LAKELSE 2060:

A 50 YEAR VISION FOR THE LAKELSE WATERSHED

Written by: Kory Botelho, Rodney Brown, Chrysta MacKeigan Burkitt, Christa-Marie Carstens, Brady Conlon, Sarah Degerness, Cassie Dusdal, Paul Geier, N. Kerby, Patricia Kohler, Magda Machula, Morgan Oleksewich, Maureen Rowlett, Hikari Shiga, Adam Simons, Colin Spangl, Laura Webb, and Meagan Whyte

Instructor, Supervisor, Summary Comments, Editor: Dr. Norma Kerby

Course: Geography 112, Northwest Community College, Terrace, B.C., 2010

NORTHWEST COMMUNITY COLLEGE

Lakelse 2060

April 14, 2010

RE: Geography 112, Environments and Planning - Coordinated Class Projects;
Instructor – Dr. Norma Kerby

We, the undersigned, are pleased to submit the following compilation of class assignments and term projects, for assistance in long term planning in the Lakelse watershed, British Columbia. Intellectual rights remain with the authors and publication in major part or whole requires their written permission.

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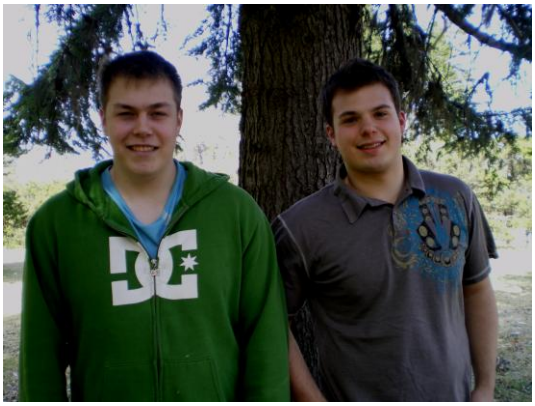


Brady Conlon and Kory Botelho; Missing Adam Simons

Moose Management Study

Cassie Dusdal, HIkari Shiga, Morgan Oleksewich

Benthic Environment: Freshwater Mussels

Colin Spangl; missing Patti Kohler

Water Quality at Lakelse Lake

Paul Geier and Laura Webb

Lakelse Hotsprings: 2060

Magda Machula

Amphibian Management Plan

Meagan Whyte and Sarah Degerness:
Public Values and 2060 Visions

Maureen Rowlett and Christina-Marie Carstens:
Historical Changes to Lakelse Lake

Chrysta MacKeigan Burkitt:
Grizzly Bears: Projections

Rodney Brown

Motorized Recreation Traffic

ACKNOWLEGMENTS

This coordinated project was undertaken in cooperation with the Regional District of Kitimat-Stikine and the Lakelse Watershed Society, who provided information, logistical support, reports, and maps. Special thanks are due to Margaret Kujat, Coordinator of the Lakelse Watershed Society, and to Ted Pelligrino, Planner, Regional District of Kitimat-Stikine.

The following individuals, groups, and agencies provided essential information to this planning project and assisted students with their projects:

Ian and Thelma Maxwell and other members of the Lakelse Watershed Society

Margaret Kujat, Coordinator, Lakelse Watershed Society

Chris Broster, Ecosystem Specialist, Ministry of Environment

Ann Hetherington, Ministry of Environment

Len Vanderstar, Ministry of Environment

Tony Hamilton, Ministry of Environment

Mike Leggat, Ministry of Environment

Brad Pollard, R.P.Bio., Consultant

Carl Johansen, District Recreation Officer

Ben Sabal, Lakelse Area Supervisor, Parks Branch

Northern Health Authority

Terry Unran and Adolph Ludke, Terrace Snowmobile Association

Earl Houlden, Terrace Motocross Association

Mitch Drewse and Rob Dams, Fisheries and Oceans Canada

Eva Kerby, map specialist, Regional District of Kitimat-Stikine

Ken Newman and Ted Pellegrino, Planners, Regional District of Kitimat-Stikine

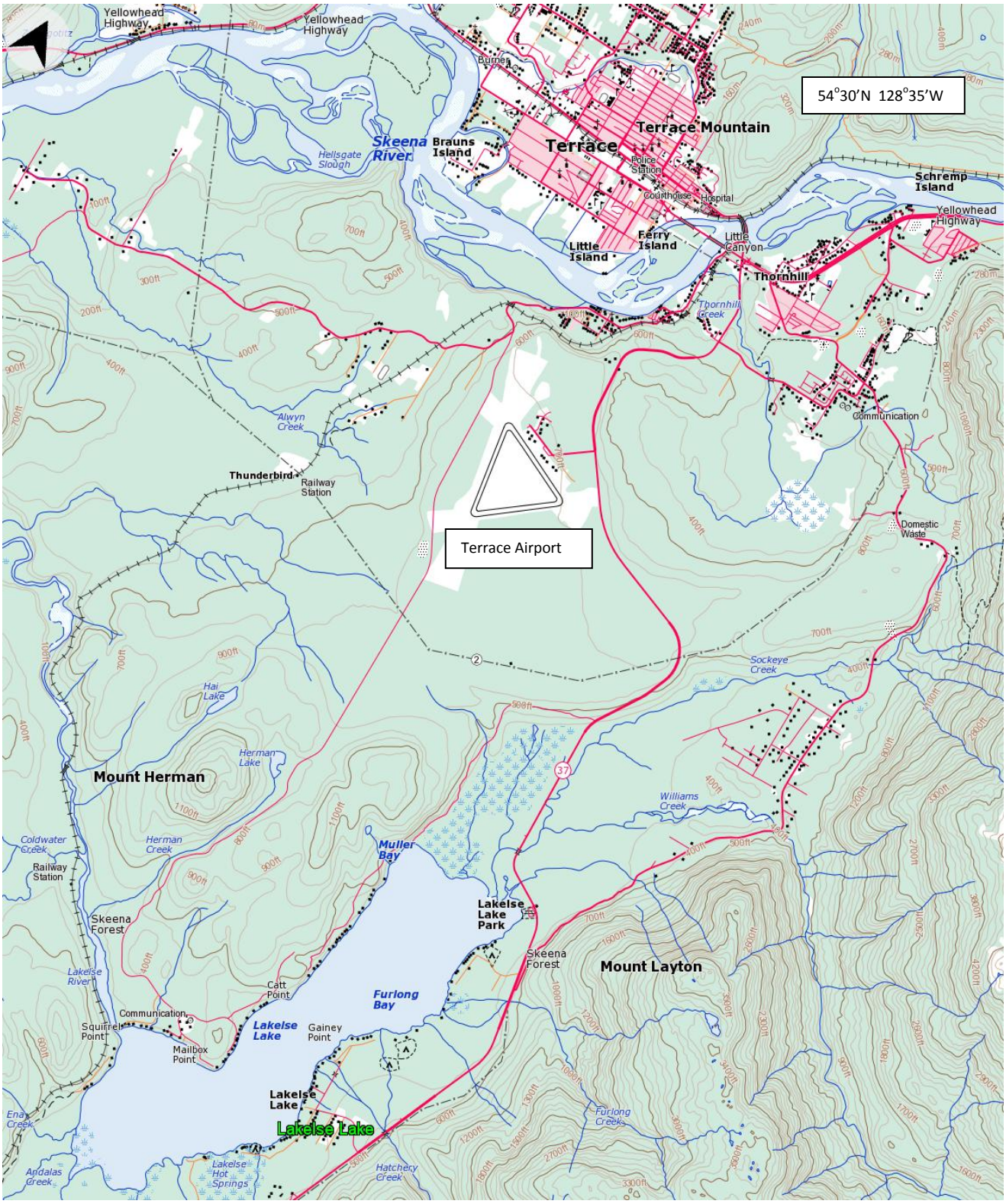
Edward Kenney, Historian and long-time resident of Lakelse Lake

Mrs. Mamie Kerby, Historian and long-time resident of the Terrace area

Bert Orleans, owner of Mt. Layton (Lakelse) Hotsprings Resort

Rob Brown, Fisherman, columnist, writer, long-time Lakelse River observer

Dave 0'Leary, Public Relations, Northwest Community College



Map showing location of Terrace, B.C. and Lakelse Lake

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NORTHWEST COMMUNITY COLLEGE
Take a closer look.

March 9, 2010

Dear :

RE: **Lakelse 2060**: Coordinated Class Projects Looking at Planning Issues in the Lakelse Watershed; undertaken by the students of Geography 112, Environments and Planning, Northwest Community College.

On April 7th, 2010, from 8:45 a.m. to 12:00 noon, the students of Geography 112 will be presenting their term projects examining planning and environmental issues in the Lakelse Watershed. These projects may include:

- a public survey of what people value in the Lakelse area
- how historical events have impacted the Lakelse area
- water and water quality
- freshwater mussels as indicators of lake health
- an amphibian management plan for Lakelse Lake
- moose, wolves and terrestrial ecosystems within the watershed
- grizzly bear projections to 2060
- motorized recreation use of the Lakelse watershed
- the Lakelse Hotsprings: an international resource?

The theme of these projects is to project ahead to 2060 and determine which planning and management processes might be necessary to maintain certain values in the watershed and in Lakelse Lake.

We would like to invite you to this presentation. It will be held in Room 1108 of the Cedar Building (Waap Amgam) at 8:45 a.m. on April 7th. Each presentation will last between 10 and 15 minutes. You are welcome to come to all or some of the presentations throughout the morning. If you have any questions, please feel free to contact me at (250) 635-6511 Ext. 5251 or email nkerby@nwcc.bc.ca.

Yours truly,

Dr. Norma Kerby

College Professor

University Credit Program

NORTHWEST COMMUNITY COLLEGE

Geography 112: Environments and Planning

PLANNING FOR LAKELSE 2060:

PRESENTATION

OF STUDENT PROJECTS

Cedar Building Room 1108

Waap Amgam

9:00 am to Noon

For more information contact:

Dr. Norma Kerby

(250) 635-6511 Ext. 5251

NORTHWEST COMMUNITY COLLEGE
Take a closer look.

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Instructor, Supervisor, Summary Comments, Editor: Dr. Norma Kerby

Course: Geography 112, Northwest Community College, Terrace, B.C.

MAY, 2010

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SECTION 1

LAKELSE 2060

A 50 year planning framework to maintain important values in a watershed with many land-use conflicts

by N. Kerby

1.1. **Background of the Lakelse 2060 Project**

The best education occurs when students are engaged with real-life, hands-on learning that has tangible returns to the community. In the fall of 2009, Margaret Kujat, coordinator of the Lakelse Watershed Society, a group of volunteers dedicated to appropriate management for the Lakelse watershed, approached me with the proposal that my Geography 112, Environments and Planning, class work with the Society. Margaret was familiar with some of the other community projects that my classes had undertaken – ranging from planning and economic development projects with the District of Stewart, to analysis of a highly polluted urban stream in the community of Thornhill, near Terrace, B.C.

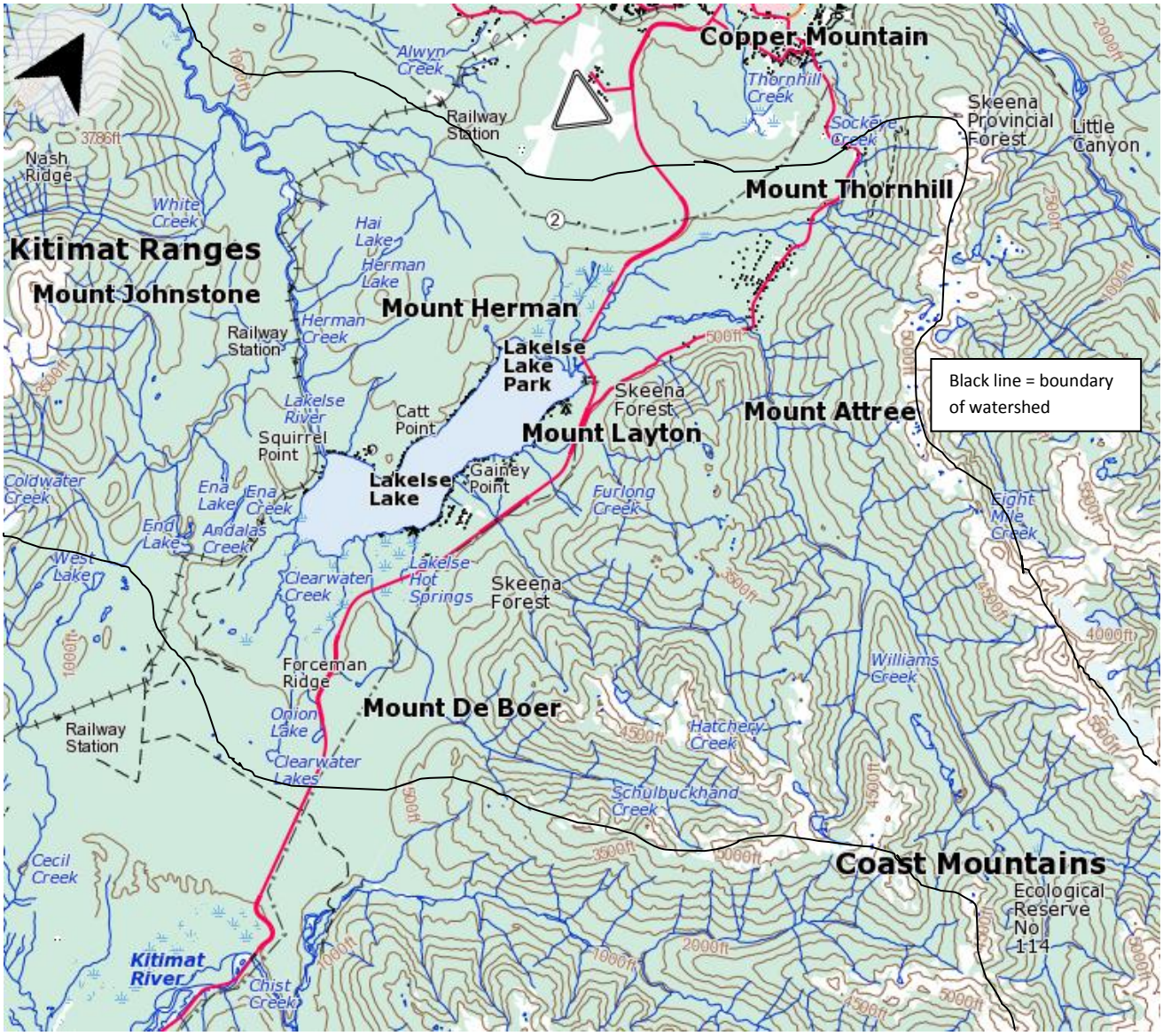
I was hesitant at first, as the Lakelse area has had a long history of ecological and land use conflicts which could be very overwhelming to students in a first year course. We discussed the options and decided that any assistance the class could provide, in terms of an unbiased, objective overview of the issues in the Lakelse watershed, would be of benefit to the situation. The planners at the Regional District of Kitimat-Stikine were supportive, and the students were interested.

In order to avoid bogging down in the large amount of literature available on the Lakelse watershed, and the almost overwhelming nature of the problems faced by the area, I suggested to the class that we needed to define what was important to people about the Lakelse area and work at outlining how these values could be preserved over the long term.

An ecological planning timeframe would be greater than 350 years in the temperate rainforest of the Terrace area. Planning legislation, such as the B.C. Local Government Act, works on 5 and 20 year timeframes. For a watershed, and especially for a recreational lake faced with pollution and shoreline damage, 5 or 20 years is not long enough to plan for retention of values such as fish, frogs, and water quality. In order to work within a feasible cultural passage of time, and looking back at the changes that have occurred over the last 100 years, we decided to work towards a 50 year planning framework. To maintain important values in a watershed with many land-use conflicts, there must be some definition of what is important and what can be done to ensure that the value is still in place 50 years from now.

The projects in this report are planning exercises based upon the simple thesis, “If you want this specific value in 50 years (be it swimming or water quality or grizzly bears), these are the requirements for that value which must be in place in order for it to be there 50 years from now.” For some values, the changes to the watershed over the last 100 years have already degraded the parameter below the threshold valued by the public e.g. water quality and amphibians. To meet public expectations, these values will need to be rehabilitated back to acceptable levels. For other values, they sit on the threshold of sustainability, but, without management and an overarching plan, they too may slip below the value place on them by the people of this region.

This report provides many points for discussion and consideration, but, overall, the consensus of the students was that the Lakelse Watershed needs a plan for the future, a plan that identifies what is important and how we preserve those values; a plan that defines conflicts and how we avoid them; and a plan that recognizes we cannot keep going in the same direction or at the same rate of development within the watershed, and expect to have what we value now still functional in the watershed 50 years into the future.

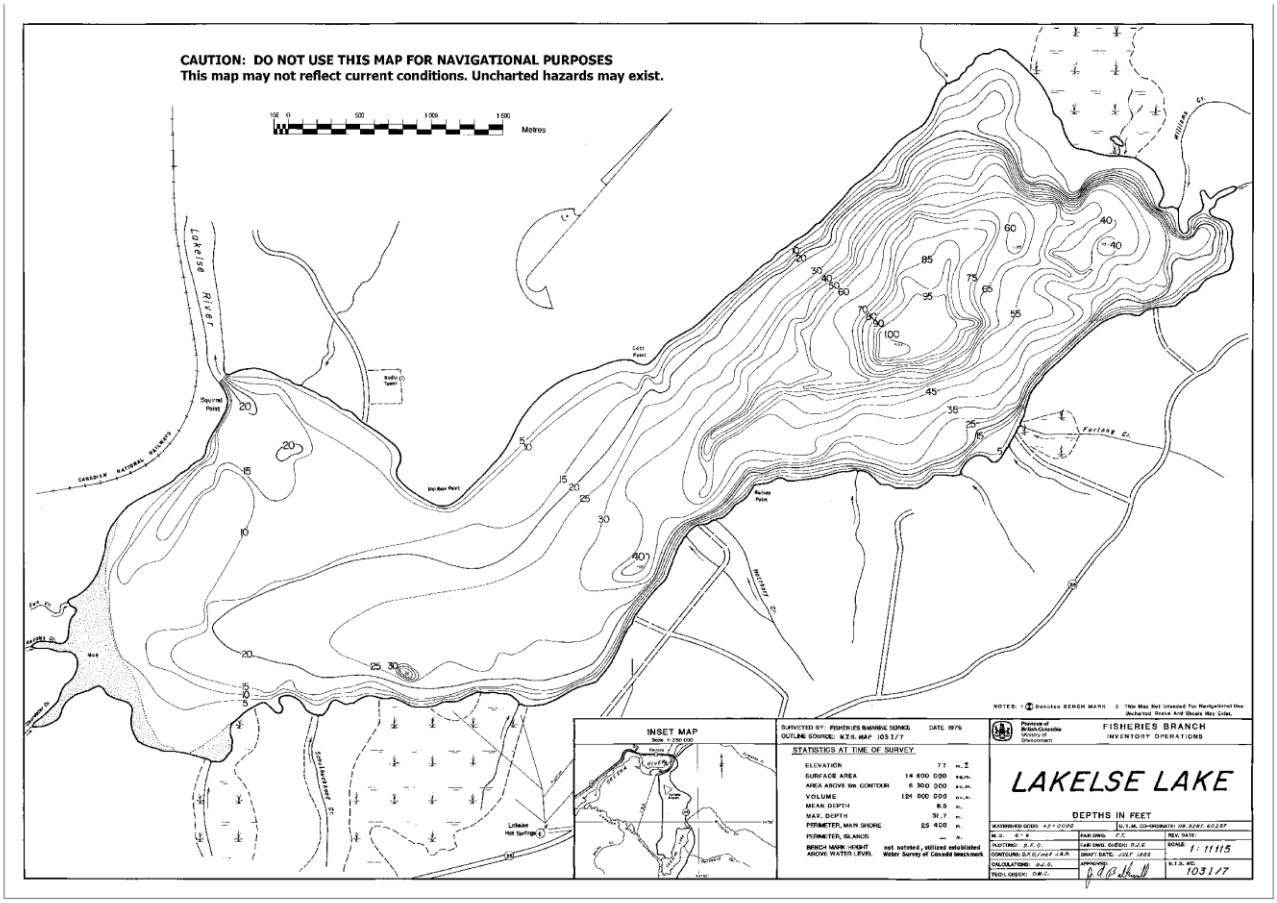


Map showing Lakelse Watershed

The Lakelse Watershed includes Sockeye (Eliza) Creek, Williams Creek and Blackwater Creek draining into the north end of Lakelse Lake; Furlong Creek, Hatchery Creek, Mountain Creek, Hotsprings Creek, and Schulbuckhand (Scully) Creek draining into the east side of Lakelse Lake; Clearwater Creek, Andalas Creek, and Ena Creek draining into the south end of Lakelse Lake; Eel Creek draining into Beam Station Beach; and Coldwater Creek, White Creek, Herman Creek, Hai Creek and Mink Creek draining into the Lakelse River.

BATHYMETRIC MAP OF LAKELSE LAKE

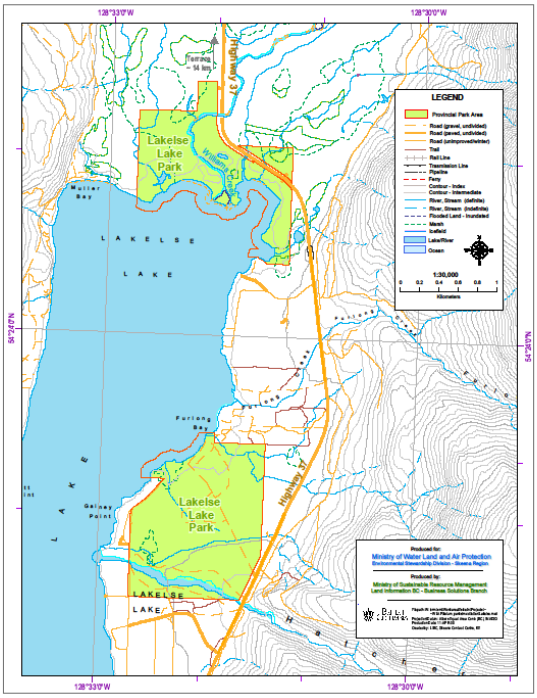
Showing depths of water relative to shoreline.



Bathymetric map of Lakelse Lake – this is a relatively shallow lake – its deepest area, at the north end of the lake, is in the range of 34 meters deep. Most of the lake is less than 5 meters deep, with the south end of the lake being very shallow with extensive growth of aquatic macrophytes. The drop-off shelves to deeper water are pronounced on the east and north sides of the lake. In many cases, these shelves were formally areas of reedbeds. Reedbeds were also abundant in the northwest corner of the lake, at the south end, between Catt Point and Mailbox Point, and at Beam Station Road Beach. Reedbeds, essential for many ecological characteristics and factors for Lakelse Lake, have been significantly reduced by residential development.

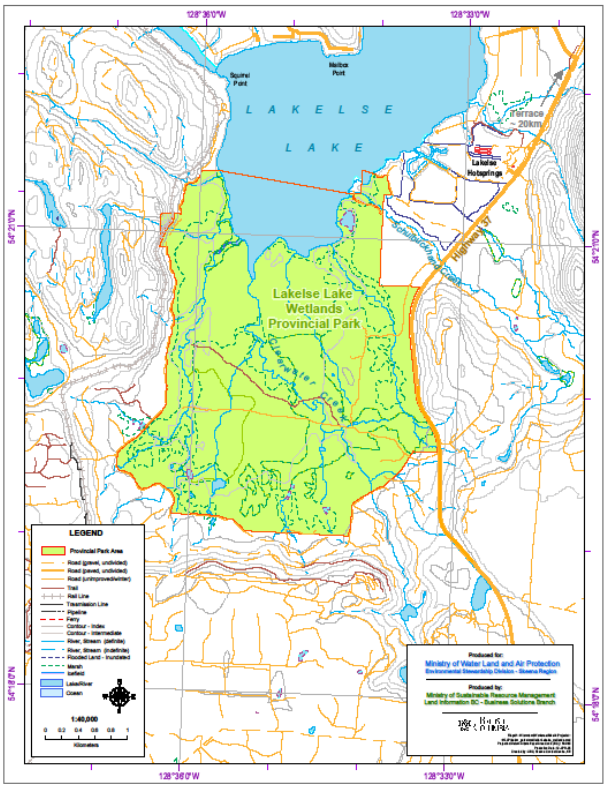
The Provincial Parks of Lakelse Lake are important features in the long-range planning for the watershed.

Lakelse Lake Provincial Park



Established originally in 1956, Lakelse Lake Park contains 356 hectares in two locations on Lakelse Lake. The north park includes a picnic site and swimming area in the northeast corner of the lake. To the west, the park includes the mouth of Williams Creek and sandy Gruchy's beach. The habitats in the wetlands and the floodplain of Williams Creek are rich and include large, old growth Sitka spruce. Moose, bears, waterfowl, and fish use these wetlands. Sockeye salmon spawn in Williams Creek, the largest tributary of Lakelse Lake. The Furlong Bay portion of the park includes a large, 156 site campground and beach facilities. The campground is known as a swimming area and boat launch. The back portions of the park protect areas of old growth and mature forest, as well as many small streams associated with the alluvial fan of Hatchery (Granite) Creek. This habitat is used by many species of birds and wildlife and is important as winter range for moose. Furlong Bay is popular as a campground and attracts tourists, but is also important for locals from Prince Rupert, Kitimat, and Terrace who do not own recreation cabins and spend time each summer camping at the Park.
Reference: B.C. Parks, 2010

Lakelse Lake Wetlands Provincial Park



Established in 2004, Lakelse Lake Wetlands Park protects an exceptional warm-water wetland complex fed by groundwater springs. The Park includes the largest bog ecosystem in the region, overwintering Trumpeter swans (Blue-listed) and grizzly bears ,as well as pocket of original old growth forest. The south end of Lakelse Lake contains the most extensive cover of emergent and submerged aquatic plants remaining in Lakelse Lake, and shelters fish populations, including overwintering steelhead. Lakelse Lake Wetlands Park contains internationally significant salmon spawning streams and rearing habitat. The large reed beds around the southern shoreline of Lakelse Lake and the streams that run through the alluvial fans and wetlands provide prime fish habitat. One of the region's highest seasonal (fall) concentrations of Grizzlies is found along Clearwater Creek, which supports a late fall run of coho. Grizzly bears use the Park as spring and fall habitat, as well as a corridor to the Lakelse River. Bears can hibernate in the Park during deep snowfall years. Over 100 Trumpeter Swans also overwinter in the Park due to areas of open water. The Park is open to recreation activities, especially canoeing and kayaking, as well as hunting and fishing.

Reference: B.C. Parks, 2010.

Part 1.2: Lakelse Watershed: 1910 and 1960

As part of the planning process of looking ahead 50 years, it was necessary to provide the students of Geography 112 with a sense of how much change can occur in 50 years, and what had happened to the Lakelse watershed over the previous 50 and 100 years. The Terrace area has only undergone severe changes to forest cover and hydrology of its watersheds since the mid 1950's and, in particular, since the 1960's and 1970's. The changes to the Lakelse watershed and its resources during this period of time have been profound. Combined with these changes has been the trend, since the mid-1980's, of the watershed increasingly becoming a rural residential area for people working in Terrace or Kitimat, in particular, the Jackpine, Old Lakelse Lake Road, Beam Station Road, west side of Lakelse Lake, and east side of Lakelse Lake. As all of these residential areas are on septic systems, and the watercourses, shorelines, and reedbeds are not protected from alteration, further detrimental changes have occurred to the water quality in the watershed and to fish and wildlife habitat.

An extensive planning process from the mid-1980's predicted the impacts of allowing expanded permanent residential growth upon Lakelse Lake and its ecological values (Kerby, 1984). We are now 25 years later and the many issues facing this watershed in the 1980's still remain unresolved. Projecting ahead 50 years at the same rate of change does not present scenarios that most residents in the Terrace/Kitimat region are willing to accept. It is the purpose of this report to provide some positive options as to the planning and management directions that can be taken for the Lakelse watershed, options that in 50 years, 2060, might allow us to retain the values so important to the residents of this region.

1.2.1. LAKELSE WATERSHED, 1910 – where we were at 100 years ago

B y 1850, the Lakelse Watershed had experienced at minimum 3500 years of stewardship by the Tsimpsian people, with limited impacts on the fish, water, and forest assets of the watershed. After the mid-19th century movement of Europeans into the lower Skeena watershed, and the diseases and social disruption experienced by the Tsimpsian villages in the Terrace area, there was translocation of many First Nations people from the region. By 1904, major changes started to impact the Lakelse watershed. In 1904, survey work and right-of-way clearing began for the ill-fated Kitimat-Omineca railway. A tote road was constructed in 1904 from the base of Thornhill Mountain, following the east side of Lakelse Lake (close to where the current Old Lakelse Lake Drive is now located). In 1905, the company building the railway collapsed, but by 1908, construction of the Grand Trunk Pacific Railway started, establishing the community of Terrace and bringing many European settlers to the Kitsumkalum and Lakelse valleys.

In 1910, the Lakelse Watershed had already had a Dominion government fish hatchery on Coldwater Creek (built in 1901 and moved in 1919 to Hatchery Creek), with a trail up Mink Creek to connect to the little canyon on the Skeena River (now the location of the old bridge at Terrace). This hatchery was in response to diminishing fish stocks in the Skeena River due to intensive harvesting and several fish canneries at the mouth of the Skeena River.

By 1910, land had already been purchased and subdivided in 1905 by Bruce Johnstone in the vicinity of the Lakelse Hotsprings in anticipation of a railway terminus at the head of the Douglas Channel. The railway terminus for the Grand Trunk Pacific Railway was located in Prince Rupert instead, stopping Johnstone's dream of a large townsite at Lakelse Lake. By 1910, Bruce Johnstone had built a hotel at the Lakelse Hotsprings and was advertising it as a health spa and fishing resort. The tote road for the Kitimat-Omineca Railway was used as the road access to Lakelse Lake and the Hotsprings, but there wasn't a bridge over the Skeena River at Terrace until 1925. Access was instead by ferry at Ferry

Island. In 1910 or shortly thereafter, early pre-emptions at the lake including Bruce Johnstone at the Hotsprings and adjacent lakeshore (D.L. 684), Carl Muller and R.L. McIntosh in the vicinity of Muller's Bay (D.L. 5244 and D.L. 3982)), E. Gruchy at Gruchy's beach (D.L. 3981), Peter DeBoer at the mouth of Hatchery Creek (D.L. 3984), and R. Langley at Gainey Point (D.L. 3991). By 1910, portions of D.L. 3991, 3984, and 5133 on the east side of the lake had been surveyed into two thousand 30 foot by 110 foot lots in anticipation of the railway passing by Lakelse Lake. This did not happen and by 1914, the non-lakeshore portions of the subdivisions were cancelled. First Avenue at Lakelse Lake resulted from this subdivision plan.

There was no development on the west side of the lake in 1910, as the steep rock slopes of Mailbox Point, and the steep clay slopes from there to Muller's Bay were not considered to be desirable homestead sites.

Sawmilling and pole removal had not yet occurred in 1910, as the Lakelse area was too far from the construction of the Grand Trunk Pacific Railway.

Fish stocks in the Lakelse watershed in 1910 were being impacted by commercial fishing and the canneries at the mouth of the Skeena River. Enhancement efforts were already being made at the Coldwater Creek hatchery.

In 1910, the net impact of European land settlement on the Lakelse watershed was not sufficient to change the water characteristics of the streams, Lakelse Lake,or Lakelse River. Except for clearning associated with scattered homesteaders, and construction of the hotel at the Lakelse Hotsprings, the watershed was in a natural state, although the salmon that used the watershed were diminished and on the path to recovery of large runs again.

1.2.2. LAKELSE WATERSHED, 1960 – where we were at 50 years ago

By 1960, the Lakelse watershed had already had over 50 years of settlement impacts. Starting in the 1910's, removal of cedar poles and Sitka spruce close to the Lakelse Lake Road had already started, but forest harvesting was on a selective basis and the changes to the watershed were not severe. Lakelse Lake was the major recreation resource for the Terrace area, especially after a bridge was built across the Skeena River in 1925. Throughout the 20's, 30's, 40's and 50's, the north end and east side of Lakelse Lake were the sites of legal and informal summer cottages. Even at this early date, families in Prince Rupert owned property at Lakelse Lake and would spend time in the summer at their cottages. There were few permanent residents at the lake, with the hotel at the Lakelse Hotsprings not operating throughout most of the Depression. The forties and fifties brought increased interest in property at the Lake, and, during the construction of the community of Kitimat and the Alcan smelter in the early 1950's, Lakelse Lake was the staging area for a large amount of float plane traffic.

By 1960, the crown had established water access recreation subdivisions on the west and southwest sides of the lake (a total of 55 lots developed in 1949). The west side of the lake now experienced land development. At the same time, a sawmill operated from the late 1940's in the northeast corner of the lake, dumping wood waste into the lake until the mid-1950's. The Lakelse Hotsprings had been sold to Ray Skoglund in 1958, who undertook a major resort development. In 1960, the Federal Department of Fisheries continued its efforts in the Lakelse watershed, including building a fish fence on the Lakelse River, but by 1960, they had not yet started their enhancement efforts on Schulbuckhand Creek (the Hatchery Creek hatchery had closed in the late 1930's).

The biggest changes to the watershed occurred due to the construction of the aluminum smelter and the community of Kitimat at the head of the Douglas Channel. By 1960, the Kitimat spur line for the C.N.R. had been built through the Thunderbird area and along the SW corner of Lakelse Lake (completed in 1954). This railway construction started the loss of water quality in portions of the Lakelse River due to eroding clay soils.

In 1956, the Province established Lakelse Lake Provincial Park at the north end of Lakelse Lake. With the completion of the road to Kitimat in 1957, by 1960, the pressures on Lakelse Lake in terms of recreation and summer cottage development had greatly accelerated, with road access cabins on the east side of the lake and water access cabins on the west side of the lake (the 1949 recreation lot subdivisions) being in demand and heavily used in the summer.

In 1960, the current location of Highway 37 (25) had not yet been constructed. This road was built in 1962 to 1963, with significant impacts to Williams Creek and the wetlands at the north end of the lake. The major Provincial campsite for the lake in 1960 was in the NE corner of the lake, and this campground was wiped out by the mudslide of 1962. A second mudslide in 1962 impacted the shoreline south of Furlong Creek. The Province had already purchased the Furlong Bay property in 1961 and a new campsite was built on the alluvial fan of Hatchery Creek in 1968.

In 1960, Beam Station Road had not been built* and there wasn't road access to the southwest corner of the lake (the road was built in 1961, and a boat launch was established at this time). The lots at the outlet of Lakelse River were not subdivided until 1963 to 1966. The logging of the west side of Lakelse Lake had not yet occurred in 1960 - in the late 1960's, logging and subsequent slash burning did extensive damage to the soils and regeneration in that area.

In 1960, Kroyer Road and Kresten Road subdivisions southeast of First Avenue did not exist. The residential lots were subdivided in 1966 to 1971. Many of the individuals buying these non-lakeshore lots commuted to work in Kitimat.

In 1960, private and recreation lots on the west side of the lake were water access only. In the 1960's and 1970's, through crown subdivisions, the number of lots on the west side of the lake and at Squirrel Point were greatly expanded (e.g. an additional 34 lots by 1970). These lots have subsequently converted to private ownership with road access.

In 1960, the lots on the east side of the lake were mostly the same historic lots that were developed in the 1910’s to 1920's. There were (estimated) less than 50 people living full-time at the lake in 1960. In the 1960's and 1970's, these properties were extensively subdivided, due in part, to recreational demands and residential development for people commuting to Terrace or Kitimat. At least 81 new lots were created at this time, with many of them being non-shoreline properties.

In 1960, strata-title did not exist. This did not occur until the 1970's.

In 1960, the change from selective logging in the Lakelse watershed to clearcut logging had started but most of the watershed was still untouched. Clearcutting of the Thunderbird area, lower Williams Creek and Sockeye Creek, south of Lakelse Lake, the Williams Creek watershed, and the Lakelse River and its tributaries, started in the mid-1960's and accelerated until the early 1980's.

In 1960, there was not a comprehensive plan for the Lakelse watershed or its land uses, and no-one had a vision for the lake or the river 50 years ahead to 2010.

References

Asante, N., 1972. "The History of Terrace". Totem Press Terrace Ltd.

Frank, Floyd, 1991. "My Valley's Yesteryears". Orca Books Publishers Ltd., Victoria, B.C.

Kerby, N., 1984. "Greater Terrace Official Settlement Plan: Background Studies". Regional District of Kitimat-Stikine.

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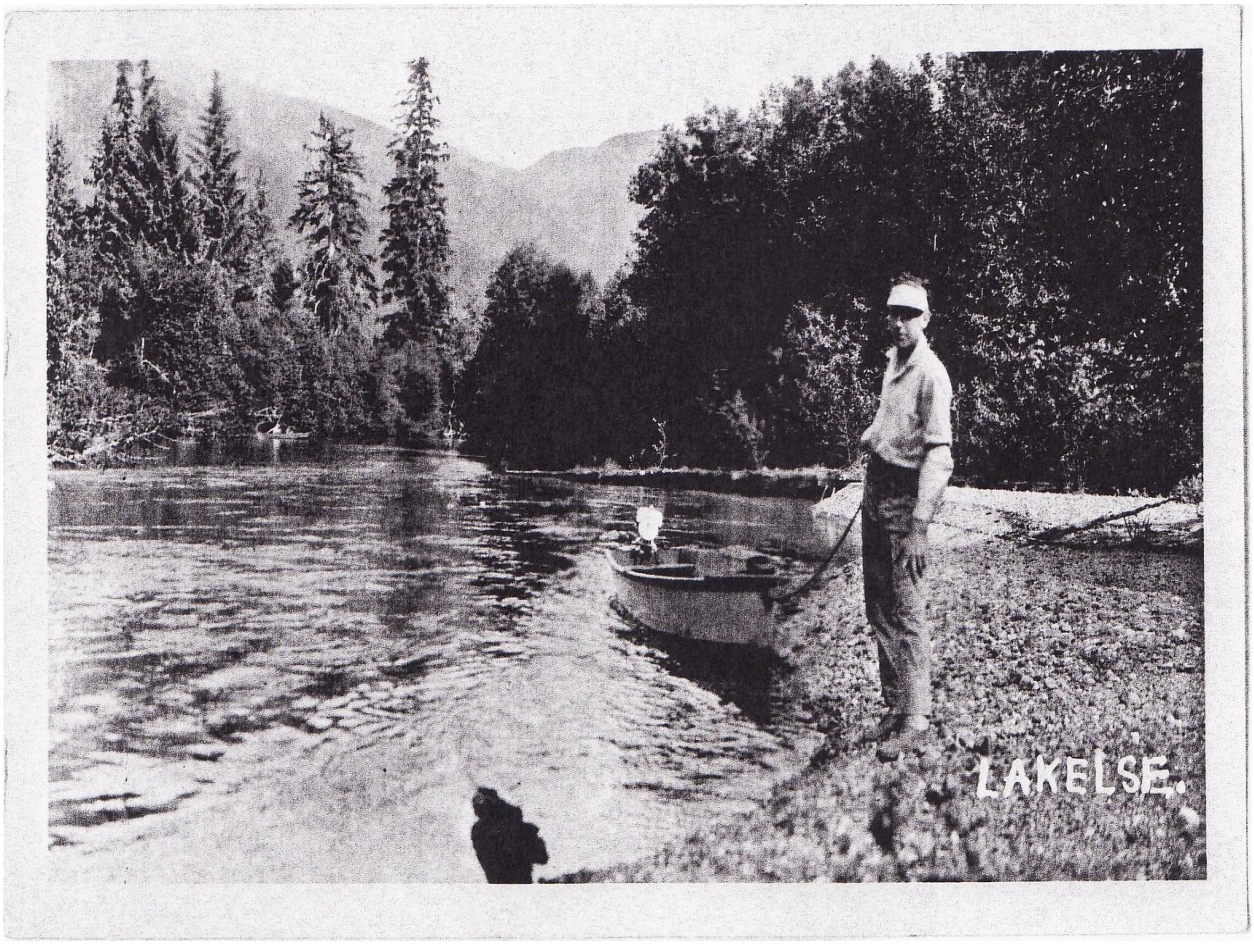
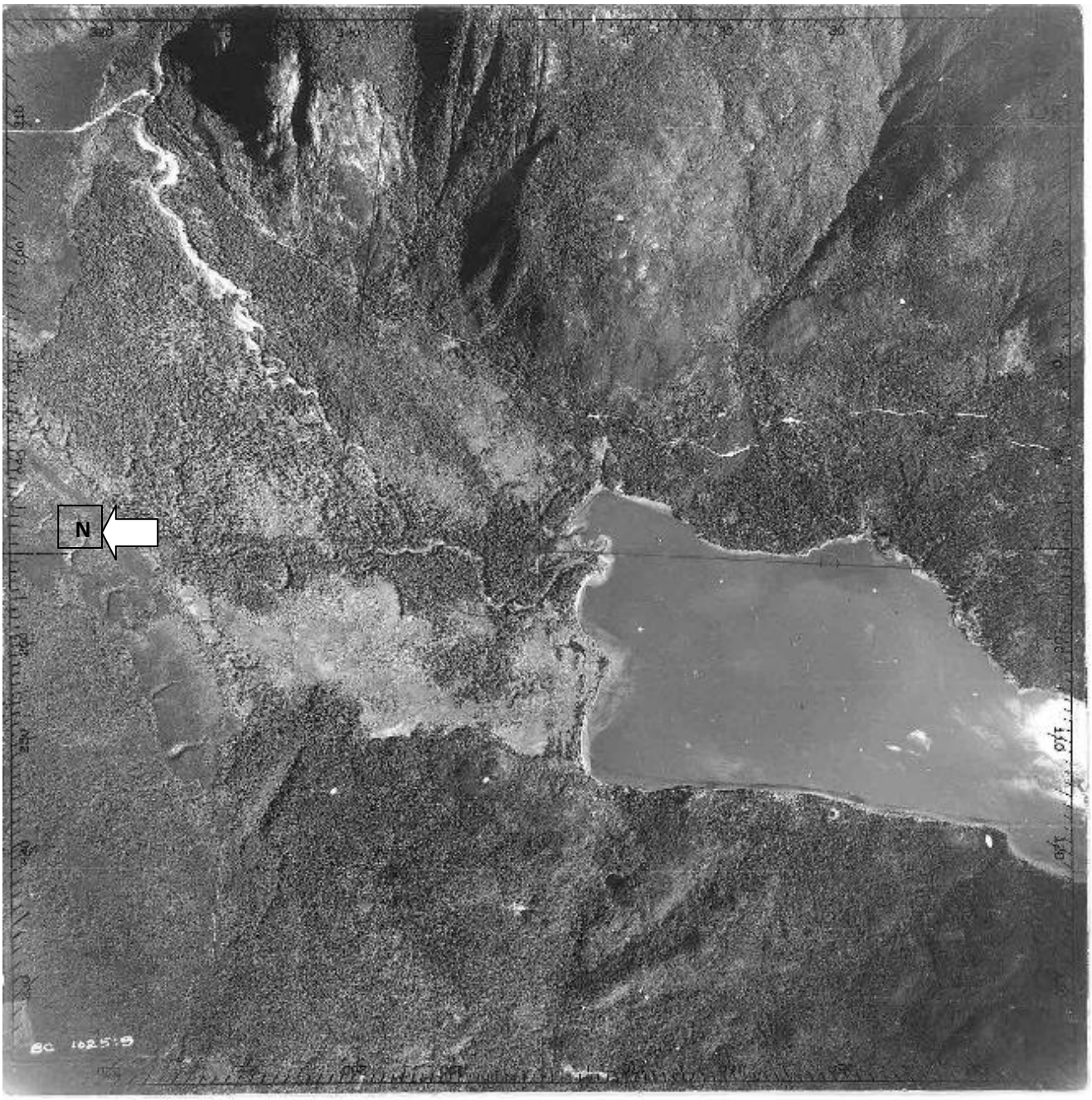
* According to Ed Kenney, during constructions of the CNR spurline to Kitimat in the early 1050's, a road link was built from the right-of-way to the bay at the outlet of Lakelse River and equipment for railroad construction was ferried across at this point.



