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REPORT ON

Mountain Pine Beetle Threats to Salmon and Fisheries Resources in BC: Proceedings of the Pacific Salmon Foundation and Fraser Basin Council Workshop (January 30-31, 2007, Prince George)

Submitted to:

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EXECUTIVE SUMMARY

Mountain pine beetles (MPB) (*Dendroctonus ponderosae*) are currently expanding their distribution and levels of infestation in BC pine forests at rates greater than previously experienced. The enhanced range and distribution of MPB is strongly linked to climate change conditions associated with warmer winters and longer growing seasons in interior British Columbia. Little is known about the full range of potential MPB impacts on forests and the implications to aquatic ecosystems, and in particular, sensitive salmon and fisheries habitats. The “**Mountain Pine Beetle Threats to Salmon and Fisheries Resources in BC**” workshop was convened in Prince George, late January 2007 to address:

1. The state of knowledge and the many questions around MPB infestations in our forests, and,
2. The short and long term threats to Pacific salmon, resident fish, aquatic resources and habitats.

The MPB - salmon workshop attracted over 70 participants from First Nations, agency staff, non-government organizations (NGO) and industry. Workshop presentations were given and workshop participants were asked to comment on the history and management of MPB, industry and First Nation perspectives, current research, and planning tools. Workshop participants entered into broad ranging conversations about the issues, areas of concerns, as well as the next steps to planning and potential management strategies to understand and respond to MPB forest infestation threats to salmon and fisheries resources.

Workshop participants agreed that fisheries issues, particularly those of sensitive salmon and salmonids resources, need to be protected from threats of MPB forest infestations and managed proactively to conserve resources. Participants suggested that the next steps should develop key planning and communication initiatives to focus on understanding and engaging interest on:

- Providing workshops and other forums to more fully open and engage discussion on MPB threats to salmon and fisheries among multiple groups from First Nations, agencies, NGOs and forest industry;
- Work with forest industry, First Nations and federal and provincial agencies to develop proactive rather than reactive management strategies and programs for monitoring and research; and to facilitate adaptive management responses for protection, conservation and restoration of salmon and fisheries resources affected by MPB infested forests; and,

- Work with interested parties to develop a smaller more focused working group to consider existing management regimes; identify regulatory and statutory mandates; resource protection and conservation strategies; and First Nation and industry perspectives to move discussion, communication, planning and management initiatives forward in regimes of 5 to 50 years to respond to the loss of forest function and the implications of aquatic, salmon and fisheries resources and habitats in BC.

ACKNOWLEDGEMENTS

We acknowledge funding and support from Pacific Salmon Foundation and Fraser Basin Council to facilitate and coordinate this workshop. Pacific Fisheries Resources Conservation Council helped coordinate note taking throughout the workshop. Fisheries and Oceans Canada contributed staff time and energy to help build discussion on the mountain pine beetle and salmon potential interactions. Golder Associates assisted in organizing, coordinating and facilitating the workshop process and reporting on workshop proceedings.



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1.0 INTRODUCTION

Mountain pine beetle (MPB) infestations of British Columbia's pine forests have spread at an unprecedented rate, due in part to climate warming trends (Carroll et al. 2004). Little is known about the full range of potential MPB impacts on forests and the implications of the loss of forest natural function to aquatic ecosystems (Bunnell et al. 2004). "**Mountain Pine Beetle Threats to Salmon and Fisheries Resources in BC**" was a workshop convened in Prince George, January 2007, to address the state of knowledge and the many questions around MPB infestations in our forests and the short and long term threats to Pacific salmon, resident fish, fisheries, aquatic resources and habitats in BC.

The workshop originated from the Fraser Salmon and Watersheds program through efforts by the Pacific Salmon Foundation (PSF) and the Fraser Basin Council (FBC) to address threats to salmon and sustainability issues in the Fraser River watershed. The workshop was convened to bring together diverse groups to begin a discussion on the pressing issue of:

- Climate change, MPB infestations and the potential threats and consequences to wild Pacific salmon and fisheries in BC to further planning, and,
- Adaptive management solutions.

As the first step, the workshop objectives addressed three primary questions:

1. What management is happening on-the-ground in MPB infested forests?
2. What monitoring is being undertaken to understand the impacts of MPB infested forests on salmon, resident fish and their habitats?
3. What future adaptive management and planning, linking our forests and rivers, should be developed to protect, conserve and manage our salmon, resident fish and fisheries resources?

The "**Mountain Pine Beetle Threats to Salmon and Fisheries Resources in BC**" workshop was organized around four specific themes and sessions (see Appendix I for Agenda):

- **Session 1:** Climate impacts, history and management of MPB in BC;

- **Session 2:** Knowledge and understanding of the links between MPB infestations, wild salmon resources and communities, industry and salmon and fisheries resources;
- **Session 3:** Future planning, management and implications of MPB on salmon resources; and,
- **Session 4:** Management approaches and next steps.

The following Proceedings is a summary of the “Mountain Pine Beetle Threats to Salmon and Fisheries Resources in BC” workshop including:

- Sessions presentation summaries and breakout discussions;
- Conclusions and recommendations regarding management priorities for assessing impacts and adaptive management responses;
- Workshop contacts and agenda (Appendix I); and,
- Workshop information backgrounder on salmon and MPB (Appendix II), list of conference participants (Appendix III), and a reference and citation list (Appendix IV).

1.1 Workshop Contacts

The workshop was organized by Pacific Salmon Foundation (SPC) and the Fraser Basin Council (FBC) through work with Golder Associates Ltd. and funding from the Living Rivers Fund and the Fraser Watershed Program. An advisory committee was used to help focus and build content and participation in the workshop. The following key contacts led the development and implementation of the workshop.

- Mark Johannes: Workshop Coordinator and Facilitator, Senior Biologist, Golder Associates, mjohannes@golder.com
- Alan Kenney: Director, Fraser River Recovery, Pacific Salmon Foundation (now Senior Environmental Specialist, Golder Associates), akenney@golder.com
- Bill Granger: Manager, Fraser Salmon and Watershed Program, Pacific Salmon Foundation, bgranger@psf.ca
- Mark Saunders: Director, Fraser Salmon and Watershed Program, Pacific Salmon Foundation, msaunder@psf.ca

1.2 Workshop Advisory Committee

The following individuals contributed to development of the workshop content and coordination through the advisory committee.

- Peter Delaney: Fisheries and Oceans Canada, delaneyp@pac.dfo-mpo.gc.ca
- Coral deShield: Fraser Basin Council, cdeshield@fraserbasin.bc.ca
- Gordon Ennis: Pacific Fisheries Resource Conservation Council, ennis@fish.bc.ca
- Richard Holmes: UNBC, unbcqrrc@laketown.net
- Jason Hwang: Fisheries and Oceans Canada, hwangj@pac.dfo-mpo.gc.ca
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- Nick Leone: Fisheries and Oceans Canada, leonen@pac.dfo-mpo.gc.ca
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- Chris Ritchie: Ministry of Environment, chris.ritchie@gov.bc.ca
- Marcel Shepert: Upper Fraser Fisheries Conservation Alliance, mars_shepert@shaw.ca
- Art Tautz – Ministry of Environment, art.tautz@gov.bc.ca
- Peter Tschaplinski – Ministry of Forests and Range, peter.tschaplinski@gov.bc.ca
- Alan Wiensczyk – FORREX, alan.wiensczyk@forrex.org

1.3 Workshop Attendance

A total of 75 people attended the workshop and participated in discussions (66 participants provided contact details, attached in Appendix 3). Participants represented a variety of organizations and affiliations from across BC's forest and fisheries sectors (Figure 1).

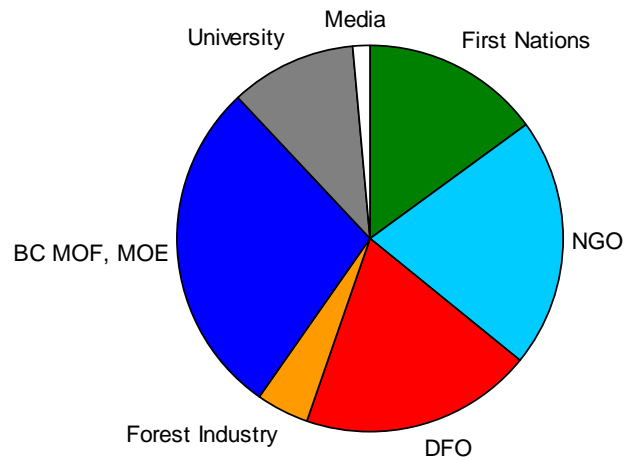


FIGURE 1: Workshop Participant Affiliation

2.0 SESSION 1: WORKSHOP INTRODUCTION, GOALS AND FRAMEWORK

Workshop **Session 1** provided an introduction to the workshop and the state of knowledge on climate impacts, MPB history and management in BC. Pacific Fisheries Resource Conservation Council (PFRCC) provided workshop note taking covering the presentations and discussions can be shared with all participants. Summaries of presentations from Section 1 are provided in the following sections.

2.1 First Nations MPB Initiative (FN MPBI) *Chief Thomas Alexis, Tl'azt'en Nation*

Chief Thomas Alexis gave an overview of the FN MPB initiative. The initiative was launched 2 years ago by First Nations prompted by concerns that other groups and agencies were not involving First Nations in MPB planning. The 98 bands attending that forum decided to develop their own MPB action plan to ensure First Nations' participation in managing the MPB epidemic. A committee was formed to pursue this, led by three chiefs representing communities across the province. This led to the creation of a First Nations Forestry Council and a MPB Working Group to support First Nations' collaboration in dealing with the infestation.

Key messages that have emerged from First Nation elders include concerns about water levels, with 100-year lows last year, and fears that spawning grounds will be lost. This winter brought extremes, with snow pack at 50-year highs. Questions emerged about whether these observations are linked to climate change or natural cycles; and in this context, could the MPB have positive impacts for groundwater and salmon?

2.2 Workshop Development, Background *Mark Johannes, Senior Biologist,* *Workshop Coordinator and Facilitator, Golder Associates*

Noting his special interest as a biologist in issues linked to climate change and salmon, Dr. Johannes explained this workshop was organized as a case study on climate change issues and to initiate adaptive planning for the future. The workshop was derived to form a conversation to build an understanding of the issues and perspectives among key groups in BC, including the forest industry, the province, First Nations, DFO and other groups.

2.3 MPB in BC, BC Ministry of Environment, View and Action

Chris Ritchie, MPB Response Manager, BC Ministry of Environment (MOE)

Mountain Pine Beetles are the size of a rice grain and burrow through the bark of pine trees to lay their eggs; when the eggs hatch, larvae chew their way out of the pine tree. In the process, the beetles often introduce a fungus that causes further damage to live trees. Infestations start with a few trees, spread to other patches of the forest and then can lead to extreme landscape-level infestations. Such infestations are now common in BC's interior. This MPB epidemic started around 1999 in the central interior, and now affects extensive portions of mature pine forests throughout the province. As understanding of MPB life history increases, the definition of "mature" trees has become younger, with only very young trees now seemingly immune from MPB infestation.

The epidemic has increased exponentially since 1999, and is the largest outbreak in recorded history in North America, though the accelerating rate of spread now seems to be stabilizing. By 2013, the MPB is predicted to have killed 80% of BC's 12 million hectares of pine forest, threatening communities, First Nations, wildlife, fisheries and BC's overall economic health. This represents a priority concern for all of Canada in terms of sustainable forest management, Canada's Kyoto Accord commitments, and international trade implications. Further, there are no climatic or physical barriers to the beetle's easterly spread into Alberta's jack pine stands, and potentially further across Canada.

In 2005, Ottawa announced \$100 million to combat the MPB. That same year, BC launched an action plan to guide the provincial response and coordinate activities. This plan, which guides all provincial government action and is updated annually, outlines seven objectives:

1. Recover the greatest value from killed timber before it burns or decays, while respecting other forest values;
2. Maintain and protect public health, safety and infrastructure;
3. Conserve the long-term forest values identified in land use plans (These plans were developed without consideration of MPB impacts, so most plans will need to be revisited);
4. Restore the forest resource in areas affected by the epidemic;
5. Encourage immediate and long-term economic sustainability for communities;

6. Prevent or reduce damage to forests in areas susceptible but not yet experiencing infestation; and,
7. Maintain the organization necessary to carry out these objectives.

Mr. Ritchie reviewed management activities linked to various stages of infestation, including single tree removal, air surveys, and a “fall and burn” program to control leading edge spread. He suggested, for most of BC it’s too late for such controls, so the focus is on salvage and finding innovative ways to make use of killed trees, such as biofuels.

BC MOE’s mandate is to promote clean water, land and air, and healthy and diverse native species and ecosystems. For the MPB response, MOE has the primary responsibility for ecological restoration and mitigation of impacts in Parks and it also has a role in inventory and research. The Ministry’s views include the position that the MPB situation is not unnatural, just unusual. The pine beetles are native to the BC forests. What has changed is that fire suppression practices in recent decades have led to more mature pine tree hosts, in conjunction with recent climate warming trends. However, it’s not a dead forest, just dead pine trees. Clearly, there is an economic crisis. Many environmental and social values remain in a stand of dead pine; therefore clear-cutting all the dead trees may have more impact than just letting them stand.

