	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Instream mechanical disturbance	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Instream mechanical disturbance	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, increasing	Low
Columbia	Habitat	Instream mechanical disturbance	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Columbia	Habitat	Instream mechanical disturbance	Linear Projects	Large	Moderate	Ongoing, stable	Medium
Columbia	Habitat	Instream mechanical disturbance	Forest Harvest	Negligible	Negligible	Ongoing, diminishing	Negligible
Columbia	Habitat	Instream mechanical disturbance	Mining	Negligible	Negligible	0	Negligible
Columbia	Habitat	Large scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Large	Unknown	Ongoing, stable	Unknown
Columbia	Habitat	Large scale habitat modifications	Agriculture	Small	Slight	Residual only	Low
Columbia	Habitat	Large scale habitat modifications	Mining	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Large scale habitat modifications	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, increasing	Low
Columbia	Habitat	Large scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Negligible	Ongoing, stable	Negligible
Columbia	Habitat	Large scale habitat modifications	Invasive Species	Negligible	Negligible	0	Negligible
Columbia	Habitat	Large scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Columbia	Habitat	Riparian clearing and alteration	Forest Harvest	Large	Moderate	Ongoing, stable	Medium
Columbia	Habitat	Riparian clearing and alteration	Mining	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Riparian clearing and alteration	Agriculture	Restricted	Slight	Ongoing, stable	Low
Columbia	Habitat	Riparian clearing and alteration	Water Use – permanent withdrawal – consumptive	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Riparian clearing and alteration	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, increasing	Low
Columbia	Habitat	Riparian clearing and alteration	Linear Projects	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Riparian clearing and alteration	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
Columbia	Habitat	Riparian clearing and alteration	Oil and Gas	Negligible	Negligible	0	Negligible
Columbia	Habitat	Small scale habitat modifications	Invasive Species	Unknown	Unknown	Future only	Unknown
Columbia	Habitat	Small scale habitat modifications	Agriculture	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Small scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, stable	Low
Columbia	Habitat	Small scale habitat modifications	Mining	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Small scale habitat modifications	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Columbia	Habitat	Small scale habitat modifications	Linear Projects	Small	Slight	Residual only	Low
Columbia	Habitat	Small scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
Columbia	Habitat	Small scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Columbia	Habitat	Water quality	Invasive Species	Unknown	Unknown	Future only	Unknown
Columbia	Habitat	Water quality	Forest Harvest	Large	Moderate	Ongoing, increasing	Medium
Columbia	Habitat	Water quality	Mining	Small	Slight	Residual only	Low

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Columbia	Habitat	Water quality	Agriculture	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Water quality	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Water quality	Water Use – permanent withdrawal – consumptive	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Water quality	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Water quality	Linear Projects	Small	Slight	Ongoing, stable	Low
Columbia	Habitat	Water quality	Climate Change & Severe Weather	Restricted	Slight	Ongoing, increasing	Low
Columbia	Habitat	Water quality	Oil and Gas	Negligible	Negligible	0	Negligible
Columbia	Non-Habitat	Altered community dynamics	Invasive Species	Small	Unknown	Ongoing, stable	Unknown
Columbia	Non-Habitat	Altered community dynamics	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Columbia	Non-Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Restricted	Moderate	Ongoing, stable	Low
Columbia	Non-Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Pervasive	Slight	Ongoing, increasing	Low
Columbia	Non-Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Columbia	Non-Habitat	Altered community dynamics	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Columbia	Non-Habitat	Altered community dynamics	Aquaculture, Hatcheries and Stocking	Small	Extreme	Ongoing, stable	Low
Columbia	Non-Habitat	Altered community dynamics	Fishing	Small	Negligible	Ongoing, stable	Negligible
Columbia	Non-Habitat	Altered community dynamics	Linear Projects	Negligible	Negligible	0	Negligible