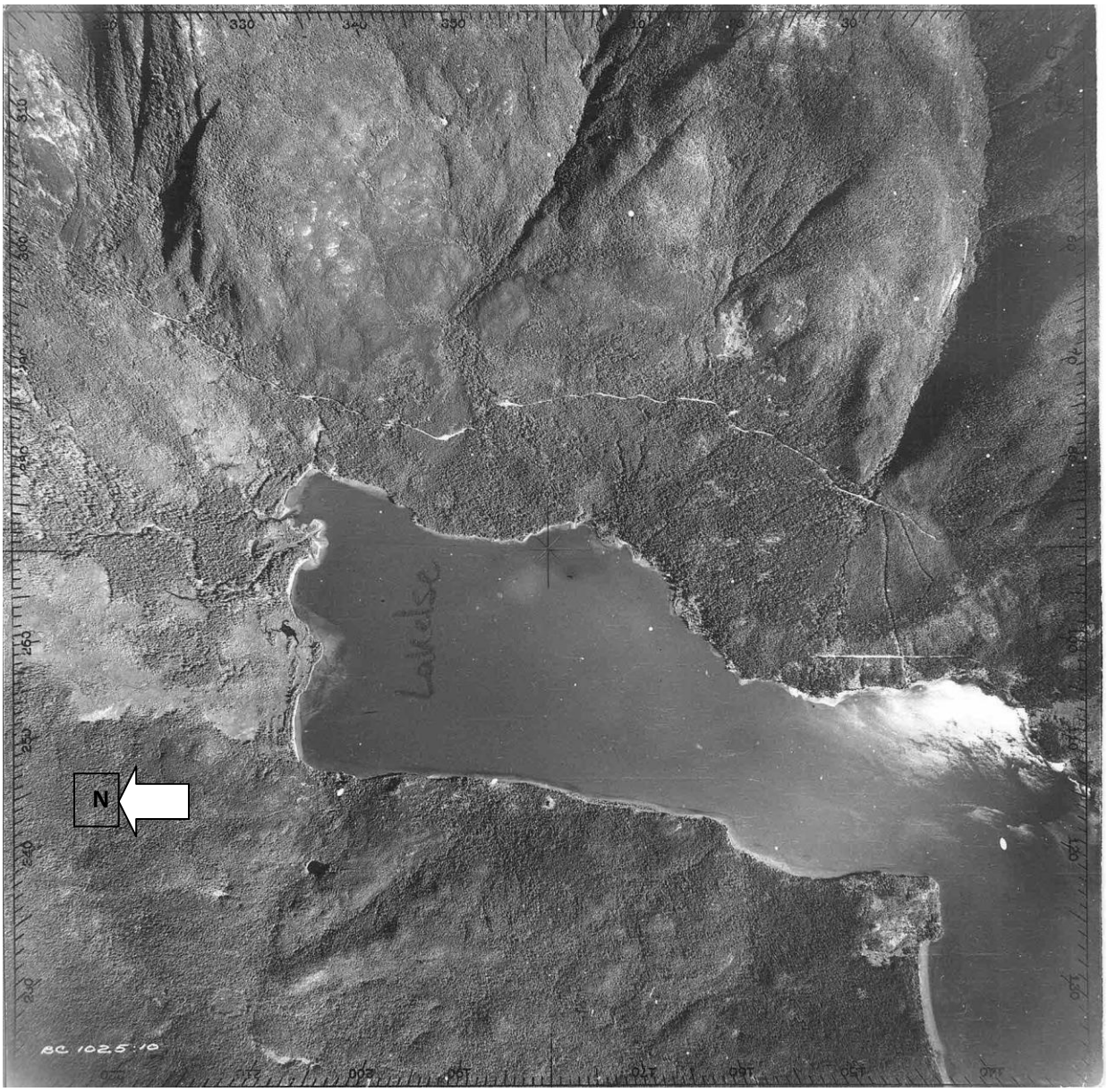
Lakelse River, 1940's – where Herman Creek enters the Lakelse River Photo: courtesy Edward Kenney

1947 airphoto of Lakelse Lake – airport is to the far right of the picture; Skeena River is in the far background. Note the steepness of the Hatchery Creek valley. Lakelse Lake Road is located at the base of of the mountain. The Lakelse River exits from the upper left of the lake.

1947 airphoto of Jackpine Flats - Thornhill Mountain covers the bottom ¾'s of the air photo; Lakelse Lake Road is the line in the mid + upper left; the dark area crossed by the road is Sockeye (Eliza) Creek.

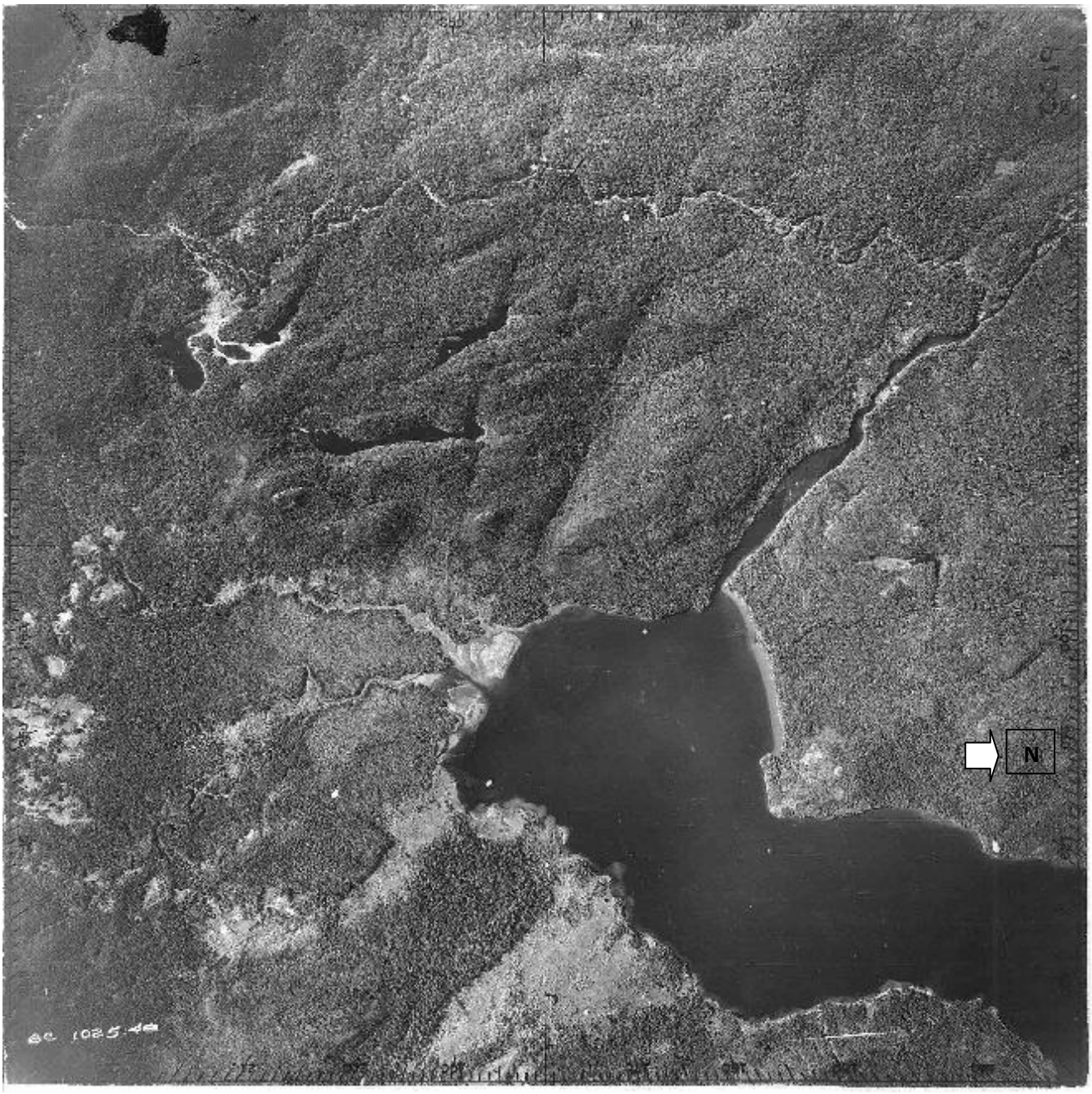


1947 airphoto of the north end of Lakelse Lake – Lakelse Lake Road crosses Williams Creek in the upper left and travels along the base of Mt. Layton. Note the active alluvial fan of Williams Creek and its delta where it enters Lakelse Lake. Furlong Creek alluvial fan is on the upper mid right of the lake.



1947 Airport photo – north end of Lakelse Lake

In 1947, road access to Lakelse Lake followed the right-of-way at the top of the airphoto (today's Old Lakelse Lake Drive). One access road went down to the NE corner of the lake. Another road access went from the south side of Hatchery Creek down to First Avenue. First Avenue shows clearly on the airphoto. Note the lack of development on the west side of the lake and the multiple channels within the alluvial fan of Hatchery Creek.



1947 airphoto of the South end of Lakelse Lake – note First Avenue in the lower right corner. Lakelse River exits in the top mid photo. Sculbuckhand (Scully) Creek is located between the two light coloured swampy areas in the mid bottom left of the photo. Lakelse Lake Wetlands Park, established in 2004, now encompasses the wetlands at the south end of the lake.

SECTION 2

LAKELSE 2060

SUMMARY OF RECOMMENDATIONS

by N. Kerby

2.1 Overview of Recommendations

Recommendations from the nine projects in this report detail the parameters that would need to be in place for each specific value to still be present in the Lakelse watershed in 2060. Across all of the topics, the following recommendations are the most consistent:

1. **There needs to be a comprehensive 50 year management plan for the Lakelse Watershed that addresses all of the issues in an integrated fashion and priorizes which values are to be retained.**
2. **Rehabilitate the shorelines – including the riparian zones and the reedbeds – rehabilitation will need to be undertaken if values such as water quality, lack of sedimentation, amphibians, fish habitat, and lack of erosion are to be achieved.**
3. **Restore the reedbeds as they are essential to the ecology of the lake.**
4. **Control the amount of residential and recreational development before the carrying capacity of the lake is exceeded.**
5. **Control the amount of nutrients entering the lake by community sewage systems or by holding tanks for septic systems.**
6. **The water should be safe for swimming and recreational activities – correct the amount of bacteria found in the water in the summer months.**
7. **Set aside critical wildlife habitat for preservation – for values such as moose and grizzly bears, critical habitat needs to be identified and protected.**
8. **Where are the fish? Restoration of fish stocks is necessary to restore the foodchains of the Lakelse watershed and the complex interrelationships such as between salmon and freshwater mussels.**
9. **Plan for recreation – develop a plan that allows recreational activities in areas that do not conflict with the ecological values of the watershed e.g. trail systems for ATVs and snowmobilies; non-motorized traffic in sensitive wetland areas.**
10. **The Lakelse Hotsprings could be a major international tourism destination and an economic factor that would encourage environmentally sound management of the Lakelse watershed.**
11. **Despite the large number of reports available regarding the Lakelse watershed and its issues, there needs to be consistent, ongoing monitoring programs in order to gather data that can be used to identify trends in the quantity and quality of the factors valued in the Lakelse area.**

2.2. Summary of Recommendations

1.Public Values (based on an e-mailed based public survey asking " what do you value and what is your vision for Lakelse")

- The value with the highest response from the public was recreation, followed by nature and a healthy lake; the common visions were improved water quality, followed by increased recreation and preservation of nature.

- "My hope is that we have learned from our mistakes in time to change things for the better".
Quote from respondent**.**

2. Lessons from History (based on changes to Lakelse Lake and the Lakelse watershed)

- The most important lesson learnt from historical changes to the watershed is that, without a plan to guide decisions, no-one at 100 or 50 years ago could have anticipated what would happen to the lake.

- "If you plan carefully, it will provide a lot more money in the long term." (quote from authors)

3.Water Quality

- By 2060, if you want to:

Swim in the lake – At some if not all popular swimming locations, such as Furlong Bay, swimming may already be a health risk.

Drink the water – Drinking the water may be a health risk due to contamination. It is already advised not to drink from the lake without a high end filter and boil water advisory.

Recommendations to maintain and improve water quality include:

- **Community sewer and water** for both sides of the lake;
- **Density of development** relative to carrying capacity of lake;
- **Garbage pick-up and disposal**;
- **Riparian zone and Reedbeds** should be restored as filters to contaminants entering the lake.
- **Water monitoring** of Lakelse Lake must be ongoing and consistent.

4.Benthic Environment: Freshwater Mussels

- **freshwater mussels are indicators** for water quality and aquatic ecosystem health.
– they are dependent upon **good water quality**.
- a **mussel management plan** would require a healthy watershed, which benefits other species.

Recommendations to maintain and improve mussel habitat and populations:

a. Install **community sewage system** to improve water quality;
b. **Regulate motorboat activity** to prevent wave erosion and sedimentation.
c. Limit **dike systems in alluvial fans** to protect mussels from sedimentation.
d. Protect **wetlands and tributaries** to protect water quality.
e. Evaluate and mitigate **highly altering processes** such as logging and motorized recreation.
f. **Develop a management plan** ; define **stewardship of the lake**.
g. **Limit the use of fertilizer and pesticides**.
h. Re-introduce **reedbeds** and preserve existing reedbeds.

i. **Re-establish riparian zones** by reintroducing native riparian vegetation.
j. Manage and protect the **host fish**, habitat, food source, and breeding grounds.
k.Remove and reduce the chance of **invasive species**
l. Conduct a **baseline study** to determine the status of the mussel populations and the locations of key habitat areas. Continually monitor their status and habitat conditions.
m. **Protect and restore mussel habitat**.

5.Amphibians including frogs, toads, and salamanders; similar to freshwater mussels, amphibians are indicators of a healthy aquatic and wetlands environment, and are very sensitive to pollutants. Recommendations associated with an Amphibian Management Plan include:

a.Educate the people as to why amphibians are important and what ecological impacts would result from their losses.
b. Teach young people about how to properly treat amphibians to avoid injury and death.
c. Restore amphibian habitats, including wetlands with ponds of variable depths.
d. Restore water quality as pollution can cause amphibian damage and death.
e. Restore shoreline and riparian zone habitats which are essential for amphibian populations.
f. Create buffers and corridors that allow amphibians to travel between habitat areas and between amphibian populations.
g. Design all new residential and commercial developments with **setbacks** to prevent modification of shoreline areas.
h. Place new ponds in heavily developed areas to mitigate habitat losses.
i. Construct corridors and passageways around and through developed areas, including amphibian **underpasses/bridges** for major roads acting as barriers.
j. Modify logging practices to protect tailed frog habitat and populations.
k. Improve water quality in the lake, including moving away from standard septic systems.
l. Treat highway run-off to avoid putting salt into amphibian habitat.
m. Restrict the use of fertilizers and pesticides within the watershed.
n. Restrict motorized vehicles in sensitive wetland areas, e.g. Lakelse Lake Wetlands Park.
o. Monitor amphibian populations and habitat on an ongoing basis.
p. Enforce the legislations that protects amphibians and their habitats.

6.Moose and Wildlife Habitat

a. Identify critical moose habitat including thermal cover, visual cover, and buffer zones.
b. Locate recreational trails systems for both hiking and motorized recreational vehicles to not interfere with critical moose habitat, both in winter and summer.
c.The amount of permanent residential development in the Lakelse watershed should be carefully regulated.
d. Design new and mitigate existing residential areas to minimize moose/human conflicts.
e. Assess highways and roads in the Lakelse watershed to minimize moose mortality associated with roads – reduce browse by brushing in fall; plough exit points along roads during heavy snowfalls; design bridges where applicable to provide underpasses for moose movement.
f. Protect natural primary moose habitat along watercourses and in alluvial fans.
g. Use forest management and harvesting practices to create rotational secondary moose habitat throughout the watershed.
h. Assess right-of-ways in the Lakelse watershed(e.g. hydro, natural gas) **as moose habitat and travel corridors.**

7.Grizzly Bears – population viability analysis based on computer modeling; grizzly bears are considered a keystone species for the Lakelse area and have been impacted by collapses in fish stocks and continued development within the watershed. The modeling process experienced the following problems:

a. Lack of detailed information on the North Coast (GBPU) grizzly bear population, including details of demographic characteristics and patterns, restricts the ability to model population trends.
b. Dispersal of bears between watersheds is prevalent throughout this region, but these patterns of dispersal need to be confirmed and recognized in land use planning.
c.Habitat fragmentation could be a major issue as development increases in the Lakelse watershed.
d. The proposed Onion Flats landfill site might be in conflict with movement of grizzly bears.
e. Reduction in carrying capacity had the greatest impact on simulated bear populations – with 2.5 to 5% reduction of carrying capacity per year, the bear population crashed in under 50 years.

8.Motorized Recreation– motorized recreation in the Lakelse watershed is important to many local residents, but can be in conflict with other users and preservation of ecological values.

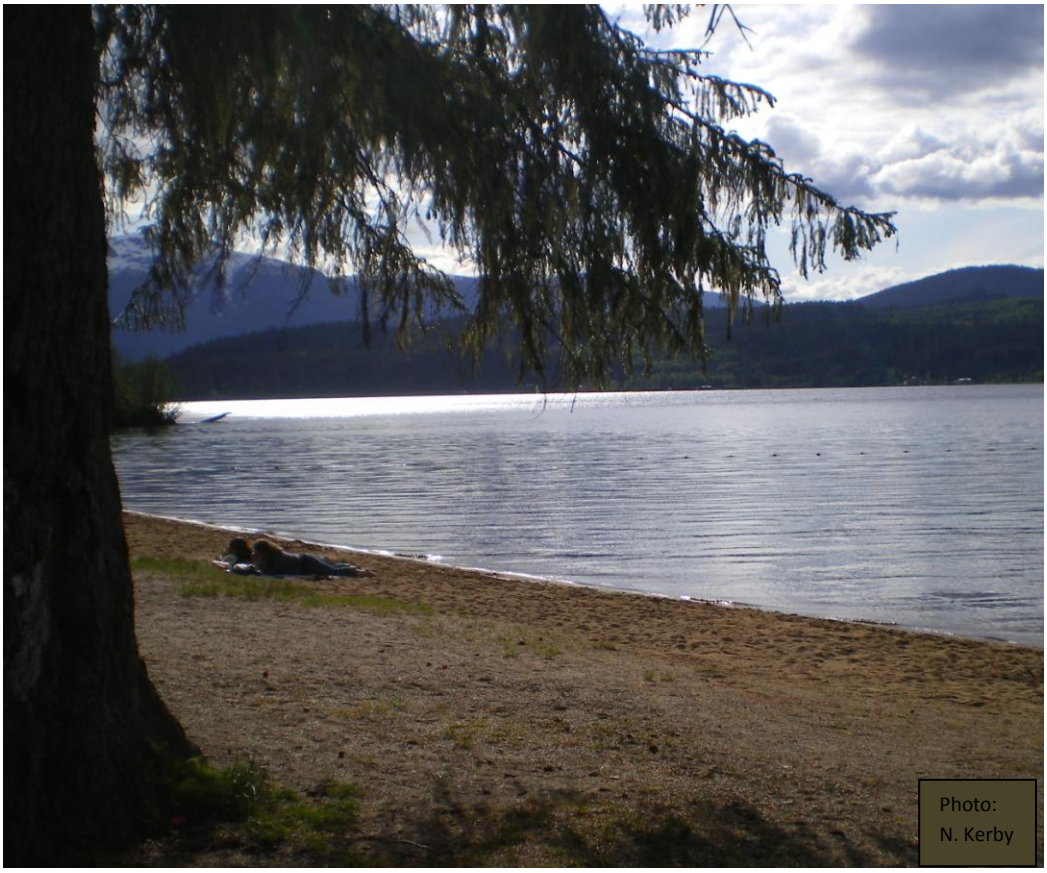
a. Establish a management body to oversee planning for motorized recreation in the Lakelse watershed.
b. Identify existing trails and their users.
c. Establish a trail network for motorized users which minimizes conflicts with other types of users and wildlife.
d. Provide infrastructure such as bridges to mitigate damage to streams.
e. Educate motorized recreation users about conflicts with environmental values and other types of users.
f. Prohibit snowmobiles and ATVs from sensitive wetlands areas.
g. Evaluate and regulate motorized recreation on Lakelse Lake.
h. Enforce regulations for motorized recreation use.
i. Develop a Motorized Recreation Management Plan for the Lakelse watershed.

9.Lakelse Hotsprings: A Vision for the Future in 2060 – ideas of how the Lakelse Hotsprings could become an international destination and the key to environmental management for Lakelse.

a.Develop a resort that attracts international tourists as well as locals - in particular youth from the region (multi-use).
b.Construct the resort from natural local materials using local artists.
c. Make a 'green' resort showcasing natural landscaping, greenhouses, and a range of hotel, dining, and pool options, including exclusive cabins with personal hot pools.
d.Work with the sensitive natural environment around the Hotsprings.
e.Attract international visitors for health and wellness retreats.
f.Link with other local tourism operations, especially skiing and fishing.
g.Explore the options for working with Shames Mountian ski hill.
h.Embrace technologies that allow new types of recreation and energy efficiency.
i. Embrace ideas that are exciting e.g. the Flowrider wave maker. J.
j.Primary uses of hotsprings should be for tourism and recreation, followed by greenhouses and geothermal energy.

SECTION 3

LAKELSE 2060



PUBLIC VALUES AND 2060 VISIONS OF LAKELSE LAKE

by

Meagan Whyte and Sarah Degerness

NORTHWEST COMMUNITY COLLEGE

ENVIRONMENTAL STUDIES AT NORTHWEST COMMUNITY COLLEGE

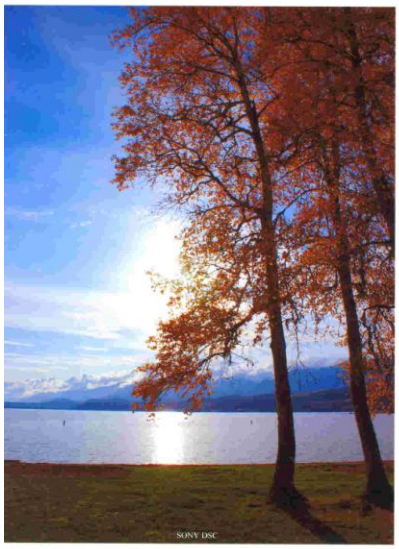


Photo: D. Hall

What is important to you about Lakelse Lake and the Lakelse Watershed?

Your 2060 Vision of Lakelse Lake

We want to know what you value:

Lakelse2060@gmail.com

A planning project by Students in Geography 112 – Environments and Planning at the Northwest Community College.

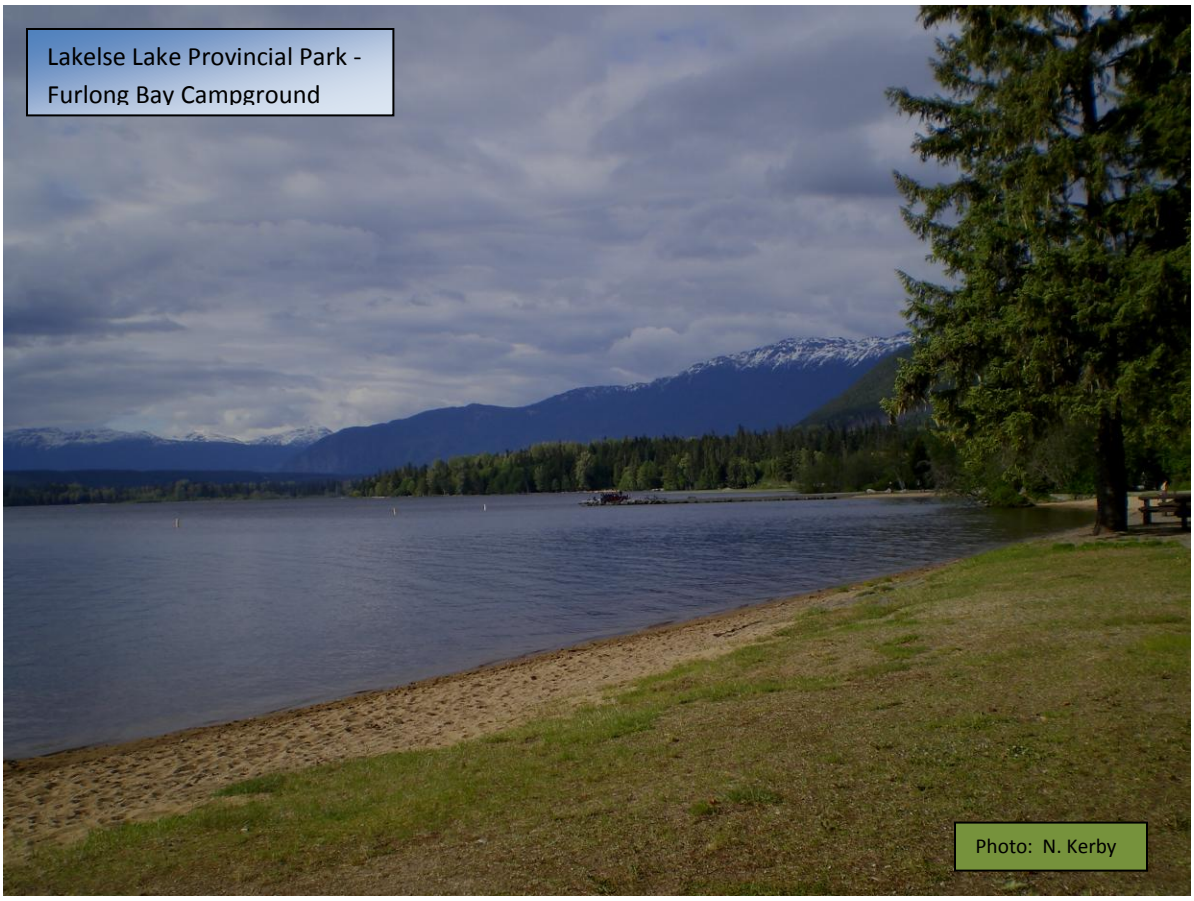
For more information contact:

Dr. Norma Kerby

(250) 635-6511 Ext. 5251 or nkerby@nwcc.bc.ca

NORTHWEST COMMUNITY COLLEGE

Take a closer look.



Executive Summary

The goal of this project was to gather **public input** about Lakelse Lake, such as what is important to people about the lake and how it affects their lives. People were asked to respond to the following questions: What they **value** about Lakelse Lake and what they would like the Lake to look like in the year, 2060.

In order to gather this information, the **e-mail** account, Lakelse2060@gmail.com was set up. This enabled people to send their opinions about Lakelse Lake to the e-mail.

In people's responses, we found that they valued **recreation** the most, whereas the smallest percentages valued water quality and the history of the lake.

Fewer people gave a 50 year vision of the lake compared to what they valued. The people that responded about their **vision for the lake wanted improved water quality** more than anything, which is a contradiction from water quality being one of the smallest values that people valued. This proves that the public isn't educated enough about the issues at Lakelse Lake. Many people do not know the details of the poor water quality in the lake, but just wish for it to be improved.

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Recreation was the number 1 value for Lakelse Lake in the public survey.

Photo: Rodney Brown

3.1 Introduction

Gathering the **opinions of the public** about Lakelse Lake is a great contribution to the planning process for new ideas and improvements. Under the Local Government Act, in order to pass an **Official Community Plan**, local government must have the public's input. It is a required step in the process of planning. **Allowing people to get involved** while planning also gets the public interested in the topic and gives them more knowledge about the situation.

The first step in a planning process is to **generate an idea**; the second is to **gather input** from the public on their perspective of the issue (Kerby, 2010). Therefore, this project will be the **first step** in helping other projects and ideas to develop. This **input from the public is crucial**, because, if we are unaware of the public's interests and concerns, then we will have few ways of knowing how to improve things for the future, besides only a planner's perspective and views. This may, in time, lead to greater problems and situations. Public input can also help **raise awareness of factors** that other people did not see as a problem, and can also contribute **new ideas** for planners.

3.2 Traditional Values

As well as many factors that were identified by the public as values for the Lakelse Lake area, some people that gave responses valued the traditional history of Lakelse Lake. The lake is an important historical site for many First Nations. The following e-mails explain and prove why the history of Lakelse is so important.

Testimonial 1

"There is a lot to be said about the beauty the clean water, the fish, and the plant life there for sure – but one little known fact is the name of the place ….Lakelse was pronounced Lax Gyels – because there are freshwater Gyels or Musssels that grow there – there is some aboriginal history about that and how they got there."

Testimonial 2

"Lakelse Lake is the English version of the Tsimshian name for the lake, which is Lax gyels (Lax = place of; gyels = mussels). The lake and watershed are a special heritage area where there are many traditional Tsimshian house estates belonging to families who now are living in Kalum, Kitselas, and Lax Kw'alaams. The culturally modified trees that are in the park's heritage tour are part of that history but there are also many traditional town sites and camp sites throughout the watershed. It also is filled with many important archaeological sites."

3.3. Results from Survey

From this project, we managed to gather input from 33 of the e-mails which answered the questions, 'what do you value' and 'what is your vision'.

3.3.1. What People Value the Most About Lakelse Lake

People who live in Terrace or at Lakelse Lake tend to value **recreational activities** such as swimming, boating, fishing, hiking, and picnics. As well, they value **nature**, such as wildlife, vegetation, and the scenery.

People who live out of town and only come to visit the lake tend to enjoy things like **camping, fishing, the scenery, and wildlife**.

Recreation was the highest value at 46%, with nature second at 21% and a **healthy lake and environment** at 15%.

Results

Recreation – 15 out of 33 people (46%)

Nature (animals, plants, scenery) – 7 out of 33 people (21%)

A healthy lake and environment – 5 out of 33 people (15%)

Water Quality – 3 out of 33 people (9%)

History – 3 out of 33 people (9%)

3.3.2. 2060 Vision Statistics

In comparison, the visions of people for Lakelse Lake were not the same as their values. Even though we wer able to get 33 e-mails to answer the questions, only 23 of the people wrote their vision of the lake. Out of 23 visions, 7 people (30|%) wanted **improved water quality**; 6 people (26%) wanted **improved recreation**; 5 people (22%) wanted to **protect nature**, such as habitats, trees and animals; 4 people (17%) wanted to protect the natural state of the **lake** and environment, such a shorelines and air quality; and 1 person (4%) believed **nothing** would improve and it would continue to travel down the same path.

Results

Improved water quality – 7 out of 23 people (30%)

Improved recreation – 6 out of 23 people (26%)

Protecting nature (habitats, trees, animals) – 5 out of 23 people (22%)

Protecting natural state of the Lake + Environment (shorelines, air quality) – 4 out of 23 people (17%)

Nothing will improve by 2060 – 1 out of 23 people

3.4. Testimonials from the Survey

The following are more of the statements made by people about what they value at Lakelse Lake.

Testimonial 3

"What is important to me about Lakelse Lake:

Every summer, my family and I often make trips to Lakelse Lake. I dislike swimming, so when I go to the lake, I usually spend my time looking for fish, frogs, and anything else I can find alive in the water and around the shorelines. The many various organisms that live at the lake are what I most value, and what I would be most saddened about if something were to happen to them.

My 2060 vision for Lakelse Lake is for the lake to be in a state that the essential habitats for its organisms would still exist. I'd like to see the lake water cleaner, the damaged shorelines and banks repaired, and surrounding wetlands to be maintained. High speed power-boats should be banned or at least strongly regulated (in order to prevent shore erosion from waves), and canoes and other non-power boats encouraged. All new housing would be set back a bit from the lake (not almost directly on the shore as it is now), and the clearing of shoreline areas would not be allowed. Oh, and all houses must have proper sewage systems, no septic."

Testimonial 4

"I have lived in Terrace for 38 years. 61 years old. I'm a school teacher and have renovated a cabin in the vicinity of Lakelse River and built two residences for owners in the Mailbox Point area. Regularly enjoy walks into the provincial parks, all seasons. For many years our family enjoyed water skiing from Gruchy's beach and the area near the river as we also invite many friends to enjoy our boat and activity. We have 4 Jet skis and attempt compatible use by ensuring our activity is well offshore as some find the noise from this type of craft annoying. We have also had many enjoyable canoeing events as a family and at private school events, in particular in the river area and the two creeks that are at the Kitimat end of the lake. We have also gone down the Lakelse River from the lake to Whitebottom. We've also enjoyed wind surfing and sailing on this beautiful lake. Finally we've also enjoyed many winter walks on the lake and ice skating.

If I could suggest any future hopes for the lake, remain a clean lake, support variety of activities, but in particular, motorized activities as this lake has a nearby airport which fosters the flight path and ensuing aircraft noise, has a sea plane base, and has been a traditional water ski/wake board friendly environment. There are nearby areas for the dedicated canoeist etc. who wish the tranquility etc. which we use when desiring that type of activity. Feel free to contact for more into or clarification as this is a very important resource and one of the reasons we live here. Thanks."

Testimonial 5

"My vision for 2060 is simple. I would like Lakelse Lake and it's watershed to be healthy and clean so that it can continue to be a place that people can enjoy and wildlife can thrive in. I hope that the people who call the lake their home will understand that they are the stewards of the area and will make informed decisions based upon what is best for the lake and for future generations to come. Similarly, I hope that those who use the area will do so with the understanding that their actions have an impact. I would love for my son to be able to bring his grandchildren there and create some great memories that they in turn will pass down to their children."

Testimonial 6

"Over the next 50 years, I would like to see the entire Lakelse Lake watershed be recognized and put under protection though legislation. All creeks coming into and out of the lake should be considered as vital to the Eco-system as a whole and planning should take place to mitigate the damage already caused by roads, erosion, sewage, motor boats, private properties, development, etc. …

A ban on gasoline motor boats would be important; electric motor boats would be acceptable. Recreational access should be maintained in the areas already designated, and expanded if deemed appropriate. Private property owners should be asked over a reasonable period of time to resolve issues with sewage and access to drinking water: it would be appropriate for local and provincial government to assist with infrastructure projects of a larger scale in this regard. Creeks flowing through residential areas should be given due consideration as to maintain their integrity and viability within the Eco-system. Shoreline areas should be assessed and rehabilitated where needed to enhance wildlife (aquatic, land, and birds) habitat and improve water quality, especially along private properties where changes (improvements) have been made.

Water quality should be the utmost priority considered in all aspects of planning around the lake, including logging and other resource extraction activities. Another priority would be to enhance fish habitat and spawning grounds (creeks). Weland areas adjacent to the lake should be protected and enhanced as well, and overall, I think the whole community should take pride in our beautiful lake and see it as a privilege and responsibility to enjoy it's water quality, it's productivity as an Eco-system, it's value as a recreational area, and it's contribution in making Terrace a beautiful tourism destination."

3.5. Potential Impacts

This project will impact the future of Lakelse Lake greatly. The public's opinions will impact how the planning of the lake's future will be undertaken. Gathering **public input** from many people is part of a planning process, therefore public opinions can affect the potential impacts on Lakelse Lake. If the majority of people would like the lake to be used for recreation, then this will have to be taken into consideration when planning for the lake's future.

Establishing a 50 year vision is another important aspect of planning because it gives the planners something to work towards. People want a clean and healthy lake in 50 years, so planners have to develop ways to provide this 2060 vision of the lake.

To get more public input about Lakelse Lake, the people must be given **more knowledge about the issues** affecting Lakelse Lake and the surrounding environment. Many people aren't aware of the issues at Lakelse and do not realize the many factors that contribute to these issues, such as the number of residential properties at the lake. **Education** is definitely an important aspect for addressing the issues at Lakelse Lake.

Some issues between public responses may **oppose each other**, which may lead to a delay in the planning process. One person, a resident from out of town, may believe that recreation is of the most importance to them, whereas a resident of the lake may believe that nature, wildlife, and scenery are of much more importance to them.

3.6. Visions for 2060

The 2060 vision of Lakelse Lake from the public was very well established, and was similar to our own vision. Some of the visions of others included:

- clean, healthy **water**

– a natural **habitat** for organisms to live

- **shorelines** repaired and **protected lands**, such as wetlands, to be maintained

- no more **buildings** to be built or provide a **setback from the shoreline** on buildings

– restrictions and regulations put in place for **motorized vehicles**

- improved **recreation** and more recreation.

Our vision for Lakelse Lake in 2060 is for:

- Lakelse to be known as a **clean, environmentally stable lake** and a place where people want to go and feel **safe**. We want a lake that's safe for not only ourselves, but also the other species that we share the area with as a home or an important part of their ecological niche.

- We would like the **water quality** to be greatly improved and the **shorelines** to be protected.

- People should be able to **swim in the lake safely**, and maybe even be able to **drink the lake water** in 50 years without having to worry about their health.

- Restrictions and regulations regarding **motorized vehicles** should be applied and enforced.

- If a **sewer system** were to be installed for residents around the lake, this would prevent any further damage to the water quality at the lake.

- The **natural state of the lake** should not be disturbed, such as shorelines and plant life.

There are many factors that can be added to our 2060 vision, in order to improve Lakelse Lake and have a lake that matches our vision in 50 years.

While reading the responses from people, we came across one that caught our attention and stood out as the perfect quote to sum up a way to achieve our 2060 vision.

"My hope is that we have learned from our mistakes in time to change things for the better".

Acknowledgments

Advertising and Publicity of Survey – Rod Link, Terrace Standard; Dave O'Leary, NWCC
Poster – Meagan Whyte and Kelli Louie, Northwest Community College
References – Dr. Norma Kerby, Class note package for Geography 112, "Environments and Planning"; Local Government Act, Government of British Columbia, 2010.

SECTION 4

LAKELSE 2060

Photo courtesy Edward Kenney

HISTORICAL CHANGES TO LAKELSE LAKE AND THE LAKELSE WATERSHED

by Christa-Marie Carstens and Maureen Rowlett

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Photo courtesy
Edward Kenney

Executive Summary

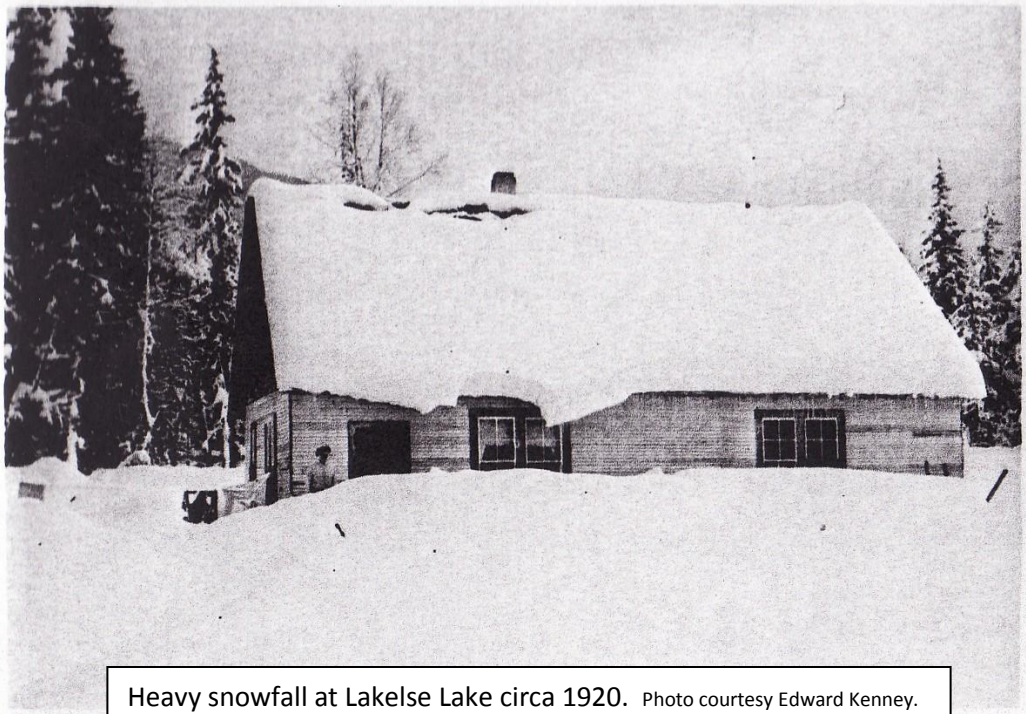
The important points of our project are:

Lakelse Lake needs a plan,
what was there in 1910,
what it is now,
the Hotsprings,
what happened to the fish,
recreation,
what we have learned from history.

Our project relates to **planning** because in order to plan ahead, it is necessary to know what has happened in the past, and to plan accordingly. We've learned from history that **if you plan carefully, it will provide a lot more money in the long term**.

A good example of this is **Ray Skoglund's plan for the Hotsprings**. He was willing to put money into the Hotsprings for features such as parking for up to 200 cars, picnic sites, and trailer sites (Rough, 2). He also built two large concrete pools fed by the main hotspring on the south side. One of these pools had dressing rooms which could accommodate up to 400 guests (Rough, 2). It included a steam bathroom and two rooms with 4 by 8 foot Roman baths for guests requiring special therapeutic treatment (Rough 2). Obviously with this kind of planning, you're going to attract a lot of tourists.

What have we learned from history? We need a plan for the Lakelse area.



Heavy snowfall at Lakelse Lake circa 1920. Photo courtesy Edward Kenney.

4.1. Impacts of History

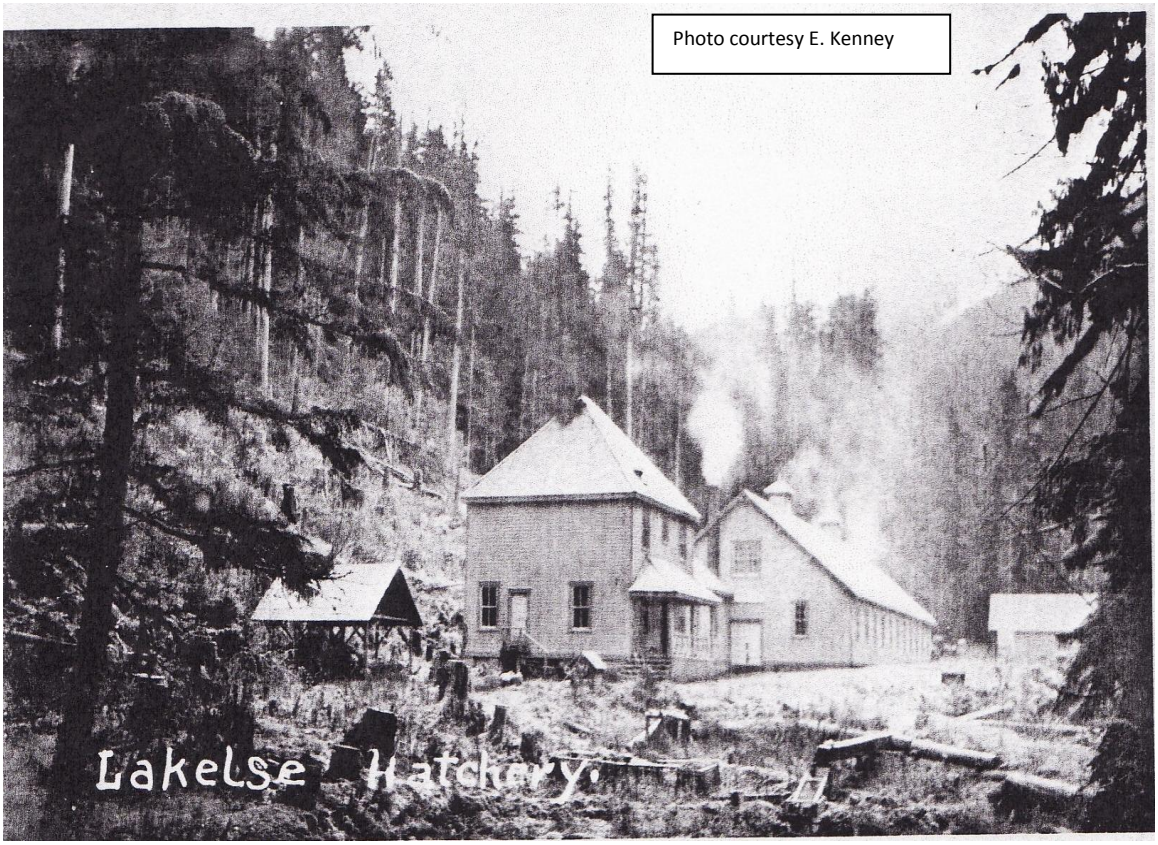
The goal of our project is to analyze the changes the Lakelse Watershed has experienced throughout history to create a greater awareness of what has happened, and prevent the same mistakes from being made again. And most importantly, the purpose of our report is to show why **Lakelse Lake needs a plan** and to help the public understand **key changes to the watershed** from actions in the past. It will assist in **projecting ahead for 50 years** through the planning process. Through identifying what we value in our lake, and understanding the changes, we can save it for the future.

4.1.1. Historical Impacts on the Lakelse Area (based on Kerby, 2010; Asante, 1972; and Frank, 1991)

The Tsimshian First Nations had used the Lakelse Watershed for resource extraction for about 3500 years before 1850, with very few impacts on the fish, water, and forest assets of the watershed (Kerby 1). Major changes started to impact the Lakelse watershed in 1904 (Kerby 1). Survey work and right-of way clearing began for the Kitimat-Omineca railway and a tote road was constructed from the base of Thornhill Mountain, following the east side of Lakelse Lake (Northwest Digest 11). In 1908, construction of the Grand Trunk Pacific railway started, bringing many European settlers to the Kitsumkalum and Lakelse valleys (Kerby 1). Settlement concentrated on the east side of Lakelse Lake, where a community was anticipated to be established. On the west side of the lake, the steep rock slopes of Mailbox Point, and the steep clay slopes from there to Muller's Bay were not considered desirable homestead sites (Kerby, 2010).

Access to the Lakelse Lake area before 1925 was via train to Terrace, then ferry across the Skeena River, road to the NE corner of the lake, and boat or 'water' taxi to the Hotsprings

The rich **fish resources** of the Lakelse watershed were important to both the Tsimpsean and the early European settlers. Impacts on the rich fish stocks of the Lakelse watershed started in the 1880's with the large commercial fisheries and several canneries at the mouth of the Skeena River. By 1901, fish stocks in the Lakelse Lake watershed had been noticeably diminished and a Dominion fish hatchery was built at Coldwater Creek, which drains into the Lakelse River (Kerby, 2010). The hatchery was built to increase the sockeye salmon catch for commercial use (mcdonald.unbc.ca, 2010). The numbers of hatched salmon, which averaged at 15% under natural conditions, increased to 98% in the hatchery. After several flooding events, in 1919, a new hatchery was built on the east side of Lakelse Lake at Hatchery Creek. In 1936, this fish hatchery was closed due to lack of funding (Asante 94).



Dominion Hatchery on Hatchery (Granite) Creek in the 1930's. Access was via a large wharf in Furlong Bay and a road to the hatchery, located approximately 1 kilometer upstream of today's Highway 37. Some buildings were moved down to the Lake area after the Hatchery closed.

Due to the distance to the sawmill and railroad at Terrace, and limitations of the ferry across the Skeena River, **harvesting for poles and sawlogs** in the Lakelse watershed was minimal until the construction of the Skeena Bridge in 1925. During the 1920's and 1930's, cedar poles and Sitka spruce were harvested close to the Lakelse Lake road; however, this was on a selective basis and impacts on the watershed were not severe (Kerby 204). In the 1940's, a sawmill operated in the northeast corner of the lake, dumping wood waste into the lake (Kerby 256). This sawmill ceased operations in the 1950's. By 1960, there had been over 50 years of European impacts on the forest resources but most of the watershed was still untouched. This changed significantly in the 1960's when the watershed was rapidly logged from the mid 1960s to early 1980s, doing extensive damage to the soils and forests in the area.

Lakelse Lake has always been important for recreation, with many families, from both Terrace and Prince Rupert, having summer cabins at the lake from the 1910's through the 1920's and 1930's. Pressures on Lakelse Lake for recreation and cottage development accelerated in the late 1950's and 1960's with the development of the highway from Kitimat and the growth of Terrace. During this time, there were road access cabins on the east side of the lake (Kerby 3). Private and recreational lots on the west side of the lake were water access only until the 1980's (Kerby 3).

