The Horsefly River
State of the Watershed Report
Volume II-Stage II
Of A
Watershed Based Fish Sustainability Plan

Prepared For:

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Intierra Resource Intelligence Mapping

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

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Executive Summary

The Horsefly River Roundtable (HRR) initiated a Watershed-based Fish Sustainability Plan (WFSP) for their watershed in 2007. This ongoing process designed by the Province of British Columbia and the Canadian governments endeavors to bring together the many voices concerned with the conservation of fish and fish habitat.

The WFSP identifies watershed priorities to conserve and enhance fish and fish habitat and encourages stewardship from many sectors including First Nations, government, anglers, conservation groups, organizations and individuals. The WFSP is designed to compliment other planning documents in place for a watershed and is intended to be flexible in application although a guidebook has been prepared to guide proponents such as the HRR.

The ongoing WFSP involved the creation of a Technical Committee whose role is to provide information and advice to the HRR. In autumn 2008 the Technical Committee decided to provide the HRR with this State of the Watershed report as a means to determine health of fish stocks in the watershed and the positive and negative influences on this valuable resource.

The report offers information on population estimates and related trends for sockeye, coho, chinook salmon, kokanee and rainbow trout. It provides the reader with a forecast of salmon run sizes for 2009 for comparative purposes and information on the interaction of all species in the Horsefly River and Quesnel Lake. Additionally the report details the enhancement and monitoring initiatives that are or have occurred in the drainage, and provides the reader with background data on the value of fish stocks in the Horsefly River watershed.

The report also discusses the possible negative anthropogenic influences on fish and fish habitat in the drainage as well as natural events that can be detrimental to the health of the local fish stocks. In closing, the report offers the reader the primary watershed concerns that may be affecting the resource and related recommendations that will conserve and enhance the fish and fish habitat of the Horsefly River watershed.

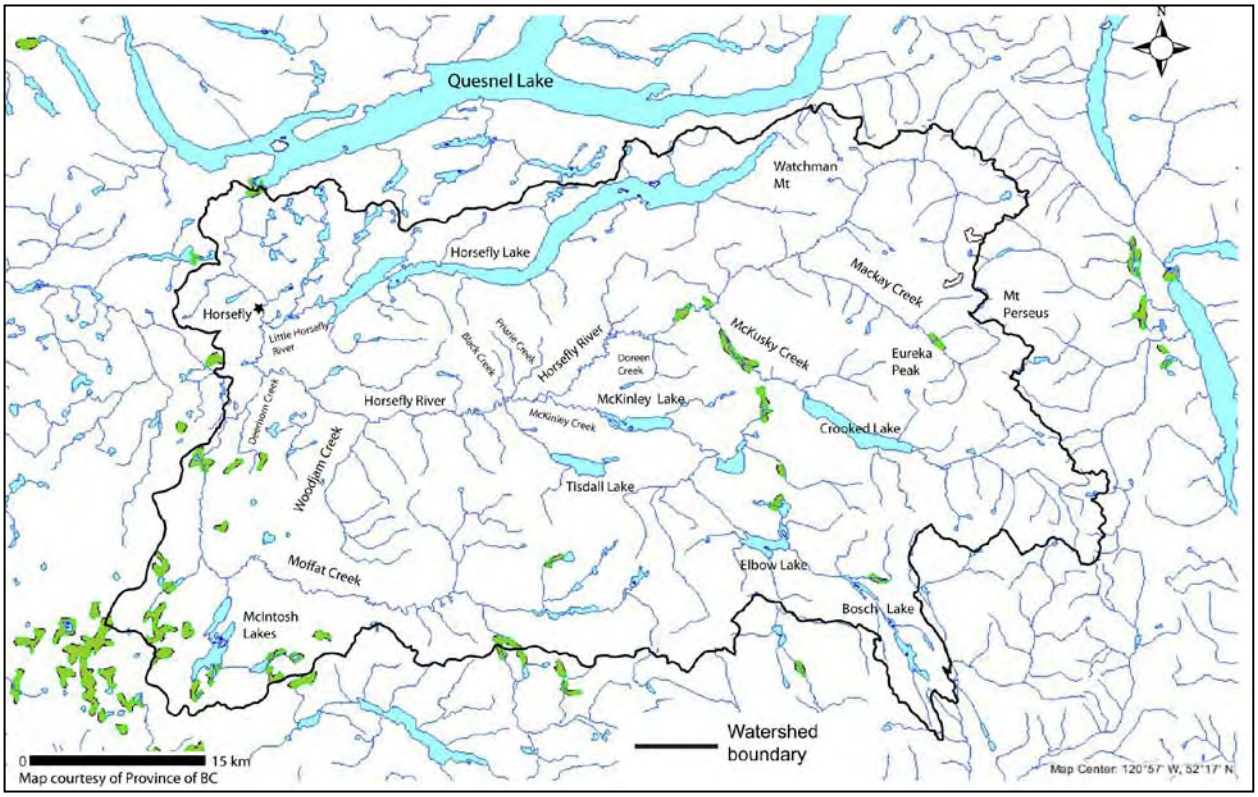

Figure 1. Horsefly River Watershed

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1.0 Introduction

1.1 The Horsefly River Watershed Roundtable

The Horsefly River Watershed Roundtable was conceived during the fall of 2006 with its inaugural meeting scheduled for February 15, 2007. A total of 22 individuals attended the first meeting after advertisements were placed in the local paper the Horsefly Buzz and through "word of mouth". Participants include community residents, First Nations (at the technical committee level at this time), industry, federal and provincial regulatory bodies such as Fisheries and Oceans Canada and the BC Ministry of Environment, the Cariboo Regional District, and non-governmental organizations such as The Land Conservancy.

The Roundtable meets on a scheduled basis with meetings now being held approximately six times per year to discuss ongoing issues. A Technical Committee has been formed to advise the Roundtable and their meetings are usually held during the afternoon of the scheduled evening meetings. In an effort to recognize the importance of people's volunteer time, both meeting are limited to two hours each in length. The Roundtable is a registered society within British Columbia.

Watershed Roundtables have been formed throughout British Columbia in an effort to engage local citizens in watershed issues that usually affect the watershed residents more than any other users of a watershed. These Roundtables have been in existence in British Columbia for quite sometime with the Salmon River Watershed Roundtable being formed in 1991.

Operational funding for the Horsefly River Watershed Roundtable has been provided by the Fraser Salmon and Watersheds Program jointly managed by the Pacific Salmon Foundation and the Fraser basin Council. This core funding has allowed the Roundtable to operate for two years now and has provided an opportunity to attract additional funding for interpretive trail enhancement along the river in the community. The Roundtable has also applied to Fisheries and Oceans Canada for access to their land adjacent to the sockeye spawning channel for utilization as a campground

1.2 Watershed Based Fish Sustainability Plans

Cariboo Envirotech Ltd. described in detail in an earlier report on the Horsefly River Watershed the origination of Watershed Based Fish Sustainability Planning (WFSP) (Cariboo Envirotech Ltd.). The process was designed by federal and provincial regulators to ensure long term conservation of fish and fish habitat. It was recognized that including the public as well as other interested parties engaged in a watershed would provide a beneficial and more effective outcome. The establishment of Watershed Roundtables has become an effective forum for this undertaking.

A process Guidebook has been provided and details four stages of planning as follows (WFSP):

- **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.

1.3 The State of the Watershed Report

The genesis for this "State of the Watershed" report was derived from a Horsefly River Roundtable Technical Committee meeting that was scheduled on November 20th 2008. The meeting's focus centered on ways and means to proceed from Stage II to Stage III of the Watershed Based Fish Sustainability Planning Guidebook.

Recognizing that the Guidebook was simply that, the Technical Committee members in attendance that day decided that a State of the Watershed report may be an effective document in tracking fish stock status and the anthropogenic influences on the species residing in the watershed. It was felt that such a document could be revisited in the future for comparative purposes to determine whether or not gains were being made on stock status and that their negative influences were being managed in a positive fashion by regulatory agencies. The sections in this report were determined at that meeting by those in attendance and subsequently added to by Fisheries and Oceans Canada biologist Judy Hillaby, Ministry of Environment biologist Rob Dolighan and by the author.

Additionally, a request from Roundtable members to provide information on independent power production-run of the river projects and kokanee/sockeye interaction with other species has resulted in these two sections being added to the report.

1.4 The Horsefly River Watershed

The Horsefly River watershed is located approximately 75 km southeast of the City of Williams Lake in the Cariboo region of British Columbia and encompasses approximately 286,000 hectares. The river is approximately 98 km in length and drains into Quesnel Lake which in turn feeds the Quesnel River which meets the Fraser River in the community of Quesnel. The watershed is comprised of numerous landscape types and ranges in elevation from approximately 800 metres in the Village of Horsefly to 2500 metres in the headwater area. The watershed has been developed by forestry, agriculture, lodges, mining, trapping, recreational users and individual home owners. The Village of

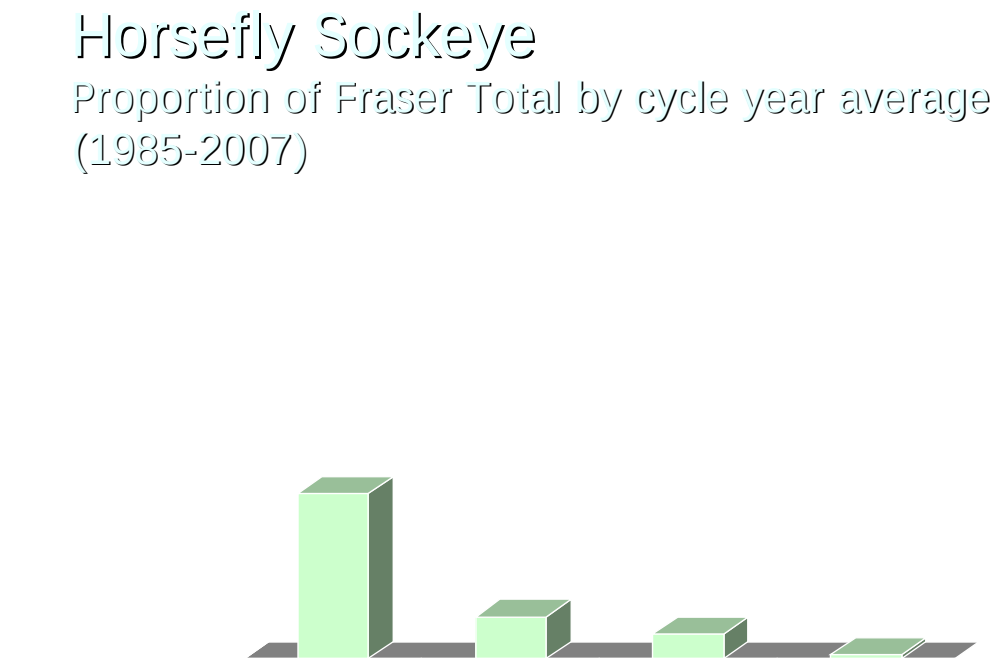
Horsefly is the nearest local centre of commerce and is located immediately adjacent to the river. Anthropogenic influences have affected the watershed for more than 150 years and a Horsefly River Timeline chart prepared by Fisheries and Oceans biologist Judy Hillaby can be viewed in Appendix A showing events and their relationship to salmonids.

From a fisheries perspective the watershed is known for its world famous sport fishery on rainbow trout, and as one of the largest producers of sockeye salmon in the world. Other salmonid species of note in the watershed are coho and Chinook salmon, kokanee, bull and lake trout.

The coho salmon in the watershed are a deme of the Interior Fraser River coho which have been listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and has been recommended for protection under the Species at Risk Act (FOC). Bull trout, while not in danger of extinction in British Columbia, are listed as a species of special concern (MOE).

It is estimated that the Horsefly River produces 75% of the large rainbow trout for the Quesnel Lake sport fishery; a sport fishery that can produce trophy size fish over twenty pounds (Angling Management Plan-Appendix B) Additionally, Horsefly River sockeye salmon during the peak cycle year are an important contributor to the overall Fraser River catch as can be seen in the figure below:

Figure 2: Horsefly Sockeye Proportion of Fraser Total by Cycle year Average.



(Benner)

The challenge in managing fish stocks in the watershed is balancing the economic and societal needs with environmental needs that ensure the long term conservation and enhancement of fish and fish habitat.

2.0 Up to Date Fish Stock Status and Trends over Time:

2.1 Sockeye Salmon

The Horsefly River sockeye salmon stock is one of the most important salmon runs in the world and as such escapement enumeration has been ongoing for decades. The sockeye return to the Horsefly River on a four year cycle with a dominant year (2005, 2001, etc.) followed by a sub dominant year (2006, 2002, etc.) followed by a dominant weak year (2003, 1999, etc.) and finally by a weak year (2004, 2000, etc.). Table 1 below provides sockeye escapement data from 1986 to 2008.

Should DFO projections for the summer Quesnel stock be accurate at an estimate of 3,575,000 (50% probability level), this would show an increasing trend in sockeye stocks for the Horsefly River for the upcoming 2009 dominant year of the cycle.

