The Horsefly River
Watershed Code WSC 160-635400
Watershed-Based Fish Sustainability Plan
Stage 2 - Watershed Profile

Prepared For:

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March 31, 2008

Acknowledgements

Cariboo Envirotech Ltd. would like to thank Linda Bartsch and the Horsefly and District Board of Trade for initiating the Horsefly River Roundtable process and for the provision of funding for this project. Additionally we would like to thank the Fraser Basin Council and staff members Mike Simpson and Maureen LeBourdias for their participation and contributions that have enabled this process to move forward.

We would also like to thank the members of the Horsefly River Roundtable who volunteer their time and are engaged in this process to ensure the health of the Horsefly River Watershed. No one looks after a watershed better than the people who live in it and who are reliant on its sustainability.

A special thank you goes out to Fisheries and Oceans Canada biologists Don Lawrence whose thesis for his Royal Roads University Master of Science degree provided the genesis for the Horsefly River Roundtable, and Judy Hillaby who contributed salmon life history reports for this document found in Appendix E .

We would also like to thank Fisheries and Oceans Canada biologists Judy Hillaby and Don Lawrence, Stewardship Coordinator and ecologist Sue Hemphill, Barry Booth of the Land Conservancy of BC, Ecosystems Specialist Geoff Price and Biologist Rob Dolighan of the BC Ministry of Environment, Mike Simpson of the Fraser Basin Council and riparian specialist and biologist Richard Case for their advice and participation in the Watershed Technical Committee. Additionally we would like to thank Tracy Bond for efforts as the Horsefly River Roundtable coordinator and her participation on the Technical Committee.

The opinions expressed in this document are solely those of the author.

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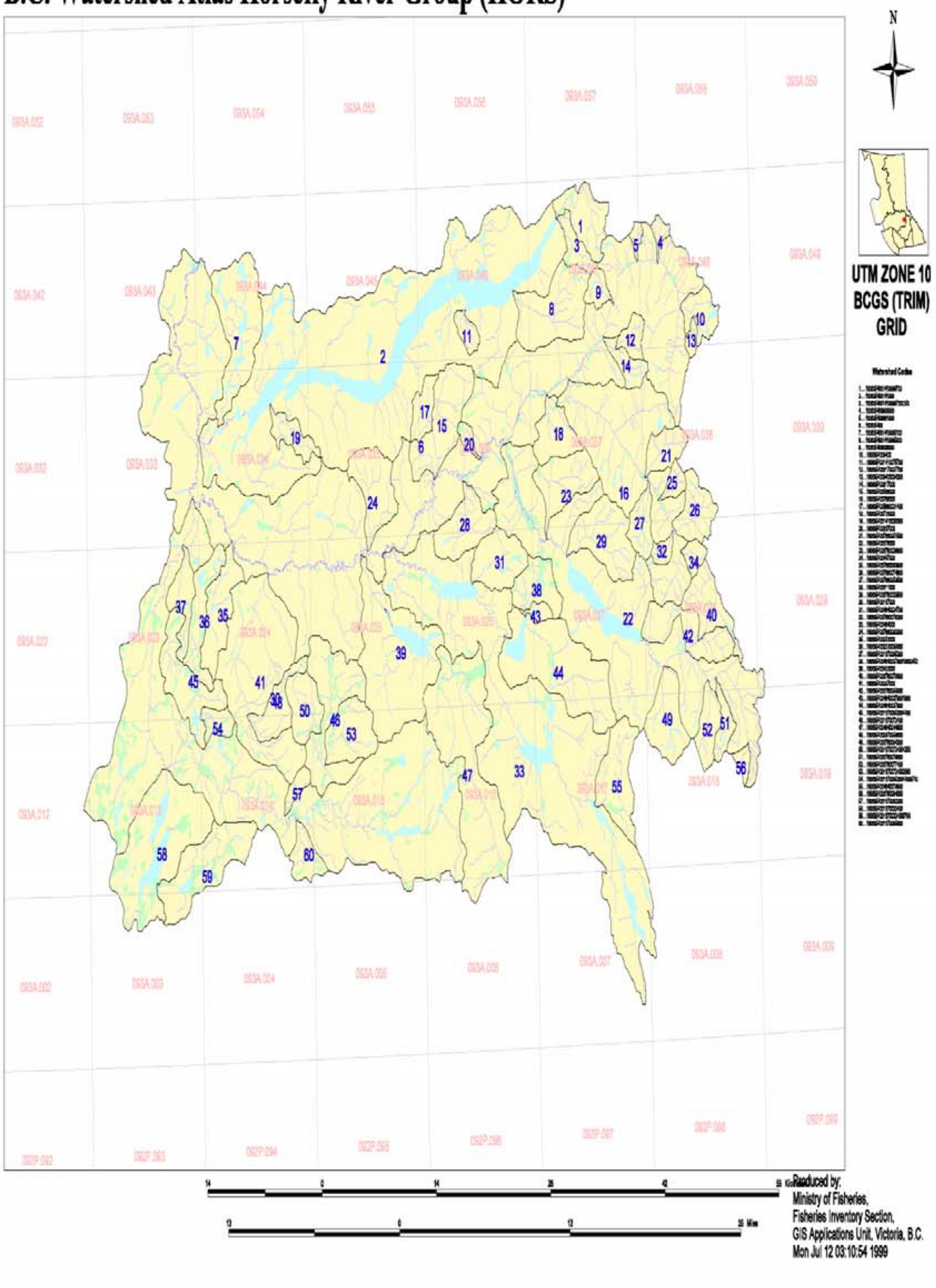
B.C. Watershed Atlas Horsefly River Group (HORS)



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1.0 Introduction

Draft Mission Statement of the Horsefly River Roundtable:

"To be a catalyst to achieve and maintain healthy Horsefly community watersheds, through coordinated management of all resources, respect for all concerns and cooperative, positive action".

The following introduction is being provided to give the reader a sense of how the Watershed-based Fish Sustainability Planning program came into being. Its genesis was the 1997 Auditor General's Report to Canadians.

1.1 1997 Auditor General's Report

In 1997 Chapter 28 of the Canadian Auditor General's Report on Fisheries and Oceans Canada's Pacific Salmon: Sustainability of the Resource Base recommended the following main points:

"28.1 *Canada's ability to sustain the Pacific salmon resource at the present level and diversity is questionable given the various factors influencing salmon survival, many of which are beyond its control. While Fisheries and Oceans has built up major salmon stocks, others are declining and many are considered threatened. There is evidence that habitat loss is contributing to these declines. However, no overall status report on salmon habitat is available to assess the impact of habitat loss on the resource.*

28.2 *Fisheries and Oceans has a strong mandate in the Fisheries Act to protect salmon and their habitat. However, due to the division of environmental powers under the Constitution Act, the support and co-operation of the Province of British Columbia (B.C.) and municipalities are prerequisites for sustainability of the resource.*

28.3 *The Department's Habitat Policy (1986) promotes both sustainability and genetic diversity. The Policy balances proactive elements (land use planning, integrated resource management and development of guidelines) and reactive elements (project review/approval, compliance monitoring and enforcement). The Department has tended to focus more on the reactive elements, but without sufficient emphasis on monitoring and follow-up.*

28.4 *Habitat management requires improved co-ordination within the Department and the increased involvement of external groups, including provincial and municipal governments, stakeholders and the public, under agreements that include accountability provisions, where appropriate. The Department's overall responsibility for habitat requires clear accountability to maintain control of the process and depends especially on B.C. being held accountable for its own habitat responsibilities.*

28.5 *The opportunity now exists for Fisheries and Oceans to further develop and strengthen its relationship with the Province following the signing in April 1997 of the* *new Canada-B.C. Agreement on the Management of Pacific Salmon Fishery Issues. The Agreement is intended to revisit existing areas of intergovernmental co-ordination covered under the 1985 General Fisheries Agreement and to examine other areas for co-operation. B.C. has released a discussion paper in anticipation of future negotiations. The Department's position on habitat management is expected to be clarified to prepare it for these negotiations"* (Auditor General).

Of particular interest in 28.3 of the main points listed above is the comment that Fisheries and Oceans Canada "has tended to focus more on the reactive elements, but without sufficient emphasis on monitoring and follow-up". Additionally in 28.4 above, the Auditor General recognizes that the Province of British Columbia plays a key role in the sustainability of salmon stocks by being accountable for its own habitat responsibilities. Furthermore, the Auditor General is suggesting that the Department would benefit from a cooperative effort including the Province and its municipalities, as well as stakeholders and the public.

As a result of the 1997 Auditor General's report, the Canada and British Columbia Agreement on the Management of Pacific Salmon and Fishery Issues (1997) and the Canada B.C. Habitat Management Agreement (2000) "committed both governments to work jointly in watershed-based fish production planning processes, to develop joint objectives for habitat protection and commit to better program coordination and information sharing" (WFSP[1]).

1.2 Canada – British Columbia Agreement on the Management of Pacific Salmon Fishery Issues

The preamble of this Memorandum of Understanding (MoU)states the following:

"Whereas the Government of Canada and the Government of British Columbia:

- share a mutual interest in conserving, enhancing and protecting the salmon resource, its habitat and the marine environment, that will help ensure a sustainable and viable fishery for the future;
- agree to provide a cooperative basis for a sustainable fishery resource, sustainable jobs in the fishery sector, and sustainable communities involved in the fishing industry;
- recognize that changes are necessary to the structure and management of the fisheries sector in order to achieve conservation objectives and ensure a sustainable fishery for the future; and
- recognize that the Government of British Columbia will assume an enhanced role in the management of fisheries issues.

Whereas both Governments continue to support the principles set out in the 1996 Memorandum of Understanding between Canada and British Columbia on Fisheries Issues and the Terms of Reference for the bilateral review of federal and provincial roles and responsibilities in the management of the Pacific Salmon Fishery, which include:

- maintaining and enhancing the conservation and long-term sustainability of the resource;
- providing for the long-term viability of the industry;
- bringing decision-making closer to clients and stakeholders;
- creating effective partnerships to better manage the fishery; and
- recognizing the Constitutional protection provided to Aboriginal peoples and treaty rights" (FOC[1]).

Of particular interest in the above MoU as it relates to the Horsefly River Roundtable are the third and fourth bullets which encourages stakeholders and clients to become engaged in partnerships with both levels of government to better mange the fishery and ensure the sustainability of salmon stocks in British Columbia.

1.3 Canada B.C. Habitat Management Agreement

The Canada B.C. Habitat Management Agreement was signed on July 13, 2000 by both federal and provincial ministers to improve habitat protection and coordinate the efforts of both levels of senior government in their desire to ensure the sustainability os west coast salmon stocks.

The Fisheries and Oceans Canada news release goes on to state:

"Under the habitat agreement, the two governments will:

- Co-ordinate work activities to ensure comprehensive and effective protection of fish habitat, and efficient and timely decision-making;
- Establish, wherever possible, clear, comprehensive and harmonized policies, standards, guidelines and procedures to guide decisions in protecting fish habitat;
- Pursue co-operative arrangements with local governments, First Nations, industries and non-government organizations to enhance the protection of fish habitat; and,
- Monitor, evaluate and report on the implementation and ongoing delivery of the agreement (FOC[2]**)**.

Of particular interest to the Horsefly River Roundtable in this news release is the third bullet above once again recognizing the need for both levels of government to engage non governmental organizations in the protection of fish habitat.

1.4 Discussion Paper – A Federal-Provincial Framework For Habitat Restoration and Salmon Enhancement in British Columbia

In 1998 a discussion paper was provided to further the inter-governmental relationship in an effort to protect and enhance salmon and salmon habitat in British Columbia. One of the issues identified in this discussion paper was that "salmon enhancement and habitat restoration activities should include additional opportunities for public involvement"

(**FOC**[3]). The recommendation to address this issue stated "Explore ways for communities, First Nations and the public to become more involved in planning and program delivery, as well as preparing coordinated responses to government-stakeholder disputes"(FOC[3]).

The opportunity for community groups to become more involved with both the federal and provincial governments in the protection and enhancement of salmon and their habitat was clearly stated in this document.

As a result of the above mentioned initiatives, the Province of British Columbia and Fisheries and Oceans Canada produced a guidebook in 2001 titled "Watershed-based Fish Sustainability Planning"- Conserving B.C. Fish Populations and Their Habitat-A Guidebook for Participants.

1.5 The Watershed-Based Fish Sustainability Planning Guidebook

The creation of this guidebook was lead by members of the Watershed-Based Fish Sustainability Planning (WFSP) steering committee comprised of senior members of Fisheries and Oceans Canada, the BC Ministry of Fisheries, and the BC Ministry of Environment, Lands and Parks. Two workshops were held in 1999 and 2000 in Richmond, British Columbia that included approximately forty members of the above noted government ministries as well as consultants, First Nations, non governmental organizations, and others directly involved with fish and fish habitat in the waters of British Columbia.

The Guidebook was published in 2001 and was designed to assist governments, First nations, stewardship groups and other stakeholders in focusing their resources and coordinating their efforts to ensure fish sustainability in watersheds. It has been noted and in fact stressed that the Guidebook is just that – a guidebook, and that individual groups should use it as such, and endeavor to design a WFSP that suits their needs and the needs of the watershed engaged.

Some summary points relating to this new approach to watershed planning have been taken from the Guidebook and are provided in Sections 1.6 to 1.8 below (WFSP[2]):

1.6 What's New About WFSP?

- Reflects a joint federal-provincial mandate
- Encourages partnerships between governments and other parties with an interest in fish conservation
- Coordinates other ongoing fish and habitat conservation initiatives
- Introduces a consistent approach to planning

1.7 How Does WFSP Work?

- Focuses on fish sustainability
- Focuses on watersheds
- Takes a "fish first" approach
- Identifies priorities
- Builds on existing initiatives
- Uses the best information currently available
- Incorporates adaptive implementation

1.8 What Are the Benefits of WFSP?

- Enhance the capacity of participants to develop effective fish sustainability plans
- Strengthen the voice of fish conservation interests
- Guide traditional fisheries and habitat management activities
- Guide other ongoing land and resource planning activities
- Promote the development of publicly accessible data sets and analytical models

2.0 Watershed Based Fish Sustainability Plans

The Guidebook suggests a four stage process to undertake a WFSP. A brief description of each stage is presented below:

2.1 Stages 1-4

- **Stage I** produces a biophysical and sociopolitical profile of a region (major river basin or sub-basin) and identifies watersheds within the region that are the highest priorities for fish sustainability planning.

- **Stage II** produces a biophysical and sociopolitical profile of each of the priority watershed planning units identified in Stage 1 and identifies objectives, strategies and targets that must be met to achieve fish sustainability within these watersheds.

- **Stage III** produces a detailed fish sustainability action plan that spells out how these objectives, strategies and targets will be met and by whom.

- **Stage IV** involves actual implementation of the plan and monitoring of its effectiveness. It also involves revisiting earlier stages of the planning process, and improving the fish sustainability plan based on new information.

2.2 Don Lawrence Thesis

A Royal Roads University Master of Science in Management and Environment thesis written in April of 2004 by Fisheries and Oceans Canada biologist Donald F. Lawrence of Williams Lake was instrumental in setting the stage for a WFSP to be undertaken in the Horsefly River Watershed.

Titled "The Feasibility of Conducting a Watershed-based Fish Sustainability Plan on the Horsefly River Watershed", the thesis lays the groundwork for the Stage I and part of Stage II as described above. It identifies the Horsefly River as a high priority candidate for this process and makes numerous related recommendations. Included is a recommendation that a Horsefly River roundtable be established on a permanent basis to ensure the fish sustainability of this regionally important watershed (Lawrence).

2.3 Stage 2 Requirements

The Stage II requirements as recommended by the WFSP Guidebook include the establishment of both a Watershed Planning Team and a Watershed Technical Committee (WFSP²). The Horsefly River Roundtable effectively represents the Watershed Planning Team whereas selected members of the Roundtable represent the Watershed Technical Committee.

The recommended tasks of **Watershed Planning Team in Stage II** as provided in the Guidebook are as follows:

- Develops a working protocol that describes the roles and responsibilities of WFSP participants
- Works closely with other parties with an interest in fish sustainability
- Develops a strategic overview of local values and resources
- Establishes the overall strategic direction(s) for management
- Establishes specific management objectives, targets, and strategies
- Develops a monitoring and assessment framework and
- Brings the resulting Stage II plan to government for review and approval

(WFSP²)

The recommended tasks of **Watershed Technical Committee in Stage II** as provided in the Guidebook are as follows:

- Coordinates the collection and analysis of data about the watershed
- Develops a watershed profile
- Identifies strategic management options consistent with fish sustainability, and
- Identifies appropriate indicators of effectiveness

(WFSP²)

The thesis written by Donald Lawrence included a watershed profile of only the larger tributaries and included only salmonids as the species for research. The author of this report will build on that foundation and include information on all the named tributaries as well as include information on all the freshwater species of fish residing in the Horsefly River watershed.

The **watershed profile** (as recommended by the Guidebook) includes information about the following:

- Fish populations
- Fish habitat
- Impacts of development on the watershed
- The cumulative effects of past, present, and potential future activities, and
- Important gaps in information about fish populations and habitat

(WFSP²)

It also identifies:

- Causes of any observed change in populations and/or habitats over time
- Factors that are likely to cause future changes in the status of populations and habitat
- The potential for maintaining or restoring productive capacity, and
- Factors that limit the degree to which populations or habitat can recover on their own

(WFSP²)

Development of the watershed profile involves:

- Description of the watershed planning unit based on existing knowledge
- Identification of gaps in information about fish populations and habitat, and
- Analysis of data and/or other elements of the preliminary description

(WFSP²)

3.0 The Horsefly River Roundtable

Based on the recommendation to create a Horsefly River Roundtable (HRR) from the Donald Lawrence thesis, the initial meeting of the roundtable was organized by Linda Bartsch of the Horsefly Board of Trade and the Fraser Basin Council's (FBC) Mike Simpson of that organization's Williams Lake office.

The inaugural meeting was held in Horsefly on February 15, 2007 and was well attended by approximately 22 individuals representing government, industry, non governmental organizations, and interested residents of the Horsefly area. The meeting was chaired by Mike Simpson who has continued in this role with the full support of the FBC.

3.1 Organizational Membership and Structure

The membership of the HRR is comprised of Horsefly community residents, industry, Federal and Provincial government agencies, non governmental organizations. First Nations have been invited to participate. It currently operates under the umbrella of the Horsefly Board of Trade but the intent is to have the Roundtable obtain its own status as a registered society. The Roundtable will make decisions on a consensus basis allowing all voices to be heard. Issues will not be voted on which will prevent an outcome of winners and losers. The meetings will generally be held once per month and held in the evening at the Horsefly Community Hall for a maximum of two hours.

The area of representative interest will be the Community of Horsefly (Appendix A - 2006 Census Profile), the Horsefly River watershed and include Beaver Valley as well. Although Beaver Creek does not flow into the Horsefly River, numerous residents who live there utilize Horsefly as their service centre. Minutes recorded for the meetings to date can be found in Appendix B of this report.

3.2 List of Issues and Concerns

The following list of issues and concerns were first presented by Roundtable members at the inaugural meeting in February and discussed and complimented by additional submissions throughout 2007 (HRR).