Note reedbeds in background.

Photo courtesy Edward Kenney

The development of Kititmat and the aluminum smelter on Douglas Channel had many other impacts on the Lakelse watershed. By 1955, with the construction of Kitimat and Alcan already underway, Lakelse Lake became the staging area for a large amount of float plane traffic. Further impacts on the lake resulted from the construction of the Canadian National Railway to Kitimat, which caused clay particles to go into the Lakelse River from exposed banks.

Although there was increased European settlement and forest harvesting on the Lakelse Watershed up to 1960, it was not sufficient to change the water characteristics of the streams, Lakelse Lake, or the Lakelse River. This point in time would have been ideal to come up with and implement a strict **plan for the Lakelse Watershed**. If this had been done, many of the problems we face today could have been avoided.

4.1.2. Historical Impacts of the Lakelse Hotsprings

In 1907, Bruce Johnstone gained title to the land surrounding the Hotsprings. He later went into partnership with Hank Boss to develop the site as a tourist attraction (Weber 75). Bruce became one of the first permanent employees of the fish hatcheries on Coldwater Creek (Asante 61). The Hotsprings was advertised for hunting, fishing and also as a hotel and health spa. The hotel became very successful. In 1929, a new hotel was built on the lakeshore 5000 feet from the main spring.

Hotsprings Hotel Photo courtesy B. Orleans

In 1927, Bruce Johnstone sold one quarter of his shares to Mrs. Bowen-Coldthurst (Asante 60). In 1936, the Skeena River flooded, preventing anyone from entering or leaving the Hotsprings. That same year, there was a fire, and the First Lodge burnt down. Johnstone lost everything and the Hotsprings remained dormant, except for local use, until 1958, mainly because of the Depression. Lloyd Johnstone bought back the original 310 acres in 1945.

Lakelse Hotsprings, 1932 – photo courtesy Bert Orleans.

In 1954, Ray Skoglund formed the Lakelse Construction Company. He bought the undeveloped spring from Lloyd Johnstone in 1958, clearing 8 acres of heavy timber and underbrush, and hauling in 20,000 cubic yards of gravel for roads and parking for 200 cars, picnic, and trailer sites (Rough 2). A year later, he built a large concrete pool with a water temperature of 75 degrees which was served by an up-to-date building. He then built a second pool of 85 degree water temperature, also fed by the main hotsprings on the south side. This pool had a building with dressing rooms to accommodate up to 400 guests. It included a steam bathroom and two rooms with 4 by 8 foot Roman baths for guests requiring special therapeutic treatment (Rough 2). 150,000 gallons of water was funnelled from the main spring into the pools every day (Rough 2).

The second structure was destroyed by another fire in 1962 (A Brief History, Pamphlet). Mr. Skoglund sold the Hotsprings to new owners in 1969. It was still known as the Skoglund Hotsprings Resort. At the time, concerns were raised regarding pollution of Lakelse Lake by the untreated Hotsprings resort water. To rectify the situation, a sewage plan was constructed. With the greater public awareness, public health standards were later expected to be enforced.

In 1978, a flood jammed the creek running alongside the property and water rose through the remaining buildings, damaging them beyond repair (A Brief History, Pamphlet). Conflicts with home owners concerning sewage leaking into the Lake closed the Hotsprings once again. In 1979, the Skoglund Hotsprings were donated to the Provincial government (A Brief History, Pamphlet). Burt Orleans purchased the Hotsprings from the Province in 1985, renaming it Mount Layton Hotsprings after the mountain across the highway (A Brief History, Pamphlet). Gradually, more land was acquired to make a total of 1000 acres (A Brief History, Pamphlet).

4.1.3. Historical Impacts of the Fisheries

There were very few efforts ever made to stock Lakelse Lake. In the 1920s, stocks of Atlantic salmon from Miramichi River were released into the lake. Another stocking effort was made in 1940, when 25,000 eyed egg rainbow trout from Pinantan Lake were released. These are the only stocking records for the Lakelse Lake, and current species come from naturally reproducing stocks. Currently there are about 21 species of fish observed in the lake.

Water quality is one of the factors which have contributed to the decline in fish stocks. In 2004, it was decided that, after two years of investigation and testing by the Water, Land and Air Protection Ministry, the most measurable change in Lakelse Lake was a change in sedimentation from the mid-1990s. The 2002 water sampling at 10 Lakelse Lake sites classified the water quality as good, finding no link between water quality and property development (The Northern Sentinel 2004).

Fishery officials estimated that 15,000 sockeye are taken in the Terrace-Lakelse area alone by local First Nations as food fish and an additional 10,000 by outside bands, as well as 3,800 fish of other species (mcdonald.unbc.ca). Comparing this to an escapement after commercial fishing of 385,000 in the area in the same year, only 7.9% of the escapement into the local system near Terrace is taken in the food fishery (mcdonald.unbc.ca). It was estimated that 20,000 to 30,000 fish were taken in pre-contact times for food on the Skeena (mcdonald.unbc.ca). Canneries at the mouth of the Skeena River were eventually closed as a result of the depletion of fish stocks. After the closure of the canneries, fish hatcheries were opened to counter the damage.

Loss of fish habitat has also had a severe impact on fish. Disturbance caused by boat propellers was one of the reasons reedbeds were damaged. The main reason, however, was the development of residential areas along the shore line. Most people did not appreciate the reed beds near their properties so they removed them. Unfortunately the reedbeds are critical fish habit.

Boat launch circa 1930's.

Photo courtesy Edward Kenney

4.1.4. Historical Impacts of Recreation

The historical uses for recreation included hunting, fishing, hiking, swimming, and camping. There even used to be horseback riding. These activities had a very limited impact on the lake. Recreational activities did not have much impact on the environment until quads, jet-skiis, and boats became popular.

Gruchy's beach circa 1920's

Photo courtesy E. Kenney

4.2. Lessons Learned from History

From History we learned that in order to protect our lake, **we need a plan** and we need to **implement this plan as soon as possible** in order to protect our Lakelse Watershed.

Lessons learned from history:

a. We have learned through our mistakes in the past that we must **consider our surrounding environment when implementing any laws**.

b. We should also **educate the public** to make them aware of how sensitive our shorelines and all of the Lakelse Watershed are. This will help them make wiser decisions in the future. They will be more aware of their impact through recreational activities, and hopefully respect the environment more by sticking to designated trails for quadding and following the rules concerning boating and other motorized activities. It should also make residents at the lake more sensitive about the reedbeds and the shorelines around their properties.

4.3. Recommendations (for Lakelse Lake and Mount Layton Hotsprings)

4.3.1. Lakelse Hotsprings

a. **Renovations**, including proper upgrading of the facilities.

b. Advertise as a **health spa** and a five star resort with many recreational activities available.

c. Make the hotsprings resort **environmentally friendly**!
- -solar panels
- -geothermal heating
- -building structure: glass allowing for maximum heat and lighting from natural sunlight
- -greenhouses: local produce for serving in the restaurant and selling locally
- -enhance agriculture: livestock and vegetable farming

4.3.2. Lakelse Lake

a. Implement **restrictions and strict law enforcement** around the Lakelse Lake area
- -boating restrictions
- -no damaging of the reed beds or shoreline
- -only motorized recreational activity in designated areas (trails; no motorized boats in wetlands)

b. **Proper septic systems** MUST be in place within a certain time limit

c. **Tourism**
- -convenience store/souvenir store for tourists
- -proper maintenance along the shoreline (garbage pickup and cleanup)

4.4.Fifty Year Vision

Our 50 year vision for the Hotsprings is a **clean, environmentally friendly five star resort** that attracts many tourists from all over the world for its sulphur free, natural and therapeutic waters while benefitting its surrounding communities by providing organic local produce.

In 50 years, the goal should be that Lakelse Lake will have **fresh, clean water safe enough to drink and swim in**, with a **well-maintained shoreline with reed beds** to protect the shoreline and provide the **many species of fish** with a healthy habitat. The permanent residents should have an exclusive part of the lake shoreline, away from the noise of locals and tourists. They will be provided with **proper waste management for both sewage and garbage** and clean tap water from a **community water system**.

Note reedbeds and healthy riparian zone vegetation.

Circa 1930's.

Photo courtesy Edward Kennev

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Photos courtesy of Mr. and Mrs. Orleans, and Mr. Edward Kenney.

Lakelse Lake circa 1940's – note healthy reedbeds and riparian zone. Photo courtesy E. Kenney.

SECTION 5

LAKELSE 2060

Water Quality at Lakelse Lake

by Patti Kohler and Colin Spangl

Executive Summary

Based on 2003 **microbiological** indicator concentrations and variations between upstream and downstream sites, the poorest water quality values were detected in the following tributaries. All sites exceeded Bacteriological guidelines **at least once**. (Lakelse Lake Draft Management Plan, 2004).

- **Furlong Creek**
- **Hotsprings Channel South**
- **Mountain Creek**
- **Sockeye Creek**
- **Provincial Park Creek**

Based on 2003 **phosphorus** concentrations, the poorest water quality values, exceeding Canadian Drinking Water Standards, were detected in the following tributaries:

- **Eel Creek**
- **Provincial Park Creek**
- **Mountain Creek**
- **Williams Creek**
- **Whalen Creek**

Based on 2003 **turbidity** values, the poorest water quality, exceeding Canadian Drinking Water Standards, was detected in the following tributaries. Turbidity guidelines were exceeded at 16 locations, ten downstream, five up stream and one at Deep station. These levels may compromise disinfection systems, and water may require filtration prior to treatment.

- **Eel Creek**
- **Provincial Park Creek**
- **Furlong Creek**
- **Hotsprings Channel North**

Due to high nutrient and bacteria levels at several sample sites, it is strongly suggested that contamination must be originating from **human or animal wastes**. For more definitive testing to determine if high bacterial and nutrient levels are resulting from human waste contamination, it is advised that testing be undertaken e.g. for **caffeine** or **human DNA**.

By 2060, if you want to:

Swim in the lake – At some if not all popular swimming locations, such as Furlong Bay, swimming may prove to be a health risk if it is not already in 2010.

Drink the water – Drinking the water may be a health risk due to contamination. It is already advised not to drink from the lake without a high end filter and boil water advisory in 2010.

Recommendations to maintain and improve water quality back to drinking water standards include:

- Community sewer and water for both sides of the lake;
- Permanent residential expansion must follow proper building code and community; requirements, including density of development relative to carrying capacity of lake;
- Garbage pick-up and disposal;
- Repair the Riparian zone and Reedbeds as filters to contaminants entering the lake.
- Consistent program of water monitoring

5.1. Introduction

Clean water has been a vital part of a civilization ever since the first community was constructed. In our modern world, we take it for granted, assuming that there will always be clean water, after all you just need to turn on the tap and a seemingly endless supply pours out. This is not the case; the larger our population grows, the more water we need. It appears, however, that the larger we get, the more we pollute our water supplies.

A community as small as the one that surrounds Lakelse Lake is no different. Many of the lake's residents draw water either directly from Lakelse Lake or from the mouth of tributaries. With the either gravely or clay surroundings, most, if not all, contaminants from humans and animals within the Lakelse Lake watershed are washed right into Lakelse Lake. With the larger population centres near Lakelse Lake, such as Terrace, Kitimat, and Prince Rupert, many people choose to swim at Lakelse Lake based on its location and being one of the only warm water lakes in the area. For this reason, a clean and healthy body of water is crucial to the continued use of the lake.

5.2. Water Standards in Canada

a. Canadian Drinking Water Standards

In Canada public safety takes the forefront of government policy and as such, the drinking water standards are quite clearly stated and only allow very low levels of contaminants. Information regarding drinking water standards can be found at:

Health Canada. *Guidelines for Canadian drinking water quality* - supporting documents. http://www.hc-sc.gc.ca /hecs-sesc/water/dwgsup.htm

BC Fresh Water Act, http://srmwww.gov.bc.ca/risc/pubs

Cavanagh, N., R.N. Nordin, L.W. Pommen and L.G. Swain, 1997. *Guidelines for Interpreting Water Quality Data*. **Resources Inventory Committee, Province of B.C.**
http://srmwww.gov.bc.ca/risc/pubs/aquatic/interp/index.htm

b. Bacteria

The *Guidelines for Canadian Drinking Water Quality* state that **0 colony forming units (CFU) per 100mL are permitted** (see Appendix A). Considering that some Lakelse residents draw untreated water directly from Lakelse Lake, it is important to consider a threshold of 1CFU/100mL in raw (untreated) water as being unsafe. This guideline includes three indicators, E.coli, Enterococci and fecal coliforms.

c. Nutrients

According to both the *Canadian Drinking Water Standards* and the *BC Fresh Water Act*, the maximum allowed amount of phosphorus is 0.010mg/L. The maximum allowed limit for Nitrates in 45mg/L.

d. Turbidity

The *Guidelines for Canadian Drinking Water Quality* list three possible limits for Turbidity, 0.3, 1.0 and 0.1 NTUs, all based on the surrounding area type. For Lakelse Lake, we will be using 1.0 Nephelometric *Turbidity* Units (NTU).

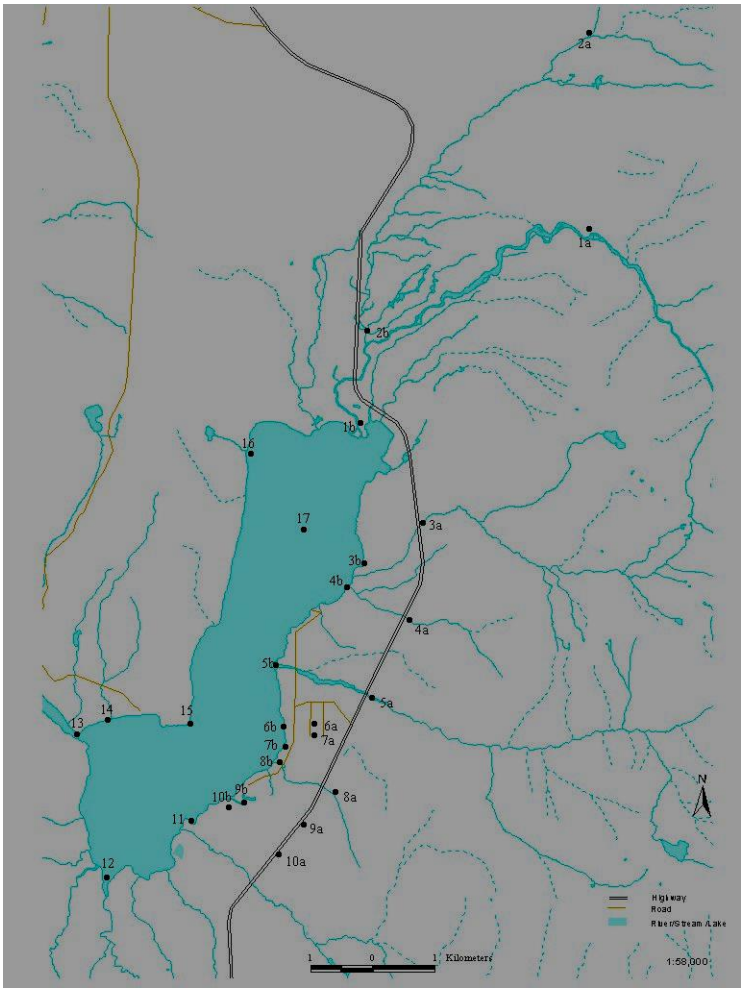
e. Heavy Metals

Safe drinking levels of heavy metals vary depending on what type of metal it is, based on the *Guidelines for Canadian Drinking Water Quality*. The main metals we looked at were Cadmium, Iron, Zinc and Manganese. **Cadmium** has a safe drinking limit of 0.005mg/L, **Iron** has a limit of less than 0.3mg/L, **Manganese** has a limit of less than 0.05mg/L and **Zinc** has a level of < or = to 0.005mg/L.

5.3 Current Water Quality at Lakelse Lake

With such defined guidelines, it would seem easy to maintain water quality, although due to budget cuts, loopholes and enforcement problems, it has been quite the opposite. All the following data was taken from the Ministry of Environment's Lakelse Lake Draft Management Plan ADDENDUM, 2004. This is published, public information regarding water quality at Lakelse Lake in 2003/2004.

Map of Lakelse Lake Sample Sites in 2003 Study



Site Name
1a. Williams Creek upstream
1b. Williams Creek downstream
2a. Sockeye Creek upstream
2b. Sockeye Creek downstream
3a. Furlong Creek upstream
3b. Furlong Creek downstream
4a. Provincial Park Creek upstream
4b. Provincial Park Creek downstream
5a. Granite Creek upstream
5b. Granite Creek downstream
6a. Whalen Creek upstream
6b. Whalen Creek downstream
7a. Crystal Creek upstream
7b. Crystal Creek downstream
8a. Mountain Creek upstream
8b. Mountain Creek downstream
9a. Hotsprings channel north upstream
9b. Hotsprings channel north downstream
10a. Hotsprings channel south upstream
10b. Hotsprings channel south downstream
11. Scully Creek downstream
12.Clearwater Creek outlet
13. Lakelse River
14. Eel Creek outlet
15. Mailbox Point
16. Muller Bay
17. Lakelse Lake Deep Station

5.3.1. Bacteria

E. coli, *Enterococci* and fecal coliforms are indicators to estimate the degree of fecal contamination in the water from human and animal wastes. Fecal coliforms are bacteria that are associated with human and animal waste. Acceptable levels are **less than 1 CFU** per 100 ml. Values greater than 10X the acceptable level are bolded.

Fecal Coliform Levels

Site #	Tributary name	May		July		September	
		upstream	*downstream*	*Upstream*	*downstream*	*upstream*	*downstream*
1	Williams Creek	<1	2	7	32	2	30
2	Sockeye Creek	<1	<1	43	**210**	11	74
3	Furlong Creek	<1	1	5	**260**	<1	9
4	Provincial Park Creek	<2	2	83	**140**	3	7
5	Granite Creek	<2	5	4	10	1	<1
6	Whalen Creek	2	<1	<1	58	<1	<1
7	Crystal Creek	<1	<2	28	16	5	15
8	Mountain Creek	<1	37	17	**160**	<1	25
9	HotspringchannelN	5	6	90	**130**	7	**105**
10	HotspringchannelS	22	29	**110**	**150**	30	**230**
14	Eel Creek	n/a	n/a	n/a	61	n/a	9

Fecal coliforms are bacteria that are associated with human and animal waste. Although fecal coliforms themselves are generally not pathogenic, **when fecal coliform counts are high, there is a greater chance that pathogenic organisms are also present** (USEPA, 2003).

E. coli is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. The presence of *E. coli* in water is a **strong indication of recent sewage or animal waste contamination** (USEPA, 2003). Safe values are less than 1 CFU per 100 ml. Sample values greater than 10 times this standard have been bolded.

E. coli Levels

Site #	Tributary name	May		July		September	
		upstrea	*downstrea*	*Upstrea*	*downstrea*	*upstrea*	*downstrea*
1	Williams Creek	<1	2	5	29	2	14
2	Sockeye Creek	<1	2	39	**180**	5	8
3	Furlong Creek	<1	2	3	**240**	<1	<1
4	Prov. Park Creek	2	1	81	**140**	<2	<1
5	Granite Creek	<2	<1	2	10	1	0
6	Whalen Creek	<1	<1	1	42	<1	<1
7	Crystal Creek	<1	<2	21	22	3	<1
8	Mountain Creek	<1	43	11	**140**	<1	24
9	Hotsprings channel N	6	4	68	**110**	3	52
10	Hotsprings channel S	28	17	**100**	**120**	16	55
14	Eel Creek	n/a	n/a	n/a	55	n/a	17

Enterococci include a number of species that occur in the fecal material of humans and warm blooded animals. They are a valuable indicator for assessing the significance of the presence of coliform bacteria in the absence of *E. coli*, or to provide additional information when assessing the **extent of possible fecal contamination**. *Enterococci* of fecal origin are more resistant to environmental stress and chlorination than *E. coli* and coliform bacteria (Drinking Water Inspectorate, 2002). Acceptable levels of *Enterococci* species are less than 1 CFU per 100 ml. Values more than 10 times this level are bolded.

Enterococci species

Site #	Tributary name	May		July		September	
		upstrea m	*downstrea m*	*Upstrea m*	*downstrea m*	*upstrea m*	*downstrea m*
1	Williams Creek	<1	4	1	11	13	5
2	Sockeye Creek	<1	<2	9	39	17	23
3	Furlong Creek	<1	<1	1	**220**	<1	11

4	Provincial Park Creek	4	<1	1	**140**	<2	18
5	Granite Creek	<2	<1	<1	15	<1	<1
6	Whalen Creek	<1	<1	2	11	<1	6
7	Crystal Creek	<1	32	48	23	1	<1
8	Mountain Creek	<1	<1	1	**430**	<1	29
9	Hotsprings channel N	2	5	45	60	1	29
10	Hotsprings channel S	2	14	23	**140**	17	**1130**
14	Eel Creek	n/a	n/a	n/a	59	n/a	5

5.3.2. Phosphorus

Phosphorus is an essential plant nutrient, and, in excessive quantities, has been shown to cause algal blooms and increased aquatic plant growth. It can be introduced into the environment from human and animal wastes, fertilizers, industrial wastes and human disturbance of the land and its vegetation (Cavanaugh, 1997). **Canadian Drinking Water Guidelines** have set acceptable phosphorus levels at less than 0.010mg/L. Values exceeding twice this level have been bolded.

Phosphorus levels exceeding Guidelines

Site #	Tributary Name	# of times guideline not met	Concentration (mg/L)	Date
*	Ambient site #4	1 of 3	0.012	13-Aug-02
1b	Williams Creek downstream	2 of 6	0.017	21-May-03
			0.011	03-Sept-03
4a	Provincial Park Creek upstream	1 of 3	0.018	07-July-03
4b	Provincial Park Creek downstream	3 of 3	**0.028**	21-May-03
			0.019	07-July-03
			0.021	04-Sept-03
6b	Whalen Creek downstream	1 of 3	0.014	07-July-03

8b	Mountain Creek downstream	1 of 3	0.018	04-Sept-03
14	Eel Creek outlet	3 of 3	0.016	20-May-03
			0.024	06-July-03
			0.034	03-Sept-03

Nitrates are a much better indicator of contamination, as they reside in an ecosystem much longer than phosphorus, which is taken up very rapidly by aquatic plants and algae. Information concerning levels of Nitrates was not found, and as such, was not taken into account regarding water health in this study.

5.3.3. Turbidity

Turbidity is a measurement of the suspended particle matter in a water body that reduces the transmission of light. High levels of turbidity increase the area upon which bacteria can grow and interfere with the disinfection of drinking water (Cavanagh, 1997). Turbidity can also inhibit the growth of salmonids (Larkin et al., 1998). Increases in turbidity can be a result of forest harvesting, road building, urban development and sewage (Cavanagh, 1997). The table of values on the next page indicates when **drinking water standards were not met** and the number of sampling times that this occurred. Values greater than 2 times the standard of 1 NTU are bolded.

Turbidity Levels

Site #	Tributary Name	# guideline not met	Value (NTU)	Date
1a	Williams Creek upstream	2 of 3	1.93	07-July-03
			6.37	03-Sept-03
1b	Williams Creek downstream	2 of 3	1.93	07-July-03
			1.84	03-Sept-03
2a	Sockeye Creek upstream	1of 3	**2.45**	07-July-03
2b	Sockeye Creek downstream	2 of 3	1.1	07-July-03
			1.78	04-Sept-03
3b	Furlong Creek downstream	3 of 3	1.31	20-May-03
			2.38	07-July-03
			3.42	04-Sept-03

4a	Provincial Park Creek upstream	3 of 3	1.49	21-May-03
			1.74	07-July-03
			3.75	04-Sept-03
4b	Provincial Park Creek downstream	3 of 3	**4.66**	21-May-03
			6.68	07-July-03
			10.7	04-Sept-03
6b	Whalen Creek downstream	1 of 3	1.15	07-July-03
8b	Mountain Creek downstream	3 of 3	1.05	21-May-03
			1.81	07-July-03
			2.37	04-Sept-03
9a	Hotsprings channel north upstream	3 of 3	1.27	21-May-03
			1.53	07-July-03
			3.31	03-Sept-03
9b	Hotsprings channel north downstream	3 of 3	1.33	21-May-03
			1.76	07-July-03
			7.42	03-Sept-03
10a	Hotsprings channel south upstream	2 of 3	1.36	07-July-03
			1.96	03-Sept-03
10b	Hotsprings channel south downstream	3 of 3	1.1	21-May-03
			1.37	07-July-03
			3.41	03-Sept-03
11	Scully Creek downstream	2 of 3	1.53	20-May-03
			2.17	03-Sept-03
14	Eel Creek outlet	3of 3	**3.37**	20-May-03
			4.36	07-July-03
			5.25	03-Sept-03
17	Deep Station (surface)	9 of 12	1.09	15-Apr-03

	(6 m depth)		**2.07**	15-Apr-03
	(30 m depth)		**2.42**	15-Apr-03
	(surface)		1.01	20-May-03
	(6 m depth)		1.09	20-May-03
	(28 m depth)		3.5	20-May-03
	(6 m depth)		1.16	07-July-03
	(28 m depth)		1.81	07-July-03
	(28 m depth)		**2.84**	03-Sept-03

5.3.4. Heavy Metals

For human safety, heavy metals appear to be not an issue at Lakelse Lake as safety guidelines were met for Cadmium, Zinc, Iron and Manganese in most water samples. However, aesthetic guidelines were failed multiple times.

The **Cadmium levels did exceed the guidelines for aquatic life**. The guideline is 0.00001mg/L at a water hardness of 30mg/L. **Zinc levels also exceeded guidelines for aquatic life**. The guideline is 0.0075mg/L at a water hardness of less than or equal to 90mg/L

a.Cadmium

In all chemical forms, **cadmium has cumulative and highly toxic effects**. It has been known to have extremely toxic effects on trout and zooplankton. Studies have shown that aquatic plants can accumulate non-essential elements such as cadmium and can mobilize them from sediments to the water column (French and Chambers, 1992). Sources of cadmium include erosion of natural deposits, galvanized pipes, discharge from refineries, and runoff from waste batteries and paints (USEPA, 2003). Cadmium guidelines for aquatic life were exceeded seven times in the 2003 sampling. (Note: Cadmium is also bioaccumulative so small amounts in the water can accumulate in aquatic food chains and cause ecological disruption.)

Cadmium Levels

Site #	Tributary Name	# of times guideline not met	Concentration (mg/L)	Date
1a	Williams Creek upstream	1 of 6	0.00002	12-Aug-02
3b	Furlong Creek downstream	1 of 6	0.00003	09-July-02
4b	Prov. Park Creek downstream	1 of 3	0.00011	07-July-03

14	Eel Creek	1 of 3	0.00002	07-July-03
16	Muller Bay	2 of 5	0.00002	08-Oct-02
			0.00007	06-July-03
17	Deep Station (surface)	1 of 24	0.00008	15-April-03

b. Iron

At concentrations greater than 0.3 mg/L, **iron** can stain laundry and plumbing fixtures, and cause undesirable tastes in drinking water. It may also encourage the growth of some microorganisms, resulting in a slimy coating in water pipes (Health Canada, 2003). Iron enters water bodies through the weathering of rocks and minerals. It can also be released to the natural environment through acid mine drainage, acid rain deposition, landfill leachates, sewage effluents and iron-related weathering such as old car bodies or abandoned logging equipment. The guideline value for iron based on aesthetic criteria is less than 0.3mg/L. Values more than 5 times the guideline are bolded.

Iron Levels

Site #	Tributary Name	# of times guide -line not met	Concentration (mg/L)	Date
	Ambient site #4	1 of 3	0.73	13-Aug-02
1b	Williams Creek downstream	1 of 6	0.4	03-Sept-03
2b	Sockeye Creek downstream	3 of 3	0.55	21-May-03
			0.56	07-July-03
			0.91	04-Sept-03
3b	Furlong Creek downstream	2 of 6	0.5	07-July-03
			1.3	04-Sept-03
4a	Provincial Park Creek upstream	3 of 3	0.75	21-May-03
			1.19	07-July-03
			3.11	04-Sept-03
4b	Provincial Park Creek downstream	3 of 3	**1.72**	21-May-03
			2.28	07-July-03
			3.49	04-Sept-03

8b	Mountain Creek downstream	2 of 3	0.64	07-July-03
			1.12	04-Sept-03
9a	Hotsprings channel south upstream	1 of 3	1.1	04-Sept-03
9b	Hotsprings channel south downstream	3 of 3	0.44	21-May-03
			0.51	07-July-03
			1.67	04-Sept-03
10a	Hotsprings channel north upstream	1 of 3	0.83	04-Sept-03
10b	Hotsprings channel north downstream	3 of 3	0.30	21-May-03
			0.36	07-July-03
			1.53	04-Sept-03
11	Scully Creek downstream	5 of 6	0.42	09-July-02
			0.49	13-Aug-02
			0.36	08-Oct-02
			0.48	21-May-03
			0.93	04-Sept-03
14	Eel Creek outlet	3 of 3	0.66	20-May-03
			1.46	06-July-03
			3.19	03-Sept-03
15	Mailbox Point	1 of 6	0.34	08-Oct-02
17	Deep Station (28m depth)	8 of 24	1.26	13-Aug-02
	(6 m depth)		0.34	13-Feb-03
	(28m depth)		0.38	13-Feb-03
	(surface)		0.36	15-Apr-03
	(6 m depth)		0.40	15-Apr-03
	(28m depth)		0.40	15-Apr-03

c. Manganese is naturally present and widely distributed in minerals, rocks, and soils. It is usually present in natural surface water as dissolved or suspended matter at concentrations below 0.05 mg/L. At concentrations above 0.15 mg/L, it can stain laundry and plumbing fixtures and cause undesirable tastes in drinking water. It may also encourage the growth of some microorganisms, resulting in a slimy coating in water pipes (Health Canada, 2003). Manganese can be liberated from soils through acid rain deposition. Other sources of manganese include industrial effluent and sewage leachate. Acceptable drinking water standards are **less than 0.05mg/L**. Values greater than 2 times that level are bolded.

Manganese Levels

Site #	Tributary Name	# of times guideline not met	Concentration (mg/L)	Date
3b	Furlong Creek downstream	1 of 6	**0.16**	04-Sept-03
4a	Provincial Park Creek upstream	3 of 3	0.076	21-May-03
			0.104	07-July-03
			0.23	04-Sept-03
4b	Provincial Park Creek downstream	3 of 3	0.08	21-May-03
			0.13	07-July-03
			0.11	04-Sept-03
8b	Mountain Creek downstream	1 of 3	0.089	04-Sept-03
10a	Hotsprings channel north upstream	1 of 3	0.061	04-Sept-03
10b	Hotsprings channel north downstream	1 of 3	0.063	04-Sept-03
14	Eel Creek	2 of 3	0.088	07-July-03
			0.49	03-Sept-03
17	Deep Station (28m depth)	8 of 24	**0.19**	13-Aug-02
	(28m depth)		**0.12**	13-Feb-03
	(28m depth)		0.06	20-May-03
	(28m depth)		0.051	07-July-03
	(28m depth)		**0.11**	03-Sept-03

d. Zinc

Zinc is **acutely and chronically toxic to aquatic organisms**, especially fish. Its toxicity increases with decreasing hardness, increasing temperature and decreasing dissolved oxygen. Sources of zinc include industries (paints, rubber, textiles, printing), mining, agriculture (fertilizers, pesticides) and urban runoff (Cavanagh, 1997). The acceptable drinking water standards for zinc are less than or equal to **0.005.0mg/L.** Values more than twice this level are bolded.

Zinc Levels

Site #	Tributary Name	# of times guideline not met	Concentration (mg/L)	Date
4b	Provincial Park Creek downstream	1 of 3	0.009	07-July-03
15	Mailbox Point	1 of 6	**0.017**	08-Oct-02
17	Deep Station (surface)	1 of 24	**0.017**	13-Feb-03

5.4. Recommendations

Under normal circumstances, a watershed is more than capable of taking care of itself, regulating its mineral and chemical inputs by having **natural filtration methods** and different organisms to utilize the excess nutrients and contaminants. When a watershed has an unnatural amount of freely available nutrients and contaminants, such as excess human or animal wastes, a watershed becomes overloaded and can no longer handle the contaminants on its own.

In a case such as Lakelse Lake, where public **safety is already at risk due to bacteriological levels**, as all sites failed the guidelines at least once, a **management plan** for the entire watershed must be implemented to prevent further damage and repair that which is already done. In order to protect the lake, the watershed must be sampled and **all inputs of excess contaminants** must be contained and removed to maintain homeostasis. When the contaminant inputs are found, they must be removed, either by cleaning the area or removing the input.

A similar plan was implemented in Ireland to protect their lakes and rivers, first on rivers - the Suir, Boine, and Liffey Rivers, and watersheds - the Loughs Derg, Ree, and Leane Watersheds (The Shannon Regional Fisheries Board, 2010). The Irish Environmental Protection Agency (IEPA) implemented this plan to help maintain Ireland's "green" image for tourists, and to maintain a safe drinking water standards.

To rehabilitate Lakelse Lake to **water quality homeostasis** (stable, safe, and sustainable nutrient levels), we must manage the watershed and all of the contaminants entering the watershed. Sources of excess nutrients need to be removed. To confirm the sources of wastes, it is suggested that the water be tested for **caffeine** as this is an indicator of human activity. If it is determined to be human waste contamination, a communal sewer system needs to be constructed for the residents.

The Regional District of Kitimat-Stikine has prepared a **liquid waste management plan** for a portion of the lake, but this will be a costly infrastructure to build. However, as it would protect public health, it should be at the top priority of government.

With **sewage disposal infrastructure** in place, it is very possible that the value of the lake can increased as a recreational and tourism location and more property may be utilized without damaging the watershed. If pre-existing and potential new housing is placed on sewer, human waste will be controlled and thus, a large source of potential nutrients may removed from the widespread bacteria occurring in the lake.

Turbidity in the lake appears to be coming from soil erosion or land wash as it appears to be much higher downstream compared to upstream of residential development. The most common source of excess particulate entering a watershed is from soil washing, such as in large clear cut logging blocks. Either fine debris is added to the water, or other matter is broken down into finer particles and added to the water. Lakelse Lake does have a number of large clear cut logging blocks within its watershed, which may in fact play a roll towards the excess turbidity.

An additional input of other contaminants to the lake may be **human garbage**. If human garbage being improperly disposed e.g. down sideroads and over embankments, other contaminants such as heavy metals may be introduced into the watershed. For this reason, and again for basic sanitation and public health, a regular garbage pickup or safe dumping site must be formed.

Repairs to the riparian zone should be made also, as a means of accelerating the lake's natural ability of purifying. Stable banks and oligotrophic (low) nutrient levels must be met if the lake is ever to be **usable for swimming or drinking** by the year 2060, as at current levels, this is already unsafe to do in some areas.

5.4. Conclusions

Water quality is important to the safety and health of a population, even one as small as the permanent residents at Lakelse Lake. The Canadian government has laid out strict guidelines to try to regulate the amount of toxins allowed within drinking water. According to the Ministry of Environment's **Lakelse Lake Draft Management Plan ADDENDUM (2004)**, many of the locations around Lakelse Lake exceed these limits. If the amounts of contamination continue in Lakelse Lake, all of the popular locations and perhaps all accessible places for the large amount of recreational use of the lake may be too contaminated to safely drink or swim in by 2060.

Even at current levels of nutrients and bacteria, **all sites sampled for water quality failed bacteria guidelines at least once**. Nutrients, metals and turbidity samples also exceeded guidelines multiples times, showing a danger in some areas, such as the popular Furlong Bay Park and swimming area. A **management plan** is needed to monitor all contaminant inputs and limit or stop them. Proper infrastructure and services to the lake must be implemented to ensure that contaminants are contained and kept from the watershed.

Acknowledgments: The information in this report, including collection data, has been taken from the **Lakelse Lake Draft Management Plan ADDENDUM** (2004) and the **Guidelines for Canadian Drinking Water Quality Summary Table.** The **Northern Heath Authority** was also contacted and they were extremely helpful in the locating of required guidelines and other documents.

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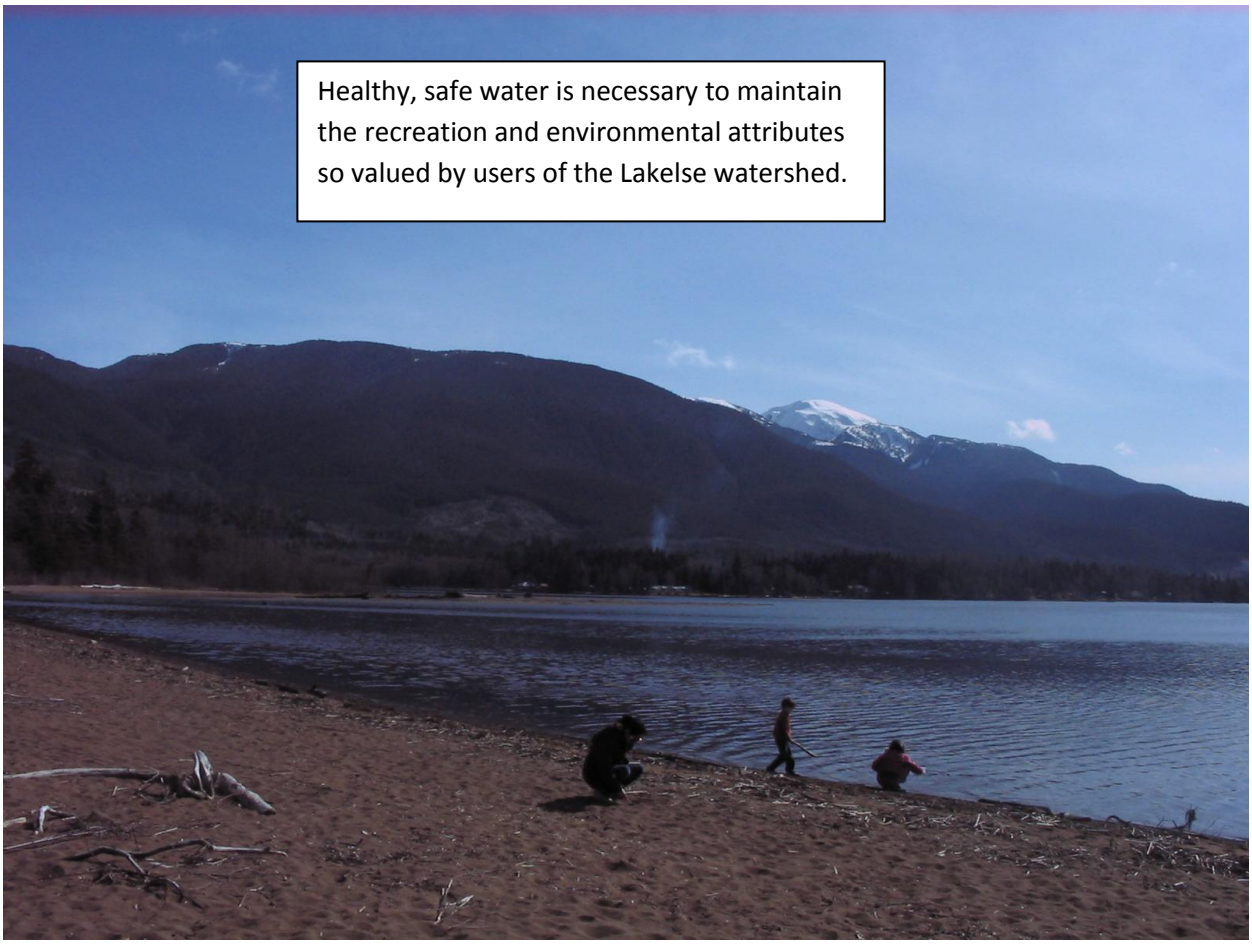

Photo: Rodney Brown

SECTION 6

LAKELSE 2060

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Western Floater

The Benthic Environment: Management of Freshwater Mussels

by Cassie Dusdal, Morgan Oleksewich, and Hikari Shiga

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Lakelse Lake at South End – looking north towards Mailbox Point Photo: Cassie Dusdal

Executive Summary:

The current species of freshwater mussels in the Lakelse Watershed are *Anodonta kennerlyi, Anodonta californiensis,* and *Margaritifera falcata*, the Western Floater, the California Floater, and the Western Pearlshell respectively. The Floaters are found almost exclusively in the lake while the Pearlshell is found almost exclusively in the river. These freshwater mussels are an excellent indicator species for nutrient and contaminant levels as well as the overall conditions of the watershed due to their role as filters and decomposers. All particulate matter in the watershed is concentrated in the mussels and therefore if the water is affecting the mussels, it is slowly affecting those who swim in and drink the watershed water. Also, high nutrient levels cause the lake weed, *Elodea*, to flourish, choking out the mussel populations. These high nutrient levels are caused by waste due to naturally occurring wildlife in the area, but largely to the use of septic tanks in combination with high water tables in residential areas. The diminishing reed beds around the lake are also a concern since they help to dissipate waves caused by speedboats and high winds. Without them, the shoreline erodes quickly, adding large amounts of sediment to the watershed and sediment covers the clams, suffocating them.

According to Lakelse Lake Zoning Bylaw No. 57, in commercial I areas (CI): "Where the site is not serviced by a community sewer system, there shall be sufficient area on the site to dispose of human and other wastes in accordance with the authority having jurisdiction." Similar regulations are outlined in residential (RI), commercial II (CII) rural (RRI) and parkland (PI). However, the septic systems at the lake are not satisfactory since many of the lots have insufficient area to allow time for bacterial action and also the high water table causes the liquid effluent to seep into the lake, causing eutrophication. The eutrophication encourages *Elodea* growth and greatly affects the mussels.

The Lakelse River has western Pearlshell mussels and needs to be protected from sedimentation and benthic disturbance.

Photo: C. Dusdal

6.1. Introduction:

The species of freshwater mussels in the Lakelse Watershed that were studied are *Anodonta kennerlyi, Anodonta californiensis,* and *Margaritifera falcata*, the Western Floater, the California Floater, and the Western Pearlshell respectively. Their roles in the ecosystem include being filters,decomposers, and indicators.

As filter feeders, they filter particulate matter as well as algae and bacteria out of the water, reducing turbidity. They then digest this particulate matter and release it as bound, larger molecules that sink to the bottom for benthic organisms, thus acting as decomposers. Since they filter the water, they can be excellent indicators of the water quality of the entire Lakelse Watershed. The mussels studied range in lifespan of 10 to 100 years and can therefore accumulate high levels of contaminants that may be found in the water draining from the watershed.

Distinct threats to mussel populations include dissolved oxygen levels, chemical contaminations, sedimentation and loss of host fish. These factors are in direct correlation with the health of the watershed. Low dissolved oxygen levels cause decline in many benthic organisms, however the movement of mussels helps to stir up the benthic environment and oxygenate it.

Chemical contaminants from seepage or dumping of industrial wastes into the watershed cause chemical accumulation in the mussels and a toxic area for other aquatic life. Sedimentation caused by dumping of sand and gravel to make boat launches or to create a sandy beach adds tremendously to the sedimentation levels in the lake, as does erosions caused by wave action. This sedimentation suffocates the mussels. Loss of host fish caused by unsuitable habitat or over fishing, causes decline of mussel reproduction and therefore overall mussel populations (Nedeau et al. 7,8).

Lakelse Lake looking towards east shoreline and Hatchery Creek watershed

Photo: Amy Warner

Lakelse Lake is the largest warm water lake in northern British Columbia, and is an important natural resource to the Terrace, Thornhill, Kitimat, and Prince Rupert area. The rate of development at Lakelse Lake has steadily increased over the years as the Terrace area grew and living out of Lakelse Lake transitioned from rustic seasonal to permanent residences. Increasing rate and density of development at Lakelse Lake has created pressures on the ecological integrity and diversity of the Lakelse area.

When ecological and health risks begin to appear in an area of development, additional planning is required to preserve resources and the quality of living for the people. Planning arises from a need for order, health and safety. One of the key requirements for any community is water quality that supports public and environmental health. In some areas in the Lakelse watershed, it is already suspected that water quality has been compromised.