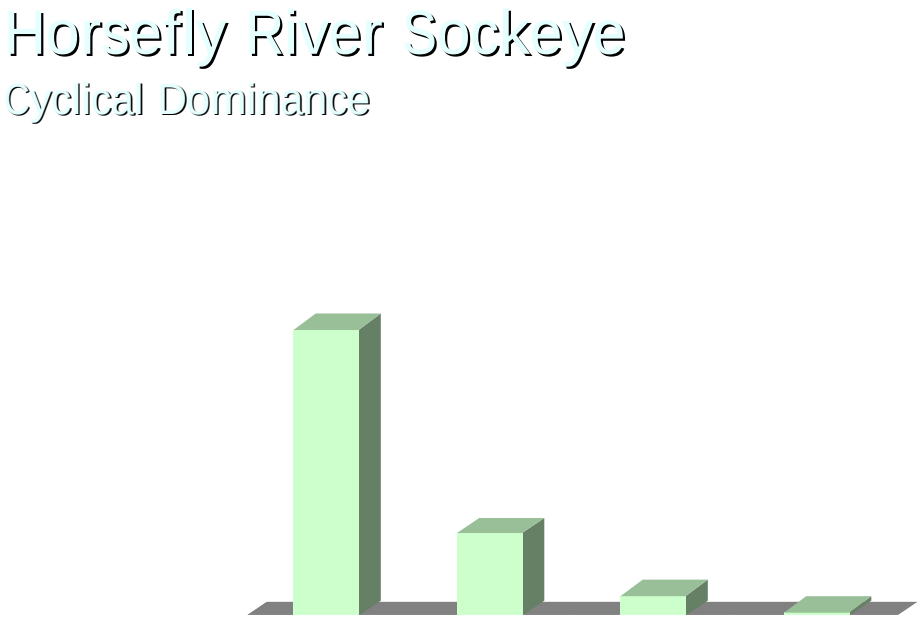
Table 1: Escapements of Sockeye for Horsefly and Fraser Rivers.

Escapement Year	Horsefly Watershed Sockeye	All Summer Run Sockeye	All Fraser River Sockeye
2006	133,000	N/A	N/A
2005	**800,100**	**N/A**	**N/A**
2004	4,500	N/A	N/A
2003	182,300	N/A	N/A
2002	No data	3,804,400	10,201,000
2001	**2,084,100**	**4,683,000**	**5,256,000**
2000	36,600	1,650,000	2,353,000
1999	139,400	1,282,000	1,831,000
1998	843,900	2,381,000	4,419,000
1997	**1,191,900**	**3,807,000**	**4,252,000**
1996	34,200	1,413,000	2,061,000
1995	178,900	926,000	1,731,000
1994	549,900	1,352,000	3,129,999
1993	**1,837,100**	**5,072,000**	**6,202,000**
1992	5,900	635,000	1,069,000
1991	38,600	1,256,000	3,306,000
1990	439,500	1,597,000	6,064,000
1989	**1,614,400**	**2,553,000**	**3,060,000**
1988	5,900	745,000	1,370,000
1987	16,800	659,000	1,896,000
1986	150,386	581,000	3,658,000

The Table 1 information above on Horsefly River sockeye has been provided by Fisheries and Oceans biologist Judy Hillaby and further information on sockeye can be found in Appendix C. Additional information on 2009 forecasts for salmon is provided by Fisheries and Oceans Canada and can be found in Appendix D.

The following Figure 3 provides the reader with a visual sense of the annual differences in escapement between the dominant year and the weakest year of the four year cycle with averages taken from 1985 to 2007.

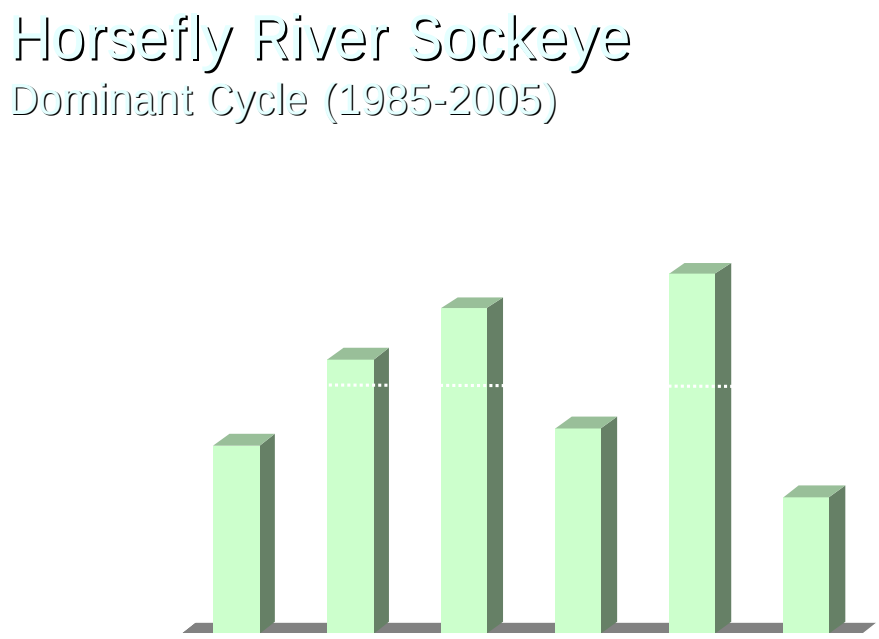
Figure 3: Horsefly River Sockeye Cyclical Dominance.



(Benner)

As we await the dominant cycle year returns of 2009, the following Figure 4 shows the trend since 1985 with an average return of 1.45 million spawners.

Figure 4: Horsefly River Sockeye Dominant Cycle (1985-2005).



(Benner)

2.2 Chinook Salmon

It can be stated that based on data since 1991 when they Chinook escapement was estimated to be 500, Chinook salmon in the Horsefly River are, in recent years, in decline. Table 2 below provides information on Chinook escapements to the Horsefly and Quesnel Rivers as well as spring and summer run Chinook estimates for five year old Chinook in the Fraser River.

The 2009 DFO Salmon Stock Outlook lists upper and mid Fraser River Chinook stocks as a "stock of concern". The Horsefly River Chinook fall into this group suggesting a downward trend.

Table 2: Escapements of Chinook salmon to the Horsefly and Quesnel Rivers.

Year	Horsefly Chinook	All Spring Run 5-2 Chinook	Quesnel Chinook	All Spring Run 5-2 Chinook
2008	98	N/A	3,235	N/A
2007	51	N/A	3,356	N/A
2006	345	N/A	5,265	N/A
2005	509	N/A	5,467	N/A
2004	375	32,325	2,943	30,546

Year	Horsefly Chinook	All Spring Run 5-2 Chinook	Quesnel Chinook	All Spring Run 5-2 Chinook
2003	246	47,106	1,718	41,699
2002	380	41,589	1,620	31,522
2001	281	31,521	4,906	33,560
2000	174	26,761	3,185	21,739
1999	137	20,740	3,100	24,847
1998	43	37,862	3,073	35,388
1997	115	44,373	1,549	40,622
1996	400	38,398	5,028	42,430
1995	185	44,975	3,375	26,241
1994	4154	51,290	4,400	23,337
1993	200	32,481	6,195	21,285
1992	400	33,449	3,000	37,761
1991	500	27,177	6,300	28,003

The Table 2 information above on Horsefly River Chinook has been provided by Fisheries and Oceans biologist Judy Hillaby and further information can be found in Appendix E. Additional information on 2009 forecasts for Chinook salmon is provided by Fisheries and Oceans Canada and can be found in Appendix D.

2.3 Coho Salmon

Coho salmon are found in numerous tributaries of the Horsefly River as well as the mainstem. The Northern Shuswap Tribal Council has been operating a coho counting fence on McKinley Creek on behalf of Fisheries and Oceans Canada since 1998. This tributary of the Horsefly River serves as an "indicator" stream to provide data that can be interpreted to reflect the stock status in other Interior Fraser River coho streams. Table 3 below provides coho escapement information for the Horsefly River and McKinley Creek from 1998 to 2008. No definitive trend can be seen in the limited data below for the Horsefly River, however of important note is the large escapement into McKinley Creek in 2007 and a possible trend upwards of that stock.

The 2009 DFO Salmon Stock Outlook lists upper and mid Fraser River coho stocks as a "stock of concern".

Table 3: Annual Coho Escapements for the Horsefly River and McKinley Creek Populations.

Return Year	Horsefly River	McKinley Creek
1998	185	790
1999	400	212
2000	638	223
2001	597	1,989
2002	525	1,453
2003	18	642

Return Year	Horsefly River	McKinley Creek
2004	678	1,523
2005	107	498
2006	40	273
2007	367	5,050
2008	27	391

The Table 3 information above on Horsefly River coho has been provided by Fisheries and Oceans biologist Judy Hillaby and further information can be found in Appendix F. Additional information on 2009 forecasts for salmon is provided by Fisheries and Oceans Canada and can be found in Appendix D.

2.4 Rainbow Trout

The large species of rainbow trout found in the Horsefly River are primarily Quesnel Lake stock that utilize the river for spawning and rearing opportunities. These trout are late maturing for spawning and can grow to 9 kg. in weight and are likened to the famous Gerrard rainbow trout found in Kootenay Lake.

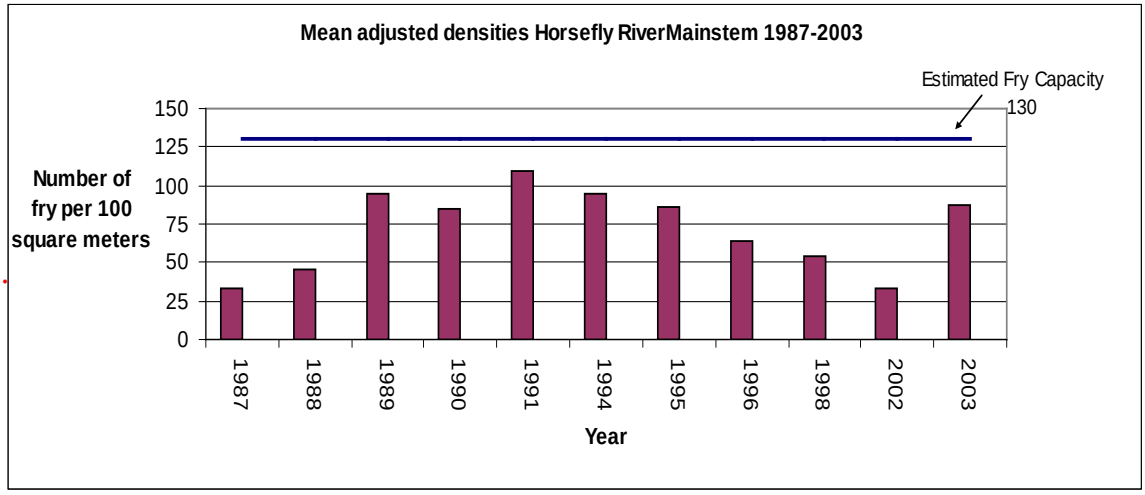
For many years anglers on Quesnel Lake noted a decline in catch of these large rainbow trout and it was thought that this decline may have been in part precipitated by the decline in the kokanee population of which these rainbow trout rely heavily on for food. In turn, the downward trend in the kokanee population may have been caused by increased escapement of sockeye salmon into the Quesnel system. This can be confirmed by referring to the attached 2003 Stock Management Report No. 17 found in Appendix G that states that sockeye dominant returns to the Quesnel Lake drainage have nearly doubled from 1.9 million fish in 1989 to 3.6 million fish in 2001 and have increased by 32 fold since the early 1950s.

This important document summarizes the relationships and status of rainbow trout, kokanee and sockeye salmon within Quesnel Lake. In concluding the findings, the report confirms that the Horsefly River is the most important rearing and spawning tributary of this Quesnel Lake stock. Additionally the report confirmed that kokanee were the most important contributor to the rainbow trout diet. The population estimate of spawners determined in this study was estimated to be between 500 – 1000 from the Horsefly system, with the Mitchell River providing half as many again.

Currently the rainbow trout population in the Horsefly River generally remains unchanged from the 2003 report. A new report is scheduled to be released later in 2009 however BC Provincial lake biologist and Technical Committee member has provided an interim overview of the rainbow trout status for this report. Rob states "*Direct enumeration of rainbow spawners was first conducted on McKinley Creek in 2002 as part of a previous study and has been carried out annually until spring, 2006. This project has employed a Logie electronic fish counter which uses resistivity to count and size migrating fish and a "target activated" video system to record events and provide size calibration and species validation. In spring 2006, estimations of total rainbow trout*

spawners in the Horsefly River, was carried out using a combination of radio telemetry and the resistivity counter technology. Annual reports of this project have been produced each year and are currently being synthesized into the new report which examines complex issues related to counter efficiencies and includes the development of a standardized population index model which will have application for other areas of the province. Important spawning areas for Quesnel Lake rainbow trout include the Horsefly main stem, Moffat Creek and McKinley Creek. Annual escapements have ranged between 300 and 900 fish. An additional complimentary index of rainbow trout stock productivity has been undertaken through the analysis and reporting on the trends in juvenile trout abundance in the primary juvenile rearing habitat. As indicated below densities have always been lower than the projected carrying capacity and have cycled through valleys and peaks resulting from mainly alterations to harvesting strategies".

