THE FISH TANK 2011

FINDINGS OF AN INLAND FISHERIES RESEARCH THINK TANK
February 23 – 25, 2011

Think Tank Location:

Dr. Max Blouw Quesnel River Research Centre
University of Northern British Columbia
Likely, BC

Organizing Committee:

Mr. Gord Sterritt
Northern Shuswap Tribal Council

Richard Holmes, MSc
Dr. Max Blouw Quesnel River
Research Centre

Daniel Lousier, PhD
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Sarah Hood
Northern Shuswap Tribal Council

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Sponsors:

Logos for: QRRC, Fraser Salmon Watershed Program, Pacific Salmon Foundation, and Cariboo Envirotech Inc.

THINK TANK SUMMARY – RECOMMENDATIONS FROM THE FISH TANK

The February 23-25, 2011 inland fisheries research think tank was organized by the Northern Shuswap Tribal Council, and met at the Dr. Max Blouw Quesnel River Research Centre in Likely, BC. The representatives of the lead c0llaborators formulated the following recommendations for consideration by their governments, organizations, institutions, and agencies:

(1) That **The Quesnel Watershed Fisheries Research Program** should be established and integrated with existing and future programs at the Dr. Max Blouw Quesnel River Research Centre, Likely, BC.

(2) That the **vision** for the Quesnel Watershed Fisheries Research Program is:
- ***healthy, breeding populations of all genetic variants of wild salmon utilizing the Quesnel River watershed (sustainable communities through sustainable salmon populations).***

(3) That the **mission statement** for the Quesnel Watershed Fisheries Research Program is to:
- ***design and implement a research and extension program addressing interior fisheries issues, with a focus on the Quesnel River watershed.***

(4) That this research and extension program will be collaborative and multi-disciplinary.

(5) That the **goals** of the Quesnel Watershed Fisheries Research Program are to:
- increase our knowledge and understanding of the biology, ecology, and behavior of the major fish species in the Quesnel River Watershed, especially salmon, bull trout and white sturgeon;
- identify and develop a protection strategy for productive fish spawning, rearing, and in- and out-migration habitat in the Quesnel River Watershed;
- identify and develop a protection strategy for productive fish in- and out-migration habitat in the Fraser River south of its confluence with the Quesnel River;
- increase resource managers' and decision-makers access to and utilization of the knowledge generated through the research and extension projects; and
- establish and maintain a communicative, functioning network of researchers and extension specialists to address the defined issues.

(6) That the research program be guided by a **Partnership Steering Committee**, currently comprised of representatives of the following institutions, agencies, and organizations:
- University of Northern British Columbia, Dr. Dan Ryan, Dean, College of Science and Management, University of Northern British Columbia, Prince George, BC;
- North Shuswap Tribal Council, Gord Sterritt, Williams Lake, BC; and
- Canada Fisheries and Oceans, Richard Bailey, Kamloops, BC.

(7) That someone should be hired to '**champion**' this initiative through its formative stages. The roles and responsibilities of the champion will be set by the Partnership Steering Committee.

This Fish Tank has resulted in some major steps forward in a possible resolution to the Pacific salmon crisis facing British Columbia. The Fish Tank participants and organizers ask that you recognize that this is a beginning of a process, not the end.

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ACKNOWLEDGEMENTS

We would like to take this opportunity to thank the participants of the workshop for travelling to Likely and dedicating their time over the 2.5 day workshop to bringing closer to reality, a goal, vision or pipedream of establishing a collaborative research program in the Quesnel Watershed. Whichever way it is perceived, it is ever more apparent that all are concerned with the future of our fish and willing to go the extra step to ensure the longevity of the resource.

Thank you to: Cariboo Envirotech Ltd. for their support and planning in this project; Erin Robinson and Sam Albers for their capture of ideas and logistical support; Sarah Hood from the Northern Shuswap Tribal Council for patiently getting us all in one room at the same time; and also to the caterers who ensured that everyone was fed well throughout the workshop. Also to the Fraser Salmon and Watershed Program for providing the resources to ensure this project occurred.

And lastly to Dan Lousier, for keeping the project alive and facilitating the process, Dan's familiarity of the history of the UNBC QRRC and dedication to seeing that "something" happens are very much appreciated.

Gord Sterritt
Northern Shuswap Tribal Council

1.0 RECENT EVENTS

1.1 Spring 2010

In late spring 2010, discussions with a number of stakeholders and Cariboo community members raised a number of concerns and questions with regard to the long-term survival of the Pacific salmon species, especially after the disastrous 2009 salmon runs. Representatives from the Northern Shuswap Tribal Council and Canada Fisheries and Oceans recommended that a think tank be organized to identify and discuss the knowledge needs for the inland portion of the salmon life cycles, and the possibilities of initiating an inland fisheries research program.

1.2 2011 – The Year of the Phenomenal Sockeye Returns

One of the truly great "good news" stories of the past several years in British Columbia is the outstanding returns seen for the Adams River sockeye run early last autumn, 2010. If there was any doubt that the **wild** salmon is iconic in this province, that doubt should have been erased completely. All the stakeholders were astonished at the size of the run, and all segments of the fishing industry seemed very happy to be able to capture 11-12 million sockeye. Perhaps the most interesting response was the reaction of the public – the enthusiasm and awe expressed by people flocking to the docks to buy fresh sockeye. Contrast this situation with that of 2009 when the sockeye return numbers (and indeed numbers for other returning species) were devastatingly low. Because numbers of returning salmon have been on the general decrease for the past 20-25 years, nearly all segments of the British Columbia fishing sector had accepted the eventual loss of commercial salmon fishing (and perhaps all salmon fishing) and perhaps even the loss of the salmon species themselves from British Columbia waters.