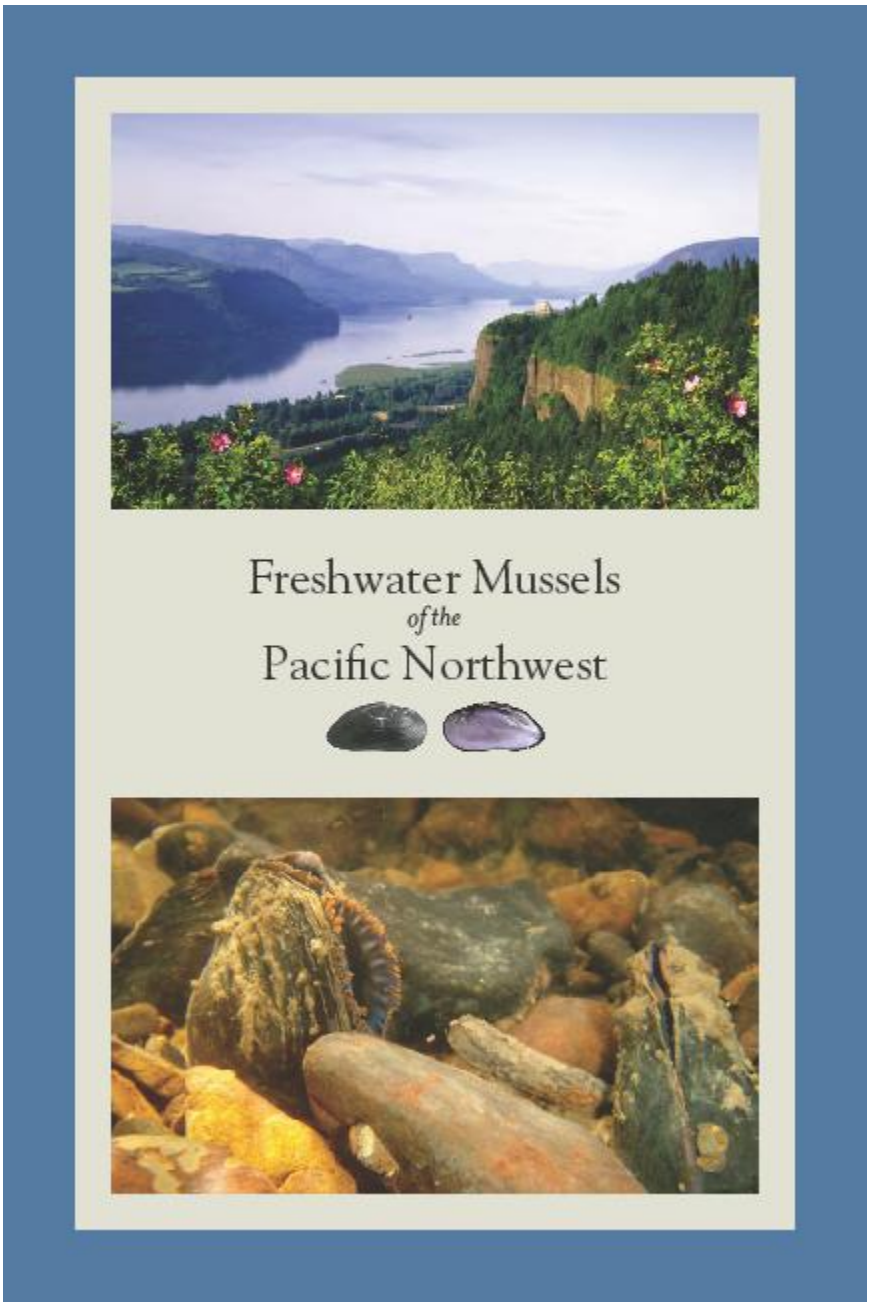
Thus, a long-term management plan for the freshwater mussels of the benthic environment at Lakelse Lake can avoid loss of water quality at Lakelse that could create detrimental future ramifications. As filter feeders, sensitive to environmental changes and stresses, freshwater mussels can be used as indicators for water quality and overall aquatic ecosystem health. Managing for freshwater mussels can then in turn achieve more than the preservation of freshwater mussel populations, but guarantee health of the ecosystems and overall value of the Lakelse Lake as a home, recreation attraction and natural watershed.

Planning for mussels is essentially the same as planning for a healthy watershed in which people can swim and live around. Lakelse Lake has been a recreational meeting area for many generations. It must remain a safe meeting place, with no health hazards associated with it. Planning for a healthy watershed means planning for an environment that can sustain a healthy population of natural wildlife, such as many different fish species, waterfowl, moose, deer, coyotes, bears, amphibians and mussels.

Photo: Lakelse Watershed Society

Outlet of Lakelse Lake in SW corner - view of Lakelse River draining towards Skeena River; housing development at Beam Station Road and Squirrel Point.

The biology, ecology, distribution, and identification characteristics of freshwater mussels have been recently published in a new freshwater key for the Pacific Northwest. This key provides an essential tool in any assessment of freshwater mussels in the Lakelse watershed.



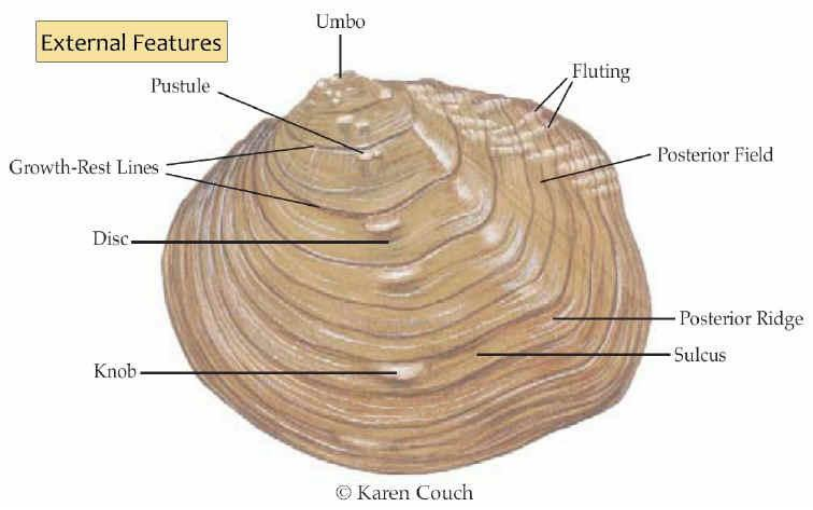
Ethan Nedeau, Allan K.Smith, and Jen Stone, 2010. Freshwater Mussels of the Pacific Northwest. <www.fws.gov/pacific/combiariver/musselwg.htm>

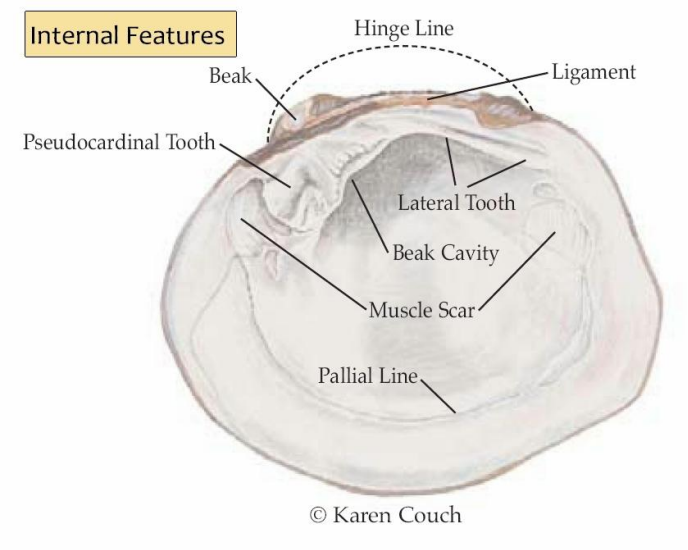
Key for identifying mussels in Washington, Oregon and British Columbia.

6.2. Biological/ Ecological Background

a. Anatomy

The anatomy of a freshwater mussel shell is shown below:

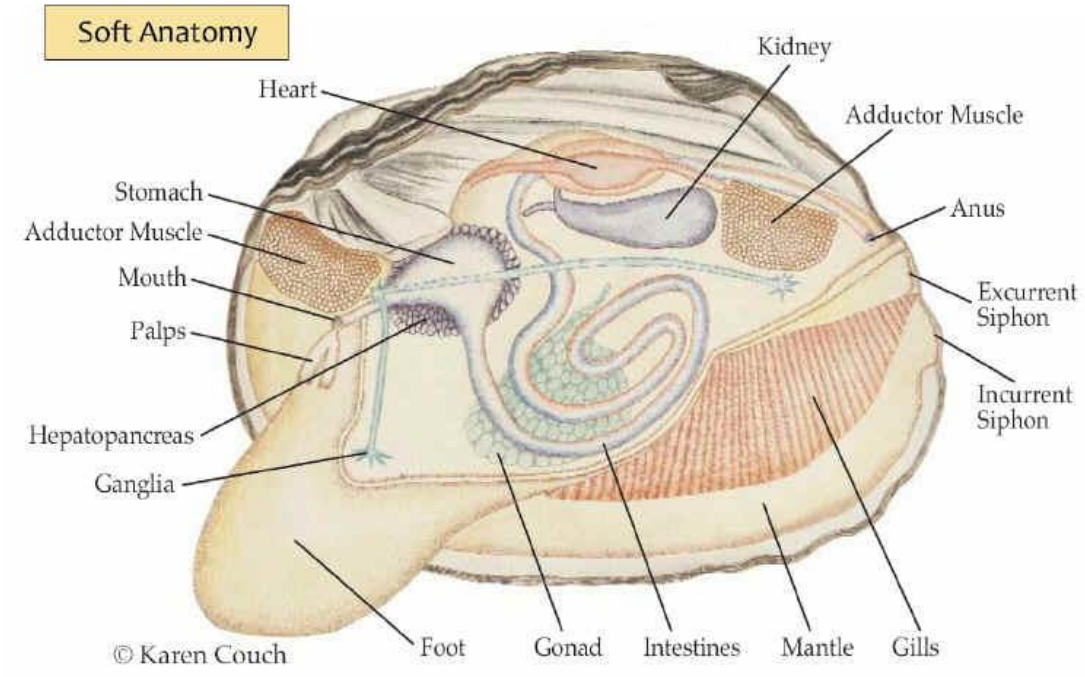




The periostracum is the outer surface of the shell, and the nacre is the inner surface of the shell.

Reference: Karen Couch, *Anatomy of Unionid Mussels*, originally from "A Pocket Guide to Kansas Freshwater Mussels." <http://www.gpnc.org/shells.htm>

The inner anatomy of a freshwater mussel is shown below:



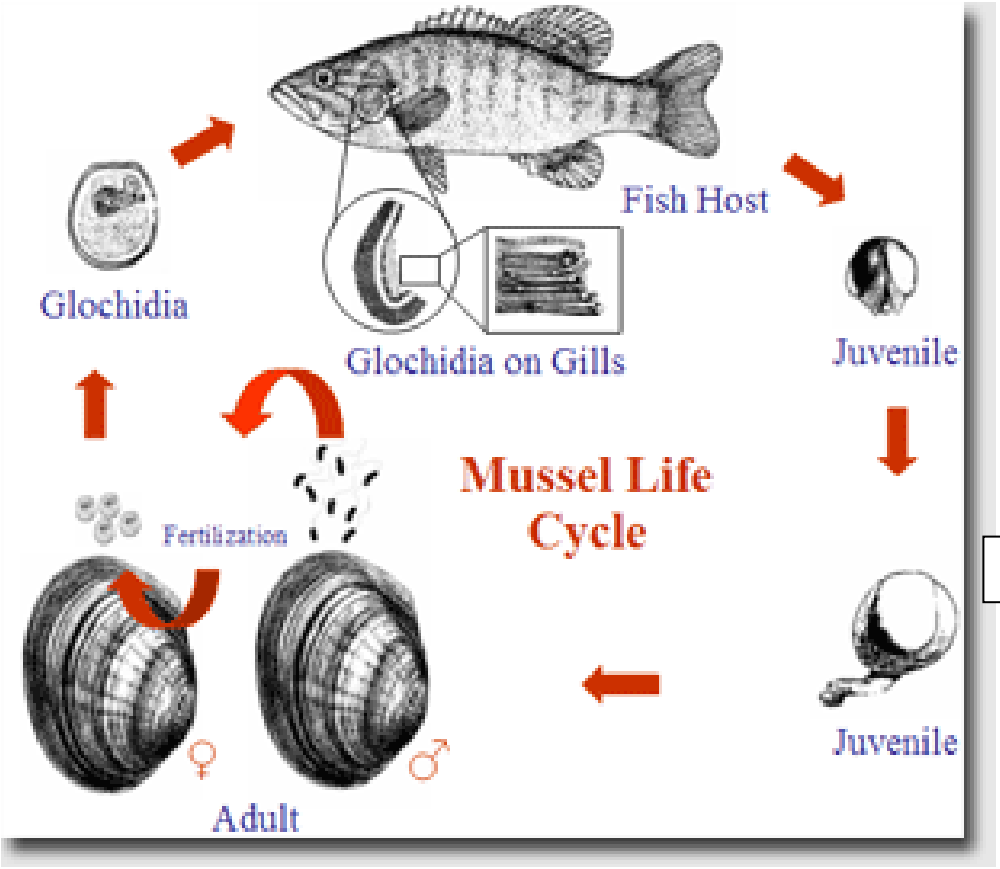
b. Lifecycle

The lifecycle of freshwater mussels is quite complex. The males release the sperm into the water through the excurrent siphon. The females inhale the sperm through the incurrent siphon and the sperm fertilizes the eggs inside the mussel. The eggs mature into the larval form of the mussel called glochidia. These glochidia remain inside the mother for several weeks or months, depending on the species, water temperature and the presence of fish activity. (Nedeau et al. 4,5)

When the glochidia are expelled through the excurrent siphon, they must encounter their specific host fish in order to attach to its gills or fins. Some mussel species release all of their thousands of separate glochidia at once, hoping they will encounter their host fish, while other species release their glochidia in clumps bound together by mucus. These clumps are called conglutinates that can be coloured and shaped like the natural prey of the host fish, such as insect larvae, small fish, or worms. The host fish attack the conglutinates, releasing the glochidia, and the glochidia attach themselves to the gills. The Western Pearlshell produces loosely bound conglutinates that disintegrate to leave the glochidia to find their host fish on their own. (Nedeau et al. 4,5)

Once the glochidia have found their host fish, they form cysts around themselves and travel with the fish around the watershed for several weeks, depending on the water temperature and the mussel species, until they remove themselves from the fish. In this way, the fish help the mussels spread throughout the watershed. The mussels then burrow into the sediment where they mature so as to protect themselves from animals and rocks that may crush them. (Nedeau et al. 4,5) Freshwater mussels can live for a range of 10 to 100 years, depending on the species. (Nedeau et al. 4,5)

LIFE CYCLE OF A FRESHWATER MUSSEL



Virginia Department of Game and Inland

Note that glochidia (larvae) attach themselves to the gills or fins of the host fish, and travel with the fish, dropping off to form mussel colonies, often in new locations upstream.

Photo: Michelle Steg, Oregon Nature

Gochidia attached to host fish's gills – in Western Floaters, this will commonly be bullheads (sculpins); in Western Pearlshells, host fish are normally trout or salmon.

c. Floaters, *Anodonta* - two species, the Western Floater and California Floater

Floaters inhabit silty or sandy areas in rivers and lakes due to their thin shells. They are unable to inhabit small, rocky streams, which are ideal for Western Pearlshells. They usually inhabit mid- to high elevation watersheds.

Floaters are very general when it comes to habitat requirements but they seem to be more tolerant of lake-like conditions than other freshwater mussels. They inhabit natural lakes, reservoirs, and depositional habitats in downstream, low-gradient reaches of rivers. They are more tolerant of low-oxygenated water than most freshwater mussels and are able to live in small, nutrient-rich bodies of water such as farm ponds, permanently flooded marshes, and oxbow lakes.

Floaters have very general reproductive requirements. They are long-term brooders. Fertilization occurs in late summer or early fall, the embryos develop during the winter, and the glochidia are released the next spring and summer. Floaters do not usually have a specific host fish.

Floaters are fast growing and short-lived mussels. They grow quickly, usually reaching sexual maturity within four or five years. The growth rate is dependent upon water temperature and productivity of the environment. Floaters grow quickly in nutrient-rich, stable bodies of waters such as lakes. They usually live only 10 to 15 years, less than most freshwater mussels. (Nedeau et al. 20, 21)

Floaters live in areas of high deposition, in the downstream reaches of watersheds where chemical and organic pollution accumulate. They cannot tolerate excessive turbidity, very low levels of dissolved oxygen, or toxic contaminants such as industrial wastes, oil and chemical spills. They are also very sensitive to removal of sediment and gravel from their habitat. Water-level fluctuations, due to removal of water for water supply or water diversion, are the main threat for Floaters. This leaves them exposed to the air, drying them out, and scavenging animals will eat them when out of water. (Nedeau et al. 23) The Western and California Floaters are found in **Lakelse Lake**. (Survey, 2010)

California Floater – up to 5 inches with an elliptical or ovate shape and laterally inflated shell; often prominent brown growth lines on periostracum.

Western Floater - up to 4.75 inches with an elliptical or elongate shape; periostracum shiny; shell fairly thin and fragile; nacre usually white or bluish-white, with some pink at centre

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c.i. The Western Floater, *Anodonta kennerlyi*

The Western Floater can range in size up to 4.75 inches with an elliptical or elongate shape. Their periostracum can be yellowish, yellowish-brown, or brown, sometimes with a tinge of green. There are often prominent brown growth lines. The periostracum is shiny, but the growth lines can cause it to be rough. The nacre is usually white or bluish-white, with some pink near the centre of the body. The nacre can also appear iridescent toward the posterior end. The shell is fairly thin and fragile. (Nedeau et al. 30) Western Floaters may be able to use several fish species for their larvae, but they are thought to use the sculpin, Cottus bairdii, commonly known as the bullhead. (Adair et al. 2)

c.ii. The California Floater, *Anodonta californiensis*

The California Floater can be as large as 5 inches with an elliptical or ovate shape and is laterally inflated. Their periostracum can be black, reddish brown, pale brown or olive in colour with green rays on the posterior slope. There are often prominent brown growth lines. The periostracum is smooth, but the growth lines can cause it to be rough. The nacre is usually white, but occasionally it can have a purple or flesh-coloured tint. (Nedeau et al. 24) California Floaters are able to use a wide range of host fish. (Nedeau et al. 25)

d. Pearlshells – Margaritifera: The Western Pearlshell, *Margaritifera falcata*

The Western Pearlshell can be as large as 5 inches with an elongate shape. The shell is relatively thick and strong compared to the shell of a Floater. Their periostracum can be light brown, in juveniles, to dark brown or black in adults. There are prominent brown growth lines. The nacre is usually purple, salmon-coloured, or pink. The nacre fades to white over time. (Nedeau et al. 35)

The Western Pearlshell is thought to be hermaphroditic on rare occasions, but most of the population comprised of the separate sexes. Fertilization occurs in the spring and release of the glochidia usually occurs in May or June. Pearlshells can have a lifespan longer than 100 years and are therefore an excellent long-term indicator of a water body. The Western Pearlshell can use a variety of fish for its host fish including cutthroat trout, rainbow trout, Sockeye, Coho, and Chinook.

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Western Pearlshell showing the typical thick shell, dark coloured periostracum, and thick, pink to salmon-coloured nacre on the inside; up to 5 inches in length; mussel long-lived, up to 100 years; able to live in streams and rivers with cobbles and boulders.

The Western Pearlshell tends to inhabit cold creeks and rivers. Conveniently, these areas also support salmonid populations and therefore host fish are abundant. The Pearlshell prefers coarser substrates such as coarse sand, gravel and cobble in stable areas of the streambed, usually near banks or in pools since the current is slower. Large boulders can create suitable habitat by anchoring the substrate and shielding the mussels from strong currents. Pearlshells can be dispersed as far as their host fish will take them, far into the headwaters. Unlike Floaters, Pearlshells cannot tolerate fine sediments since it will suffocate them. (Nedeau et al. 36, 37) Western Pearlshells are found almost exclusively in the **Lakelse River**. (Survey, 2010)

6.3. Impacts on Mussel Populations

There are several factors that greatly affect freshwater mussel populations. **Destruction of mussel and host fish habitat** causes a large decline in mussel populations. If there is **excessive turbidity** in the aquatic environment, the mussels and fish are suffocated. Also, if there are no deep pools with a gravel-like substrate somewhere in the watershed, there are no suitable spawning areas for the prospective host fish.

If there are **alterations in the flow of water**, oxygen levels and sedimentation rates change also. Most aquatic organisms are unable to survive in areas with **low dissolved oxygen levels**, and though the Floater does help to stir up the benthic environment to introduce dissolved oxygen, if there is too little oxygen, even the Floaters will die. Also, **deforestation and channelization** alter natural meandering flow patterns of streams needed for host fish. Deforestation and residential development often increase rates of erosion and sedimentation carried downstream or into lakes. Channelization carries all sediments straight into the watercourse instead of being distributed over the natural floodplain.

Pollutants such as chemicals, organic waste and heavy metals greatly affect the mussels and the host fish. Any elevated levels of chemicals and heavy metals will kill the host fish quickly. Low levels of chemicals and heavy metals will accumulate in the mussels and kill them, accrediting them to their indicator abilities. **Organic wastes** will choke the fish and mussels out. Organic wastes also increase the growth of ***Elodea***, which grows on top of the mussels and smothers them. Increased **sedimentation** also decreases the amount of light that is able to penetrate the water. This slows the growth of algae, a major food source for the mussels. (Jennings, 1998)

Removal of reed beds causes many problems for mussels and and host fish. Reed beds prevent erosion by waves caused by high winds and motorboats. (Lakelse Watershed Society, 2010) Without them, the shoreline slowly erodes, and, in the case of Lakelse Lake, the sediment is moved around Mailbox Point and settles along the SW side of the lake and into the Lakelse River. These high levels of sedimentation can choke out the Western Pearlshells, which cannot tolerate silty sediments, and even the Western Floaters, which are tolerant of the finer sediments but can be buried by excessive amounts.

Ethan Nedeau, Allan K.Smith, and Jen Stone, 2010

Mussels are surface dwellers and feed by filter-feeding. Excessive sediments will bury the mussels and/or clog their gills, as well as reduce the amount of microscopic food in the water.

6.4. Comparative Projects

6.4.1. National Strategy for the Conservation of Native Freshwater Mussels

In the United States, the plan entitled **National Strategy for the Conservation of Native Freshwater Mussels** (1998) addressed the declining mussel populations. They dealt with several problems, however only a few of them were related to the Lakelse Watershed freshwater mussel problems. One of their problems was entitled "Quality mussel habitat continues to be degraded and lost." The strategies included that are useful to the Lakelse Watershed were:

a. locate and determine the density, species composition and status of **existing mussel communities**.

b. Gather **historical information** concerning mussel distribution data and make it more readily available.

c. Develop programs to **conserve and rehabilitate prime mussel habitat**.

d. Encourage **local residents** to monitor their activities, and if possible, provide financial incentives to the residents to preserve and rehabilitate the mussel habitat.

e. Encourage **conservation organizations**, schools, civic groups, and universities to assist in the preservation and rehabilitation of the mussel habitat. (Shellfish Research 3)

One of the goals of the plan was to determine the factors that impact mussels and their habitats and provide managers with information needed to minimize or eliminate threats and protect important mussel habitat. The **Strategies** that are useful to the Lakelse Watershed were:

a. Determine how different **habitat alterations** (increased siltation, introduction of pesticides and other chemicals, stream-flow modifications, alteration of water temperature and pH, levels of dissolved oxygen) affect mussel species and populations and to what extent.

b. Determine if current **water quality criteria** are suitable for all stages of life for freshwater mussels.

c. Determine if the current **water laws and regulations** are adequate for the protection of freshwater mussels.

d. Determine which factors have previously caused the **decline or extirpation of mussel populations**. (Shellfish Research 5)

6.4.2. New Hampshire Department of Environmental Services

Another management plan that could be implemented in the Lakelse Watershed was that proposed by the New Hampshire Department of Environmental Services. They stated that the following actions would ensure that mussels would continue to be part of the freshwater ecosystem:

a. **Reintroduce riparian vegetation** along the tributary and lake shorelines in order to provide a natural filtering system for surface waters. This could remove some sediments and pollutants.

b. **Reduce heavy boating traffic**, which increases turbidity. Too much sediment will clog the mussels' gills and suffocate them.

c. **Fertilizers and pesticides on shoreline lawns** should be monitored to help reduce the chances of imposing pollutants accumulating in the mussels.

d. **Protect the host fish**. Minimizing sedimentation of surface waters and keeping healthy plants can increase chances of having appropriate oxygen levels and providing suitable breeding grounds for fish. (Hampshire 2)

6.4.3. National Strategy for the Conservation of Native Freshwater Mussels

In the paper by Sue Jennings, ***Needs in the Management of Native Freshwater Mussels in the National Park System*** (1998), the suggestions and plans that applied to the Lakelse Watershed were as follows:

a.Conservation tillage can be used to grow crops while **reducing soil erosion by 70%** (e.g. areas subject to erosion and putting sediments into water courses can be revegetated to stop the erosion).

b.**Riparian zones can be revegetated** by working with Soil and Water Conservation districts, local botanical groups, university extension services, and other types of volunteer or government sponsored work programs.

c. Evaluate the influences of **external activities and habitat alterations** on aquatic resources such as fisheries, water quality, and mussels.

d. **Partnerships** with local school groups, agricultural agencies, environmental groups, and water quality assessment programs can be made. They can provide powerful means for long-term conservation of mussel populations.

e. Include **host fish species management** in the development and implementation of fisheries management plans.

f. Implement integrated pest management to reduce or even **eliminate pesticide use**. (Jennings 18,19)

6.5. Special Initiatives and Questions

The Lakelse area has many parks at which are many **informational bulletin boards**. Meetings could be held at these parks to discuss in and educate the residents and visitors on the topics of water quality, reed beds, and fresh water mussel conservation. Also, **pamphlets** on these topics could be available at these bulletin boards.

At one time, Coldwater and Hatchery Creeks both had **hatcheries** and had the capacity to produce, respectively, four million and 15 million sockeye fry annually. If these hatcheries could start up again, the fish populations would increase and therefore host fish populations would increase and mussel populations would increase.

The issue of **water quality** at the lake is another important question in freshwater mussel management. Currently, as residences are without a community sewer system, overwhelmed **septic tanks** during high water events allow nutrient release into the lake. This discharge causes an increase in the phosphorous in the lake water.

Phosphorus can be stirred up from bottom sediment by wave action . Reed beds are the lake's natural way of dampening these waves. If oxygen levels ever get to zero, phosphorus can be drawn from sediments into the water column. This adds greatly to lake fertilization and increases the growth of the invasive weed, *Elodea*. (Lakelse Watershed Society, **Phosphorus.**)

The input of nutrients into Lakelse Lake from septic systems is related to high water tables, flooding events, and development densities. According to the ***Lakelse Lake Zoning Bylaw No.57***, housing density will be able to be increased if community sewer systems are installed:

a) One Single Family Dwelling and One Guest House can be placed on a 5000 m^2 lot on septic system and a 1660 m^2 lot if there is a community sewer system.
b) One Two Family Dwelling and One Guest House can be placed on a 6000 m^2 lot on septic system and a 1660 m^2 lot if there is a community sewer system.

The **density of residential use on septic systems** is directly affecting water quality in Lakelse Lake and the freshwater mussel populations. With the installation of a community sewer system and potential increases in residential density along the shoreline, this impact may be replaced by increased sedimentation and destruction of the shoreline.

6.6. Recommendations

Rob Brown, who is an avid fisherman in the Lakelse River and a long-time conservationist in the Terrace area, was consulted and the following are his list of recommendations for management of the Lakelse watershed and resident mussel populations:

a.**Reduce rate of development** and **clean up existing development**.

b. **Reduce harmful recreation** such as power boating.

c. **Limit the alterations of the natural environment by the residents on their lots** e.g. do not put in lawns right down to shoreline, destroying the riparian zone in the process

d. **Logging in Williams Creek** had a large impact on the lake, causing increased levels of sediment entering the lake. Further logging around the watershed should be limited and monitored.

e. **Limit the hauling of sand, gravel and bedrock rip-rap** to make boat launches which increases the levels of sedimentation in the lake.

f. **Do not allow dredging down the Lakelse River**; put the rocks back into place.

g. **Hot Springs contribute to eutrophication** of the lake and Lakelse River; this needs to be monitored.

For **our management** plan, some of the recommendations can be carried out immediately and others will take longer to implement. **Recommended immediate actions** are as follows:

a. Install **community sewage systems** on both sides of the lake to improve water quality.

b. **Limit motorboat activity** to the middle of lake to allow waves to dissipate before reaching shoreline in order to reduce erosion, and stir up benthic environment.

c. Limit the installation of **dike systems in alluvial fans** in order to reduce the amount of sediment deposited into the lake.

d. Limit the alterations of the **wetlands and tributaries** in the watershed.

e. Evaluate and **prevent invasive species and highly altering processes** such as logging and motorized recreation vehicles in sensitive sites near tributary streams and wetlands. Also, develop **strategic plans** to mitigate these hazardous influences.

f. **Develop a management plan** with the local community, and encourage residents and visitors to take **stewardship of the lake**.

g. **Limit the use of fertilizer and pesticides** on existing shoreline lawns to reduce phosphates entering the watershed, causing eutrophication.

Recommended long-term actions are as follows:

a.Re-introduce **reed beds** and preserve existing reed beds.

b. **Re-establish riparian zones** by reintroducing native riparian vegetation.

c. Manage and protect the **host fish**, habitat, food source, and suitable breeding grounds

d. Remove and reduce the chance of **invasive species**

e. Conduct a **baseline study** to determine the status of the mussel populations and the locations of key habitat areas. Continually monitor their status and habitat conditions.

f. **Protect and restore mussel habitat**.

6.7. Conclusions

The **species of freshwater mussels** in the Lakelse Watershed are *Anodonta kennerlyi, Anodonta californiensis,* and *Margaritifera falcata*, the Western Floater, the California Floater, and the Western Pearlshell respectively. The Floaters are found almost exclusively in the lake while the Pearlshell is found almost exclusively in the river. As filter feeders, they are excellent indicators of the surrounding aquatic environment since any contaminants accumulate in their flesh and shell and will affect them before any other organisms. They also filter out bacteria and algae from the water and excrete larger particles that will sink to the bottom for benthic organisms to utilize.

The negative impacts on freshwater mussels caused by environmental change may arise from **multiple sources**. Most often, the list of negative impacts is long and overwhelming, with no obvious place to begin management work. Managing for freshwater mussels thus requires a set of short-term and long-term goals and plans. It is also important to incorporate ideas from comparative management plans that have been initiated.

The **short-term plan** includes efforts to regulate or reduce the frequency of human activities contributing to sediment loading, water pollution, and water flow alterations at Lakelse Lake. Limiting the motor boat activity to the middle, deepest parts of the lake will reduce the amount of turbidity and suspended particles in the shallow waters that can smother freshwater mussels. Limiting the use of chemical pesticides and fertilizers on existing shoreline lawns will reduce the risk of these chemicals leaching into the water. Regulations for new shoreline development that protect existing riparian zones could also be installed.

Most importantly efforts should be taken to **educate people** on the value of mussels as indicators for the lake. If recreationalists and residents of the Lakelse area understood the importance and sensitivity of mussels, and could identify areas of significant mussel habitat, better stewardship of the lake could be achieved.

Water quality must be addressed in the short-term plan. Currently, development and residency has increased in density and transitioned to permanent use, causing concern septic tanks and septic fields on individual lots cannot handle the amount of sewage being generated. Overwhelmed septic tanks and fields allow nutrient release into the lake that compromises water quality and creates health risks.

A long-term plan consists of efforts to **restore degraded habitat and regulate external activities** that have long-lasting impacts on mussel populations or habitat. Undisturbed watershed have the ability to purify water as water travels through meandering tributaries and the wetlands, but modification to the water course and landscape impair this ability. Thus, to improve the watershed's natural ability to repair small amounts of damage from pollution and sediment loading, diking and channel modification should be cautioned and natural water course formation should be encouraged. Reed beds and riparian zone vegetation should be re-established and existing reed beds and riparian vegetation preserved. Host fish must also be managed and host fish habitat preserved. The invasive waterweed elodia must be addressed. Elodia invades mussel habitat and smothers mussels. Prevention and removal of this invasive weed must be included in the long-term plan.

Finally, a **baseline study** would be a very useful tool to identify the status of mussels in Lakelse Lake, distribution and threats to mussel populations and habitat. After a baseline study is accomplished, continual monitoring of status and population numbers of mussels to identify impacts of future development should be conducted.

Fulfillment of the elements of the short-term and long-term plans will ensure freshwater mussels will be preserved for the **next fifty years** at Lakelse Lake. Successful management includes planning for a set long-term timeframe with goals and policies to achieve such goals. In order to plan for freshwater mussels in 50 years, water quality must improve and habitat must be preserved. This not only will ensure that mussels are present in the next 50 years, but it will also ensure that Lakelse Lake is a safe, pleasant place for wildlife, residents and visitors in 50 years.

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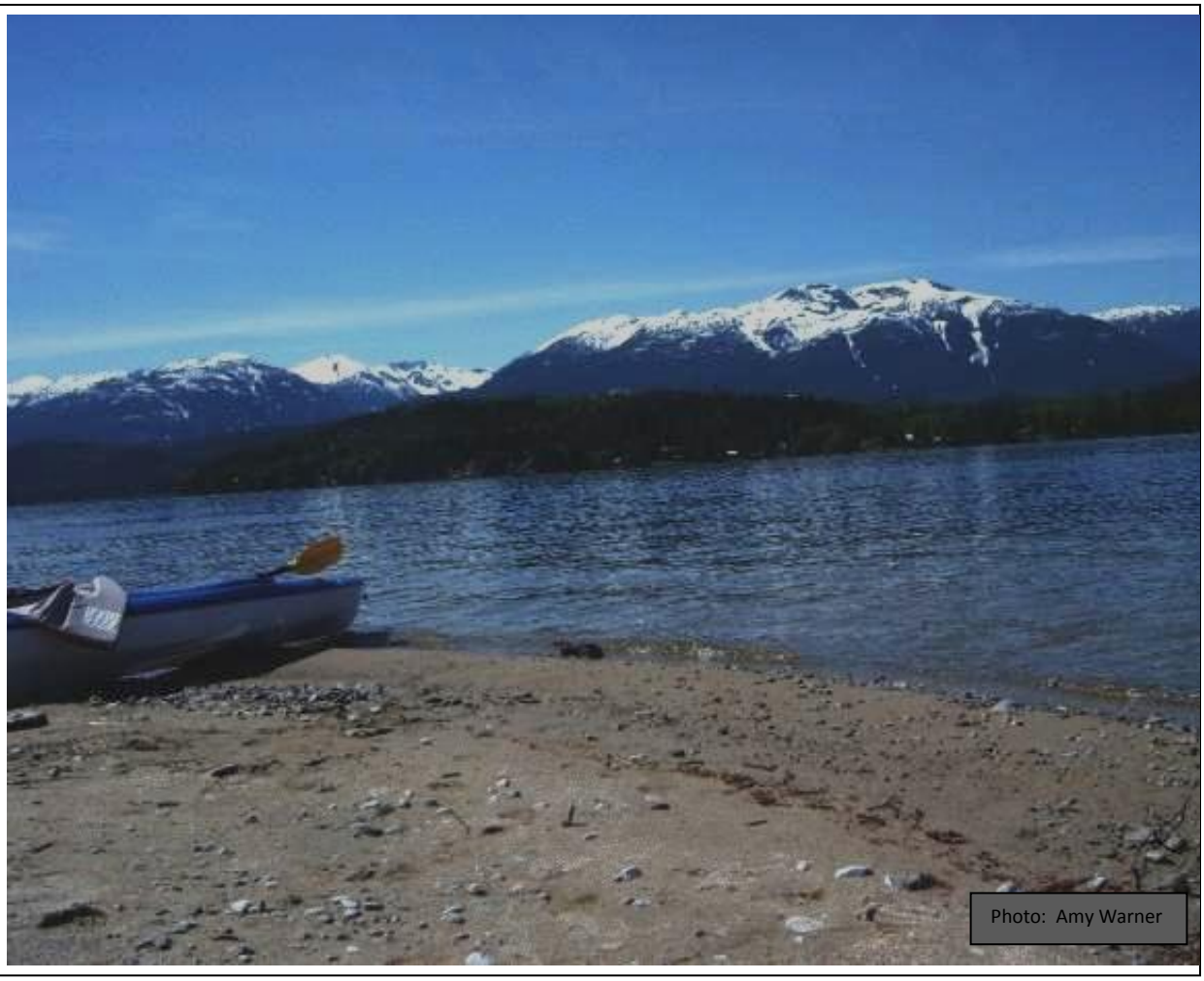
Appendices: Table of Contents



Lakelse Lake looking from east side across to Mailbox Point – outlet of lake in top left corner.

Anodonta kennerlyi /oregonensis = Clade 2
Anodonta californiensis /nuttalliana = Clade 1.

Freshwater mussels of the Pacific Northwest
Second Edition Nedeau et al 2009

Lakelse Lake Freshwater Mussel Sampling

Date	Sample	Location	Zone 09U GPS East	Gps North	Accuracy	Substrate	Lake Level: 77 Depth	Aqu. Veg.	Abundance Live	Shells	
02-Aug-09	#1	Kincamp			?	sandy/silt	3ft	none	none seen	a few	Anodonta Clade 2
02-Aug-09	#2	Maxwell's	529420	6024589	?	unknown	3ft	water moss	none seen	v.few	Anodonta Clade 2 *
06-Aug-09	#3	Kincamp	529010	6024159	?	sandy/silt	3 ft	none	"	a few	Anodonta Clade 2
	#4	SnowlBay	528256	6023609	?	sandy/silt	3ft	none	"	"	Anodonta Clade 2
	#5	Scully Cr	527681	6023148	?	sandy/silt	3ft	none	"	"	Anodonta Clade 2
	not taken	Wilfrid Pk	527631	6022927	?	sandy/silt	3ft	none	lots	none	
	#6		527631	6022895	?	sandy/silt	3ft	water moss	none seen	a few	Anodonta Clade 2
07-Aug-09	#7	Henrik's	525343	6024064	?	5"cobl/silt	3ft	none	few	"	Anodonta Clade 2
07-Aug-09	#8	Olson's	527950	6025184	?	6"cobl/silt	4ft	none	few	"	Anodonta Clade 2

* identified based on L:H ratio = 1:2, although bases remained free. A. nuttalliana (Clade 1)

From Sara Marsden, Director,
Lakelse Watershed Society
Phone 250 798-9505
e mail lanmark@telus.net

ID by Lea Golling
BC Conservation Data Centre.

Appendix 1: Mussels Samples, 2009

Appendix 2: Fact Sheet

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

BB-55 2005

Freshwater Mussels in New Hampshire: Hidden Treasures of Our Lakes

Countless species of aquatic organisms live their lives in the lakes, ponds, and streams of New Hampshire. Most dwell along the shorelines or swim in the deeper waters, contributing to the com-plex aquatic web of life. One organism, however, lives its life burrowed in the bottom sediment, almost motionless and unnoticed. This organism is the freshwater mussel, a species that has been on Earth for at least 240 million years and plays a critical role in the health of freshwater ecosys-tems.

What are Freshwater Mussels?

Freshwater mussels belong to the mollusk family, and North America is home to more species of mussels than any other place on Earth. New Hampshire alone houses at least ten species of fresh-water mussels. On average, mussels live between ten and 15 years, and, reportedly, some North American mussel species can live up to 100 years! Mussels spend most of their lives as relatively stationary filter feeders and are usually found attached to substrates or burrowed beneath the sand in cool, shallow, or moving waters. They continuously filter water through fine gills to obtain bacteria, protozoans, and other organic particles for food.

The reproductive cycle of the mussel is one of the most interesting in the freshwater ecosystem. Using a unique symbiotic relationship with certain fish species, mussel larvae attach themselves to a fish host, where they develop into juvenile mussels and eventually drop off the host. They then sink to the bottom of the water and begin to develop into full-grown mussels. This relationship has no significant negative effect on the fish host, but is critical for the survival of the young mussel.

Why are Mussels Important?

Throughout history, freshwater mussels have been used by humans as important components of tools and jewelry. Native Americans also used freshwater mussels as a supplemental food source. Although most species are edible, freshwater mussels are not as tasty as their saltwater relatives. In addition, since they are long-lived filter feeders, pollutants can easily settle and build up inside them, making them distasteful and potentially unhealthy for human consumption. However, fresh-water mussels are eagerly consumed by other members of the food chain, including raccoons, otters, and aquatic birds. Mussels also serve the aquatic ecosystem by filtering debris out of water, making the aquatic environment more suitable for other freshwater life.

Appendix 3: National Strategy

Journal of Shellfish Research, Vol. 17, No.5, 1419-1428, 1998

NATIONAL STRATEGY FOR THE CONSERVATION OF NATIVE FRESHWATER MUSSELS

Prepared by
The National Native Mussel Conservation Committee, June 1, 1997

HISTORY OF THIS DOCUMENT

On April 1995, representatives from several federal and state natural resource agencies, the commercial mussel industry (Shell Exporters of America), academia, and The Nature Conservancy met to discuss freshwater mussel declines and gather information on freshwater mussel trends, research, and recovery activities (Appendix I). As a result of the magnitude and immediacy of the nationwide threats to the freshwater mussel fauna, the group agreed that a coordinated effort of national scope was needed to prevent further mussel extinctions and population declines.

To address this need, the group decided to (1) draft a National Strategy for the Conservation of Native Freshwater Mussels (National Strategy) and (2) establish a national ad hoc committee with broad-based representation from state, tribal, and federal agencies, the mussel industry, private conservation groups, and the academic community to help implement mussel conservation at the national level. A draft National Strategy was presented at the second Symposium on the Conservation and Management of Freshwater Mussels organized by the Upper Mississippi River Conservation Committee, in St. Louis, Missouri in October 1995. Comments received at and subsequent to the symposium were incorporated into another draft dated September 16, 1996. The September 1996 draft was presented at a February 1997 meeting of the newly formed National Native Mussel Conservation Committee in St. Louis, Missouri. Comments from the February 1997 meeting have been incorporated into this current document.

STATUS AND ROLE OF NATIVE FRESHWATER MUSSELS

The world's greatest diversity of freshwater pearly mussels, nearly 300 species, reside in the continental United States (Turgeon et al., 1988). However, within the last 50 years this rich fauna has been decimated by impoundments, sedimentation, channelization and dredging, water pollution, and, more recently, the nonindigenous zebra mussel *(Dreissena polymorpha)* (Neves, 1997). Approximately 67% of freshwater mussel species in the United States are vulnerable to extinction or are already extinct; more than 1 in 10 mussels may have become extinct during this century (Williams et al., 1993; Master et al., 1998).

Freshwater mussels are a renewable resource, providing significant ecological and economic benefits to the nation. They are ecologically important as a food source for many aquatic and terrestrial animals; they improve water quality by filtering contaminants, sediments, and nutrients from our rivers; and because they are sensitive to toxic chemicals, they serve as an early-warning system to alert us of water quality problems. In recent years the annual value of shells to the mussel shell industry has been estimated at $40-$50 million dollars. The mussel shells are used in the cultured pearl and jewelry industries, and the shell harvest provides employment to about 10,000 residents, primarily in the Mississippi River basin.

CONSERVATION STRATEGY GOALS

The goal of this National Strategy is to conserve our nation's freshwater mussel fauna and ensure that the ecological and economic values to society are maintained at a sustainable level. Specifically, the purposes of this document are to (1) identify the research, management, and conservation actions necessary to maintain and recover the mussel fauna; (2) increase government and public awareness of the plight of these animals and their essential ecosystems, and garner support for species and habitat protection programs; and (3) foster creative partnerships (working and funding) among federal, state, tribal, and local governments and the private sector to restore the mussel fauna and environmental quality to our rivers.

Identification of Specific Problems, Goals, and Strategies

In order to conserve and restore native freshwater mussels, the National Strategy has identified a number of conservation needs or problems. Tasks or strategies designed to address the problems are subsequently enumerated, and when implemented, will direct the successful conservation of freshwater mussels.

The following problems, goals, and strategies have not been prioritized. The intent is to provide a list of strategies and allow each agency or organization to prioritize and choose the strategy(s) that best fits its own mission, funding, and expertise. However, Appendix II provides a list of ranking criteria to assist in ranking specific projects.

PROBLEM 1: There is no coordinated national strategy for the conservation of freshwater mussel resources.

GOAL: Increase coordination and information exchange among entities that study, manage, harvest, conserve, or recover native freshwater mussels.

SECTION 7

LAKELSE 2060

Lakelse Lake Amphibian Management Plan

by Magda Machula

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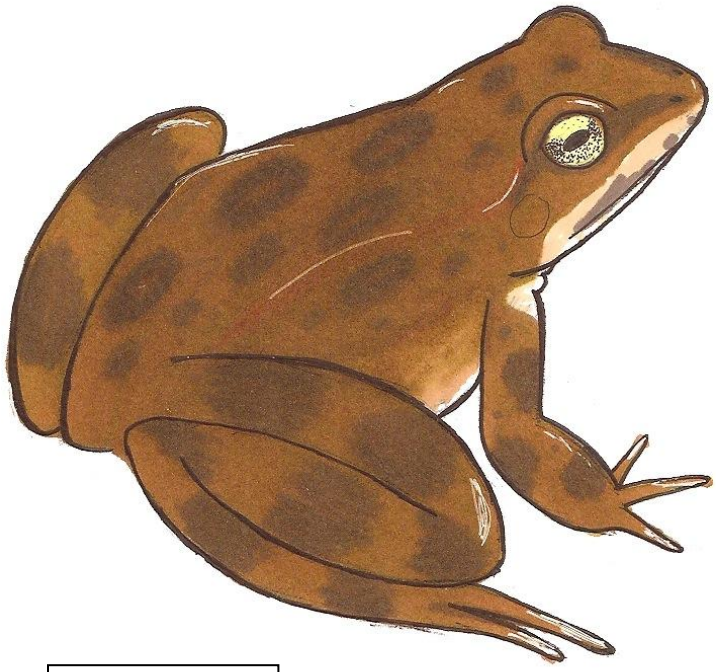
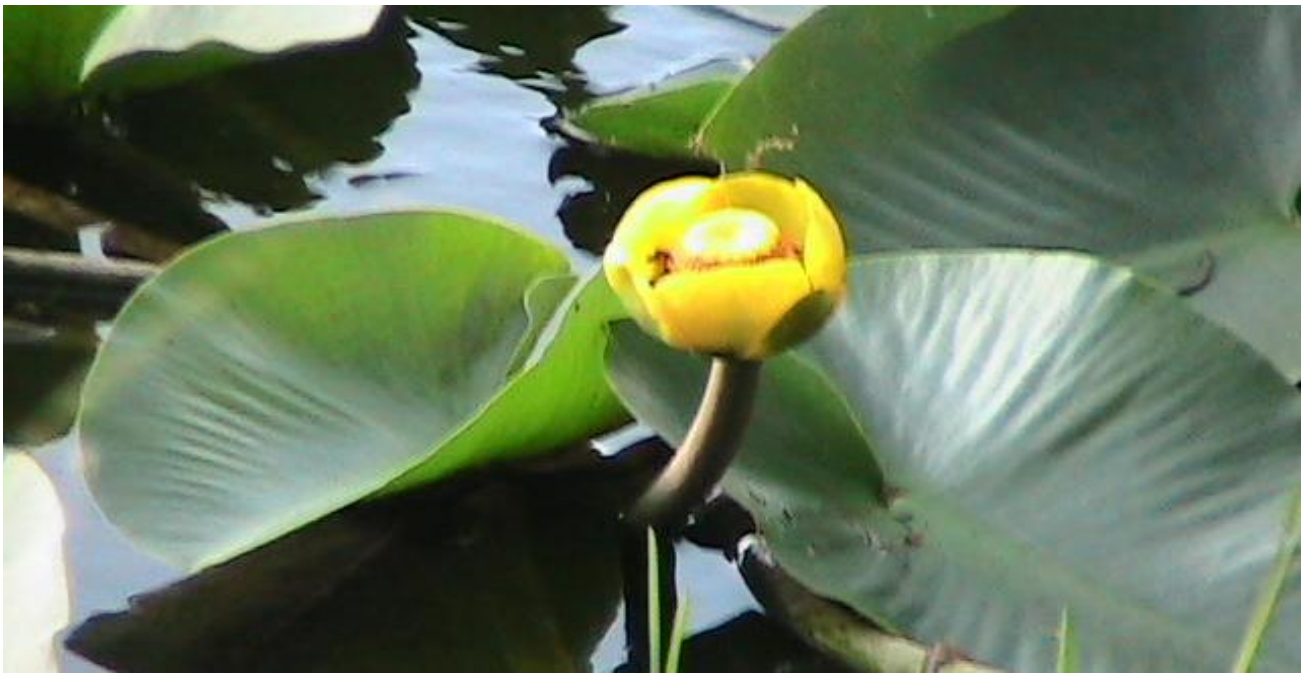


by Magda Machula

Executive Summary

The area surrounding and including Lakelse Lake has been negatively impacted by land use changes due to large amounts of residential development and industrial/transportation/utilities uses. Species at risk from these changes include the amphibians. Pollution and habitat losses may be affecting the ability of several species of salamanders and frogs to survive and could result in population declines. The effects of amphibian losses on the lake's ecosystems would be significant and could impact many other animal species, including insects, fish, birds, and mammalian predators such as fishers.