Figure 5: Mean adjusted densities Horsefly River Mainstem 1987-2003



2.5 Stream Type Kokanee

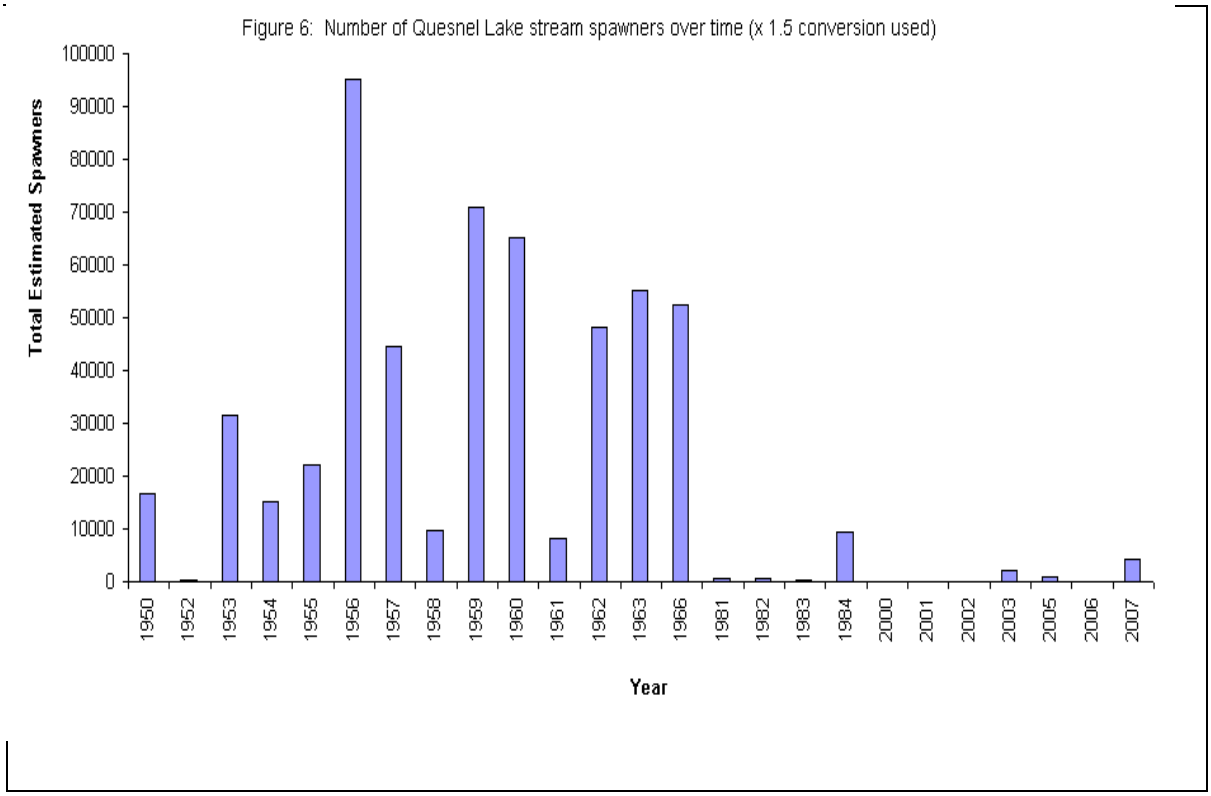
The 2003 Stock Management Report described in section 2.4 above states that stream spawning kokanee can be found in the lower reaches of the Horsefly and Little Horsefly Rivers. Historically stream spawners were thought to number between 50,000 to 100,000 adults from the 1950s to the 1980s, although the data is considered to be limited.

The 2003 document went on to state that the stream population in these areas has virtually disappeared over the past two decades and the contribution to Quesnel Lake is minimal. The Quesnel Lake kokanee population is now primarily propagated by shoal spawners and there is no information or data to indicate that this stock's abundance has changed.

For the purpose of this report, BC Provincial lake biologist Rob Dolighan has provided interim information on kokanee fry densities in Quesnel Lake from 1991 to 2008 in the figure below. Of note is the sight increase in 2008. Mr. Dolighan went on to state that

"*Horsefly River stream spawning populations are at such low density they remain undetectable"* (Dolighan).

Figure 6: Number of Quesnel Lake stream spawners over time (1.5 conversion used)



3.0 Fisheries Enhancement and Monitoring

Numerous initiatives have been undertaken in the Horsefly River watershed attempting to enhance anadromous and non anadromous fish residing in the drainage. The following is a list and brief description of some of these undertakings prefaced by some watershed history:

3.1 Historic Perspective

One of the earliest recorded assessments of sockeye salmon came in 1909 when it was estimated that over 4 million sockeye migrated into the Quesnel system and prior to that it was estimated that escapements totaled as many as 10 million spawners (Roos). Anthropogenic influences such as a dam constructed for mining purposes at the outlet of Quesnel Lake began to take their toll on this large sockeye run. During 1898 and 1899 no salmon were allowed through the dam and a small 11 by 10 inch fishway was installed in 1901 to allow for fish passage (Roos). Additionally, a large placer mining operation a few miles downstream of the Quesnel Lake outlet called the Bullion Pit may have had an adverse affect on fish and fish habitat in the area. It has been estimated that more than

12,000,000 cubic yards of earth had been hydraulically mined from the Bullion operation and deposited in the Quesnel River prior to 1905. This type of mining activity was common throughout the area including the Horsefly River itself.

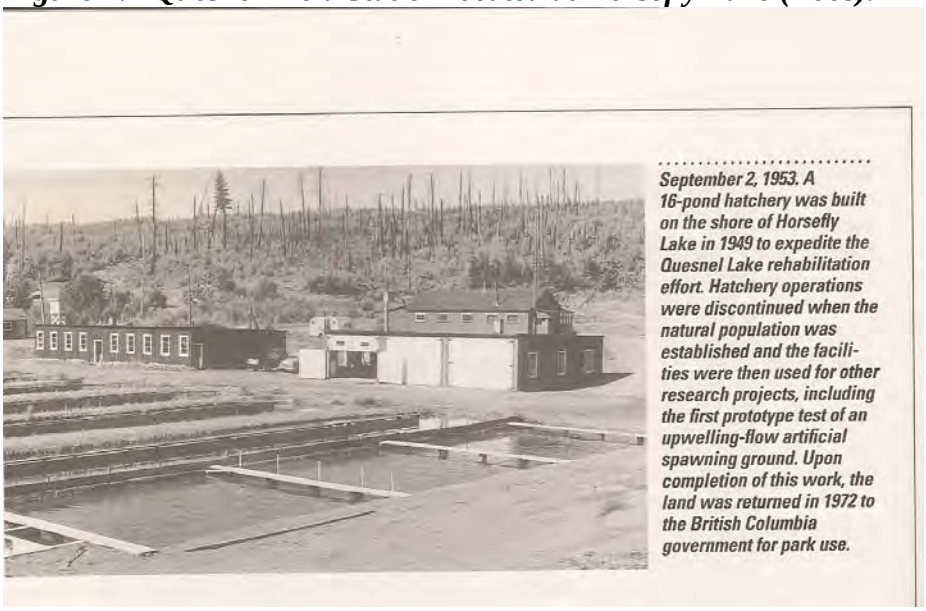
Over time in the early to mid 20th century the Pacific Salmon Commission recognized the value of the Horsefly River run and through cooperation with the United States government and implementation of stricter laws, the salmon runs came under greater protection from industrial influences. However in addition to these challenges, natural process was at times having a negative affect on this salmon stock. It was determined that pre spawning losses in the Horsefly River from the myxobacterium *Chondrococcus columnaris* in 1953 was approximately 30%, in 1961 it was 62%, and in 1965 it was 47%. This disease outbreak is complicated by warmer water temperatures and as a result of these outbreaks the McKinley Dam and siphon was planned and constructed in 1969 (Section 3.4).

3.2 Sockeye Hatchery

This enhancement facility known as the Quesnel Field Station was constructed by the Pacific Salmon Commission in 1949 adjacent to Horsefly Lake (Figures 7 and 8). Its primary purpose was to rehabilitate sockeye from the Horsefly River and to determine if it could enhance previously productive rivers in the Province of British Columbia.

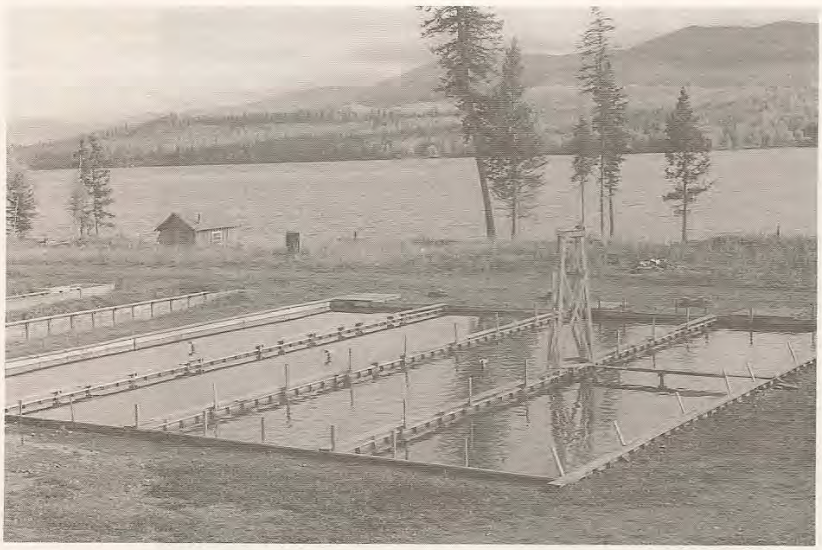
In addition, the Commission undertook studies at the facility relating to gravel size, dissolved oxygen, percolation flow, water temperature, and other in-gravel conditions on survival of incubating gametes. The transplants and local enhancements were met with limited success with the best results coming from the Horsefly River when 218 adult sockeye returned in 1953 from an original release of 94,000 fingerlings (Roos).

Figure 7: Quesnel Field Station located at Horsefly Lake (Roos).



September 2, 1953. A 16-pond hatchery was built on the shore of Horsefly Lake in 1949 to expedite the Quesnel Lake rehabilitation effort. Hatchery operations were discontinued when the natural population was established and the facilities were then used for other research projects, including the first prototype test of an upwelling-flow artificial spawning ground. Upon completion of this work, the land was returned in 1972 to the British Columbia government for park use.

Figure 8: Rearing ponds at Quesnel Field Station (Roos).



September 30, 1956. In an effort to develop a method of increasing egg-fry survival rates in northern areas, an experimental upwelling-flow spawning area was built at the Quesnel Field Station in 1955. Adult sockeye spawned very successfully in the upwelling flow. Egg-fry survivals of up to 68% were obtained from natural spawning and from manual planting of eggs.

Upwelling flow was obtained by covering perforated 1-inch diameter pipes with a 14-inch layer of gravel from which the fines had been removed. The water supply was obtained by pumping from Horsefly Lake, using three intake depths for temperature control - 3.5, 50 and 82 ft.

3.3 Sockeye Airlift

During the peak cycle year 1985 of returning sockeye, it was decided that due to an abundance of spawners, a helicopter airlift of adult sockeye would transfer live fish upstream above the Horsefly Falls to spawn. The Horsefly River upstream of these falls provided an abundance of spawning gravel and would prevent late arriving sockeye from spawning on redds established by earlier arrivals.

The airlift involved the seine netting of adult sockeye at the confluence of McKinley Creek and the Horsefly River by staff from the DFO Quesnel River Hatchery, and the

subsequent transfer upstream of 32,000 adult sockeye to spawning habitat above the falls utilizing a "monsoon bucket" equipped with aerators.

3.4 McKinley Siphon

The DFO McKinley Dam and Flow Control Structure was built in 1969 after concerns were raised about large adult sockeye losses in the system in 1953 as a result of the myxobacterium *Chondrococcus columnaris*, a disease enhanced by high water temperatures.

The dam and flow control structure is designed to withdraw cold water through a pipeline siphon from the bottom of McKinley Lake and mix this water with surface water at the dam for release into McKinley Creek. Storage of cold water occurs during freshet for release during peak sockeye migration into the creek during August and September. The dam continues to be operated by Fisheries and Oceans Canada and includes a fishway designed within the structure to allow for fish migration. Upstream and downstream views of the dam are provided below.

Figure 9: Upstream view of McKinley Dam with fishway on the right. Water storage occurring in May 2008.

Figure 10: Downstream view of McKinley Dam in May 2008.

3.5 Sockeye Spawning Channel

The DFO Horsefly River Sockeye Spawning Channel (Figure 7) was built in 1989 and designed to enhance sockeye stocks from the river. It is located in the Village of Horsefly and can provide spawning access to approximately 23,000 adults. The channel provides optimum flows and a safe haven from flood events that may occur naturally in the river and disturb incubating eggs in the gravel. Additionally a fixed number of females (12,500) are allowed access into the channel based on available spawning area to prevent overcrowding and females digging up previously constructed redds.

The channel is utilized on an as needed basis and when funding permits. It generally does not operate on the peak year of the sockeye cycle as it is felt that the river can provide spawning opportunity for the maximum number required by Fisheries and Oceans Canada. This number is based on the carrying capacity of Quesnel Lake where sockeye reside for a year prior to migrating downstream to the ocean. It has been established that there is no increase in fry numbers above escapements of 0.85 to 1.06 million effective female spawners (EFS) (Hume).