Mr. Ritchie also reviewed general trends in impacts related to the MPB infestation, as follows:

- In impacted areas with no salvage: spring flows can be earlier and larger, potentially resulting in channel destabilization and dewatering. Loss of riparian trees can cause temperature increases in some streams. Warmer temperatures may lead to increased productivity (increased food availability) but can also promote algae growth, thus reducing oxygen availability and impacting drinking water supply. Warming may benefit fish that prefer warmer water, while negatively impacting cold water fish. Impacts on air include reduced air quality, because of the increased risk of catastrophic forest fires.
- In impacted areas with tree salvage: increased sedimentation and enhanced runoff at road crossings. Tree removal can further affect flow cycles (higher runoff, higher water table and higher peak flows). There is also increased risk of increased water temperatures and soil instability, and reduced fire risk. There may be loss of large woody debris due to salvage harvesting. Culverts may blow out or may no longer be appropriately placed due to changed water flows. Salvage harvesting also causes more diesel emissions from trucking and reduced air quality due to burning of debris. Killed trees and salvage logging may also have positive or negative impacts for different species of wildlife.

MOE activities include an ecosystem restoration program to remediate values or functions affected by MPB or salvage logging, and a Parks and Protected Areas mitigation program. MOE is doing spread control and fuel management in Parks and Protected Areas, along with inventory and monitoring, research and pre-code culvert replacement. Outstanding areas of concern include the need for access management and for more structure in retention planning.

Discussion: Questions, comments and responses included the following:

- With salvage logging, what are the prescriptions regarding stream banks? Mr. Ritchie responded these were the same as for traditional logging;
- Will First Nations be consulted about the use of fire to control MPB? Mr. Ritchie said the Province is developing a wildfire management strategy. It's not clear what shape that will take, but it is understood that First Nations will have to be engaged. A participant reported that the First Nations Forestry Council planned to meet soon with senior federal and provincial officials to discuss fuel management and a fire protection strategy for First Nations;
- Is the Canadian Forest Service (CFS) involved in discussing planned burning? Mr. Ritchie confirmed that CFS was involved, mostly in research aspects;
- Has there been any effort to look at carbon storage and emissions aspects? Yes, Mr. Ritchie replied, but it is still early and there is a big learning curve;
- Where is burning being done? Mr. Ritchie said small tests were done from Dawson Creek to Nelson, with larger fires in Mount Robson Park and some research-level burns near Vanderhoof. Some are also being considered in the Kootenays, and near communities like Nelson, Cranbrook and Kelowna;
- A participant said that when the trees die, they no longer draw up water, so more water stays in the ground;
- What will happen to the debris piles visible from the road in areas of salvage logging? These will present a higher fire risk if they are not burned before spring. Mr. Ritchie said operating limits are not clear yet, but air quality impacts are a concern and dilution is the solution;
- How long does a beetle stay around? The beetles attack in July and infested trees turn red by the next summer. By that time the beetles have dispersed to surrounding areas. This pattern continues until there is nothing left to eat and they starve. Tests show the MPB may be adapting, for example by riding air currents for hundreds of kilometres;

- A participant expressed concern about potential risks to First Nations communities linked to selective burning. How would First Nations be consulted and would evacuation be funded, if necessary? Mr. Ritchie said he was not certain how the Ministry for Forests and Ranges would go about this; and,
- Another participant expressed concern about MPB effects in her local watershed, including impacts on fish. Her community is engaged in treaty discussions, but meanwhile, natural resources are being extracted or lost in their territory, including important non-timber forest products. There is also concern about fires and logging trucks and the safety of local community members who are out using the forest. Mr. Ritchie said it is not clear how such concerns will be addressed, but suggested that the First Nations MPB Initiative might provide a valuable mechanism to work through such issues in parallel with provincial and federal processes.

2.4 Threats to Salmon and Fisheries Resources

*Allison Webb, Regional Director of Policy,
Fisheries and Oceans Canada (DFO)*

Allison Webb began by expressing appreciation for the opportunity to speak and also for the diversity of those participating in this workshop. Many people don't see the connection between the MPB and fish, she added. The questions facing DFO include what role it will play and what it can contribute going forward. Ms. Webb reviewed the three key objectives of a recently-committed Federal MPB funding to:

1. Slow the spread of the beetle;
2. To recover the economic value of affected trees; and,
3. To protect communities and forestry resources. It's critical to inject the fisheries aspect into this discussion.

This is happening in a context in which the environment is the new "health" issue for Canadians. There is much attention in particular to climate change, which is interesting and important for both fisheries and forestry, as both are affected by climate change. The MPB issue is connected to climate change and also to the larger question of how to manage resources within an uncertain paradigm due to a changing climate.

Ms. Webb suggested, when we lose forests, we potentially lose riparian vegetation, shading, stream habitat and snowmelt, all of which can affect salmon habitats. In 2006, some salmon stocks already experienced very high pre-spawning mortality. In the process of harvested MPB killed forests to recover the economic value of the trees, how

does that affect fish? What are the downstream impacts, for example, for those First Nations who rely on salmon for their traditional food fishing? Ms. Webb suggested that we may be trading off one benefit for another. This highlights the need to look at how our decisions affect each other and to take a broader ecosystem approach.

DFO sees the MPB issue as having clear connections for salmon stock assessment, fisheries management and Aboriginal fisheries. Less clear is how this should be linked to other areas such as the ocean environment, the Wild Salmon Policy (WSP), and the Species at Risk Act (SARA). It's not just salmon; this also affects invertebrates and freshwater species. Of the 29 freshwater fish species found in MPB-affected areas, one-quarter are already at risk. Some salmon stocks are already very depressed, with fish harvests already reduced as part of the response. Habitat is a limiting factor for salmon and the MPB and related salvage logging raise further habitat issues. How do we manage this?

If BC is trying to rebuild stocks, all groups cannot act in isolation. Government, First Nations, industry and other stakeholders need a process in which everyone's voice is heard. This is a very complex issue that involves science, emotions, multiple jurisdictions and tradeoffs. This work needs to be across jurisdictions and make the best use of available resources. DFO must look internally to ensure that our programs are complementary to what others are doing. DFO is here to learn and listen so that we can use this information to develop our own robust, complementary programs, Ms. Webb concluded, many people need to be involved, so the relationships we build here will also be important going forward.

2.5 Industry Approach and Perspectives

Doug Routledge, VP Northern Operations, Council of Forest Industry (COFI)

As a trade organization, COFI represents the solid wood and lumber manufacturing side of the forest sector, promoting access to sustainable timber, public policy that supports industry competitiveness, and access to markets. COFI programs address forest policy, regulation, economics, market access and trade, community relations, education and quality assurance.

The MPB is not an exotic species. Resident/native MPB populations are a natural part of BC's pine ecosystems. The recent epidemic relates in part to recent climate changes. Mild winters and hot, dry summers affect the MPB life cycle, speeding their growth while stressing trees and reducing the trees' ability to reject infestations by increasing natural pitch production. The MPB's one-year life cycle allows a rapid population response to favourable conditions. Trees under attack remain green at first, so infestations are hard to detect until the damage is done. Initial outbreaks of this epidemic

also occurred in hard-to-reach areas. Another key factor was the extent of mature and over-mature pine stands throughout BC's interior, due to fire suppression policies. As available habitat has increased, MPB outbreaks have also increased. At the onset of the current outbreak in the late 1990s, the forestry sector was also facing administrative and economic constraints, challenges linked to implementation of the new Forest Practices Code and an unresponsive timber pricing system that undermined industry's ability target beetle-killed stands. No one factor individually caused the epidemic, but collectively it all added up to "the perfect storm".

Mr. Routledge presented a series of maps documenting the spread of the MPB epidemic. From an area of 2,500 hectares, with a total volume of 100,000 m³ of trees affected in 1994, the beetle has spread over 17 million hectares, leaving 582 million m³ of killed wood in its wake. The volume of killed wood is now equivalent to the total annual provincial cut (50 million m³) multiplied by 10 to 12 years.

Response strategies in the initial stages of an outbreak sought to control beetle populations and to limit spread. However, most of the BC interior is now well into the next stage, which focuses on recovering the value of killed trees and mitigating future timber supply impacts. Strategies in this second stage include increasing harvest rates and manufacturing capacity, and developing a better understanding of the economic and biological "shelf life" of killed trees. Biological shelf life varies by location. Market conditions affect economic shelf life. New products like pellets and biofuel could extend the economic shelf life of older killed trees.

Land use planning constraints may also need to change in order to reduce long-term impacts. Low-value timber stands might be left to accommodate other resource use values, so that harvesting can focus on higher-quality stands. Another strategy is to reduce susceptibility by harvesting stands before they're attacked and lose value. Rehabilitation is also needed for stands that lose their commercial value, along with studies to ensure that re-established forests are "beetle-proofed", for example, by fragmenting MPB habitat.

The third stage, which is just starting, and involves industry indirectly, seeks to promote community economic stability through economic diversification. Such strategies include building on the existing economic engine of forestry over the short and long term, by developing new markets and products for beetle-killed pine. Longer term economic diversification is also needed, but there are no one-size-fits-all solutions, so these have to be very community-specific.

Is the sky falling? No. Fifty-five percent of our forestry resources consist of other species. Steps can also be taken to mitigate impacts, including impacts on water quality. Each timber supply unit and community is unique, with a different species mix and age class, different land use planning assumptions and economic shelf lives for killed pine. Timber supply impacts and opportunities for mitigation will vary by area; the same harvest pattern may produce quite different impacts for two different communities. One possible solution is to shift the “timber supply area” paradigm, with “horse-trading” between two or more communities to enhance their overall stability.

Turning to possible impacts on water and fisheries, Mr. Routledge said site-level operations are all still guided by the Forest Practices Code (FRPA). There is no change with regard to riparian zone management, machine-free zones, soil disturbance, permanent access structures, crossings and biodiversity requirements at the stand or landscape level. Site by site, harvesters are not doing anything differently than before. The Bark Beetle regulation reduces permit approval timing to allow loggers to respond quickly before the beetles move on, but it does not reduce regulations at the site level.

Stand- and landscape-level impacts on water and fisheries may result from planning and business practice changes. These include leaving behind non-pine species, increased winter harvest, and new harvest systems. At the landscape level, there may be shifting distribution of harvest (more concentrated) and hydrological “green up” (stands will regenerate more quickly if harvested than if killed trees are left in place). There will also be effects on peak and low flows.

Sharing of MPB impacts on our forests, resources, economies and communities is important.

Discussion - Questions, comments and responses included the following:

- The presentation did not mention the role of silviculture and the replanting of single-species pine forests as factors contributing to the epidemic. Mr. Routledge said available data does not suggest that more pine was replanted than would naturally have occurred;
- Given the extent of the MPB-affected area, the concentrated management now occurring and the shifts needed to maintain a healthy forest industry, the compliance with FRPA standards is certainly laudable. But this level of disturbance has never been seen before. Can the same ground rules still maintain environmental standards in this situation? Mr. Routledge said the regulations seek to achieve site-specific standards. No one has demonstrated that changes in those regulations would have significant benefit. Industry is open to discussion if it is demonstrated that current activities are contributing to more problems;

- There is a network of effects from forestry and there is concern about activities that affect resources at a watershed scale. Traditional tools such as watershed assessment processes gauge what's going on with the attributes that are of concern. It's necessary to review those tools in order to gauge the impacts;
- The MOE presentation tomorrow will discuss a model being used to try to understand fisheries and other values in watersheds and to determine areas that may be particularly sensitive to MPB impacts;
- Discussion is needed on the impacts of spraying for young pines that are regenerating. Mr. Routledge said industry uses various tools and is meeting biodiversity objectives, though there may be questions about the adequacy of those objectives;
- It should be decided before harvesting what the landscape will look like, so that retention rates can be determined for each area, instead of harvesting the biggest trees closest to town. Some areas are being ravaged. Companies are targeting non-pine stands and other species, using MPB as the excuse to access those species. Routledge agreed with the need to look at impacts across the landscape. However, focussing all reserves in non-pine areas would create other problems; and,
- Non-harvested areas should be spread out more. Mr. Routledge said this issue relates to current market conditions-companies can't go after trees that are not economically viable. Industry is urging a review of stumpage pricing to increase the differential for MPB timber, thus making it economically feasible to go after those trees under current market conditions.

2.6 Session 1 Discussions: MPB Threats to Salmon/Fisheries Resources

Participants were invited to raise further questions and comments. Additional comments include:

- Does the Province have a strategic perspective on how to bridge timber supply management with watershed management? To a certain extent, Mr. Ritchie replied. The situation is still somewhat chaotic, for example, with no planning framework yet in place to identify forest stands of lesser interest for manufacturing in relation to their value for fish habitat. Personnel are so busy handling issues like determining "shelf life", so that it's hard to step back and think. Some discussion is under way, but there is a long way to go;

- What's happening south of the border? Mr. Ritchie said the pine forest and MPBs extend all the way down to Mexico. The U.S. situation appears to be less severe than BC in part because the U.S. does not have the same intensity/density of pine. The U.S., like Alberta, is just starting to react and is looking to BC for answers; and,
- Are there natural predators that might control this? Mr. Ritchie said there are several forest pathogens that could play an important role, but at the moment it looks like only density-dependent factors will limit reproduction and spread of forest pests. The former key limiting factor-cold winters on a broad enough scale-are infrequent and less likely to stop the spread, given the large scale of infestation.