What we witnessed was the tremendous impact such salmon runs can have on the fishing and fish-processing industries. It is equally important to also recognize that such runs of sockeye in particular, and salmon in general, have substantial social and cultural impacts as well. However we choose to examine and explain this 2010 phenomenon, we have seen first-hand evidence of the ecological, social, cultural and economic importance of the Pacific salmon. We have seen an unprecedented example last year of how **one** run of **one** species of salmon can feed not only the First Nations along the south coast and the Fraser River but also all the other communities in the same area.

1.3 What Did Happen in 2010?

According to a recent report:[1]

> *"About 29 million Fraser River sockeye salmon returned to the coast this year. This was the largest return since 1913, and well above the 11 million that had been forecast. This high return was in strong contrast to the trend since the early 1990s of declining productivity of the Fraser, culminating in only 1.5 million Fraser sockeye returning last year. This sudden reversal of fortunes has led to questions about science and management….:*

The report also described the aggregate return of Fraser sockeye for 2010 as somewhat mixed:

[1] Fraser S0ckeye 2010 – Findings of a Scientists' Think Tank, Speaking for the Salmon Program, Simon Fraser University, Vancouver, BC. December 6, 2010

> *"While returns were higher than forecasts for most stocks, the strong aggregate return was driven largely by fish from the Adams River, which has high runs every four years, including 2010. There were also stronger than average returns to the Harrison and Chilko Rivers, which, like the Adams, are in the lower-to-middle part of the watershed. In contrast, returns were still below average for populations in the upper watersheds, such as the Early Stuart complex that spawns in areas around Takla and Stuart lakes northwest of Prince George. Thus, while aggregate returns to the Fraser watershed were indeed exceptionally high, this was only true for a subset of tributaries. The Fraser watershed was not full of fish."*

The 2010 Think Tank posed two fairly solid factors contributing to this large return:

(1) In 2006, continuing low returns had led to reductions in the fishery in order to protect the spawning population. This allowed the sixth highest number of fish to reach the spawning grounds since 1952 and possibly since the Hells Gate slide in 1913. The large number of spawners five years ago was one reason for the large number of fish which returned in 2010.

(2) A second contributing factor for the large 2010 returns was cooling coastal ocean temperatures in early 2008 when the fish which returned in 2010 were juveniles entering the sea. Cool temperatures support food webs, including those for energy-rich zooplankton, which are favorable to growth and survival of juvenile sockeye salmon.

In sum, what we observed in 2010 was a return to the historical average of productivity seen in the 1970s. Were the favorable ocean conditions a one-time event or mark a return to more favorable conditions observed in the past? Since we lack adequate and sufficient information on pathogens and parasites on salmon farms along the migration route, the role of this potential factor in both the recent declines in marine survival and the remarkable turnaround in 2010 cannot be assessed.[2]

Something which has not received much publicity is that the average size of the individual sockeye is higher than normal.[2]

1.4 Lessons Learned

Two lessons learned are relevant to salmon in inland waters:

(1) Conservation efforts to permit fish from the parental generation to reach the spawning grounds can work very well. Combine this decision with more amenable ocean conditions which prevailed in 2008 and 2009 and it appears that we can make great management decisions. The think tank report ascribes this 'coincidence' more to luck than to skill and knowledge.

(2) The unexpected returns of 2010 emphasize the challenge of tracking and forecasting targets which move several thousand kilometers in their life cycles. Salmon survive or perish because of a number of different interacting factors during both the freshwater and marine phases of their life cycles.

[2] Brian Riddle, PhD, Pacific Salmon Foundation, and Richard Bailey, MSc, Canada Fisheries and Oceans, pers. comm.., February 24, 2011.

2.0 MOVING FORWARD – DECISION MADE

The December 2010 Think Tank made a strong statement about our 'collective uncertainty' pervading our salmon biological/ecological and management knowledge base, particularly after such dramatically different results from 2009 and 2010. We have no clear understanding of the relative roles of fisheries management, aquaculture, and climate change in determining salmon returns.[2]

The December 2010 Think Tank recommended that efforts be made to develop a coordinated multi-disciplinary research program to address the specific identified questions. The recommendation also included that research and knowledge transfer partnerships which are established "...should mobilize existing resources and studies, augmented by improved monitoring."

In our view, the conclusions of the December 2010 Think Tank meshed well with the objectives of the Fish Tank planned and delivered by the Northern Shuswap Tribal Council and supporters in February 2011.

> **The Likely Fish Tank agreed that The Quesnel River Watershed Research Program should be established and integrated with existing and future programs at the Dr. Max Blouw Quesnel River Research Centre.**

Implicit in this recommendation is the extension component of the program, in other words, how do we deal with the research results and implement them into operational practice?

3.0 MOVING FORWARD – LET THE PROGRAM BUILDING BEGIN

3.1 The Quesnel Watershed Fisheries Research Vision, Mission, and Goals

Vision – The vision for the Quesnel Watershed Fisheries Research Program is:

> ***Healthy, breeding populations of all genetic variants of wild salmon utilizing the Quesnel River watershed (sustainable communities through sustainable salmon populations)***

Mission – The mission statement for the Quesnel Watershed Fisheries Research Program is to:

> ***Design and implement a research and extension program addressing interior fisheries issues, with a focus on the Quesnel River watershed.***

This research and knowledge program will be collaborative and multi-disciplinary.