Columbia	Non-Habitat	Direct mortality	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Direct mortality	Aquaculture, Hatcheries and Stocking	Restricted	Unknown	Ongoing, stable	Unknown
Columbia	Non-Habitat	Direct mortality	Linear Projects	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Direct mortality	Fishing	Small	Negligible	Ongoing, stable	Negligible
Columbia	Non-Habitat	Disease	Invasive Species	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Disease	Industrial and Municipal Discharges	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Disease	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Disease	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Columbia	Non-Habitat	Entrainment	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Entrainment	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	Residual only	Negligible
Columbia	Non-Habitat	Entrainment	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	Ongoing, stable	Negligible
Columbia	Non-Habitat	Introgression	Invasive Species	Unknown	Unknown	0	Unknown
Columbia	Non-Habitat	Introgression	Aquaculture, Hatcheries and Stocking	Small	Extreme	Ongoing, stable	Low
Elk	Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Small	Unknown	Ongoing, increasing	Unknown
Elk	Habitat	Altered community dynamics	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Elk	Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Small	Serious	Ongoing, stable	Low
Elk	Habitat	Altered community dynamics	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Altered flow regime	Climate Change & Severe Weather	Large	Unknown	Ongoing, increasing	Unknown
Elk	Habitat	Altered flow regime	Water Use – permanent withdrawal – consumptive	Restricted	Serious	Ongoing, increasing	Medium
Elk	Habitat	Altered flow regime	Agriculture	Restricted	Moderate	Ongoing, stable	Low
Elk	Habitat	Altered flow regime	Water Use - temporary diversions/dams, non-consumptive	Small	Moderate	Ongoing, increasing	Low
Elk	Habitat	Altered flow regime	Forest Harvest	Restricted	Moderate	Ongoing, diminishing	Low
Elk	Habitat	Altered flow regime	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Altered flow regime	Mining	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Altered flow regime	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Altered flow regime	Oil and Gas	Negligible	Negligible	0	Negligible
Elk	Habitat	Altered flow regime	Linear Projects	Negligible	Negligible	0	Negligible
Elk	Habitat	Fish passage	Forest Harvest	Restricted	Unknown	Ongoing, diminishing	Unknown
Elk	Habitat	Fish passage	Climate Change & Severe Weather	Unknown	Unknown	Ongoing, stable	Unknown
Elk	Habitat	Fish passage	Water Use – permanent withdrawal – consumptive	Restricted	Serious	Ongoing, increasing	Medium
Elk	Habitat	Fish passage	Linear Projects	Large	Moderate	Ongoing, stable	Medium

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Elk	Habitat	Fish passage	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, increasing	Low
Elk	Habitat	Fish passage	Mining	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Fish passage	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Elk	Habitat	Fish passage	Oil and Gas	Negligible	Negligible	0	Negligible
Elk	Habitat	Instream mechanical disturbance	Agriculture	Small	Serious	Ongoing, stable	Low
Elk	Habitat	Instream mechanical disturbance	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, increasing	Low
Elk	Habitat	Instream mechanical disturbance	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Elk	Habitat	Instream mechanical disturbance	Linear Projects	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Instream mechanical disturbance	Water Use - temporary diversions/dams, non-consumptive	Negligible	Slight	Ongoing, stable	Negligible
Elk	Habitat	Instream mechanical disturbance	Forest Harvest	Negligible	Negligible	Ongoing, diminishing	Negligible
Elk	Habitat	Instream mechanical disturbance	Mining	Negligible	Negligible	0	Negligible
Elk	Habitat	Large scale habitat modifications	Agriculture	Small	Slight	Residual only	Low
Elk	Habitat	Large scale habitat modifications	Mining	Small	Serious	Ongoing, stable	Low
Elk	Habitat	Large scale habitat modifications	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, increasing	Low
Elk	Habitat	Large scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	Ongoing, stable	Negligible
Elk	Habitat	Large scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Negligible	Ongoing, stable	Negligible
Elk	Habitat	Large scale habitat modifications	Invasive Species	Negligible	Negligible	0	Negligible
Elk	Habitat	Large scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Elk	Habitat	Riparian clearing and alteration	Forest Harvest	Large	Moderate	Ongoing, stable	Medium
Elk	Habitat	Riparian clearing and alteration	Mining	Restricted	Serious	Ongoing, stable	Medium
Elk	Habitat	Riparian clearing and alteration	Agriculture	Restricted	Slight	Ongoing, stable	Low