The channel has unfortunately been constructed downstream of the outlet of Moffat Creek which delivers an abundance of sediment during freshet. Additionally, the channel has very little slope and as a result it accumulates silt when operational. This necessitates a gravel cleaning program in the summer prior to operation to give sockeye optimum

gravel conditions for spawning. Indeed, since its initial construction, the entire gravel substrate was removed and cleaned with a wash plant. The summer gravel cleaning program utilizes a cat with a tined blade to scour the substrate with high flows for 10-14 days with the resultant silty water pumped into a settling basin adjacent to the channel.

Figure 11: Upstream view of the spawning channel showing the valve house.

3.6 Quesnel River Hatchery

The construction of the DFO Quesnel River Hatchery located approximately 2 kilometres downstream of the outlet of Quesnel Lake was completed in 1981. Designed as a satellite Chinook hatchery it produced approximately 2 million Chinook fry and smolts on an annual basis enhancing stocks from numerous rivers throughout the mid and upper Fraser River. In addition to Chinook, the facility also raised coho salmon and on occasion raised rainbow trout on behalf of the BC Ministry of Environment.

The facility undertook Chinook egg collection of McKinley Creek and Horsefly River stock during the 1980s. This was accomplished by gill netting females off the redds and if ripe, stripping the eggs and expressing milt from males with the gametes being mixed and incubated at the facility in Likely. Subsequently, the resultant offspring were trucked back to their natal streams the following year as fed-fry. Additionally coho were captured in McKinley Creek through the use of a broomstick fence. Similarly, the gametes were mixed at the hatchery in Likely and the coho fry released back into the creek the following spring.

As a result of government downsizing in the early 1990s the Quesnel River Hatchery was closed in 1995 for large production. It carried on as a public involvement facility until the University of Northern British Columbia acquired the facility in 2002 for use as part of their Landscape Ecology research program and to this day functions as such. More information on this facility and its research can be provided by their website at: www.unbc.ca/qrrc

3.7 The Land Conservancy – Horsefly River

The Land Conservancy of British Columbia (TLC) is a non-profit organization dedicated to protecting important habitat for plants, animals and natural communities as well as properties with historical, cultural, scientific, scenic or compatible recreational value (The Land Conservancy).

The Horsefly River Riparian Conservation Area (HRRCA) is an assemblage of 7 properties totaling almost 400 ha along the Horsefly River. TLC purchased these 7 properties from local ranching operations and a local resident between 1999-2006 to protect and enhance low elevation, flood plain riparian habitat that has been lost throughout in BC. One of the main reasons for this acquisition is the fact that portions of the property represent prime sockeye salmon spawning habitat. Portions are also used for spawning and rearing by rainbow trout, Chinook and Coho salmon. This broad riparian valley bottom (up to 800 m in places) is also home to a wide range of songbirds, waterfowl, wading birds. The area is known for its high density of grizzly and black bears which gather to feed on spawning sockeye in the fall. It is also exceptional moose winter habitat.

TLC and its partners have engaged in the restoration of various parts of the HRRCA to ameliorate past land management practices (clearing land for the establishment of hay fields and pastures). Restoration activities are designed to help restore and enhance riparian habitat and ecosystem processes that will benefit a number of aquatic and terrestrial species. The area has undergone a significant amount of bioengineering, riparian plantings, constructed off channel rearing habitat, and provided artificial nesting habitat for ospreys and woodpeckers. Efforts have also been made to reconnect the main stem of the Horsefly to large portions of flood plain habitat that was cut off from the main stem by containment dykes. This has had a number of benefits including reducing downstream flooding, eliminating fish stranding issues, and providing additional rearing habitat for salmon. While restoration of a large portion of this 380 ha has taken place, ~30% of the land is in active agriculture through long term leases with adjacent ranches for hay production and spring calving.

The HRRCA is currently managed by TLC under the guidance of an ad hoc management committee made up of DFO, MOE and interested community members. Continued enhancement of the aquatic and terrestrial habitats are proposed and a management plan was developed in February of 2007 to address identified concerns in this important land reserve (Booth). This report also provides a synopsis of conservation initiatives on the HRRCA and other locations within the watershed. Appendix H provides the reader with

an aerial overview of the HRRCA, and the Management Plan can be found in Appendix I.

3.8 Creel Surveys

In an effort to assess angling pressure and fishermen satisfaction on valuable sport fisheries such as the Horsefly River rainbow trout fishery, creel surveys are undertaken every few years to collect data. A creel survey randomly interviews fishermen about such things as place of residence, how long they have been fishing, number of fish caught, amount of time fishing and whether or not the fishing is better or worse than previous visits. Appendix J provides the reader with creel surveys on the Horsefly River for 2008, 2005, and 2001.

The creel survey information plays a very important role in providing the Ministry of Environment biologists with data to prepare management plans such as the Horsefly River Angling Management Plan last released on January 30th, 2006. The management plan can be reviewed in Appendix B and includes rationale on the river's regulations, allocation of guide days, and conservation efforts such as planned closures during the warm summer months that have historically affected the sport fishery in a negative way.

3.9 Aerial Flights

To assess angling pressure on the many lakes in the watershed, annual aerial surveys of selected lakes is undertaken by the BC Ministry of Environment. This information may be complimented by creel surveys and gill net inventories and provides the Ministry with management data that can be peer reviewed and is standardized province wide. The data is assessed and the results analyzed for informed regional lake stocking decisions to be made on sport fishing opportunities on lakes in the area.

3.10 Small Lakes Stocking

The Freshwater Fishing Society of British Columbia is a non profit organization that works closely with the Province of BC to provide fish stocking programs on lakes and streams throughout the province. Stocking requests from Cariboo provincial fisheries biologists are assessed and provision of fish is undertaken from several hatcheries in the province in the spring and summer months. Proposed for spring stocking in 2009 is Hen Ingram Lake located northeast of Horsefly which is scheduled to receive 3000 rainbow trout yearlings of Blackwater origin (FFSBC). Additional information on historical fish stocking from 2003 to 2007 in the Horsefly drainage can be reviewed in Appendix K where the Cariboo Region summary can be found.

4.0 Population Assessment Structures

Both the Provincial Ministry of Environment and Fisheries and Oceans Canada have developed structures to assist in the enumeration of fish species in the Horsefly River

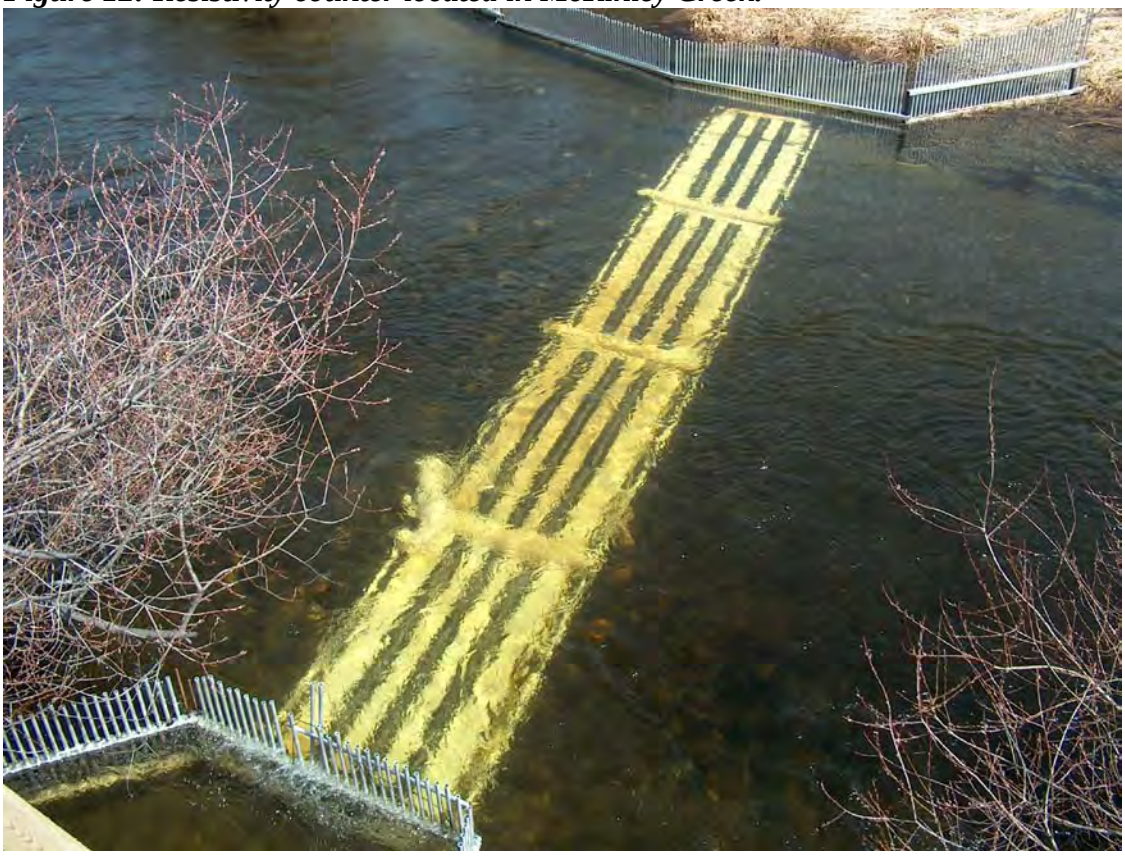
watershed. The following four structures have been effective tools in determining population estimates as well as migration patterns and timing.

4.1 Mckinley Creek Resistivity Counter

A resistivity counter is a counting device installed in the stream bed and is comprised of a group of three electrodes that fish swim over. The fish is more conductive than water and when it swims over the electrodes, a change in resistance occurs. Analytical and recording equipment quickly determines if the change in resistance is fish typical and records time of migration, direction and size. Resistivity counters work well in tandem with underwater cameras which are activated during fish passage and can confirm results.

A resistivity counter and underwater camera have been used in McKinley Creek to assess spawning rainbow trout populations by the Williams Lake Ministry of Environment Fisheries Branch. Figure 12 below shows the layout of the resistivity counter used in McKinley Creek. Figure 13 below shows a rainbow trout being photographed after triggering the camera.

Figure 12: Resistivity counter located in McKinley Creek.



(Photo courtesy of R Dolighan)

Figure 13: Rainbow trout photographed at McKinley Creek resistivity counter.

(Photo courtesy of R Dolighan)

4.2 Mckinley Creek Coho Fence

The McKinley Creek coho fence was first installed at the mouth of the creek by staff from the DFO Quesnel River Hatchery during the mid 1980s to capture brood stock for enhancement purposes. Since 1998, the Northern Shuswap Tribal Council has operated the fence approximately 0.5 km upstream at the old Pacific Salmon Commission site.

The fence is operated during the autumnal migration of Interior Fraser River coho and is utilized to provide "indicator" stock information to Fisheries and Oceans Canada. While not feasible to assess all Interior coho streams, this information collected is critical in making assumptions on all streams known to have coho. Figure 14 below shows the McKinley Creek coho fence being cleaned by staff from the Northern Shuswap Tribal Council.

Figure 14: McKinley Creek coho fence.

(Photo courtesy of G Sterritt)

Complimenting this counting fence in recent years is an annual BC Forest Investment Account funded project managed by Tolko Industries Ltd. of Williams Lake. This project assesses numerous known coho streams on Quesnel Lake by foot and by helicopter and provides additional data for comparative purposes (Cariboo Envirotech Ltd. 2007).

4.3 Horsefly River Didson Counter

A DIDSON (Dual-frequency IDentification SONar) Counter is an effective tool for fisheries managers in assessing fish migration. The system utilizes high resolution imaging acoustics and can be used in a variety of applications including rivers as large as the Horsefly.

Fisheries and Oceans Canada installed a DIDSON counter in the Horsefly River from August 6 to October 9 during the last dominant year (2005) of the sockeye salmon cycle. This counter installation was the first attempt by the Department in the Province of British Columbia to operationally assess adult sockeye salmon migration. The results showed that the counter is unbiased and as accurate as a counting fence often used for such assessments (Cronkite). Figure 15 below provides an aerial view of the sockeye fence and DIDSON counter on the lower Horsefly River in 2005.

Figure 15: Sockeye fence and DIDSON counter on the lower Horsefly River.

(Photo courtesy of R Dolighan)

4.4 Sockeye Spawning Channel Fence

Fisheries and Oceans Canada opened a sockeye spawning channel in the Village of Horsefly in 1989. Part of this operation includes a diversion fence in the Horsefly River

that denies upstream access to sockeye but encourages them to enter the channel located immediately adjacent to the diversion fence (Figure 16).

Figure 16: Sockeye diversion fence on the Horsefly River allowing fish passage.

While not often utilized as an enumeration device, it has been used as such occasionally to monitor upstream migration. The fence was also instrumental in supporting a pilot project in 2001 to capture approximately 1700 sockeye to be used to assess quality of a smoked and canned product. More information on this study can be sourced directly from the Northern Shuswap Tribal Council who undertook this initiative.

5.0 Use of Fisheries Resource

5.1 Freshwater Sport Fishery

The freshwater sport fishery of Horsefly River fish stocks includes the world famous rainbow trout fishery in the river itself, as well as the freshwater salmon fishery of stocks of this origin on their upstream migration through the Fraser and Quesnel Rivers.