3.2.1 Stewardship

- Ecosystem health, including hydrology, fish and fish habitat
- Knowledge and appreciation of natural history
- Viewscapes and aesthetics
- Recreational tubing on the river – pollution,safety
- Education of those outside the roundtable
- Water stewardship – quantity and quality

3.2.2 Community Voice

- Economic, environmental and social opportunities and issues
- Communication with government agencies, industry, and other organizations
- education of the roundtable members

3.2.3 Industrial Development

- Logging and trucking
- Road development and access
- Mining, mineral exploration, and placer mine reserve on the Horsefly River
- Hydroelectric production

3.2.4 Planning

- Cariboo Chilcotin Land Use Plan, Horsefly Sustainable Resource Management Plan
- Settlement planning and access
- Other plans

3.2.5 Ranching and Private Land

- Erosion issues on the Horsefly and Moffat mainstems

3.3 Funding of This Project

The writing of this report is being funded by the Fraser Salmon and Watersheds Program. "The Fraser Salmon and Watersheds Program (FSWP) is a multi-year initiative that aims to conserve and restore the diversity and abundance of salmon within the Fraser Basin. FSWP was initiated in 2006, with a contribution of $10 million over four years from the provincial Living Rivers Trust Fund and $10 million ($5 million in cash and $5 million in staff time, technical expertise and resources) from Fisheries and Oceans Canada (DFO) over five years. Resources provided by DFO are managed as a FSWP sub-program referred to as the Fraser Basin Initiative (FBI).

The Fraser Basin Initiative is jointly managed by the Pacific Salmon Foundation (PSF) and the Fraser Basin Council (FBC). A Steering Committee, with representatives from federal, provincial, and Aboriginal governments, as well as the two co-managing organizations, provides oversight to the program. Finance is administered through the Pacific Salmon Foundation.

The Fraser Basin Initiative is a strategic program, developed to be consistent with the business plan for the Fraser Salmon and Watersheds Program. Through planning sessions and a meeting of collaborators (the Fraser Assembly), overall priorities are identified. These are reflected in this call for submissions for the Fraser Basin Initiative. This process also identifies specific strategic projects carried out under the Fraser Salmon and Watersheds Program.

Projects funded under the FBI are intended to support one of the following key areas:

- Improved science for decision making
- Stewardship and habitat;
- Enhanced fisheries management elements; and
- Collaboration and relationship building" (ThinkSalmon)

The Horsefly & District Board of Trade submitted a proposal titled the "Horsefly River Watershed Management Plan" and this proposal was approved for funding during the fall of 2007. The funding enabled the Board of Trade to undertake the writing of this report as part of their Roundtable initiative, and included funding to hire a project coordinator. This position has subsequently been filled by Tracy Bond who has a strong background as a watershed stewardship coordinator with the Baker Creek Enhancement Society of Quesnel, BC

3.4 Technical Committee

A technical committee has been formed as part of the Roundtable process and their role has been defined in Section 2.3 above. The following members of the Roundtable have agreed to sit on this committee:

Barry Booth — The Land Conservancy of British Columbia

Tracy Bond	Horsefly River Roundtable Project Coordinator
Richard Case	R.L. Case and Associates Riparian Ecologist
Sue Hemphill	Scout Island Nature Centre Project Coordinator
Judy Hillaby	Fisheries and Oceans Canada Restoration Biologist
Richard Holmes	Cariboo Envirotech Ltd. Fisheries Biologist
Maureen LeBourdais	Fraser Basin Council Program Coordinator
Mike Simpson	Fraser Basin Council Associate Regional Manager
Geoff Price	BC Ministry of Environment
Rob Dolighan	BC Ministry of Environment

An invitation has been extended to local First Nations to participate in both the Roundtable and the Technical Committee.

4.0 Watershed Profile

4.1 Fish Populations

4.1.1 Species Mix

The Horsefly River is home to numerous species of fish (Table 1). More specifically it is world renown for its trophy size rainbow trout and a sockeye salmon run that contributes millions of dollars to the commercial fishery. The table provides the reader with a list of the species known to inhabit the Horsefly River. The table also provides the Latin name as well as the common abbreviation used to describe the fish species.

Of particular concern regarding fish species in the Horsefly River is the recent discovery of Smallmouth Bass (*Micropterus dolomieui*) being introduced into Beaver Creek located approximately 50 kilometres down stream. Beaver Creek drains into the Quesnel River which drains Quesnel Lake into which the Horsefly River flows.

Table 1: Fish Species Known to Inhabit the Horsefly River Watershed

Common Name	*Latin Name*	Abbreviation
Brassy Minnow	*Hybognathus hankinsoni*	BMC
Burbot	*Lota lota*	BB
Chinook Salmon	*Oncorhynchus tshawytscha*	CH
Coho Salmon	*Oncorhynchus kisutch*	CO
Dolly Varden	*Salvelinus malma*	DV
Lake Trout	*Salvelinus namaycush*	LT
Kokanee	*Oncorhynchus nerka*	KO
Leopard Dace	*Rhinichthys falcatus*	LDC
Longnose Dace	*Rhinichthys cataractae*	LNC
Mountain Whitefish	*Prosopium williamsoni*	MW
Northern Pikeminnow	*Ptycheilus oregonensis*	NSC
Peamouth Chub	*Mylocheilus caurinus*	PCC

Common Name	*Latin Name*	Abbreviation
Rainbow Trout	*Oncorhynchus mykiss*	RB
Redside Shiner	*Richardsonius balteatus*	RSC
Sockeye Salmon	*Oncorhynchus nerka*	SK
Steelhead	*Oncorhynchus mykiss*	ST
Longnose Sucker	*Catostomus catostomus*	LSU
Largescale Sucker	*Catostomus macrocheilus*	CSU
Sucker (General)	*Catostomus*	SU

(FishWizard)

Note: Detailed FishWizard information - Appendix C.
Fisheries Inventory Summary System (FISS) information – Appendix D.
Detailed Chinook, coho and sockeye information – Appendix E (Hillaby)

4.1.2 Genetic Distinctness

The following descriptions of each of the fish presented in Table 1 above have been researched in the newly released book by J.D. McPhail titled "The Freshwater Fishes of British Columbia". J.D. McPhail is professor emeritus of the Native Fish Research Group in the Department of Zoology at the University of British Columbia in Vancouver.

Brassy Minnow

- Two forms of Brassy Minnow in Alberta; one that survived the last glaciation in the Upper Mississippi system and another that survived in the Missouri system
- British Columbia and northern Alberta are derived from the Mississippi form (Wells)
- A molecular study of the Brassy Minnow is currently in progress

Burbot

- Probably survived glaciation in multiple refugia
- At least two sub species have been recognized; a western sub species (Alaska parts of the Yukon, and Northern British Columbia), and in Eastern North America
- Although the two differ morphologically, the two forms appear to integrate smoothly across the Northern Great Plains

Chinook Salmon

- The species is genetically heterogeneous and locally adapted populations are common
- Two behavioral forms of Chinook; a stream type and an ocean type
- The stream type (Horsefly River) have a relatively long period of freshwater residence (one or more years)
- The ocean type usually migrate to sea within three months of emergence
- Seven recognizable genetic groupings in the Fraser River system
- Upper, middle , lower Fraser group; northern, southern, lower Thompson group; and the Birkenhead River population
- Horsefly River Chinook form part of the Upper Fraser River group

Coho Salmon

- Taxonomic status of the coho is not an issue, the species is genetically heterogeneous, and locally adapted populations are common
- There is molecular evidence for geographically patterned genetic variation in North American coho
- Microsatellite DNA suggests five geographic groups; Alaska and Northern British Columbia, the Queen Charlotte Islands, the BC mainland and Northern Washington State, the Thompson River, and Oregon and California
- The Horsefly River coho help form part of the Interior Fraser River coho group that is part of the BC mainland and Northern Washington State geographical group

Dolly Varden

- The taxonomy of Dolly Varden and its relationship with other char has been a tangled history
- McPhail recognizes Dolly Varden and bull trout as separate species
- Some authors recognize several subspecies of Dolly Varden
- Strong evidence shows that the Dolly Varden of southwestern British Columbia are derived from the Chehalis refugium, whereas those on the central and northern coast are derived from a northern refugium

Lake Trout

- At present lake trout taxonomy is stable
- A stable taxonomy does not imply genetic homogeneity and there is evidence that lake trout survived (and diverged) in at least five different rufugia during the Pleistocene era
- Most populations appear to be derived from two northern sources; the Bering and Nahanni refugia

Sockeye Salmon, Kokanee

- A genetically heterogeneous species and locally adapted populations are common
- Kokanee (freshwater residents) have evolved repeatedly from many different sockeye populations
- Some kokanee populations spawn in the same stream at the same time as anadromous sockeye
- The sockeye/kokanee dichotomy is a classic example of parallel evolution (the independent evolution , from the same ancestral form, of similar phenotypes (morphological, behavioral, or ecological) in similar environments)

Leopard Dace

- Minnow (Cyprinidae) family
- Compared with the longnose and speckled dace, the leopard dace exhibits relatively little geographically patterned morphological variation
- Unpublished molecular data supports the early view that the leopard dace and the speckled dace are close relatives

Longnose Dace

- Minnow (Cyprinidae) family
- Given its extensive geographic range the longnose dace has been divided into subspecies
- There are unresolved taxonomic problems with the longnose dace
- Behavioral observations indicate major differences in spawning behavior and nuptial coloration between eastern and northwestern longnose dace

Mountain Whitefish

- Salmonids, whitefishes (Coregoninae) family
- Two forms exist in many BC rivers; a "normal" from with typical head shape, and a "pinocchio" form with a turned-up nose and an elongated snout
- The "pinocchio" form spends more time digging in the substrate than the "normal" form

Northern Pikeminnow

- Minnow (Cyprinidae) family
- Formerly known as the Northern Squawfish
- There are no taxonomic issues with this distinctive minnow
- Some populations exist with exceptionally small adult size and are confined to a few small lakes on the Bonaparte Plateau and were most likely introduced

Peamouth Chub

- Minnow (Cyprinidae) family
- A member of a western North American lineage of minnows that includes the northern pike minnow, redside shiner, and chiselmouth
- Adult peamouth are distinctive but the fry are not
- Young-of-the-year peamouth are often found schooling with northern pike minnow, redside shiner, and chiselmouth fry

Rainbow Trout, Steelhead

- Salmonids, salmon, trout, and char (Salmonidae) family
- Occur both as freshwater residents and anadromous (steelhead) populations
- Two subspecies occur in BC; coastal rainbow trout and in the Interior, the Columbia redband trout (often called the Kamloops trout)
- Many BC sites include both subspecies however the coastal is dominant in coastal streams and the Columbia is dominant in southern inland populations
- Three major groups of steelhead are recognized in BC; a northern coastal, a southern coastal, and a southern Interior group

Redside Shiner

- Minnow (Cyprinidae) family
- Morphologically speaking the redside shiner is one of the most variable species in northwestern North America
- However, no taxonomic problems affect the BC population
- Recognizable subspecies are found elsewhere (i.e. Snake River)

- Differences between Columbia redside shiners and Oregon coastal residents suggest that the coastal form may be a subspecies

Longnose Sucker
- Sucker (Catostomidae) family
- Three kinds of longnose sucker in British Columbia; a "normal" form that breeds at a relatively large size, a geographically scattered "dwarf" population that breed at a relatively small size, and the genetically distinctive "Salish" sucker
- It is unknown if the "dwarf" population is simply stunted growth or a genetically programmed life history type
- The "Salish" sucker is not sufficiently divergent to warrant a separate taxonomic name

Largescale Sucker
- Sucker (Catostomidae) family
- No taxonomic issues with this species in BC, however
- The relationship between Columbia-Fraser largescale suckers and those in rivers along the central Oregon coast is an unresolved problem

Sucker (General)
- In British Columbia this would represent one of the following five species of the catostomidae family:
  - Longnose Sucker
  - Bridgelip Sucker
  - White Sucker
  - Largescale Sucker
  - Mountain Sucker

4.1.3 Distribution (McPhail)

Brassy Minnow
- The brassy minnow is a North American species with an unusual geographic distribution
- It ranges in a broad belt from the St. Lawrence River in the east to the Fraser system in the west – from Fort McMurray, Alberta to eastern Colorado
- It is locally abundant in western Canada but populations are widely scattered and sporadically found in the Fraser and Peace sytems
- The brassy minnow probably crossed the Continental Divide from the Peace River system into the Fraser drainage sometime during deglaciation
- In the Fraser system it is abundant in lakes and sluggish streams near Vanderhoof and Prince George and abundant in the lower Fraser Valley from Chilliwack to the Fraser River Delta, ***however there is only one confirmed record in the intervening 500 kms; a beaver pond in the Horsefly River drainage near the Village of Horsefly***

Burbot

- It is one of the most widely distributed freshwater fish in the Northern Hemisphere
- In North America it ranges from the Seward Peninsula in Alaska to the Northern parts of Washington, Idaho, and intermountain Montana
- On the Great Plains burbot have been found from the Mackenzie Delta to Wyoming, and in eastern North America from Labrador to Pennsylvania
- In the BC Interior burbot are widespread but absent from short coastal drainages and islands including Vancouver Island and the Queen Charlotte Islands
- They occasionally stray into the lower reaches of the Skeena, Fraser and Columbia rivers but are not able to maintain a self sustaining population in these systems

Chinook Salmon

- Chinook are found in rivers on both the Asian and North American coasts of the Pacific Ocean
- In North America they have been observed historically as far south as the Ventura River in southern California and as far north as Point Hope in Alaska
- There are unconfirmed reports of sightings on the Actic Coast of Alaska and a confirmed record on their presence in the lower Liard River in the Mackenzie drainage
- Chinook are found in most medium to large rivers on the west coast of BC
- In the Fraser River they have been observed as far upstream as Rearguard Falls (680 km from the ocean) and in the Skeena River upstream to its headwaters

Coho Salmon

- Coho are found on both the Asian and North American shores of the Pacific Ocean
- In North America the most southerly run of coho occurs in the San Lorenzo River near Monterey, California, and individuals have been caught in the sea as far south as Baja California
- They are found as far north as Kotzebue Sound, Alaska and individuals have been captured as far east as Great Bear Lake in the Mackenzie River watershed
- Coho have been successfully transplanted into the upper Great Lakes

Dolly Varden

- The Dolly Varden is primarily a coastal species and is continuously distributed in coastal areas around the North Pacific Ocean
- They are found as far south as the Quinault River on the Olympic Peninsula in Washington State
- It is found on most coastal islands that contain lakes or permanent streams
- They penetrate further inland in systems like the Skeena and there have been headwater transfers from this system into the upper Fraser (Stuart drainage system) and the upper Peace (Finlay and Ingenika rivers)

Lake Trout

- Lake trout were originally restricted to northern North America but are now widely introduced outside their natural range to the United States, Europe, South America, and New Zealand
- Their natural distribution lies almost entirely within glaciated areas
- The Lake trout's natural range in BC includes the upper and middle Fraser, the upper Skeena, Nass, Iskut-Stikine, Taku, Yukon, as well as the Peace and Liard systems
- Self sustaining populations of eastern Canadian origin are now established in Okanagan and Columbia drainages as well as in Allouette Lake in the lower Fraser Valley

Sockeye Salmon, Kokanee

- Sockeye are native to both sides of the Pacific Ocean
- In North America anadromous sockeye are found as far south as the Sacramento River in California to the Mackenzie River and other Beaufort Sea tributaries in the western Arctic
- Their region of maximum abundance is from the Columbia River north to the Kuskokwim River in Alaska
- The North American distribution of kokanee is similar to sockeye however they are not widespread in Alaska
- Sockeye and kokanee are widely distributed in BC and anadromous sockeye spawn in over 300 lakes and streams

Leopard Dace

- The leopard dace is a Columbia endemic that also occupies the adjacent Fraser River
- It is common in the Fraser River in suitable habitats from Chilliwack to Prince George
- In the Prince George area it is common in the mainstay Fraser upstream to at least the confluence of the Fraser and Willow rivers
- It is also locally abundant in major tributaries such as the Nechako, Blackwater, Thompson and Nicola Rivers although not in the headwaters of these rivers
- The leopard dace is relatively uncommon in the BC portions of the Columbia River drainage

Longnose Dace

- The longnose dace has the widest geographic distribution of any indigenous minnow in North America
- It ranges from the Atlantic to the Pacific Coast and from the Arctic (just upstream from the Mackenzie River delta) to northern Mexico
- In BC they are found in suitable habitats in the Columbia and Fraser systems in the south, to the lower Liard River in the north, and are found in the Kliniklini River that flows west from the Interior Plateau through the Coast Range Mountains to the ocean

- Longnose dace are absent from coastal islands, most of the short drainages on the coast, and most of the large coast rivers although they are found in the Skeena and Nass River drainages

Mountain Whitefish

- Mountain whitefish are only found in North America and are widely distributed along both slopes of the Rocky Mountains form northern Utah to the lower Mackenzie River
- They are also found in California where they inhabit the eastern slope of the Sierra Nevada
- Primarily an inland species, although they are found in western Washington along the west side of the Olympic Peninsula and the east side of Puget Sound
- In BC they are primarily an Interior species although they reach the coast where major rivers broach the coastal mountains
- They are absent from coastal islands including Vancouver Island and the Queen Charlotte Islands, and most short coastal rivers
- In BC they extend from the US border north to the Iskut-Stikine and Liard Rivers

Northern Pikeminnow

- The northern pikeminnow is restricted to the Columbia River and the adjacent drainages that received fish fauna from the Columbia drainage
- In BC they are widely distributed throughout the province including the Columbia and Fraser drainages and have colonized the Skeena, Nass, and upper Peace systems through the Fraser drainage
- It is absent from the Iskut-Stikine, Yukon, Taku, and Liard Rivers
- Along the central BC coast they are found in the Dean and Klinaklini Rivers and although they reach the coast in large rivers like he Fraser and the Skeena, they are high salinity intolerant and have not colonized Vancouver Island or other coastal islands

Peamouth Chub

- The peamouth is another Columbia endemic and it colonized adjacent drainages
- In BC they range from the upper Columbia River system to the Nass River and in the Interior they reach the headwaters of both the Fraser and the Columbia
- They are absent from the Iskut-Stikine, Yukon, Taku, and Liard Rivers
- They are also found in the Dean and Klinaklini although absent from most rivers along the central BC coast
- They are found on Vancouver Island in lakes such Kennedy, Cecilia, Easter and a small lake on Meares Island
- The Vancouver Island introductions are thought to have been the result of migrations from the Olympic Peninsula during deglaciation which lower salinity levels sufficiently to allow for this migration

Rainbow Trout, Steelhead

- Rainbow trout are native to North America and northeastern Siberia and have been introduced to cold water systems throughout the world

- West of the Continental Divide they range from Baja California to the Kuskokwim River in Alaska however the range of the anadromous strain (steelhead) is more restricted
- In North America, steelhead have been found as far south as Malibu Creek in California and as far north as the Alaska Peninsula
- Steelhead have been historically observed throughout the entire coast of British Columbia
- Most of the native range of rainbow trout were likely in west flowing rivers and in the upper Peace and Athabasca drainages although introductions are common throughout the Province of BC

Redside Shiner

- Another Columbia endemic, it originally ranged from the Nass River system to the Great Basin (Utah and Nevada) although bait bucket distribution has spread this species into the Missouri and Colorado drainages
- Mainly an Interior species in BC, it does reach the coast in large rivers like the Fraser and the Skeena
- It has a low salinity tolerance and redside shiners have not reached any coastal islands
- Through the Fraser system they have colonized the Skeena and the upper Peace but are not found in the Iskut-Stikine, Yukon, Taku, and Liard Rivers
- In central BC they are present in rivers that rise onto the Interior Plateau such as the Homathko, Klinaklini, and the dean Rivers

Longnose Sucker

- Found in Asia (a few Arctic coastal drainages in eastern Siberia) and North America from Labrador to the Pacific Coast, and on the Great Plains from the Arctic Coast to Colorado
- Longnose suckers are found throughout BC in cool waters from the Columbia River in the south to the Liard and Yukon Rivers in the north
- Primarily an Interior species it approaches the coast in the Fraser system downstream as far as Hope
- It is also found in rivers that have their headwaters east of the Coast Raange such as the Dean, Homathko, and Klinaklini Rivers