Elk	Habitat	Riparian clearing and alteration	Water Use – permanent withdrawal – consumptive	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Riparian clearing and alteration	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, increasing	Low
Elk	Habitat	Riparian clearing and alteration	Linear Projects	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Riparian clearing and alteration	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
Elk	Habitat	Riparian clearing and alteration	Oil and Gas	Negligible	Negligible	0	Negligible
Elk	Habitat	Small scale habitat modifications	Invasive Species	Restricted	Unknown	Future only	Unknown
Elk	Habitat	Small scale habitat modifications	Agriculture	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Small scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, stable	Low
Elk	Habitat	Small scale habitat modifications	Mining	Small	Moderate	Ongoing, stable	Low
Elk	Habitat	Small scale habitat modifications	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Elk	Habitat	Small scale habitat modifications	Linear Projects	Small	Slight	Residual only	Low
Elk	Habitat	Small scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
Elk	Habitat	Small scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Elk	Habitat	Water quality	Invasive Species	Restricted	Unknown	Future only	Unknown
Elk	Habitat	Water quality	Forest Harvest	Large	Moderate	Ongoing, increasing	Medium
Elk	Habitat	Water quality	Mining	Restricted	Serious	Residual only	Medium
Elk	Habitat	Water quality	Agriculture	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Water quality	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Water quality	Water Use – permanent withdrawal – consumptive	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Water quality	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Water quality	Linear Projects	Small	Slight	Ongoing, stable	Low
Elk	Habitat	Water quality	Climate Change & Severe Weather	Restricted	Slight	Ongoing, increasing	Low
Elk	Habitat	Water quality	Oil and Gas	Negligible	Negligible	0	Negligible
Elk	Non-Habitat	Altered community dynamics	Invasive Species	Small	Unknown	Ongoing, stable	Unknown
Elk	Non-Habitat	Altered community dynamics	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Elk	Non-Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Restricted	Moderate	Ongoing, increasing	Low
Elk	Non-Habitat	Altered community dynamics	Aquaculture, Hatcheries and Stocking	Restricted	Serious	Ongoing, stable	Medium

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Elk	Non-Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, increasing	Low
Elk	Non-Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Elk	Non-Habitat	Altered community dynamics	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Elk	Non-Habitat	Altered community dynamics	Fishing	Large	Negligible	Ongoing, stable	Negligible
Elk	Non-Habitat	Altered community dynamics	Linear Projects	Negligible	Negligible	0	Negligible
Elk	Non-Habitat	Direct mortality	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Direct mortality	Aquaculture, Hatcheries and Stocking	Restricted	Unknown	Ongoing, stable	Unknown
Elk	Non-Habitat	Direct mortality	Linear Projects	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Direct mortality	Fishing	Large	Slight	Ongoing, stable	Low
Elk	Non-Habitat	Disease	Invasive Species	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Disease	Industrial and Municipal Discharges	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Disease	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Disease	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Elk	Non-Habitat	Entrainment	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Entrainment	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	Residual only	Negligible
Elk	Non-Habitat	Entrainment	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	Ongoing, stable	Negligible
Elk	Non-Habitat	Introgression	Invasive Species	Unknown	Unknown	0	Unknown
Elk	Non-Habitat	Introgression	Aquaculture, Hatcheries and Stocking	Large	Extreme	Ongoing, increasing	High
Flathead	Habitat	Altered community dynamics	Climate Change & Severe Weather	Small	Slight	Ongoing, increasing	Low
Flathead	Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered community dynamics	Invasive Species	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered community dynamics	Industrial and Municipal Discharges	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Forest Harvest	Restricted	Moderate	Ongoing, diminishing	Low
Flathead	Habitat	Altered flow regime	Climate Change & Severe Weather	Restricted	Slight	Ongoing, stable	Low
Flathead	Habitat	Altered flow regime	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Agriculture	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Industrial and Municipal Discharges	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Mining	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Oil and Gas	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Altered flow regime	Linear Projects	Negligible	Negligible	0	Negligible