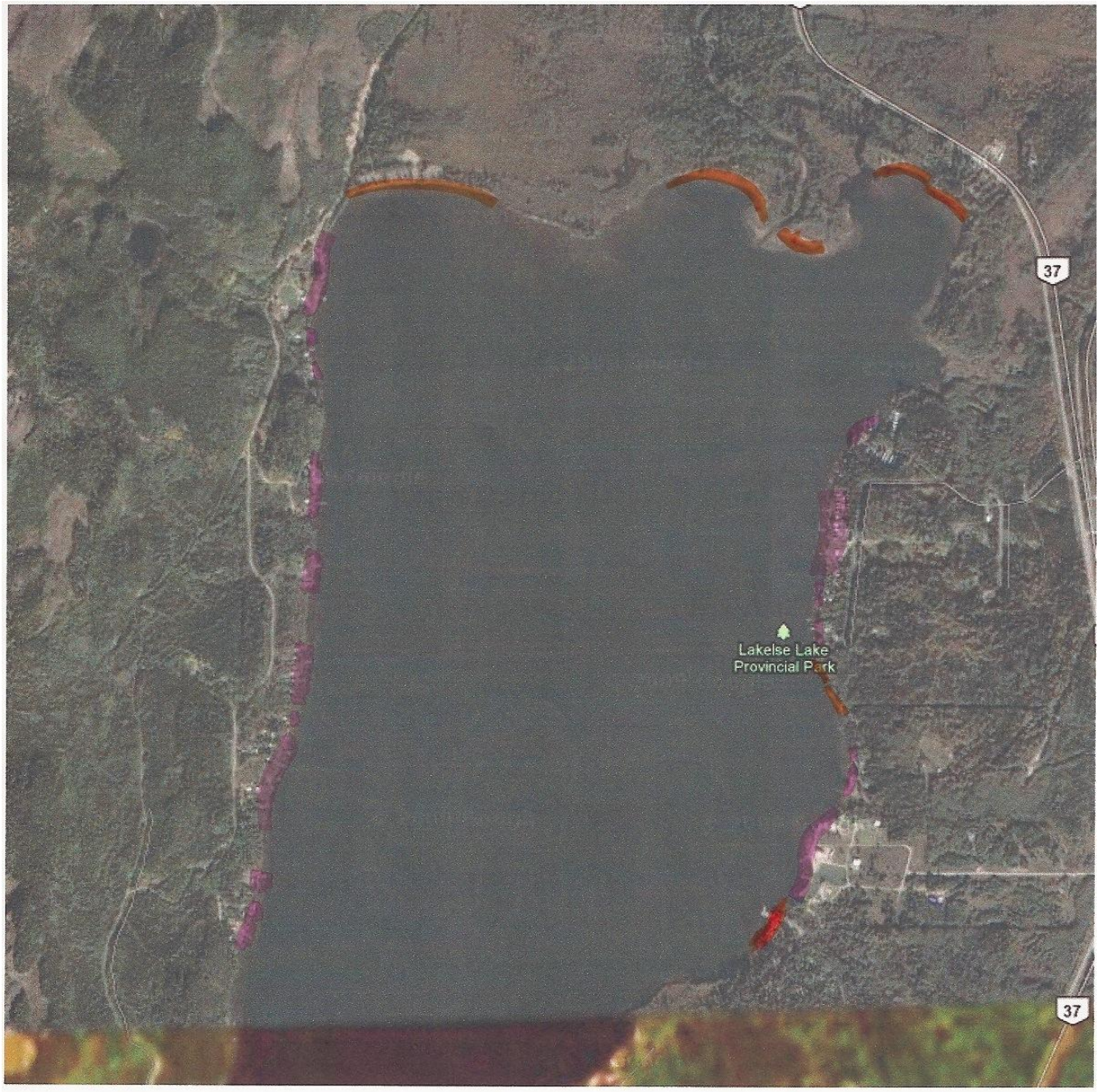
The following report will outline proper management practices in regards to amphibians. The potential impacts of a restoration plan will be covered, as well as methods needed to realize its objectives. The plan necessitates that species and habitat requirements be analyzed, and for detrimental habitat alterations and polluted areas of the lake and riparian zones to be identified. A plan of action must be made. This must include a clear vision of what needs to be achieved in order to ensure the future sustainability of the lake's ecosystems. Once the details of the plan have been established, implementation should be considered. This report includes steps to be taken, and ways in which to achieve public support for these steps. In order for the results of these projects to maintained, bylaws and regulations will need to be enforced. Planning for and restoring the aquatic and riparian areas of Lakelse Lake has the potential to ensure both the survival of amphibians plus restoration of the health of the lake into the 2060 planning timeframe.



Lakelse Lake wetlands: Waterlily (*Nuphar polysepalum*)

Photo: Magda Machula

Shoreline of Lakelse Lake showing major sandy beaches (orange) and former zones important for reedbeds and amphibian habitat (purple). Important amphibian habitat includes the wetlands north of the lake (top of picture), in the area of the clay slide of 1962 (NE corner of lake, stretching across Highway 37), the small streams in the alluvial fans of Furlong Creek, Hatchery Creek, Park Creek (Furlong Bay campground), and Hotsprings Creek, plus the south end of the lake – Lakelse Lake Wetlands Park. The west side of the lake, which was once extensive reedbeds, still has areas of important amphibian habitat e.g. Catt Point.



Lakelse Lake - www.google.ca

7.1. Introduction

Amphibian management is an important topic in regards to the health of Lakelse Lake. When working to maintain amphibian habitats, water quality, shorelines, and wetlands are important features. Poor water quality can have significant impacts on frogs, toads, and salamanders. If water is dirty, the amphibians become stressed. This may result in a deadly fungal disease which has become epidemic throughout North America. The fungal spores travel through water and latch on to frogs, invading their bodies. These fungal infections have resulted in huge declines in frog populations at some locations.

The shorelines also serve an essential purpose for amphibians. If banks become too eroded, amphibians may not be able to get out of the water. Eventually, they will succumb to fatigue and drown. A healthy shoreline also has plants and shrubs for the vulnerable amphibians to quickly hide in after leaving the water.

The presence of wetlands serves the biggest purpose in amphibian health and survival. The constant moist environment allows them to rest on solid surfaces without having to worry about drying up. The shallow areas of water also provide excellent breeding grounds for many amphibian species. An example would be western toads, which lay their eggs in shallow water. The tadpoles usually stay in the sunniest, shallow water. Other amphibians, such as certain species of salamanders, prefer deep water for breeding, so a wetland with varied water depths is the best to maintain.

Amphibians serve a very important purpose in natural ecosystems. They eat many kinds of insects, helping to keep insect population levels down in summer. They also serve as food sources for many larger animals, such as blue herons. Many of their larval stages eat algae and organic matter from the water, helping to purify it. By maintaining healthy amphibian populations, food chains can be kept balanced.

The maintenance of amphibian habitats also helps other species. Good water quality assists in keeping fish healthy, as well as people who decide to go swimming. Healthy shorelines keep the body of water from deteriorating and its banks from falling apart. A healthy wetland is not only home to amphibians, but also to many species of invertebrates, many of which need the water to reproduce and are important food for fish. Wetlands have important populations of aquatic mammals, such as beavers, and multiple species of birds.

Lakelse Lake has been suffering from deterioration and alteration resulting from its heavily developed environment. Due to its large area, there has been a lot of difficulty presented towards how to properly manage it in order to return it to a sustainable state. The topic of amphibian management is often overlooked, despite the important role that amphibians play in maintaining aquatic environments within natural ecosystems. Amphibians are essential to maintaining food chains and preventing problematic invertebrate populations. While many amphibian species are rarely seen, the impact of their losses could be devastating. Unfortunately, many amphibian species in BC are currently suffering from population declines due to poor management and contamination from urbanized areas.

Amphibians are very sensitive to pollutants and are usually the first to be affected by environmental change. Often by the time something is determined to be wrong, it is too late for many native amphibian species. To protect the amphibian populations in Lakelse Lake, a proper review of planning practices will need to be made in order to find the most efficient and beneficial way to restore the lake's natural ecosystems.

The planning processes for managing amphibians must include data for not only the amphibians themselves, but also the environment and species with which they interact. Current problems will need to be identified and assessed in order to determine how much damage lakeshore development has caused. Many people do not consider all related factors when moving forward with development projects, but a successful plan cannot be achieved unless there is a long term vision for the future. This can have huge consequences towards the sustainability of environments. Once impacted, species may not recover and may be extirpated from an area such as Lakelse Lake.

Good practices must be put into effect as soon as possible in order to preserve sensitive environments. A lost species can not only affect other native species, but people too (e.g. the loss of amphibians eating insect larvae, which in turn affects biting insect populations). The amphibians of Lakelse Lake are most likely being impacted by heavy environmental alterations. Many species are still surviving, but this may not last if the lake continues to degrade. Planning is essential for sustainability and requires careful consideration and implementation to be successful.

By incorporating amphibian health into a 50 year plan for Lakelse Lake, we would be working towards maintaining sustainable habitats for a variety of different species.

7.2. Potential Impacts

The management of amphibians in Lakelse Lake could have huge impacts towards restoring the **natural state** of its environment, as well as creating better conditions for **other species** necessary in a healthy ecosystem. The main focus of the plan is to **restore natural environments to sustainable conditions**. A healthier, less polluted and disrupted habitat would allow amphibians to survive and reproduce successfully. Amphibians that have been suffering from the impacts of pollution and improperly managed areas should recover if these issues are corrected.

However, while restoration for habitat would greatly improve living conditions for amphibians, the **impacts towards the residents and developers** would be quite different. In order to reduce pollution, many modifications to lifestyles and properties would have to be made. Poorly implemented **septic systems** leak nitrates into the water and impact amphibian health, but in order to correct this issue, a lot of work and money would be required. The Regional District of Kitimat-Stikine is in the process of a **liquid waste management plan** for the east side of the lake, which will help with this issue.

Restoring essential riparian vegetation would also impact residents, as it would requirea lot of their time. Gaining their co-operation is another issue: many residents may be resistant to giving up their lawns or private beaches for replanted vegetation.

Although it would take a lot of hard work and negotiation, the end result would be a beautified and healthy Lakelse lake. By **restoring the wetlands, water, and riparian zones**, the lake's image would greatly improve. This could please residents who moved to the lake to enjoy its beauty, as well as attract more people to come and see it. Lost money could potentially be returned by people coming to visit the clean, natural environment at Lakelse Lake. While amphibians would thrive, so to would the **native vegetation and other species** which rely on it. The final outcome would be an environment where not only native species would be able to thrive, but where people could learn to enjoy the potential beauty that this lake has to offer.

7.3. Recommendations

There are many requirements in order for this plan to realize its objectives. The first step to any ecological planning process regarding wildlife species is, as stated by the Ministry of Water, Land, and Air Protection, "dependent upon **an understanding of their range and distribution, as well as their habitat requirements**" (Ministry 5). The second step is to determine where **critical habitats** are and map them out so that they can be incorporated into future planning documents (10). This can ensure that these areas will be considered and protected from any damage caused by future development.

Once the issue of future development damage is addressed, the problem of **local residents** arises. Many lack knowledge of amphibian significance and their roles in the environment. For instance, amphibians are important components in the food chain, serving as both predators and prey; they eat large numbers of insects, helping to reduce invertebrate populations and pests. They are also very important ecological indicators as they are some of the first species to be affected by pollution. In order for residents and users to understand this, and to improve future consent to restoration attempts, more emphasis needs to be placed on **the importance of amphibians**. **Education programs** would teach people the importance of amphibians and how people are impacting their habitats. It would provide them with information on why not to clear shorelines, how to reduce damage, as well as discourage the use of motorized vehicles, especially boats, in sensitive wetlands areas. Hopefully, with this knowledge, many residents would be supportive of future restoration attempts .

Important **government acts** can also help to ensure amphibian safety. The **Species at Risk Act** is relatively new, and its purpose is to provide protection for species and critical habitats that are listed as threatened or endangered e.g. the tailed frog. The second act is the **Wildlife Act**, which protects all wildlife including amphibians. The third is the **Local Government Act**, which gives Regional Districts the ability to create **stewardship bylaws**. North Vancouver has already taken advantage of this and has bylaws stating that natural areas must be conserved (Ministry 5-6).

Proper identification and maintenance of habitats, education of local users, and the consideration of government acts are factors that must be put into place if the Lakelse Lake amphibian habitats are to be conserved. There are also many small details and projects that should be considered, as well as a lot of careful planning in order to fully realize the goals that we are trying to attain. The following pages contain a **proposed Amphibian Management Plan** for the Lakelse area.

7.4. Lakelse Lake Amphibian Management Plan

Lakelse Lake is experiencing habitat degradation, which is now threatening the survival of the extremely sensitive amphibian populations. A plan of management must be implemented if we are to give them a chance at survival even 50 years into the future. An effective management plan will require careful steps and must follow proper planning procedure practices. The first step should be data gathering. This can include species identification, habitat requirements, and concerns.

7.4.1. Biology of Amphibian Species

There are several amphibian species that frequent the Lakelse Lake area. Most of the listed amphibians are on the Yellow list, which includes species that are not facing any immediate threats and are managed at an ecosystem level. The Tailed Frog, however, is on the Blue list, and has been placed on the status of Special Concern (Frogwatch, 2010). The following list gives a detailed description of each amphibian's characteristics and habitat requirements, as well as any threats to their populations, not only in the Lakelse Lake area, but also in other regions of B.C. (Frogwatch, 2010; Green & Campbell, 1984; E-Fauna of B.C., 2010).

a.Columbia Spotted Frog

Status: Yellow list
Protection: Wildlife Act
Description: Olive, tan, light brown, or reddish brown in colour with light centred black spots on its back. Can be easily mistaken for Red-Legged Frogs due to the orange markings on their legs and lower belly.
Food: Adults mainly feed on invertebrates, especially insects, and earthworms. Juveniles feed on algae and detritus (E-Fauna of B.C.).
Habitat: Spotted frogs live in marshes, permanent ponds, lake edges, and slow streams where aquatic vegetation is abundant and shallow, warm water available (Corkran 104, E-Fauna of B.C.).
Concerns: Many populations have disappeared due to development and invasive species (mainly due to bullfrogs, though they are not a concern at Lakelse Lake) (Corkran 103). Eggs also tend to be laid in a single spot, which can result in the destruction of an entire generation if something happens (E-Fauna). The frogs also take a long time to become sexually mature, making them especially sensitive to population disturbances (Frogwatch, 2010).

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Columbia Spotted Frog – common lake frog of interior B.C.; lives where there is shallow, warm water; slow to mature; lay egg masses in single clump; adults feed on insects and earthworms.

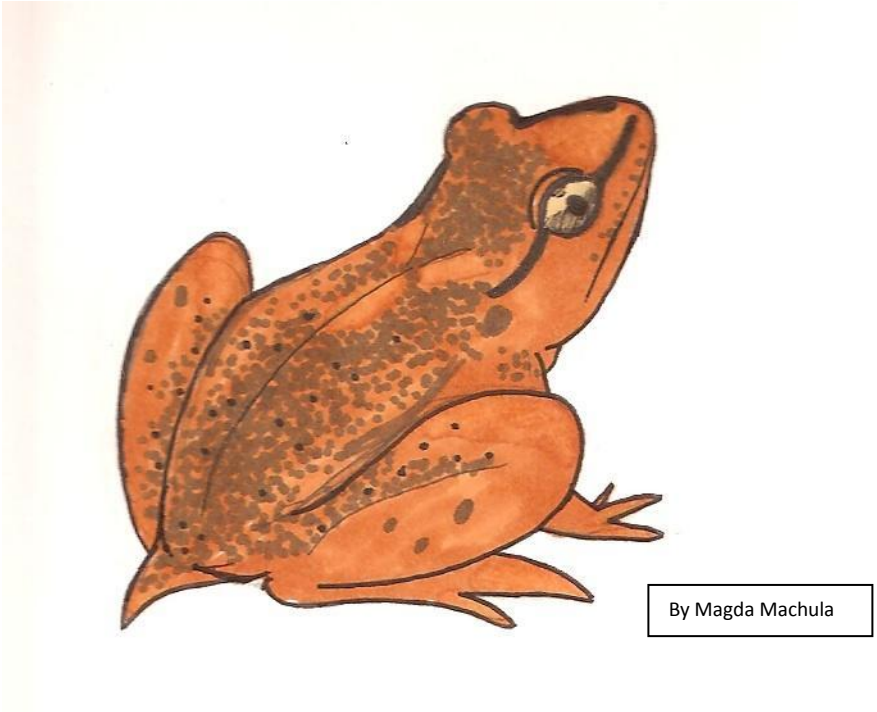
b. Wood Frog

Status: Yellow list
Protection: Wildlife Act
Description: Small to medium sized frogs with body sizes of 5-6 centimetres. They have a black mask running behind their eyes and come in tan, grey, deep brown, blue-green, or distinctly red, usually with dark spots on their backs. Some may have a white stripe on their back instead. All individuals have white, mottled bellies. Adults eat insects, worms, snails, millipedes, and other small invertebrates. Tadpoles are herbivores and eat algae and plant material (Frogwatch, 2010).
Habitat: Live in wet meadows, riparian areas, and moist brush or wood. They breed in shallow ponds, seasonal pools, and slow parts of streams when the ice is beginning to melt. Wood frogs are well adapted to cold climates and are the only North American amphibian to live north of the Arctic Circle (Corkran 106-107)
Concerns: Currently not in any risk (Frogwatch, 2010).

Wood frog – common small frog of forests and wetlands; black mask passing behind eyes; white mottled bellies; breed early in spring; adults eat terrestrial insects and other invertebrates; tadpoles live in shallow water; species adapted to cold climates**.**

c. Tailed frogs

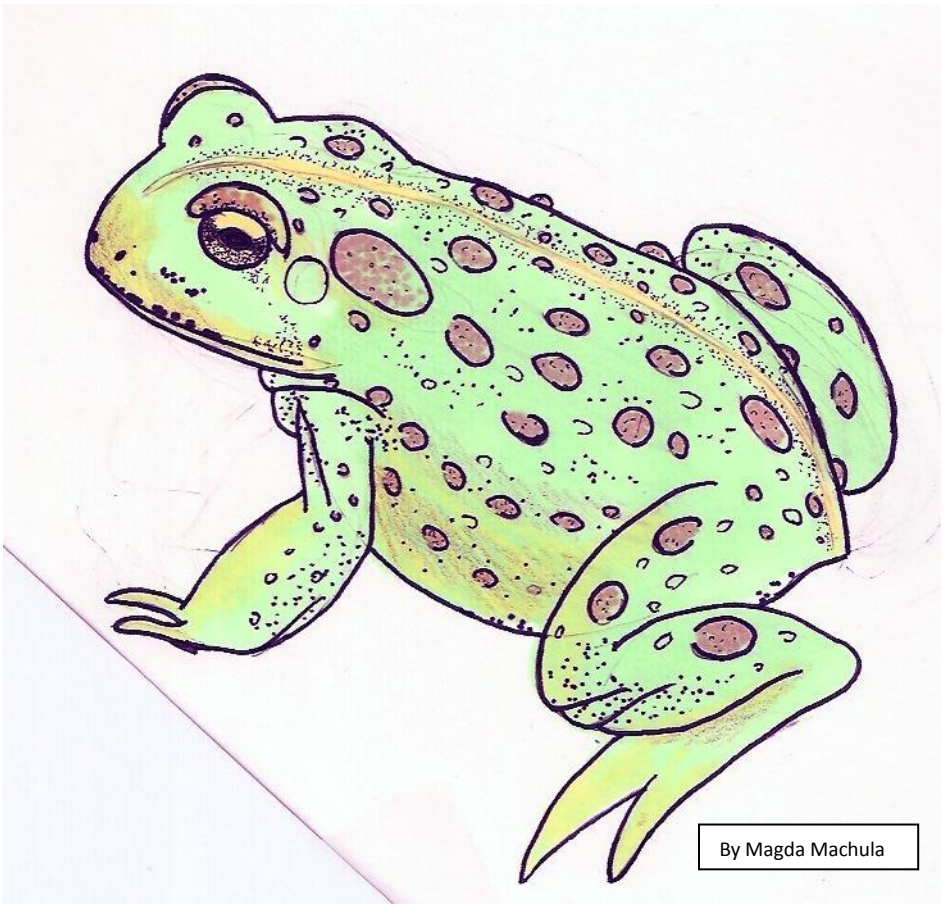
Status: **Blue list**
Protection: Wildlife Act; Species at Risk Act
Description: Tailed frogs are very small (40-50mm) with a large head and a short tail found on adult males that is used in copulation. Fertilization is internal and females lay 35-100 eggs each in clear, cold streams in mid-summer. Development from the larval stage can take multiple years, and the frog's overall life span can go up to 15 years. Larvae eat diatoms and adults eat insects and other invertebrates (E-Fauna of B.C.).
Habitat: Tailed Frogs like cold conditions and are found in cold, fast flowing streams. They prefer clear water with some boulders and small rocks. They require forested, shady areas for maintaining the cold water temperatures. Tadpoles are usually found on the underside of rocks. Adults can occur on stream banks, under gravel, or in rotted logs in the forest. The adults may come out at night or in wet weather (Corkran 80-81).
Concerns: Due to their slow development cycle, Tailed Frogs are extremely sensitive to environmental damage. Logging and development can cause silt and debris to fall into the streams, clogging up crevices between rocks, making it difficult for tadpoles to cling, avoid predators, and forage. Clearing of forests is also a concern as it opens up the forest and warms up the cold streams that the Tailed Frogs require (Frogwatch, E-Fauna of B.C.).



Tailed Frog: rare species, blue listed; very small frog from 4 to 5 cm long; requires clear, cold, fast flowing streams without damage from logging; very slow development rate – tadpoles can take more than 2 years to metamorphose to adults; species is very susceptible to habitat disturbance.

d. Western Toad

Status: Yellow list
Protection: Wildlife Act
Description: Western Toads have short limbs and rough, warty skin. They come in green, grey, dark brown, and red and have pale bellies. Located behind their eyes are a pair of glands used to produce toxin. The toads breed in communal breeding sites in spring and lay long strings of eggs wrapped in vegetation. They can lay up to 12,000 eggs which hatch in 7-10 days. Tadpoles develop in 6-10 weeks and emerge in masses in the summer. Adults feed on insects and invertebrates and tadpoles feed on aquatic plants and algae (E-Fauna of B.C.).
Habitat: Western Toads live in a variety of forested, brush, and mountain meadow areas. They like ponds and shallow lakes for breeding. The tadpoles live in the shallowest, warmest water available. Toadlets can be found under rocks near ponds, while adults usually live underground, under large debris, and in grass and brush. During dry periods, they may occur along ponds and streams (Corkran 86).
Concerns: Populations have declined, and ultraviolet light and the spread of an egg fungus may be the cause (Corkran 85). Other causes may be damage to breeding sites, the vulnerability of toadlets to people and roads, and habitat loss and fragmentation (E-Fauna of B.C.).



Western Toad – common toad of the forest and wetlands; breed in shallow water; tadpoles rear in shallow, warm water; toadlets emerge in large numbers in summer and are vulnerable to harassment and death on roadways; western toads are important in terrestrial insect control.

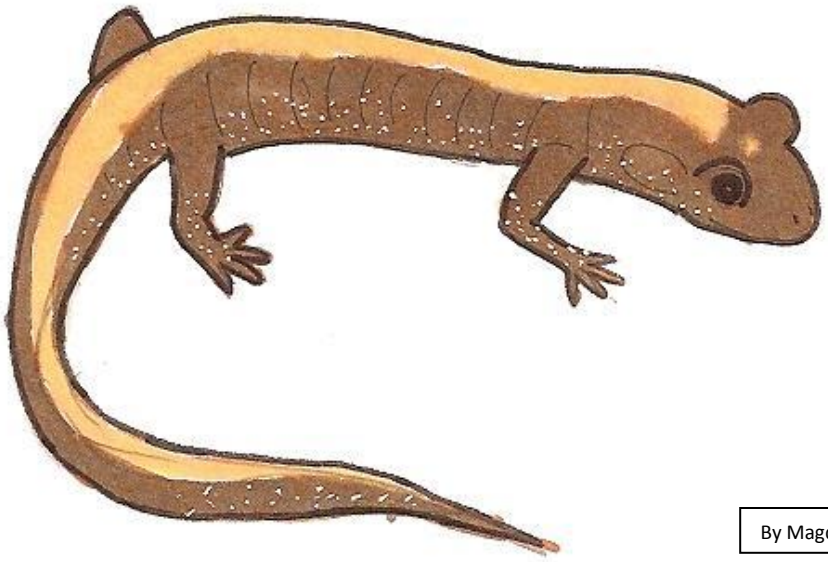
e. Northwestern Salamander

Status: Yellow list
Protection: Wildlife Act
Description: Large and dark brown in colour. Poison glands are located behind the eyes and are presented when the salamander feels threatened. This salamander can be neotenic, reaching sexual maturity while still retaining larval characteristics such as gills. Both larval and adult stages are carnivores, eating a wide variety of invertebrates (Frogwatch, 2010).
Habitat: The Northwestern Salamander lives in moist forests and partly wooded areas. They breed in permanent ponds, beaver ponds, and stream backwaters that have a water depth of 0.5m or deeper. Hatchlings will live in surface sediments or under small debris. Adults live underground and come out during rain or at night (Corkran 37).
Concerns: Although they are elusive and hard to find, they are not facing any threats at this time (Frogwatch, 2010).

Northwestern Salamander: brown salamander of forested and mixed wooded areas; have poison glands that discourage predators such as cats and dogs; breed in pools deeper than 50 cm; adults live under logs and debris and emerge only in wet weather or at night; adults live on terrestrial invertebrates

f. Long-Toed Salamander

Status: Yellow list
Protection: Wildlife Act
Description: Dark grey or black skin with a yellow stripe running down its back. It has poison glands on its back and tail which secretes poison when it feels threatened. They can have white speckles on their sides and belly. Both adults and larval forms are carnivores, and eat a wide variety of invertebrates. (Frogwatch, 2010),
Habitat: Long-Toed Salamanders live in wet, coastal forests, cold mountain meadows, grassland, woods, and disturbed areas. They breed in newly formed or recently disturbed pools of water and are the earliest species to breed each year. They usually breed in water less than 0.5 m deep. Hatchlings live in surface sediments or rocks and logs in shallow water. Juveniles can be found under rocks at the edges of ponds in mid-summer. Adults live underground in organic debris or under logs and rotting wood. (Corkran 40)
Concerns: Although they can be affected by habitat fragmentation, water pollution, and forestry Practices such as clearcut logging, Long-Toed Salamanders are currently doing well. Their ability to breed in recently disturbed ponds makes them more adaptable to disturbances than other amphibians. (Frogwatch, 2010)



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Long-Toed Salamander: common salamander in wet, cool forests and cold meadows; adults live under organic debris and logs and eat a variety of invertebrates; breed in recently formed pools or disturbed water accumulations less than 0.5 meters deep; sensitive to forest harvesting practices; have poison glands which reduce predation.

7.4.2. Habitat

The main features of amphibian habitats are aquatic areas. All amphibian species in this region have **aquatic larval stages**, so a reliable water source, whether from surface runoff, groundwater, or topographic drainage accumulation, is of extreme importance. Amphibians also require an abundance of **moist areas**. Many amphibians **respire through their skin**; if their skin dries out, they die (Ministry 4). Amphibians also require sufficient temperatures, which is usually **warmth**. Both Wood Frogs and Western Toad tadpoles require warm, shallow waters for development. But there are some exceptions: Tailed Frog tadpoles thrive best in cold water. If a change in the environment occurs, it could change surrounding temperatures, threatening species survival.

Amphibians must have enough food. As their **diets consist primarily of invertebrates**, their habitats must have an abundance of them. One of the most essential aspects of an amphibian habitat is the **amount of cover available**, both for the amphibian and for its invertebrate prey. These areas include riparian vegetation and coarse woody debris complexes in forests (Corkran 26). Cover provides amphibians with shelter from hungry predators, but it also serves to help the environment to retain moisture, prevent erosion, and filter out contaminants from things such as highway runoff. Without vegetation, amphibians would be **vulnerable to predators and drying out**. It should also be noted that many amphibians have **small home ranges**, and may be unable to move to new areas. Thus disturbances to their current occupied areas could compromise their survival. The amphibians will often remain exposed to contamination for long periods of time, leaving them with little chance to escape alive (Ministry 4-5). Lakelse Lake has much to offer in respect to amphibian habitat. Unfortunately, the current health of the lake is in decline.

7.4.3. State of Lakelse Lake

There are many concerning factors with the current state of Lakelse Lake. Much of the land has been heavily developed for residential and recreational use, as well, many uplands areas have been subject to clearcut logging. As a result, many **areas of critical habitat** have been altered or destroyed. Some of the most concerning factors include the following.

The first is the **loss of natural shorelines**. Many shorelines around Lakelse Lake have been cleared or ploughed down by residents and/or other activities. Looking at satellite maps, many properties can be seen as having **cleared areas or lawns running right to the lake shore**. This has destroyed much of the native vegetation along the banks. Without vegetation, the banks become very susceptible to **erosion**. This can further deteriorate the shoreline, resulting in steepness or a surface no longer suitable for vegetation growth. **Steep banks**, even 50 to 100 cm high, can result in amphibians being unable to get out of the water; eventually they may **succumb to fatigue and die**.

Erosion may also lead to **increased siltation and sedimentation** in the water. This can damage amphibian eggs and clog up the gills of tadpoles (Ministry 36). Streams and creeks that flow into Lakelse Lake are experiencing human alterations resulting in bank erosion and increased amounts of sediments being washed downstream. This is not only potentially impacting amphibians down in the lake, but also Tailed Frogs who reside within the cool, fast flowing waters of some of the tributary streams. Bank erosion can also **change water flows** resulting in permanent or premature water drainage from alluvial fans and essential breeding spots.

Vegetation loss can have one of the most extreme impacts towards amphibian populations. Forests and riparian zone vegetation provide cover, and without it, amphibians are vulnerable to predation and moisture loss. Vegetation loss can also cause temperature increases, which can threaten species which require cooler environments, such as Tailed Frogs (Ministry 8). The **density of housing** around the lake has resulted in heavy modification and removal of native vegetation around the shorelines (see page 20).

Pollution may be impacting amphibians in the lake as well. Amphibians are **extremely sensitive to pollutants** due to their permeable skin and eggs, as well as their long exposures to both aquatic and terrestrial contamination. They can easily become ill or die from too much pollution in their environment (Ministry 35). Some of the most harmful pollutants include **salts, heavy metals, and nitrates**. Salts cause habitat deterioration and can affect an amphibian's ability to breathe. Salts can enter the water from road run-off (Ministry 38). Lakelse Lake is close to the highway, so salt concentrations may be a factor, especially in the marshes and riparian areas near roads.

Heavy metals are highly toxic, and have been found to accumulate in amphibian skin tissue (36). However, heavy metals in Lakelse Lake are shown to not be at any dangerous levels according to the 2004 statistics prepared for the Lakelse Lake Watershed Society by Julia Kokelj (3.4.4). **Nitrates are toxic** and can result in behavioural and developmental issues, such as reduced growth, deformity, paralysis, and death (Ministry 37). Nitrates come from animal wastes, fertilizers, and liquid effluents from septic tanks, and may be accumulating in Lakelse Lake due to the poorly implemented septic systems in residential areas. According to the 2004 statistics, nitrate levels met standard guidelines, however, elevated levels were noticed in certain areas such as the Provincial Park Creek outlet (Kokelj 3.4.3).

Habitat fragmentation is another factor. Breaks in habitat cover make it difficult for amphibians to **reach breeding grounds** and **escape unfavourable conditions**, creating isolation and inbreeding. Due the heavy development within the Lakelse area, it is almost certain that the wetlands and water bodies have been fragmented. An example can be seen on Highway 37 near the Provincial Park picnic site, where the large swamp branching off the lake is cut in half by the highway.

A final concern for Lakelse Lake is the issue of **harassment**. Lighting and noises from recreation areas and vehicles can **disrupt mating courtship and impact breeding**. The lake is surrounded by recreation facilities and private properties, most of which are likely to produce noise and light. Another problem is **lack of education** about amphibians. Many people are unaware of how to handle amphibians, and the poor creatures can often become injured or die from rough handling and stress. Children taking tadpoles or even adult amphibians home is another issue, as it places the amphibian under stress or in life threatening conditions (Ministry 48).

7.4.4. Impacts of Amphibian Loss

Although no immediate concerns towards amphibian populations have been presented at this time, if conditions are left as is, they could experience substantial population declines. The impacts of amphibian losses could be devastating, and would result in long term effects to the lake's ecosystems and users. **Amphibians play a vital role in the food chain**, as they are **prey** for many larger carnivorous species, such as herons, garter snakes, and foxes. Their larvae are prey for a large number of bird and fish species and invertebrates such as dragonfly larvae. Amphibians also serve as important **predators for invertebrates**. Their loss would not only reduce a food source for the predators, but also cause insect populations to spike, resulting in a large number of unwanted pests.

Amphibians also serve as very important **ecological indicators** due to their sensitivity (Ministry 10). They can often indicate when something is wrong with the environment. Without them, pollution may not be able to be detected until less sensitive species begin to die, after which it may be too late.

7.4.5. Lakelse Lake Amphibian Management Plan

1. Gather data

The first step in the planning process is to gather data. In the case of amphibians, **current populations** must be determined, as well as **critical habitats** located. Data should be collected on how much habitat has already been altered and deteriorated, and how much of this has already affected populations, as well as what may affect them later. Amphibian habitat restoration programs have been implemented in the past, but many were designed without the knowledge of the species **specific habitat requirements**. This has often led to the establishment of non-native species after restoration efforts (Corkran 26). It is very important that any planning for amphibians in the Lakelse Lake watershed has all the data and habitat requirements for its native species.

2. Define a Clear Vision and Set of Goals

Next, a visualization of what the planner is trying to achieve must be made. In the case of amphibian management in Lakelse Lake, this should be a **clear vision and set of goals** defining the environmental health necessary for the lake in order to sustain amphibian populations and which factors are required for an ecologically healthy lake. For this plan, this would the **2060 vision** – what we believe Lakelse Lake should be like in 50 years in order to sustain healthy amphibian populations.

3. Realization

The next step is the **creation of a management plan** that will realize the vision. The most critical issues should be the first things considered. For Lakelse Lake, this would include:

a. shoreline and riparian zone repairs,
b. determining how much area needs to be preserved in order to sustain amphibian populations,
c. the replacement of septic systems with cleaner community sewage systems,
d. education for residents and recreation users on how to minimize their impacts on amphibians and amphibian habitat,
e. implimentation of long-term regulations and enforcement for maintaining amphibian populations and habitat.

4. Monitor the Success of the Management Plan

It is also important to make predictions and monitor the **outcomes and impacts of the plan**. This can help formulate a plan that will cover what needs to be done and avoids problems that could arise. Revise the plan to meet emerging needs.

7.4.6. Implementation of the plan

Once all the required data has been gathered and planning practices and ideas reviewed, it is time to implement the plan. A plan for providing protection, for not just one species, but multiple species, can be tricky, and can require a lot of work and funding in order to be fully realized. There is also the problem of public acceptance of the management plan. It is important that all stakeholders buy into processes and be committed to long term goals of maintaining amphibian populations and habitat.

a.Education

The first step in the plan must be to **educate** the people and teach them why amphibians are important and what ecological impacts would result from their losses. The first step towards educating the public would be to make amphibians more known. This could be achieved through pamphlets and public presentations. Emphasis should be placed on making amphibians more recognizable and alerting the public to the impacts of their losses, such as increased mosquito populations. Elementary schools could also place more focus on teaching students about amphibians. Many children inadvertently harm amphibians with poor handling or by taking buckets of tadpoles or adult amphibians home. Teaching young people about how to properly treat amphibians could prevent this from happening. By involving the public and having them understand the situation, acceptance of future projects protecting amphibians and amphibian habitat could be increased.

b. Habitat Restoration and Water Quality

Once people are made aware of amphibians and their importance, major priority projects can be discussed, such as **habitat repair and water quality improvement**. Habitat restoration includes **re-establishing ecological processes and habitat features** that have been altered by people (Ministry 18).

The main habitat features that need restoration in Lakelse Lake are the **shorelines and riparian zones**. Implementation for these projects could include either gaining residents' permission to restore land on their property or encourage residents to repair their shorelines. They could be asked to replant native riparian vegetation, which could be provided to them. Also, benefits could be provided for residents who choose to help, creating a stronger initiative to make a change.

Developers could be given tax breaks for putting amphibian habitat into consideration, such as creating **buffers and corridors** to allow them to travel (Ministry 10). All new developments should also be given **setbacks** to prevent them from modifying shoreline areas. **New ponds** placed strategically could be created in heavily developed areas to allow for easier amphibian movement to new areas, reducing isolation and inbreeding (Ministry 19).

Other fragmented areas could be corrected with proper **corridors and passageways** around and through developed areas. **Bridges** should be used for trails, roads and highways that cross water bodies of any size instead of culverts, as culverts often discourage species from passing through. The marsh along Highway 37 in the NE corner of the lake is split with a culvert running under it. A bridge in this area could be beneficial (see Section 7.5).

Logging practices by companies should also be restricted so that no logging would be done close to frog-bearing cold, clear-flowing mountain streams in order to preserve **Tailed Frog habitat** and reduce increased sediment build-up in the lake.

In order to improve **water quality** in the lake, factors that allow pollutants to enter the lake would need to be corrected. For example, one major source of pollution is **highway run-off**. In order to reduce contamination from roads, **densely vegetated buffer zones and porous pavement** are some of the ways in which run-off contamination could be reduced. The porous pavement reduces the amount of water running off the road and vegetation serves to filter out contamination (Ministry 20). The correction of nutrient level problems would require heavy restrictions to be placed on **fertilizer and pesticide use**, as well as an implementation of **proper community sewage systems** for both sides of the lake. The Regional District of Kitimat-Stikine is presently proceeding with a Liquid Waste Management Plan for a portion of the east side of Lakelse Lake, dependent upon funding.

c. Motorized Vehicles and Harassment

Once the habitat restoration projects are addressed, other projects could be considered. These include **restrictions on motorized vehicles in sensitive areas** and reduction of factors that lead to **harassment**. Motorized boats should be strongly discouraged in sensitive wetlands and watercourses, such as the Lakelse Lake Wetlands Park. A ban altogether of motorized boats from shorelines and wetlands would only result in conflicts with lake users, but benefit programs, or promotional events and campaigns for people who use traditional boats could be made. This would hopefully encourage more users to use non-power boats in these areas.

The problem of **harassment** could be corrected by determining the times when amphibian species court each other and regulating recreational usage in critical habitat areas during these times. **Restrictions on noise and lights** during mating times, as well as temporarily keeping the public away from prime mating areas, could address these issues.

d. Habitat Protection

In order to prevent the further destruction of remaining habitat areas, protection bylaws need to be implemented. The **Local Government Act** has the power to create bylaws for land protection. In North Vancouver, a bylaw stating to "preserve and conserve our natural setting and ecological systems of watercourses, trees, soils, lands and visual assets" has been implemented, and serves to reduce impacts made to species habitat due to development (Ministry 6). In the Lakelse Lake area, a **bylaw** like this could be implemented to provide protection as well. However, public support would be required, which is what the education programs are designed for.

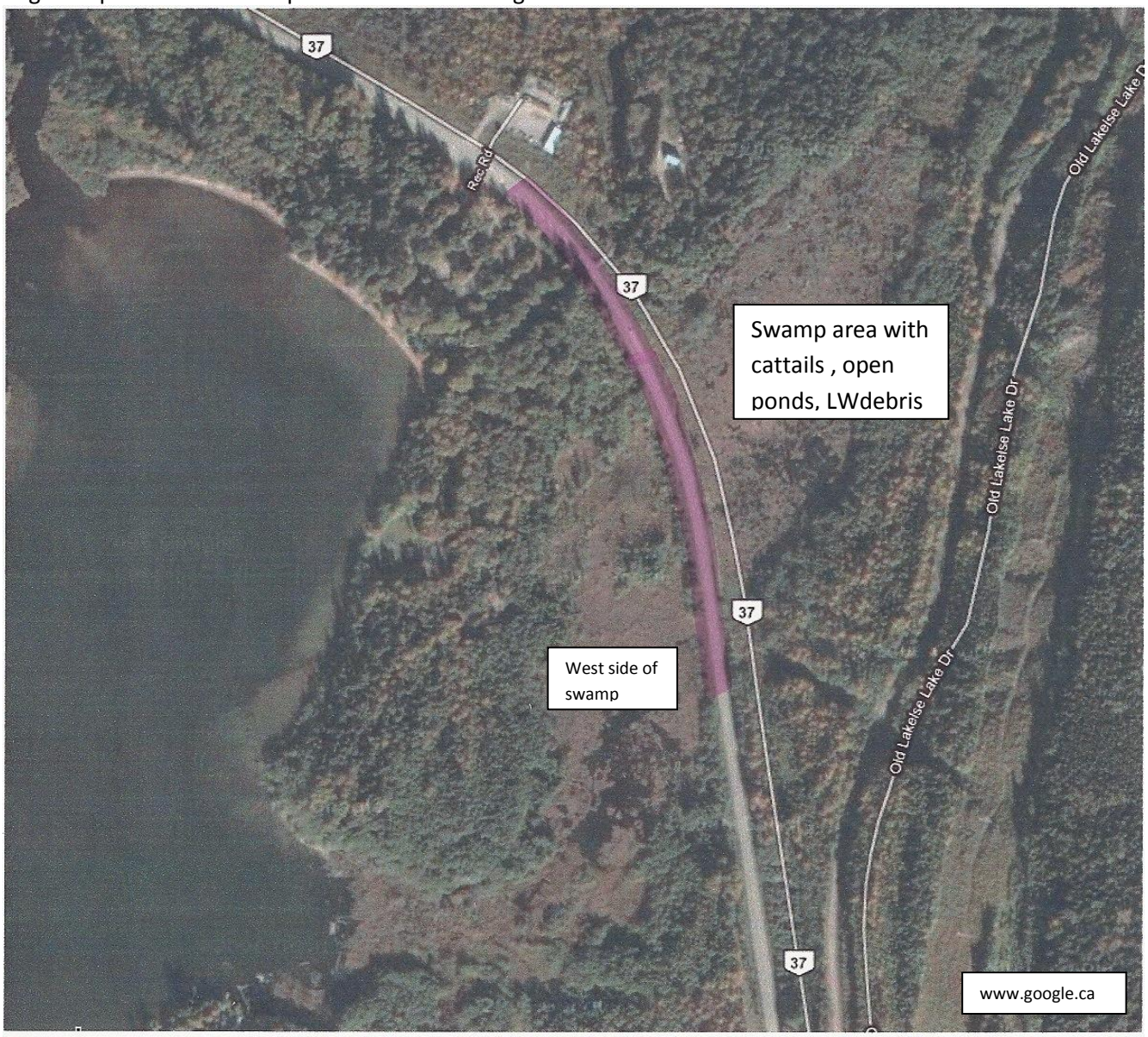
In order for new bylaws to be followed, **enforcement** needs to be established, and frequent surveys by enforcement officers are required. Acts such as the **Species at Risk Act** and the **Wildlife Act** could be used to help with enforcement. The Species at Risk Act is a relatively new Act developed to protect "individuals, residences, and critical habitats of those species listed as endangered or threatened". On Federal land, protection can be placed on areas that have been identified and officially approved. The B.C. Provincial Wildlife Act protects all species, including amphibians, and punishes individuals who harm or threaten wildlife without a permit (Ministry 5).

e.Monitoring Programs

Finally, **local monitoring programs** could help determine how well amphibians are doing and if their population numbers are experiencing any changes. Volunteer-driven monitoring programs could help the public become familiar with the sounds of frog calls, and how to listen for them. This could help in **locating areas** where frogs and other amphibians have decided to reside in and help with further attempts in enhancing their habitats (Ministry 10).