3.0 SESSION 2: IMPLICATIONS OF MOUNTAIN PINE BEETLE INFESTATION TO SALMON

Workshop **Session 2** developed understanding and knowledge about MPB infestations and the potential interactions with aquatic and salmon habitats. Summaries of Session 2 presentations are included in the following sections.

3.1 MPB and Fisheries: First Nations Perspectives

*Chief Thomas Alexis, Tl'azt'en Nation,
Peter Nicklin, Stock Management Biologist,
Upper Fraser Fisheries Conservation Alliance*

Formed in 2002, the Upper Fraser Fisheries Conservation Alliance (UFFCA) now encompasses over 25 First Nations and First Nations governments. Most have spawning habitat for sockeye in their territory and covers a large portion of the interior, from Deadwater Creek to the Fraser headwaters. The Aboriginal Aquatic Resources and Oceans Management (AAROM) program was launched to support training and capacity building for a First Nations role in managing fisheries.

The territory and fisheries covered by UFFCA is divided into five sub-regions, each represented by First Nations from those sub-regions and include pink salmon, Interior Fraser coho, chinook and sockeye salmon stock. Sockeye are considered very important by First Nations.

Salmon-related environmental concerns in the Upper Fraser include warm water and low flows. Nicklin presented a series of slides on water temperatures trends in the Upper Fraser watershed for recent years. Temperatures in the Stuart River were over 21°C twice last summer. In the Horsefly, temperatures of nearly 22°C were recorded in early September, just as sockeye were heading in to spawn. In 2006, temperatures in Qualark Creek were over 18°C at key early and late/summer migration times. Record low flows were also seen in 2006, which can have a compounding affect on high water temperatures.

Last year also brought significant conservation and management issues for salmon in the Upper Fraser. These include significant concern over Early Stuart Sockeye, with low escapements despite conservation closures and no Food, Social and Ceremonial (FSC) access for First Nations. The Bowron also saw low sockeye escapements, as did the Quesnel, where FN food fishing was seriously impacted. Abundance and escapement are also declining for Late Stuart Sockeye, which is becoming a real management concern. Interior Fraser Coho and several runs of Early-timed Spring Chinook are at critically low levels of abundance and escapements, raising another management challenge. This run

falls in the middle of the best commercial fishing, which presents a real danger of over-harvesting for the weaker stock. A proposed listing under the Species at Risk Act (SARA) was not successful, but efforts continue to secure funding and to launch a conservation action plan. In this context, the MPB presents a very real threat to First Nations.

In September 2005, the BC First Nations MPB Action Plan called it “the single greatest natural disaster our communities have ever faced”. From First Nations’ perspective, it’s not just a threat to resources and the ecosystem; it’s a socioeconomic problem that directly threatens the people. Threats to salmon affect the First Nation’s ability to harvest stocks for food. Therefore, First Nations have a big interest in identifying problems and solutions, and minimizing impacts from threats of MPB.

Upper Fraser First Nations have significant capacity, a tradition of dedication to the resource and are involved in numerous ground level assessment and salmon management, including stock assessment, and habitat and environmental monitoring. There is significant capacity and a tradition of dedication to the land. Mr. Nicklin noted there is a strong focus on planning for the future. First Nations want to be part of the solution. They have capacity and knowledge and need to be involved. Resource managers must ensure that information on threats to the resources and response plans are communicated to First Nations communities. The obligation to consult First Nations is also a legal reality. Finally, communication and consultation must be meaningful; it’s not enough to just provide a highly technical report and ask lay people to comment on it. No one group or agency has the capacity to limit and manage the threats to salmon stocks. This workshop brings together a lot of expertise and many agencies which is very encouraging. However, it’s important to ensure that the outcome builds to future action.

Discussion: Questions and comments included the following:

- First Nations need to be in the forefront, not at the back of the bus; and,
- What percentage of salmon runs within these areas is now affected by the MPB? Mr. Nicklin proposed putting this question to individual First Nations participants who could describe the situation in their territories in more detail during the breakout sessions. The geographic area covered by the UFFCA matches the area worst hit by the MPB infestation.

3.2 Changing Climates and BC's Forest and Fish Habitats

Stephen Déry, Assistant Professor, University of Northern BC

Dr. Déry illustrated the major components of the climate system, including atmosphere, biosphere, cryosphere and hydrosphere, and how they interact. These components and interactions are also influenced by factors such as solar inputs, volcanoes and, increasingly, man-made influences on climate.

Observed 20th century changes include two periods of pronounced global warming—one from 1910 to 1940 and another from 1970 to the present. It is mostly agreed that the first was due to natural variation, but that greenhouse gasses due to human activity have played a big role in the current warming trend. Preliminary data now suggest 2006 may surpass 2005 as the second warmest year on record. Trends in global surface air temperatures and precipitation show an increase in temperatures and in precipitation throughout most of BC. Annual surface air temperature data from 1895 to 1995 show warming of about 1°C for most of BC, which is twice the global average. Warming trends were greater in northern BC and were unevenly distributed though the year. Increases in maximum temperatures were seen mainly for spring, along with increases in minimum seasonal temperatures. Precipitation trends for BC from 1929 to 1998 show increases in southern BC of 2% to 4% per decade. Broken down by season, these increases occurred mostly in spring, summer and fall.

Data for Prince George show surface air temperatures increased on average by 1.5% from 1944 to 2005. Average monthly and annual temperatures range widely, but overall the number of very cold days in Prince George has been declining. The last decade has not seen temperatures below -40°C, the limit for MPB survival. Indeed, the isotherm line representing the southerly limit of -40°C temperatures has been moving northward.

BC has also seen changes to the hydrologic cycle. For example, observed changes in the Quesnel River's annual cycle of daily discharge include earlier spring freshet, higher flows in spring, and declining flows in late summer and early fall. Average Fraser River temperatures also show that stream temperatures directly correlate to air temperatures.

The 2001 assessment of the Intergovernmental Panel on Climate Change (IPCC) predicted average global temperature increases of 1 to 5°C over the 21st century. Regional models suggest North American surface air temperatures will increase more than the global average, with a rise of 2°C to 10°C over the 21st century. More winter precipitation is also predicted regionally, though projections for summer precipitation are unclear. Projections for river discharges suggest an increase overall, especially for the Pacific Northwest. Expected impacts of climate change in the 21st century therefore include increases in surface air temperature, especially in winter; a 10 to 20% increase in

annual precipitation, with more rain and less snow; less snow depth and an increase in the length of the growing season; more droughts, less soil moisture and more thunderstorms; and for rivers, earlier freshet, longer periods of low summer flows and warmer water temperatures.

These changes could have a number of impacts on forests and fisheries. For example, the area of forest burned in future forest fires might increase to three or four times that which burned in 20th century fires, unless mitigative measures are taken. Other impacts on future forests include more drought stress, amplified populations of native pests or arrival of non-natives, and lower water tables, favouring invasion/expansion of drought-tolerant species. Effects on river discharge include earlier snow melt, earlier spring freshet, extended summer low flow period, lower summer flows, and more autumn rain. Effects on sockeye and other salmon species include more energy being required for migration in warmer water, and increased risks of parasitic infections, pre-spawning mortality and failure to spawn.

Dr. Déry also described a new meteorological monitoring program in the Quesnel River watershed. Equipment installed at three remote sites will gather long-term data on air temperature, humidity, wind speed and direction, atmospheric pressure and snow level. In summary, he said, increases and projections in global surface air temperature and precipitation over the 20th century imply increasing stresses on BC's forests from drought, fire and pests, and also on fisheries, due to warmer water and lower flows.

Discussion: Questions and comments included the following:

- How is the “noise” of impacts related to local land use decisions separated from that of global climate change? Dr. Déry said historical data suggest the Quesnel is typical of what is being seen in other systems due to climate factors, as opposed to development or the MPB. This also suggests that MPB effects to date are relatively low compared to these other factors; and,
- Is anyone studying changes in stream channel morphology associated with these trends? Dr. Déry said some work is underway at UNBC and UBC to examine stream channel changes following fires, but he did not know of any work specific to impacts related to MPB or beetle kill responses.

3.3 Beetles, Streams, Fish Habitat: Hydrologic Considerations

John Rex, Hydrologist, Ministry of Forest and Range

MPB-killed forests can affect the hydrologic cycle in several ways. The loss of the pine overstory means less interception of precipitation (an estimated 20% - 30% of annual precipitation) and loss of transpiration (estimated at 20% to 40%). Snow accumulation and melt can also be affected. These impacts may lead to higher peak stream flows in spring and during rain storms, along with more low flows at other times and increased annual water yield. These potential impacts are climate dependent.

It's important to remember that the MPB causes a dead forest overstory, not a dead forest, Mr. Rex noted. Salvage operations bring further impacts, with the greatest influence related to the Three 'R's: roads, riparian areas and runoff. In responding to the MPB, we are therefore dealing with two disturbance agents: the beetle, over which we have no control; and human activities, which can be controlled through management.

The following key points were noted:

- A recent study showed small stream ecosystems are not being adequately protected;
- Riparian zones in MPB-affected forests include mixed species stands;
- MPB-affected stands are not the same as cut-blocks; and,
- There is a need and an opportunity for retention of trees within MPB-affected areas, including within riparian zones.

Mr. Rex reviewed three regional research projects related to the above points.

1. The Prince George Small Streams Project involved a detailed study of small stream riparian attributes, in the context of riparian management objectives laid out in the Prince George District Manager's policy. Those objectives include maintaining shade and a supply of large woody debris (LWD) in riparian zones, minimizing disturbance of soil and natural root structures close to stream banks, preventing excess stream sedimentation and concentrating tree retention within 10 to 15 metres of streams. The study showed some attributes were being maintained, but not all, with litterfall, shade and particularly LWD identified as concerns. A related study showed that most LWD in streams came from within 10 m. of the streams. However, before proposing more retention within 10 m. of streams, an estimate of timber values in those zones would be needed.
2. A second project, the Riparian Zone Basal Area Study, examined 30 watersheds in the Vanderhoof area. Although the selected sites were pine dominant, the study found that spruce often dominate within the 10-metre riparian zone. This suggests the potential to increase riparian tree retention, without lowering MPB salvage effectiveness.

3. A third study looked at snow hydrology. The study disproved the standard view that MPB-affected areas are hydrologically similar to cut-blocks. Interception still occurs and impacts related to the Three 'R's (roads, runoff, riparian) are absent. The study found that in MPB "grey attack areas", the average daily rate of snowmelt was about midway between green forests and clear-cut areas.

In summary, the review of these studies suggests the need for increased retention of trees in riparian zones during salvage logging of MPB-affected forests. Unlike clear cutblocks, MPB-affected stands still play a hydrologic role by intercepting precipitation. Further, there is an opportunity for increased retention of spruce in riparian areas, without negatively impacting MPB-salvage effectiveness. This suggests an opportunity for more integrated management to meet multiple objectives.

Mr. Rex concluded that increases in peak, annual and low flows should be expected, along with changes in soil and runoff water chemistry. The magnitude of MPB impacts will be influenced by the scale and application of forestry practices. Landscape planning should guide management to reduce risk and mitigate impacts, along with due diligence (applying the lessons learned from past experiences). Retention of as much green wood as possible may reduce watershed impacts and improve the medium/long term timber supply. For those considering studies of MPB impacts on salmon, Mr. Rex recommended considering the host of available management tools already developed, including those designed to risk-rank watersheds that are most prone to flooding.

Discussion: Questions and comments included the following:

- Has there been a study on MPB impacts on groundwater? Mr. Rex noted an ongoing project in Vanderhoof district to identify watersheds at greater risk due to elevated groundwater levels;
- Will models be developed to look at impacts on salmonid, such as spring Chinook and Coho, which are highly dependent on groundwater? Mr. Rex said others were doing such modeling in the south, but significant variations were being observed; and,
- Did these studies find adverse effects from wind throw on channel morphology? Not in this area, Mr. Rex replied.

3.4 Risk Assessment for MPB Impacts on Salmon Habitat

Erl MacIsaac, Fish-Forest Science, Fisheries and Oceans Canada

Risk assessment can provide the information needed to determine the real risks that MPB poses for salmon, using an objective, science-based evaluation of the magnitude and probability of impacts. It can pinpoint particular species, life stages and habitats of concern; help focus limited resources for research and monitoring; and also help identify habitat and management options. Risk assessment involves three steps:

1. Identifying potential impacts on fish and habitat;
2. Rating the probability of impacts occurring; and,
3. Assessing the severity of the potential impacts.

For the first step, Mr. MacIsaac proposed examining impacts using “pathways of effects” scenarios:

- Short- and long-term watershed, riparian and stream impacts of MPB alone;
- Short-term effects of MPB, plus the impacts of salvage logging and roads; and,
- Short-term impacts of MPB plus fire.

For each of the three scenarios, it will be necessary to identify all potential impacts on fish habitat, including effects on hydrology, recruitment of large woody debris, bank stability, channel morphology, sedimentation, water temperature and litter fall.

The proposed model focuses attention on the “pathways of effects” between three distinct sets of changes:

1. Changes in stream, riparian and watershed processes;
2. Changes in fish habitat; and,
3. Changes in fish productivity. The tendency has been to focus on the first of these two, because it is harder to show how changes in habitat affect different life stages, species of salmon and overall salmon productivity.