Flathead	Habitat	Fish passage	Linear Projects	Unknown	Unknown	0	Unknown
Flathead	Habitat	Fish passage	Forest Harvest	Restricted	Moderate	Ongoing, stable	Low
Flathead	Habitat	Fish passage	Climate Change & Severe Weather	Small	Slight	Ongoing, stable	Low
Flathead	Habitat	Fish passage	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Fish passage	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Fish passage	Mining	Negligible	Negligible	0	Negligible
Flathead	Habitat	Fish passage	Oil and Gas	Negligible	Negligible	0	Negligible
Flathead	Habitat	Fish passage	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Instream mechanical disturbance	Linear Projects	Restricted	Moderate	Residual only	Low
Flathead	Habitat	Instream mechanical disturbance	Agriculture	Negligible	Negligible	Ongoing, stable	Negligible
Flathead	Habitat	Instream mechanical disturbance	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Instream mechanical disturbance	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Instream mechanical disturbance	Forest Harvest	Negligible	Negligible	Residual only	Negligible
Flathead	Habitat	Instream mechanical disturbance	Mining	Negligible	Negligible	0	Negligible

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Flathead	Habitat	Instream mechanical disturbance	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Large scale habitat modifications	Agriculture	Negligible	Negligible	0	Negligible
Flathead	Habitat	Large scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	Ongoing, increasing	Negligible
Flathead	Habitat	Large scale habitat modifications	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Large scale habitat modifications	Invasive Species	Negligible	Negligible	0	Negligible
Flathead	Habitat	Large scale habitat modifications	Mining	Negligible	Negligible	0	Negligible
Flathead	Habitat	Large scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Flathead	Habitat	Large scale habitat modifications	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Riparian clearing and alteration	Agriculture	Small	Slight	Ongoing, stable	Low
Flathead	Habitat	Riparian clearing and alteration	Forest Harvest	Restricted	Moderate	Residual only	Low
Flathead	Habitat	Riparian clearing and alteration	Linear Projects	Restricted	Slight	Ongoing, stable	Low
Flathead	Habitat	Riparian clearing and alteration	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Riparian clearing and alteration	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Riparian clearing and alteration	Mining	Negligible	Negligible	0	Negligible
Flathead	Habitat	Riparian clearing and alteration	Oil and Gas	Negligible	Negligible	0	Negligible
Flathead	Habitat	Riparian clearing and alteration	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Small scale habitat modifications	Invasive Species	Unknown	Unknown	0	Unknown
Flathead	Habitat	Small scale habitat modifications	Oil and Gas	Small	Slight	Residual only	Low
Flathead	Habitat	Small scale habitat modifications	Linear Projects	Small	Slight	Ongoing, stable	Low
Flathead	Habitat	Small scale habitat modifications	Agriculture	Negligible	Negligible	0	Negligible
Flathead	Habitat	Small scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Small scale habitat modifications	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Small scale habitat modifications	Mining	Negligible	Negligible	0	Negligible
Flathead	Habitat	Small scale habitat modifications	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Habitat	Water quality	Invasive Species	Unknown	Unknown	0	Unknown
Flathead	Habitat	Water quality	Agriculture	Small	Slight	Ongoing, stable	Low
Flathead	Habitat	Water quality	Forest Harvest	Restricted	Moderate	Ongoing, diminishing	Low
Flathead	Habitat	Water quality	Oil and Gas	Small	Slight	Residual only	Low
Flathead	Habitat	Water quality	Linear Projects	Restricted	Slight	Ongoing, stable	Low
Flathead	Habitat	Water quality	Climate Change & Severe Weather	Small	Slight	Ongoing, stable	Low
Flathead	Habitat	Water quality	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Water quality	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Habitat	Water quality	Mining	Negligible	Negligible	0	Negligible
Flathead	Habitat	Water quality	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Altered community dynamics	Linear Projects	Unknown	Unknown	0	Unknown
Flathead	Non-Habitat	Altered community dynamics	Invasive Species	Small	Slight	Ongoing, stable	Low
Flathead	Non-Habitat	Altered community dynamics	Aquaculture, Hatcheries and Stocking	Restricted	Slight	Ongoing, stable	Low
Flathead	Non-Habitat	Altered community dynamics	Climate Change & Severe Weather	Small	Slight	Ongoing, stable	Low