7.5. Lakelse Wetlands Bridge

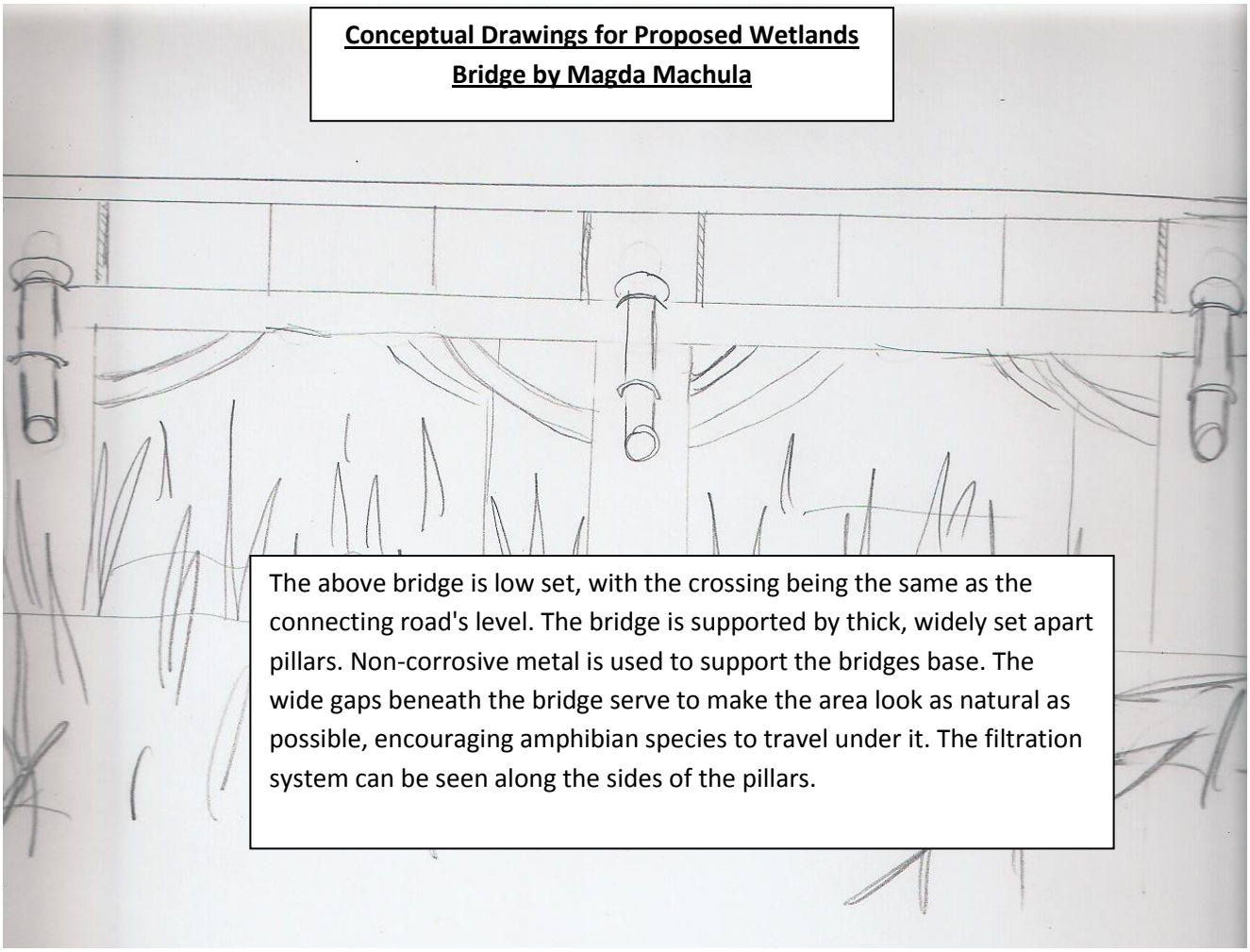
The section of Highway 37 running over the swamp* extending from the NE corner of Lakelse Lake divides the swamp in half. A culvert is all that connects the two halves. An amphibian bridge in this area might help to eliminate the problem of habitat fragmentation at this location.



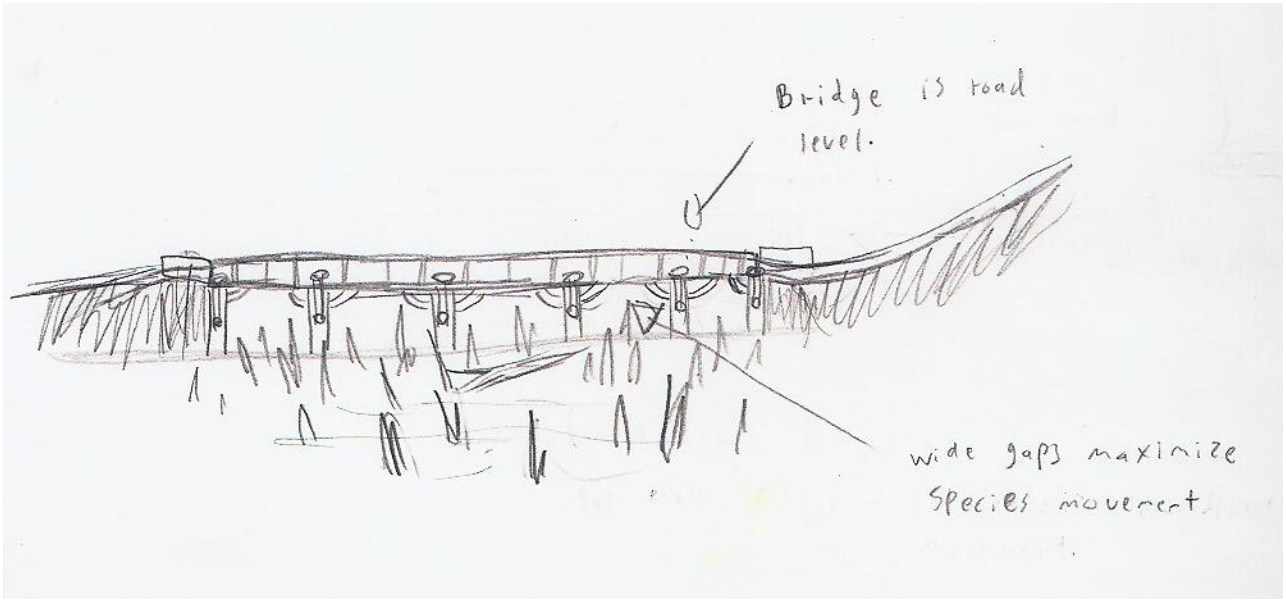
However, the problem of highway run-off could occur if a bridge was put in this location. The current set-up has vegetation along the road to filter out contaminants. A bridge would not have this, and run-off would just drain directly into the water. Unlike rivers and other moving forms of water, contamination cannot be carried away and dispersed from a swamp; it will instead build up in the areas below the bridge. **A bridge with a filtration system** would be best suited for this location – diagrams for this design are on the next pages. *Note: this swamp originated from the 1962 glaciofluvial marine clay slide into Lakelse Lake; the slide was triggered by the construction of Highway 25 (37) at that time.

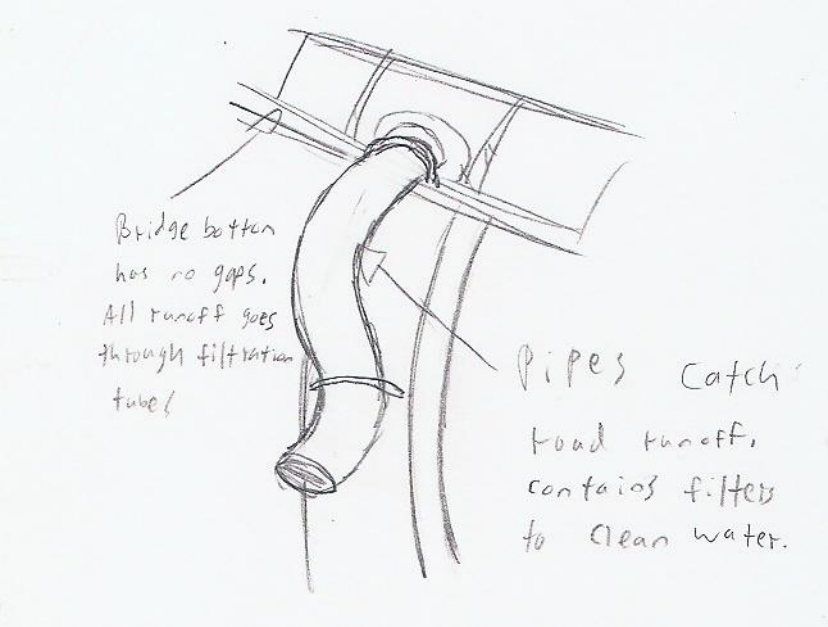
PROPOSED AMPHIBIAN BRIDGE TO LINK HABITAT SEPARATED BY HIGHWAY 37

Conceptual Drawings for Proposed Wetlands Bridge by Magda Machula

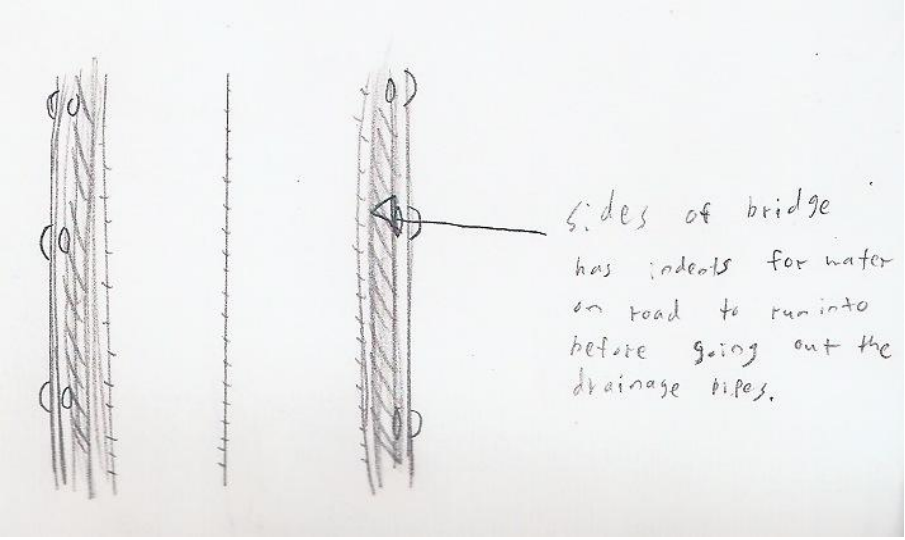


The above bridge is low set, with the crossing being the same as the connecting road's level. The bridge is supported by thick, widely set apart pillars. Non-corrosive metal is used to support the bridges base. The wide gaps beneath the bridge serve to make the area look as natural as possible, encouraging amphibian species to travel under it. The filtration system can be seen along the sides of the pillars.





The bottom of the bridge would be gapless, forcing all run-off liquid to go through the filtration corridors. The filters in the corridors would remove salts and other chemicals from the water. The clean water would run out through the pipes into the wetland below.



The road sides are indented, forcing liquid to fall into it instead of building up on the road. The filtration access points are located along this indent.

Filters would need to be cleaned often to prevent blockage

If a sewage or liquid waste management system is built for Lakelse Lake, filters may not be required. Instead, the pipes could connect to this system and take contaminated liquid away.

If filtration pipes do not work, perhaps a some sort of permeable road surface that would catch particles and contaminants and only allow water to pass through could be implemented instead.

7.6. Extra Notes

I have found **Roughskin Newts** in Kitimat. One very small one on the Pine Creek trail and and another large one in a pond along Forest Avenue. In Kitimat they appear to be right on the border of their habitat range, so they may not be a factor at Lakelse Lake.

In summer, 2009, I found **two dead adult toads** in different locations, one in the Methanex area next to a pond, and another floating down a creek in a logged area near the Kitimaat Village road. Although two isn't a very large number, this is the first time I have ever seen dead adult toads that appeared to not be injured in any way.

In summer, 2009, I found a toad at Lakelse Lake with an **abnormally shaped foot**. I couldn't determine if it was from an injury or malformation, but the foot was much shorter than the normal one and appeared to have all of its toes fused together. It also didn't have normal skin on the abnormal foot. The toad was a full sized adult.

In all the times that I have gone to Lakelse Lake, I have only **ever seen one frog**. Sightings of Western Toads have been frequent, however.

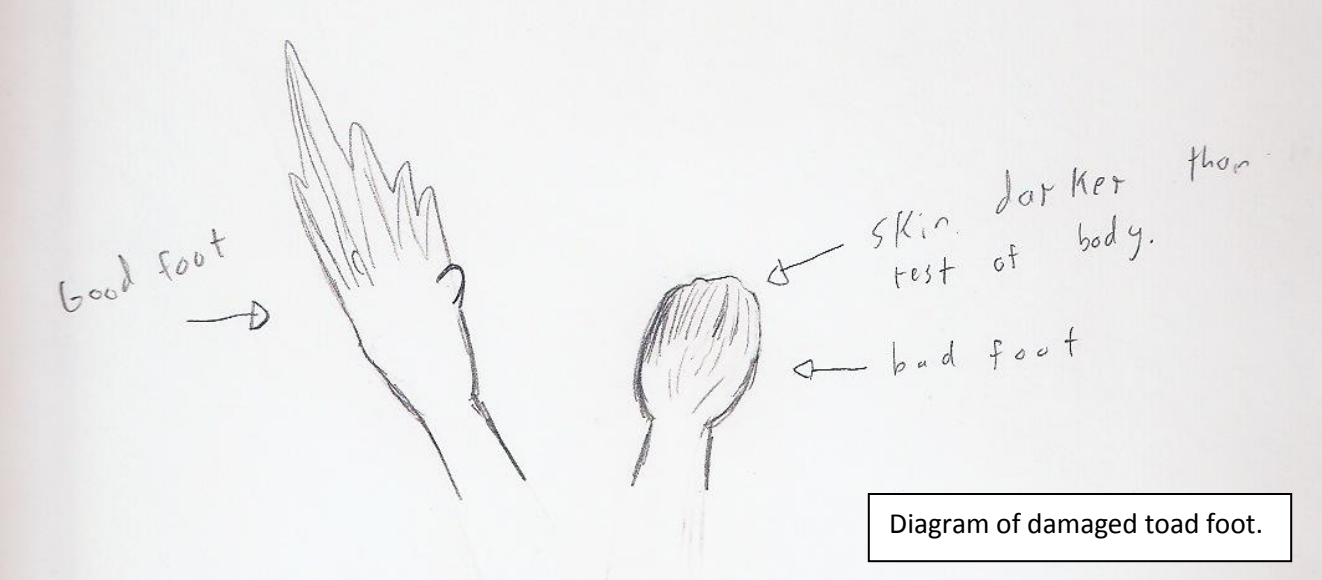


Diagram of damaged toad foot.

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SECTION 8

LAKELSE 2060

Moose Management Study

by Kory Botelho, Brady Conlon, Adam Simons

ABSTRACT

This project was done in partnership with the Lakelse Watershed Society and the Regional District of Kitimat-Stikine. The project's goal was to determine important moose habitat, identify the ecology of moose, study moose planning, and determine what was needed to be done to have moose continue to be a part of the terrestrial ecosystems of the Lakelse watershed in 2060. Moose eat willow, red osier dogwood, and young cedar in the winter. Moose habitat is located along roads, transmission lines, riparian zones, and zones of disturbance. Moose are attracted to the browse along highways and can cause conflicts. Management Plans that were similar to our project are the Cariboo River Provincial Park and Wells Gray Provincial Park management plans. Our management plan focused on the Lakelse Watershed as having high recreation and scenic values. Our Moose Management plan emphasizes balancing these values with the critical needs for moose habitat in the area.

INTRODUCTION

The Lakelse Watershed Moose Management Study was undertaken as part of an overall study of the Lakelse Lake watershed by the Geography 112, *Environments and Planning*, course from NWCC, under the instruction of Dr. Norma Kerby. The purpose of the overall study was to characterize the Lakelse area's social, economic, and environmental values across multiple subjects (e.g. recreation, water quality, and ecological values) in order to create a general 50 year plan for sustainable planning in this already over-developed rural area.

The moose study looked mainly at the ecological aspects of moose in the Terrace area, the available habitat for them within the Lakelse watershed, and how current residential and recreational use around Lakelse Lake affects the ability of moose to use this habitat and remain in their natural ecological niche. Apart from the "moral" ecological view that moose have a right to exist in the area, it is also necessary to preserve moose populations to uphold ecosystem functionality (moose/predator relations will be touched on) and to retain the natural appeal of wildlife that attracts tourists, residents, and recreational users to the area. The information for this study was collected from local research publications and interviews with local experts. Planning directions are recommended, with reference to the Regional District of Kitimat-Stikine's *Lakelse Lake Zoning Bylaw No.57,* on how to conserve and protect the moose populations and habitat over the next 50 years.

PART 1: MOOSE HABITAT/ECOLOGY IN THE LAKELSE AREA BY ADAM SIMONS

a. ECOLOGY and HISTORY

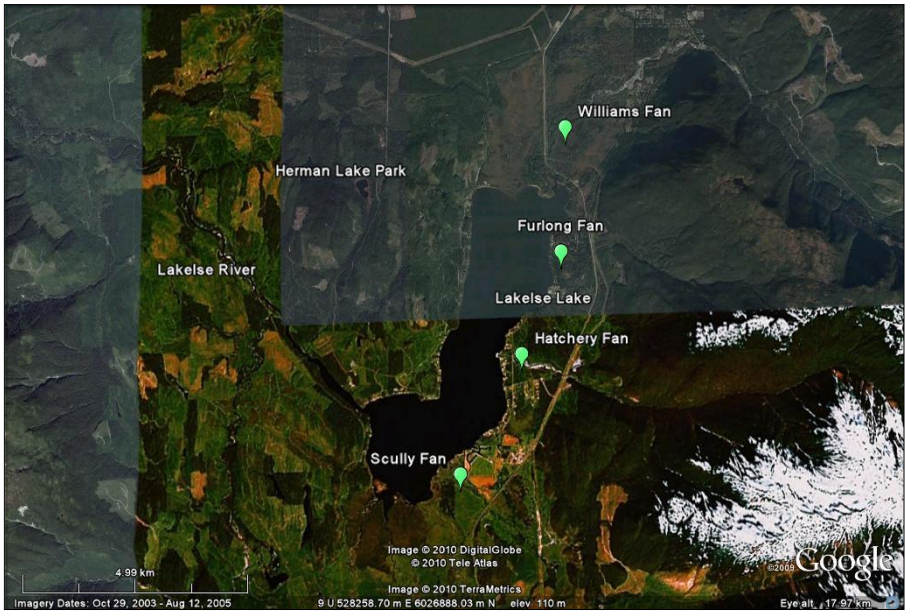
The moose of northwestern B.C. (Alces alces) first came to Terrace in 1934 (Frank, 1991), the mountainous-valley terrain serving as great habitat for these ungulates. Moose base their habitat, in particular winter and summer ranges, on energy conservation, or the areas with the most nutrient-providing browse that requires the least effort. This means that their summer range includes all accessible areas, mountains included, while their winter range is limited to valley bottoms where there is more food and less snow. Primary habitat (the ideal niches) for both winter and summer ranges are floodplains and alluvial fans, with nutrient-rich soil, lots of small edible shrubs, and aquatic vegetation, such as the "perpetual shrub communities" established on floodplains. Secondary habitat includes disturbed areas with new, nutrient-rich shrubs, usually created by forest harvesting or natural

disturbances. Finally, tertiary habitat includes small open, essentially secondary habitat areas located within old growth forests, which are usually driven by water drainages or perched water tables. Old growth or mature forests are used for shelter from snow and protection from predators (for example, moose back up against large trees to protect their backsides from wolf swarms).

The Lakelse watershed has much primary and secondary habitat, but limited tertiary habitat due to past logging (Pollard, 2010). The average mature moose in this area is 2m tall, with cows (females) weighing 340-420kg, and bulls weighing 450-500kg. The primary vegetation consumed by moose in the Lakelse Lake area is willow, followed by red osier dogwood, cottonwood, aspen, and young cedar. Cows have been observed barking cedar trees for calcium when pregnant. The primary natural predators of moose are wolves, whose winter diets consist of 90% moose, but predators in the Lakelse area also include grizzly bears, cougars, and humans. The habits, diet, habitats, and other ecological aspects of moose are important in basing planning decisions for them in the Lakelse area for 2060.

b. HABITAT SUITABILITY IN THE LAKELSE LAKE WATERSHED

The lower elevations of the Lakelse Lake watershed serve as great winter range for moose. There are 4 main creeks entering the lake from the east side, and the alluvial fans associated with each of these are very productive with nutrient-rich shrubs, but are also very unstable due to changing creek geomorphology. Williams Creek Fan is the northern most creek fan identified as important moose habitat by Ministry of Environment Ecosystem Officer, Chris Broster, and R.P. Bio, Brad Pollard. Furlong, Hatchery, and Sculbuckhand (Scully) Creek Fans entering the lake south of Williams Creek (see image below). The swamp areas surrounding Sockeye Creek on the east of Highway 37 are prime moose habitat, while the swamp areas directly north of Lakelse Lake and adjacent to Williams Creek, part of which includes park land, are also identified as moose winter range by the Ministry of Forests.

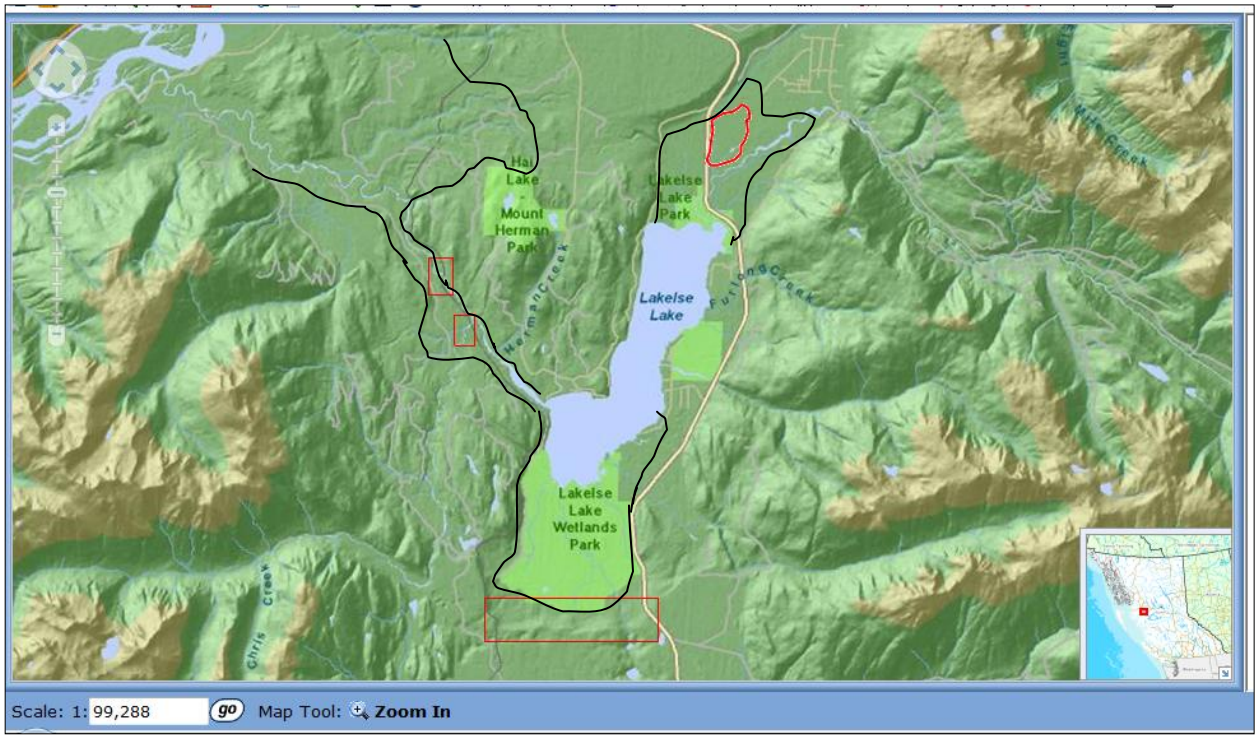


The Furlong, Hatchery, and Scully Fans are all affected by the increasing house densities near the lake, especially Hatchery Creek near First Avenue. This human activity can have negative and positive effects on moose. The residential housing on the west side of the lake is more spaced out, allowing moose to access the shoreline and swim across the lake in summer, or walk across in the winter- one of the natural spectacles that draw users to the lake, but more importantly, acting as a shortcut for getting to the other side of the water body. The east side however, particularly around Hatchery Creek Fan, has been increasingly developed and densified, which blocks moose migration and use of the fan's nutrients. While moose are somewhat afraid of humans, they will overcome their fear to go into the residential

areas to escape wolves (which are more frightened of people and dogs), browse on the store-bought plants, and use the plowed roads for easy travel.

Scully Creek Fan is another prime moose habitat area, and, according to Mike Legget from the Ministry of Environment (2010), its structure has been altered due to industrial development, such as the Pacific Northern Gas right-of-way, resulting in a shift of water flows from a southern stem, to a north and west stem. Good browse depends on the quality of nutrients flowing in a water course, and therefore erosion events may have caused alteration of the amount of nutrients available in the alluvial fan area. (Note: the erosion events have also eroded areas of browse and changed the hydrology of the Schulbuckhand Creek fan)

The Lakelse Lake Wetlands Park south of the lake is also winter range, despite some areas of Douglas Spiraea, alder, and pine bog growth, which are not suitable for winter browse. The area of the Onion Lake Flats south to the Kitimat River is heavily populated with moose, and the area just north of the ski trails is extensively used by moose, as well as wolves (Broster, 2010). In terms of the west-side of the watershed, areas identified as good winter range for moose include the floodplains of lower Coldwater Creek, South Eagle, many of the harvested, smaller mountains on the west side (rated 2 out of 6 for suitability by M.of E. standards), Lakelse River near the railroad crossing, and the Herman Lake park area. Suitable early spring range includes the south-facing aspects of the west mountains also (Broster, 2010). In terms of tertiary habitat, there is very little in the Lakelse Lake watershed. This type of forest requires a minimum of 200 year old stands, which allow light to pass through the canopy and support shrubs below, but the area surrounding the lake has been logged over the past 70 years, preventing this.



According to Pollard (2010), there are some small old growth stands left in riparian zones which are important moose winter habitat.

Moose are found throughout this map area in both winter and summer, especially cows and calves in the lowland valleys in winter. The above map outlines the most important winter range areas (black) as identified by Ministry of Forests, and the critical moose winter habitat areas (red) as identified by Brad Pollard and Chris Broster (2010).

c. VALUE OF MOOSE IN THE LAKELSE WATERSHED

There are many reasons why the moose are a valuable species for the area, and why they should be planned for over the next 50 years. For one, moose have become a valuable food staple for First Nations and hunters in the Terrace area. Moose, while fairly new to the area relative to the geological time-scale (76 years since 1934), have become a major part of the local food chain, with wolves being dependent on them in winter. Moose also maintain shrub ecosystems by browsing the apical meristems of plants such as red-osier dogwood, limiting plant overgrowth while ensuring future growth and extending the vegetation's life. Finally, the more obvious value is the recreational and tourism allure of large wildlife that brings nature loving people to Lakelse.

If the values of Lakelse Lake continue being based around increasing permanent residential development rather than protecting natural species such as moose, then the moose will be pushed out of the area due to too much human confrontation and habitat destruction. If the values turn towards restoring Lakelse to a more natural state, then the preservation of the critical and winter range habitat listed above needs to be prioritized, as it has been to a degree with the existing B.C. Parks established around the lake. While the current human disturbance caused by residential areas has some benefits for moose, too much interference with the natural ecosystems will cause migration blockage for moose and their predators, which will in turn affect the species that they use for browse. For example, if the number and density of permanent residences continues to increase, the owners bring with them their dogs, and the dogs scare away the moose that migrate to the area for winter, then the cedars which moose browse on and stunt the growth of would begin to mature, and eventually shade out the smaller shrubs and trees used by smaller organisms. Everything affects everything in an ecosystem, Lakelse Lake included.

d. CONCLUSIONS

Mapping of winter range is one of the most important management tools because it encompasses the time when moose populations are confined to the lower elevational, nutrient rich areas such as the alluvial fans near Lakelse Lake. It is during this time that adequate habitat is vital, and interaction with humans increases, and therefore it is what most planning decisions should be based.

The aim of a moose management plan is to use the habitat data, and the habits of the moose and their predators to make recommendations on how to preserve populations over the next 50 years. However, in doing so, **environmental changes need to be considered**, such as the fact that, as the forests in the area mature, they become less valuable to moose as the amount of secondary habitat decreases, or the prediction that moose are starting to move out of the area as black-tail deer come back into these maturing forests (Pollard, 2010).

The use of the nearby CN **railroad** as a corridor for moose and grizzlies, the **illegal road use** accessing Squirrel Point, and the **increasing permanent residential development** around the lake are all issues that need to be assessed. There needs to be "a balance between conservation and development", and a look at the "broader level", rather than "little pockets of protection" if moose values are to be maintained in the Lakelse watershed over the next 50 years (Broster, 2010).

e. RECOMMENDATIONS

The biggest issue with Lakelse Lake that could have adverse effects for moose in the area over the next 50 years is the increasing push for **permanent residential development**. Building on or near critical habitat zones such as the creek fans along the east side of the lake needs to be monitored or prevented in total, and a push back towards seasonal residential in the summer should be encouraged.

With increased residents all year round, and building of residences either in or accessed through critical moose habitat (e.g. Squirrel Point), comes **increased human-moose conflicts** in the critical winter season. As suggested in the 2009 NWCC *Moose/Predator/Human Interaction Study: Terrace North, BC*, things such as fences, which block moose travel, need to be planned to allow **corridors for movement** through developed areas.

Recreational or natural sections of land within the developed areas need to be set aside for **moose travel and shelter**, and **lot sizes should be kept larger** to increase the ratio of undeveloped to developed land, which creates more edge habitat for moose.

In terms of the current *RDKS Lakelse Lake Zoning Bylaw No.57*, a big issue currently and in the future will be **density of development**, and the allowance of up to 2 guest houses on a single lot should be re-examined to address the needs of moose and their use of residential areas, which can be hampered by not allowing enough space for them.

While **more data needs to be collected** on the moose in the Lakelse Lake area, the information gathered thus far illustrates a general need to **continue protecting critical and winter range habitat through the establishment of parks**, and **decrease the rate** of potentially harmful development in the area.

PART 2: COMPARATIVE MOOSE MANAGEMENT PLANS BY BRADY CONLON

a. CARIBOO RIVER PROVINCIAL PARK

The Cariboo River Provincial Park is located 70 km east of Barkerville, B.C., Canada (Ministry of Environment, 2010). Carrier and Sepwepmac First Nations traditionally used the park for catching salmon and trout as well as for a travel passageway (Ministry of Environment 2). In 1860's, this same corridor was used for travelers hoping to cash in on the Cariboo Gold Rush (Ministry of Environment, 2010). The Wildlife Management Area was designated park status through the Cariboo-Chilcotin Land Use Plan by the recommendation of the Cariboo CORE process (Ministry of Environment, 2010).

The Cariboo-Chilcotin Land Use plan designated Cariboo River Provincial Park as 3,900 ha (Ministry of Sustainable Resource Management, 1995). The recreational corridor stated that there was great recreational potential for the area with fish and hunting opportunities (Integrated Land Management Bureau, 1996). The Plan says that 7000 hectares of the river valley contain important moose winter range, along with grizzly, waterfowl, and recreational fish values (Ministry of Sustainable Resource Management, 1995). The watershed was planned to have restoration, monitoring, and hydrologic stability assessment (Ministry of Sustainable Resource Management, 1995). The plan identified maintenance of old growth forest along trails and management of the area for beauty along the highway (Ministry of Sustainable Resource Management, 1995).

The Ministry of Water, Land, and Air Protection took these plans, along with the recommendations of an advisory of various stakeholders and experts, to create a vision for the park.

"The vision for Cariboo River Park is primarily focused on the critical moose wintering grounds and the wetland values located along the Cariboo River. Research and monitoring has increased understanding and knowledge of this important riparian area and the migratory bird and waterfowl values in the area. The herbaceous vegetation and wetlands along the Cariboo River are managed to ensure they are in proper functioning condition, and recreational activities, both commercial and public, are managed to ensure the ecological integrity of the area is maintained.

The Cariboo River corridor is a destination area for people wishing to see wildlife in a natural setting, and is also used for fishing, drift boating, canoeing and kayaking as well as trapping and hunting. Local guides take people on various tours, and the communities of Likely and Wells, in recognition of the prominent role this park plays on the 3100/8400 road, have taken a role in providing information on the user ethics and values of the area." (Ministry of Water, Land, and Air Protection, 1996)

The Cariboo River Provincial Park is zoned as Natural Environment (Ministry of Water, Land, and Air Protection, 1996). The objective of the park is to protect scenery and beauty while providing backcountry recreation in a pristine, unaffected. The size of the zone is 3,137 hectares. Hunting and trapping are permitted in the park. Hunting is permitted due to previous hunting activities, but in the Upper Cariboo River, hunting is not permitted. Snowmobiles are not permitted and there are very few man-made facilities in the area (Ministry of Water, Land, and Air Protection, 1996).

To manage for moose, the plan identified a buffer zone between humans and moose in winter, with sight barriers, noise barriers, and cover to conceal moose along these zones (Ministry of Water, Land, and Air Protection, 1996). Transportation and snowmobile passages are situated outside of moose winter range. In winter, breaks and exits are created along the ploughed roads so moose can escape traffic conflicts and collisions. Water-based activities are permitted as to not affect the moose (Ministry of Water, Land, and Air Protection, 1996). Cariboo River Provincial Park is a fire management zone, with fire used to create forest succession stages suitable for moose populations (Ministry of Water, Land, and Air Protection, 1996). Monitoring reports of moose in the region or progress reports on how the plan has been followed were not located.

b. WELLS GRAY PROVINCIAL PARK

Wells Gray Park is located just north of Kamloops. The park was established November 28, 1939 (Ministry of Environment, 2010). The Kamloops Land and Resource Management Plan added the Clearwater River Corridor expansion of 3100 hectares in 1996. Hunting is permitted in the park.

The Kamloops Land and Resource Management Plan was published July 15, 1995 (KLRMP). The objective for Moose Winter Range in the KLRMP is to preserve thermal and visual cover, while enhancing browse vegetation production (KLRMP Section 2.1). The strategies to achieve these objectives are to preserve forest and thermal cover, maintain browse species while brushing and weeding, create visual screenings along swamps and roads, create mixed forests, create grazing management that will preserve red osier dogwood and willow, and institute moose management plans into local planning (KLRMP Section 2.1).

The KLRMP specifically identifies the Clearwater River Corridor as high value critical moose winter range (KLRMP Section 2.3). This area is documented as Natural Environment and is managed for scenic values (KLRMP Section 2.3). The KLRMP recommends that the park manages for moose habitat by creating disturbance through controlled fires (KLRMP Section 2.3).

The Wells Gray Provincial Park Master Plan states fire is a suitable management tool for moose habitat (Ministry of Lands, Parks, and Housing, 1986). Moose habitat will be preserved in accordance to the ecological carrying capacity of the habitat. Forest harvesting will be limited to create growth of forests in which moose have visual cover (Ministry of Lands, Parks, and Housing, 1986).

A monitoring report for Kamloops Land and Resource Management plan came out in February, 1999 (Reay, 1999). The wildlife objectives after four years were only being partially met, leaving low moose populations and low critical habitat areas. Moose populations, however, were increasing due to new timber regulations. Moose hunting activity had decreased due to new hunting regulations (Reay , 1999). An increase in moose population and habitat were to be created from this plan.

PART 3: MOOSE vs HIGHWAY CONFLICTS BY BRADY CONLON

a. Conflicts with Right-of-Ways

Moose like to use man-made disturbance such as highways, railroads, secondary roads, logging roads, pipelines, and transmission lines as travel corridors and the shrubby browse along them is part of their diet. Red osier dogwood, willow, and young cedars are their main sources of food in the winter.

Right-of-way west of Sockeye Creek adjacent to Highway 37 – extensive growth of red osier dogwood. Photo by Brady Conlon.

As can been seen in the pictures along Sockeye Creek swamp, in the right-of-way next to Highway 37 and under the hydro transmission lines, there is plentiful browse and habitat.

Willow and red osier dogwood – right-of-way near entrance to Gruchy's Beach trail.

Photo by Brady Conlon

In the winter, roads are ploughed, which causes snow pileups along the sides of the roads. This causes the snow to be too deep to walk on and the moose are forced to walk on the actual road or rail-line. When traffic comes, moose are unable to escape to the side and are very vulnerable to collisions. A solution to this problem is to create exit corridors along the roads (e.g. breaks in the snowbanks), so when traffic does come, the moose have an exit strategy, increasing their chances for survival. The large trees on the sides of right-of-ways are used by moose for thermal and snow cover shelter and to protect their backs from predators by attacking with their front legs. Mature and old growth forests next to right-of-ways creates important diet and shelter at the same time (Kerby, 2009 –Biology 211 moose study)

These traffic ways are also barriers for the natural movement of moose across habitats. For moose to cross with no possibility, they need a tunnel, overpass or underpass to pass through. This is quite expensive, so another option is to have all existing bridges built tall enough and have safe walkways to pass through (Kerby, 2009 – Biology 211 moose study).

It is also an option to provide visual cover for moose along these corridors to avoid moose and human conflicts. Another strategy to not attract moose near the roads is cut the brush in the fall and not the spring, so that the brush does not have time to regrow before winter (Kerby, 2009 – Biology 211 moose study).

Photo taken at Schulbuckhand Creek Culvert next to Highway 37, by Brady Conlon April 1st, 2010, showing browsed red osier dogwood.

b. RECOMMENDATIONS

Further residential development could cause roads, right-of-ways, and residential areas to be more frequently travelled by moose, which are attracted to the dietary benefits of new growth associated with disturbance. These disturbed areas have decreased thermal and visual cover from wolves and other predators (Kerby, 2009, Biology 211 moose study).

Further residential development in the Lakelse area will also cause **more barriers for moose** trying to cross the watershed. Increased human and dog populations, especially in the winter, will cause **greater moose-human conflicts** when the moose move down the watershed to feed on the riparian zones. Further residential development, and even the existing level of residential development within the Lakelse Lake area, is detrimental to moose. **The amount of permanent residential development should be carefully regulated.**

Highway conflicts can be minimized by a few practices and plans. As recommended in the Cariboo River Provincial Park management plan, **exit corridors** must be created along ploughed roads in winter so that moose, which are forced to travel on the road during heavy snowfalls, can escape when danger comes along (Ministry of Water, Land, and Air Protection). Brush should be **cleared in the fall** instead of the spring, so when winter comes around, the brush has not had time to grow tall enough for the moose to eat (Kerby, 2009, Biology 211 moose study). To create **underpasses**, it was recommended on the Nisga'a highway to clear brush under bridges to encourage moose to use the bridges as underpasses while making sure all new bridges that are built are tall enough for moose to pass underneath (Kerby, 2009, Biology 211 moose study).

The best approach for the Lakelse Lake Watershed is to protect natural **primary moose habitat** in alluvial fans, floodplains, and riparian zones in order to retain stable moose populations. To keep moose in the area, a **rotational disturbance plan** could also implemented. Once forests reach 30 years of age, due to forest succession, they are not valuable to moose for browse anymore. Both the Cariboo River and Bowron Lakes areas use controlled fires to create seral succession for moose. The Lakelse area is too wet for this technique. Forest harvesting could **use other forest harvesting practices that create moose habitat**, such as small-sized rotational cutblocks or selective logging. This would help the forestry business, while protecting the homes and recreational spots in the area.

As well, **thermal cover** must be retained in the watershed. Moose need areas of coniferous tree cover to form travel corridors with reduced snow depths. If moose travels too long in deep snow, too much energy will be expended and the moose will not survive. Moose also use larger conifer trees to protect their backs while defending against predators, and for visual screening from predators and human disturbances.

Buffer zones between critical moose habitat and human activity areas should be established. By creating **visual cover** for moose along human-used areas, this will be an effective solution. Moose will be camouflaged and not intimidate humans, avoiding conflict and poaching. Areas of critical moose habitat should **not be allowed for snowmobile trails**. The noise causes them to use extra energy by running away from the perceived danger. **Meetings** with snowmobile stakeholders should be held to educate and design proper areas of travel.

These recommendations, if followed, will allow moose to remain an integral part of the ecosystem in the Lakelse Watershed in 2060.

PART 4: MOOSE MANAGEMENT PLAN FOR THE LAKELSE AREA by Kory Botelho

Moose have been present in the Northwest, and specifically in the Lakelse Lake region, for a span of about 80 years. Before one discusses ways of managing them, one must analyze and consider if moose are really a priority in this area. Would managing for this species endanger other native species around this area like the black-tailed deer? Before declaring that moose are positive/negative to this region, let us discuss some characteristics about their habitats and needs for survival.

The classification for moose in this region is (Blood,D., 2000): Order Artiodactylos,Family Cervidae, Genus Alces, Species Alces, Subspecies andersonii (Northwestern Moose)

Moose in this area have now become an important factor in promoting the northwest as a region of natural beauty. It has become a symbol of the northwest, but, more than that, it has become a major important part of sustenance use by First Nations and, alongside with other animals, has brought in many tourists and residents alike to participate in hunting, sightseeing and other outback activities (Vanderstaar, 2010). But will trying to maintain these animals serve to be more costly then the benefits attained from their presence?

Moose primary habitat in the Terrace region includes the floodplains and islands of the Skeena River, Nass River, Beaver (upper Kitsumkalum) River and lower Kitsumkalum River. What makes these areas primary habitat is the level of disturbance associated with these areas. They are subject to great levels of flooding and movement of sediments, allowing shrubby riparian re-growth to take place (Kerby, 2009, Biology 211 moose study).

As populations of moose in these primary habitat areas increase, the moose migrate out, inhabiting other areas of lower or temporary habitat value. These areas include secondary habitat created and maintained by man. Areas logged by Columbia Cellulose, Skeena Forest Products, BC Timber, West Fraser, and Coast Tsimpsian have, over the last 6 decades, provided areas of new growth of shrubby browse critical for the survival of the moose. Due to mill closures and closure of most forest industry companies in the Terrace region over the last decade, the amount of logging has been reduced, permitting coniferous forests to regrow and reducing the areas of secondary habitat as the shrubs are replaced by trees.

In addition to cutblocks, right-of-ways, including trails, areas with telephone poles, gas lines, hydro lines, and other man-made corridors, are excellent habitat areas where moose are able to browse on red osier dogwood and other small shrubs. These man-made corridors, maintained as shrub ecosystems, can be considered more critical and useful to moose habitat over the longterm as they are maintained as open, shrubby areas and do not regrow as coniferous forests.

Natural primary moose habitat directly within the Lakelse watershed includes the riparian zones of the Lakelse River, Coldwater Creek, Williams Creek, and Sockeye Creek, the south and north ends of the Lakelse Lake, Williams Creek alluvial fan, and the alluvial fans of Furlong Creek, Hatchery Creek, and Sculbuckhand Creek. These areas will remain primary habitats due to the large amount of disturbance from flooding and sedimentation. Some tertiary habitats which support small populations of moose also occur in the Lakelse watershed, associated with wet pockets (e.g. Herman Lake) and small drainages (e.g. Eel Creek). Just as there are some riparian zones present around Lakelse Lake, these areas alone are not large enough to sustain large populations of moose, but are enough to encourage moose to be present.

After researching and understanding where moose occur in the Lakelse watershed, one can conclude that there is sufficient habitat that moose are not going to be going away any time soon. They will continue to inhabit the Lakelse area unless extreme weather conditions, such as massive snowfalls or other storms wipe out the populations to such low numbers that moose are not be able to cope. It is with that confidence that moose have now become an important wildlife component of the Lakelse Lake area (Vanderstaar, 2010).

The next big worry is that theories say that black-tail deer may have inhabited this region in great numbers in the past, but for some reason, whether it was due to large winter snowfalls (e.g. the 1970's) or the extent of forest harvesting in the Lakelse watershed, deer populations plummeted. (Pollard, 2010) However, over the years, their presence is beginning to pick up and will this increase become a conflict with the survival of moose?

Understanding the ecology of the two species, both species are able to coincide with one another without a large threat to each other's needs for survival. During the winter months, moose primarily eat willow, red-osier dogwood, young cedar, birch and Viburnum, while black-tailed deer eat western red cedar, willow, and red-osier dogwood (Banfield, 1974). At first observation, one cannot help but predict that there this will be conflict over browse, especially when it comes down to willow and red-osier dogwood, but the physical attributes of these mammals limit the amount of conflict. Since moose are significantly larger animals compared to black-tailed deer, they are able to move to areas of deeper snowfall and eat growth at higher heights than the black-tailed deer. This suggests that, even if a black-tailed deer has eaten a large percentage of the branches found at lower levels, this will not cause too much harm to the moose (Banfield, 1974.)

Coming to the realization that moose will be present in this area serves as the motivation for moose management plans to be implemented. The critical time for survival of moose is during the winter; therefore, planning steps to preserve critical winter range must be taken into account if we want moose to be present in 2060.

First of all, we are going to have to recognize the **primary habitat** present around the Lakelse lake watershed, especially the areas inhabited by moose during the winter months. By recognizing these critical areas, one must change the classification of the land to be either park or wildlife reserve.

These designations are necessary in order to apply any rules or regulations best fitting for the needs and objectives of managing moose. Some of the **Regulations** needed to be implemented revolve around human/ moose interactions. Disturbances by humans include the presence of ATVs and snowmobiles, roads, blocked access to shorelines and wetlands, and human pets such as dogs. Some of the primary habitat found at the south end of Lakelse Lake is classified as a wetland park, but areas, such as Williams Creek and Furlong Creek, have alluvial fans that are divided into crown and private land. If classified as **park or reserve**, the human/moose contact in primary habitat can be restricted.

The **Lakelse River** is also a very important area for moose habitat due to its many natural disturbances. Wildlife management plans for the Lakelse River are important for preserving moose populations.

The boundaries of critical habitat used by the moose need to be reassessed and redone to include all important primary habitats. For example, an area that should be included in protection for moose habitat includes the groundwater springs at the base of the escarpment at the south end of Lakelse Lake – these springs feed into wetlands and primary habitat of the Lakelse Lake Wetlands Park.