The next step is to rate the probability of each of these effects occurring in each scenario. This may depend on factors like the ratio of pine in surrounding forest, extent of the affected watershed and the proportion of non-pine riparian vegetation. For example, small headwater streams may have less thermal buffering. Spatial forest data for the watershed and riparian areas will be needed to assess this. For salvage logging impacts, probability depends on factors like the proportion of the watershed being logged, riparian buffer zones used, number of stream crossings, etc.

The final step is to assess the relative severity of impacts. Mr. MacIsaac presented a sample table summarizing the relative severity risk to stream habitats, based on the expected magnitude of key ecological effects and their probability under each of the three scenarios. Where higher risks are linked to logging or fire, these could be mitigated by forestry management practices.

There is currently very limited knowledge of MPB effects on streams. There is fairly good knowledge of logging impacts on fish habitat, but poor knowledge of linkages between habitat and fish productivity, and limited knowledge of fire risks to salmon streams. In approaching this, the first step would be to map what is known to narrow the

scope to salmon-bearing watersheds that overlap with MPB infestation. Areas of higher risk can be identified by looking at the percentage of the watershed affected, road and stream crossing densities and other similar factors. DFO, the Province and industry already have some of this spatial data and will hopefully share it.

Mr. MacIsaac also listed key information needed for the risk assessment approach, which are not yet available. We also need to know the location of the most sensitive fish habitat; where and how is salvage logging occurring; what road and stream crossing management is being done; fire frequency, intensity and stream effects; and how fish habitat changes translate into fish productivity changes.

3.5 Breakout Discussions: Major Issues and Response

Participants broke out into three groups to discuss what they felt were the major issues and how to manage them.

Key points are summarized in the following sections.

3.5.1 Group 1: Session 2 - Summary Report

- Economic incentives are shaping the response; include data and consideration of non-timber values;
- Landscape level planning is needed to decide now what to retain;
- MPB infestation and response must be considered separately because the impacts are different;
- More understanding is needed of habitat requirements for different species throughout the year, and how physical changes to habitat impact salmon;
- Implement riparian/management practices (*e.g.* increase buffer zones). What are best practices?
- A multidisciplinary approach for planning and more expertise is needed, given the complexity, size, scope and speed of the MPB infestation and the context of climate change. Value was seen in the former watershed assessment process;
- Poorly integrated management and government capacity issues: communities and First Nations can help address government gaps in data gathering and monitoring;

- Improve the communication of study results and plans back to communities; and,
- How effective is monitoring retention compliances in meeting objectives? A Formalized process of how to monitor impacts of MPB is needed.

3.5.2 Group 2: Session 2 - Summary Report

- MPB may not be as big a problem as we thought. The MPB impacts may not be as great as the impacts related to the rate of cut;
- The magnitude of the problem is not fully known;
- It is important to have more bodies in the field, in light of government cutbacks;
- Problems of the time scale of impacts and time lags; we may not see impacts for decades and they may look much more significant than predicted;
- We need to better understand relationships and collect more data for modeling;
- Applying the precautionary principle is difficult due to the focus on extracting economic value;
- There is a need to consolidate, store, share and communicate information and data;
- Explore experimental design that lead to adaptive management;
- All parties must be at the table. Are all agencies and groups here?
- Interdisciplinary approach is required;
- Climate change is complicating the effects of the MPB;
- Two approaches:
 1. More monitoring and research and;
 2. Risk assessment approach;
- Who is making the decisions? First Nations and communities should be more involved. Currently, decisions are too centralized; and,
- More communication and empowerment is needed.

3.5.3 Group 3: Session 2 - Summary Report

Impacts

- Impacts on water quality and quantity (pH, nitrogen, temperatures, water flow);
- Impacts on different life cycle stages and different species;
- Silviculture and regeneration strategies may need revisiting in the context of MPB;
- Productivity and energy flow cycle: better understanding is needed of links between trees, beetles and fish; and,
- Fish aren't the only species impacted by MPB (*e.g.* beavers).

Fish Management

- Should escapement be increased to raise the probability of survival?
- Economic diversification initiatives, such as increased mining may bring more serious impacts for fish than MPB;
- Better models are needed for predicting impacts of MPB on fish;
- More roads and increased access to humans may lead to over-fishing;
- Low flows may be more due to climate change than MPB; and,
- If water licensing is changed, will it be allocated for the long term?

What Can We Do?

- Risk assessments;
- A more conservative approach to escapement;
- Use more tools to priorities resources and research;
- With a leaner government, many organizations and groups will need to get together to coordinate activities, so more attention must be paid to encouraging coordination;
- Look for partnerships for collaboration and coordination; and,
- Linkages are needed for fisheries management to manage differently, depending on species.

4.0 SESSION 3: WHAT WE PLAN FOR THE FUTURE?

Workshop **Session 3** developed a discussion about planning for the future and where understanding and initiatives are warranted and needed.

Dr. Johannes reviewed the day's agenda, noting the discussion would be more focussed, hopefully leading to the identification of priorities and next steps. The intent is to follow up the discussion started at this workshop in future forums. He also welcomed follow-up comments, and said the meeting notes and presentation decks would be distributed to all participants.

4.1 Planning Forests and Fisheries Resources Now and Into the Future

Art Tautz, Senior Biologist, BC Ministry of the Environment

Planning essentially requires defining current reality and a vision of the desired state, and then setting out how to get from A to B. It's simple enough in theory, but Dr. Tautz noted some of the challenges to actually doing this. Defining current reality requires identifying the problem. However, in this case there is still broad disagreement on what that might be. Then there are competing solutions, practical constraints and political consequences that are constantly changing. Interested parties come and go, fail to communicate and often change the rules. These characteristics are typical of what are termed "wicked problems".

Approaches to such problems typically involve bringing in academics, appointing independent panels, using community advice or developing collaborative teams. The latter is probably the best approach in this case because control is distributed among several agencies, communities and industries and because salmon conservation involves many complex aspects and interrelationships.

Possible elements of a future vision that supports a collaborative model include improved coordination among agencies, improved knowledge management and data sharing, the use of risk assessment and adaptive management, and adoption of ecosystem-based principles. Dr. Tautz expanded on each of these elements.

Improved Coordination: There are many different groups and initiatives involved in salmon management. Though interactions are starting to happen, there is still much repetition. The various players have significant funding between them, so there should be enough money if better coordination is achieved. Dr. Tautz proposed a technical coordination model that lists partner organizations and roles, and a Fraser salmon and watersheds work-plan that would divide up the tasks of looking at terrestrial and aquatic values.

Knowledge Management: Knowledge management needs include the ability to conduct needed research, inventory and monitoring. Data sharing is needed to aid decision-making and the results must be incorporated into management frameworks. Dr. Tautz proposed using the “Rumsfeld Cube” approach, *i.e.* dividing relevant knowledge into the four categories of:

1. What we know we know (managed knowledge);
2. What we know we don’t know;
3. What we don’t know we know (unmanaged knowledge); and,
4. What we don’t know we don’t know (surprises). The Hectares BC initiative is an example of how to organize available knowledge.

Adaptive Management and Risk Assessment: To illustrate the use of adaptive management and risk assessment, Dr. Tautz used hydrology as a case study. The first step is to develop a model using the best available science and a risk analysis framework. Use that model to make predictions, monitor systems on the ground, and use that feedback to adapt and refine the model over time. The risk assessment part involves inputting threats, pressures and watershed characteristics into the model. This produces hydrologic hazard ratings, which in turn lead to an assessment of consequences and values at risk. The information can be combined using a Watershed Assessment Tool to spatially map fisheries values, pine forests, harvesting locations and areas of MPB infestation. Much of this has already been mapped by various groups, but it will be necessary to resolve where the salmon values are. By combining fisheries values with MPB effects on stream types, it becomes possible to predict the expected changes over time resulting from various choices, thereby increasing decision-makers awareness.

Ecosystem-Based Approach: If the approach incorporates ecosystem values, it provides a slightly different perspective on predictions. Beetle kill will cause ecosystems to change and evolve, potentially benefiting about 65% of resident terrestrial vertebrates and fauna in the short term. Salvage will have negative effects on about 35% of species present. To achieve potential benefits while reducing negative impacts, specific actions can be taken at both the stand and landscape level (See Bunnell et al, 2004). Most important is riparian protection and retention of other species like spruce.

In summary, Dr. Tautz noted, the MPB illustrates a new type of problem involving catastrophic change. To cope with such problems, some form of collaborative planning model is needed. Good opportunities exist to improve collaboration and salmon provide a good focus for such efforts because so many different groups and people already have an interest at stake in this resource.

Discussion: Questions and comments included the following:

- It's important to clarify the benefits and negative impacts. Risk assessment is key, given the vast scope of salvage extraction. First Nations want to be involved and should be included from the very beginning. Also, funding is available; the bigger problem is finding people to do the work. Dr. Tautz acknowledged the importance of involving First Nations. He said his suggestions represented a "first cut" of the technical analysis, with the idea of getting government's house in order before bringing in the regions, agencies, communities and First Nations. In terms of winners and losers, he added, some species will do well under the ecosystem changes caused by the MPB. The message is that there are management actions that can be taken to help those species that are considered valuable;
- This situation is larger in scope than anything we've faced before. However, it is possible to identify anticipated changes to the hydrologic cycle and habitat based on what we already know. In terms of coordination, there are systems in place that have been used before that we can bring back. The challenge is management. We can identify the information needed, however, we need a system of checks and balances to ensure that the information we have is contributing to the management regime;
- We all live in a system of silos and we are not cross-pollinating. It's not a science problem. This issue is relevant to Environment Canada, Parks Canada, Western Economic Diversification, Indian and Northern Affairs Canada, DFO, etc. How are they all talking to each other to solve the problem? We're here, but the bosses aren't talking to each other and that needs to happen;
- Much of the funding available for university research requires industry partners; maybe funding for MPB activities should also be tied to partnerships;
- It's important to separate the discussion about values and culture from the straight science. Science is a very blunt instrument for management. The science is necessary, but a bigger process is also needed to discuss tradeoffs, industry roles, etc. You can't let the science dictate cultural values or vice versa, but it needs to be worked out how to get the technical information to where the decisions are made;
- As government looks to funding agencies and developing the science program, it must involve First Nations to help frame questions and do the actual work;
- Everyone is looking at how to fill gaps and work collaboratively and do adaptive management. But the current regime has deregulated and prevented government from being able to implement the results. There is no longer any legal mechanism for government to provide that kind of direction to industry;

- A champion or leader is needed. Which agency will lead? Also, agencies have their own interests, whereas First Nations tend to have a more holistic view. They also have a way of celebrating success and involving everyone, which would be very helpful. Is there a way to bring agencies in to supply the science and then go to the regions to have things dealt with at that level? This would be a new way of doing things, instead of the usual top-down management. It would encourage meaningful involvement and greater effort to try to make it work;
- A case study on collaboration and how people approach crises such as the New Orleans hurricane or the ice storms in Ontario and Quebec might be of interest. Those were examples in which political direction brought together a multidisciplinary group of specialists to address urgent and complex problems; and,
- A minority government is unlikely to show much leadership, but participants can take the lead and offer win-win solutions. Political leaders should welcome that.

4.2 Managing Socioeconomic Issues

Roxanne Scott, Golder Associates

Forestry is still BC's single largest export sector, earning an average of \$14.4 billion annually in export income. This represents 43% of the province's export income and 14% of employment. Forestry also remains the most important employer in many rural communities, and is becoming a more important source of direct employment for First Nations. In many districts affected by MPB, forestry provides as much as half of all income and employment. BC's fisheries and aquaculture sector, meanwhile, provided revenues of \$1.9 billion in 2001, along with 20,000 jobs.

To date, the MPB has affected over 400 million m³ of timber in BC. That total is expected to double by 2014, with the spread of infestation levelling off after affecting 80% of the timber harvesting land base. In the short term, the socioeconomic effects of this epidemic include an increase in annual allowable cut (AAC), higher forestry exports, economic growth in forestry and related sectors and expansion of roads and access. There may also be effects on public health and safety (*e.g.* logging traffic). Potential long-term effects (if all else is held constant) would include a significant decline in forestry exports and non-timber forest products, with effects on forestry-related economies such as recreation, tourism, and agriculture, and resulting in unemployment and workforce dislocation. There would also be long-term impacts on First Nations' traditional use of forests and declining crown and industry revenues. BC's Ministry of Forests estimates a potential revenue loss of \$53 to \$170 billion over the long term (BC's total GDP, for comparison, is \$156 billion).

Little research is available on how this will impact interior communities. One study by the Canadian Forestry Service (CFS) modelled the projected economic impacts for Prince George and Nadina Forest District in 10 to 15 years' time, when annual harvest rates are expected to drop sharply. Nadina is expected to see declines of about 3% in revenue, employment and labour income, compared to pre-MPB levels, while the corresponding declines for Prince George will be almost double that.

Interior communities vary in their vulnerability to MPB impacts. The effects will depend on the extent and proximity of MPB infestation, along with community sensitivity factors. The latter include population size (smaller communities may be less able to adapt); levels of dependency on the forestry sector and economic diversification; and social factors like poverty and education levels, which may affect capacity to plan, manage and adapt to change. Cultural and institutional factors (*e.g.* social capital) can also affect a community's ability to come together and organize a response. Cultural factors are especially important for First Nations, who also rely more heavily on forests to meet a range of needs. These vulnerability factors illustrate the importance of avoiding "one size fits all" management strategies.