Goals – The goals of the Quesnel Watershed Fisheries Research Program are to:

(1) Increase our knowledge and understanding of the biology, ecology, and behavior of the major fish species in the Quesnel River Watershed, especially salmon, bull trout and white sturgeon.
(2) Identify and develop a protection strategy for productive fish spawning, rearing, and in- and out-migration habitat in the Quesnel River Watershed.

(3) Identify and develop a protection strategy for productive fish in- and out-migration habitat in the Fraser River south of its confluence with the Quesnel River.
(4) Increase resource managers' and decision-makers access to and utilization of the knowledge generated through the research and extension projects.
(5) Establish and maintain a communicative, functioning network of researchers and extension specialists to address the defined issues.

The wild salmon play a vital ecological role throughout the Fraser watershed:

- They provide food for many indigenous animal species along the waterways: e.g., species such as grizzly and black bears, bald and golden eagles, ravens, and wolves; and many scavenging species such as gulls, crows, and wolverines,.

- They are a substantial source of nutrition in the streams in which they spawn and then die. These nutrients either stay in the sediments and pools of the streams or are washed downstream to lakes and rivers.

- They are a significant source of nutrition in riparian and adjacent terrestrial ecosystems (an anadromous nutrient pump). This is brought about in two ways. At times, the animals preying on the spawning salmon and those animals scavenging salmon carcasses drag their catch up from the creeks and rivers, devour the fish, and leave portions of the carcasses on the forest floor. In addition, the concentration of animals around the streams during the spawning period results in an increased deposition of nutrient-enriched faeces to these areas.

Also, the salmon are an ecological gift to the people of British Columbia, a gift we can enjoy only if we begin to respect the nature and source of that gift, and the importance of that gift to plant and animal species along the Fraser waterways. Consider also that this gift is wrapped in water, a component of our natural capital which is becoming increasingly difficult to sustain. Water, watershed dynamics, watershed ecology, and impacts of climate change on watershed dynamics are central foci of current and future research programs at QRRC.

Our vision for healthy, breeding populations of all genetic variants of wild Fraser salmon must be a priority. This vision requires an ethic of no-net-loss (quality and quantity) of salmon habitat in any future industrial, agricultural or residential developments, and a commitment to habitat maintenance and restoration where required.

3.2 Integrating Programs

3.2.1 Quesnel Watershed Integrated Research Program – Initial Thoughts[3]

Initial thoughts expressed at the "QRRC Fish Think Tank" highlighted the need for an integrated approach for fisheries research in the BC interior and discussion led to the idea of using the Quesnel watershed as a focal area. Many of the important research questions focused on habitat, fish physiology/behavior, climate change, aquatic habitat, water quality, to name a few. In parallel, UNBC has been working on a conceptual model to create and grow a body of expertise in Integrated Watershed-based Science focused on Northern BC and global issues, and

[3] Initial thoughts compiled by Dr. Dan Ryan, Dean of College of Science and Management, and Dr. Ellen Petticrew, Joint-Chair, Landscape Ecology Program, after discussions held at Fish Tank in Likely, BC, February 23-25, 2011.

predominantly based out of the QRRC. In this context, a very initial concept of an expanded research and extension mandate for QRRC was proposed at the "Think Tank" and is captured in Appendix 1. The ideas presented here about QWFRP could easily overlap with the human and physical resources of this Integrated Watershed-based Research Program.

4.0 MOVING FORWARD – BUILDING PARTNERSHIPS & GOVERNANCE

4.1 Partnerships – Lead Collaborators

The initial collaborators in the Quesnel Watershed Fisheries Research Program (QWFRP) are those who attended the Fish Tank and who are the following, in no particular order:

- Northern Shuswap Tribal Council, Williams Lake, BC
- Xat'sull Nation, Soda Creek, BC
- T'exelc Nation, Williams Lake, BC
- Dr. Max Blouw Quesnel River Research Centre, Likely, BC
- College of Science and Management, University of Northern British Columbia, Prince George, BC
- Landscape Ecology Program, College of Science and Management, University of Northern British Columbia, Prince George, BC
- Canada Department of Fisheries and Oceans, Kamloops, BC, and Cultus Lake, BC
- BC Ministry of Environment, Williams Lake, BC
- Likely/Xat'sull Community Forest, Likely, BC
- The Land Conservancy, Prince George, BC
- The Horsefly River Round Table, Horsefly, BC

4.2 Partnerships – Steering Committee

It was recommended that the Quesnel Watershed Fisheries Research Program should be led in its formative stages by a Partnership Steering Committee whose main responsibilities might include:

- Facilitating the establishment and implementation of a research and extension program to address the knowledge gaps in inland fisheries management by:
    - working with UNBC/QRRC to assist in the building of the infrastructure to achieve Goal 1 and 2; and
    - providing advice and insight to establish financial stability to sustain the program.

The think tank did not have the opportunity to have an open and thorough discussion about the Partnership Steering Committee, its composition and its function. Such a discussion should be one of the first steps on the road to developing a world-class inland fisheries research program.