Largescale Sucker

- The largescale sucker ranges from the Nass and Peace Rivers in the north to the Columbia River in the south
- In BC this species is abundant throughout the Columbia, Fraser, Skeena, Nass and upper Peace drainages, as well as the Dean, Homathko, and Klinaklini Rivers
- They are absent from Iskut-Stikine, Yukon, Taku, and Liard Rivers
- They reach tidal waters through migrations down the Fraser and the Skeena, are known to inhabit some tidal flats suggesting some salinity tolerance, however they are not found on coastal islands or in coastal rivers

4.1.4 Conservation Status (McPhail)

Brassy Minnow

- Not listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
- Listed as S3 (rare or uncommon) by the British Columbia Conservation Data Centre (BCCDC)
- Distribution in BC is highly fragmented, but ecologically appears adaptable
- The fragmented distribution makes it vulnerable to habitat alteration
- Largest populations are known to be in the lower Fraser River especially in the drainage ditches in the Richmond area

Burbot

- Neither COSEWIC nor the BCCDC list burbot
- Known to be abundant in the northern half of BC
- Some healthy populations are known to exist in the southern half of BC
- A species of regional concern in the Kootenay Lake and the Columbia River areas due to a major burbot fishery that occurred in this area about 50 years ago
- McPhail states that the declining southern population should be monitored

Chinook Salmon

- COSEWIC lists the Okanagan Chinook population as endangered
- At least 866 chinook stocks are found in BC and the Yukon
- 17 stocks listed as extirpated (locally extinct) in BC and the Yukon (11 due to hydro electric dams)
- 47 at high risk, 6 at moderate risk, 7 are stocks of special concern
- The status of 459 stocks is unknown

Coho Salmon

- ***COSEWIC lists the Interior Fraser River coho as endangered***
- Approximately 2,600 coho stocks in BC
- Status of 1,200 stocks is unknown
- 29 stocks have been extirpated, 214 are at high risk, about 20 stocks are of special concern
- Half of the extirpated and most of the stocks at high risk are in the Straight of Georgia region or in the Interior of BC
- Most of the high risk stocks are small and may have been so historically

Dolly Varden

- Not listed by either COSEWIC or the BCCDC however fluvial populations benefit from angling regulations designed to protect bull trout
- Dolly Varden are abundant and not heavily exploited in coastal BC
- Of particular conservation interest are sites where Dolly Varden and bull trout coexist
- McPhail states that areas where these two species coexist should be protected from disturbance

- Greatest threat may be from the brook trout as they hybridize and both species are infertile

Lake Trout

- Aside from some exploited populations of lake trout, this species is not a conservation problem in BC
- Global warming and exploitation rates are of future concern
- Important to distinguish between native and introduced populations (eastern origin)
- Caution should be exercised to prevent the mixing of the two species

Sockeye Salmon, Kokanee

- COSEWIC lists Sakinaw and Cultus Lake stocks as endangered
- Approximately 900 sockeye salmon stocks in BC and well over 500 kokanee populations
- Information is known on approximately 60% of the sockeye stocks
- 20 have been extirpated, 61 are at high risk, and 2 endangered
- Dams have caused some of the extirpations
- An unknown number of small stocks occur along the west coast of BC

Leopard Dace

- Assessed by COSEWIC and listed as not at risk
- Abundant in gravel deposition reaches of the Fraser River and its major tributaries
- Not abundant in the BC portion of the Columbia River system
- The contrast in abundance between the two systems is unclear and unknown if dams on the Columbia have made the difference
- Leopard dace should be monitored in the Columbia system and be regarded as a species of regional concern

Longnose Dace

- One of three BC forms of the longnose dace, the Nooksack dace is listed as endangered by COSEWIC and listed by BCCDC as S1 (critically imperiled)
- The common form is considered healthy throughout most of BC, however gravel washing in the Lower Fraser River has degraded some of their habitat
- The Great Plains form is restricted to northeastern BC and its provincial status needs to be evaluated

Mountain Whitefish

- Abundant in British Columbia
- Not a conservation concern at present
- McPhail recommends that the nature of the relationship between the “normal” and “pinocchio” forms needs to be clarified

Northern Pikeminnow

- The northern pikeminnow is not a conservation concern in BC
- Is a persecuted species

- Rarely used as food, yet seldom returned to the water unharmed
- Thought to be “bad” therefore killing them is “good”, yet northern pikeminnow and their prey mostly are still in their natural balance in BC

Peamouth Chub

- Not listed by either COSEWIC or the BCCDC
- Populations on the east coast of Vancouver Island are in trouble
- Either extirpated or have declined dramatically due to urbanization and the introduction of exotic species

Rainbow Trout, Steelhead

- Freshwater resident rainbow trout are not a conservation concern in BC
- Care should be taken to protect wild stocks and not have them mixed with introduced hatchery stocks
- Steelhead are a stock of concern
- Out of 867 stocks, 9 are listed as extirpated, 8 are at high risk of extirpation, and 143 stocks are of special concern
- Urbanization, loss and degradation of habitat, ocean survival, dams, over exploitation and interception by the commercial fishery are all causes of concern

Redside Shiner

- Not listed by either COSEWIC or the BCCDC
- Probably the most abundant minnow in the Interior of BC and not a species of concern in this area
- It has disappeared from many sloughs and shallow lakes in the lower Fraser River, possibly due to the spread of largemouth bass

Longnose Sucker

- The subspecies Salish sucker is protected in Canada
- Listed as endangered by COSEWIC and as S1 (critically imperiled) by the BCCDC
- Some other “dwarf” populations in BC may merit designatible unit status

Largescale Sucker

- Is abundant in BC
- Most populations appear healthy
- Not a conservation concern

4.1.5 Long Term Trends

Aside from the primary salmonid species residing in the Horsefly River drainage, very little if any trend analysis is available for the other species. However, a great deal of information is available for most of the salmonid species, especially those that are anadromous.

Although we have long understood the life cycles of most fishes, we have been unable to stop the decline in their populations. Pacific salmon have been well studied and researched for well over a century, and yet in spite of knowing their needs to survive, we have not found the cumulative will to halt their rapid decline, extirpation, and in many instances, their complete disappearance from numerous watersheds.

In 2006, Dr. Robert Lackey's recent publication titled "Salmon 2100: The Future of Wild Pacific Salmon" presents the views of more than two dozen salmon scientists, salmon policy analysts, and salmon advocates. In it he provides information from Slaney et al stating that of the 9,662 identified salmon stocks in British Columbia and Yukon, 624 were found to be at high risk, at a minimum, 142 stocks have disappeared within the last century (Lackey, et al). The book also provides information from Noakes et al that the total Canadian salmon catch in 1998 was at the historic low for the 20th century.

The Lackey book shows a graph provided by Gresh et al. presented below in Table 2 that compares current and historical run sizes for areas on the west coast from California in the south to Alaska in the north.

Table 2: Comparison of Current and Historical Run Sizes (Gresh et al. 2000)

Area	Historical run size	Current run size	Percent of historical run size
Alaska	150-200	115-259	106.7 %
BC (non-Columbia River)	44-93	24.8	36.2 %
Puget Sound	13-27	1.6	8.0%
Washington coast	2-6	0.07	1.8%
Columbia basin	11-15	0.11-0.33	1.7%
Oregon coast	2-4	0.10-0.032	7.0%
California	5-6	0.28	5.1%
California, Oregon Washington, Idaho	33-58	2.16-2.60	5.2%

(Lackey, et al.)

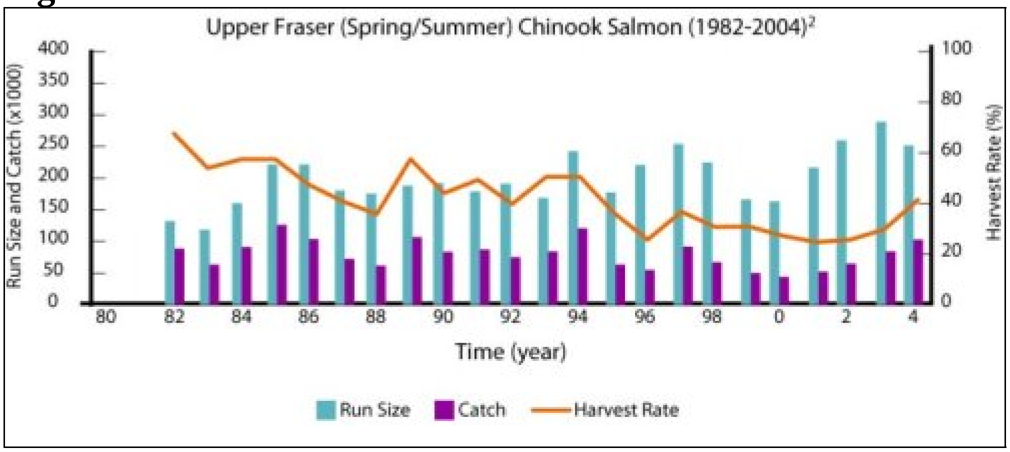
Aside from Alaska, Pacific salmon stocks are in sharp decline throughout the Pacific Northwest. A ripple effect of concern relating to these declines is the lack of marine derived nutrients (MDN) returning to salmon streams and watersheds. Not only do these carcasses assist the offspring of anadromous fish and others in development and growth, these nutrients are an important source of food for terrestrial and other freshwater animals.

Chinook Salmon

The following figure extracted from the Fraser Basin Council's 2006 State of the Fraser basin Report shows Upper Fraser Chinook salmon run sizes, catches and harvest rates from 1980 to 2004. The report gave Chinook the following status report:

MIXED RESULTS/POOR - Between 1982 and 2004, catch and harvest rates have been higher and more consistent for Interior Fraser stocks than for the Lower Fraser "fall-run" stocks, especially in recent years. Harvest opportunities for fall-run stocks have been reduced because of conservation measures for other salmon stocks and steelhead.

Figure 1:

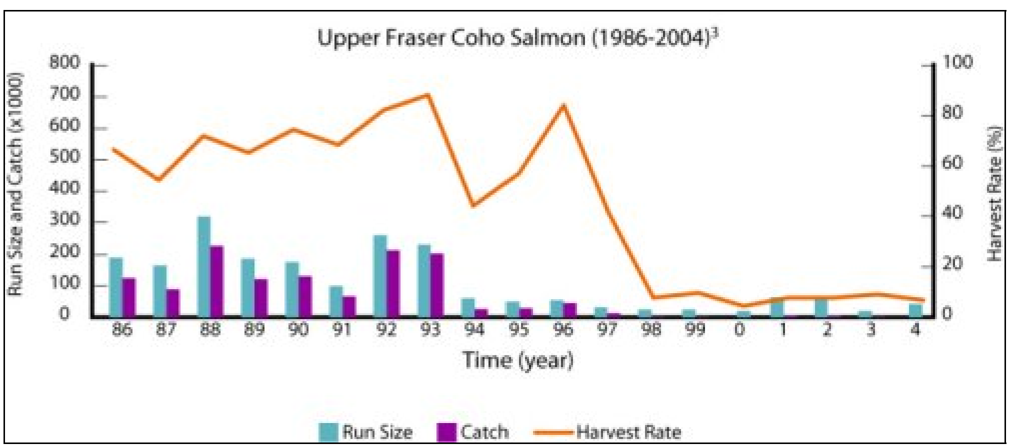


(Fraser Basin Council)

Coho Salmon
The following figure extracted from the Fraser Basin Council's 2006 State of the Fraser basin Report shows Upper Fraser coho salmon run sizes, catches and harvest rates from 1986 to 2004. The report gave coho the following status report:

GETTING WORSE - Between 1986 and 2004, run size, catch and harvest rates have declined significantly for both Interior (mostly Thompson) and Lower Fraser Coho.

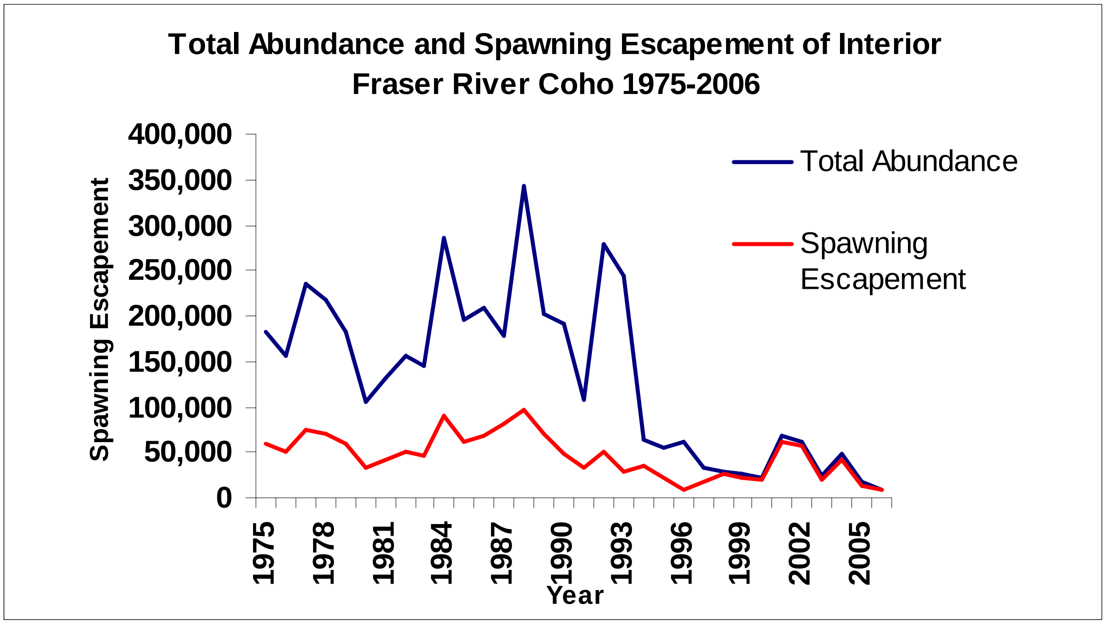
Figure 2:



(Fraser Basin Council)

The following figure showing the decline in Interior Fraser River coho stocks has been provided by Richard Bailey of Fisheries and Oceans Canada in Kamloops.

Figure 3:



(Bailey)

One very good sign of the ability for salmon stocks to rebound became evident during the fall of 2007. A counting fence located on McKinley Creek and operated by the North Shuswap Tribal Council on behalf of Fisheries and Oceans Canada enumerated more than 5,000 adult coho on their migration upstream to spawn. This is by far the greatest known escapement of coho into the McKinley Creek drainage.

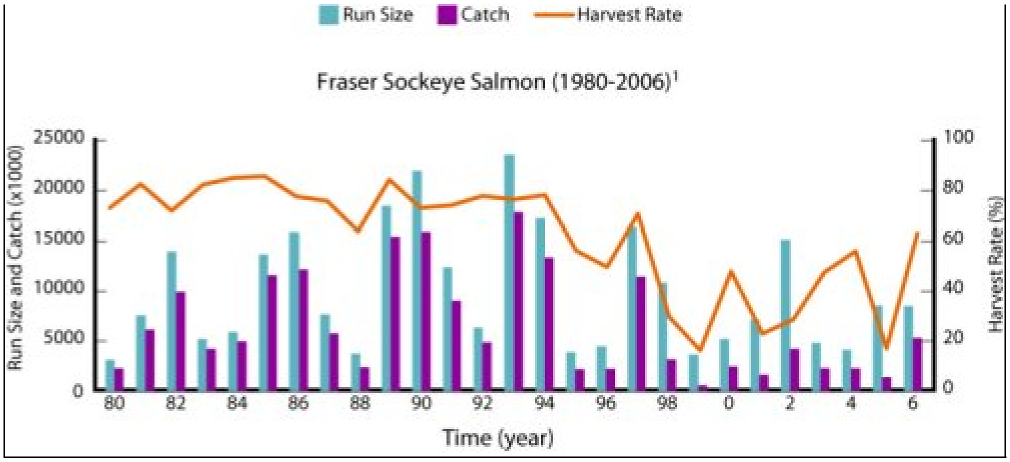
Additionally, a fall 2007 study on streams entering Quesnel Lake undertaken by Cariboo Envirotech Ltd. on behalf of Tolko Industries Ltd. of Williams Lake supported this positive story as they enumerated adult coho salmon in13 separate drainages; many of which had never been known to support coho salmon in the past (Holmes, J.).

Sockeye Salmon

The following figure extracted from the Fraser Basin Council's 2006 State of the Fraser basin Report shows Fraser sockeye salmon run sizes, catches and harvest rates from 1980 to 2006. The report gave sockeye the following status report:

GETTING WORSE - Between 1980 and 2006, run size, catch and harvest rates have generally declined after 25-year highs in the early 1990s.

Figure 4:



(Fraser Basin Council)

4.1.6 Life History Information (McPhail)

Brassy Minnow

- Life history of the brassy minnow is not well known
- In the Prince George region spawning starts in early June and continues into early August although some areas in BC have fall spawners
- Females produce about 100 – 1,000 eggs depending on body size
- Eggs are released into the water column and fertilized near the surface or in mid-water and over vegetation and fertilization is undertaken by several males
- Embryo development is rapid (hatching occurs within 70 hours at 18º C)
- By day 8 the embryos are about 6 mm long and begin to feed
- Growth in the first few months is rapid
- Both males and females reach sexual maturity after one winter if spawned in the spring
- Maximum age recorded in BC is 4 years old
- Diet consists of algae, organic detritus, chironomids, cladocerans, copepods, and small insects

Burbot

- In BC there are three general life history patterns; lacustrine, riverine, and adfluvial (migrating between rivers and lakes)
- Adult burbot aggregate for spawning in winter or early spring in cool water temperatures ranging from 0º to 5º C
- The adults ball up in some lake spawning sites and their writhing cleans the substrate and excavates depressions for spawning
- Spawning in lakes occurs in relatively shallow water (1.0-10.0 m) over sand or gravel bottoms
- Spawning in rivers occurs in low velocity areas in main channels and in side channels behind deposition bars

- Eggs and sperm are released into the water just above the bottom
- Females are very fecund and large females produce over a million eggs
- The eggs take about 30-60 days to hatch depending on water temperature
- The larvae remain sedentary on the bottom for about 5 days then begin wriggling their way to the surface and then back filling their swim bladders and becoming neutrally buoyant
- They can grow from being planktonic to fry within a month
- Burbot can grow rapidly in their first year depending on food resources and may reach 100-120 mm by fall
- Sexual maturity can occur between the ages of 7 and 14
- Burbot have been known to live for 20 years and reach lengths of 700 mm
- Their diet as young is small phytoplankton and rotifers (small, many-celled, chiefly freshwater aquatic invertebrates) and as they grow they rely more on larger organisms such as amphipods and as adults their diet includes fish species such as trout, grayling, suckers, minnows and sculpins

Chinook Salmon

- There are two basic life history types; ocean type that migrate to the sea in their first year and stream type (Horsefly River chinook) that migrate to sea after 1-2 years in freshwater
- In BC chinook adults enter freshwater as early as April and as late as August
- In the Fraser River system there are two peaks of migration; one in July and another in the fall (September-October)
- Females choose the spawning sites in small and large streams preferring sites with sub gravel flow such as in the tail-outs of pools immediately above riffles or in upwelling sites
- Females dig a redd (egg nest) in the substrate and deposit eggs in this redd while a dominant male fertilizes recently deposited eggs while other males dart in when possible and are able to fertilize eggs on the fringe of the redd
- Fifty percent emergence times from alevin to fry can vary from about 211-220 days at 4º C to 61.7-62.8 days at 15º C
- Stream type fry transform to smolts enabling them to adapt to salt water and migrate to the ocean in the spring after 1 or 2 years in freshwater
- Once at sea chinook grow rapidly however ocean type grow much faster than stream type
- Stream type jacks (sexually precocious males) return to spawn in their third year however most adults return as four or fiver year olds
- A chinook fry diet in freshwater includes adult chironomids, chironomid larvae and pupae, terrestrial insects, and nymphs and larvae of aquatic insects
- While at sea their diet as juveniles includes small fish such as chum salmon fry, herring larvae, smelts and other small fish, and as adults their diet includes fish such as herring, anchovies, sand lance, and pilchards