Analysts have also developed a forest vulnerability index, using data on income dependency and economic diversity to indicate the vulnerability of a local area to downturns in the forestry industry in general. This index identified the Prince George and Quesnel regions as those most vulnerable to any downturn in forestry. These also happen to be the worst-hit regions of MPB infestation.

Strategies to manage socioeconomic impacts of MPB include recovering the economic value of killed pine by developing value-added products for beetle wood (*e.g.* biofuels) and building milling and marketing capacity. Further strategies under discussion include building economic diversity and stability by expanding existing sectors like tourism and agriculture; developing other resource-based sectors like mining and energy; developing new non-timber forest products; and building viable First Nations economies based on forest resources and diversification. Other potential strategies focus on institutional arrangements: for example, how to modify tenure systems to benefit rural communities and First Nations, and how to support local groups and coalitions trying to lead community responses. Strategies related to consultation and accommodation include shared decision-making, improving understanding of First Nations interests and traditional uses, developing more effective processes for provincial referrals and building First Nations capacity to provide MPB technical support.

A number of knowledge and research gaps need to be filled. These include better socioeconomic baseline profiles for affected communities and First Nations and more understanding of the long-term impacts of harvesting on jobs, business, demographics

and economic viability. More study is also needed on economic opportunities in value-added recreation, tourism, etc.; on community-specific impacts over the short and long term; on the community structures needed to support diversification; and impacts to fishery economies. The message heard yesterday was that we don't yet understand the impacts on fish productivity, Scott noted, and without that we can't assess the impact to fishery economies.

Discussion: Questions and comments included the following:

- How do you get government to lower stumpage rates for tenure holders to make it economically feasible to log dead wood? Will there be a market for wood pellets?
- BC's entrepreneurial spirit has been disappointing. Why haven't people jumped on these new opportunities? Also, housing costs have skyrocketed as income has grown, and this raises concerns about debt, depression, drugs and related social impacts in communities like Prince George when it all goes back down;
- Has there been meaningful assessment of the feasibility of proposed economic diversification?
- These ideas about diversification have been discussed for many years and the opportunities are more theoretical than real, in my opinion. Pellets are a real opportunity, but not after the fall down. We need to accelerate plans for that and the Province needs to step up with more dollars;
- Community effects are potentially devastating. We really need to jump on them now; and,
- Some communities are already working on this, but there is need for a wider framework and expertise to support local initiatives.

4.3 Fisheries Sensitive Watersheds: Designating Priority Areas

Ray Pilipow and Suzanne Williamson,

Fish and Wildlife Science, Ministry of Environment (MOE)

Mr. Pillipow gave an overview of the MOE's Watershed Evaluation Tool (WET). This was developed following introduction of BC's new Forest and Range Practices Act (FRPA), when it was found that the new results-based code could not address sensitive fisheries watersheds. The WET is a geographic information system (GIS) tool that uses watershed atlas boundaries and codes, along with 17 data inputs from various sources. The objective is to identify high-priority fisheries sensitive watersheds by combining relative fisheries values with relative sensitivity to physical disturbance.

Fisheries values scores are derived from combining biodiversity scores (reflecting endangered species, species richness and special stocks) and socioeconomic scores (based on recreational-angler days, commercial values and First Nations cultural values). Biodiversity scores take into account which species are most sensitive to logging and the probability of such occurrence. Watershed sensitivity scores are based on terrain stability (erodible soils and mainstem polygon slope) and channel stability (hydrographic sensitivity and watershed alluvial stream density). A third component rating existing disturbance levels was removed from the model, in order to identify which watersheds were inherently more sensitive. Running the model with both fisheries values and watershed sensitivity values shows where the two overlap, thus in theory identifying priority fisheries sensitive watersheds across the province.

However, this model still has several remaining issues, including the quality of NUSED's data, which results in a huge gap in salmon values. It also does not address the value of non-natal rearing streams and produces a rounding down effect with low escapement. A consistent approach is also needed in assigning special status to fish stocks. Further, the predicted values still need to be verified with regional data. On the watershed sensitivity side, the spatial scale of available soils data is too coarse, which results in sensitive areas being missed. Highly sensitive lowland lacustrine valleys are also not scoring as high as they should be.

Williamson continued the presentation, discussing a pilot project that combines the WET with further analysis to assess current and future MPB impacts in key watersheds. This illustrates how the WET tool could be used beyond identifying fisheries sensitive watersheds.

The purpose of this pilot, called the MPB Augmented WET project, is to prioritise third-order watersheds based on overall sensitivity to current and future MPB impacts. Several fisheries scientists are currently helping refine the model, so that it can be used to identify areas that should be set aside now for future timber supply, along with areas for future monitoring, restoration, enhancement and conservation. The project will also consolidate watershed information for all stakeholders on fisheries resources, habitat and sensitivities.

Model inputs will include data on fisheries values, watershed sensitivity, distribution of pine forests and high MPB impacted forests, geoclimatic information, and areas that could provide understory growth for modest harvest opportunities in the mid-term. The intent is to provide a coarse first look at these values and then to discuss the results with groups including First Nations, incorporating their feedback into the model to make it as robust as possible. Future plans include verifying the data, refining the model, coordinating with other agencies, and supporting designation of fisheries sensitive watersheds and other habitat protection measures. Although the model is not yet ready to identify priority areas, the hope is to have a first cut by March 15 2007, and to secure funding in the new fiscal year to carry on this work.

Discussion: Questions and comments included the following:

- It is scary to see the entire mid-upper Fraser missing in the initial cut, considering that's where the bulk of the salmon are, and their importance to First Nations. Has any ground-truthing been done yet to see if this makes sense? Mr. Pillipow agreed that the watershed sensitivity aspect needs some fixes. Work is being done on that, but it will still be necessary to make adjustments based on local knowledge. It's not a silver bullet and it will need continuing improvement;
- The MPB issue is happening now and answers are needed now. How does this fit with the watershed sensitivity pilot in Vanderhoof, in terms of being able to provide answers right now? Williamson said the areas in the pilot study were chosen because funding was tied to those specific areas. Mr. Pillipow added that the Vanderhoof information is being considered in tandem;
- It might be better to use a different colour in the output maps to denote areas where values are unknown. Also, North Vancouver District has a lot of information on erodible soils that might be useful. Mr. Pillipow said the model is based on information that is available province wide, and acknowledged that there is better information in some cases at the local scale;
- There is a fundamental difference between professional opinion and objective ranking. The hope is that one can support the other. Mr. Pillipow said the intent was that this would serve as a prioritization tool to help focus resources;
- Dr. Johannes noted the relevance in this context of PFRCC efforts underway to ask communities to map out local priorities;
- The WET can be a good tool but there is also a need to look at how the regulations are working. It would be hoped that forestry would not impact any watershed;
- Regarding problems with NUSED data, there were significant cutbacks of on-the-ground surveys in 2001/02. Federal staff may be able to provide information for validation;
- How do you address non-natal rearing streams which may play a key role in rearing, but not spawning for some species?
- What recommendations would be associated with designation? Designation alone is not enough. Mr. Williamson said legal objectives would be set and a consultative process would be part of that.

5.0 SESSION 4: PANEL DISCUSSION

Workshop **Session 4** provided an opportunity for the workshop facilitator and workshop panel members to engage the participants in a discussion about priorities, management approaches and next steps for management, coordination of research, communication and management of mountain pine beetle infestations and the potential interactions with aquatic and salmon habitats. The following sections summarize presentations in Session 4.

5.1 Threats to Salmon From MPB Infestations

Mark Johannes, Golder Associates

Dr. Johannes reviewed key issues, including accelerating temperature increases, which are affecting MPB biology (Appendix 2). Salmon already face a number of challenges; MPB and related management may have further implications for their habitat. Salmon might therefore be viewed as an indicator of thermal stresses. What are the links between salmon and landscapes?

There are two views about how to react to climate change and the MPB. Government, First Nations, industry and other stakeholders can be proactive or reactive, but the better approach is to be proactive through adaptation solutions. The challenge is that the extent of the MPB epidemic is so large that it has left many people numb. However, there will be implications for salmon, so how should we plan for the future? Adaptation and forms adaptive management has been suggested.

Dr. Johannes invited the panellists to introduce themselves and offer brief comments before opening up discussion to all participants.

5.2 Panelists and Background Presentations

5.2.1 Alan Kenney, Pacific Salmon Foundation

Mr. Kenney outlined the joint Pacific Salmon Foundation (PSF)-Fraser Basin Council (FBC) project underway to inspire changes in human behaviour to improve salmon and their watersheds. The provincial Living Rivers program was developed to make a difference on the ground through work with people to reduce the collective footprint that affects salmon. In this context, concerns about the impacts of MPB and climate change on salmon led to this workshop. The plan is for the PSF and the FBC to take the results of this workshop forward and recommend specific actions that can be taken.

5.2.2 Marcel Shepert, Upper Fraser Fisheries Conservation Alliance

Inclusiveness is a key issue from the perspective of First Nations. Federal and provincial initiatives must include First Nations right from the beginning. Mr. Shepert indicated that the Upper Fraser Fisheries Conservation Alliance are building technical capacity and need to be involved, whether in science or management, from the very start. Cultural values must be included and we need to improve communication both ways. Given the concerns about a number of salmon stocks in the region, the earlier discussion on priorities was not comforting. All watersheds need to be protected. Some of the highest temperatures ever were recorded in the Fraser last year, and this is cause for alarm. The scale of the challenges means that many group need to be involved. There are many great minds-the challenge is coordination. The agencies, First Nations, industry and stakeholders need to build sustainable relationships and certainty, with an approach that focuses on biological diversity and sustainability. Governance will be important. What models will we use to make decisions? There must be open minds regarding First Nations being part of this and changing the way decisions are made and business is done. Inclusiveness and meaningful dialogue will be key.

5.2.3 Nick Leone, BC Interior, Oceans, Habitat and Enhancement Branch, Fisheries and Oceans Canada

The MPB issue is now on everyone's radar and it's good to see the focus on aquatic impacts and the involvement of First Nations. This is a huge issue, with potential impacts for aquatic resource that are both significant and unknown. But much is already known and this workshop has seen good presentations on some of the knowledge that exists. Mr. Leone suggested we can also learn from history and already know a lot about potential impacts of forestry on fish and their habitat. In areas near the southern boundaries of the MPB epidemic, these impacts are compounded by significant impacts related to water extraction for irrigation.

One of the biggest advantages is First Nations capacity and their interest in these resources, though the importance of salmon to First Nations in the BC Interior must be better recognized. Mr. Leone suggested we already have a whole shed full of tools that we can use. None of these issues are new, and many are well understood. What's less well understood is the distribution and impacts related to life histories of different species and First Nations are well situated to assist in this. These forums can be used to develop meaningful management systems that are time sensitive. Put them on the ground now and look at what shifts are occurring and whether management objectives are being achieved.

Discussion

- A participant asked what could be done to make forestry and fisheries the priority that they should be. More is being spent on the Vancouver Convention Centre than on the MPB action plan. Only about 1% of the forestry sector's contribution to provincial revenues is being put back into management.

5.2.4 Ray Lauzier, Wild Salmon Policy, Fisheries and Oceans Canada

Mr. Lauzier presented across the province the strategies and implementation of DFO's new Wild Salmon Policy (WSP). The policy represents a new way of managing wild Pacific salmon, by defining and rating the status of salmon "conservation units" and developing and monitoring indicators of habitat status. The MPB represents a new pressure indicator that will have to be considered as part of this. The WSP also calls for an ecosystem approach to managing wild salmon. Ecosystem values do not just encompass the contribution of the ecosystem to salmon, but also that of salmon to the ecosystem.

In its ongoing efforts to implement the WSP, DFO will be asking communities to identify non-consumptive values of salmon. Interestingly, the geographic adaptive zones developed as part of the WSP almost perfectly match the traditional geographic boundaries of First Nations linguistic groups. Consultations in the WSP process are also helping to identify local values. No one agency can address the pressing problem of the MPB alone, Mr. Lauzier noted, but this forum represents a start on how to manage it.

5.2.5 Paul LeBlond, Pacific Fisheries Resource Conservation Council

Dr. LeBlond outlined the background and mandate of the PFRCC, an independent body that reports to the federal Fisheries Minister and the public on the state of Pacific salmon stocks and habitat, and examines strategic issues related to salmon conservation. Over the years, the PFRCC has stressed the need for federal/provincial cooperation because of overlapping responsibilities, and also the need for First Nations' participation. It can sometimes be difficult to create frameworks for cooperation, but when an important issue arises, it seems to happen-as seen in this meeting. The PFRCC has also emphasized the importance of an ecosystem approach. This has not been done much in practice, but the MPB problem, with all its interconnecting parts, has forced an ecosystem approach on us and the hope is that it will spill over to other areas of salmon conservation.

5.2.6 Richard Bailey, Fisheries and Oceans Canada

Mr. Bailey, DFO's program head for Chinook and Coho stock assessment in the Fraser, noted that the shift to an ecosystem approach means assessment personnel are being encouraged to get more involved in issues like the MPB. Fish behaviour changes are being observed due to the presence of MPB, so the methods used to count fish must also change in response. Fish behaviour is changing in response to lethal or sub-lethal disturbance to habitat caused by MPB or salvage logging. It's not as complex as we have tended to make it look.