Flathead	Non-Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Altered community dynamics	Industrial and Municipal Discharges	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Altered community dynamics	Fishing	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Direct mortality	Linear Projects	Unknown	Unknown	0	Unknown
Flathead	Non-Habitat	Direct mortality	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Direct mortality	Fishing	Small	Negligible	Ongoing, stable	Negligible
Flathead	Non-Habitat	Direct mortality	Aquaculture, Hatcheries and Stocking	Negligible	Negligible	Ongoing, stable	Negligible
Flathead	Non-Habitat	Disease	Invasive Species	Unknown	Unknown	0	Unknown

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Flathead	Non-Habitat	Disease	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	0	Unknown
Flathead	Non-Habitat	Disease	Climate Change & Severe Weather	Unknown	Unknown	0	Unknown
Flathead	Non-Habitat	Disease	Industrial and Municipal Discharges	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Entrainment	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Entrainment	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Entrainment	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
Flathead	Non-Habitat	Introgression	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	Future only	Unknown
Flathead	Non-Habitat	Introgression	Invasive Species	Unknown	Unknown	0	Unknown
Upper Kootenay	Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Small	Unknown	Ongoing, increasing	Unknown
Upper Kootenay	Habitat	Altered community dynamics	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Upper Kootenay	Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Small	Serious	Ongoing, stable	Low
Upper Kootenay	Habitat	Altered community dynamics	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Altered flow regime	Climate Change & Severe Weather	Large	Unknown	Ongoing, increasing	Unknown
Upper Kootenay	Habitat	Altered flow regime	Water Use – permanent withdrawal – consumptive	Restricted	Serious	Ongoing, increasing	Medium
Upper Kootenay	Habitat	Altered flow regime	Agriculture	Small	Slight	Ongoing, increasing	Low
Upper Kootenay	Habitat	Altered flow regime	Water Use - temporary diversions/dams, non-consumptive	Small	Moderate	Ongoing, increasing	Low
Upper Kootenay	Habitat	Altered flow regime	Forest Harvest	Restricted	Moderate	Ongoing, diminishing	Low
Upper Kootenay	Habitat	Altered flow regime	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Altered flow regime	Mining	Small	Slight	Residual only	Low
Upper Kootenay	Habitat	Altered flow regime	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Altered flow regime	Oil and Gas	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Altered flow regime	Linear Projects	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Fish passage	Forest Harvest	Restricted	Unknown	Ongoing, diminishing	Unknown
Upper Kootenay	Habitat	Fish passage	Climate Change & Severe Weather	Unknown	Unknown	Ongoing, stable	Unknown
Upper Kootenay	Habitat	Fish passage	Water Use – permanent withdrawal – consumptive	Restricted	Serious	Ongoing, increasing	Medium
Upper Kootenay	Habitat	Fish passage	Linear Projects	Large	Moderate	Ongoing, stable	Medium
Upper Kootenay	Habitat	Fish passage	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, increasing	Low
Upper Kootenay	Habitat	Fish passage	Mining	Small	Slight	Residual only	Low
Upper Kootenay	Habitat	Fish passage	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Upper Kootenay	Habitat	Fish passage	Oil and Gas	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Instream mechanical disturbance	Agriculture	Small	Serious	Ongoing, stable	Low
Upper Kootenay	Habitat	Instream mechanical disturbance	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, increasing	Low
Upper Kootenay	Habitat	Instream mechanical disturbance	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Upper Kootenay	Habitat	Instream mechanical disturbance	Linear Projects	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Instream mechanical disturbance	Water Use - temporary diversions/dams, non-consumptive	Negligible	Slight	Ongoing, stable	Negligible
Upper Kootenay	Habitat	Instream mechanical disturbance	Forest Harvest	Negligible	Negligible	Ongoing, diminishing	Negligible
Upper Kootenay	Habitat	Instream mechanical disturbance	Mining	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Large scale habitat modifications	Agriculture	Small	Slight	Residual only	Low
Upper Kootenay	Habitat	Large scale habitat modifications	Mining	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Large scale habitat modifications	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, increasing	Low
Upper Kootenay	Habitat	Large scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	Ongoing, stable	Negligible
Upper Kootenay	Habitat	Large scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Negligible	Ongoing, stable	Negligible