Coho Salmon

- Coho in British Columbia are known to spawn in over 300 rivers and streams

- Adults returning to freshwater can be part of an early run (September – October) or a late run (October - December)
- Spawning typically occurs in cold water ranging from 1º - 8º C although in California sometimes as high as 13.3º C
- Coho often spawn in small streams and like other salmon the female chooses the site of the redd
- Females prefer sites with sub-gravel flow much like Chinook but are able to utilize smaller substrate
- One dominant male accompanies the digging female however additional males will attempt to spawn with her as well
- Incubation time of eggs during the winter in the gravel varies based on water temperature and emergence occurs about three months after hatch
- Fecundity of female coho in the Karluk Lake population of Alaska varied from 1,724 to 6,906 eggs
- In BC coho fry usually reach 80-90 mm in their first year however growth rates are dependent on temperature, food abundance and temperature
- Yearling coho smolts can range from 7 to 12 cm when migration to the ocean occurs and two year old smolts range in size from 10 to 15 cm
- Coho are often drift feeders and feed on aquatic insects in the water column and in the summer their diet is complimented with aerial insects
- As they grow juvenile coho prey more on other fish such as sockeye fry
- Adult coho are highly piscivorous (fish eating) and include herring, sand lance, and other small fish in their diet

Dolly Varden

- In BC Dolly Varden display three general life history forms; an anadromous form, a stream resident form, and an adfluvial form that resides in lakes but spawns in streams
- Sea run Dolly Varden tend to remain in or near estuaries and their migration into fresh water includes immature and mature individuals
- Adults spawn in the fall in running water and aside from stream resident populations this usually involves a migration
- Females dig a redd and fertilization is undertaken by a dominant male
- Bull trout coexist with Dolly Varden and as a result hybrids can be produced
- Fecundity of Dolly Varden varies with body size and the number of eggs recorded has ranged from 70 to 6,000 eggs
- Eggs incubate in the gravel over the winter and fry emerge in the spring with timing dependent on over winter water temperatures
- Most fish of both sexes reach maturity in their fifth growing year and maximum age is about 9 years old
- Fry and juveniles feed on primarily on chironomid larvae and as they grow they feed on aquatic insects
- As they become larger the juveniles switch their diet to small fish as well as larvae of aquatic insects such as mayflies, caddisflies, stoneflies and chironomids

Lake Trout

- Little is known about lake trout history in British Columbia and as such the following information is derived from eastern and northern Great Plains populations
- Lake trout spawn in the fall usually when temperatures drop below 10º C
- The spawning can occur from September to November based on latitude and lake size
- In BC lake trout have only been observed spawning in lakes however they have been observed spawning in rivers
- Spawning depths have been recorded in water 5 to 50 metres and as shallow as 20 centimetres
- Some lake trout spawn at night, the females do not construct a redd however some gravel cleaning is undertaken
- Usually more than one male is involved in the fertilization and the males swim alongside the females, press against her and quiver
- Eggs are released and fertilized as they drop into cracks and crannies between the rocks and are not covered
- Lake trout eggs are large and fecundity can be low with eggs totaling between 500 and 20,000 per female
- Females in many populations do not spawn every year
- Incubation time varies based on water temperatures and as with most salmonids the alevins emerge from the gravel at night
- Lake trout growth varies depending on temperature, productivity, population density, and age at maturity
- Lake trout in large northern lakes are especially long lived and 20 years old is not uncommon and the oldest recorded individual was found to be 62 years old
- Maturity is usually reached between 5 and 13 years with males maturing 1 to 2 years before females
- First year lake trout fry forage on plankton and the larvae of aquatic insects and as they grow add larger benthic organisms (amphipods and mollusks) to their diet
- Once they reach a length of 35-40 cm. they usually become piscivorous however if fish are not available they can remain planktivorous but may remain stunted
- Piscivorous lake trout will grow larger and live longer

Sockeye Salmon, Kokanee

- Two life history types that differ in a suite of morphological and physiological traits are presented below for both the anadromous (sockeye) and non-anadromous (kokanee) types of this species
- Most sockeye are lake type meaning they rear in a lake as juveniles however there is also a stream type that lives in rivers for 1 or 2 years prior to migrating to the ocean
- There are also a sea type sockeye in which the fry migrate directly to the ocean
- Kokanee spawn in the fall in streams and on lake shoals usually during the months of September and October
- Sockeye usually enter freshwater during the summer months and spawn from August to November although there are isolated exceptions to this

- Females choose the redd site usually in upwelling areas or with sub gravel flow and will also spawn on lake shores like kokanee
- Both sexes defend the spawning site and males will court the female while she is digging her redd, brush against her and quiver
- Eggs are fertilized as they are dropped or immediately after laying in the redd and the female covers the redd after spawning
- In both sockeye and kokanee the egg size varies and female sockeye can typically have between 3,000 to 4,000 eggs and kokanee can have between 200 to 1500 eggs
- Eggs incubate throughout the winter months and development is temperature dependent however interior stocks develop faster, hatch earlier, and emerge earlier than coastal stocks
- Upon emergence, kokanee and sockeye stocks migrate at night to a nursery lake before starting to feed
- Growth rate of both types of fry is dependent on temperature and food availability
- Zooplankton are the primary food source for newly emergent fry in freshwater, but if unavailable they will feed on chironomid larvae and pupae, copepods, and cladocerans
- At sea the sockeye fry will feed on macrozooplankton such as euphausiids and amphipods, and as they grow, small fish and squid

Leopard Dace

- Life history data in British Columbia is very sparse
- Early July spawning is suspected in the lower Fraser system
- Eggs are released above the substrate and fall into spaces between rocks or are swept into spaces under rocks by the current
- The eggs hatch within 6 days at 18º C however the larvae remain in the gravel for a week before emerging to feed by the first week in August
- In BC they reach about 20 mm in length by the end of their first growing season
- Most males attain sexual maturity at the end of their second summer and spawn for the first time during their third summer
- Females typically mature a year later than males
- The oldest individual known was a female in her fifth summer
- Maximum size recorded in BC was 120 mm and most individuals over 80 mm are females
- The diet of young-of-the-year and juvenile leopard dace are similar to those of adults (larvae of aquatic insects)

Longnose Dace

- In BC longnose dace begin spawning in the spring when temperatures rise above 10º C choosing riffle areas over coarse gravel substrates
- Males are territorial and defend a small area (about 10 cm in diameter) of clean gravel
- Females may be territorial and actively court males in a series of complex actions
- Males and females will both assume a side by side position in a slight depression in the substrate, quiver and eggs and sperm are released

- Females do not release all of their eggs in one spawning and usually spawn with more than one male
- Fecundity varies with female size ; small females (55 mm) producing around 150 eggs whereas the largest (>120 mm) can produce more than 3,000 eggs
- Eggs start to hatch within a week depending on water temperature
- Typically longnose dace reach sexual maturity at the end of their second summer and spawn for the first time the following spring
- Most of the largest adults in spawning aggregations are female of which most are in their fifth year with some being in their sixth year
- Adult longnose dace forage generally at night with the diet of fluvial (pertaining to the river) adults comprised mostly of the larvae of aquatic insects
- In the fall, stomach content analysis has shown that they eat terrestrial insects and larger adults have been known to eat newly emerged kokanee and largescale sucker larvae
- Young-of-the-year longnose dace forage during the day in the mid water as well as the substrate eating chironomid larvae, periphyton (algae and diatoms), and occasionally plankton

Mountain Whitefish

- There are three basic life history patterns associated with mountain whitefish; a lacustrine completed entirely in lakes, a riverine completed entirely in flowing water, and an adfluvial that involves movement between lakes and rivers
- Mountain whitefish usually spawn in flowing water including the lacustrine type that migrate into streams, however they have been observed spawning in lakes as well
- There is no site preparation and neither gravel size nor water velocity appear to be a consideration
- If spawning occurs in a lake setting the mountain whitefish prefer an area with upwelling water
- Spawning occurs usually in the fall or early winter when water temperatures drop below 10º C
- Spawning generally occurs at dusk or night and the eggs are released over the substrate
- The eggs incubate over the winter in cracks and crannies amid the gravel and rocks on the bottom with fry emerging in the spring or early summer depending on incubating water temperatures
- In BC fecundities range from 1,000 to 15,000 eggs and is a function of the female body size
- Newly emerged fry in lakes are small and feed primarily on plankton whereas fry originating in streams feed on the smallest life stages of aquatic insects
- Growth is rapid for the first four years of life and most individuals are mature by age 6
- In rivers, adults and juveniles feed on nymphs of aquatic insects and occasional terrestrial insects and in lakes the primary feed is plankton, snails, surface insects and occasionally young fish

Northern Pikeminnow

- No detailed life history study is available for the northern pikeminnow even though it is an abundant species in BC
- Northern pikeminnow spawn in the spring as early as late April or in summer as late as July depending on latitude and water temperatures
- Although most spawning occurs in streams, it can occur in lakes as well
- Northern pikeminnow do not ascend streams very far to spawn and usually choose the first or second riffle above their natal lake
- Males congregate in a school while females cruise the perimeter and then swim within the school of males when ready to spawn
- Eggs and sperm from as many as eight males (referenced observations) are released onto the substrate which is usually sand-free gravel or cobble
- Females have been observed releasing the eggs at 4 to 6 second intervals
- Fecundity in females is dependent on body size and can range in number from 5,000 to 95,000 eggs
- Eggs can reach the hatching stage after approximately 6 days at 18º C
- Young-of the-year northern pikeminnow feed on prey located both on the surface and the bottom and include cladocerans, copepods, ostracods, and chironomid larvae and pupae in their diet
- Ass they grow they seek out larger prey and begin to include fish in their diet and will also eat any other prey of suitable size such as crayfish, frogs, toads, and small rodents
- Sexual maturity in males is generally reached in 3 to 4 years with females usually maturing a year later
- Most northern pikeminnow in BC over 500 mm is a female about 15 to 20 years old

Peamouth Chub

- Peamouth are spring spawners and the activity is triggered by increasing water temperatures and longer daylight hours
- Spawning usually occurs in flowing water, however some have been observed spawning in clean gravel on lake shorelines
- Lacustrine types usually spawn in connected creeks but never migrate very far upstream and choose to spawn on the first couple of riffles upstream of the lake
- Most populations spawn during the day but some have been observed spawning at night
- A ripe female is joined by an entourage of males who crowd against the female, vibrate rapidly and cause the female to release her eggs
- Female peamouth may spawn many times with many different males
- Female fecundity can range from 10,000 to 20,000 eggs and development to hatch is about 6 days at 18º C
- The fry begin feeding at about 9 mm in length and can reach 35-60 mm by the end of their first growing season
- Peamouth fry feed on the bottom and on the surface as well
- Their diet can include benthic organisms such as amphipods, benthic copepods, chironomid larvae, and oligochaetes

- As they grow, peamouth will feed in the water column, the bottom and on the surface eating larvae and nymphs of aquatic insects and larger peamouth will prey on small fish
- Males typically reach sexual maturity in their third summer and females a year later
- The maximum age observed in BC has been a female aged 19 years however males rarely live longer than 8 years

Rainbow Trout, Steelhead

- The rainbow trout is one of the most thoroughly studied fish in the world
- In BC some populations are freshwater residents while others are anadromous (steelhead)
- Populations differ in size, migratory behavior, run timing and reproductive characteristics
- Rainbow trout spawn in the spring/early summer usually in flowing water between April and July depending on altitude and latitude
- Some lake introduced rainbow have been observed spawning in upwelling gravel on the lake shoreline
- Steelhead in BC are either winter run (fall and winter river entry and fully mature) or summer run (spring and summer river entry and immature and may hold up to 8 months to ripen)
- Females of both rainbow trout and steelhead choose the redd site usually located on a riffle in flowing water with larger members of the species spawning in deeper and faster water
- A dominant male accompanies the female and fertilizes the eggs as they are dropped into the redd and the female will cover the redd with upstream gravel when spawning is complete
- Fecundity in female rainbow is based on size and can generally vary from 200 to 3,000 eggs
- Larger members of the species such as the Gerrard rainbow can have fecundities that range from 3,000 to 14,000 eggs
- Fry remain in the gravel until the yolk sac is absorbed and incubation time varies with water temperature
- Emerging fry forage primarily on the drifting stages of aquatic insects and as they grow include small fish in their diet
- Steelhead smolts will usually migrate to the ocean at the end of their second or third year in freshwater and mature after 2 or 3 years at sea
- Steelhead can spawn more than once, however in BC that number is low at about 10% (usually females) and longevity for steelhead is around 8 or 9 years
- The Horsefly River has a unique strain of rainbow trout that can grow to a range of 7-10 kg and reach maturity at age 6 to 7 (Dolighan, et al)

Redside Shiner

- Redside shiners spawn in the spring and depending on latitude and water temperature, the spawning may be carried out between April and June in different locations in BC

- Some spawning has been observed in lakes however most occurs in flowing water and lacustrine populations generally spawn in connected streams and do not migrate long distances to do so
- Ripe fish will mill about in a pool or low velocity area until a female is about to spawn and she will swim upstream to a riffle with an entourage of males
- Males will crowd against the female and she will release some eggs that wil be immediately fertilized by the males
- Each female spawns many times over the spawning season wit many males
- Eggs take about 5 days to hatch at 18º C and after about 10 days in streams associated with lakes the fry migrate to the lake at night
- Young-of-the-year grow rapidly in their first summer while feeding on organisms taken from the bottom and the water surface (diatoms, cladocerans, copepods, ostracods, and chironomid larvae and pupae)
- As they grow, redside shiners take on larger prey that includes nymphs and pupae of aquatic insects, adult terrestrial insects and the eggs and fry of fish including their own species
- Males reach sexual maturity in their third summer, females a year later, and the maximum recorded age in BC was 7 years

Longnose Sucker

- Spawning is thought to be triggered primarily by temperatures (5º C) and evidence shows that increased spring flows may initiate spawning migrations
- Some populations in the Peace and Cariboo regions delay spawning until mid-June and breed in water temperatures of about 15-16º C
- Spawning period is usually short at about 2 weeks in duration
- Longnose suckers prefer to spawn over gravel substrates in moderate currents and this usually occurs during the day however some lake populations have been observed spawning in shallows along lake shores
- There is no site preparation but the spawning act does clean the gravel and typically several males will simultaneously spawn with a female
- The eggs drop to the substrate and fall into crevices and any exposed eggs are quickly eaten either by other suckers or other fishes
- Fecundity of females can range from 3,000 to 44,000 eggs
- Development rate is temperature dependent and hatching occurs in about 11 days at 10º C
- The fry remain in the gravel until they are about 12 mm long (1-2 weeks after hatching) and rely on their yolk sac after emergence but begin feeding at about 14 mm in length
- When young their mouth is frontal but by the time they reach 16-20 mm they mouth becomes subterminal and their diet becomes more benthic
- Food availability, density and latitude influence initial growth and they reach approximately 30-40 mm after their first year
- In lakes plankton is common in their diet and river resident longnose suckers eat chironomid larvae and pupae, trichopteran and plecopteran larvae

- Males generally mature at 5 or 6 years whereas females mature at 6 or 7 years however this is extended to 7 and 9 years respectively in the extreme north of the province
- The longnose sucker seldom reaches 500 mm and the oldest known individual in BC was 19 years old, however individuals in the Slave River, NWT have been aged at 28 years

Largescale Sucker

- No detailed study of the largescale sucker is available in BC with the only life history description available for the Columbia River in Washington
- Typically the largescale sucker spawns in the spring and like the longnose sucker the spawning varies in timing with Interior populations spawning much later (June)
- Spawning occurs in both flowing water and in lakes over areas of coarse gravel
- As with longnose suckers, there is no site preparation but the spawning act does clean the gravel and typically several males will simultaneously spawn with a female
- Females will swim onto the spawning sites accompanied by males who press against both sides of the females causing her to release the eggs which the males fertilize on the way down to the substrate
- Eggs that do not find a way in to crevices and crannies and are exposed in the substrate are eaten by other suckers and other fish within minutes of spawning
- Fecundity in female largescale suckers can range from 9,000 to 30,000 eggs
- Water temperature determines incubation timing and hatching occurs in about 20 days at 10ºC
- Swim up fry are dependent on their yolk sac until they are about 15 mm in length when they become exogenous
- As young 80% of their feed is planktonic (Daphnia, Cyclops, Bosmina, and various nauplii) due to the terminal position of the mouth
- As they grow, their diet is complimented with aquatic insects such as tricopteran larvae
- Typical sexual maturity for largescale sucker males is 5 or 6 years whereas female maturity is 6 to 9 years
- Largest recorded BC specimen was a female who measured 740 mm.
- Ages of 27 and 28 years have been recorded in largescale suckers in Washington State, and a female in BC measuring 620 mm was estimated to be 18 years of age

4.1.7 Habitat Use Information (McPhail)

Brassy Minnow

- Typically occur in small lakes, small slow-moving streams, beaver ponds and drainage ditches
- Usually found in stained waters in the upper Peace and Fraser systems, but found in both clear and turbid waters in the lower Fraser Valley
- Adults like lakes with soft mud bottoms and dense vegetation
- In summer they are rarely observed in water more than 1.5 metres deep

- Adults in streams remain close to vegetation and avoid water with surface velocities >50 cm/s
- No habitat preference difference between adults and juveniles, fry like shallower and quieter water than adults

Burbot

- Adults like cooler water and are benthic and seldom enter water that is less than 2 metres deep
- In the fall some burbot move into shallow areas and creek mouths of known spawning streams
- River dwelling burbot also like cool water and are more prevalent in northern streams and are restricted to cool streams in the south of BC
- Juveniles usually occupy water less than 2 metres deep and utilize stream side cover
- Young-of-the-year start life at moderate depths then eventually utilize near shore areas
- Fry tend to shift from surface day time activities to a benthic night-active species where they will remain closely associated with the bottom for the rest of their lives

Chinook Salmon

- Stream type adults (Horsefly stock) rear and are most abundant in the eastern North Pacific
- Adults return to their natal streams in the summer and fall and seek refuge in holding pools in the rivers until they are ready to spawn on fast flowing stream reaches with spawning gravel
- Stream type juveniles spend a year and sometimes two in the streams before migrating to the ocean in the spring
- Juveniles like off channel ponds for rearing and are abundant close to instream dense cover
- Chinook fry emerge from the gravel at night and utilize channel edges, sloughs, backwaters, small tributaries for rearing
- As they grow they shift into faster deeper areas and seek cover in pools and in spaces between rocks and boulders

Coho Salmon

- Adults typically spend about 18 months at sea with Jacks (precocious males) spending about 6 months at sea
- Northern coastal coho make more extensive oceanic migrations and spend longer time at sea and return to natal streams larger than southern coastal coho
- Juveniles migrate to the ocean usually between April and late June after 1 to 2 years in freshwater
- As juveniles they seek out undercut banks, large woody debris, and root wads for rearing habitat
- Newly emerged fry are secretive and stay in the gravel during the day but emerge at night

- Coho fry utilize backwaters, side-channels, and shallow, quiet embayments along stream margins for rearing

Dolly Varden
- Habitat use by adults is influenced by life history type and the presence of other fish species
- Some populations are anadromous
- Stream dwelling juveniles are associated with shallow, slow, runs and pools
- Juveniles utilize cover such as large rocks,, woody debris, root wads, and undercut banks during the day but are less associated with cover at night
- Dolly Varden fry utilize the shallows, remain close to the substrate and are found in and around coarse gravel and cobbles in areas of low water elocities
- The fry often move into deeper water in streams that are subject to freezing