Members – The Partnership Steering Committee should include representatives of the following institutions, agencies, and organizations:

- University of Northern British Columbia, Dr. Dan Ryan, Dean, College of Science and Management, University of Northern British Columbia, Prince George, BC;

- North Shuswap Tribal Council, Gord Sterritt, Williams Lake, BC; and
- Canada Fisheries and Oceans, Richard Bailey, Kamloops, BC.

The Fish Tank deemed that the Provincial government (perhaps through the Ministry of Environment) should be represented on the Partnership Steering Committee, but participation of the Provincial government was not possible at the time of the think tank. Possible terms of reference for the Partnership Steering Committee are given for consideration in Appendix 2.

4.3 Partnerships – Project Champion

The suggestion was made that someone should be hired to 'champion' this initiative through formative stages. A **project champion** is usually an individual who has the authority to use resources within an organization for completion of a given project. A project champion is generally chosen by management so as to ensure supervision of a specific project so that the specific objectives are met. Information on the potential role and traits of an effective champion is presented for consideration in Appendix 3.

5.0 MOVING FORWARD – BUILDING INFRASTRUCTURE

5.1 Location

The recommended location of the core research program is the Dr. Max Blouw Quesnel River Research Centre (University of Northern British Columbia) located in Likely, BC.

5.2 Landscape and Waterscape

The landscape and waterscape of relevance to the QRRC are illustrated on three maps on the QRRC website:

(1) catchment area – http://www.unbc.ca/assets/qrrc.dem.pdf,
(2) land cover classification – http://www.unbc.ca.ca/assets/qrrc.landcov/.pdf, and
(3) biogeoclimatic units – http://www.unbc.ca/assets/qrrc/becplot.pdf.

QRRC is located on the Quesnel River in the foothills of the Cariboo Mountains. It is surrounded by lakes, rivers, and streams that act as linkages to the various landscapes in the area. A wide variety of habitats, from grasslands to glaciated mountain peaks, is located within a short drive of the research centre.

5.3 Facilities and Equipment

QRRC is a well-equipped field research centre capable of handling of variety of research projects.

6.0 MOVING FORWARD – IDENTIFICATION OF KNOWLEDGE NEEDS

6.1 Major Themes

For the initiation of this program, the Fish Tank broke the knowledge gaps into three general themes:

(1) basic biology: life history, behaviour and plasticity for interior and anadromous and resident fish species (especially coho, chinook, large lake rainbow trout, cutthroat throat, bull trout, and white sturgeon);

(2) basic ecology: habitat requirement and availability at all stages of the inland life cycle; and

(3) impacts of climate change on fish species, behavior and plasticity, on inland habitat quality and quantity, and on interactions among terrestrial and aquatic ecosystems processes.

6.1.1. Basic Biology – Life history, behaviour and plasticity

Despite: (a) how long we in British Columbia have been fishing salmon commercially, (b) how much time, money and effort have been invested in salmonid research and monitoring studies, including enhancement programs, we do not know enough about the basic biology of salmon spawning in the interior of British Columbia. When we consider that there are in excess of forty breeding populations of sockeye salmon alone, some of this lack of knowledge can be explained. Part of this lack may be explained away also by temporal and spatial limitations, inconsistencies of time-series data sets, a lack of coordination of research and monitoring efforts, and a lack of cooperation and agreement on management strategies. And, it appears to the general public, that the Pacific salmon situation is becoming more and more critical, despite all the efforts to try and understand what we do not understand.

Perhaps the first key question is, "What do we know of the basic biology of salmon spawning in the interior of British Columbia?" It is expected that the current Cohen Commission will address a large piece of this unknown.

Other key questions might include:

(1) What is the natural phenology of in-migrating and spawning populations?
(2) What is the natural phenology of growing and out-migrating populations?
(3) What are the salmon's ecophysiological requirements during spawning, incubation, rearing, and out-migration?
(4) What factors initiate spawning activity?
(5) What are the natural life-stage-size relationships within species of salmon?
(6) What environmental stimuli are important at what life stage of the salmon?
(7) What are the threshold levels for the critical ecological factors, e.g., water temperatures, dissolved oxygen, living space, siltation level, and dissolved nutrients?
(8) Are the correct food types and quantities thereof available to the rearing and out-migrating populations?
(9) What is the health status of out-migrating salmon?
(10) What is the health status of in-migrating salmon?

A key basic biological knowledge gap which has emerged relates to the estimation of smolts in the Fraser River. This is a multi-faceted gap with key questions including:

(1) What is the freshwater productivity of smolts in the Fraser River?
(2) What are the details of the smolts' life history, physiology and behavior in the Fraser, particularly during over-wintering?
(3) What are the estimations of over-winter survival of smolts in the Fraser?

This knowledge gap is particularly difficult to address since technology currently does not exist for cost effective and efficient tagging of smolts. There is a need for innovative advances in the technology with which to study and monitor long-distance migrating salmon. A similar situation exists for complications resulting from periphyton lugging up sampling nets.

The December 2010 Think Tank report also raised the issue of mortality of fish during their upstream migration and prior to spawning as an on-going concern in the Fraser. One of the key factors in such mortality is thought to be water temperature. How do local and annual weather conditions affect up-stream migrations of salmon? What will be the growing challenges facing the Fraser salmon as a consequence of climate change?