Upper Kootenay	Habitat	Large scale habitat modifications	Invasive Species	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Large scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Riparian clearing and alteration	Forest Harvest	Large	Moderate	Ongoing, stable	Medium
Upper Kootenay	Habitat	Riparian clearing and alteration	Agriculture	Restricted	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Riparian clearing and alteration	Water Use – permanent withdrawal – consumptive	Small	Slight	Ongoing, stable	Low

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
Upper Kootenay	Habitat	Riparian clearing and alteration	Mining	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Riparian clearing and alteration	Residential, Recreational and Commercial Development	Small	Moderate	Ongoing, increasing	Low
Upper Kootenay	Habitat	Riparian clearing and alteration	Linear Projects	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Riparian clearing and alteration	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
Upper Kootenay	Habitat	Riparian clearing and alteration	Oil and Gas	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Small scale habitat modifications	Invasive Species	Restricted	Unknown	Future only	Unknown
Upper Kootenay	Habitat	Small scale habitat modifications	Agriculture	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Small scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Small scale habitat modifications	Mining	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Small scale habitat modifications	Residential, Recreational and Commercial Development	Small	Slight	0	Low
Upper Kootenay	Habitat	Small scale habitat modifications	Linear Projects	Small	Serious	Ongoing, stable	Low
Upper Kootenay	Habitat	Small scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
Upper Kootenay	Habitat	Small scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
Upper Kootenay	Habitat	Water quality	Invasive Species	Restricted	Unknown	Future only	Unknown
Upper Kootenay	Habitat	Water quality	Forest Harvest	Large	Moderate	Ongoing, stable	Medium
Upper Kootenay	Habitat	Water quality	Agriculture	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Water quality	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Water quality	Water Use – permanent withdrawal – consumptive	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Water quality	Mining	Small	Slight	Residual only	Low
Upper Kootenay	Habitat	Water quality	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Water quality	Linear Projects	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Habitat	Water quality	Climate Change & Severe Weather	Restricted	Slight	Ongoing, increasing	Low
Upper Kootenay	Habitat	Water quality	Oil and Gas	Negligible	Negligible	0	Negligible
Upper Kootenay	Non-Habitat	Altered community dynamics	Invasive Species	Small	Unknown	Ongoing, stable	Unknown
Upper Kootenay	Non-Habitat	Altered community dynamics	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Upper Kootenay	Non-Habitat	Altered community dynamics	Aquaculture, Hatcheries and Stocking	Restricted	Extreme	Ongoing, stable	Medium
Upper Kootenay	Non-Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Restricted	Moderate	Ongoing, increasing	Low
Upper Kootenay	Non-Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, increasing	Low
Upper Kootenay	Non-Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Non-Habitat	Altered community dynamics	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
Upper Kootenay	Non-Habitat	Altered community dynamics	Fishing	Large	Negligible	Ongoing, stable	Negligible
Upper Kootenay	Non-Habitat	Altered community dynamics	Linear Projects	Negligible	Negligible	0	Negligible
Upper Kootenay	Non-Habitat	Direct mortality	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Direct mortality	Aquaculture, Hatcheries and Stocking	Restricted	Unknown	Ongoing, stable	Unknown
Upper Kootenay	Non-Habitat	Direct mortality	Linear Projects	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Direct mortality	Fishing	Large	Slight	Ongoing, stable	Low
Upper Kootenay	Non-Habitat	Disease	Invasive Species	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Disease	Industrial and Municipal Discharges	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Disease	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Disease	Climate Change & Severe Weather	Unknown	Unknown	Future only	Unknown
Upper Kootenay	Non-Habitat	Entrainment	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Entrainment	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Residual only	Negligible
Upper Kootenay	Non-Habitat	Entrainment	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	Ongoing, stable	Negligible
Upper Kootenay	Non-Habitat	Introgression	Invasive Species	Unknown	Unknown	0	Unknown