The next important feature present in effective moose habitat is **thermal cover** (Kalum LRMP, 1996). Mature coniferous forests are necessary in order to reduce snow accumulation on the ground. Moose are able to travel in snow up to 40cm with no difficult; however when the snow gets up to levels of 40-70cm deep, the moose begin to have some problems (Blood, D., 2000). The trees that are essential in providing thermal cover are old growth or mature forests. These trees provide not only a canopy of physical proportions, but also are used as a means of protection for moose against predators. When a moose has an encounter with a predator, say a pack of wolves, the moose will back up to a large diameter tree and using its front legs to attack the predators (Pollard, 2010). When it comes to discussing the presence of old growth in a particular habitat, one must calculate the percentage that the inhabiting moose will need in retrospect to new growth. Large cutblock logging will provide browse for moose but it will not be an area that moose will be encouraged to go (Vanderstaar, 2010). There must be a distribution between old growth and new growth to ensure that the moose can still eat while knowing if danger strikes, they will have a fighting chance.

During the winter months, as snow levels begin to accumulate, moose will look for different habitat attributes to ensure survival. A moose will try to use the **least amount of energy** they can to provide for their essential needs. Walking in deep snow takes up a lot of energy, therefore it is quite common for moose to use man-made ploughed roads to travel (Kerby, 2009, Biology 211 moose study). In order to protect the moose, suggestions from other management plans include producing **exit corridors** through the snowbanks along commonly travelled roads to allow moose to avoid vehicles and humans as much as possible.

Not only are roads primary travel pathways for moose, but many **right-of-ways** are also used as optimal habitat areas. Right-of-ways include gas lines, telephone pole corridors, hydro lines, railways, highways, trails, and other man-made corridors. Since these right-of-ways are cleared of trees and provide growth areas for shrubs, moose are attracted to the new growth. This becomes a huge problem for humans that also use the corridors for travel. Many accidents occur yearly on Highways 16 and 37 due to **moose/vehicle encounters**. As per the pictures in Part 3, right-of-ways in damp areas will grow an abundant amount of red-osier dogwood, attracting moose. A suggestion to prevent this conflict is to clear the brush around the highways in the fall instead of the spring (Kerby, 2009, Biology 211 moose study). This will prevent the moose from browsing around highways because regrowth will not be suitable during the winter season. Other corridors that are used by many **recreational groups** follow the gas lines and/or hydro lines. Many of these areas are heavily used for ATVs and snowmobiles due to the continual maintenance being done, making it a great area to ride on with the smallest amount of extra impact on the environment. However, moose are also attracted to the new growth around these areas and they will travel back and forth, going from the forest to the open right-of-ways. This is a recipe for disaster if a motorized vehicle comes in contact with a moose.

An important feature when it comes to maintaining, if not increasing the moose population around the Lakelse Lake, centers on the **survival of the cows and their calves**. The 2009 moose study describes encounters of cows and their calves with people and dogs in the winter ranges near Terrace (Kerby, 2009). There are many issues that come with the movement of cows and their offspring. In the spring and winter, pathways enabling access to primary habitat areas are critical. These pathways will encourage population growth and sustainability. These **corridors** will enable moose to moose interactions, increasing genetic diversity, as well as ensuring enough resources are available and distributed amongst the moose populations (Kalum LRMP, 1996).

Before any of the plans or ideas are put into commission, an assessment of the current moose population and the **long term goals for the numbers of moose** desired in this area need to be established. If the population of moose in the area needs to be increased, a grid-iron forest succession pattern can be set up. In 20 year intervals, harvest a small area of land that is allowed to regrow in shrubs. This will provide **sustainable food sources** for the moose, increasing the moose populations, however this form of maintenance may affect the hydrology of the land (Dr. Kerby, 2010). Another action that has been suggested and has been implemented in other areas is burning of forest areas to increase browsing shrubs (B.C. Parks, 2002. Bowron Lakes). Even though this has been effective in some areas, the primary habitats in the Terrace area are mainly in wetter areas, making it extremely difficult to use fire as a management tool.

The main interaction that causes most concern for planners is the interaction between moose and humans. Implementing **buffer zones**, or creating sight and noise barriers between winter moose and humans, will prevent unwanted interactions between moose and humans (B.C. Parks, 2002. Bowron Lakes), but, this will not help residents or non-residents wanting to encounter the moose for hunting purposes. Based on the **Hunting and Trapping Regulations Synopsis** 2009-2010, many restrictions have been put on hunters. Some limitations include, only one week during the year is acceptable for hunting moose with firearms, other weeks must be by bow, some parks and areas are restricted, and only the bulls are allowed to be killed.

Cows are critical to the survival of moose populations so implementation of these rules is crucial (Yukon Fish and Wildlife, 2010). However, the problems that arise with hunting are not the hunters that abide by the laws, but the illegal poachers. The **Alsek Management Plan** (Yukon Fish and Wildlife, 2010) discusses these issues and suggests harvest monitoring systems should be implemented, distributing

hunting based on safe harvest levels, determining numbers of moose needed before stress is put on the gene pool, public education, and discipline if illegal actions are taken. Even though humans are not the only killers of moose populations, they are the primary. Second to them would be the wolves.

Wolves have been in this area for a long time. Initially before moose moved into northwest B.C., wolves mostly ate small mammals and deer, and, in the fall, salmon. However, as moose migrated into the northwest, suggestions are that wolf packs followed the migrating moose, impacting on the native wolves in this area. This change of subspecies increased the diversity of the present day wolves to be able to attack prey that would be of greater value to these predators. Wolves mainly live in the foothills and mountain valleys but, in winter, wolves move out into the moose winter ranges. In winter, Pollard (2010) suggests that wolves primarily live where the moose live.

The moose have become an integral part of the wolves' ecosystem. As moose populations increase, so do wolf populations and if moose populations decrease, so do the wolves. The numbers for each species are relative to one another. For example, in Prince Rupert, the moose populations in that region are few; therefore, the populations of wolves are stable. In contrast, the moose population in the Terrace area are high, so the number of wolves in this area will fluctuate (Hoffos, R., 1987) For the most part, moose have become the **main food source** for wolves and it is these predator qualities of wolves that put fear into many people who consider wolves as a danger instead of a valuable asset to this area. If wolves ceased to exist, moose populations would increase drastically, possibly over-powering the sustainable habitat in this area. Wolves, besides managing for moose, manage other small mammals like voles and snowshoe hares. The presence of wolves have been known to be detrimental to livestock; however, in the Terrace area, the numbers of livestock are so small that the number of losses found in the Skeena region are marginal compared other areas like Alberta (Hoffos, R. , 1987)

Overall, moose and wolves are important contributors to this area and, if moose management plans are not put into action soon, one cannot help but imagine the detrimental affects it will have on the Lakelse Watershed. Not only will moose and their predators be affected, but the remainder of the ecosystem could be affected by either a surplus of moose/overgrazing or a loss of moose/loss of moose as prey. Good or bad, **change is a likely expectation** if moose populations are not stabilized.

Moose in rural residential subdivision in the Terrace area. Moose, which browse on woody twigs in winter, are attracted to residential yards by shrubby growth resulting from disturbance, plus edible species such as fruit trees and berry bushes. There is evidence that they will also use proximity to houses to escape predation from wolves. This can lead to conflicts with dogs and people (Kerby, 2009).

Photo: Emily Braam

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Young moose in rural residential subdivision near Terrace, B.C. Cow and calf had entered yard and were grazing on the cedar and red osier dogwood at the side of the yard. Conflicts occurred with the resident dog. As residential development increases adjacent to Lakelse Lake, moose, especially cows and calves, which need lowland valley areas as winter range, are placed in conflict with the residents of these areas, leading to displacement of the moose from former habitat areas (Kerby, 2009). Photo: Emily Braam

SECTION 9

LAKELSE 2060

Photo: Public Domain

Through a Grizzly Bear's Eyes

by Chrysta MacKeigan Burkitt

Hypothetical Projections of the Health of Grizzly Bear Populations using Vortex Model Analysis

North Coast GBPU Management

by

Chrysta MacKeigan Burkitt

4/12/2010

Editorial Note: ALL PROJECTIONS IN THIS PAPER ARE HYPOTHETICAL ONLY AND ARE NOT INTENDED TO BE USED FOR ANALYSES OR PROJECTIONS OF GRIZZLY BEAR POPULATIONS IN PLANNING PURPOSES.

Some of the values used in these projections have been taken from other populations of grizzly bears and may not reflect the values inherent to the North Coast GBPU population.

The grizzly bear, *Ursus arctos horribilis*, once roamed British Columbia with a population of approximately 25,000. In present day, only half the population is left to occupy 90% of the historical range of the province. Human activities are largely responsible for much of the grizzly bear decline. These activities include agriculture, plantation forestry, highways, hydroelectric developments, and settlements which all play a part in fragmenting and eroding valuable grizzly habitat. Population viability analysis (PVA) was conducted using demographic data obtained from several publications to determine the current trend of the North Coast GBPU. To observe the trends in the population, the mathematically based model VORTEX was used. Three scenarios were developed to evaluate data assumptions of reproductive strategies (polygynous versus monogamous), reproductive rates, and birth ratios. Scenarios were simulated to determine the trend in the GBPU as a result of the current threats: inbreeding, hunting, and reduced carrying capacity. Three recovery strategies, including increased carrying capacity, reduction of cub mortality, and increased percent of females breeding were simulated. Current threats and recovery strategies were modelled against a control population to determine both their significance, and the effects that they may have on the persistence of the grizzly bear population. The most detrimental threat simulated was a 5% decline in carrying capacity, while all of the support strategies had similar results.

9.1 Introduction

The grizzly bear, *Ursus arctos horribilis*, is a subspecies of the North American brown bear (Gyug, Hamilton, & Austin, 2004). The brown bear is the most widely distributed member of the Family Ursidae, having populations in North America, Europe, and Asia (McLellan, Servheen, & Huber, 2010) (Appendix Figure A). In British Columbia, the range of grizzly bears has been divided into Grizzly Bear Population Units (GBPU). There are 57 GBPUs which represent individual populations. The boundaries of GBPUs in coastal and northern British Columbia follow natural and ecological boundaries or transition areas while the boundaries in the south follow natural and human caused fractures in the distribution (Hamilton, Heard, & Austin, British Columbia Grizzly Bear (*Ursus arctos*) Population Estimate, 2004). The grizzly bear is listed as least concern (LC) on the Red list of Threatened Animals by the World Conservation Union (IUCN). It is estimated that there are 25,000 grizzly bears in all of Canada (McLellan, Servheen, & Huber, 2010). However, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists this species as a special concern (SC). The grizzly bear is at risk of habitat degradation due to expanding industrial, residential, and recreational developments. These habitat factors, in addition to sensitivity to human caused mortality, make this species a special concern (COSEWIC, 2009).

The grizzly bear is the second largest member of the Ursidae Family, with its weight reaching up to 500kg and exceptionally large bears having recorded weights up to 680kg (Gyug, Hamilton, & Austin, 2004). The average weight of the female is 130kg (290lbs) while the average weight of the male is 220kg (480lbs) (Blood, 2002). In the measurement from nose to tail, grizzly bears average 1.8m long, though there are records of bears 2.7m long (Gyug, Hamilton, & Austin, 2004). In addition to their large size, many grizzly bears have silver or cream tipped guard hairs that create a grizzled appearance (Schwartz, Miller, & Haroldson, 2003). Their coat colour is highly variable, making it an unreliable characteristic to distinguish grizzly bears. Other than a grizzled appearance, grizzly bears can be distinguished from other bear species by their dished facial profile, presence of a hump of muscle on their shoulders, and long front claws. The hump and front claws are adaptations for digging (Gyug, Hamilton, & Austin,2004).

Grizzly bears occupy a variety of habitats, including old-growth forests, coastal sedge meadows, and avalanche slopes (Schwartz, Miller, & Haroldson, 2003). Activities such as forage, security, and hibernation require different habitats. Forage occurs often in non-forested areas, areas of partial forest, or older forests with tree gaps. A closed forest close to foraging sites is beneficial for security and day bedding. Hibernating individuals select steep north-facing slopes for their dens. The soils must be suitable for digging and vegetation must be present to stabilize the roof while allowing snow to accumulate for insulation (Gyug, Hamilton, & Austin, 2004).

The movement of grizzly bears among different habitat is influenced by key food items, reproduction, security, and human disturbance. These factors define the home range of the grizzly bear (Schwartz, Miller, & Haroldson, 2003). For grizzly bears in coastal British Columbia, the home range is an average of 137 km^2 for males and 52 km^2 for females. Female grizzly bears of the same lineage tend to have overlapping home ranges as the dispersal as they age is approximately 10 km from the home range used as cubs with their mothers (Gyug, Hamilton, & Austin, 2004). It has been suggested that these overlaps of kin may reduce the cost of mutual tolerance (Schwartz, Miller, & Haroldson, 2003). The home range of male grizzly bears often overlaps with several adult females. The average dispersal for male grizzly bears is 30 km from the range they used as cubs with their mothers (Gyug, Hamilton, & Austin, 2004).

Grizzly bears are typically solitary animals. Social groups of grizzly bears are observed during the mating season, in sows with cubs, and sibling groups (Gyug, Hamilton, & Austin, 2004). Grizzly bears have a lifespan of 20-30 years; during this time they may reproduce several times (Gyug, Hamilton, &

Austin, 2004). Grizzly bears are polygamous animals (Blood, 2002). Male grizzly bears may breed with multiple females and vice versa during a breeding season. The breeding season is typically May to July and females normally bear their first litters at five to eight years of age (McLellan, Servheen, & Huber, 2010). The females remain in estrus throughout the breeding season until mating occurs, however, they will not ovulate again for two to four years after giving birth (Gyug, Hamilton, & Austin, 2004). Implantation of the blastocyst is delayed until late autumn (McLellan, Servheen, & Huber, 2010). The combination of being polygamous animals and having delayed implantation may explain how littermates may have different fathers. Litters range in size from one to three cubs, though rarely four or more cubs have been reported in the same litter (McLellan, Servheen, & Huber, 2010). Cubs are born in January or early February while the mother is hibernating (McLellan, Servheen, & Huber, 2010). At birth, the cubs weigh 0.5 kg (1lb) (Blood, 2002), are blind, and lack fur (Gyug, Hamilton, & Austin, 2004). The sows nurse the cubs until late April or May when they emerge from their dens (Blood, 2002). Although the cubs are weaned at five months of age, they remain with their mothers until at least their second spring but more often their third or fourth (Gyug, Hamilton, & Austin, 2004).

The productivity and density of grizzly bears corresponds with the productivity of their habitat (McLellan, Servheen, & Huber, 2010). Despite often being referred to as carnivores, grizzly bears are omnivore animals. They are efficient predators and scavengers but rely heavily on a vegetarian diet for most of the season (Gyug, Hamilton, & Austin, 2004). The diet of the grizzly bear changes considerably as the seasons change. These diet changes occur to make use of the most digestible food of the time. On the coast, grizzly bears feed on green vegetation such as skunk cabbage (*Lysichiton americanus*) and sedges located in estuaries when they emerge from their dens in the spring (Gyug, Hamilton, & Austin, 2004). As the snow recedes up the avalanche chutes, grizzlies follow to feed on emerging vegetation and roots. Floodplains and lower slopes provide grizzly bears with vegetation including devil's-club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), raspberry (*Rubus* spp.), black twinberry (*Lonicera involucrata*), elderberry (*Sambucus* spp.) and a variety of blueberries (*Vaccinium* spp.) (Gyug, Hamilton, & Austin,2004). Grizzly bears switch from their vegetation diet once the salmon (*Oncorhynchus* spp.) begin travelling upstream. Salmon then comprise most of the grizzly bear diet until late fall. Once the salmon supply is deteriorated, grizzlies return to a diet based on vegetation such as skunk cabbage (Gyug, Hamilton, & Austin, 2004). When the opportunity presents itself, grizzlies will feed on insects, grubs, and mollusks or other animals in the intertidal zone (Gyug, Hamilton, & Austin, 2004).

Grizzly bears once occupied large portions of North America, Europe, Asia, the Middle East, and North Africa (McLellan, Servheen, & Huber, 2010). In North America, grizzly bears ranged from as far south as northern Mexico and as far east as the Great Plains and Hudson Bay (Blood, 2002) (Appendix Figure B). In British Columbia, grizzly bears still occupy approximately 90% of their historic range. This range extends across northern British Columbia, south in the Coast Mountains to Jervis Inlet, and down through the Rocky, Purcell, and Selkirk mountains to the Canada-United States border (Blood, 2002). Previous to the settlement of Europeans in British Columbia, approximately 25,000 grizzly bears roamed throughout the province. At present day, approximately half as many grizzly bears are left (Blood, 2002). Though grizzly bears are still relatively abundant in the northern areas of the distribution, the southern portions have become highly fragmented (McLellan, Servheen, & Huber, 2010). Human activities are responsible for much of the grizzly bear decline. Negative human influences such as agriculture, plantation forestry, highways, hydroelectric developments, and human settlements fragment and erode valuable grizzly habitat (McLellan, Servheen, & Huber, 2010).

The main objective of this study was to determine if the North Coast GBPU could sustain itself despite the current land use trends in the area, particularly those trends in the Lakelse Watershed.

9. 2. Methods

Initial baseline figures were entered into VORTEX based on values reported by Herrero *et al*., (2000) and Hamilton *et al*., (2004) (Table 1). Preliminary trials were run using the Habitat Capability Population Estimate (269) and Habitat Effectiveness Population Estimate (250) Hamilton *et al*., (2004).

Table 1. VORTEX Baseline Input Values

VORTEX INPUT	**VALUES from Herrero *et al*., (2000) and Hamilton *et al*., (2004)**	
Iterations	500	
Total Years	100	
Definition of Extinction	Quasi-Extinction: 10 Bears	
Sex Ratio	50:50	
Inbreeding Values	3.14 lethal alleles	
Breeding System	Polygamous	
Males in Breeding Pool	25%	
Females in Breeding Pool	27% (SD 13.6%)	
First Breeding Age: Females	6	
First Breeding Age: Males	8	
Maximum Breeding age	20	
Mortality Rates (%)	Males	Females
0-1 Years	12	12
1-2 Years	10	10
2-3 Years	2.5	2.5
3-4 Years	16.3	5.7
4-5 Years	16.3	5.7
5-6 Years	16.3	5.7
6-7 Years	16.3	1.2
7-8 Years	16.3	1.2
8+ Years	6.6	1.2
Litter Size:		
1	Percent:	
2	26.3	
3	52.6	
	21.1	
Initial Population Size		
	214	

Three threats were applied to each of the initial baseline figures (Table 2). The first was altering the lethal equivalents of the inbreeding depression to 1.0 and 6.0. The second threat applied was harvesting of individuals. Harvesting began the first year of the program, routinely harvesting four adult males and two adult females every year for the entire 100 year duration of the program. The third threat explored was the reduction of carrying capacity per year. Three simulations of reduced carrying capacity were run. In one scenario, the carrying capacity was reduced by 0.1% per year while the other two scenarios had reductions of 2.5% and 5% per year.

Table 2. VORTEX Threat Input Values

VORTEX INPUT	VALUES
THREATS	
Inbreeding	
Initial Lethal Equivalents	3.14
Scenario 1: Decrease Lethal Equivalents	1.0
Scenario 2: Increase Lethal Equivalents	6.0
Harvesting (Hunting)	
First Year of Harvest	1
Last Year of Harvest	100
Interval between Harvests	1
Adults Harvested	4 Males, 2 Females
Carrying Capacity (K)	
Scenario 1 Reduce (K)	0.1%
Scenario 2 Reduce (K)	0.25%
Scenario 3 Reduce (K)	2.5%
Scenario 4 Reduce (K)	5.0%

Table 3. VORTEX Recovery Strategy Input

VORTEX INPUT	VALUES	
RECOVERY STRATEGIES		
Increase Carrying Capacity (K)		
Increase per year (%)	0.01	
Reduction in Cub Mortality		
Initial Cub Mortality (%) 0-1 Years 1-2 Years 2-3 Years	Males 12 10 2.5	Females 12 10 2.5
Adjusted Cub Mortality (%) 0-1 Years 1-2 Years 2-3 Years	Males 6 5 1.25	Females 6 5 1.25
Increased Adult Females Breeding (%)		
Initial Female Breeding	27%	
Adjusted Female Breeding	33%	

Three recovery or support strategies were applied to the baseline figures. The first recovery strategy applied was an increase in carrying capacity by 0.01% per year in hopes to correct poor planning practices and human encroachment into bear habitat. The second support strategy was reducing cub mortality. Initially, cub mortality (cubs being classified up to the age of dispersal from the sow) was 24.5% for male and female cubs. To anticipate effective management and monitoring of infant grizzly bears, the mortality was decreased by 50%. The third support strategy involved increasing the percent of adult females breeding. Initially Herrero *et al.*, (2000) reported 27% of adult females breeding with a 13.6% standard deviation. To maximize offspring production, the percent of adult females breeding was increased to 33% as females produce a litter on average every three years. Assuming 100% of the adult females are breeding with a litter produced every three years, would result in an annual percent of adult females breeding of 33%.

9.1 Results

Baseline Trials

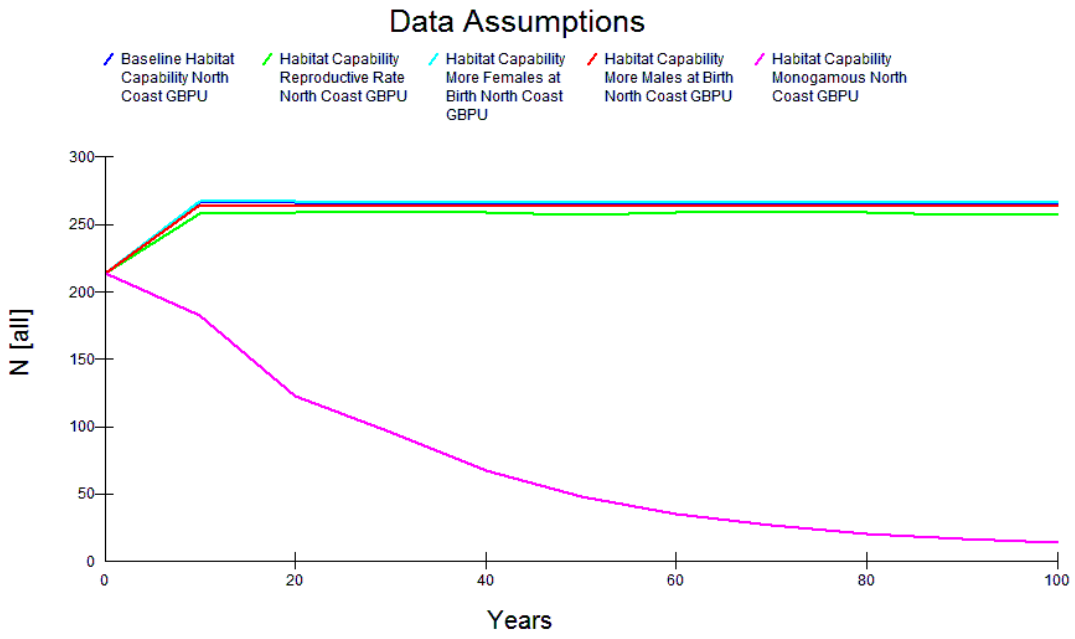

Figure 1. Data Assumptions Modelled against the Habitat Capability Population Estimates.

Data assumptions were equal birth ratios, 27% females breeding, with polygamous mating. The monogamous mating scenario showed that polygamous mating was important. Altering the number of females and males at birth did not have an effect during the course of 100 years. The reproductive rate scenario did see a small decline in population following a reduction in the percent of females breeding.

Threats

The threats had a range of effects on population size (Figure 2). The alteration of lethal equivalents did not show an effect on the population size in either the habitat capability model or habitat effectiveness model (Appendix Figures E and F).

The harvesting of six individuals per year showed a decrease in population size (Figure 2). In both the habitat capability model and the habitat effectiveness model, the population increased to just below carrying capacity during the first approximate ten years (Appendix Figure G). Following this rise in population, the population set on a slow decline.

The third effect modeled on the population was four severities of reduced carrying capacity (Appendix Figure H). A decrease in carrying capacity of 0.1% per year produced a gradual decline in population over 100 years. Reductions of 0.25% per year in the carrying capacity lead to a population decline over 100 years. The third and fourth severities modelled resulted in extinction at approximately 50 years for a reduced carrying capacity of 2.5% and 30 years for a reduced carrying capacity of 5.0% per year.

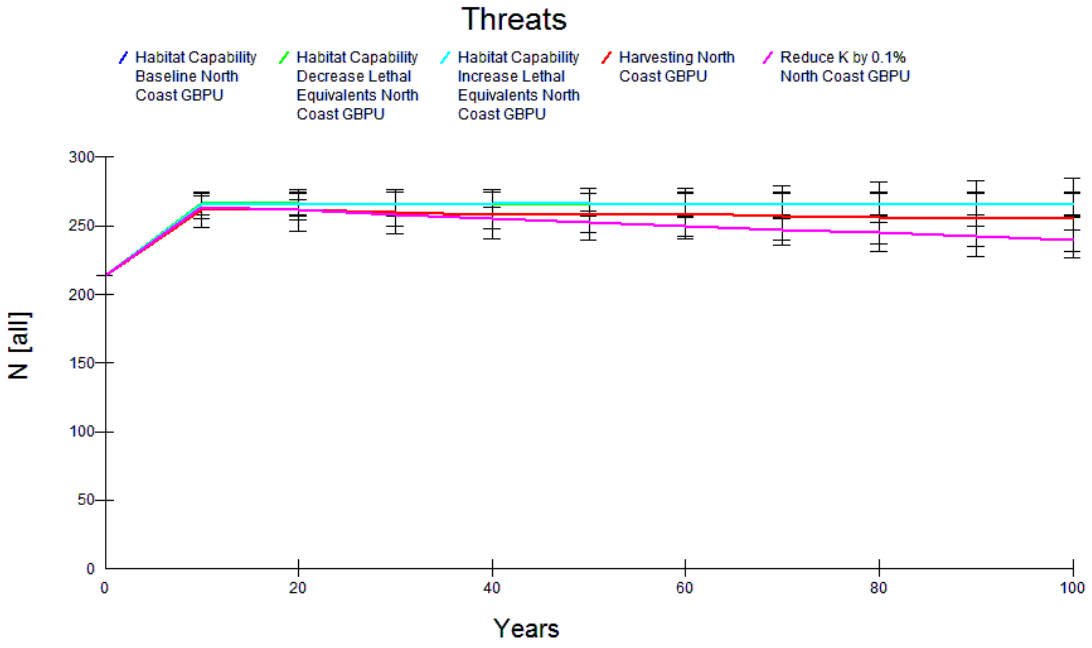

Figure 2. Threats Modelled against the Habitat Capability Population Estimates.

Recovery Strategies

Three recovery or support strategies were proposed. All the recovery strategies maintained the population around the original carrying capacity (Figure 3). The first recovery strategy proposed was increasing the carrying capacity by 0.01% per year. The second support strategy was to decrease cub mortality by 50%. The mortality of grizzly bears ages 0-3 were reduced to half in this model. The third support strategy modelled was an increase in adult females breeding from 27% to 33%.

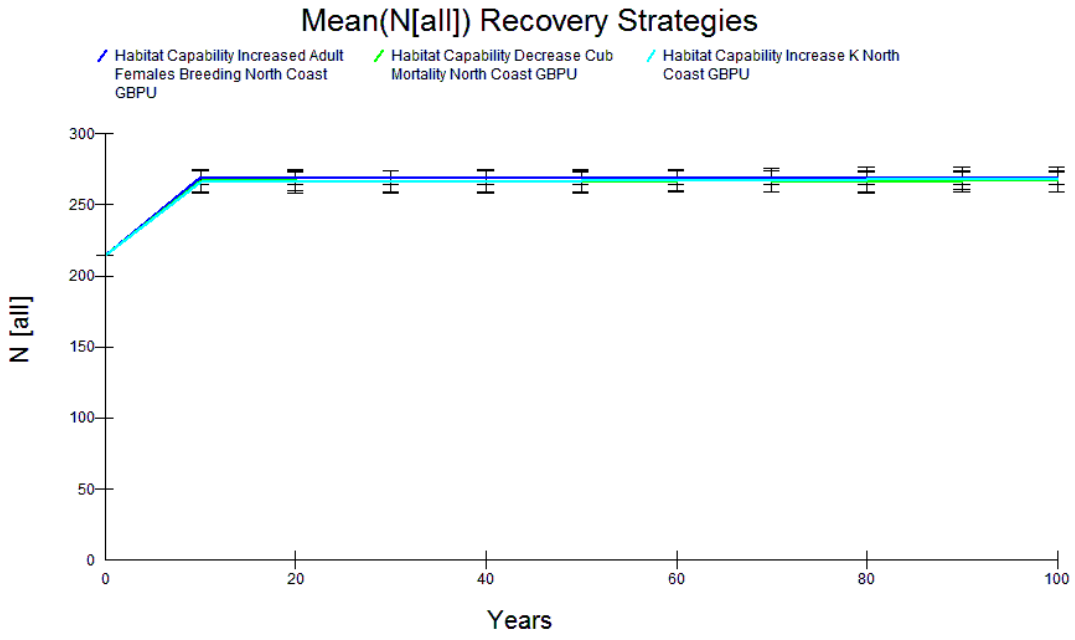

Figure 3. Recovery Strategies Modelled against the Habitat Capability Population Estimates.

9.4 Discussion

VORTEX is a simulation model for population viability analysis (PVA) (Miller & Lacy, 2005). It is a Monte Carlo simulation of the effects of deterministic forces in addition to demographic, environmental, and genetic stochastic events on wild populations. Population dynamics are modeled as discrete sequential events occurring as defined probabilities.

The results given by VORTEX do not provide absolute answers as the interactions of many parameters are projected stochastically and there is a random process in nature that a computer simulation cannot account for (Herrero, Miller, & Seal, 2000). This study illustrates how PVA models can be used to modify the ecology and predict population trends of animals in areas where human activities may have a significant impact.

Many factors have lead to the grizzly bear population decline; many of these factors are human caused. Values from Herrero *et al*., (2000) and Hamilton *et al*., (2004) were used to run simulations of the grizzly bear over 100 years. Within a century, much of the habitat and environmental conditions can change. Factors such as mortality and viable habitat are unlikely to remain constant over such a time period.

The patterns produced by the results are simply indicators of trends that may occur if the conditions are applied at a constant rate. This study integrated two habitat variations into all of the scenarios. These habitats were based on habitat capability population estimates and habitat effectiveness population estimates reported by Hamilton *et al*., (2004) (Appendix Figure A).

In this investigation, a number of scenarios were implemented to learn how different situations affect the population of grizzly bears. **Inbreeding, harvest, and carrying capacity** were scenarios used to examine the effects on grizzly bear populations in the North Coast GBPU (Figure 2). **Increasing carrying capacity, reducing cub mortality, and increasing the percent of breeding females** were recovery strategies simulated in VORTEX (Figure 3).

The validity of the scenario results is limited by the **lack of detailed information on the North Coast GBPU**. Much of the biological inputs used in these scenarios were obtained from the grizzly bears of the Central Rockies Ecosystem which is an inland ecosystem while the North Coast GBPU is a coastal ecosystem. In addition, **dispersal is prevalent** between GBPUs though without knowledge of dispersal in and out of the North Coast GBPU, the GBPU was treated as an isolated population.

With increasing human impacts, grizzly bear habitat is being degraded in many areas. Grizzly bears in the North Coast GBPU are at risk of **habitat fragmentation**. Some grizzly bears in the area move from the upper Kitimat River watershed, across Onion Lake flats to the area surrounding Lakelse River. A portion of these bears may also continue moving up the Exstew and as far as the Khutzeymateen. A **new landfill** has been proposed in the Onion Lake area which would disrupt the movement of grizzly bears through the area. This location for a new landfill could potentially fragment the population.

Habitat fragmentation is a serious threat that isolates population units and may lead to an accumulation of deleterious demographic and genetic impacts (McLellan, Servheen, & Huber, 2010). Though the model did not show an effect on the grizzly bear population when the lethal equivalents of inbreeding are altered, inbreeding depression reduces the fitness of individuals as a result of breeding with close relatives (Beebee & Rowe, 2008). Had the simulations been run for a longer time period, the effects of inbreeding may have been observed more readily.

The harvest of grizzly bears is monitored by the Director of the BC Fish and Wildlife Recreation Allocation Branch. The director determines the number of **Limited Entry Hunting** authorizations available for each area based on technical input from provincial wildlife biologists (Austin, Heard, & Hamilton, 2004). The purpose of the Limited Entry Hunting is to achieve the wildlife management objectives without shortening seasons or completely closing areas to hunting (Ministry of Environment, 2007). The allowable human-caused mortality of grizzly bears in the North Coast GBPU is 3.2% (Gailus, Moola, & Connolly, 2010). In the harvest scenario, harvest rates were low enough to not have a significant impact on the overall population over 100 years.

However, harvest does not account for the **bears killed illegally**, along **highways**, or **for management reasons**. High human densities, intensive agriculture, and livestock grazing prevent people from co-existing with grizzly bears. For reasons of public safety, every year approximately 50 grizzly bears are killed by Conservation Officers (Blood, 2002).

The **Lakelse area** has some of the best habitat suitability and forage supply (Hamilton, Grizzly Bear Population Questions from College Student, 2010). In coastal areas with abundant levels of spawning salmon, high densities of grizzly bears and high reproductive rates are observed (McLellan, Servheen, & Huber, 2010). The productivity of grizzly bears is highly reliant upon the **carrying capacity** of the area.

In the model, large declines in the grizzly bear population size in the GBPU were observed as the carrying capacity was reduced.

The reduction of carrying capacity in the Lakelse area can also be linked to **human activities**. Carrying capacity reflects the availability of space, food, and other environmental resources. Human activities often reduce the amount of space and food available to wildlife.

According to Hamilton (2010), in order to **maintain a population of grizzly bears** in the area in the future, several factors must be addressed. Grizzly bears need a link to and from seasonally important habitats in the area. The seasonally habitats need protection and to remain intact without fragmentation. The landscape forage supply must also be maintained. All sources of human caused mortalities must be kept to a minimum, even if that means no legal hunting in the future if habitat supplies are dwindled. Lastly, the active road density and traffic use should be minimized to reduce the impact on grizzly bears.

Though some residents may not desire to have grizzly bears roaming around their property, grizzly bears are an **important keystone species** (Gailus, Moola, & Connolly, 2010). Grizzly bears are ecosystem engineers. They regulate prey species; disperse seeds; aerate soils when digging for roots, nuts, and ground squirrels; and supply nitrogen to trees by dragging salmon carcasses into the forest (Gailus, Moola, & Connolly, 2010). It has also been said that grizzly bears are an indicator of sustainable development as when there are viable populations of grizzly bears, the landscape is being managed sustainably (Gailus, Moola, & Connolly, 2010).

Scientists predict that with the **current rate of human caused habitat degradation**, grizzly bears could become threatened or critically endangered in about half their current B.C range by 2065 (Gailus, Moola, & Connolly, 2010). Conservation is a slow process and costly process therefore prevention is a more practical approach to grizzly bear management.

B.C. has several pieces of legislature or methods to maintain healthy grizzly bear populations. For example, the Ministry of Forests and Range determine how much of the forest will be cut (including how many kilometres of roads required for removing logs) and how many cattle or other livestock can graze in grizzly bear habitat (Gailus, Moola, & Connolly).

In 1995, the British Columbia ***Grizzly Bear Conservation Strategy*** was published. This publication provides a blueprint for the conservation and management of B.C.'s grizzly bear population. It addresses the number of grizzly bears killed by hunters each year and establishes grizzly bear management areas (GBMAs) that include no hunting zones in each of the 57 GBPUs. Despite the strategies outlined by this publication, they have not been implemented to date (Gailus, Moola, & Connolly, 2010).

At a more local level, the ***Kalum Land and Resource Management Plan*** outlines objectives and strategies for grizzly bear management in the area. It is designed to help meet the goals of the provincial Grizzly Bear Conservation Strategy and provides the framework to manage grizzly bears and their habitat throughout the LRMP area (Government of British Columbia, 2002).

Grizzly bear management of the North Coast GBPU may benefit from **further studies** monitoring the biological characteristics of the species and their behaviour. This would allow for future, more accurate population viability analyses. **Education**, such as bear aware programs, in surrounding communities is also very important. If people are uneducated about how to co-exist with bears, there will continue to be illegal and management killings. Lastly, **implementation of studies** such as the British Columbia ***Grizzly Bear Conservation Strategy*** may help slow the decline of GBPUs and allow for a viable population to persist for future generations.

APPENDICES

Figure A. British Columbia Grizzly Bear Population Units. (Gailus, Moola, & Connolly, 2010)

Figure B. Current and Historical Ranges of Grizzly Bears in North America. (Ministry of Environment, 2007)

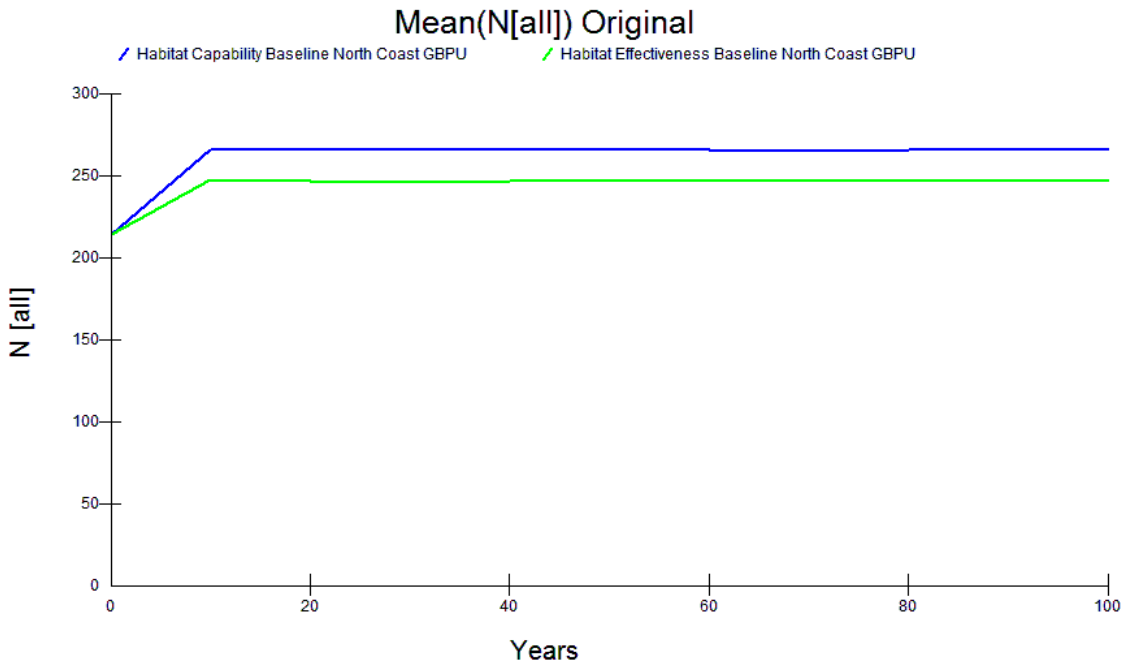

Figure C. Original Data from Herrero et al., (2000) and Hamilton et al., (2004) modelling Habitat Capability and Habitat Effectiveness Population Estimates.

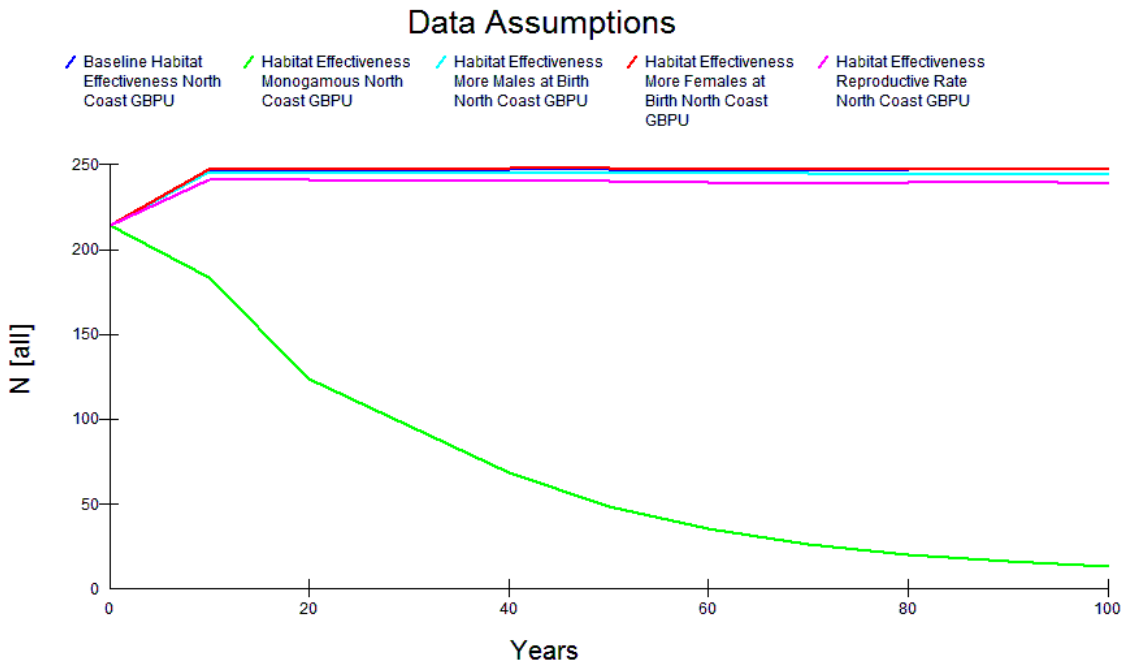

Figure D. Data Assumptions Against the Habitat Effectiveness Population Estimate.

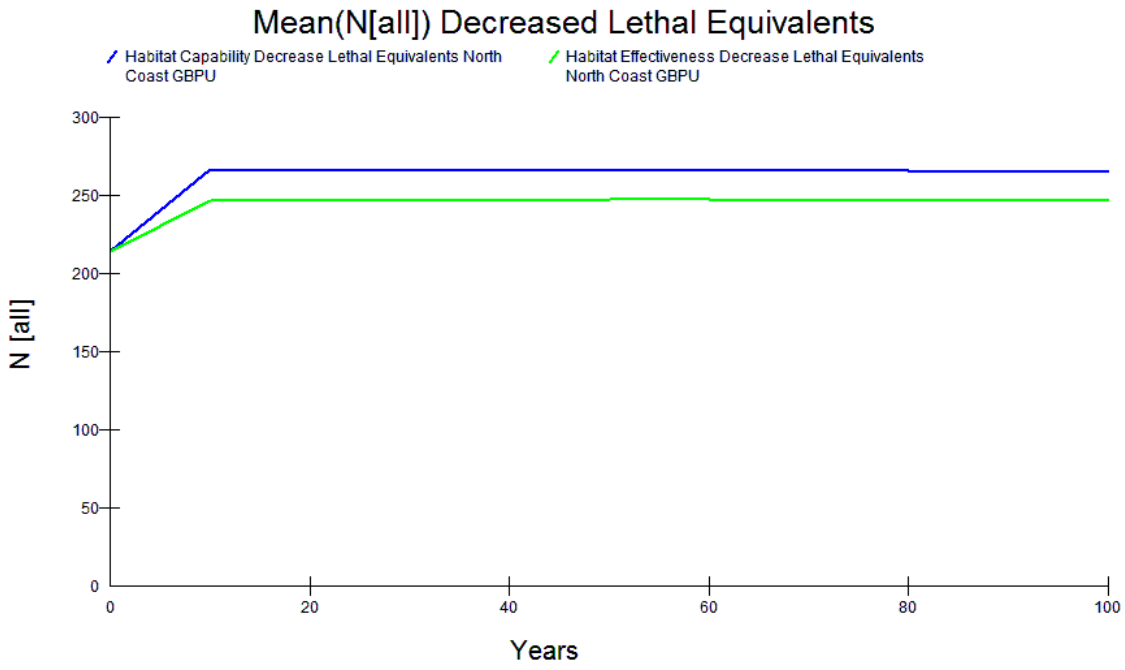

Figure E. Two Baseline Populations Subjected Lethal Equivalents of 1.0.

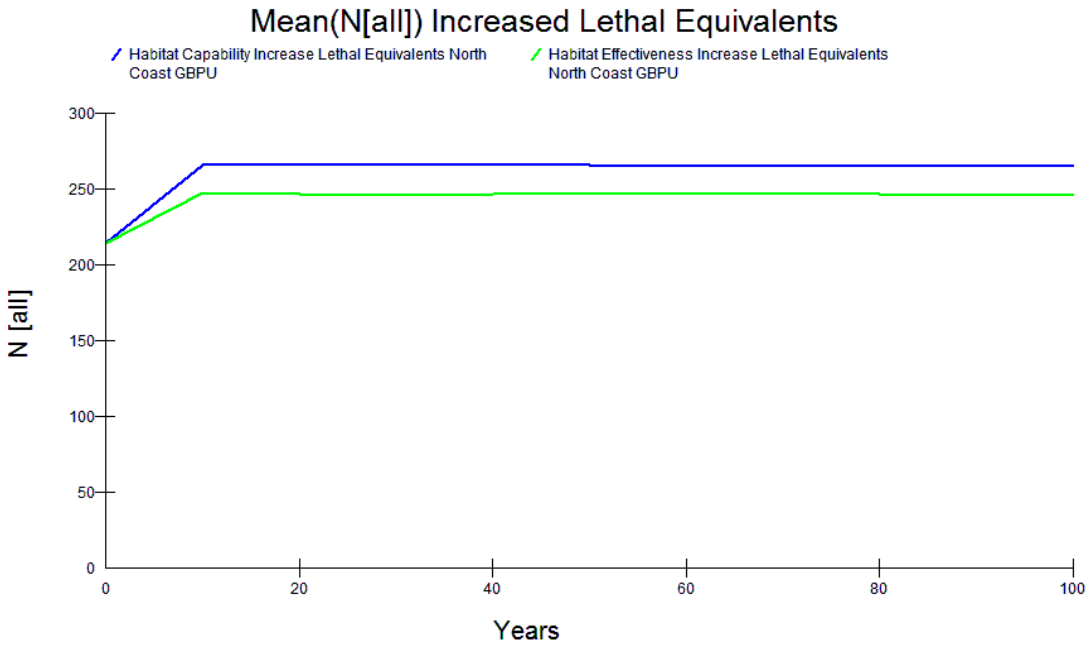

Figure F. Two Baseline Populations Subjected to Lethal Equivalents of 6.0.