6.1.2 Basic Ecology: Habitat Requirement and Availability

There are some significant habitat concerns, both freshwater and marine, with regard to the sustainability of fish life in the Fraser River, particularly for salmon. These habitat concerns are, for the most part, because of industrial, agricultural and residential developments and operations. Some of the more challenging concerns include:

(1) Industrial activities in watersheds have led to increased levels of siltation and sedimentation in streams home to spawning salmon. This is of particular concern in the slower-moving, smaller streams located mid- and higher-levels in the watersheds. As water tends to run downhill, the downstream siltation and sedimentation impacts tend to be cumulative.

(2) Industrial activities throughout the Fraser watershed have generally not recognized the importance of riparian ecosystems to surrounding terrestrial ecosystems or, in particular, to aquatic ecosystems home to spawning salmon and freshwater species of fish. Many riparian ecosystems have disappeared because of industrial activities in British Columbia.

(3) Forest harvesting has increased the exposure of streams, particularly the smaller streams, to increases in water temperatures, surface run-off, debris accumulation, mass wasting, landslides, and channel disturbance. Streams have traditionally been seen as a barrier or constraint to overcome in forestry operations, not as a natural resource which is part of the province's natural capital.

(4) The pulp and paper industries in the Fraser watershed have been dumping effluent into the Fraser River for decades. While substantial investments have been made in cleaning up the effluent as much as possible, the Fraser is still being used as an industrial sewer. Is such effluent having an effect on the habitat of migrating sockeye?

(5) Mining activities have, in many cases, completely disrupted watersheds (including lakes), and caused increases in run-off rates, stream-water temperatures, and the toxic chemical content of stream and lake waters. Placer mining has a long history in the central part of British Columbia, and has produced several examples of severe disruption of salmon habitat (e.g., Quesnel River, Bullion Pit). And, the province continues to consider mining proposals which will result in the destruction of salmon-producing waterways.

(6) The use of inorganic fertilizers and pesticides in the industrial-scale agriculture industries along the Fraser River has been a source of pollution for many years.

(7) Riparian ecosystems and streams in areas of open grazing range have been severely impacted by grazing cattle in the interior. Such activities have resulted in decreased availability of riparian habitat, increased siltation and sedimentation, and increased manure deposition in salmon-spawning streams.

(8) Residential developments have disrupted floodplains and stream channels in different areas throughout the Fraser watershed, resulting in severely-compromised riparian ecosystems, and in concentrated run-off (during storms, for example), and increased pollution from particulate material and toxic chemicals.

(9) Groundwater is believed to be an important spawning and rearing habitat component during low-water periods in interior streams. We have little or no knowledge of the impacts industrial activities have on such groundwater sources and supplies.

Habitat Needs and Availability – Key Questions

General Habitat

As with any living organism, fish have certain habitat requirements: space, clean water, clean air, and food to eat. Are these basic habitat needs being met throughout the Quesnel River drainage for incubating and out-migrating salmonids?

(1) What impacts are we having on the quality and quantity of water in the rivers, lakes, and creeks used as migration channels?
(2) What impacts are we having on the quality and integrity of incubating (spawning and rearing) habitat?
(3) What role does groundwater play in sustaining the quantity and quality of salmon incubating habitat?
(4) How much of the available spawning and rearing habitat has been mapped? How long ago? How reliable are the data? Do we have reliable time series data?
(5) Can technology provide us with comprehensive and useful habitat maps for entire drainages?
(6) How reliable are the estimates of the out-migration numbers of salmon? Are these estimates reflective of productivity potential within these streams?
(7) What are the ecological triggers which cause the switch from usage of spawning to rearing to out-migration habitat?
(8) What is required for maximum spawning success and out-migration from the interior streams and lakes?
(9) Is there a need for an enhanced Salmonid Enhancement Program to provide hatchery-produced fry for release in those streams which have sockeye runs in jeopardy?

Lake Studies

There is a myriad of factors which affect salmonids during their migrations though or residency within in a lake environment. It is through landscape-level processes that lakes can provide the necessary stability and productivity at the ecosystem level for the salmonids to thrive.

(1) We need to continue and support, or establish, lake productivity studies throughout the Quesnel River drainage.

(2) It is within lakes that incubating fish may face their greatest early-life predation pressures. What are the species of predatory fish and what are the quantifiable impacts on out-migrating salmonids?
(3) What are the impacts of the recreational and residential developments on lakeshore on availability and quality of salmon habitat?

Quesnel River

For many decades, the Quesnel River drainage has been a site for a number of industrial activities (e.g., placer and open-pit mining, forestry harvesting and road-building, increased residential and recreational settlements).

(1) What invasive animal and plant species are gaining access through the Quesnel River?
(2) How are in-river and upstream habitat conditions providing preferred habitats for invasive species?
(3) What have been the effects of historical industrial and residential development activities on floodplain and channel stability, down-stream flows, mass wasting, debris flows, and fish production?
(4) Are current operations (e.g., Hazeltine Creek and Mt. Polley) being monitored correctly to determine actual impacts on fish productivity?
(5) What are the impacts on habitat uses for other purposes: e.g., jet boats for recreational purposes?

What happens to marine-derived nutrients (MDNs)?

It is only within recent years that spawning salmon have been recognized as a significant nutrient source in riparian and adjacent upland forest ecosystems, as well as in the streams in which the fish migrate, spawn and grow. Much of this nutrient deposition comes from the carcasses of adult salmon after they have spawned and mortality has occurred. A number of animals, e.g., bears, wolves, eagles, gulls, and ravens, devour dead or dying fish and distribute fleshy and other debris throughout riparian and upland ecosystems.