The Horsefly River sport fishery is primarily designed for rainbow trout and is based on the Horsefly River Angling Management Plan (Appendix B) and the annual BC Provincial fishing regulations. The rainbow trout angling in the river is known to be one of the best in the world and these trophy sized Quesnel Lake trout utilize the river for spawning and rearing.

It has been estimated that this fishery has an economic value now measured in the millions of dollars (Rob Dolighan pers. comm.) The fishery is catch and release for trout and char and fish are to be angled by fly only as there is a bait ban on the river. The river is also classified as Class II and as such a classified waters license must be purchased in addition to the regular angling license.

The Fraser River salmon sport fishery intercepts stocks of Horsefly River origin in tidal and non tidal waters. Regulations that govern this fishery are provided by Fisheries and Oceans Canada and are in place to compliment the BC Freshwater Fishing regulations. The value of the Horsefly River contribution to this fishery, that includes sockeye, could easily be measured in the millions of dollars especially during the dominant and sub-dominant years of the Horsefly River run when the Horsefly portion of the Fraser River escapement is 39% and 10% respectively. The Fraser River in stream sockeye fishery has become very popular and has increased in catch from 10,000 to as high as 150,000 in a very short period of time (Kristianson and Strongitharm).

The Quesnel River salmon sport fishery to date has been provided for Chinook only, however subject to run size, a sockeye sport fishery may open on the Quesnel River and Lake in 2009. The determination of an opening is reviewed annually during the summer migration based on in stream estimates of escapement. The openings are usually announced in newspapers, radio, and posted locally on bulletin boards. The chinook opening in 2007 allowed for fishing in the Quesnel River downstream of Poquette Creek from July 15th to September 1st. For Chinook, there is an annual catch limit of 10 in all fresh waters with a limit of 4 per day of which 2 can be over 50 cm and 2 must be between 30-50 cm. This chinook fishery is considered to be quite small, of low economic value and its impact on the resource is limited. A non-tidal salmon tag is required to be purchased along with the regular angling license.

5.2 Ocean Salmon Sport Fishery

The west coast sport fishery for salmon is world renowned and a large economic generator for resorts, lodges and guides living along the Pacific coast of British Columbia. Angler costs include licensing, gear, travel including air, water and land, accommodation, meals, boat rentals, marina costs, and guides. All of this financial bounty remains primarily in the local area of service.

On October 24, 2005 (last dominant year of the sockeye cycle in the Horsefly) the Sport Fishing Institute of British Columbia made a presentation to the Senate Fisheries Committee in Ottawa. This document is provided in Appendix L and was presented to alert Fisheries and Oceans decision makers that the sport fishing industry is the dominant sector with respect to contribution to the economy.

Some highlights of the sport fishery's presentation are as follows:

- Approximately $550 million was spent in the industry with $400 million used for boats, motors, tackle, accommodation, 120 million for lodges and $30 million for charters.

- The tidal sport fishing industry in 2005 generated approximately $625 million annually with over 2 million angler days recorded in salt water.

- The industry created 7,240 jobs (3,590 person years of employment with 2,470 person years dedicated for boat, motor, tackle and accommodation services, 820 person years dedicated to lodge employment, and 300 person years dedicated to chartering.

- The average angler spends $262 per angler-day with minimal impact on fish stocks:
    - $780 angler-day average for lodges
    - $510 angler-day average for charters
    - $190 angler-day for independents
    - More than 330,000 tidal angling licenses sold

The Institute's presentation went on to state that a 2000 DFO National Recreational Sport Fishery survey that the Barclay Sound Recreational Sport Fishery (communities of Bamfield, Ucluelet, Port Alberni) generated $70,000,000. Of this total it was determined that each fisherman spent $178 to $816 per day, with an average of $256 spent per angler-day.

Additionally the presentation stated that in 2000 each fish (245,800 total) caught in the sport fishery in the Alberni-Clayoquot Region was worth $113.91 to $284.78, and that some selected lodges in the Queen Charlotte Islands valued each fish at more than $1000 in sport fishing value.

Compared to the value of the commercial fishery discussed below, a strong case can be made that the sport fishery is a far greater economic generator utilizing far less of the resource than the commercial fishery

5.3 Commercial Salmon Fishery

The wholesale value of the wild salmon fishery off the west coast of British Columbia was estimated to be approximately $189.7 million in 2007. Table 4 below provides the reader with data from 1998 to 2007 (Province of British Columbia[2]).

Table 4: B.C. Capture Salmon Wholesale Value ($millions) 1998 - 2007										
Species	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Chinook	9.2	6.6	5.3	5.1	11.8	17.3	26.9	24.9	29.1	26.2
Chum	57.2	41.2	34.5	26.6	40.4	45.6	46.8	54.1	50.7	30.4
Coho	6.5	5.8	8.9	5.0	8.1	14.2	19.3	24.0	21.5	23.6
Pink	58.7	53.2	36.5	43.3	32.1	33.3	22.9	46.9	8.5	43.2
Sockeye	76.0	63.1	113.1	77.7	103.5	75.2	100.8	67.5	113.6	65.6
Total[1]	**208.3**	**170.5**	**199.8**	**161.9**	**198.6**	**188.4**	**220.1**	**218.6**	**224.7**	**189.7**

1. The total wholesale value of wild salmon includes the value of salmon products such as offal, meal and oil which cannot be identified by species.

Updated: August 13, 2008

In an effort to determine a very rough estimate of the Horsefly River contribution value of sockeye to the commercial fishery an estimate of the wholesale value of each sockeye must be made. In 2007, the commercial sockeye catch from seine, gillnet and troll fisheries was 643,510 pieces (FOC[2]) making the wholesale value of each sockeye to be approximately $102 based on the $65.6 million dollar value of sockeye shown in table 4 above.

The FOC 2009 Salmon Stock Outlook available in Appendix D shows the 50% probability level return forecast for Quesnel sockeye to be 3,575,000. Of this total, one can assume that 73.4% are from the Horsefly River. This is based on an average of the Horsefly contribution of 5 dominant cycle years from 1985 to 2001 (Benner). If effective female spawners (EFS) for Quesnel Lake is 900,000 (Dolighan), one can assume that an escapement of approximately 2 million sockeye may be allowed leaving 1,575,000 for First Nations, commercial and sport fishing. Of this total, 73.4% or 1,156,050 could be the Horsefly River contribution to these three fisheries. If we assume the commercial fishery has access to only half of this total, it would still have a wholesale value of approximately $59 million dollars (based on 2007 wholesale values).

5.4 First Nation Salmon Fishery

First Nations throughout British Columbia have access to west coast fish for food, ceremonial and cultural purposes. Horsefly River stocks of salmon are fished not only by First Nations on the ocean and in the estuary, but by First Nations along the Fraser River since time immemorial. The upcoming peak cycle year 2009 of the Horsefly River sockeye run will provide First Nations with an opportunity to once again acquire fish that their culture has historically relied upon.

For future comparative purposes, Table 5 below shows the harvest levels in the mid and upper Fraser River of the First Nations food fishery for sockeye during the last peak cycle

year of 2005. Additional fisheries will occur in the lower Fraser River and other rivers and tributaries throughout the Province for sockeye and other species.

Table 5: 2005 First Nations Food Fishery Sockeye Harvest (Post-season)

Week Ending	Sawmill Cr to Texas Cr	Texas Cr to Kelly Cr	Kelly Cr to Deadman Cr	Deadman Cr to Marguerite Ferry to the Blackwater River	Naver Cr to Shelly and Nechako R to Isle Pierre	Total Weekly	Total Cumulative
03-Jul	Closed	Closed	closed	closed	Closed	0	0
10-Jul	Closed	Closed	closed	closed	Closed	0	0
17-Jul	Closed	Closed	closed	closed	Closed	0	0
24-Jul	Closed	Closed	closed	closed	Closed	0	0
31-Jul	Closed	Closed	closed	closed	Closed	0	0
07-Aug	10,384	2,430	299	546	Closed	13,659	13,659
14-Aug	22,945	6,367	317	1,044	123	30,796	44,455
21-Aug	9,396	7,438	293	1,227	229	18,583	63,038
28-Aug	26,304	11,105	247	2,269	517	40,442	103,480
04-Sep	19,514	16,380	305	2,718	884	39,801	143,281
11-Sep	10,541	15,295	373	3,847	1,975	32,031	175,312
18-Sep	1,577	2,629	133	1,086	1,463	6,888	182,200
25-Sep	487	377	N/M	259	329	1,452	183,652
02-Oct	N/M	N/M	N/M	N/M	1,290	1,290	184,942
09-Oct	N/M	N/M	N/M	N/M	102	102	185,044
16-Oct	N/M	N/M	N/M	N/M	N/M	0	185,044
Total	101,148	62,021	1,967	12,996	6,912	185,044	185,044

(FOC[3])

Of particular note and concern to First Nations in the mid and upper Fraser is the lack of sockeye available in the Fraser River, upstream of Deadman Creek for their traditional harvest of primarily Stuart River fish, of which this decline has been ongoing now for years.

To provide the reader with a sense of how the sockeye salmon are allocated within the Fraser River drainage, a 2004 preliminary estimate of distribution for American and Canadian harvesters by sector and escapement estimates is provided in Appendix M. This information is provided by the Pacific Salmon Commission in their annual report for 2004 which was released in 2008 (PSC).

In addition to the existing fisheries, a new program managed by Fisheries and Oceans Canada called Pacific Integrated Commercial Fisheries Initiative (PICFI) is now underway in British Columbia. This program is designed to purchase salt water salmon licenses from commercial fisherman and encourage freshwater commercial fisheries during spawning migration (PICFI). This instream fishery can provide stock managers with a sustainability tool in addressing openings on stocks that are known to have a surplus as enumeration of spawners in rivers can be far more accurate than ocean assessments.

6.0 Horsefly River Kokanee-Sockeye Influences

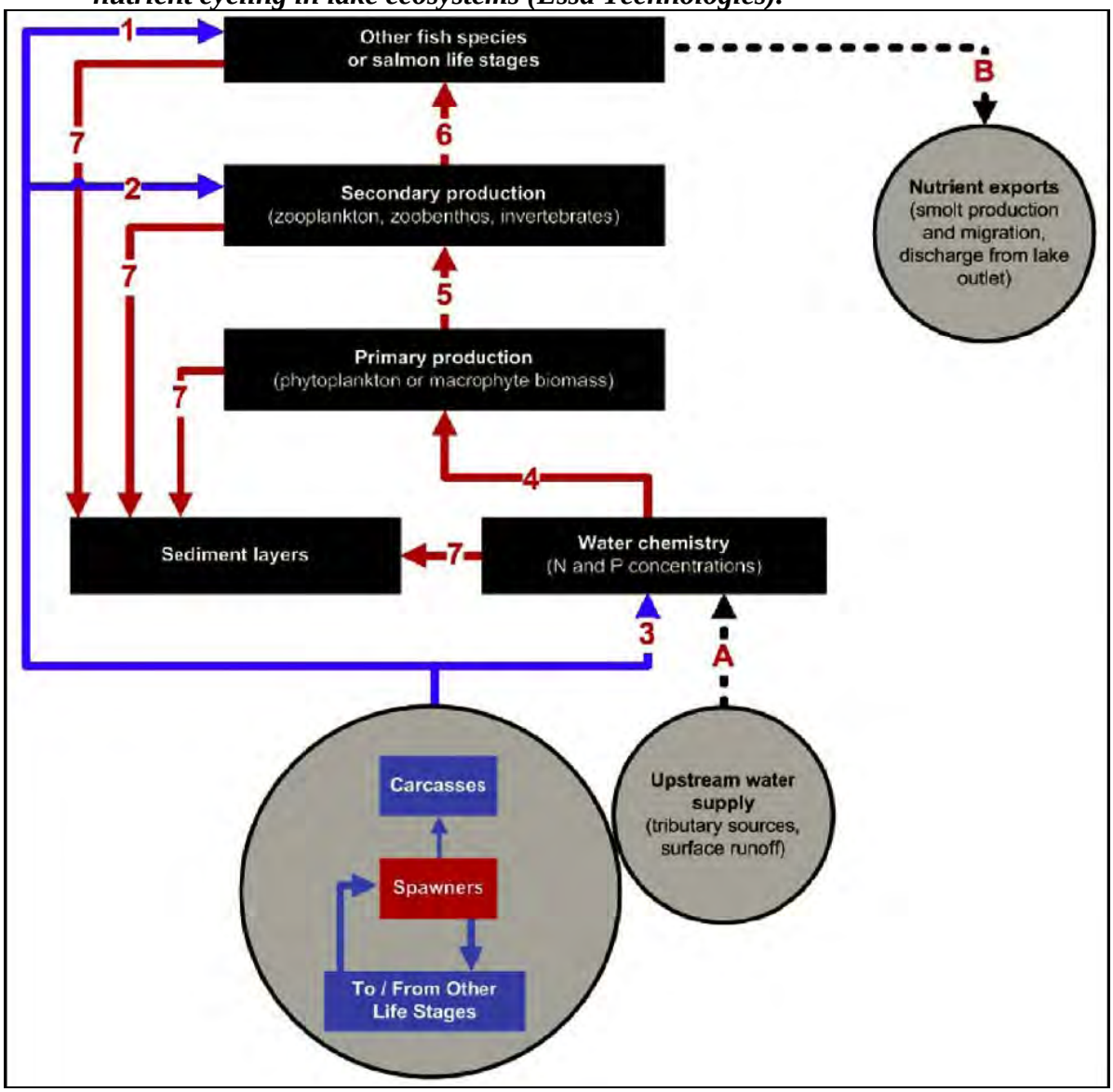
As shown earlier in this report, the Horsefly River is home to one of the most prolific sockeye salmon runs in the world. Additionally it also provides habitat to kokanee, a fresh water version of the sockeye that does not migrate to sea. The interaction between all species in an ecosystem is a very delicate balance and this is true of the aquatic species residing in the Horsefly River watershed, and downstream in Quesnel Lake; and especially true with kokanee and sockeye.