Upper Kootenay	Non-Habitat	Introgression	Aquaculture, Hatcheries and Stocking	Large	Extreme	Ongoing, increasing	High
West Kootenay	Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Large	Moderate	Ongoing, stable	Medium
West Kootenay	Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Altered community dynamics	Invasive Species	Restricted	Slight	Ongoing, stable	Low

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
West Kootenay	Habitat	Altered community dynamics	Industrial and Municipal Discharges	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Altered community dynamics	Climate Change & Severe Weather	Small	Slight	Ongoing, increasing	Low
West Kootenay	Habitat	Altered flow regime	Water Use – permanent withdrawal – consumptive	Large	Moderate	Ongoing, stable	Medium
West Kootenay	Habitat	Altered flow regime	Forest Harvest	Large	Moderate	Ongoing, diminishing	Medium
West Kootenay	Habitat	Altered flow regime	Agriculture	Small	Moderate	Ongoing, stable	Low
West Kootenay	Habitat	Altered flow regime	Water Use - temporary diversions/dams, non-consumptive	Restricted	Moderate	Ongoing, increasing	Low
West Kootenay	Habitat	Altered flow regime	Industrial and Municipal Discharges	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Altered flow regime	Mining	Restricted	Slight	Ongoing, diminishing	Low
West Kootenay	Habitat	Altered flow regime	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Altered flow regime	Climate Change & Severe Weather	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Altered flow regime	Oil and Gas	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Altered flow regime	Linear Projects	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Fish passage	Linear Projects	Large	Unknown	0	Unknown
West Kootenay	Habitat	Fish passage	Water Use – permanent withdrawal – consumptive	Large	Moderate	Ongoing, stable	Medium
West Kootenay	Habitat	Fish passage	Forest Harvest	Large	Moderate	Ongoing, stable	Medium
West Kootenay	Habitat	Fish passage	Water Use - temporary diversions/dams, non-consumptive	Restricted	Slight	0	Low
West Kootenay	Habitat	Fish passage	Mining	Restricted	Slight	Residual only	Low
West Kootenay	Habitat	Fish passage	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Fish passage	Climate Change & Severe Weather	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Fish passage	Oil and Gas	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Instream mechanical disturbance	Linear Projects	Large	Moderate	Ongoing, stable	Medium
West Kootenay	Habitat	Instream mechanical disturbance	Forest Harvest	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Instream mechanical disturbance	Agriculture	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Instream mechanical disturbance	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Instream mechanical disturbance	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Instream mechanical disturbance	Water Use - temporary diversions/dams, non-consumptive	Small	Negligible	Ongoing, stable	Negligible
West Kootenay	Habitat	Instream mechanical disturbance	Mining	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Large scale habitat modifications	Agriculture	Small	Slight	Residual only	Low
West Kootenay	Habitat	Large scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Moderate	Ongoing, stable	Low
West Kootenay	Habitat	Large scale habitat modifications	Mining	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Large scale habitat modifications	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, increasing	Low
West Kootenay	Habitat	Large scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Restricted	Negligible	Ongoing, stable	Negligible
West Kootenay	Habitat	Large scale habitat modifications	Invasive Species	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Large scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Riparian clearing and alteration	Forest Harvest	Large	Moderate	Residual only	Medium
West Kootenay	Habitat	Riparian clearing and alteration	Agriculture	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Riparian clearing and alteration	Water Use - temporary diversions/dams, non-consumptive	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Riparian clearing and alteration	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Riparian clearing and alteration	Mining	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Riparian clearing and alteration	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Riparian clearing and alteration	Linear Projects	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Riparian clearing and alteration	Oil and Gas	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Small scale habitat modifications	Agriculture	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Small scale habitat modifications	Water Use - temporary diversions/dams, non-consumptive	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Small scale habitat modifications	Water Use – permanent withdrawal – consumptive	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Small scale habitat modifications	Mining	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Small scale habitat modifications	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low