From the fisheries perspective, we first need to know what we have to conserve, and that relates in part to what must be conserved for First Nations values. Then we ask what habitats are required to conserve that. Are there critical habitats in impacted areas that we need to conserve? Are there habitat functions that are critical at certain times of year? Are there requirements for inter-connectivity between time and habitat functions? For example, Interior Chinook have different life histories, with different dispersals at different times of year. It is critical to ensure that the needed pathways are open at the required times. So we need to determine what quantity, quality and connectivity of habitat we need to conserve. We can then advise forestry and fisheries managers on what to set aside. In the end, all this must be put out to the public to let them decide what will be conserved and what socioeconomic tradeoffs will need to occur.

5.3 Mountain Pine Beetle – Salmon Interactions: Workshop Open Discussion

- How can we ensure that the recommendations that come out of this exercise will be considered by the people who make decisions? Building relationships is key, Mr. Shepert replied. This discussion is being recorded and the organizers are committed to following up. Mr. Kenney added that this workshop is part of the larger Fraser Watershed and Salmon program, in which a key goal is to ensure that decisions moving forward are consensus-based. Mr. Leone said this discussion will inform all participants, who will take the key messages back to their own agencies and organizations. Systems are already in place, though the MPB situation will require adjustments to those systems. Mr. Bailey added that if core suggestions from this process are watered down through a conflict resolution process, the results will be problematic.
- Mr. Leone noted capacity is a serious challenge and there are no easy answers to that. Everyone here faces competing demands, but this is an issue that integrates a number of those other demands;

- Dr. LeBlond commented that in assessing socioeconomic considerations, if you look at money alone, fisheries can't win against forestry. But there is more than the economic value of salmon at stake, especially for First Nations. The groups that can have the most impact in this discussion are the groups that depend on the resources;
- Have MPB studies looked at interactions between MPBs and other beetle bugs? Another participant replied that the Douglas fir bark beetle and the spruce beetle are also significantly on the rise, whose expansion is also linked to climate change;
- This all links to the real issues, which are climate change, the rise in disturbance in general, and what we will be looking at 20 to 40 years in the future. We should be using climate change as the focus and looking at flooding regimes, temperature regimes and the whole list of projected disturbances to salmon. These are much bigger than the MPB and other pests that are on the rise. If we used that as our focus, we might be able to generate more interest. Dr. Johannes replied that the issues related to salmon and climate can be almost overwhelming, so the approach with this initiative is to use the MPB as a starting point in tackling the broader concerns. Mr. Shepert said environmental conditions and climate change are now key drivers for management within DFO. The Fraser Panel also takes these very seriously, with adjustments to permitted salmon harvest levels to account for anticipated en route mortality due to river temperature and discharge levels. Mr. Bailey replied that a lot of work was already being done on climate and salmon. MPB is just a symptom of what's going on but there is value to compartmentalizing and dealing with symptoms. DFO is starting to deal with these issues in predicting productivity and planning harvest levels. There will be more pressure to be more risk averse. Mr. Leone said the two approaches are not mutually exclusive but rather complementary. He agreed that there is value on linking the two and explaining to the public what is going on, as this will help draw attention and encourage government to address the MPB;
- A participant thanked Shepert for his efforts to include trainees in this discussion and asked what government agencies would do to build capacity and support implementation? Mr. Leone said both the Province and DFO are starting to work on succession planning, but there is no simple answer. Agencies need internal capacity to support external expectations and the stability to collaborate with others. Mr. Shepert agreed this was a big challenge. It was one of the issues identified in a recent PFRCC report on challenges confronting DFO;
- Many university students might be interested in this. A bulletin might be a way to reach them;

- Capacity is also a big challenge for First Nations. Small communities of a few hundred people are being asked to respond to so many issues at the same time, and this limits their ability to respond to opportunities;
- The Forestry Code wasn't written to address MPB. Companies have switched from chasing the beetle to chasing cut based on shelf life;
- One of the workshop objectives is to look at short- and long-term plans. Several groups have asked what will be done in the short-term in relation to linking with industry and getting the message across that there is concern with what is going on. Is there a mechanism to communicate these concerns about fisheries and communities in the short term? Mr. Kenney said the next steps could include a working committee to move issues forward, and part of that could be approaching industry to discuss these issues in a collaborative manner, along with possible alternate management regimes. Clearly, the forestry industry has significant economic clout and faces a short timeline, so there is not a lot of time, but there must be ways to work collaboratively;
- Apart from a working committee, what are we going to do individually? Another participant described it as a unique situation that represents an opportunity. There are stands with different shelf lives, cuts and environmental settings. The first task of a working committee might be to develop a strategic environmental monitoring program. Mr. MacIsaac's presentation provided a good framework and identified the gaps. The work needs to be done very quickly because of the timelines. We should determine what questions need to be asked, set up the monitoring program, and set up data collection system so that all partners and stakeholders can use the information. A deliverable is needed. For example, a committee that will frame a monitoring network, funding sources, and what strategies will be used to include First Nations;
- Mr. Shepert said a key question is how to make an effective case to big multinational forestry companies. How do you even get into the boardroom? Another key question relates to governance. Participants should seek a mandate from their constituents and it's important that this process be structured to avoid it becoming positional. A participant agreed that reaching industry decision-makers is a challenge. He also noted that government agencies must work within the confines of the policy of the day. Ministry personnel therefore rely on outside participants to insist that they be part of the decision-making process and to ensure that those policies work for them;
- A good step would be to include more representatives from the licensees and MOF. Also encourage ENGOs and First Nations to put as much pressure on government and industry as possible to help move things ahead in the short-term;

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- Industry is probably not as far away as they may seem to be. There are still many operations that are being guided by watershed assessments. Companies may have already hit the targets but they need to continue cutting to get all the wood. So they are going to the hydrologists for advice on how to continue. Short of cutting down the forest industry, there is a need for suggestions on what industry can do to restore balance;
 - Many people are becoming conscious of this and communities understand the need to get more people out in the field to monitor. But MOF has reduced its staff in recent years. There is a need to change the way forestry and fisheries are governed to give communities a stronger voice in decisions;
 - Significant oil and gas development is planned in the Nechako area, and this will have huge impacts on fisheries. Is any proactive planning being done for that, instead of waiting and being reactive? Mr. Leone said this relates to the earlier point about the MPB being part of the bigger issues related to climate and development changes across the landscape. Some change will happen inevitably because of market forces. But those changes will now be coupled with the impacts of climate. Many industries use water and water extraction is not being adequately regulated. When MPB impacts are added, the overall impacts will be very significant. There is need for monitoring and for prioritization strategies. Management must recognise that there has already been previous disturbance, and that natural disturbance and further development are likely to take place. This leads to the emerging issue of broader landscape development and planning that does not just consider forestry but also other development pressures. MPB affects mainly lower elevations, but fish may also be subject to impacts from development of other resources that will affect watersheds at higher elevations.

6.0 PRIORITIES AND NEXT STEPS

Next steps will include working collaboratively to move this initiative forward, presenting the best management and monitoring practices to industry and developing an effective mechanism to move forward.

6.1 Mountain Pine Beetle – Salmon Interactions: Priorities

- Development of a technical working group:
 - Smaller with key representation (decision makers);
 - Balanced summary from First Nations, agencies, industry and general public;
 - Discussion needs to occur at the regional level involving politicians at all levels; and,
 - Next meeting should have individuals representing key agencies or group with mandate to proceed and contribute to discussion, management and solutions for MPB threats to salmon.
- More of the supporting science should be made available for communication and public awareness;
- What management solutions/outcomes are feasible. Be clear about outcomes supported by the appropriate people to develop informed decisions;
- Knowledge and involvement from industry is essential. Context for management and regulatory approaches should be considered in balance against natural recourses and resource use;
- Stronger provisions in existing regulatory/management structures to include climate issues, MPB epidemic, forest harvesting and riparian area protection (*i.e.* new Fisheries Act);
- High priority to meet with CFS, federal agencies, MOF and industry;
- Build a proactive team responsive to a variety of forest, water climate issues (*i.e.* integrated discussion about forest pests and other threats);

-
- DFO to commit involvement in understanding and managing for MPB threats to fish and fish habitats;
 - Connect to proactive MOF initiatives over the next year. MOF is managing for ecological resilience, carbon storage/emissions and species shifts linked to climate change;
 - Talk to industry about impacts and practical management solutions. Get to table sooner than later so we can make our concerns heard and ensure industry can use that information;
 - Get a short list of impacts that we are 95% sure are going to happen. Say why the current legislation is not adequate or meeting these concerns to the right government folk, and then approach industry;
 - Develop appropriate best management practices and mitigation measures. We have to consider the socio-economic cost of mitigation and work with industry who may have their own ideas around mitigation;
 - Industry may perceive legislative constraints. Industry may have incentive to come to the table if they believe they have the support to be flexible and innovative with harvest and management solutions;
 - Fisheries component is missing from Chief Foresters report on climate change. MOF should manage for ecosystem resilience, not just forest/terrestrial ecosystems, but also aquatic ecosystems;
 - Identify pilot study or research areas;
 - Build a communication strategy. Opportunities to bring together a short-list of experts to move toward discussion with industry;
 - Set a next workshop dialogue to continue discussion; and,
 - Identify potential funding sources to support research, communication, management and public/community engagement.

6.2 Mountain Pine Beetle – Salmon Interactions: Next Steps

- Development of a working committee to approach groups for collaboration, such as First Nations, industry, agencies, and other community members;
- Development of a monitoring program (*e.g.* data collection process and protocol), and identify key gaps and information needs;
- Seek a mandate and support from constituents;
- Enhance involvement through a greater diversity of participants;
- Link industry to watershed planning initiatives and management approaches;
- Consider a potential strategy to deal with point source pollution issues (such as ranching), and their impacts to water resources, fish species and habitats;
- Develop a communication strategy for MPB threats to salmon and fisheries habitats in BC;
- PFRCC to develop a public information piece and communication strategy;
- Initiatives need to be proactive rather than reactive in nature, and include a broader view of multiple stresses;
- Initiatives need to address and support community capacity building needs and priorities;
- More supporting science is required that is available for review, public consumption, in order to develop a more informed decision-making process; and,
- Information needs to be made available in multiple forms and locations (*e.g.* paper copies in community libraries).

7.0 CLOSURE

We trust that the information contained in this technical report meets your requirements. Please contact the undersigned at 604-296-4200 should you have any questions or comments.

Yours very truly,

GOLDER ASSOCIATES LTD.

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Attachments

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APPENDIX I
WORKSHOP AGENDA

Workshop Agenda**Tuesday, January 30, 2007**

8:00 am: **Networking**

9:00 am: **Workshop Opening And Welcome**

- Alan Kenney – Pacific Salmon Foundation
- Thomas Alexis - Tl'azt'en Nations
- Mark Johannes – Introduction and Background to Workshop

9:30 am: **Mountain Pine Beetles In Bc, The Moe View And Action:**

Chris Ritchie, Provincial Beetle Response Project Manager,
Ministry of Environment –

10:00 am: **MPB Threats To Salmon And Fisheries Resources**

Allison Webb, Regional Director Policy, Fisheries and Oceans Canada

10:20 am: **Questions To Speakers**

11:00 am: **Industry Approach And Perspectives On MPB Infestations**

Doug Routledge, VP Northern Operation, Council of Forest Industry

11:30 am: **MPB Threats To Salmon And Fisheries Resources, What Is Important?**

Open facilitated session –

12:00pm: **Lunch**

1:00 pm: **Workshop Background And Process**

Mark Johannes, Golder Associates -

1:10 pm: **First Nation Fisheries Perspectives To MPB Infestations**

Peter Nicklin, Upper Fraser Fisheries Alliance
with Thomas Alexis Tl'azt'en Nations

1:30 pm: **Changing Climates And Our Bc Forests And Fish Habitats**

Stephen Déry, University of Northern BC,

2:00 pm: **Beetles, Streams, And Fish Habitat: Hydrologic Considerations**

John Rex, Ministry of Forests and Range,

- 2:30 pm: **Towards A Risk Assessment For MPB Impacts On Salmon Habitat: What We Need To Know**
Erl MacIsaac, Fish-Forestry Science, Fisheries and Oceans Canada -
- 3:00 pm: **Questions To Speakers, Comments And Areas Of Interest**
- 3:30 pm: **What Are The Major Issues Confronting Forests And Fish With MPB Infestations And How Best To Manage Them?**
Breakout Group Discussions:
- 1-5 years -in areas of salvage operations, and without forest operations;
 - What do our forests and fish habitats look like in 5-10 years and how do we manage them?
 - What do our forests and fish habitats look like in 20-50 years and how do we manage them?
- 6:00 pm: **Break For Dinner And Networking**
- 8:00 pm: **Planning Forests And Fisheries Resources Now And Into The Future.**
Art Tautz – Ministry of Environment,
- 8:30 to
9:00 pm: **Questions And Comments From Day 1, Networking**

Wednesday, January 31, 2007

- 8:00 to
9:00 am: **What should we plan for the future?**
Breakfast and Table Discussions
- 9:00 am: **The Social And Economic Issues Of Mountain Pine Beetle Infestations And Their Effects On Our Forest And Fish Communities**
Roxanne Scott, Golder Associates
- 9:30 am: **Designating Fisheries Sensitive Watersheds**
Ray Pillipow and Susanne Williamson,
Fish and Wildlife Science, Ministry of Environment –
- 10:00: **Break**

10:20 am **Lessons From Pacific Salmon On The Impacts Of Climate Change:
How Can We Adapt?**

Mark Johannes, Golder Associates

10:30 to 12:30 pm:

Session 4: Panel and Group Facilitated Discussion (M. Johannes Facilitator)

Perspectives on MPB threats to salmon and fisheries resources in BC: next steps

Open Discussion topics:

- Regional planning priorities and approaches;
- Fisheries management and monitoring options, next steps;
- How do we plan and manage for an unknown future for fisheries resources in the context of an overwhelming influence from MPB's. What's next ?
- Further research needs.