As mentioned earlier in the report, Ministry of Environment biologist Rob Dolighan of Williams is the co-author of the 2003 Stock Management Report No. 17 titled "Summary of Quesnel Lake Kokanee and Rainbow Trout Biology with Reference to Sockeye Salmon". The report presents detailed information on the interaction of these stocks residing in Quesnel Lake, and also addresses influences in the Horsefly River.

The report describes two distinct kokanee populations utilizing the lake system; shoal and stream spawners. The report states that stream spawning kokanee populations have been in decline over the past two decades concurrent with an increase in sockeye spawners. It is possible that the stream kokanee fry are in competition for food with sockeye fry as the kokanee adults spawn later than adult sockeye and the emergent fry swim up later than sockeye. While Quesnel Lake shoal spawners spawn later, it is felt that they emerge earlier due to warmer incubation waters on the Quesnel Lake shoals. A copy of this 2003 report is provided in Appendix G and an updated version of this information is scheduled to be produced by the Ministry in 2009.

Also of great importance in this freshwater ecosystem are the linkages between sockeye returns and nutrient cycling in Quesnel Lake. Figure 17 below provides the reader with a sense of this dynamic exchange of marine derived nutrients (MDN) and the resultant benefits.

Figure 17: Conceptual Diagram representing the linkages between salmon and nutrient cycling in lake ecosystems (Essa Technologies).



7.0 Watershed Research

The University of Northern British Columbia (UNBC) acquired the Fisheries and Oceans Quesnel River Research Centre in Likely, British Columbia in 2002. While not located in the Horsefly River watershed, it is located on the Quesnel River immediately downstream of Quesnel Lake. Much of the research is conducted in the larger Quesnel River watershed, however some projects have been implemented in the Horsefly River drainage itself.

The following is a brief summary of research undertaken at the Centre in 2008 and taken from the Quesnel River Research Centre website at www.unbc.ca/qrrc

7.1 Nutrient Cycling Processes - Sam Albers

"My research interests lie in examining the nutrient cycling processes that occur during the salmon spawning events within the northern interior of British Columbia. Specifically, I would like to study the role that stream bed biofilms play in the capture and storage of decayed salmon nutrients. I plan to use the outdoor flumes at the Quesnel River Research Centre to experimentally determine the effect of biofilms on overall stream bed storage of salmon-derived nutrients. Using a combination of microscopic imaging techniques and the measurement of direct physical parameters I hope to understand the mechanisms behind this process".

7.2 Hydrometeorological Processes- Dr. Stephen Dery

Although our understanding of snow and ice processes has improved in recent years, there remains some fundamental issues that need to be addressed. This is an especially urgent matter as the northern high latitudes are currently experiencing an unprecedented period of climate change. Thus there is a great need to quantify the role of snowcover in the existing and in the future states of the surface energy and water budgets and to better comprehend hydrometeorological processes in the North. My research is therefore geared towards a better understanding of northern hydrometeorological processes and their impacts on the surface energy and water budgets. To accomplish this goal, a variety of methods and tools are used, including field observations, reanalysis datasets, remote sensing data, and numerical modeling. I am concerned by both small-scale (from meters to a few kilometers) and large-scale (> kilometers) hydrometeorological processes.

7.3 Alternative Mining Technology-Catherine Henry

The Mount Polley Mine is working on extracting copper from the copper-oxide material through biologically induced copper heap leaching. Copper oxide cannot be processed through conventional milling techniques therefore the need for alternative technologies was identified. In collaboration with University of Northern British Columbia (UNBC), research is being conducted to evaluate the feasibility of this technology. Essentially, the heap is a zero-discharge acid generating facility that mobilizes the copper from the rock and is recovered through an electro-winner. The heap is amended with elemental sulphur. As the leachate solution recirculates through the heap, the sulphur is oxidized by naturally occurring bacteria, *Acidithiobacillus thiooxidans*. The sulphuric acid produced in this reaction is the key to liberating copper ions and leaving them in solution. Because heap leaching of this nature has not yet been preformed at an industrial scale, researchers are evaluating the changes in solid and leachate phases. The goal of this study is to provide sound scientific data that identifies the chemical and physical dynamics of the heap such that future work in this field are built from a strong academic foundation.

7.4 Coho Spawning Site Locations-Crystal McRae

Factors related to Spawning Site Locations in Interior Fraser Coho Salmon- Selection of spawning sites by adult salmon is thought to insure that the incubation environment for eggs and larval fish (alevins) is suitable and guarantee the animal's reproductive success. Suitable site selection is crucial because the highest rates of mortality over the life of a fish generally occur during the incubation period. Much of the mortality that occurs during this time is directly related to characteristics of the site that the female selected. There are a range of factors that have been identified to play an influential role on survival and growth of embryos and alevins, but their relative effect may depend on species and/or region. My thesis study aims to develop a better understanding of the spawning habitat and incubation requirements of the Interior Fraser coho (IFC) in a northern interior watershed, McKinley Creek. The objectives of this study are to (1) determine locations within the McKinley Creek watershed where IFC spawn; (2) characterize the physical and chemical features of specific spawning sites; and (3) gain a better understanding of survival and growth during incubation. Findings of this investigation will play a key role in understanding the early life history of IFC as well as contributing significantly to the identification of critical habitats and their basin-wide distribution; both of which are major knowledge gaps required for the recovery of declining IFC stocks.

7.5 Landscape Disturbances-Dr. Phil Owens

Dr. Owens' main research interest is the effect of landscape disturbance (e.g. forestry, agriculture, mining, urbanisation, wildfire, climate change) on the behaviour, fluxes and fate of water, sediment and chemicals in the environment at a range of time and space scales, and the development of appropriate information and advice for improved management of land and water resources. Specific interests include: Sediment sources, transport, storage and budgets, Sediment management in river basins, Soil erosion, Effects of wildfire and forest disturbance on soil erosion and sediment fluxes, Mountain geomorphic processes, Fallout environmental radionuclides and other environmental tracers, Nutrients and contaminants in soils and waters, Ecology-water-sediment interactions.

7.6 Sediment Movement-Dr. Ellen L Petticrew

The underlying theme of Petticrew's research is the fate and effect of sediment moving from terrestrial systems through the aquatic system. Her work addresses the role of inorganic and organic sediments on the biological (plants, fish), chemical (nutrients, contaminants) and physical (sediment erosion and transport) aspects of land-water systems. Specific focus areas include: 1) Landscape scale linkages between terrestrial and aquatic systems, 2) Landscape disturbances on sediment transfers (fire, forest harvesting, agriculture), 3) Biogeomorphology: influence of organisms on physical attributes of aquatic systems and vise versa, 4) Ecological implications of transfers and storage of fine sediment (both organic and inorganic) in rivers and lakes, 5) Fine

sediment morphology and composition (flocculation processes), and 6) Lake restoration and community stewardship.

7.7 Floculation in Nutrient delivery-John Rex

Anadromous fish such as Pacific salmon play an important role in global nutrient cycling because they return substantial quantities of marine derived nutrients (MDN) to terrestrial and freshwater environments during spawning events. These MDN are known to support riparian zone vegetation and terrestrial organisms, benthic macroinvertebrates, algae, and other fisheries populations within natal watersheds. Despite the recognized importance of MDN to stream ecology, little is know about the underlying mechanisms for their delivery and retention in streams. The research I am completing at the QRRC under the supervision of Dr. Ellen Petticrew addresses that gap by investigating the role of flocculation in nutrient delivery to the streambed. Flocculation refers to the aggregation of inorganic and organic particles into 'flocs' by chemical, physical, or biological means. Using outdoor channels at QRRC that have been converted to both flow-through and re-circulating systems, we have been able to study floc formation, streambed delivery, and retention processes to determine the potential for salmon based flocs to play a role in nutrient delivery. To date our results suggest that flocs formed by the bacterial aggregation of salmon organic matter and clay delivers substantial amounts of nutrients to streambeds, enhancing their retention and biogeochemical cycling within Pacific salmon streams. These findings show that flocculation is integral to downstream nutrient cycling in Pacific salmon streams.

7.8 Impact of Land Use Activities-Ty Smith

Impact of Land use Activities on Fine Sediment-Associated Contaminants; Quesnel River Watershed- A clear association between fine sediments and the transport of organic and inorganic contaminants has been documented for many river systems. Through remote sampling of tributaries to the Quesnel River with predominant land use associations, contaminant concentration signatures will be derived. Of interest is the spatial and temporal variation between sample sites representing different land uses, and in particular if each land use activity has a distinct contaminant signature. High-energy events such as storms or spring flood water levels should provide the greatest yield of fine sediment and thus the greatest concentration of contaminants into the system. Using GIS to determine land use areas within the Quesnel River watershed, the aggregate influence of fine sediment-associated contaminant inputs at the city of Quesnel will be extrapolated.

7.9 Juvenile Coho Habitat-Kyla Warren

The goal of this project is to determine the physical, chemical, and behavioural factors that affect the use of habitat by juvenile coho salmon (Oncorhynchus kisutch) in the Horsefly-McKinley watershed. The coho in this system belong to the interior Fraser coho population, an understudied population that has experienced severe declines in recent decades. The study areas of the Horsefly-McKinley watershed will include mainstem,

large creek, and small tributary habitat, which are representative of areas present within the watershed. Habitat usage patterns will be examined on a watershed scale using otolith chemistry to track movement of individual juvenile coho through the various regions and tributaries of the Horsefly-McKinley watershed. Habitat selection on a microhabitat scale will be assessed throughout the watershed by a survey of habitat characteristics including water chemistry, substrate, velocity, canopy and underwater cover, and bank characteristics. Behavioural studies in artificial stream channels will target behavioural interactions such as territoriality and schooling that may have consequences for the use of habitats in a natural stream. A better description of the impact of these factors can assist in protection and restoration of critical rearing habitats for interior Fraser coho: a goal suggested by governmental stock reports.

In addition to this UNBC research, the Ministries of Environment and Forest's research office in Williams Lake have undertaken numerous studies in the watershed that relate to fish and fish habitat within the Horsefly River drainage. Additionally, Fisheries and Oceans Canada, the Northern Shuswap Tribal Council, The Land Conservancy as well as other universities conduct research in this area as funding, needs, and interests guide the proponents.

The monetary value of the combined research described above could easily surpass $1 million dollars. The limited resources for this project prevent this information to be included in detail however a document provided by Technical Committee member Geoff Price listing numerous sources of related information can be found in Appendix N.

8.0 Water Licenses

Controlling water extraction in some watersheds plays an important role in maintaining a balance between economic and societal needs with environmental needs. For example, in the Nicola River watershed in the Merritt area of British Columbia competition for water for agricultural purposes and for fish has resulted in the involvement of the Nicola Watershed Community Round Table and the development of the Nicola Watershed Use Management Plan (WUMP) (Douglas).

Water licenses have been issued in this watershed since 1871. However the water available has been fully subscribed and ground water extraction which is not regulated and climate change issues such as the Mountain Pine Beetle epidemic and its effect on local pine stands have created problems for fish and fish habitat in the Nicola watershed.

Water licenses on the Horsefly River and its tributaries are utilized for domestic, irrigation, dust control, stock watering, storage, and for conservation purposes. While not an issue currently in the watershed, this potential problem should not be ignored, particularly on smaller tributaries of the Horsefly striving to achieve a balance between anthropogenic needs and aquatic needs for fish. Many licenses are derelict and not utilized for its intended purpose. In summary, the Province of British Columbia should

update its water regulations within one dedicated ministry as currently drinking water can be managed by up to ten separate departments.

The Province of British Columbia has provided two guideline documents that detail minimum flow levels required for fish bearing streams. These documents would be most beneficial to those seeking to withdraw water from fish bearing streams in determining whether or not such an application is feasible. The draft documents titled "Assessment Methods" and "Instream Flow Thresholds Synopsis" are available on the Internet (Province of British Columbia).

A list of the water licenses registered with the Provincial data base on named streams within the Horsefly River watershed can be found in Appendix O.

9.0 Independent Power Production

The Province of British Columbia is committed to being self sufficient in energy production by the year 2016 based on their Utilities Commission Act Special Direction No. 10 deposited on June 26, 2007 (BC Utilities Commission). This power is expected to be generated from several sources and include water, wind, biomass, tidal and ocean, geothermal, solar, and natural gas with offsets. The newly generated power is required to come from 90% clean or renewable sources. While BC Hydro is the distributor of electricity in the Province of British Columbia, much of this new power to be supplied is expected to come from Independent Power Producers or IPPs. Currently there are 43 IPPs operating in British Columbia, and the Independent Power Producers Association of British Columbia (IPPBC) provides information and represents this industry. Some of their information can be found in Appendix P of this report.