Lake Trout
- Lake trout habitat use has not been studied in BC and the following information is based on studies in eastern North America
- Lake trout prefer cool water and as such the adults are found at all depths in a lake depending on the stratified layers and temperature
- It is known that in small lakes that the introduction of lake trout adversely affect bull trout
- Juvenile lake trout occupy similar habitat as adults although often found segregated in deeper water as a means to fend off cannibalism
- Juveniles in Dease Lake were found abundant in 50 cm. of water approximately 1-2 metres offshore in coarse gravel substrate

Sockeye Salmon, Kokanee
- Habitat use by sockeye salmon is complex
- Adult kokanee live in the offshore habitat of lakes and in many lakes are crepuscular foragers (active at dawn or dusk)
- They feed in the food-rich middle or upper strata at dawn and dusk and migrate down into the cool hypolimnion at night and during the day
- Adult sockeye salmon spend 1-4 years at sea in the Gulf of Alaska
- Their circular pattern of migration in the Gulf is repeated each year with the maturing fish moving towards the coast in June and July and eventually returning to their natal streams in late summer
- Juveniles feed in lake strata much like adults and at a certain size begin to forage near shore
- Lake type juvenile sockeye migrate to the ocean after one or two years in the lake, river type juveniles also spend one or two years in fresh water, whereas sea-type juveniles enter the sea in the first year of life
- Kokanee fry feed in the strata layers or inshore in the littoral zone depending on where the food is found
- Lake type sockeye fry feed in either the littoral zone or the strat layers
- River type sockeye fry seek out sloughs, backwaters and off channel habitat

- Ocean type sockeye fry migrate down to estuaries and feed in tidal creeks before heading out to sea

Leopard Dace
- Are found in streams and lakes however the leopard dace is primarily a river dweller
- Adults are associated with slower moving water in streams and are found in areas of fine gravel and silted cobble substrates
- Juveniles are associated with similar habitat types as adults but at sites with lower water velocities
- During freshet the juveniles will seek shelter in flooded vegetated areas and move into quieter water
- Young-of-the-year like slow moving shallow water areas like shallow pools and backwaters
- In lakes the fry are found close to shore in areas where wave action is buffered by reeds or boulders

Longnose Dace
- Typical adult habitats have substrates of loose, fist sized or larger rocks
- In the BC Interior, adult longnose dace shift from riffles to slower, deeper water in the winter
- Juveniles during their first winter usually become bottom dwellers and move onto riffles
- During freshet, filed observations have shown that yearlings move back into quiet water and seek shelter along river edges
- In small streams longnose dace fry are found in shallow pools, backwaters, and other low velocity areas
- In lakes the fry are found in quiet water usually close to shore and in areas where there is cover

Mountain Whitefish
- In BC adult mountain whitefish occur in lakes and streams
- In rivers adults are found in runs or pools, close to but not on the bottom in water 1-2 metres deep over coarse gravel or cobble substrate
- In lakes adult mountain whitefish are found at depths of less than 20 metres and move to deeper water during the warmer summer months
- Juveniles in rivers appear to avoid riffles and backwaters and are associated with glides and runs showing a preference for water about 1 metre deep, large substrate and moderate currents
- Juveniles in lakes prefer shallow inshore habitats throughout the spring and summer in areas of sand and coarse gravel substrates
- In lakes fry are found in shallow water over fine gravel or sand substrates
- In streams the mountain whitefish fry prefer shallow quiet water over sand or silt substrates

Northern Pikeminnow

- In BC the northern pike minnow is found primarily in lakes and large slow moving rivers
- In lakes in the summer adults are found cruising the littoral zone about 1 metre above the bottom and on the offshore side of weed beds
- In rivers the adults occupy deeper water than juveniles and utilize similar habitat as lake dwelling adults
- Juvenile mountain whitefish in lakes are typically found in shallow water and are more surface oriented than adults and large shoals are often found at the outer edges of weed beds
- Juveniles in rivers are also associated with shallow (<1.0 m.) quiet water
- Fry are found in lakes utilizing lake margins in shallow water, close to cover in mixed schools with other cyprinids (minnows)
- Fry in rivers are also found in schools of other cyprinids in shallow water along the river edges

Peamouth Chub

- Peamouth are found in lakes, rivers and in the spring small streams
- Adults utilize lake bottoms during the winter months, and in the spring they move inshore to spawn and begin a daily migration in the summer that brings them towards the surface and inshore in the evening
- In rivers, peamouth appear to be easily caught in studies in August taper off in the fall and no catch in January
- Juveniles in lakes school in littoral areas but usually in deeper water than the fry
- In rivers the peamouth juveniles prefer slow shallow water over fine substrates , and in large rivers they congregate at the mouths of tributaries
- In lakes peamouth fry school in shallow littoral areas in the summer and are often found with other minnow species such as redside shiner and northern pike minnow
- In the Columbia River near Trail, peamouth have been congregating in shallow quiet water areas especially near tributary outlets

Rainbow Trout, Steelhead

- Five broad habitat types are recognized in British Columbia; anadromous, lacustrine, large river, stream and headwater habitats
- In summer in streams and rivers adult rainbow trout occupy riffles, runs, glides and pools
- In small streams overhead cover in the form of riparian vegetation and large woody debris is very important
- In small adult lakes rainbow trout utilize all parts of the lake
- Steelhead usually spend 1-4 years at sea then return to their natal streams either in the late fall or winter as winter run steelhead or as summer run steelhead that return between May and September
- In streams and rivers juvenile rainbow trout also occupy riffles, runs, glides and pools

- In lakes juveniles remain inshore during winter and early spring and by day are associated with cover whereas at night they are found foraging over sand and gravel substrates
- Steelhead juveniles spend two to three summers in freshwater before transforming into smolts for the migration to sea
- River and stream fry establish territories in shallow water along stream margins and as the increase in size move into mid channel areas
- Most lake resident fry migrate from their natal stream to the lake late in their first summer or early fall and remain in shallow water close to shore under cover during the day and emerge to forage at night
- Steelhead fry utilize the same habitats as rainbow trout fry

Redside Shiner

- In BC redside shiners are ubiquitous in streams, rivers, ponds, lakes, and reservoirs
- Adults in lakes cruise the littoral zones during the day foraging in weed beds as small alert groups while at night they move offshore
- Adults located in rivers prefer relatively deep, slow water over fine substrates
- Juveniles in lakes are found in loose schools around lake margins and are associated with the outer margins of weed beds and stay closer to shore than adults
- Redside shiner fry inhabit shallow water and are often schooled with peamouth and northern pikeminnow
- The fry residing in streams and rivers prefer quiet water, fine grained substrates and water less than a 0.5 metre deep
- Fry are abundant in shallow backwaters, weedy bays and again are associated with other species of minnows

Longnose Sucker

- There has been attempt to collect quantitative data on the longnose sucker in BC therefore the following information is based on observations elsewhere in Canada
- Adults are found throughout British Columbia and appear to be habitat generalists
- In the southern interior of BC aside from spawning aggregates adult longnose suckers are more common in lakes than in streams
- Adults are found in both flowing and standing water
- Juvenile longnose suckers use habitat common to the adults in both streams and lakes although utilizing quieter and shallower water
- Juvenile river dwellers prefer beaver ponds, shallow side channels and embayments
- Juveniles residing in lakes stay closer to shore than adults but move into deeper water if the lake stratifies
- Fry living in streams prefer quiet shallow water and are often located in areas of soft substrate and seasonally flooded vegetated areas
- Longnose sucker fry that reside in lakes prefer the shoreline in schools and remain near cover and as they grow the larger fry become solitary and move to deeper water

Largescale Sucker

- Largescale suckers are abundant in BC in low to moderate gradient rivers and low altitude lakes throughout the southern two thirds of the province
- Adults prefer warm water, slow currents and often forage on silt bottoms of lakes and in the large pools of rivers
- Juvenile suckers prefer slow moving water areas with sand or silt bottoms
- Fry prefer sand and silt bottoms for foraging as well as seasonally flooded vegetated areas

4.2 Fish Habitat

4.2.1 Amount

The Horsefly River watershed has a magnitude of 1009, in other words it has approximately that many tributaries potentially contributing fish habitat to the species residing in the drainage from its headwaters to the mouth at Quesnel Lake. The major named tributaries of the watershed are presented below in Table 3.

Table 3: Horsefly River Tributaries

Stream Name	Watershed Code[1]	Stream Length(km)	Stream Order[2]	Stream Magnitude[3]	Species Present
Horsefly River	160-635400	131.09	6	1009	Refer to Table 1
Barker Creek	160-635400-32500	4.82	1	1	unknown
Black Creek	160-635400-44700	6.84	3	6	RB
East Fork Black Creek	160-635400-44700-15300	5.84	2	2	unknown
Club Creek	160-635400-51400	6.20	2	2	unknown
Deerhorn Creek	160-635400-25300	7.84	3	11	CH, RB
Doreen Creek	160-635400-61100	5.71	3	12	RB
Harvie Creek	160-635400-70400	5.04	2	4	unknown
Little Horsefly River	160-635400-14100	4.81	4	118	KO, LT, LSU, MW, NSC, RB, SK, SU
Archie Creek	160-635400-14100-85900	9.58	3	12	RB
Teapot Creek	160-635400-14100-85900-6440	6.33	2	7	unknown
Dillabough Creek	160-635400-14100-18700	6.26	2	4	RB,RSC, SU

Stream Name	Watershed Code[1]	Stream Length(km)	Stream Order[2]	Stream Magnitude[3]	Species Present
Fritz Creek	160-635400-14100-83300	6.11	2	5	RB
Gibbons Creek	160-635400-14100-15600	10.67	2	7	RB, SU
Niquidet Creek	160-635400-14100-05100	6.68	3	13	CSU, LSU, MW, NSC, PCC, RB, SU
Viewland Creek	160-635400-14100-34200	7.24	2	3	RB
MacKay River	160-635400-76600	25.99	4	104	RB
Cayuse Creek	160-635400-76600-44000	2.33	2	2	RB
Chisholm Creek	160-635400-76600-74600	6.98	3	15	RB
Eureka Brook	160-635400-76600-53500	3.92	3	7	RB
Imperial Creek	160-635400-76600-53500-1480	2.36	1	1	unknown
Frasergold Creek	160-635400-76600-76200	3.02	3	5	RB
Grouse Creek	160-635400-76600-71600	1.84	1	1	unknown
Hawkley Creek	160-635400-76600-30400	7.07	2	11	No fish caught (FISS) (FDIS)
Pegasus Creek	160-635400-76600-51500	6.28	3	12	RB
McKinley Creek	160-635400-46400	35.52	5	115	BB, CH, CO, KO, LT, CSU, LNC, SK LSU, MW,NSC, PCC, RB, RSC, ST,
Balloch Creek	160-635400-46400-59400	5.28	2	2	unknown
Bassett Creek	160-635400-46400-37900	14.46	4	21	RB, Whitefish (General)
Cruiser Creek	160-635400-46400-65100	5.97	2	4	unknown
Divan Creek	160-635400-46400-62700	6.90	2	3	unidentified species

Stream Name	Watershed Code[1]	Stream Length(km)	Stream Order[2]	Stream Magnitude[3]	Species Present
Gifford Creek	160-635400-46400-58900	6.21	2	2	unknown
Molybdenite Creek	160-635400-46400-44900	18.75	3	16	RB, unidentified species
Rushing Creek	160-635400-46400-77300	5.96	2	6	unknown
McKusky Creek	160-635400-67600	38.89	4	170	RB, unidentified species
Cosmoskey Creek	160-635400-67600-31600	7.21	2	3	unknown
Moffat Creek	160-635400-18700	78.3	5	182	CH, CO, KO, LDC, LNC, LSU, MW, NSC, RB, RSC, SK, SU
Blue Moon Creek	160-635400-18700-28000	5.93	3	13	unknown
Mussel Creek	160-635400-18700-05200	10.25	3	20	unknown
Patenaude Creek	160-635400-36700	6.71	2	2	unknown
Prairie Creek	160-635400-56600	12.93	4	16	unknown
Sawley Creek	160-635400-68900	6.98	2	6	unknown
Sucker Creek	160-635400-24300	16.76	2	2	LSU, RB
Tisdall Creek	160-635400-43300	6.69	3	14	RB
Vedder Creek	160-635400-14400	3.16	1	1	unknown
Wilmot Creek	160-635400-43600	2.95	2	4	unknown
Woodjam Creek	160-635400-29700	20.78	4	29	CH, CO, RB, Dace (general), unidentified species

(FishWizard)

Definitions: (Holmes)

[1]***Watershed Code***: *a hierarchical numbering system used to identify rivers and streams*
For example: Quesnel River = 160

Horsefly River = 160-635400
McKinley Creek = 160-635400-46400
Molybdenite Creek = 160-635400-46400-44900

[2]**Stream Order:** *A scale dependent property of drainage networks that describes the position and approximate size of a stream segment in the network. First order streams are headwater streams that have no tributaries. A second order stream is formed where two first order streams join, a third order stream is formed where two second order streams join, etc. Note that the confluence of a second order stream with a first order stream remains a second order stream.*

[3]**Stream Magnitude:** *The total number of streams or tributaries upstream in a watershed.*

It should be noted that the Little Horsefly River data provided above in Table 3 shows a stream of only 4.81 km in length, yet having a stream magnitude of 118. This most likely is a result of the numerous streams that flow into Horsefly Lake and the stream length is reflective of the distance from the outlet of Horsefly Lake to the confluence with the Horsefly River main stem. BC Watershed Atlas maps can be found in Appendix F.

4.2.2 Condition

Very little information was found during the data research on stream condition for this project. It is felt by the author that the primary factor affecting stream condition in the Horsefly River watershed is timber extraction by the major forest licencees that may contribute to increased stream temperatures and sediment delivery.

The author has requested updated information on Equivalent Clearcut Area (ECA) and hydrological assessments from West Fraser Timber, Tolko Industries Ltd. and BC Timber Sales. The determination of ECA's as part of the Interior Watershed Assessment Procedure (IWAP) had been a tool in defining the area in a watershed that has been disturbed (i.e. logging, wildfire, right of ways, etc.). Disturbed areas in turn are often the source of sediment delivery affecting stream condition, and therefore affecting fish habitat.

An IWAP prepared by Pierre Beaudry in December of 2002 for a consortium of forest licencees operating in the Horsefly River Watershed (Beaudry). The report divided the watershed into the following sub-basins:

- Moffat Creek
- Woodjam Creek
- McKinley Creek
- McKinley above Bosk Watershed
- McKuskey Creek
- MacKay Creek
- Horsefly River above Mackay Watershed
- Horsefly River above the Falls Watershed

The report presented by Beaudry fulfilled the assessments recommended by the 1999 IWAP procedure and his methodology included the collection and analysis of the following watershed based information:

- Watershed and Stream Characteristics
- Harvesting and Land-use History
- Extent of Riparian Removal
- Survey of Large Sediment Sources
- Sediment Hazards from Roads
- Land-use Activities on Unstable Terrain
- Stream Channel Conditions

Although not current, it was the last known watershed based IWAP completed on the Horsefly River and the report offered several suggestions to the Watershed Advisory Committee. Of particular interest as it relates to this report is suggestion number 6.

Beaudry states:

6. *"I think that there are three main watershed management issues in these eight watersheds. The next update should focus on these and drop the other assessment components of the IWAP. The focus should also be directed at field work rather than GIS based calculations. The three issues are as follows:*

   - *For the Moffat and Woodjam watersheds I believe that a rat-of cut issue is developing. It is not so much that the level of harvest is unreasonably high by itself, but that the lower reaches are so unstable due to past activities in the riparian zone. The next update could focus on evaluating the implementation of peak flow management strategies recommended in this report.*

   - *For many of the watersheds, road related surface erosion is currently a moderate to high hazard. The next update could focus on field evaluations of erosion and sediment control at stream crossings for those watersheds with the moderate to high hazards. I recommend that there be no more calculations of sediment hazards using GIS methods (e.g. road density, road crossing density etc.). I believe that their usefulness has a limit and that limit has been reached.*

   - *Riparian management around small streams remains a controversial issue throughout North America. This issue is not explicitly addressed in the current WAP procedure. I believe that the next update should focus some efforts on evaluating the effectiveness of riparian management regimes adjacent to small streams.*

The Beaudry report without the detailed analysis for each sub-basin can be found in Appendix G.

A more recent report prepared in February of 2007 for Tolko Industries Ltd. by Dobson Engineering Ltd. provides a hydrological assessment of selected sub-basins in the Horsefly River watershed. This report can be reviewed in detail in Appendix H. Of note in the Conclusions Section is the recognition of the importance of salmon habitat in the watershed as the first bulleted item states:

- *"The Horsefly River watershed provides important habitat for Pacific salmon and other resident fish species. The most important salon habitat/reaches are the Horsefly main stem channel between Sucker and Deerhorn creeks, the main stem between the falls and McKinley Creek, Black Creek below the 100 Road and McKinley Creek below McKinley Lake. The Mackay River sub-basin is also important as late season snow melt from this basin cools the water in the lower Horsefly River and enhances conditions for fish survival during the hot summer months".*

Additionally, of particular concern presented in the Conclusions section is the state of the Black Creek sub-basin. The report states:

- *"Black Creek currently has a high hydrologic risk rating due to 40% ECA in the snow sensitive zone (moderate hazard) and the high consequence on the stream. The rest of the study sub-basins have low or moderate risk ratings".*

- *Based on the risk ratings and current ECA values, there is potential available harvest throughout the watershed, however due to past disturbance, Black Creek should recover further before additional forest development occurs in that basin".*

Recommendations (nine) are provided in the Dobson report and of note are the two provided below:

- *"Defer harvest in the Black Creek sub-basin until hydrologic recovery reduces the ECA in the snow sensitive zone to 30% or less. In the event other forest management requirements supercede this recommendation more detailed investigation is required.*

- *For sub-basins that may directly affect the most important salmon/habitat reaches (high consequence reaches) the peak flow hazard should not exceed a low rating. For all other sub-basins, the peak flow hazard should not exceed a moderate rating".*

4.2.3 Water Quality

A water sample was collected from the Horsefly River on March 9, 2008 at a location immediately upstream of the Horsefly River Sockeye Channel settling basin. This one litre sample was sent for analysis to ALS Laboratory Group in Vancouver who are accredited to ISO 17025 standards by the Canadian Association for Environmental Analytical Laboratories (CAEAL) for a wide range of parameters.

The following water sampling analysis has been undertaken and the results can be found in Appendix I.

- Ammonia by Color
- Total Phosphate P by Color
- Dissolved ortho Phosphate by color
- Total Dissolved Phosphate by color
- Drinking Water Full Package – Metals Total
    - Alkalinity by Colourimetric (Automated)
    - Chloride by Ion Chromatography
    - Fluoride by Ion Chromatography
    - Nitrite by Ion Chromatography
    - Nitrate by Ion Chromatography
    - Sulfate by Ion Chromatography
    - Color (True) by Spectrometer
    - Conductivity (Automated)
    - Hardness
    - Total Mercury in Water by CVAFS
    - Total Metals in Water by ICPOES
    - Total Metals in Water by ICPMS
    - pH by Meter (Automated)
    - Total Dissolved Solids by Gravimetric
    - Turbidity by Meter

Comparison can be made of the results found in Appendix I with applicable water quality guidelines utilized for the protection of aquatic life established by Environment Canada and available on the Internet through their website (CCME).