(1) What do MDNs mean to the fry survival and growth of salmon (inter-intra specific)?
(2) Can the mass balance of MDNs be quantified (including annual variation)?
(3) How much of this mortality is pre-spawning? How much occurs on the spawning beds?
(4) How much of this mortality is in rearing areas?
(5) Impacts of DFO practice of creating 'pitch piles' on nutrient flow?

6.1.3 Impacts of Climate Change

In general, we expect that there will be significant impacts of climate change on fish species, behavior and plasticity, on inland habitat quality and quantity, and on interactions among terrestrial and aquatic ecosystems processes. One of the initial critical variables is how rapidly these changes will occur in our open, glacial-fed watershed.

Local, regional and global climate patterns are changing, with several potential effects on the Fraser sockeye. What are the impacts of increasing mean daily temperatures in terrestrial ecosystems which surround the streams and lakes? What are the cumulative impacts on water temperatures, acidity, and oxygen levels in the Pacific Ocean?

Climate Change – Key Questions

(1) What is the rate of change in long-term weather/climate variables in the Quesnel River Watershed?
(2) What are the anticipated effects on local terrestrial ecosystems?
(3) What are the anticipated effects on aquatic ecosystems?
(4) What are the anticipated effects on terrestrial activities on the land?
(5) What are the anticipated effects on aquatic activities on the water?
(6) What are the anticipated long-term effects on fish biology and behavior ?

One of the keys to tracking the impacts to climate change and the changes/accommodations those impacts necessitate will be the accessibility and amenability of the long-term weather and climate data base for the rigorous statistical analysis to which such climate data will have to be submitted. Even simple questions such as, "Was the monitoring equipment in the correct location?" will have a bearing on analytical outcomes.

6.2 Knowledge Transfer

We in British Columbia truly do not have a handle on the full ecological, social, cultural and economic impact. It appears that once the fish are beyond the Mission-Hope stretch of the Fraser River, the residents of the Coast and the Lower Mainland tend to forget about them. And, we tend to forget also that:

(1) some species, such as the sockeye, generally have a four-year return cycle;
(2) there are in excess of forty breeding populations of wild sockeye which migrate to various rivers through the Fraser Basin;
(3) we have not been kind to the quality of the salmon-spawning habitat throughout the interior;
(4) the Fraser River Basin covers a huge portion of the province and collects run-off and pollutants from different industries, in particular the forest industry, mining operations, and agriculture, and from many different communities; and
(5) we have little understanding about the salmon's life in the high seas, especially the sockeye which spend one to four years in the Pacific Ocean.

Rather than pointing our fingers at different resource management agencies (federal and provincial), we need to look seriously at the perceptions of society as a whole in order to begin to think meaningfully about being able to sustain our wild Fraser River sockeye, and indeed all the other wild salmon species as well. Thus, the importance of the knowledge transfer part of the Quesnel Watershed Fisheries Research Program.

- Fisheries management is no longer exclusively a researcher/academic topic. As a national, natural resource, do other natural resources have a more storied past than that of our fisheries? On an issue for which everyone considers him- or herself an 'expert,' there are many end-users of information and knowledge produced through fisheries science projects/programs. Too many instances of 'government science' versus 'industry science' versus 'university science' versus 'First Nations science' have occurred in many a public, resource management, or geopolitical arena.

- For several years now, we have sitting on an enormous information base we have been unwilling to acknowledge as meaningful and useful – the traditional knowledge of the indigenous peoples. We have used words such as "anecdotal,' 'unscientific,' and 'unrecorded,' to down-grade the value of this information base. Despite our best western

scientific ways, this information base will not disappear – it is stilled valued, revered, and utilized by our indigenous colleagues because it is the word of their ancestors.

- One of the obvious benefits of knowledge transfer projects/programs is that the learning experience can be shared with a much larger number of people who might be interested only because they live in the relevant communities affected by a resource management issue. One of the less obvious (but equally important) benefits of the knowledge transfer process is that the end-users have the opportunity to test the messengers' listening powers.

- As a small, research-intensive university in Canada, the University of Northern British Columbia has been awarded three significant endowed research chairs through Forest Renewal British Columbia. One of the roles undertaken by these research chairs is extension, the delivery of research results to the stakeholders and communities. QRRC has an active and growing extension/outreach program, with UNBC faculty and graduate students working to connect with local communities by: (a) conducting tours of the research centre and field tours at research sites, (b) working with local resource roundtables and naturalists groups, (c) providing presentations at the annual open house, and (d) being open to community members who express interest in the centre and the research projects. This Fish Tank has indicated that UNBC is actively involved in increasing human resources to support more extension, particularly as it can help to integrate a fisheries research program into an integrated watershed science program. What is presented in Appendix 1 represents a significant mechanism for linking science to the stakeholders and communities, which if realized should improve the university's role in natural resource management and sustainable communities.

The operational and research merits of the extension portion of the research program will become more and more apparent as we work through the machinations of developing a fisheries research program.

APPENDIX 1. QWIRP – Quesnel Watershed Integrated Research Program[4]

Initial thoughts expressed at the "QRRC Fish Think Tank" highlighted the need for an integrated approach for fisheries research in the Quesnel Watershed, which could form part of the broader research efforts ongoing and planned for the QRRC.. Many of the important research questions focused on habitat, fish physiology/behavior, climate change, aquatic habitat, water quality, to name a few.