A recently produced document providing information on IPPs was produced in 2008 by the Province of British Columbia's Ministry of Agriculture and Lands. This informative document titled "Independent Power Production in BC: An Interagency Guidebook for Proponents" details the necessary steps for individuals and companies interested in developing IPP projects. This document can be found in Appendix Q of this report.

IPPs may be a necessary initiative if we are to forego the construction of large hydro dams on watersheds in British Columbia. However much discussion is centered on whether or not the IPPs being brought on line are indeed "green" energy. "Run of the River" hydro projects are increasingly being chosen as an alternative to large hydro projects however they do come with their own slate of environmental concerns.

The Watershed Watch Salmon Society prepared a document in 2007 titled ""Green" Hydro Power Understanding Impacts, Approvals, and Sustainability of Run-of –River Independent Power Projects in British Columbia". This document details the process in place for applicants and provides the reader with considerations that should be discussed and addressed prior to the acceptance of such projects being constructed on watersheds in British Columbia. This document can be found in Appendix R of this report.

10.0 *Forestry*

In recent history no other anthropogenic influence has played a greater role in the Horsefly River watershed than forestry. Timber extraction and sawmilling have been active in the watershed since the first settlers inhabited the area during the mid 1880s. In that earlier era, this industry was localized as the global economy and the modern role of the forest industry was unheard of.

Larger mills and the resultant need for more timber began to show its effects in the 1970s as the demand for British Columbia lumber began in earnest from buyers in the United States. This demand for Horsefly River watershed timber continues to this day although a recent downturn in the economy has delayed the local harvest somewhat. However in contradiction to this statement, the Mountain Pine Beetle epidemic has the BC government and local industry officials concerned about maximizing their profits by encouraging harvest of affected pine as soon as possible prior to losing the projected lumber value of this standing dead forest.

Appendix S is a map provided by West Fraser Mills Ltd. of Williams Lake and shows the historic and proposed logging that will occur in the Horsefly River drainage and the surrounding area. Of note is the amount of harvesting that has and will occur in the Moffat and Woodjam Creek sub-basins where the Mountain Pine Beetle has affected much of that localized forest.

To compliment the harvesting map, Appendix T provides the reader with another map prepared by the BC Ministry of Environment detailing the pine leading stands in the Horsefly River watershed. Once again of note is the number of pine leading cutblocks in the smaller Moffat and Woodjam Creek sub-basins which are known to provide prime salmonid habitat. Of further concern is the already unstable nature of these small watersheds that are known to be high sediment delivery systems to the Horsefly River mainstem.

While timber harvesting is still the greatest contributor to the local economy, the industry can contribute negatively to the local fish and fish habitat. Timber harvesting regulations have improved over the last several decades however current practices can still be improved upon to limit negative influences to a watershed. Specifically rate of harvest, road construction, the lack of bridges on streams, buffer zones on small streams, altered hydrological processes and sediment delivery, and equivalent clearcut areas are of prime concern.

Of the potential negative impacts presented above, the equivalent clearcut area (ECA) may be the most problematic for fish and fish habitat in the Horsefly River watershed. The ECA is defined by the British Columbia Integrated Land Management Bureau as "*the area of a **cutblock** weighted to estimate an equivalent effect on snow hydrology as the area of a clear-cut unregenerated block. As examples, a ten hectare clear-cut unregenerated block has an ECA of ten hectares; if a fully stocked **stand** has regenerated to a height of six metres, the block now has an ECA of five hectares. If, instead of being*

clear-cut the block was selection logged with thirty percent volume removal, the ECA is estimated to be three hectares" (ILMB).

Generally speaking, the major licensees harvesting within the Horsefly River watershed are required to hire the services of a hydrologist to provide expert opinion in the form of a watershed report on the effects increased timber extraction will have on a sub-basin if the ECA is above 25% of the affected watershed.

With an increased ECA comes the risk of a multitude of related problems that may affect fish and fish habitat in a watershed. A high level of ECA may allow for quicker spring melt and runoff on exposed areas previously forested. This potentially earlier and stronger freshet can cause a cascading flood effect downstream that may affect stream bank stability resulting in flooding, sediment delivery onto spawning substrate, and bed load movement that may damage rearing and spawning habitat.

Additionally, this anthropogenic watershed influence can affect the timing of cool water delivery when it is most needed by salmonids in the watershed for migration, spawning and rearing. Groundwater is also known to play a large role in cooling streams during the warmer summer months and the lack of snow pack and the retention factor of an intact forest allows groundwater to contribute to a stream earlier in the summer, rather than during the later summer months when salmon in the Horsefly system have been historically challenged by warm water and its effects.

During the information collection process of this document it was discovered that a watershed assessment was being undertaken on Woodjam Creek by Tolko Industries Ltd. of Williams Lake. This watershed assessment report was deemed to be the responsibility of the licensee and not being funded by government and as such the author has been unable to acquire this updated critical information at this time for the preparation of this report.

Additionally, a request to the BC Integrated Land Management Bureau for the provision of mapping related to historic and current harvest levels in the Horsefly River watershed was denied. This lack of information from the licensee noted above and the government is troubling as the author feels that this sector of the economy could potentially be the one that has the most negative effect on fish and fish habitat in the watershed.

11.0 Mining

In 1859 gold was discovered in Horsefly by Peter Dunlevey and to this day mineral exploration and mining play a large role in the Horsefly River watershed. Historically, many mines in the area utilized a hydraulic form of mining to extract gold from their claims. This type of extraction required the use of large monitors or water nozzles to direct a strong stream of water at a gravel bar or bank to wash the gravel and gold into a recovery area. Environmental concerns were not discussed or implemented during that era, and the remnants of this environmentally damaging mining activity can be found

throughout the Cariboo and the Horsefly River watershed to this day. A good regional example of this is the Bullion Pit Mine in the Likely area located approximately 5 km downstream of Quesnel Lake.

Today's 6 billion dollar mining industry is regulated by the BC Ministry of Energy, Mines, and Petroleum Resources whose Kamloops and Prince George offices share administration duties for the watershed. The demand for raw resources has been curbed somewhat by the recent downturn in the economy, however mineral exploration continues in the Horsefly River watershed. A telephone call by the author of this report to the Ministry office in Prince George during the data research for this report proved fruitless in acquiring information on current exploration in the watershed. This was due to a lack of personnel and resources in the office.

However, a summary report of mining activity from 2008 was found on the Internet and focuses on the North – Central Region of which the Horsefly River watershed lies in. This report is available in Appendix U for the reader's perusal. The report does describe exploration activity in the Region and includes a description of activity in the Woodjam Creek drainage by Fjordland Exploration Inc., and Northern Rand Resources Corp on its Megaton Project. Additional exploration has been undertaken by Hawthorne Gold Corp. on its Frasergold property and nearby Dajin Resources completed drilling on its Addie 2 property. Although usually small in scale, exploration activities can be damaging to fish and fish habitat through road development, stream crossings, ditching, bore holes, and pit sampling.

Recent sediment delivery from exploration development in the upper Horsefly River watershed in the fall of 2008 has been brought to the attention of the Horsefly River Roundtable. Additionally, the regulatory overseers seem to be overwhelmed by the speed of the industry's growth and cannot attend to all of its needs or monitoring. The author can attest to drilling road development in the Likely Xatsu'll Community Forest where road construction had occurred without notification or permission from the Community Forest's management . Mineral exploration and mining development can put a strain on aquatic life should operations not be completely isolated from water courses.

Mineral claim ownership can easily be researched on the Internet to determine claim locations, boundaries and size. For the reader's use, a description of this Internet tool is provided in Appendix U. Additionally, a map produced by Intierra Resource Intelligence Mapping can also be found in Appendix U and shows exploration and mining activity in the Quesnel Trough wherein lies the Horsefly River watershed.

12.0 Agriculture

Agriculture has played a large role in the development of the Horsefly River watershed for well over a century. Ranches were established along this riverine corridor in the late 1890s, however private land was acquired by the Harper family as early as 1861 (Appendix A).

To this day, agriculture, especially cattle ranching, plays a large role as an economic driver in the watershed. A map provided by the Cariboo Regional District can found in Appendix V and shows the amount of land allocated to the Agricultural Land Reserve (ALR) within the watershed. Of particular note is the amount of ALR located along the mainstem of the Horsefly River and major tributaries such as Moffat, Woodjam, and McKinley Creeks. This only stands to reason as agriculture, in any practice requires water for such things as irrigation or stock watering.

In British Columbia, agricultural governance falls under the direction of the Ministry of Agriculture and Lands. The ministry's mandate is "to enable economic and social development and environmental sustainability for the agriculture, aquaculture and food sectors, supporting them in delivering safe, healthy and high-quality food, and to manage Crown land in an innovative manner that contributes to the economic, societal and environmental goals of government" (MAL). While this ministry effectively addresses agricultural concerns related to the land base, the Ministry of Environment and Fisheries and Oceans Canada interact with ranchers and farmers on issues relating to aquatic life such as salmonids.

Although regulated by the above ministries, the agricultural industry can have a negative impact on the watershed. Historically some older ranches were built in questionable locations such as on flood plains that can affect river hydrology and subsequently fish and fish habitat. Some of these older homesteads have been abandoned leaving a host of problems from abandoned irrigation systems to chemical and natural waste dumps located adjacent to streams. In addition to the above noted historical problems, the watershed today could in some cases be negatively influenced by cattle having unfettered access to riparian zones and fish habitat, and a lack of screening for irrigation waterlines and ditches.

The agricultural industry including that which is located in the Horsefly River watershed, is supported by organizations such as the BC Cattlemen's Association and the Horsefly Cattlemen's Association. Assistance programs that are from or through these organizations are available such as Environmental Farm Programs or Riparian Stewardship and can provide the rancher or farmer with funds to help alleviate possible negative impacts to localized fish and fish habitat.

Additionally, initiatives such as the Horsefly River Riparian Conservation Area described in Section 3.7 and managed by the Land Conservancy of British Columbia assist greatly in protecting the vital riparian zones located adjacent to prime salmonid spawning and rearing habitat.

13.0 Urban Development

Europeans and other non indigenous people have been settling in the watershed for more than 150 years, yet the community of Horsefly had a population of only 150 as of May

16, 2006, down by 37% from the census taken in 2001 when the population was 238 (BC Stats). The census in 2006 went on to state that there were 50 occupied private dwellings of which 100% were single detached dwellings. Many of the existing residences are built within close proximity of the Horsefly River and the same is true for the historic farms, ranches and homesteads found throughout the drainage that could easily number as many or more than the number found within the village area. This is not unusual, as most communities throughout the world, no matter the size, benefit from an adjacent river and its network of tributaries. This natural desire to live near waterways unfortunately creates adjacent infrastructure such as roads and hydro lines. Rivers and their associated ecosystems are productive and unfortunately our desire to live near them can come with a high cost to the environment.

The community of Horsefly has no water and sewer network and home owners in Horsefly and within the watershed are responsible for their own water and septic systems. The local governing body is the Cariboo Regional District (CRD) with their office located in Williams Lake. The Regional District's governance includes their Shoreland Development Policy which regulates a 15 metre buffer strip between new development and lakes/streams (CRD). In addition to the CDR regulations, all development within riparian areas must address federal and provincial law as detailed by the BC Ministry of Environment and Fisheries and Oceans Canada.

Within the community of Horsefly an informal and unregulated campground exists immediately across the main Horsefly River bridge and adjacent to the Fisheries and Oceans sockeye spawning channel. The Horsefly River Watershed Roundtable is currently involved in addressing fish and fish habitat and safety issues associated with this development. The Roundtable also recognizes that the bridge would benefit from a pedestrian walkway as salmon viewing occurs from this vantage point and is considered to be unsafe.

The Cariboo Regional District along with Fisheries and Oceans Canada and the Real Estate Foundation of British Columbia are currently assessing the viability of real estate development in the foreshore areas of Quesnel and Horsefly Lakes. A report is in draft stage as of this writing and community surveys along with open house meetings are scheduled for the communities of Horsefly and Likely. More information on this initiative can be acquired through the CRD office in Williams Lake.

14.0 Recreation

The Horsefly River watershed is primarily noted for its angling opportunities for rainbow trout however other recreation in the watershed includes hunting, rafting, kayaking, canoeing, swimming, tubing and wildlife viewing and photography. A number of resorts in the area rely on the tourist trade associated with this recreation.

While not a large negative impact on the fishery resource in the watershed, some related issues can have an impact on fish and fish habitat. Use of all terrain vehicles through

streams, disturbing spawning fish by boating through redd areas, poaching of anadromous and non anadromous fish, introduction of invasive species such as smallmouth bass, driving vehicles onto gravel bars, and discarding garbage into streams all can negatively impact the fishery resource.

15.0 Climate change

Possibly the greatest challenge facing fish and fish habitat in the Horsefly River watershed is the ability of aquatic species to adapt to climate change. It has been noted previously in this report the effects the Mountain Pine Beetle has on the watershed and this is directly related to warmer winters allowing the beetle to expand its population and area of influence.