4.2.4 Stream Flow

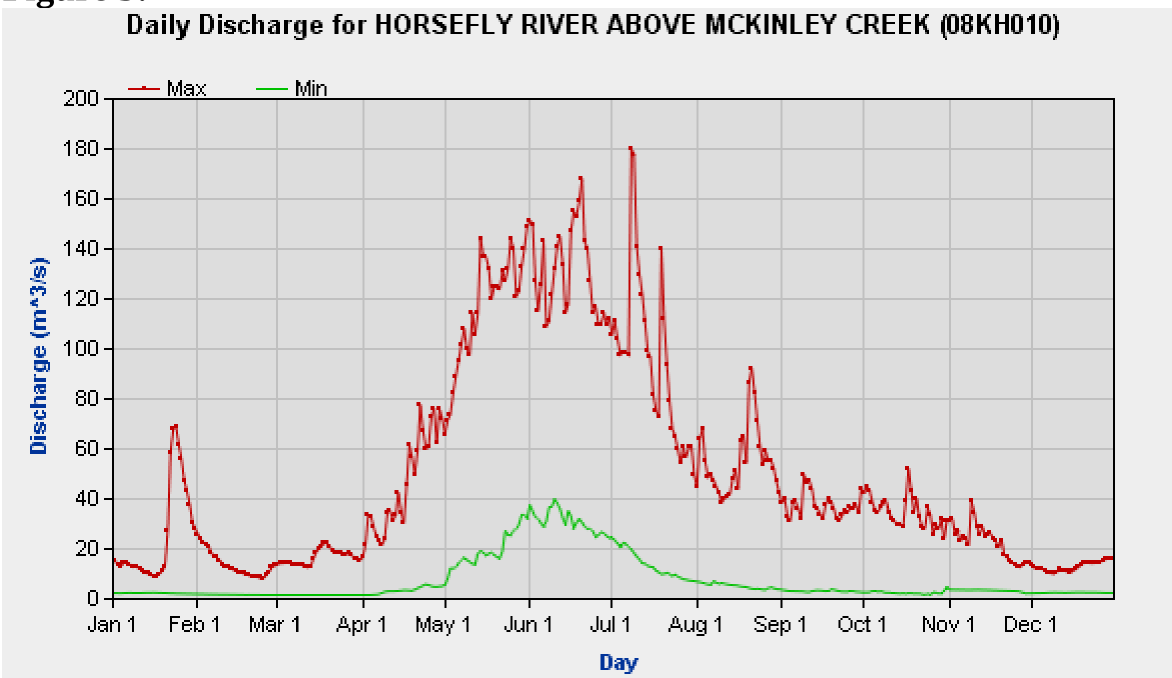
The Horsefly River watershed has a drainage area of approximately 276,600 hectares (Booth). It abuts the Clearwater watershed in the Rocky Mountain Range and flows in a westerly direction from peaks as high as 2300 metres in the east, to its mouth in Horsefly Bay of Quesnel Lake at an elevation of 730 metres (Lawrence).

Access to water discharge information for the Horsefly River has been facilitated through an Environment Canada Water Survey of Canada Branch website (Environment Canada).

The information is collected at Station 08KH010 located above McKinley Creek and has collected information from 1955 to 1958 and 1964 to 2008.

The graph below in Figure 5 shows the maximum and minimum daily discharge for the Horsefly River above McKinley Creek for 47 years from January 1955 to December 2006. Water level and streamflow statistics for this same time period can be found in Appendix J.

Figure 5:



Statistics corresponding to 47 years of data recorded from January 1955 to December 2006

4.2.5 Health

The health of the Horsefly River, as with most rivers in British Columbia is under constant threat, primarily through anthropogenic influences. Of particular concern are high water temperatures during summer months when flows are at their lowest and migrating salmon are entering the watershed to spawn.
This issue has been of particular interest to Research Hydrologist Pat Teti of the Forest Sciences Unit of the BC Ministry of Forests and Range in Williams Lake. Part of his research for several years has been focused on the effects of riparian buffers and shade on stream temperatures. It is believed that shade is the most critical variable in influences affecting temperatures in small streams.

Sockeye salmon are negatively affected by temperatures in excess of 17º C at which point they begin to lose weight showing a sign of stress (Christie). Additionally, temperature concerns relating to the unique strain of Quesnel Lake rainbow trout that spawn in the Horsefly River watershed have been presented to the author by BC Provincial Biologist Rob Dolighan.

In a paper written for Streamline Watershed Bulletin, Pat Teti provided the following three generalizations relating to stream temperatures and land usage including forestry (Teti):

- Land use can increase the summertime temperature of a forest stream by removing vegetation that shade's the water's surface.
- If timber is harvested without reducing stream shade, there will be no harvesting-related temperature increase.
- Harvesting-related increases in daily maximum temperatures can disappear downstream if a stream flows back into the forest.

In view of his research and resulting findings, it is of utmost importance that the forest sector find an optimum method for maximum harvest yields to satisfy their economic demands, yet not impact on riparian zones that provide much needed shade for a fishery resource that is also an economic generator for commercial, sport fisherman, and a ceremonial and food fishery for First Nations.

Additional concern expressed at a Horsefly River Roundtable Technical Committee meeting is the delivery of fine sediment material from the upper reaches of the Horsefly River into the lower reaches where rainbow trout and pacific salmon rely on clean gravel/cobble substrate for spawning and rearing.

4.2.6 Productive Capacity

The productive capacity of the Horsefly River for most resident fish species is unknown, especially the so called coarse species that have had little research undertaken on their behalf either in this watershed, or in fact in Western Canada. However, some salmonid species have been studied with this in mind.

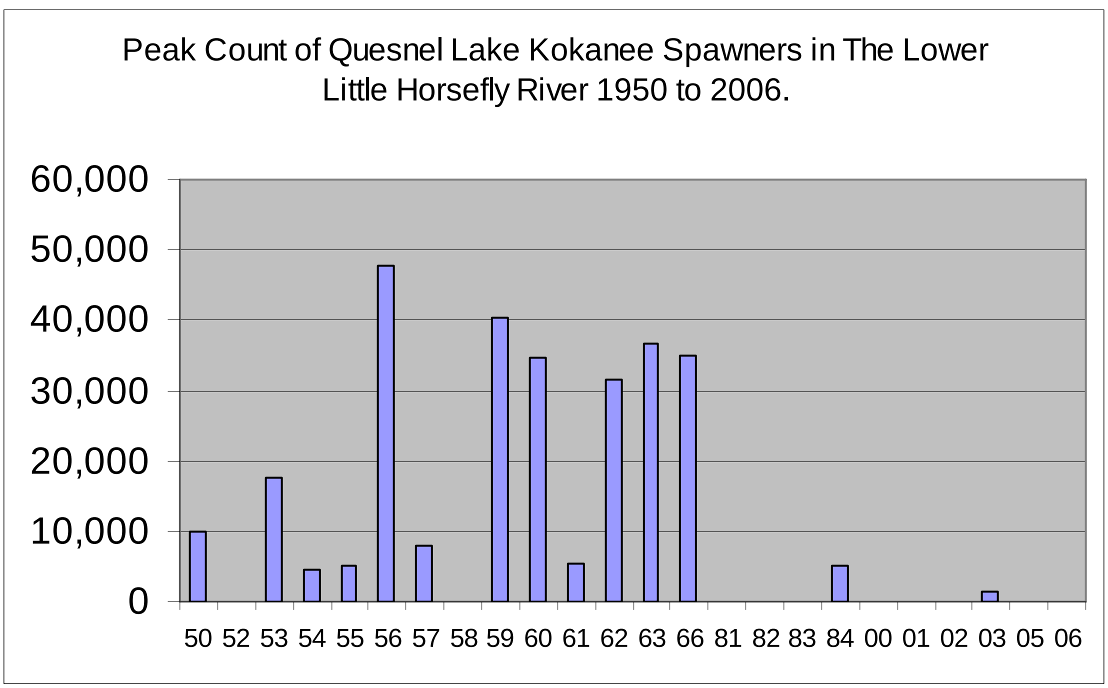
Horsefly River sockeye salmon generally rear downstream in Quesnel Lake after emerging from the gravel in the spring where they will spend one year of their life prior to their migration as smolts to the ocean. The rearing capacity of the lake is the limiting factor in determining the optimum number of spawners that should be allowed to escape the First Nation, commercial and sport fisheries that harvest adults on their way upstream to the spawning grounds. The optimum number of effective female spawners (EFS) for sockeye utilizing a Ricker model recommends an escapement into the entire Quesnel system of 733,000 EFS (Hume). Assuming a 1:1 desired ratio for males to females, one could assume the optimum productive carrying capacity for sockeye is approximately 1.4 million The Horsefly River would offer spawning grounds to the greatest percentage of this escapement.

Provincial fisheries biologist Rob Dolighan of Williams Lake has kindly provided the following information on the productive capacity of rainbow trout and kokanee.

"Rainbow trout
Due to the size and turbidity of the main spawning streams during spring it was not possible to directly enumerate rainbow spawners during earlier studies. As an alternate, an indirect strategy was adopted in the 1980s to assess the status of rainbow trout through a combination of juvenile sampling (electrofishing) and application of a theoretical habitat capability model developed for steelhead by provincial biologists. Juvenile assessment of rainbow trout was conducted from 1987-89 on the Horsefly River and estimates of theoretical carrying capacity were developed. From three years of results it was concluded that rainbow trout fry habitat was under-recruited during two of the three years of study. A first cut estimate of potential rainbow production was 53,000 age 2 migrants or 550-2600 adults for the Horsefly River system before harvest. A similar approach to estimate parr production (i.e. migrants) from the Mitchell River at 2,400 -10,000 or about 20% of that estimated for the Horsefly River. It is estimated that the Horsefly River produces approximately 75% of all rainbow production to Quesnel Lake.

Kokanee
For the Horsefly River the only kokanee data is in the attached file (Figure 6 below) and summarizes Quesnel Lake kokanee in the lower Little Horsefly River. Although we don't have reliable escapement numbers for other historic spawning areas, the data does suggest that large numbers of kokanee utilized the historic spawning sites in the drainage".

Figure 6:

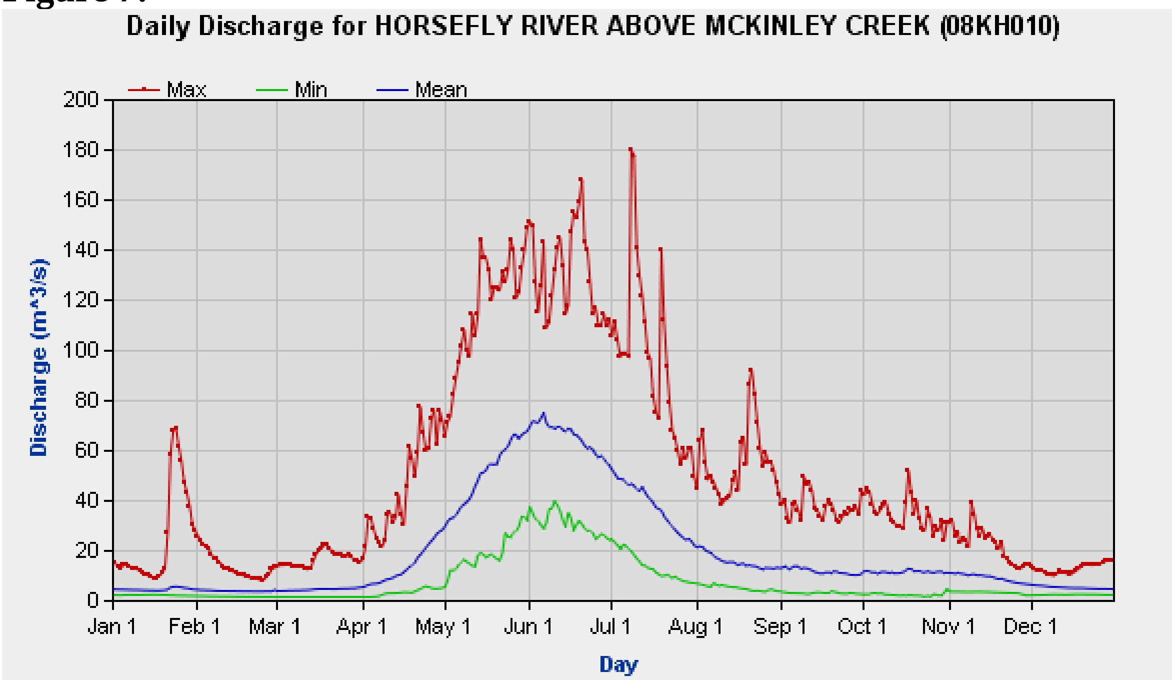


A 2005 adult kokanee spawner survey map can be found in Appendix K.

4.2.7 Long Term Trends

The graph presented below in Figure 7 shows the daily maximum, minimum, and mean discharge from 1955 to 2006 for the Horsefly River above McKinley Creek at Station 08KH010 of the Environment Canada water discharge network. Of particular note is the historic maximum discharge timing shown to be approximately from the middle of June to the first week of July.

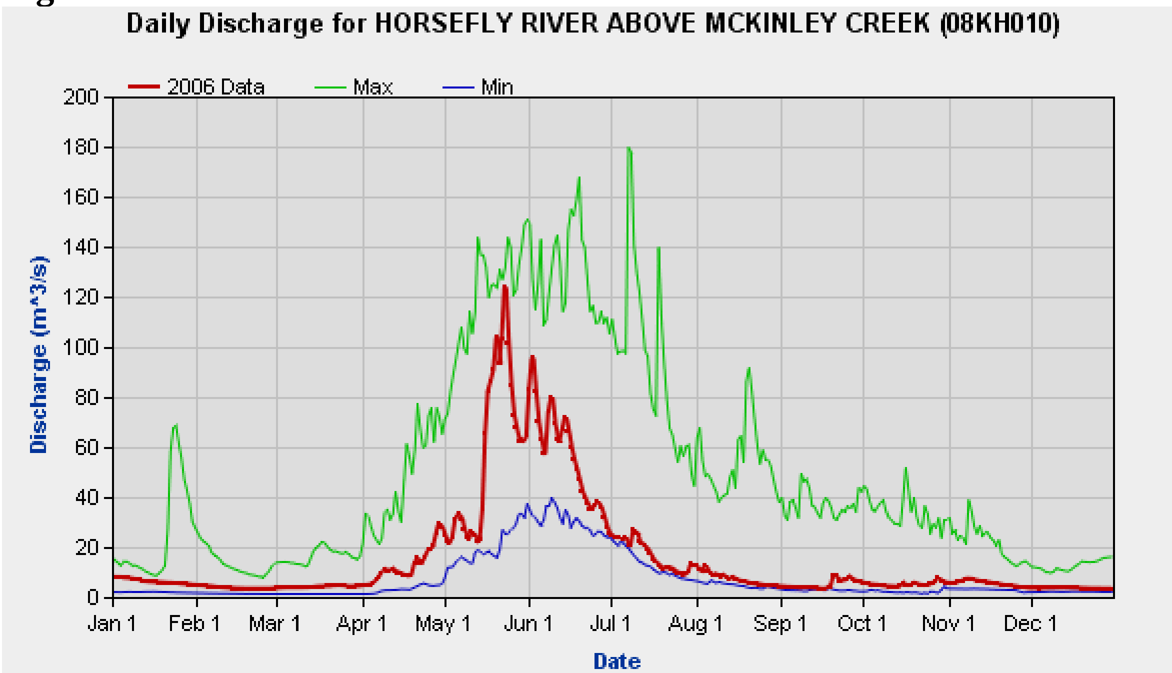
Figure 7:



Statistics corresponding to 47 years of data recorded from January 1955 to December 2006

Figure 8 below shows a comparison of the 2006 daily discharge with the maximum and minimum discharges presented in Figure 7 above. The comparison shows that in 2006 the maximum daily discharge occurred on May 24th (Appendix L).

Figure 8:



Statistics corresponding to 46 years of data recorded from 1955 to 2006.

This information compares favorably with a new research paper prepared in 2007 titled "Hydroclimatology of the Quesnel River Basin, British Columbia, Canada" (Burford, et al). Although prepared for the entire Quesnel River drainage, the information is relevant to the Horsefly River as it is a major contributor to the Quesnel River discharge.

Burford states: *"The goal of this study, therefore, is to present a focused look at conditions for the Quesnel watershed over an extended period (1926-2004) to better comprehend the particularities of its hydroclimate. This study thus fills an important gap in our knowledge of BC's freshwater resources in a changing environment and is especially timely given the increasing demands for freshwater in the area.*

Rising stream temperatures in response to warming air temperatures are potentially affecting the ability of salmon to reproduce in the Quesnel River and its tributaries. The region has also succumbed to a serious and detrimental mountain pine beetle infestation that is increasing in area owing in part to warmer winters (Aukema et al., 2006; Carroll et al., 2003; Stahl et al., 2006).

Other consequences of this warming trend include earlier spring freshets, lower early summer flows and higher early winter flows over south-central BC (Leith and Whitfield, 1999).

Furthermore, the increased ratio of the rain to snow component along with a decrease in snowcover (snow depth) indicates that the watershed hydrology may respond more rapidly to precipitation forcing. This could be further accelerated by forestry practices or recent pest infestations such as the mountain pine beetle that reduce vegetative cover.

In several salmon hatching areas in BC, streamflow has decreased due to less precipitation (and snow pack depth) along with increased warming, especially in winter (Danard and Murty, 1994). In the Quesnel River Basin, however, streamflow and precipitation are increasing, leading to more beneficial conditions for salmon spawning, as suggested by recent escapement numbers".

Increased stream flow from precipitation during the late summer and early fall may not be desirable to local residents attempting to enjoy the final days of summer, however this slight climatic change is desirable to migrating salmon that will benefit from lower water temperatures and adequate flows should this trend continue. This particular change in the local weather pattern was observed during 2007 when cool temperatures and high water was evident throughout the Horsefly River watershed.

5.0 Factors Affecting Fish Populations and Habitat

There are numerous factors affecting the population status of fish species in the Horsefly River watershed. The author of this report is presenting below some general topics related to the decline of salmonid stocks throughout the Pacific Northwest and discussed by Lackey in Salmon 2100: The Future of Wild Pacific Salmon; some of which heavily influence the Horsefly River stocks, others which have very low impact. Additionally, some of what is presented below are impacts immediately located in the watershed, whereas other topics influence the fish stock status from afar.

5.1 Commercial Harvest

A presented earlier in this report in Table 2 on Page 28, salmon run sizes in British Columbia are currently 36.2% of historic size. The table below derived from Fisheries and Oceans Canada information and provides the reader with the total commercial catch from 2001 to 2007.

Table 4: **Commercial Catch From 2001-2007 By Species**

Year	Sockeye	Coho	Pink	Chum	Chinook	All Species
2007	643,510	275,540	6,587,741	1,066,096	185,273	**8,758,160**
2006	4,459,732	149,276	773,371	2,303,381	264,440	**7,950,200**
2005	345,373	416,737	8,087,637	2,465,216	310,487	**11,625,450**
2004	1,807,426	331,791	1,954,607	3,336,364	345,566	**7,775,754**
2003	2,242,314	230,564	9,004,473	3,179,785	334,340	**14,991,476**
2002	3,713,289	131,214	5,870,674	2,886,289	260,530	**12,861,996**
2001	2,382,092	13,895	8,043,811	1,139,051	85,114	**11,663,963**

(FOC[4]) Catch details for the above can be found in Appendix M.

As can be derived from the table above, commercial catches are in decline. Further to the information provided in this table, a report by Geiger et al. in 2002 stated *"The harvest of* *salmon in British Columbia increased from the late 1880s to a peak of about 30 million fish in the late 1920s and the early 1930s. Harvest subsequently declined through the 1950s and the 1960s, then rebounded to record high levels of about 40 million fish in the 1990s. This peak was followed by a rapid decline to the historic low harvest levels, about 8 million fish, in the late 1990s and early 2000s"* (Geiger et al.).

The Horsefly River contributes sockeye, chinook and coho salmon to the commercial fishery. In fact the river has historically been a very important contributor to the Fraser River sockeye fishery and provided 39% of the entire sockeye catch in 2005 (Benner). Extreme pressure is placed on Fisheries and Oceans Canada by commercial salmon fishing interests each year to increase the commercial catch however care must be taken to ensure adequate numbers of spawners return to their natal streams to spawn each year.