Panel Members

Nick Leone, Section Head, Habitat and Enhancement Branch, BC Interior, DFO

Richard Bailey, Interior Chinook/Coho Program Head, DFO

Paul LeBlond, Chairman, PFRCC

Marcel Shepert, Executive Director, Upper Fraser Fisheries Conservation Alliance, & PFRCC.

Alan Kenney, Director Fraser Salmon and Watersheds Program, PSF

12:30pm: **Open Lunch**

For those who wish to stay

1:30 to

3:00pm: **Detailed Follow-Up Discussions for Immediate Next Steps and Planning.**

APPENDIX II

MOUNTAIN PINE BEETLE – SALMON BACKGROUNDER

Introduction

Mountain pine beetles (*Dendroctonus ponderosae*) are currently expanding their distribution in BC at rates greater than previously experienced in Canada (Figure 1, 2). This small insect is native to North America and its natural life cycle causes infested mature lodgepole and ponderosa pine to die within one year of infestation. Trees die due to the combined effects of larvae beetle feeding patterns and a fungal infection of the tree, carried by adult beetles. Mountain pine beetle (MPB) infestations occur naturally and historically are second to fire in disturbance impact on central BC interior forests. The enhanced range and distribution of mountain pine beetles is strongly linked to climate warming conditions associated with warmer winters and longer growing seasons in interior BC. With a longer growing season, more beetle larvae reach a late growth stage before winter sets in, and with fewer cold winters ($> -30^{\circ}\text{C}$), more beetle larvae survive to mature.

Climate warming trends and predictions of beetle distribution indicate that there is a little which can be done to limit a MPB infestation and its extent once it has been established in British Columbia (Figure 2 – Maps). Management and economic strategies have been developed which may allow some recovery of lost forest revenue through salvage logging of beetle dead trees. This management approach will be focused to help slow the rate of distribution of beetles to non infected forests.

Substantial effort is being developed to understand the biology and behaviour of these beetles in the context of forests and the forest industry. However, little is still known about the full range of potential impacts on natural function of forests related links to aquatic and terrestrial animals and ecosystems from mountain pine beetle infestations and from potentially large scale salvage logging being implemented to manage and harvest infected or dead trees.

Given the increase rate and magnitude the MPB infestation in BC, this workshop has been developed address the state of knowledge and the many questions around MPB infested forests, forest management, salvage harvesting and the threats to Pacific salmon, BC salmonids, aquatic and fisheries resources and habitats. Short and long term threats and potential impacts may arise from MPB infestations and forest management practices on salmonids, their life cycles in freshwater and their habitats (Figure 3, 4). This workshop was established to address potential threats and discuss options for the short and long term management of BC Pacific salmon, BC fisheries resources and their habitats.

Mountain Pine Beetle Impacts to Hydrologic Regime

The hydrologic regime of the interior pine forests of BC is driven by climate and the annual accumulation and melt of the winter snowpack. The process and accumulation of snow and melt is altered by normal climate and hydrologic cycle processes such as precipitation, evaporation, interception, transpiration, climate patterns such as wind and the biophysical characteristics of the watershed like vegetation, geology and geochemistry. The impacts and implications of MPB infestations and beetle-kill in forests on the hydrologic cycle and function in a watershed are not well understood but are related to the extent of pine mortality and salvage logging. In some watersheds the magnitude of stand mortality, salvage logging and road construction can have a large impact on hydrologic regime in forests. The speculation is that beetle-killed forests mimic, to some extent, similar characteristics of forest harvesting but potentially to a smaller extent and size. Infested pine forests retain tree trunks, needles and branches and often remain standing and can influence forest under story and regeneration.

The literature suggests the following hydrologic/watershed trends related to MPB infestations in forests:

- Increase in annual water yield due to reductions in snow interception and evapotranspiration over a 20-50 (or greater) year post infestation period;
- Earlier timing of spring/early summer snowmelt;
- changes in late summer and fall low flows;
- Little change in instantaneous peak flows;
- More rapid streamflow responses to weather events like storms; and,
- Higher elevations of ground water in low lying areas.

The extent of mountain pine beetle influenced change in the hydrologic regime is dependent on:

- The time and level of tree mortality;
- Density of understory and other forest vegetation; and,
- Level of salvage logging and fire in the watershed.

Potential Climate Change and Mountain Pine Beetle Impacts to Salmon and Fish

Climate change is expected to directly and negatively impact the spatial and temporal conditions in which fish and salmon currently live in BC. Enhanced climate warming, variation and change predicted over the next century will impact the physical characteristics of freshwater, terrestrial and marine environments through degradation, loss and fragmentation of optimal habitat characteristics and their linkages to terrestrial environments for the present distribution of many native BC fish species. The general impacts of climate change on the physical environment and the conditions which create natural habitats include altered:

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

Climate change is expected to impact the biological extent and characteristics of fish and influence individuals, species, populations to scales of ecosystems through altered:

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

The direct impacts of mountain pine beetle infestations on salmon, fish habitats and fish production is unknown, but is speculated to similar to the effects of forest harvesting practices on watershed function and salmon production. It is well understood that riparian forests play an integral interface between the terrestrial landscape and freshwater fish habitats and fish production. Riparian forests influence and regulate microclimate around streams, secure banks, provide terrestrial habitats, supply woody debris, buffer precipitation, support nutrient and sediment runoff, and leaf-tree litter act as a food sources for benthic organism and eventually fish and salmon in streams. Research to date supports a clear understanding about the value and importance of the links between the terrestrial environment, nutrient poor headwater streams and sensitive egg, juvenile salmon life histories and ultimately the production characteristics of salmon populations.

Changes in forests and altered water temperature, quality and quantity are linked to the survival and success of a freshwater fish population or an entire community through biological mechanisms which: (a) directly impact the habitat characteristics of a species or (b) indirectly impact the foodwebs or community structures in which individual species currently live. Direct impacts alter optimal habitat conditions or suitability for an individual fish and at the population, community and overall species levels by influencing experienced stress or exceeding species physiological tolerances to environmental variables like temperature, moisture, sunlight, current etc. Indirect impacts alter the availability of food and nutrients, abundance and characteristics of predators and competitors, including invasive and exotic species, and vulnerability to disease and parasites.

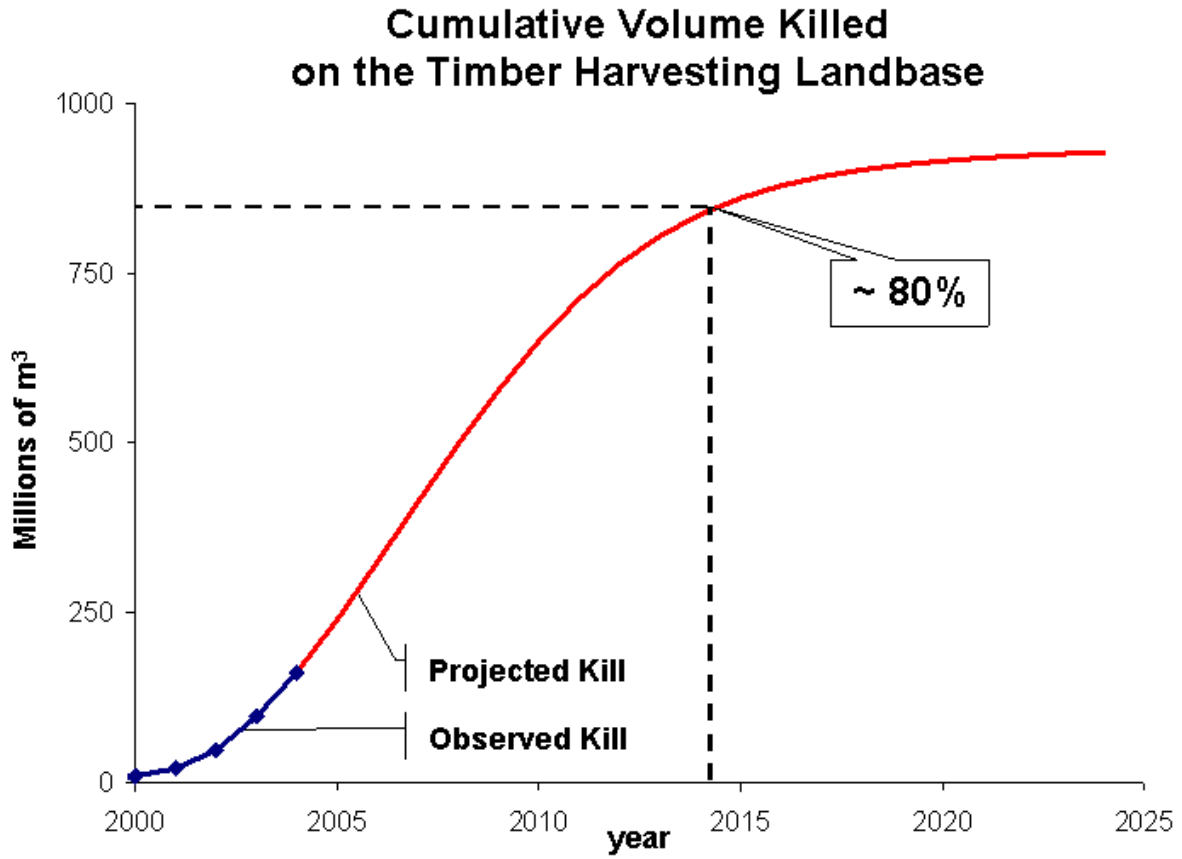


FIGURE 2: Mountain Pine Beetle Initiative of the Canadian Forest Service and the BC Forest Service cumulative percentage of pine killed observed data 1999 to 2004, projected 2005 to 2025.