In parallel, UNBC has been working on a conceptual model to create and grow a body of expertise in Integrated Watershed-based Science focused on Northern BC and global issues, and predominantly based out of the QRRC.

In this context, a very initial concept of an expanded research and extension mandate for QRRC was proposed at the "Think Tank" and is captured in Figure 1. This model requires further work and discussion both within UNBC and with the broader community.

1.0 Existing Resources at UNBC Related to the QRRC:

A: Endowed Research Chairs in Landscape Ecology - Focused on integrating the effects of changes to the landscape on water resources. Research is based largely out of the Quesnel watershed.

B: **Canada Research Chair in Northern Hydrometeorology** – Focused on hydrometeorology with an emphasis on snow and ice, and the relationship to the physical water supply in the Fraser Basin, with a commitment to maintain research within the Quesnel watershed.

C: Canada Research Chair in Health, Ecosystems and Society –Focused on the social aspects of community health and how water acts an integrating factor. Research is based out of the Fraser Basin with an interest in expanding and linking to research within the Quesnel watershed.

D: Fish Physiology –Focused on fish physiology process, with interest in the behavior and habitat, and an interest in increasing work at the QRRC.

2.0 Proposed Additional Resources to Grow Out the Mandate of the QRRC:

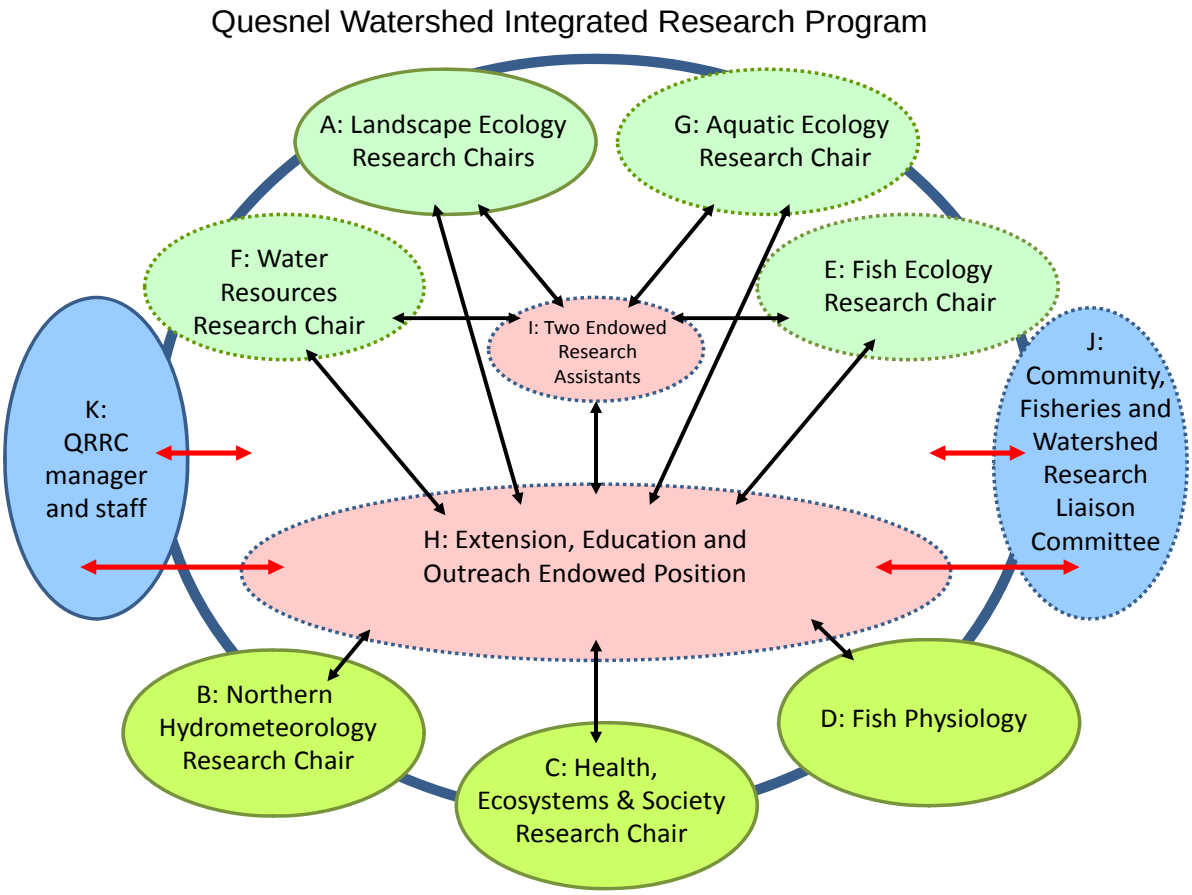
Please note that these ideas are ***preliminary*** and the focus of the proposed resources is currently general and subject to further discussions.

E: Fish Ecology Research Chair – Focused on fish habitat and behavior and the relation to the aquatic environment. Research to be carried out largely in the Quesnel watershed.

F: Aquatic Ecology Research Chair – Focused on integrating knowledge related to the ecology of freshwater streams, rivers and lakes. Research to be carried out largely in the Quesnel watershed.

Figure 1. Quesnel Watershed Integrated Research Program

[4] Initial thoughts compiled by Dr. Dan Ryan, Dean of College of Science and Management, and Dr. Ellen Petticrew, Joint-Chair, Landscape Ecology Program. after discussions held with Dr. Dan Lousier and Mr. Gord Sterritt at Fish Tank in Likely, BC, February 23-25, 2011.