5.2 Dam Construction

Although dam construction on the Horsefly River watershed is not an issue currently, this topic should not be ignored due to the BC Provincial government's search for new hydro electric generated power.

Additionally, "Run of the River" projects that are being promoted in British Columbia do not require dams for water storage however they do extract water and pipe it to generating stations resulting in reduced stream flows in sections of the stream or river with possible negative implications. These projects can reduce habitat quality and quantity for fish and the lack of flow in some areas will have a negative impact on ever important riparian cover.

The Watershed Watch Salmon Society has provided the following top 10 considerations to assist people in reaching reasonable conclusions should a project be proposed in their area (Watershed Watch Salmon Society):

1) The Project is Located Wisely
2) Cumulative Effects Have Been Seriously Considered
3) Affected First Nations, Communities and Stakeholders Have Been Contacted
4) Potential Risks to Species and Ecosystems Have Been Identified
5) Sufficient Monitoring Data on Stream Flows and Biota
6) A Qualified Professional Has Participated in the Setting of Conditions
7) The Head Pond Weir and Intake
8) The Locations and Extent of Roads and Power Lines Have Been Identified

9) The Power House Includes Fish By-Pass Valves

10) Post Construction Monitoring Occurs

5.3 Agriculture

Agriculture plays a large role in the Horsefly River drainage. Small to medium size farms and ranches are evident throughout the watershed with beef cattle and hay production being the primary undertaking.

An initiative is underway by the Land Conservancy of British Columbia to purchase riparian land along known important fish habitat and has included agricultural land in the past. Some of this land is located in the Black Creek are of the watershed and has been further enhanced through initiatives such as fencing and riparian planting. Additionally some private land owners have taken the initiative to restore and enhance their riparian areas and should be commended for this sound stewardship.

Agriculture can have a negative effect on fish and fish habitat through poor practices in dealing with irrigation, riparian zone management, livestock watering, ditching, fertilization, waste management, soil management and conservation. It is important that ranchers and farmers in the Horsefly River drainage practice good watershed stewardship when working in and around water. A reference book of value is the Watershed Stewardship Guide for Agriculture and can be found online at http://www.dfo-mpo.gc.ca/Library/216753.pdf or perhaps through the local Ministry of Environment or Fisheries and Oceans offices.

5.4 Timber Harvest

The forest sector is perhaps the most prominent industrial undertaking in the Horsefly River watershed. Two major forest licencees, the Provincial government, woodlot owners, and private land owners all harvest timber and help drive the local economy. The "devil may care" attitude regarding harvesting practices in use up until the 1980s has been replaced with a Forest and Range Act that protects fish and fish habitat like never before. No longer are "river drives" of logs, intensive road networks, and skidding through creeks part of the day to day operational planning of a forester.

Nevertheless, problems related to timber harvest can occur and this is recognized by stronger regulations and professional "sign-off" on issues that may affect the health of fish and fish habitat. This need is evident as professional foresters can no longer determine the overall effects of their management decisions and they must now rely on support from other professionals such as hydrologists and biologists to prevent potential adverse influences on the watershed from sediment delivery and increased water temperatures.

5.5 Fish Hatcheries

Fish hatcheries are not a local concern for the Horsefly River watershed, however hatcheries have operated in the past on the Horsefly River and further downstream on the Quesnel River in the Village of Likely. The hatchery in Likely historically has enhanced Chinook and coho stocks from the Horsefly River main stem and from McKinley Creek but has since been closed for this undertaking as is currently operated as a research station. However should the need arise again it could once again be utilized as such.

Much debate has occurred on whether or not hatcheries are a benefit or a detriment to wild salmon stocks. On the one hand they certainly have assisted in providing adequate levels of replacement stock in areas where the natural runs have become essentially extinct. However hatchery produced stocks may have also created problematic declines in natural runs through disease, competition for food and habitat, and the alteration of genetic diversity through interbreeding. Additionally, artificially propagated stocks have become a management nightmare as small numbers of wild stock may be intercepted in a fishery with large numbers of hatchery originated fish.

Fish hatcheries can be a useful tool in stocking selected lakes and streams with non anadromous fish such as rainbow trout and kokanee for the pleasure of sport fishing. The Freshwater Fisheries Society of British Columbia is responsible for this undertaking and they include the Horsefly River drainage as part of their enhancement area. Fish stocking information and proposed Cariboo Chilcotin locations can be found on their website (FFSBC).

5.6 Atlantic Salmon

Fish farming has become a major industry on the west coast of British Columbia and Washington State with Atlantic salmon being the preferred rearing stock due to its cost/benefit analysis (fish food/growth) and table preference in restaurants. Unfortunately it is not native to the Pacific and over the past several years there have been enough escapes from net pens to warrant concern over the species establishing itself on the west coast. Indeed, natural production from escapees may already be occurring (Volpe et al. 2000). These introductions will obviously compete for fish habitat and food with the natural stocks residing in west coast streams.

5.7 Other Non-Native Species

Of particular concern to the Horsefly River watershed regarding non-native species is the recent discovery of smallmouth bass (*Micropterus dolomieu)* in the nearby Beaver Valley drainage. This system drains in a northerly direction into the Quesnel River which in turn drains Quesnel Lake which is fed by the Horsefly River. The connectivity is relatively close.

Smallmouth bass can produce 7,000 eggs per pound size or up to 20,000 eggs per female during spawning season. They compete for similar food that salmonids would eat and as such eventually out-compete them in a watershed. This issue is of great concern as the bass could conceivably migrate throughout the Quesnel Lake system including the Horsefly River. Discussions are currently underway between BC Ministry of Fisheries' biologists and local residents on the possible use of the organic pesticide Rotenone to eradicate the introduced species from the lakes and streams of Beaver Valley.

5.8 Ocean Conditions

As salmon spend most of their lives in the ocean environment, what occurs in the Pacific Ocean off the west coast of British Columbia is of great importance to the stocks that are native to the Horsefly River watershed. Ocean events such as the Pacific Decadal Oscillation (PDO), El Nino, and the Aleutian low pressure index have all been researched and found to play a role in the marine survival of salmon stocks.

"*The Pacific Decadal Oscillation is a climate index based upon patterns of variation in sea surface temperature of the North Pacific from 1900 to the present (Mantua et al. 1997). While derived from sea surface temperature data, the PDO index is well correlated with many records of North Pacific and Pacific Northwest climate and ecology, including sea level pressure, winter land–surface temperature and precipitation, and stream flow. The index is also correlated with salmon landings from Alaska, Washington, Oregon, and California.*

The PDO is highly correlated with sea surface temperature in the northern California Current (CC) area; thus we often speak of the PDO as being in one of two phases, a "warm phase" and a "cool phase," according to the sign of sea–surface temperature anomalies along the Pacific Coast of North America. These phases result from winter winds in the North Pacific: winter winds blowing chiefly from the southwest result in warmer conditions in the northern CC. Conversely, when winds blow chiefly from the north, upwelling occurs, leading to cooler conditions in the northern CC" (NOAA).

With respect to El Nino and ocean conditions in general, the following March 9, 2008 article from the Modesto Bee is enlightening: "*Ocean conditions are the primary cause of recent declines in salmon numbers, especially in 2007.*

If the decline in Central Valley chinook salmon were primarily related to water exports from the Sacramento-San Joaquin Delta or river flows, then only these salmon would decline. But chinook salmon stocks in Oregon, Washington and British Columbia are also down. And coho salmon have dropped by more than 70 percent in California and Oregon coastal streams since 2004. For the coho salmon, there are no export facilities (canals or aqueducts) and few dams to blame.

Chinook salmon spend part of their lives in fresh water and part in the ocean. Their migrations expose them to natural and man-made threats. If conditions are unfavorable at any point, fewer fish return to spawn in fresh water.

Variable conditions off the Pacific Northwest coast over the past 30 years negatively impacted the chinook. From 1977-1998, these waters were unfavorably warm, resulting in a significant drop in returning salmon. Conditions were particularly variable during the past 10 years.

El Niño (warming) periods and La Niña (cooling) periods corresponded to significant declines and rebounds in salmon numbers.

In 2005, scientists observed catastrophic ocean conditions in the Pacific Northwest. Normally an upwelling brings nutrients from the ocean floor to the surface, providing critical support for the entire marine food chain. In 2005, this upwelling failed to appear for the first time in 50 years. Many species starved. Several scientific models predicted much lower salmon numbers in 2007 and possibly 2008. So far those forecasts have proved accurate" (Short).

The above article on the importance of ocean conditions and its effects on salmon plays a very large role in opening discussions on the salmon stocks that migrate to and from the Horsefly River watershed. In 2007 chinook and sockeye escapements were extremely low and below projections, whereas coho escapements exceeded expectations. Freshwater conditions remain somewhat the same for all three species, however one species, the threatened Interior Fraser River coho, did exceptionally well. Obviously numerous factors require consideration in this discussion but perhaps the coho spent their marine life in optimum rearing conditions.
The Aleutian low pressure index also has an influence on salmon and other stocks rearing in the north Pacific. Fisheries and Oceans Canada describes the index as follows: "*This index measures the relative intensity of the Aleutian Low pressure system of the north Pacific (December through March). It is calculated as the mean area (km^2) with sea level pressure <= 100.5 kPa and expressed as an anomaly from the 1950-1997 mean. A positive index value reflects a relatively strong, or intense Aleutian Low"* (FOC[5]). It is believed that these events affect the ocean's carrying capacity and influence the ocean survival of salmon, especially coho.

5.9 Climate Change

Climate change also plays a role in the life of fish residing in the Horsefly River watershed. It affects both the freshwater and marine environments in which they live. Profound climate change events are not a new phenomenon as history provides numerous incidents that have changed the local landscape such as the Prairie drought of the 1930s. Recently in the Pacific Northwest we have seen a warming trend that has not only affected ocean conditions, but is starting to affect freshwater rearing condition for fish through the proliferation of the Mountain Pine Beetle and its potential effects on timber growing in riparian zones.

The Pacific Fisheries Resource Conservation Council (PFRCC) recently recognized the relationship between climate change and pacific salmon. In a recent publication titled "Mountain Pine Beetle: Salmon are Suffering Too" the PFRCC states that 60 % of the

Fraser River watershed is affected and that permitted logging has been accelerated by 36% and in fact doubled in some instances. The publication strengthens the need of "*better linkages between agencies, government levels and local communities. BC's many salmon conservation groups and agencies will need to work together more closely and First Nations can contribute in key areas"* (PFRCC[2]). This speaks volumes on the need for an effective Horsefly River Roundtable to balance the needs of the economy, societal needs and the environment.

Dr. Richard Beamish is the Senior Scientist with Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo British Columbia. He is a world renowned expert on salmon and has been involved at the forefront of research on climate change and its effects on fish populations. In a paper prepared for presentation in Portland, Oregon in 1999, yet relevant today, he offered the following:

"Change is part of the make up of all living things. We are in a period of very profound and obvious change in our climate. We have a responsibility to recognize this change and adapt our thinking and our management of salmon (Bisbal and McConnaha 1998). The desire to do the right thing for salmon has always been embedded in the culture of Pacific Rim peoples. The difficulty is that as we learn more about the factors that affect salmon such as climate, we also realize how much more there is to learn. Recognising that we will always be learning, I recommend we do the following to prepare for the future. I hope that it makes sense to you:

1. *Protect freshwater habitat as a safe refuge for spawning and for baby salmon to grow.*
2. *Respect the marine habitat of salmon because most salmon do not survive the complexity of factors that can cause their death.*
3. *Recognize that the life histories of the various species of wild salmon have evolved to adapt to a wide range of natural conditions which means that if salmon were left alone they could solve their own survival problems.*
4. *Be concerned that we have not left salmon alone.*
5. *Be even more concerned that we have intervened in the natural regulation process while understanding very little about the natural mechanisms that affected survival.*
6. *Fishing should not prevent a stock from replenishing itself, but knowing what the safe level of fishing should be will always be a challenge.*
7. *Be careful of advice that tells you that you can rebuild salmon with computers.*
8. *Accept that climate affects the survival trends in salmon.*
9. *Believe that the planet is warming and the climate is changing, but do not delay responding while experts debate if the cause is from our production of greenhouse gas or natural trends as it is probably from both.*
10. *Recognize our uncertainties and speak openly about what you know and don't know as expectations will become more realistic and people will like fisheries biologists better.*
11. *Remember that everyone cares for salmon, it is the interpretation of our ignorance that creates conflicts.*

12. *Expect the unexpected, prepare for change as do all animals, and believe that the future survival of salmon is a measure of our ability as a species to live in balance with other species"* (Beamish).

5.10 Predation

Fish and indeed most wildlife are faced with the ongoing pressures of predation. Other freshwater species in the Horsefly River watershed rely on salmonids for a portion of their diet. Additionally in their freshwater life they are faced with predatory birds and mammals that prey on both trout and salmon during all life stages.

In a report by Cariboo Envirotech Ltd. prepared in 2006, the issue of predation by approximately one hundred mergansers on adult kokanee spawners in the Horsefly River during the fall of 2005 was noted to be "excessive" at 4 spawning sites. Additionally, it was felt by the field crew that the spawners were seeking refuge during the day under logs and spawning at night to avoid predation (Cariboo Envirotech).

In the ocean environment, larger fish are an ever present danger and marine mammals play a large role by consuming significant numbers of salmonids. Mammals can be especially troublesome at the mouths of streams during peak migration times for both juveniles during their out migration and adults during their upstream migration. An example of this problem are harbour seals and their predation on Chinook and steelhead smolt migration outbound from the Puntledge River on Vancouver Island where an electric barrier has been tested successfully to deter the seals.

6.0 Potential for Maintaining or Restoring Productive Capacity

The potential for maintaining or restoring productive capacity to the Horsefly River watershed is based on numerous scientific and societal factors with some being presented below:

6.1 Government Will and Funding

Key to the success for maintaining or restoring the productive capacity of fish stocks in the Horsefly River is the will of both the federal and provincial governments (who regulate and fund the resource management of anadromous and non-anadromous species residing in the watershed) to adequately fund the protection, maintenance and restoration of these resident fish stocks.

At a time when increasing pressure is evident on the fishery resource from resource based industries such as forestry and mining, increasing population, climate change and global warming, both levels of government have not maintained the needed funding to properly manage the resources under their responsibility. Rather, both levels of government within the last decade have either cut spending to the BC Ministry of Environment or Canada's Department of Fisheries and Oceans or maintained a constant level of funding in spite of increasing pressure from inflation and population growth.

6.2 Horsefly River Sockeye Spawning Channel

The Fisheries and Oceans Canada Horsefly River Sockeye Spawning Channel located in the Village of Horsefly was built in 1989 to assist in the enhancement of sockeye salmon. The channel was operated annually from 1989 to 1996 however since then it has not operated on the dominant year of the four year cycle as it is felt that the river can produce enough fry without the support of the channel.

The table below provided by Fisheries and Oceans Canada's enhancement facility support biologist Doug Lofthouse of Vancouver and shows the fry production from the facility from 1989 to 2007 aside from the latter peak years and the very weak year of 2004 when the facility did not operate. Of concern is the continued trend of the lack of spawners available to fill the channel during the weak and very weak years.

Table 5: Horsefly Sockeye Spawning Channel Fry Production

Year	Cycle	Channel Females	% of Channel Capacity	% of Total Female Escape.	# of Fry Produced (M)
1989	dominant	11650	100	1.4	25.8
1990	sub dom.	11743	101	5.1	17.60
1991	weak	11652	100	54.1	22.63
1992	very weak	898	8	29.5	2.64
1993	dominant	11650	100	1.2	3.57
1994	sub dom.	11651	100	4.2	0.85
1995	weak	9608	82	9.6	8.00
1996	very weak	5844	50	31.1	1.93
1998	sub dom.	13174	113	3.4	16.82
1999	weak	3460	30	4.1	12.00
2000	very weak	525	4	2.5	1.36
2002	sub dom.	11664	100	River not enumerated	12.80
2003	weak	11653	100	12.6	25.50
2006	sub dom.	11049	95	15.6	5.20 (est.)
2007	weak	1833	16	6.6	-

(Lofthouse)

The continued operation of the spawning channel has great potential for maintaining and restoring the productive capacity of the Horsefly River sockeye salmon stocks.

It should be noted that biologist Doug Lofthouse has recently stated "*As an interesting aside, for the three brood years in which StAD ran a downstream program on the river, the estimates of total fry production were; 80.7 M from the dominant return of '85 (est. 4.3% egg to fry survival), 44.9 M from the sub-dominant return of '86 (est. 15.7% egg to fry survival), and 81.4M from the dominant return of '89 (est. 3.5% egg to fry survival).*

So given these numbers, when clean and well-loaded, the channel can make a significant contribution to total yearly fry production".

For comparison, in 1989 with the spawning channel loaded to 100% capacity, the output of sockeye fry was 25. 8 million.

6.3 Cariboo Chilcotin Land Use Plan

"The Government of British Columbia announced the Cariboo-Chilcotin Land Use Plan (CCLUP) on October 24, 1994. The CCLUP addresses long-term concerns around sustaining the region's economy: access to timber for the local forest industry, certainty for the mining, ranching and tourism industries, and job security. It sustains the region's environment by permanently protecting the natural landscapes that make the Cariboo unique. Secure access to resources provides economic and social stability and increased opportunities for growth and investment throughout the region.

The Cariboo Chilcotin Land Use Plan (CCLUP) was designated as a higher level plan in 1995 under the Forest Practices Code of British Columbia Act, and was amended in 1999. The CCLUP guides the application of the Forest Practices Code and other resource management within the plan area" (CCLUP).

The Cariboo Chilcotin Land Use Plan's "*purpose of the Fisheries Target Committee was to identify how well short term timber sources can be reconciled with long term fisheries targets in the CCLUP area. We interpret "fisheries targets" to be no net loss of fish habitat due to cumulative watershed disturbance (CCLUP).*

In 1996, the Fisheries Target Committee provided the following Table showing that three major tributaries of the Horsefly River were at high fisheries risk with a fourth being at moderate risk. Although dated, the CCLUP is a very important planning document and it is essential that the information provided in this report be reviewed and complimented where possible and utilized in an effort to maintain and restore the reproductive capacity of the watershed.

Table 6: Comparison of Fisheries Risk Estimates and Level 1 Watershed Assessments

Biodiversity Unit	Fisheries Risk, 1996	Watershed Name	Does Level 1 Watershed Assessment indicate a concern?	Evaluation of Fisheries Risk Estimate
Mckinley	High	Mckinley Ck.	No	Appropriate
McKusky	High	McKusky Ck.	Yes	Appropriate
Moffat	High	Moffat Ck.	Yes	Appropriate
Mackay	Moderate	Mackay R. and Upper Horsefly R.	MacKay R. - Yes Upper Horsefly - No	Appropriate

Biodiversity Unit	Fisheries Risk, 1996	Watershed Name	Does Level 1 Watershed Assessment indicate a concern?	Evaluation of Fisheries Risk Estimate
Murphy Lake plus Bradley Creek	High	Eagle and Bradley Creeks	No	Appropriate
Baker plus Tibbles	High	Baker Creek	No	Appropriate
Swift	Low	Little Swift R. and McMartin Creek	Little Swift River - No McMartin Ck. - No	Appropriate
Cottonwood Total (Ahbau, Swift, Lightning, Umiti, and Victoria)	High	Cottonwood River	Yes	Appropriate

The CCLUP's Fisheries Target Risk Assessment Report prepared by the Fisheries Target Committee can be found in Appendix N.