Additionally warm winter thaws have recently created ice jams resulting in hydrological changes in river channels, earlier timing and the increased flow of spring freshets causes flooding and the unwanted earlier delivery of nutrients to Quesnel Lake. In recent history warming water in the Fraser and Horsefly Rivers has caused pre-spawn mortalities of migrating salmon and forced the closure of the rainbow trout fishery in the watershed. Appendix W provides the reader with an overview document prepared by Fisheries and Oceans Canada for their Fall Consultations in 2008. This presentation titled Climate Change and Pacific Fisheries, while not thorough in nature, highlights the effects climate change is having on the west coast and the possible outcomes from this.

Climate change and its effects on aquatic life are not simply restricted to the freshwater environment but its impacts are felt in the ocean environment as well. The presentation in Appendix W notes that sea surface temperature has risen between 0.3 and 0.9 degrees over the last 50 years resulting in an alteration of feeding opportunity for young salmon that rely on cooler upwelling water to provide nutrients. Warmer ocean currents flowing into the North Pacific bring southern predator fish such as mackerel into salmon bearing water and this depletes population levels.

Fisheries and Oceans Canada prepares a document each year titled State of the Oceans report and readers can review these concise documents prepared each year for the Pacific Ocean (FOC^4). The document prepared in 2008 provides information on ocean conditions and its effects on sockeye salmon and the reader can track this relationship in previous years to acquire a sense of how these impacts affect salmon throughout their ocean life. Predictive models of ocean productivity are presented based on ocean currents, water temperatures, nutrients and predation.

A report recently released on April 6, 2009 by the Pacific Fisheries Resource Conservation Council (PFRCC) is titled "*Landscape-Level Impacts to Salmon and Steelhead Stream Habitats in British Columbia*". The report written by Dr. Marvin L. Rosenau and Mark Angelo recognizes the impact the Mountain Pine Beetle (MPB) is having on landscapes and hydrological processes (PFRCC). The report states that recent

scientific investigation into the extreme harvesting of MPB affected areas by the Ministry of Forests and Range "*are to a degree, misguided*".

The report goes on to state that "*changes to the hydrology of a watershed once the forest has died can increase both the volume and the intensity of spring-freshet flows while also reducing late-summer flows, thus making conditions for fish more severe. Recent research results also indicate that, while dead standing timber does not have the snowmelt-mitigating capacities of a live forest, it does have hydrology-modifying benefits that can be beneficial to stream habitats when compared to the wholesale removal of beetle-affected pine over vast areas that is now taking place. Forest-harvesting policies should be revised to be more precautionary and less intrusive"*.

With respect to the Horsefly River Watershed Roundtable and its desire to become an effective voice for local watershed issues, this preliminary description of this recent report goes on to state "*One key recommendation is to have all four levels of government – federal, provincial, local and First Nations – formally recognize the importance of addressing impacts on a broader landscape basis and embed this in appropriate legislation. A more regionally focused approach to land use planning is also recommended"*.

16.0 Concerns and Recommendations

1. Moffat and Woodjam Creek Watersheds

The Moffat and Woodjam Creek watersheds are very important sub-basins of the Horsefly River and are feeling the impacts of forestry, mining, agricultural, and climate change issues; possibly more than any other tributaries of the river. Ironically, when the Horsefly River Roundtable attempted to get up-to-date data on a recent watershed assessment for the Woodjam Creek watershed undertaken by Tolko Industries who sit at the Roundtable, access to this report was denied as it was not funded with tax dollars but was deemed operational and self funded in nature.

It is strongly recommended that the Horsefly River Roundtable (HRR) urge all industries conducting development in the watershed to be transparent with their data and share the knowledge that they have. This isolationist form of information gathering can only sow seeds of distrust and does nothing to collectively maintain and enhance the fishery values of the Horsefly River watershed. Should a funding opportunity present itself to the HRR for field data collection or monitoring of fish and fish habitat, it is recommended that the project consider either or both of these impacted watersheds.

2. Climate Change

The Horsefly River watershed has been and will continue to be influenced by climate change. Winter thaws have in recent history created ice jams in the river that scour

substrate and warmer summers during the last decade or so have resulted in warmer stream temperatures that affect the survival of resident and migrating fish species. Warm winters have created an epidemic of mountain pine beetle and the resultant effects of dying and dead pine stands along streams have wreaked havoc on local fish habitat.

While recognizing that climate change is a global issue, it is recommended that the HRR work collaboratively with both the Fisheries and Oceans Canada and the Provincial Ministry of Environment to be better understand the local effects climate change will have on fish and fish habitat in the Horsefly River watershed. By becoming better informed on projected watershed outcomes as a result of climate change influence, the HRR may be better positioned to focus limited funding resources on related issues.

3. Watershed Planning-Ecosystem Based Management

Ecosystem based management as defined by the David Suzuki Foundation and coined by Grumbine in 1999 *" is integrating scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term."* It is recommended that the HRR become better informed on ecosystem based management and promote its value to all levels of government.

The environmental, social and economic management of the Horsefly River watershed by governments could easily be described as haphazard at the best of times. The provincial and federal governments have promoted and funded ($60 million dollars) this management style in such places as the Great Bear Rainforest on the west coast. The HRR should urge the Provincial government to consider funding such watershed management in the Horsefly River drainage to better protect its value which is of no greater or lesser value as a unique ecosystem than the Great Bear Rainforest.

4. Smallmouth Bass (Appendix XYZ)

The smallmouth bass introduction into the Beaver Valley watershed is of great concern. While not part of the Horsefly River drainage, the creek does drain into the Quesnel River thus providing access to the Horsefly River for the bass. Smallmouth bass are very prolific in reproduction, prey on other fish species and compete for food with salmonids. Presently funding has been targeted to better understanding the range of the bass in the watershed and its impacts on the native aquatic community and biodiversity, and no decision has been on eradication of this non-native species. Of particular concern is the possibility of dispersal of the smallmouth bass to other sub-basins of the Quesnel drainage and ultimately into the mid and upper Fraser River.

It is recommended that the Horsefly River Roundtable work closely with the BC Ministry of Environment in attempting to eradicate the smallmouth bass through efforts supported by the majority of residents of Beaver Valley. This can include providing information to locals, supporting funding efforts through letters of support, and strongly lobbying the Provincial government to provide adequate funding to this issue which presently is

lacking. Any short term financial cost saving efforts by the BC government by ignoring the severity of the issue will cost society a great deal more should the smallmouth bass eventually affect the high value sport fishing and salmon fisheries originating in the Horsefly River watershed.

5. Competing Interests

The Horsefly River watershed provides a wealth of natural resources that enhance the financial well being of the local, regional, provincial, national and indeed global population as share holders from around the world invest in corporations who are active in the watershed.

The historical value of the forest sector, mining and fisheries in the Horsefly River drainage can easily be measured in the billions of dollars and annually the area continues to provide hundreds of millions of dollars in economic value. One can easily understand the desire of the forest and mining industry to be active in the watershed. However more than any other anthropogenic influence, these two prominent industries are capable of having a negative effect on the fishery resource in the Horsefly River watershed.

Both the federal and provincial governments have in recent years enacted new laws affecting both industries that steer their development and operations into self regulating regimes with the federal and provincial government playing a regulatory role through compliance inspections and monitoring. Taken at face value, this all seems well and good, however it is this author's belief that inadequate monitoring and a lack of compliance is happening far too frequently in the watershed and having a negative impact on fish and fish habitat. Government budget cuts at both levels have been a direct cause of this lack of involvement by the regulatory agencies.

It is recommended that the Horsefly River Roundtable continue to encourage participation of both the timber and mining sectors in their ongoing efforts to enhance and maintain the fishery resource in the watershed. It is unacceptable that one resource sector benefit financially from the area's resources at the possible negative expense of another sector whose desire is to have the same access to financial well being. While the forest sector does participate to a limited degree in the HRR, the mining sector should be strongly encouraged to attend meetings and actively participate in assisting the Roundtable in its goals of having a strong fishery sector reliant on a healthy watershed. Furthermore, it is recommended that the Roundtable urge both levels of government to provide adequate funding to monitor development in the watershed.

6. Lack of Current Data

Throughout the extent of the research for data related to this document, the author has determined that there is ample historical information available on the watershed, however in view of today's "gold rush" mentality to extract as much resource as possible in a short period of time from the Horsefly River watershed, there appears to be a lack of adequate current up to date information made available to the public in support of resource

management decisions. The public, it would appear is left to assume that the right decisions are being made by industry and government on their behalf.

As mentioned elsewhere in this report, the natural resource value of the watershed is vast, and funding directed to economic development and its related return to government coffers is easier to attain than funding to study the possible related negative impacts to the fishery resource. Granted industrial development certainly has a role to play in meeting government guidelines with respect to their industrial obligations, however business operations are governed by their bottom line and subsequently their related environmental studies including impacts to fish and fish habitat are limited to providing the least amount of information necessary required by government regulators to see the project through to fruition.

Additionally, it appears to the author that often federal and provincial ministries who have management roles to play in the watershed are working in isolation of each other and their decisions may indeed be negatively impacting the efforts of others to co-manage the fish and fish habitat of the watershed. This in turn could be rectified by a concerted effort by the BC Provincial government to recognize the benefits of ecosystem based management and provide funding to address this management style such as that allocated to the Great Bear Rainforest mentioned previously in this section.

It is recommended that the Horsefly River Roundtable encourage both industry and government to be open with their watershed information and strive to work together in providing society with an overall watershed management plan that balances economic needs with societal and environmental needs. Working in isolation and hoarding information can only be detrimental to the well being of the Horsefly River watershed.

7. Lack of Government Funding For Fisheries Research

The Horsefly River watershed is well known for its rainbow trout sport fishing and as a spawning area for three species of Pacific salmon. As stated earlier in this report the combined value of these fisheries is measured in the tens of millions of dollars. Unfortunately both federal and provincial governments continually provide less than adequate funding for the related research of both anadromous and non anadromous species residing in the watershed.

Obviously both levels of government provide funding for monitoring and assessment through lake and stream surveys and related reports however this should be considered a management obligation and not a research investment. Canada contributes 1.9 percent of GDP to research and development, according to the Organization of Economic and Coperative Development (OECD) while the USA presently contributes 2.6 % with a recent pledge from President Barrack Obama to increase that to 3%. Furthermore the OECD states that "*Canada ranks 24th out of 26 countries studied by the OECD, or Organization of Economic Cooperation and Development, on firms collaborating with partners and is at the bottom of the pack for its share of business collaboration with both higher-education institutions and governments".*

Industry and business can play a key role in collaborative research with the federal and provincial governments in the watershed. While some limited forest research is undertaken in the watershed, this type of collaboration has not been seen to any great extent since the former Forest Renewal BC program in place during the last decade and funded through additional stumpage rates applied to forest industry costs. This fund to a great extent was utilized for forest research that included research on the industry's impact on fish and fish habitat.

Research in the watershed could include further studies on the impacts of the mountain pine beetle and the related harvesting prescriptions and the resultant effects on hydrology and the riparian zones of tributaries and the main stem of the Horsefly River. Additionally, research could be undertaken specifically on Fisheries Sensitive Watersheds in the Horsefly drainage as designated by the Ministry of Environment and include Moffat, Woodjam, Deerhorn, McKay and Molybdenite Creeks. Continued research should be undertaken on species interaction within the watershed and include Quesnel Lake. Of great concern and interest is the lack of a riverine spawning population of kokanee in the river, and the impacts sockeye enhancement has on other species residing in the watershed.

It is recommended that the Horsefly River Roundtable work closely with the BC Ministry of Environment, Fisheries and Oceans Canada and industries active in the watershed to determine regional fishery priorities. The HRR Technical Committee on behalf of the Roundtable should actively pursue project funding based on their priority discussions with both agencies. Collaborative funding support from those active in the watershed for research project submissions would enhance and possibly leverage the successful outcome of these submissions to funding sources.

8. Ministry of Environment Reports

As mentioned earlier in this document and included in the Appendices, a comprehensive report on Quesnel Lake was published in 2003 by the BC Ministry of Environment and coauthored by local Ministry Biologist Rob Dolighan. This excellent report discusses the interaction of rainbow trout, kokanee and sockeye salmon in the lake and in the Horsefly River. The next iteration of this report is due sometime during 2009.

With the recognized value of the rainbow trout, kokanee and sockeye salmon fisheries it would seem logical that much more funding is needed to understand and protect the related economical and ecological value of these species. Once again, it is recommended that the HRR lobby the Provincial and Federal governments for additional funding to create this report and an associated Horsefly River report in greater frequency than every six years. From a business perspective, a sustainable commodity such as these fisheries, and valued in the hundreds of millions of dollars, should warrant much more care and investigation than provided by government funding today.

9. McKinley Creek Flows and the Horsefly Channel

The McKinley Creek Flow Control Structure and the Horsefly River Sockeye Spawning Channel are both operated by Fisheries and Oceans Canada. Both facilities have been designed to enhance sockeye salmon in the watershed, however improper operating procedures in the past have possibly negatively impacted rainbow trout residing in the watershed.

It is recommended that dialogue between these two government departments on operational procedures be ongoing especially prior to and during periods of use. A meeting has been agreed upon by both parties for May of 2009 to discuss both of these facilities.

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