G: **Water Resources Research Chair** – Focused on integrating knowledge related to water with the physical and biological aspects of watersheds. Research to be carried out largely in the Quesnel watershed.

H: **Extension, Outreach and Education Endowed Position** – A unique position focused on connecting the community to the scientific resources at the QRRC. The individual in this position would focus on:

1. working as a liaison between the community and researchers to identify "on the ground" opportunities to link the resources of the research group (research skills, knowledge base, networks) to issues identified by the community
2. working with the community on teaching/mentorship in the Quesnel watershed; specifically science outreach to community groups, and connecting the community to the science related to the watershed
3. working in conjunction with the community and researchers to develop research teams, proposals and identify funding for "on the ground" research opportunities in the watershed

I: Two Endowed Research Assistant positions to support and maintain the QRRC equipment, endowed chair field projects and long-term monitoring programs in the watershed.

J: Community, Fisheries and Watershed Research Liaison Committee – An independent community group dedicated to identifying research opportunities and working with the Extension, Outreach and Education Endowed Position to carry this research out either through the QRRC, with aid from the larger UNBC research faculty, or on their own with the guidance and input from the QRRC research group

K: QRRC manager and maintenance staff

APPENDIX 2. Possible terms of reference for the Partnership Steering Committee.[5]

The QRFRP represents a number of types of partnerships which we have not seen often in the northern research and knowledge sector, and which affect a major international natural resource management problem: this partnership could involve national governments (including First Nations), international agencies, international universities. Growing the number and increasing the quality and effectiveness of these partnerships will be a challenge for the Steering Committee.

The primary functions of the Partnership Steering Committee might be to:

- provide a liaison service between the research and knowledge project and the government agencies responsible for implementing the results of the project(s);
- provide scientific and resource management guidance to and oversee the development, planning and implementation of the core research and knowledge transfer project;
- encourage the promotion and wide awareness of QRWRKP amongst their science communities;
- demonstrate progress and achievements of the project through the definition and monitoring of milestones and results;
- encourage national governments, regional and international funding agencies to support the implementation of the QRWRKP, and the achievement of QRWRKP goals through the provision of adequate support to the necessary national, regional and international research;
- encourage collaboration between QRWRKP and other international programs and agencies concerned with the scientific study and assessment of the impacts of global change; and
- build additional research partnerships as relevant and appropriate (e.g., up-river communities and salmon populations).

In undertaking these responsibilities, the Partnership Steering Committee should collectively:

- meet approximately twice a year with QRWRKP to review progress in the development and implementation of the core project and to advise the Committee Chair and the lead researchers(s) of the scientific and resource management developments which are important to the completion of the research projects or to the design and implementation of knowledge transfer projects;
- prepare and revise guidelines for the conduct of meetings, workshops, and conferences designed to assist the Steering Committee in executing its program management and extension functions;
- develop guidelines for the preparation, publication and distribution of substantive and technical reports resulting from the core research project(s); these are not the scientific, peer-reviewed publications resulting from the research; and
- develop and implement a transparent methodology for monitoring and assessing progress; this tool will be of prime importance when it is used in a public context; and
- assist in securing financial and other support for the execution of the core research project(s) adopted and approved by the Committee.

[5] Compiled by D. Lousier and presented here in support of the think tank recommendation.

APPENDIX 3. Possible role and traits of an effective project champion.[6]

Roles of a Project Champion – A project champion acts as a single point of contact between the people responsible for executing a project, including the project manager and the top management. The following are the key roles played by a project champion – he/she works with the Partnership Steering Committee (PSC) to:

- set benchmarks associated with the project and periodically reviews a project's success in meeting the benchmarks set;
- modify the scope of a project based on its status;
- grant or dismiss additional resources requests based on the modification of the scope;
- monitor the developments and changes in the project and act as a guide to drive the execution of a project successfully;
- help in eliminating any obstacles which hamper a project's success by conducting a risk assessment of a project;
- ensure best practices are deployed by the team while executing a project;
- make decisions on prioritizing individual project phases so as to eliminate redundancies while executing a project;
- make a note of the best practices and focuses on obtaining continuous improvement while executing a project; and
- report to the top management about the status of the project.

Traits of a Good Project Champion – The top management of an organization may find the task of choosing a good project champion to be challenging. This is mainly because of the demanding nature of the job responsibilities that a project champion handles. Choosing the right project champion can determine the outcome of a project to a certain extent. Some of the traits that should be considered for a Project Champion are as follows:

- (S)He must have a good understanding of the nature of the project(s) being implemented; a good understanding of the biophysical, ecological, cultural, social, and economic significance of the project(s).
- (S)He must have a good knowledge of the partnerships necessary for such a project to succeed.
- (S)He should be inspirational enough to motivate the PSC and draw the best out of them in terms of work performance.
- S(H)e should be able to achieve results with minimal or no errors while monitoring the entire execution phase of a project.
- S(H)e should have the ability to handle an integrated team and delegate the work by identifying the team's areas of strengths.

[6] Compiled by D. Lousier and presented here in support of the think tank recommendation.

APPENDIX 4: List of Participants

INTERIOR FISH TANK SESSION
DR. MAX BLOUW QUESNEL RIVER RESEARCH STATION

FEBRUARY 23 – 25, 2011

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