6.4 Horsefly Sustainable Resource Management Plan

The Horsefly Sustainable Resource Management Plan (HSRMP) is the spatial application of the CCLUP direction at the sub-region planning level. The plan offers 43 objectives to guide operational planners in an effort to balance resource use with the protection of biodiversity.

The HSRMP identifies rainbow trout, bull trout, lake trout, kokanee, coho, Chinook and sockeye as species of particular concern in the watershed. It reiterates the CCLUP recommendation of watershed assessments when areas of disturbance in a watershed exceed 25% to ensure hydrological stability for the maintenance of fish habitat. The report also recommends that key or sensitive watersheds be selected for intensive research or monitoring to assess water quality and hydrological effects of timber harvesting (HSRMP).

The plan also identified critical fish habitat as follows:

- Defined lakeshore areas on Quesnel and Horsefly Lakes where sockeye salmon and kokanee spawn. Protection of these spawning areas by retention of additional lakeshore areas will prevent disturbance to high quality surface and ground water sources necessary for successful spawning.

- Specific watercourses adjacent to main channels within flood plains. These include back channels, oxbows, wetlands and ground water sources connected to the main water course. These areas provide exceptional habitat for juvenile salmonids. Many of these aquatic areas are not included in the designated riparian reserve/management zones for the respective riparian/stream class. In these areas the reserve zone has been extended to the first elevation contour of the floodplain and upslope interface for selected S1, S2, and S3 streams.

- Selected streams with bull trout, rainbow trout and salmon populations that require increased riparian protection to maintain channel morphology and natural temperature regimes critical for spawning and rearing. This may include tributary S5 and S6 streams that require riparian buffers to maintain natural water quality and temperatures for the receiving, fish bearing streams.

The HSRMP recommends the following objectives for resource management as it pertains to fish and water:

- **Objective 33.** Maintain and enhance fish passage, natural channel width, streambed substrate, and water quality at all new road crossings of fish streams.

- **Objective 34.** Prevent the cumulative hydrological effects of forestry activities from resulting in a significant adverse impact on fish habitat

- **Objective 35.** Manage the areas shown as critical fish habitat on Map 8 as No-harvest Areas. (Appendix O)

The Horsefly Sustainable Resource Management Plan can be a useful tool in maintaining and restoring productive capacity.

6.5 Species at Risk Act

The Species at Risk Act (SARA) became law on June 5, 2003 and is designed to prevent wildlife species from becoming extinct. The law makes it illegal to kill or harm species listed under the Act, (and equally important) to destroy their critical habitats (SARA).

SARA was created to protect wildlife species from becoming extinct in two ways:

- By providing for the recovery of species at risk due to human activity; and
- By ensuring through sound management that species of special concern don’t become endangered or threatened.
  (SARA)

Species are designated ‘at risk’ by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent body of experts that assesses wildlife according to a broad range of scientific data. The federal Cabinet then decides whether those species should get legal protection under the Act. These decisions are made after consultations with affected stakeholders and other groups (SARA).

Of particular concern in the Horsefly River watershed is the status of Interior Fraser River coho which have declined by more than 60 % since 1996. COSEWIC has designated this stock as endangered and is under consideration for inclusion under the Species at Risk Act.

The Fisheries and Oceans Canada website has provided the following information on management measures that have been in place since 1998 to address the concerns relating to Interior Fraser River coho:

- *Various commercial, recreational and First Nations fishery closures and restrictions in the Fraser River and approach areas;*
- *selective seine fisheries are the only fisheries permitted in the Strait of Juan de Fuca; and*
- *closure of commercial salmon troll and gillnet fisheries off the west coast of Vancouver Island and Strait of Juan de Fuca during periods of and in areas of Interior Fraser River coho salmon abundance.*
- *In June 2005, DFO adopted the Wild Salmon Policy which identifies Interior Fraser River coho salmon as a unique "conservation unit" that needs protection.*

These measures are modified annually to reflect ongoing changes in the species' status.

DFO will continue to build on the present signs of recovery for the Interior Fraser River coho by setting clear goals for each fishery based on the principles of the Wild Salmon Policy.

DFO has developed a draft recovery strategy in collaboration with Aboriginal groups, provincial governments, industry and stakeholders.

Additional management measures are being developed through the recovery planning process and implemented only after intensive consultation. Potential recovery measures being investigated include:

- *improvements to quality and quantity of shoreline and streamside vegetation;*
- *reductions in water withdrawals from key areas; and*
- *restoration of juvenile rearing areas within nursery watersheds.*

It should be noted that the 2007 coho escapements into the Quesnel Lake system including the Horsefly River drainage were the highest on record with the counting fence on McKinley Creek enumerating more than 5,000 adult coho spawners. This is a great news story for Pacific salmon and the Horsefly drainage and we can only hope that this trend continues.

6.6 DFO's Wild Salmon Policy

Another regulatory means to protect the status of Pacific salmon has been the development of the Fisheries and Oceans Canada Wild Salmon Policy (WSP). The policy came into effect in 2005 and is slowly being implemented to conserve wild salmon stocks on the west coast. The goals of the Wild Salmon Policy are as follows:

- *The goal of the Wild Salmon Policy is to restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity.*
- *This policy goal will be advanced by safeguarding the genetic diversity of wild salmon populations, maintaining habitat and ecosystem integrity, and managing fisheries for sustainable benefits.*
- *Conservation of wild salmon and their habitat is the highest priority for resource management decision-making.*
- *Resource management processes and decisions will honour Canada's obligations to First Nations.*
- *Implementation of this policy will involve an open and inclusive process aimed at making decisions about salmon stewardship that consider social, economic, and biological consequences. People throughout British Columbia and the Yukon will contribute to decisions that reflect society's values for wild salmon.*
- *Wild salmon will be maintained by identifying and managing "Conservation Units" (CUs) that reflect their geographic and genetic diversity. A CU is a group of wild salmon sufficiently isolated from other groups that, if lost, is very unlikely to recolonize naturally within an acceptable timeframe (e.g., a human lifetime or a specified number of salmon generations).*
- *The status of CUs will be monitored, assessed against selected benchmarks, and reported publicly. Where monitoring indicates low levels of abundance, or deterioration in the distribution of the spawning components of a CU, a full range of management actions to reverse declines – including habitat, enhancement, and harvest measures – will be considered and an appropriate response implemented.*
- *Measures for habitat protection and salmon enhancement will focus on sustaining wild salmon. An integrated approach to habitat management – involving assessment of habitat condition, identification of indicators and benchmarks, and monitoring of status – will be adopted that links fish production with watershed and coastal planning and stewardship initiatives.*
- *Ecosystem considerations will be incorporated into salmon management. Indicators will be developed to assess the status of freshwater ecosystems. Information from ocean climate studies of marine survival and of the biological condition of salmon will be integrated into the annual assessments of salmon abundance that guide salmon harvest planning.*
- *The policy aims to maintain CUs but recognizes there will be exceptional circumstances where it is not feasible or reasonable to fully address all risks. Where an assessment concludes that conservation measures will be ineffective or the social or economic costs to rebuild a CU are extreme, the Minister of Fisheries and Oceans may decide to limit the range of measures taken. Such a decision will be made openly and transparently.*
- *This policy will foster a healthy, diverse, and abundant salmon resource for future generations of Canadians. It will support sustainable fisheries to meet the needs*

of First Nations and contribute to the current and future prosperity of Canadians (WSP).

The Government of Canada, through the Wild Salmon Policy, and in fact through the Fisheries Act has the tools in place to protect and enhance wild salmon stocks that have utilized the Horsefly River for thousands of years.

It is crucial that their initiatives show some positive returns on salmon resource management in an effort to prevent a collapse in stock similar to the great cod fishery decline in the Atlantic Ocean.

6.7 Pacific Fisheries Resource Conservation Council

Another great advocate and an advisor to the Minister of Fisheries and Oceans Canada and the British Columbia Minister of Fisheries is the Pacific Fisheries Resource Conservation Council (PFRCC). This independent body provides advice on conservation and environmental sustainability of Pacific salmon stocks and their freshwater and ocean habitats.

The Council was created in September of 1998 by the Minister of Fisheries and Oceans and the key roles of the PFRCC as described on their website are to:

- *Provide strategic advice regarding stock conservation and enhancement, habitat restoration, protection and improvement, and fisheries conservation objectives. This includes identifying stocks in need of conservation actions and stocks where there is insufficient information to assess their conservation status.*
- *Describe the effects of conditions in freshwater and marine ecosystems on the conservation of Pacific salmon.*
- *Review and make recommendations pertaining to research programs, stock and habitat assessments, enhancement initiatives, and government policies and practices related to conservation of Pacific salmon and their freshwater and ocean habitat.*
- *Integrate scientific information with knowledge and experience of First Nations, stakeholders and other parties.*
- *Alert the Minister of Fisheries and Oceans and the public on issues that threaten the achievement of departmentally defined conservation objectives for Pacific fish populations or their freshwater or ocean habitat.*
- *Provide information to governments and the public on the status of Pacific salmon stocks and their freshwater and ocean habitat in order to enhance understanding and support for fish conservation and habitat protection.*

*The PFRCC provides its recommendations to Ministers and the public simultaneously. The Council convenes and hosts public meetings each year at several locations in BC to receive, review and discuss information pertaining to the status of salmon stocks and their habitat (*PFRCC[1]).

A recent report recently commissioned by the PFRCC dealt with climate change issues and its effects on the Quesnel River drainage including the Horsefly River (Nelitz, et al). The report detailed two mitigating adverse effects from climate change on sockeye salmon:

1. broad landscape-level changes due to mountain pine beetle and related logging activities, and

2. changes to in-river conditions through downstream migration corridors

The recommended strategies to alleviate the above were provided as “soft” and “hard” infrastructure strategies. The “soft” strategy is to adjust fisheries management practices through:

1. Development of “harvest rules” that account for year-to-year variations in conditions of the Fraser River (i.e., water temperatures and flows) could help compensate for potential increases in enroute and pre-spawning mortality under future climate regimes.

2. Reductions in harvest rates of off-cycle years may help build up long-term abundance, whish also has the potential of increasing long-term economic benefits

The recommended “hard“ strategies in the report are:

1. Implement low impact forestry strategies / restore riparian ecosystems. The report recommends the retention of conservative riparian buffers in headwater areas and extensive monitoring should occur to help reduce uncertainties around habitat changes

2. Release cold water. The report recommends the use of the McKinley Flow Control Structure for release of cold water into McKinley Creek and to explore other opportunities for cold water release within the Horsefly River watershed

3. Conserve pristine habitats. The report recommends revisiting the CCLUP recommended “strongholds” designated for the protection of salmon as mountain pine beetle infestation. “it may be worth revisiting these designations for the sake of protecting salmon and other ecosystem values” (Nelitz, et al)

The PFRCC is a strong ally for the anadromous and non-anadromous fish that reside in the Horsefly River watershed and we can only hope that their advice to both the federal and provincial governments does not fall on deaf ears.

7.0 Limiting Factors of Habitat and Population Recovery

Numerous factors and outside influences limit the habitat and population recovery of fish residing in the Horsefly River watershed. Some are presented below and it is hoped that the Horsefly River Roundtable and its Technical Committee can identify others and act whenever possible to minimize their impacts.

7.1 Ocean Conditions - Climate Change and Global Warming

As presented earlier in this report, ocean conditions play an important, if not the most important role in limiting salmon populations. We cannot control the short term effects of climate change and global warming however we can learn from these events and better prepare ourselves for these influences in the future.

Ongoing research on El Nino, the Pacific Decadal Oscillation, the Aleutian Low Pressure Index and other ocean influences is key to understanding ocean events that impact on the salmon resource. These fish spend the greater part of their lives in the marine environment and we must collect as much information as possible on this phase of their development to better understand how these phenomena work. This is a daunting task as salmon and other species range over a large area of the Pacific.

Fisheries and Oceans Canada produces a State of the Ocean report card for each year and in their 2006 report released in June of 2007, the following top stories were discussed:

- Global warming continued and the West Coast seas remained warm in early to mid-2006
- Storms of late 2005 were the worst to hit southern BC, cooling ocean waters in autumn
- "Warm ocean pattern" of marine life continued into summer of 2006
- Juvenile coho and seabirds along Vancouver Island rebounded from very low numbers
- Where were the herring? Numbers declined all through BC waters
- Where were the hake? Few found west of Vancouver Island for first time in several years
- Returns of sockeye salmon were weak due to poor ocean conditions when they were young
- Oxygen concentration continued to decline in subsurface waters in the Northeast Pacific
- Straight of Georgia stayed warm in 2006
- Fraser River was warm for returning sockeye salmon
- Biggest plankton bloom ever observed in BC waters from space was in 2006.

(FOC[6])

Very few of the above are "good news" stories, and some in one way or another directly impacts on the habitat and population recovery of fish in the Horsefly River watershed. We await the 2007 report and expect it to be completed in the summer of 2008.

7.2 Stream Conditions – Water Temperatures/Sediment

Anadromous and non anadromous species of fish both rely on a healthy freshwater environment to sustain themselves. Studying fish in the freshwater environment can be easier than the marine environment due to the enclosed areas of directed research and we have a better understanding of this developmental phase. However in spite of this, there is much we don't understand.

Throughout this report, it has been mentioned on numerous occasions that increased water temperatures and sediment delivery are at present, and potentially will be a future threat to salmonids in the Horsefly River watershed. This we seem to know and have understood for some time.

Continued research on the natural and anthropognic influences on fish and fish habitat in freshwater environments provides us with new information to make informed decisions on our landscapes and ecosystems. We cannot continue with a "business as usual" attitude and mirror the decisions made by previous generations here in British Columbia, or look to the United States or Europe for advice on how to manage our aquatic and terrestrial resources. For the most part, these jurisdictions have failed to protect their aquatic resources which are seldom replaced or rehabilitated to their previously natural state.

7.3 Mountain Pine Beetle

As stated above, warm stream temperatures and sediment delivery have long been an issue in the Horsefly River watershed. In addition to these historical problems is the now present influence of the negative effects of the Mountain Pine Beetle (MPB) infestation which will only serve to compliment these two existing priority issues.

The outbreak of the MPB is the largest single incidence or pestilence in North American history and affects 60% of the Fraser River watershed and much of the Horsefly River watershed. These dead and perhaps marketable trees played an important role in water uptake from snow pack and rainfall and provided much needed shade in important riparian areas of the watershed tributaries and reaches in the main stem. This positive influence is now gone and will not be replaced for years to come. How drastic the effects will be are unknown and we can only make assumptions at this point.

However the assumptions and predictions are fairly clear. In a workshop held in Prince George in January of 2007 and sponsored by the Pacific Salmon Foundation the following potential impacts as a result of climate change and the Mountain Pine Beetle on the physical environment and the conditions which create natural habitats include altered:

- Air and water temperatures
- Frequency of extreme weather and storm events
- Patterns of precipitation and freshwater supply
- Ice and snow cover
- Ocean upwelling events (El Nino, La Nina) and circulation patterns
- Terrestrial and coastal sediment transport and erosion
- Soil moisture, and
- Patterns of nutrient availability

(PSF)

The workshop report also provided the following potential alterations to fish, affecting individuals, species, populations and ecosystems:

- Spatial distributions and range, migration of individual species
- Growth and physiology of individuals within a population
- Timing match – mismatches with a species life history
- Diversity of prey, predators and competitors within communities
- Species composition and distribution within ecosystems
- Migration and movement corridors
- Exotic and invasive species introductions, and distribution, and
- Parasite and disease risks

(PSF)

7.4 Neoclassical Economics

"Neoclassical economics" is a common approach to economics that relates supply and demand to an individual's rationality and his or her ability to maximize utility or profit. One great flaw to this widely held point of view is the assumption that "natural capital" such as forests, minerals, and indeed the fish in the ocean are the endless supply chain that neoclassical economics rely on. Hence the continuing pressure and need to fish stocks to the edge of extinction.

Increasing pressure on the demand side of the commercial fishery may have played a large role in the large commercial sockeye harvests in the 1990s when upwards of 40 million were taken in the fishery. The recent commercial sockeye fishery shows that only approximately 8 million have been available for the fleet, twenty per cent of its former glory. The fishery resource is not an endless stream that can increase in quantity at the whim of an economist. The present exploitation rate for most global fisheries is not sustainable.

Sustainable development as defined by the Brundtland Commission is defined as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (Brundtland). Sustainable development also needs a balance of economic needs, societal needs, and environmental needs in order to meet the above stated definition. In other words, we should be replacing what we reap with something of equal or greater value.

World renowned fisheries scientist and Director of the University of British Columbia's Fisheries Centre Dr. Daniel Pauley has authored or co-authored more than 500 articles, chapters and shorter contributions as well as authored or co-authored 30 books. His perspective on global fisheries is that governments should abolish subsidies to fishing fleets and that marine reserves should be created to help protect dwindling fish stocks. In a co-authored paper written for Nature, the abstract states *"Fisheries have rarely been "sustainable". Rather fishing has induced serial depletions, long masked by improved technology, geographic expansion and exploration of previously spurned species lower in the food web. With global catches declining since the late 1980s, continuation of present trends will lead to supply shortfall, for which aquaculture cannot be expected to compensate, and may well exacerbate. Reducing fishing capacity to appropriate levels will require strong reductions of subsidies. Zoning the oceans into unfished marine reserves and areas with limited levels of fishing effort would allow sustainable fisheries, based on resources embedded in functional, diverse ecosystems"* (Nature).

8.0 Recommendations

Numerous reports have been written over the years on fisheries and watershed issues relating to the Horsefly River watershed. The following list of recommendations for the Horsefly River is offered for consideration to the residents of Horsefly, the Horsefly River Roundtable and all who are concerned about fish and fish habitat in the watershed. It is hoped that the residents of Horsefly and the citizens of British Columbia can maintain and enhance the fishery resource that has become an important economic, social and environmental asset, not only to local residents but for all British Columbians, and indeed visitors who travel to the watershed from all over the world.

1. Maintain, support and encourage the function of the Horsefly River Roundtable. It is a known fact that no one looks after their watershed better than the people who live in it.

2. Lobby and apply for additional funding to study and protect the unique strain of Quesnel Lake rainbow trout that utilize the Horsefly River drainage.

3. Lobby and apply for additional funding to study and protect the riverine kokanee populations of the Horsefly River drainage.

4. Lobby and apply for funding to study the effects of temperature fluctuations in the watershed. Of particular importance is the delivery of cold water from tributaries flowing off the mountains located in the Upper Horsefly River drainage

5. Lobby and apply for funding to study the effects of sediment delivery in the watershed and the resultant loss of gravel/cobble substrate.

6. Lobby both provincial and federal governments to practice true sustainability by balancing economic and societal needs with the environmental needs.

7. Review and consider the recommendations provided in the Richard L. Case report of 2000. The summary recommendations can be found in Appendix P.

8. Ensure that the operation of the Horsefly River Sockeye Spawning Channel continues.

9. Ensure that the operation of the coho counting fence on McKinley Creek continues.

10. Ensure that the operation of the McKinley Creek Flow Control Structure continues.

11. Support the efforts of the BC Land Conservancy in their efforts to protect the riparian zones of the Horsefly River through land acquisition.

12. Engage the forest licensees that operate in the watershed and request their direct involvement in "on the ground" projects that research or enhance fish stocks within the Horsefly River watershed.

13. Engage the mining industry that is operating in the watershed. A presentation by the Ministry of Mines at a Roundtable meeting and an invitation to miners to participate in the Roundtable would be an effective start.

14. Encourage continued research in the watershed from the University of Northern British Columbia's Quesnel River Research Centre.

15. Localized education programs on the banks of the Horsefly River should be encouraged to continue.

16. Support the continuation of the Horsefly River Salmon Festival.

17. Compile information on the lakes in the watershed that have been surveyed by the Province and support small recreational fisheries.

18. Buy sustainable fish products recommended by Seachoice or the Living Oceans Society when purchasing marine fish and shell fish.

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