Population Group [a]	Threat mechanism 1st Level	Threat mechanism 2nd Level	Threat source	Scope [b]	Severity [c]	Timing [d]	Threat Impact [e]
West Kootenay	Habitat	Small scale habitat modifications	Linear Projects	Restricted	Slight	Residual only	Low
West Kootenay	Habitat	Small scale habitat modifications	Invasive Species	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Small scale habitat modifications	Oil and Gas	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Water quality	Forest Harvest	Large	Moderate	Ongoing, diminishing	Medium
West Kootenay	Habitat	Water quality	Agriculture	Small	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Water quality	Water Use - temporary diversions/dams, non-consumptive	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Water quality	Water Use – permanent withdrawal – consumptive	Restricted	Moderate	Ongoing, stable	Low
West Kootenay	Habitat	Water quality	Mining	Restricted	Slight	Residual only	Low
West Kootenay	Habitat	Water quality	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Water quality	Linear Projects	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Habitat	Water quality	Climate Change & Severe Weather	Restricted	Slight	Ongoing, increasing	Low
West Kootenay	Habitat	Water quality	Invasive Species	Negligible	Negligible	0	Negligible
West Kootenay	Habitat	Water quality	Oil and Gas	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Altered community dynamics	Water Use – permanent withdrawal – consumptive	Large	Moderate	Ongoing, stable	Medium
West Kootenay	Non-Habitat	Altered community dynamics	Water Use - temporary diversions/dams, non-consumptive	Restricted	Slight	Ongoing, increasing	Low
West Kootenay	Non-Habitat	Altered community dynamics	Residential, Recreational and Commercial Development	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Non-Habitat	Altered community dynamics	Industrial and Municipal Discharges	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Non-Habitat	Altered community dynamics	Invasive Species	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Non-Habitat	Altered community dynamics	Aquaculture, Hatcheries and Stocking	Restricted	Slight	Ongoing, stable	Low
West Kootenay	Non-Habitat	Altered community dynamics	Climate Change & Severe Weather	Small	Slight	Ongoing, stable	Low
West Kootenay	Non-Habitat	Altered community dynamics	Fishing	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Altered community dynamics	Linear Projects	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Direct mortality	Residential, Recreational and Commercial Development	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Direct mortality	Linear Projects	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Direct mortality	Fishing	Small	Negligible	Ongoing, stable	Negligible
West Kootenay	Non-Habitat	Direct mortality	Aquaculture, Hatcheries and Stocking	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Disease	Invasive Species	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Disease	Industrial and Municipal Discharges	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Disease	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Disease	Climate Change & Severe Weather	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Entrainment	Water Use - temporary diversions/dams, non-consumptive	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Entrainment	Water Use – permanent withdrawal – consumptive	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Entrainment	Residential, Recreational and Commercial Development	Negligible	Negligible	0	Negligible
West Kootenay	Non-Habitat	Introgression	Aquaculture, Hatcheries and Stocking	Unknown	Unknown	0	Unknown
West Kootenay	Non-Habitat	Introgression	Invasive Species	Unknown	Unknown	0	Unknown

[a] **Population Group –** As described in Section 4.2.2.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%).

[d] **Timing** – Residual only (i.e., threat is no longer occurring but residual effects continue); Ongoing but diminishing; Ongoing and stable; Ongoing but increasing; and Future only.

[e] **Threat Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest (Master *et al.* 2009). This combined score is based on the interaction between assigned scope and severity values, and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. (Very High; High; Medium; Low; Negligible; Unknown; Blank). "Unknown" means that data are not available to assess the threat. Blank means that the assessor cannot make an informed rating.