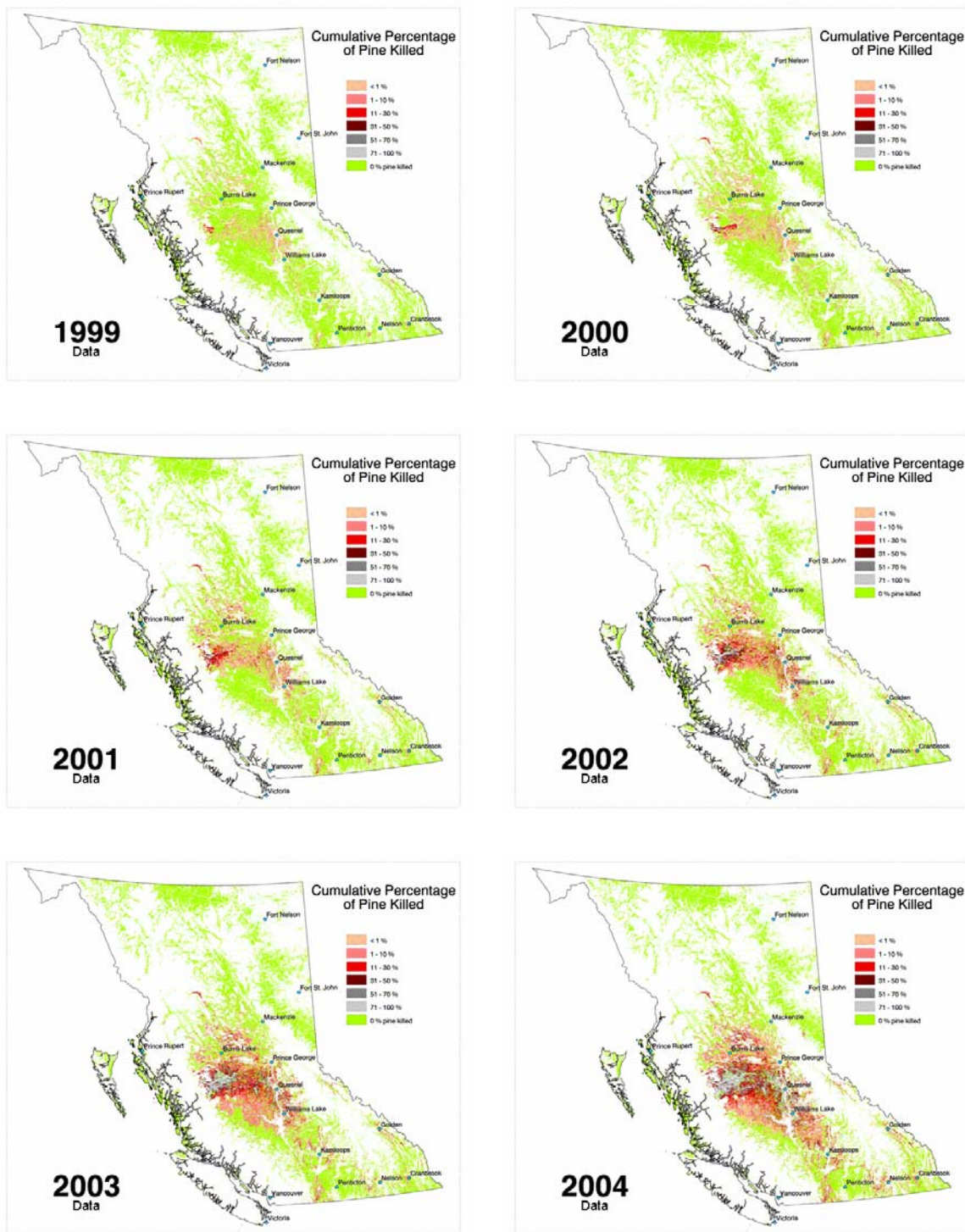
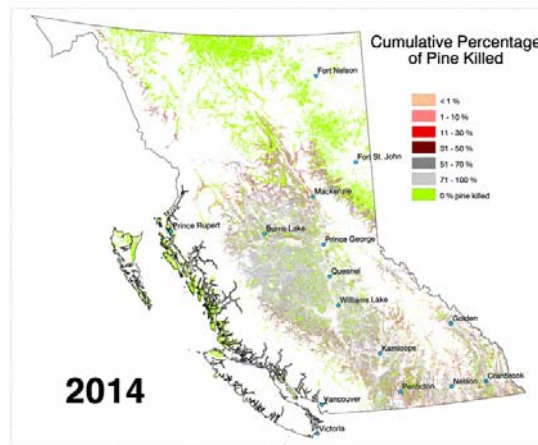
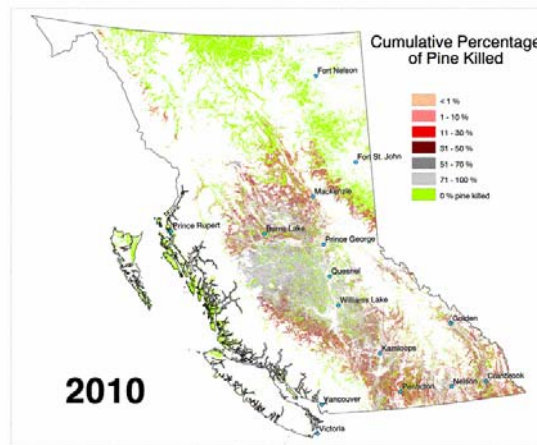
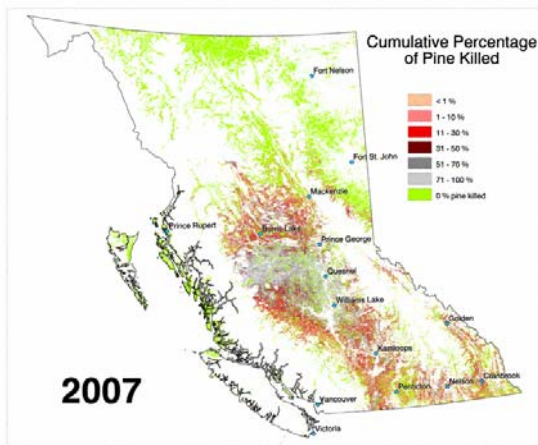
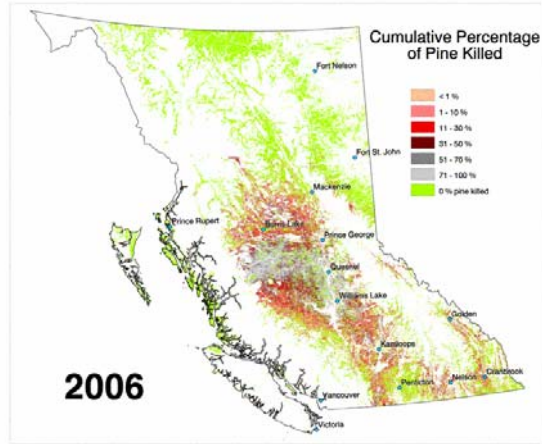
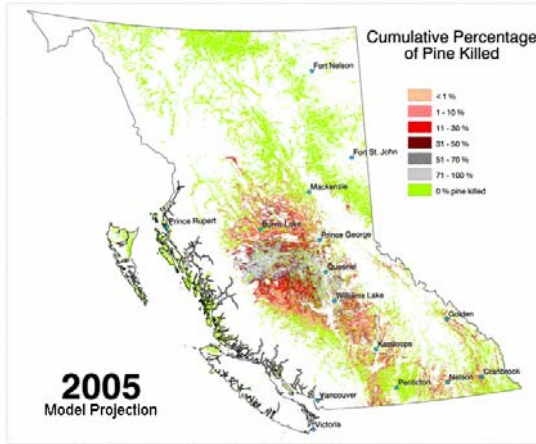


FIGURE 3: Mountain Pine Beetle Initiative of the Canadian Forest Service and the BC Forest Service cumulative percentage of pine killed data 1999 to 2004, projected 2005 to 2014.



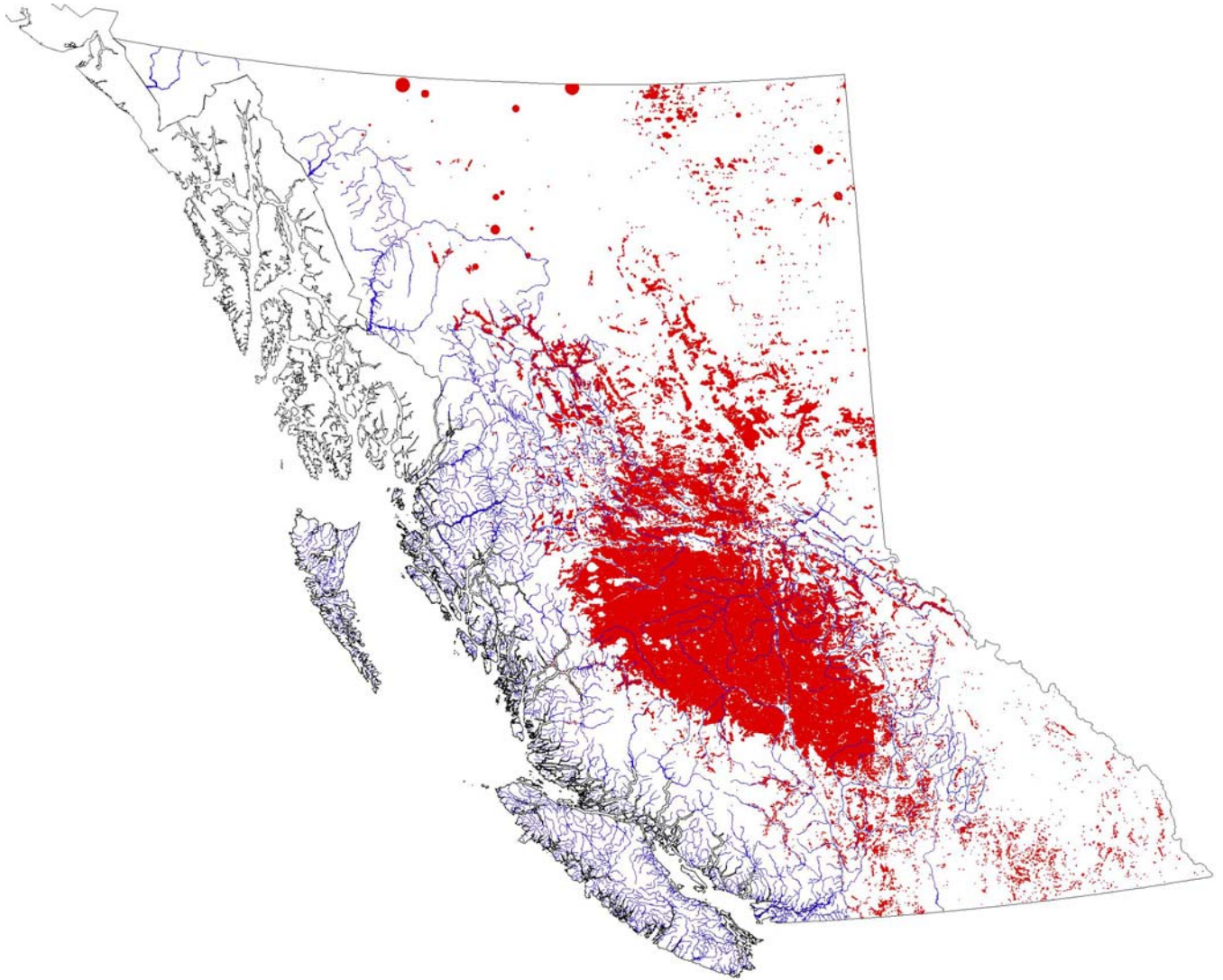


FIGURE 4: Map overlay of “major” Pacific salmon river systems and mountain pine beetle area of infestation to 2004.

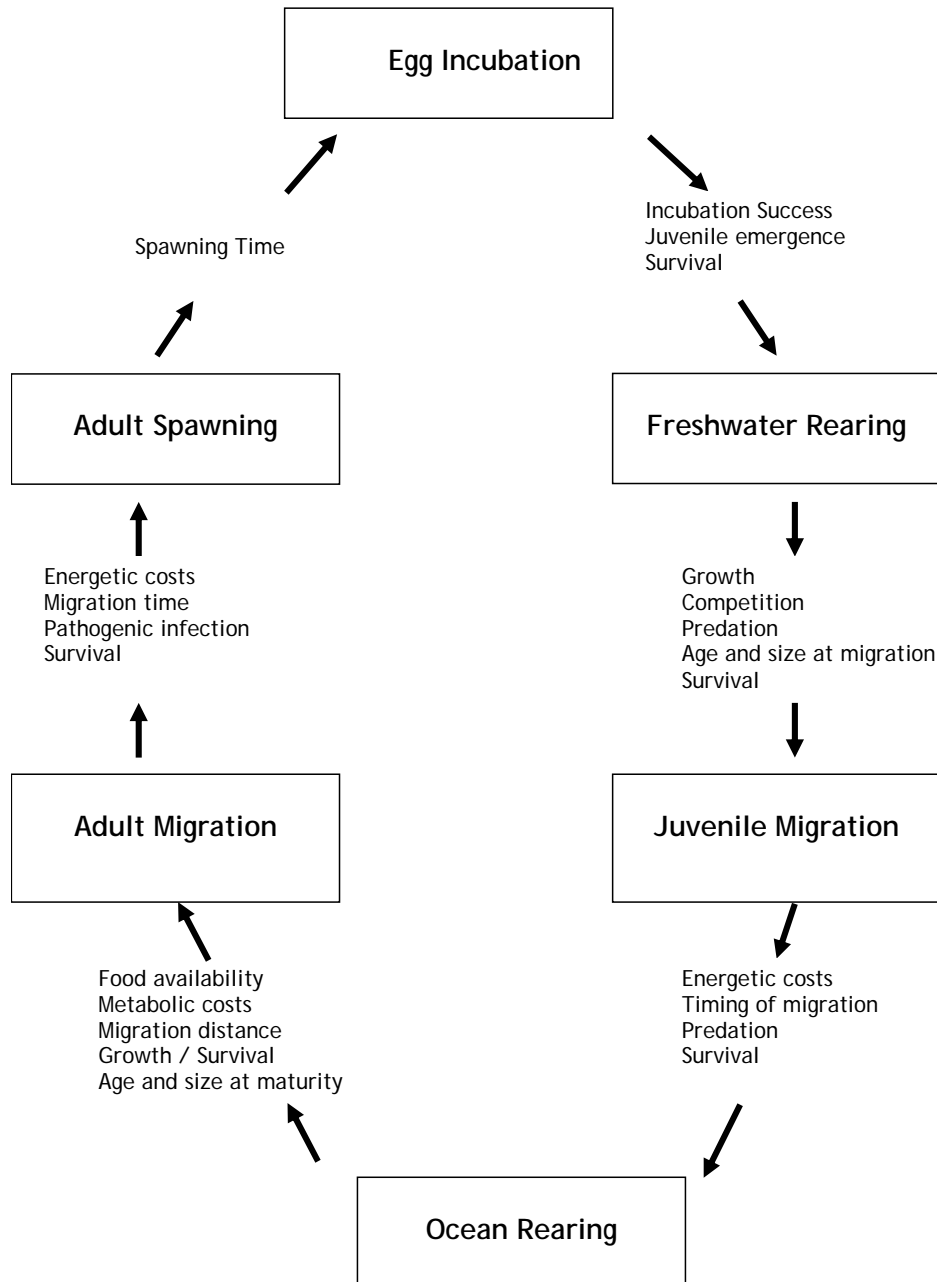


FIGURE 5: Potential impacts of climate on sensitive life history stages of salmon.

APPENDIX III
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APPENDIX IV

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Beetlewatch http://mpb.cfs.nrcan.gc.ca/beetlewatch/index_e.html

BC First Nations Forestry Council – Mountain Pine Beetle:

The BC First Nations Interim Mountain Pine Beetle Working Group
<http://www.fnmpb.ca/resources.html>

FORREX Mountain Pine Beetle Gateway - <http://nrin.forrex.org/servlet/mpb>

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