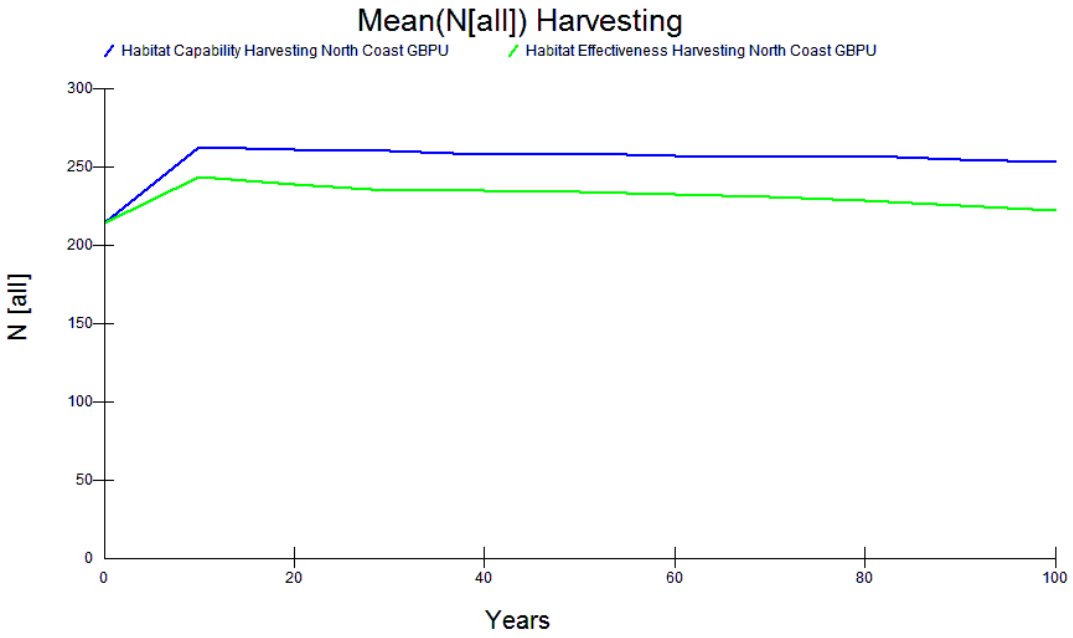

Figure G. Two Baseline Populations Subjected to the Harvesting of Two Female Grizzly Bears and Four Male Grizzly Bears per year.

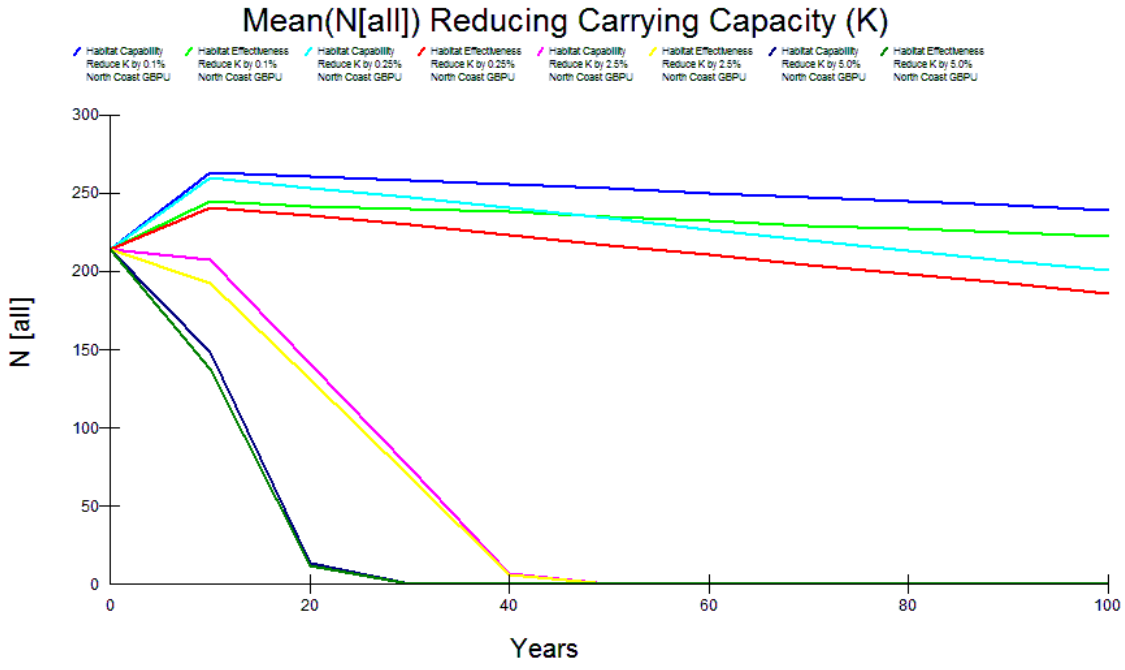

Figure H. Two Baseline Populations Subjected to Reduced Carrying Capacities of 0.1%, 0.25%, 2.5%. and 5.0%.

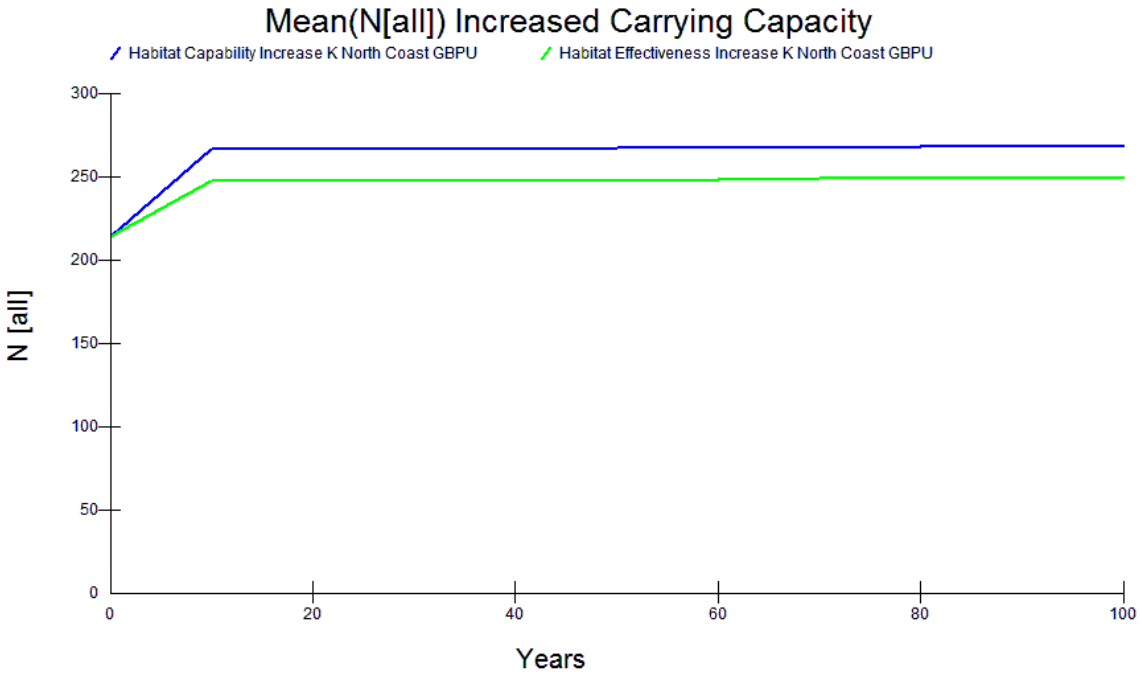

Figure I. Two Baseline Populations Subjected to an Increase in Carrying Capacity of 0.01% per year.

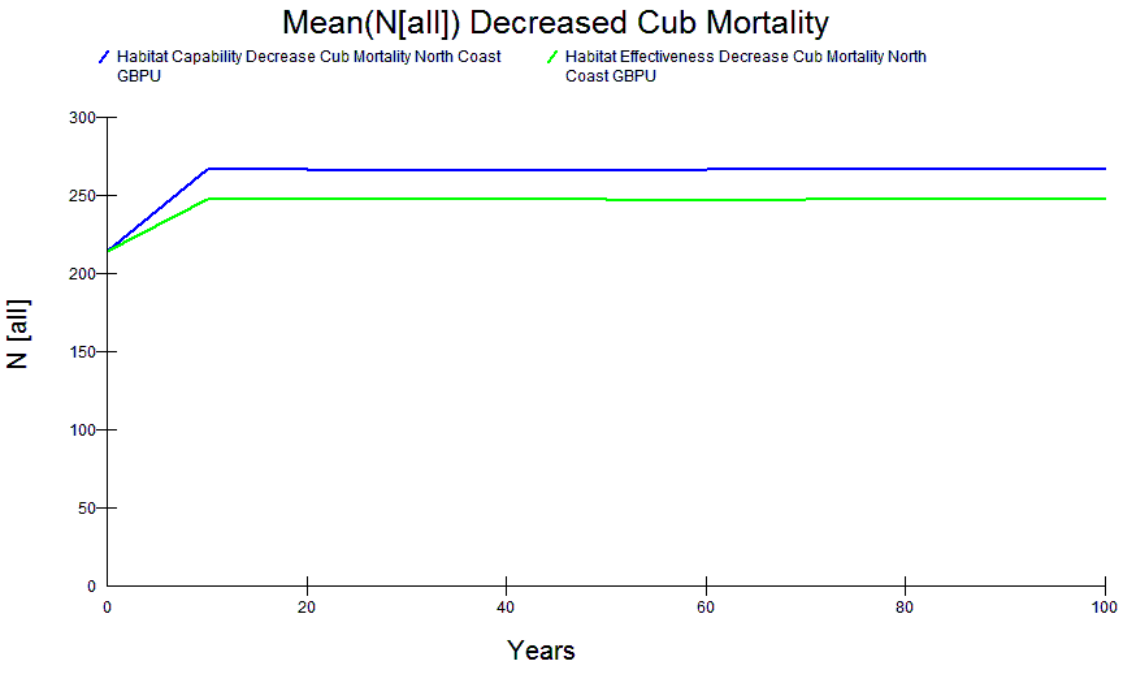

Figure J. Two Baseline Populations Subjected to a Decreased Cub Mortality of 50%.

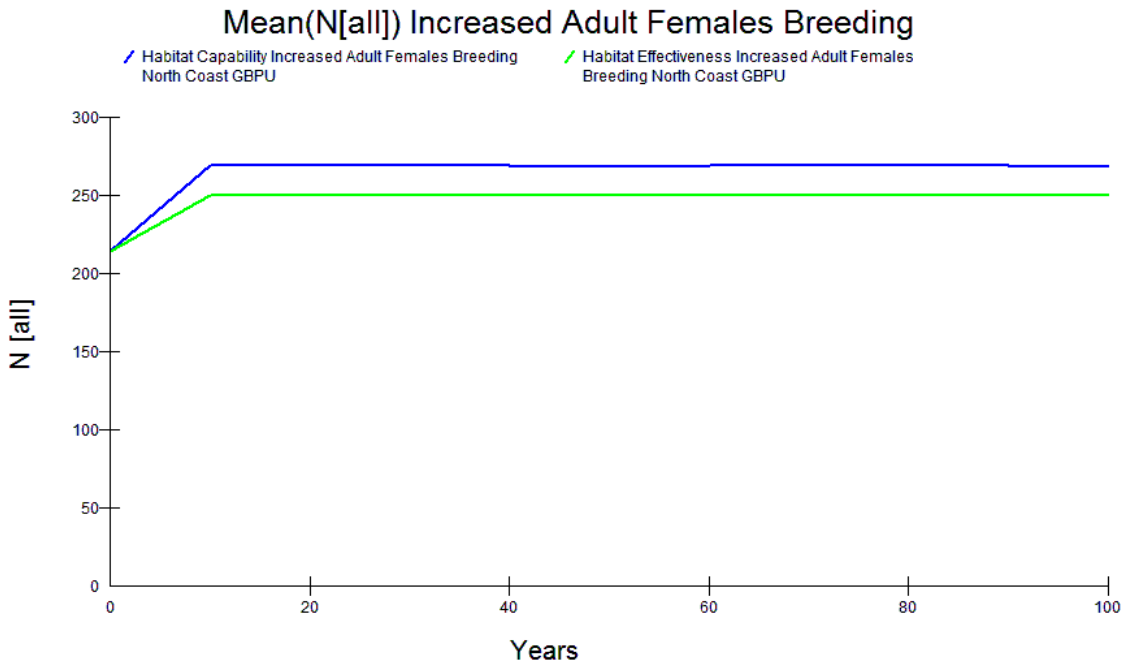

Figure K. Two Baseline Populations Subjected to an Increase in Adult Females Breeding from 27% to 33%.

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SECTION 10

LAKELSE 2060

Motorized Recreation in the Lakelse Watershed

by Rodney Brown

10.1 Executive Summary

Projecting ahead to 2060, how much motorized use can Lakelse Lake and the adjacent wetlands accommodate before there are impacts on other non-recreational resources?

The forms of motorized recreation in this study focused on snowmobiles, high speed water sports, ATV's and dirt biking. The growth of these activities in the past was examined and use was projected forward. The study examined motorized recreation in other areas, and how or why it is regulated. There is also a focus on environmental impacts caused by these specific activities. Current legislation was reviewed, including park bylaws, back country stewardship, and regional management plans. Recent studies and statistics are included in the appendices. Recommendations were made on how we can provide a balance between interests, and maintain stability to the local ecology of Lakelse Lake.

10.2 Introduction and History

The culture of northern B.C, and particularly in the Kalum Forest District, embrace outdoor recreation almost as if it is more than a privilege. Outdoor recreation, and specifically motorized recreation, is a large part of what living up north is about. Motorized recreation is also a large derivative of the tourism industry, and the tourism industry is one of the largest economic drivers in Canada. Lakelse Lake is a location in northern B.C. that has a tourism ancestry but an undefined legacy. In this study, we need to define what Lakelse Lake's future is in regards to motorized recreation for the next 50 years.

Lakelse Lake has 3 provincial parks, including camping grounds and beaches. It also has a potential world class resort, private camp grounds, and a few boat launches. There are residential areas that have the ability to provide recreational getaways in droves.

Lakelse Lake is also becoming a large bedroom community for Terrace and Kitimat. Life at Lakelse Lake is not easy and development has been on the forefront recently. The area is lacking urban amenities. There is a lack of community sewage and water utilities, so life is also primitive and needs to be addressed. The Lake itself has shown a decline in water quality, with an increase in mineral, biological, and biohazardous contaminations. The aquatic life numbers in the Lake have recently decreased, and so has the wildlife around the Lake.

The Lakelse Lake Watershed Society has particular concerns about the ecological decline and approached the college to look at the problems and to contribute information and ideas in a class study. The Watershed Society's broad concern is water quality. Their immediate concerns regarding Motorized vehicles: ATV use, dirt bikes, etc having significant impacts on the watershed . Motorized recreation is viewed primarily as destructive e.g. ATVs disturbing moose and grizzly bears in Scully Creek and Clearwater Creek areas. Creek crossings should be bridged and restrictions should apply to the Lakelse Lake Wetlands Park at Clearwater Creek. This also applies to snowmobiling. On the lake, 2 stroke outboards should be phased out. The Wetlands Park should be off limit to power boats (canoes are OK). Waterskiing and wakeboarding should be controlled to prevent shoreline erosion from boat wash.

The history of these activities would indicate that there is an existence of this type of conduct within the Watershed. There is evidence, as we will see, that this type of conduct can cause local damage if not actively regulated. Are some of these concerns from the Watershed Society heuristically intuitive reactions to the greater damage caused by residents in general, overcrowding, or larger scale ecological degeneration caused from recent permanent residential development? It is a valid question with ethical ramifications, but this report only examines the smaller focus of motorized recreation.

On interviewing, at random, local recreationists and selective queries into the associations which advocate motorized recreation, I get a positive opinion of how motorized recreation is conducted. Motorized recreationists have openly admitted that there is action in the local area around the lake but claim residents are most of its riders. ATV use and off road 4X4's are common for the area. There is a lack of maintained roads, so, to explore the back country, these machines are very useful.

The major activities by the Motocross Association are said to be calculated and arranged by permit with the Ministry of Forests recreation officials. There are trails which are being used, maybe overused, but there is no infrastructure put forth to protect, regulate, or segregate the areas they have unofficially claimed. The Snowmobile Association claims their interests are generally away from the lake in the mountain ranges, but do admit local ice fishers may be using snowmobiles in naturally questionable or restricted areas like the wetlands.

Water-sports are big in the summer. These activities may be causing problems to the shoreline, in particularly at Waterlily Bay. Talking to some enthusiasts, I have learned that there is a respect in the use of personal watercraft and the like, by claiming the usage is done in the middle of the lake. Same as the water-skiers, as though to allow kayakers, wind surfers, and slower boats space from traffic. It makes sense in terms of safety. It also would imply that there is an effort of buffering in terms of shoreline erosion. If this is the case, is the Lake too small for these activities?

The sentiment from the recreationists seems optimistic. It is probable that the truth is a line between the two sides. There is some healthy activity culturally genuine to the area, however, there is also a probability that some activities have a direct effect on the ecosystems in all regards.

10.3. Potential Impacts

Tourism is a major economic driver in Canada. In 1996, it was the 6th largest industry for employment in Canada (1). Lakelse Lake is very attractive to local tourism, and has good potential to grow in this industry. Motorized recreation is a derivative of tourism. Motorized recreation has been growing, and the amount of money that Canadians spent on outdoor recreation in 1996 was 11 billion dollars (2). The growth of off-road vehicle use in the U.S.A. from 1982-95 increased 43.8%, with snowmobiles use increasing 34.8%. Compounding a population growth for the next 50 years, it could be expected a further gross gain of users will arrive locally.

Exercise is a benefit of outdoor recreation. Motorized recreation has anti-stress benefits, provides exercise, and is a social outlet to the increasingly docile lifestyle in North America, a continent that is increasing in obesity rates and coronary diseases (3).

Safety concerns are associated with motorized recreation. Snowmobiles have been causes of avalanches that have accounted for 20 deaths from 1984-1996 in Canada, a figure that has nearly doubled in the last 14 years (4). Other concerns for high speed recreation revolve around physical safety in all respects i.e. speeding, carelessness, and undo care and attention. There are also concerns for road kill and animal safety. In addition, noises scaring animals is probably unhealthy to them.

Hazardous contamination can result from motorized recreation. Hydrocarbons are constant factors of pollutants from these machines, especially in water crossings.

Soil erosion is also a focus by many major studies. Soil erosion can cause vegetative disruption and spreading of invasive plants (5). Overactive areas of recreation can suffer catastrophic levels of ecological decline when ungoverned (6).

Motorized recreation use along hydro right-of-way on Airport Bench – note soil damage
Photo: Rodney Brown

10.4 Current Restrictions and Signage

Contrary to what may be going on, there are some restrictions set forth by multiple governing bodies in the area. **Fisheries and Oceans Canada** has posted signage around the Scully Creek and Salmon Creek areas. These would strictly prohibit stream crossings with ATV's and 4X4's in regards to damaging fish habitat. Seemingly, there is little in terms of enforcement. According to the Community Advisors, the signs are constantly being removed.

Photo: Rodney Brown

There is a conflict however. The **Kalum Land and Resource Management Plan** (Map 9) shows that all of the above are recreation areas and oddly does not show a Non-motorized designation for either Scully and Salmon Creeks or the parks and wetlands. Eventually some kind of accord will have to resolve whether or not there is a true restriction in place for any of the aforementioned areas.

The **BC Parks** area supervisor was sure to mention that unlicensed vehicles, including all-terrain vehicles and snowmobiles, are not permitted in the parks adjacent to Lakelse Lake. This includes the wetland conservation area. Local residents report both ATV and snowmobile traffic in the parks.

South end of Lakelse Lake showing Lakelse Lake Wetlands Provincial Park to left of picture – accessed by motorized traffic through a number of old logging roads and skid trails. Photo: Rodney Brown

Special Notes from web page for Lakelse Lake Park: "Licensed motor vehicles, including motorcycles, are restricted to vehicle roads and parking areas. Please keep vehicles and equipment on the camp pads or driveways. Unlicensed vehicles, including all-terrain vehicles and snowmobiles, are not permitted in the park."

10.5. Stewardship

There are existing documents that promote stewardship. ***Wildlife Guidelines for Backcountry Tourism/Commercial Recreation*** is one of them. It's like the do's and don'ts of recreation, or rules for when rules do not exist from management plans. This should be regularly viewed by all motorized association members and tourists. The Kalum LRMP has a similar but a smaller dictation of stewardship guidelines for the area.

These are great ideals, but in practical use are not always as effective. Stewardship is best use for education rather than as a guide. We have these types of programs with the DFO. They come to schools, or the students have field trips at fish hatcheries. By explaining the significance of stewardship at the source, it is hoped that the sentiment is carried on. This could be the same with motorized recreation to a smaller extent. Outreaches to the associations in larger quantities may be an idea.

10.6. Comparisons and Studies

a.Studies

Unmanaged Motorized recreation; USDA Forest Service/ USDI Bureau of Land Management;

Best Management practices for Recreational Activities on Grasslands in the Thompson/Okanagan Basins;

Impacts of ATV Traffic on Undesignated Trails;

The Effects of Motorized Watercraft on Aquatic Ecosystems;

GRAND RIVER DAM AUTHORITY'S Lake Rules for Grand Lake, Lake Hudson, W.R. Holway Resevoir;

Kalum Land and Resource Management Plan, 2004.

b.Effects on soil and vegetation

Reduction of snow pack quality by motorized traffic such as snowmobiles affects the soil and vegetation over the winter. Primarily compaction and erosion may result in sedimentation in waterways. Motorized recreation traffic can also create dust which settles and damages plants, also interferes with photosynthesis.

Damage to grasses and forbs opens the door for invasive species, which could also be spread by the vehicles themselves. Invasive species can be toxic or out-compete native species.

Adverse effects are most evident where cross-country travel is permitted BUT NOT designed for motorized traffic, leading to disturbances to wetland and riparian plants, livestock, private property, forage, fences, stream banks, hiking trails, etc

c. Effects on wildlife

Scientific literature shows some species may be affected by noises causing displacement, in turn causing other problems to habitat and survival by causing hearing loss and stressing animals, depleting energy reserves leaving animals in an adverse situation. Other effects include:

-Damaging underground burrows and surface runways when vehicles travel off-roads and trails.
-Disturbing semi-aquatic mammals when vehicles travel over ice.
- crushing hibernating animals in the winter snow pack.
- Smaller mammals rely on the insulating effects of snow, which is also broken down by snowmobile use and in turn decreasing the survival rates.
-Deer and moose are susceptible to being hit by fast moving vehicles which can cause direct animal impact and deaths.

d. Effects of wake damage

Water Clarity, Quality, Shoreline Erosion, Aquatic Macrophytes, Fish, and other Aquatic Wildlife are affected from high speed water sports. Personal watercraft "Jet skis" and a equally destructive vehicle with a different type of propulsion engine, cause more focused damage in shallow waters. The notations of multiple adverse effects are documented on each of these items, suggesting management and regulations to spare the ecosystem from probable damage (*The Effects of Motorized Watercraft on Aquatic Ecosystems*, 2010).

e. Safety as a concern

Snowmobiles have been causes of avalanches that have accounted for 20 deaths from 1984-1996, a figure that has nearly doubled in the last 14 years (4). Other concerns for high speed recreation would revolve around physical safety in all respects i.e. speeding, undo care and attention, and collisions. There are also concerns for road kill and animal safety along right-of-ways e.g. hydro lines.

f. Conclusions from studies

Conclusions from the studies are that **ALL** ATV and snowmobile traffic have **adverse effects** on natural resources, regardless of size and horsepower. **Activities should not be near softer soils**. Avoid sensitive areas. The studies also imply that limiting ATV traffic to trails alone does not always protect natural resources. Snowmobiles should be **kept to trails** and away from riparian areas and frozen wetlands. Emphasis should be on **trail planning** and other key considerations to designing trail networks away from questionable areas.

10.7 Management Plan Ideas from Comparable Studies

Typically, management directives are put in place within land and resource management plans. Lakelse Lake falls within the **Kalum Land and Resource Management Plan** which has the following directives under "Resource Values and Issues": "**Outdoor recreation** experiences are key to the quality of life enjoyed by local residents. Management intent:

· Manage for a wide range of outdoor recreational activities and experiences.

· Recognize commercial recreation as a valid and appropriate use of Crown land, subject to the acquisition of required tenures/permits and conformance with approved management plans.

· Recognize support and desire from the Table for a commitment by the BC Forest Service to continue to provide and maintain the existing Recreation Site and Trail infrastructure."

In comparison, the **Grand River Dam Authority** (2010) provides a comprehensive format that sets in place law and enforcement rules for recreational use of the lake. This study provides examples of regulations for wave damage and other issues such as noise control.

a. Use of Breakwaters

A breakwater is a structure used to protect docks, shoreline, or other structures by stopping or slowing waves or wakes (*Note: there are concerns at Lakelse Lake over the use of breakwaters and their impacts on reedbeds, erosion of adjacent shores, amphibians, and fish habitat) .

b. Noise Control

No person shall operate a vessel that exceeds the noise level of ninety (90) decibels or within fifty (50) feet of any public or private dock or at any location between the hours of 9:00 p.m. through 9:00 a.m.

c. Biostabilization of Eroded Shorelines.

- Moderate contouring of the bank may be allowed to provide conditions suitable for planting of vegetation.

-Tightly bound bundles of coconut fibre, logs, or other natural materials may be placed at the base of the eroded site to deflect waves.

-Willow stakes and bundles and live cuttings of suitable native plant materials may be planted along the surface of the eroded area.

-Native vegetation may be planted within the shoreline management zone to help minimize further erosion.

d. Use of Riprap, Gabions, and Retaining Walls

- **Riprap** may be allowed along the base of the eroded area to prevent further undercutting of the bank

-Use of gabions and riprap is permitted to **stabilize eroded shorelines**. Gabions (rock wrapped with wire mesh) that are commercially manufactured for erosion control may be used. Riprap material must be placed so as to follow the existing contour of the bank.

-The riprap material must be quarry-run stone, natural stone, or other approved material.

-Rubber tires, concrete rubble, or other debris salvaged from construction sites shall not be used to stabilize shorelines.

-**Site preparation** must be limited to the work necessary to obtain adequate slope and stability of the riprap material.

- **Retaining walls** shall be allowed only where the erosion process is severe and approval determines that a retaining wall is the most effective erosion control option

10.8. Recommendations

Looking to 2060, the idea is to propose a motorized recreation management plan for Lakelse Lake.To accomplish this plan, there would be a need to first establishing a **management body**. Ideally the body would work with the Kalum Land and Resource Management Plan objectives in order to get approval for a local management plan for Lakelse Lake. The body hypothetically should involve all interested agencies and associations.

The second step is to **identify existing trails**. Define their uses and assess the qualities and problems of the trails. This process should be extensive and meticulous, involving all stakeholders. With the amount of trail ways that exist, it would benefit the management plan to include all of the Lakelse watershed.

To my knowledge, and based on local research, there are two major areas of land trails to concentrate on. The **Thunderbird area+ Airport bench** (see map) north and north-west of the lake are used extensively by dirtbikes, ATVs and 4X4s.

Right-of-ways and old logging roads provide most of the routes used by motorized recreation traffic. The right-of-ways are owned by Utility companies and the logging roads are licensed to Coast Tsimshian Resources. There are logging roads both active and deactivated, plus roadways under the power lines or along the Pacific Northern Gas right-of-way. These should be defined and marked for certain uses.

Motorized recreation trail following hydro right-of-way.
Photo: Rodney Brown

Soil and vegetation damage in Airport area from motorized recreation traffic.

Photo: Rodney Brown

The other area(s) east of HWY 37 are in the **Williams Creek Valley**, and **Scully Creek area**, leading approximately to Gunsight Peak (see map). These areas can be used by ATV's, dirtbikes, and Snowmobiles. There are concerns of moose and deer habitat and also salmon spawning stream crossings.

Old logging road in Scully Creek area that is used for motorized recreation both summer and winter. Photo: Rodney Brown

Infrastructure within the Lakelse area trail networks will be required to make the area sustainable for 2060. Trail bridges over waterways would be an ideal step to reduce direct contact to the water resource. For safety and wildlife concerns, prohibited areas should be identified and quartered off with signage and if possible, gated access.

Stream crossing without bridging – Scully Creek area.

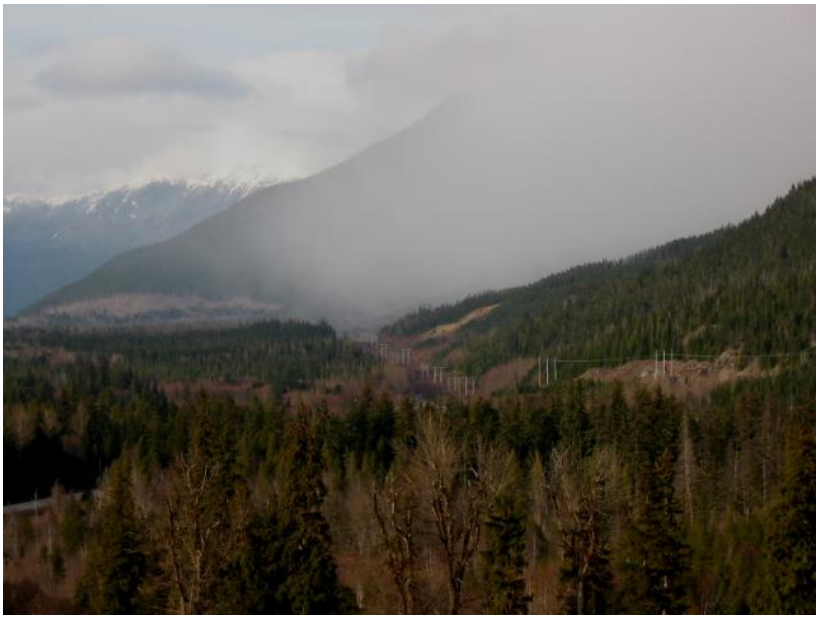
Photo: Rodney Brown

Type of bridge that would be required to avoid stream damage by recreationalists.

Photo: Rodney Brown

On and around the lake itself, rules **prohibiting Snowmobiles and ATV access** to sensitive environments and wildlife habitat are ideal. Segregating any motorized equipment from rare and endangered ecosystems would help sustain the critical habitat areas like the wetlands, riparian, and alluvial fans.

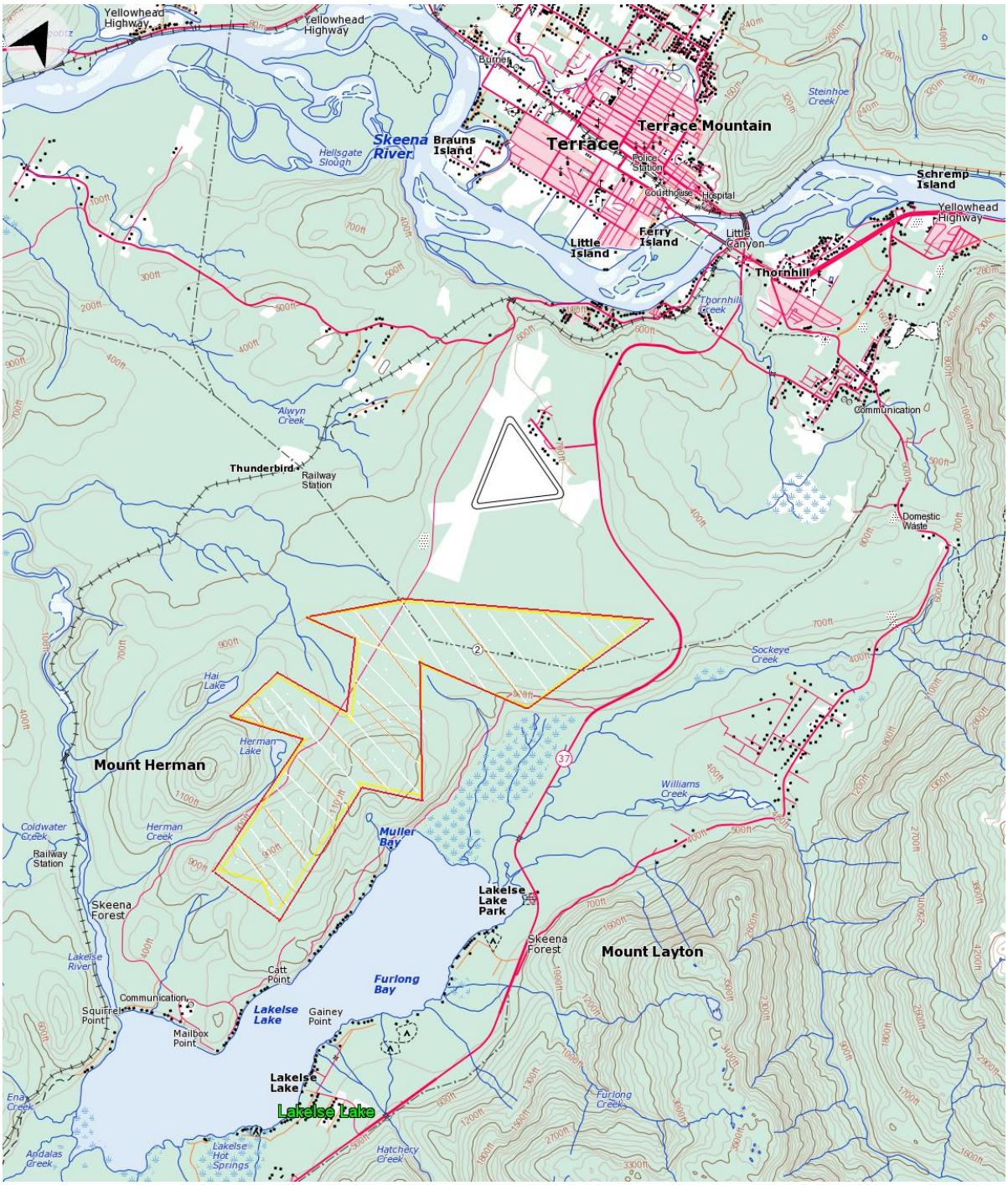
On the lake, **rules and enforcement** are important. There should be posted rules like speed limits, wake areas, and noise abatement bylaws. Enforcement should be done by specialized trained staff. Relying on the RCMP has not been effective and seems to be part-time at best.



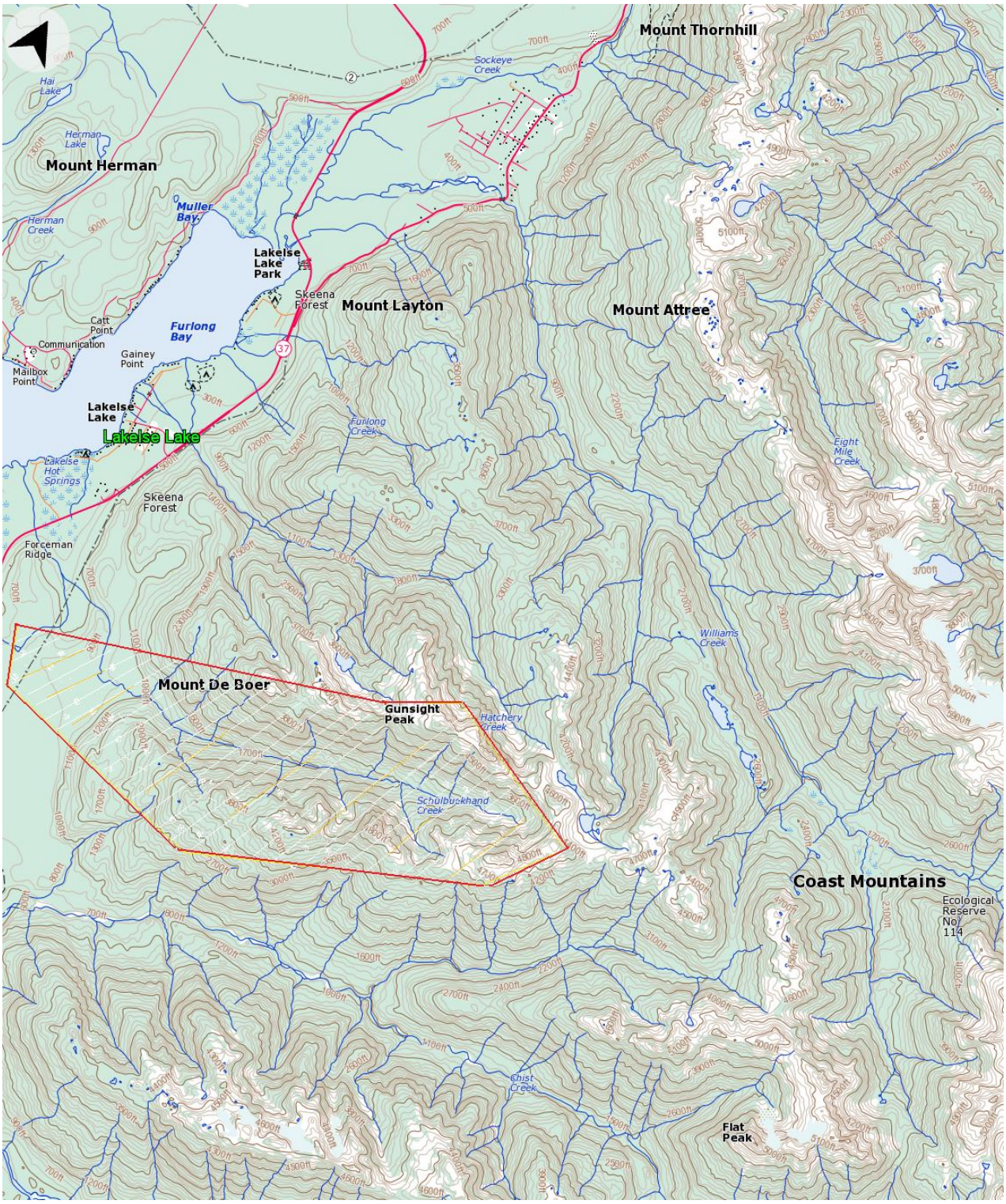
Hydro line along east side of Lakelse Lake - used by ATVs and snowmobiles. Photo: Rodney Brown

As a conclusion to this study, **Lakelse Lake needs management** in motorized recreation. There is local complaints, rising ecological issues, and little to no regulations or enforcement. To sustain the lake quality to 2060, a **local management plan for motorized recreational uses** would help reduce and buffer the increasing amount of damage cause from these activities. Going on without a plan may lead to further permanent damage.

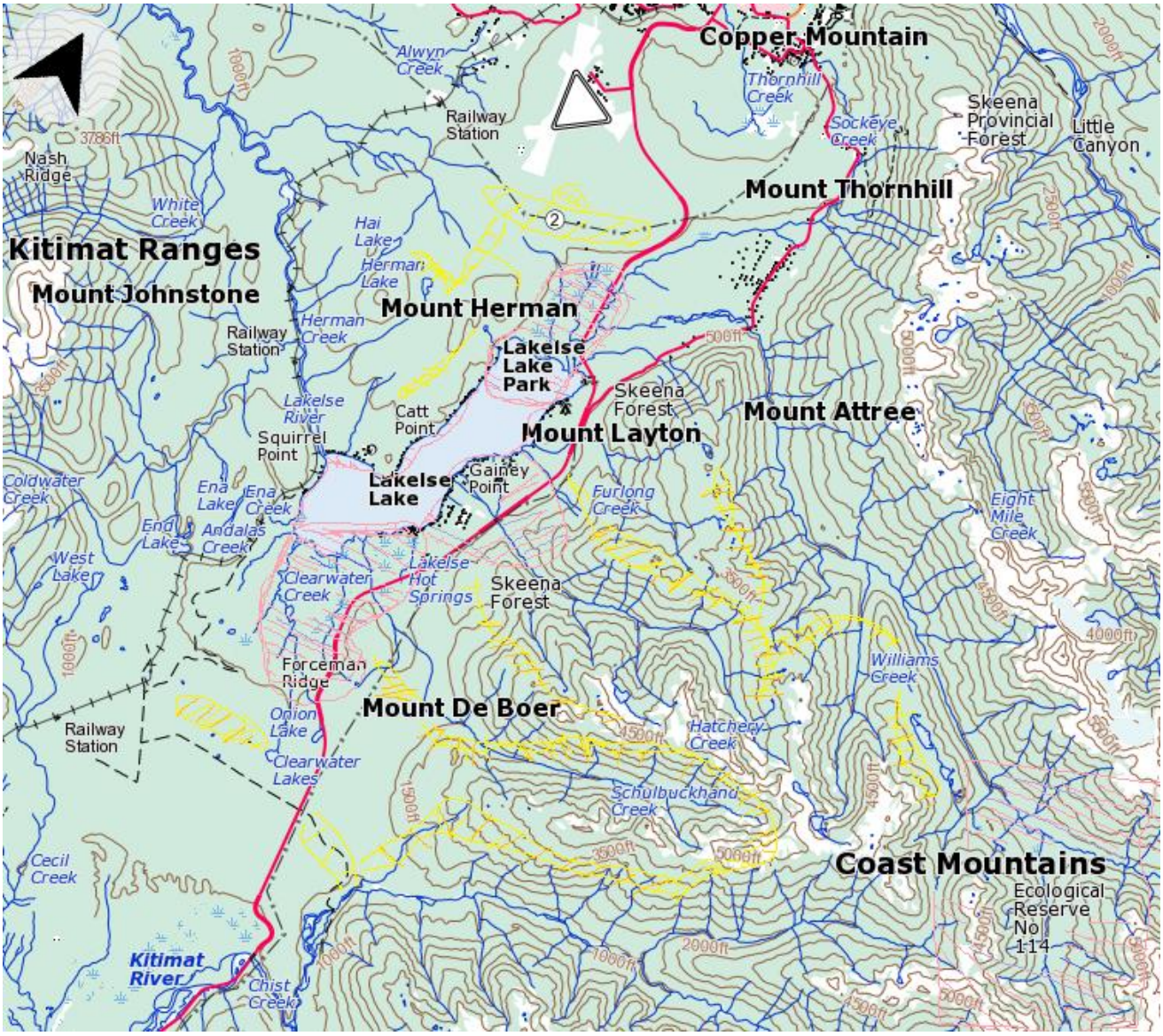
Heavily used motorized recreation trail in the Scully Creek area. Photo: Rodney Brown



Area of Interest for Motorized Recreation in the Thunderbird/Airport area



Area of Interest for Motorized Recreation in the Scully Creek/Gunsight Peak area



Areas of Interest for Potential Motorized Trail Systems in the Lakelse Area

Work Cited (2010)

Unmanaged Motorized recreation; From the USDA Forest Service and USDI Bureau of Land Management and others;

Best Management practices for Recreational Activities on Grasslands in the Thompson and Okanagan Basins;

Impacts of ATV Traffic on Undesignated Trails;

The Effects of Motorized Watercraft on Aquatic Ecosystems;

Lake Rules GRAND RIVER DAM AUTHORITY'S Grand Lake O'the Cherokees, Lake Hudson, W.R. Holway Resevoir;

Kalum Land and Resource Management Plan

Acknowledgements

Lakelse Lake Watershed Society
Carl Johansen, District Recreation Officer
Ben Sabal, Parks Area Supervisor
Mitch Drewes and Rob Dams, Fisheries and Oceans Canada
Terry Unran and Adolph Ludke, Terrace Snowmobile Association
Earl Houlden, Terrace Motocross Association
Other local input

Motorized recreation traffic on Lakelse Lake

Photo: Rodney Brown

SECTION 11

LAKELSE 2060

www.google.ca

Lakelse Hotsprings:

A Vision for the Future

by Paul Geier and Laura Webb

Lakelse Hotsprings circa 1940

Lakelse Hotsprings 2060: Recommentations

- **Develop a resort that attracts international tourist as well as locals- in particular youth from the region (multi-use)**
- **Construct from natural local materials, above flood plain, far enough from the highway in order to give a peaceful atmosphere and possible view of the lake, and showcase natural surroundings rather than built landscaping.**
- **Construction must take into consideration the surrounding dynamic hydrological environment and associated sensitive natural environment and habitats.**
- **Return to historic business model of attracting international visitors for health and wellness retreats.**
- **Link with other local tourism operations.**
- **Embrace technologies that allow new types of recreation and energy efficiency.**
- **Primary uses of hotsprings should be for tourism and recreation, followed by greenhouses and geothermal energy.**

Location of Lakelse Hotsprings property - looking NNW across Lakelse Lake

Original Hotsprings Hotel circa 1910 - owned by Bruce Johnstone

Section 11.1. Introduction

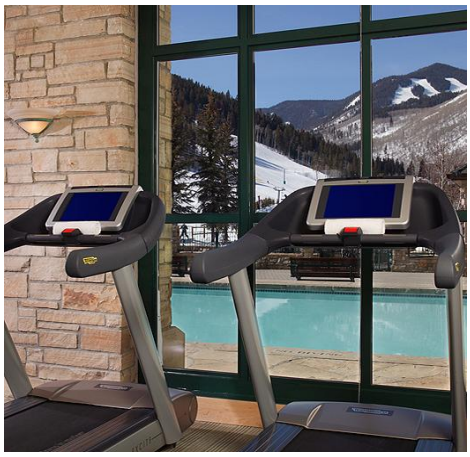
The **Lakelse Hotsprings** is an odourless, high volume, high temperature natural spring; it is the hottest in Canada (Turner, et al., 2007) and second largest in North America (Hot Springs in British Columbia, Canada, 2010). The Hotsprings is adjacent to a high value recreational lake (Lakelse Lake) and is two hours from YVR (Vancouver), a major international airport. There is a wide variety of tourism activities available in the area surrounding the Lakelse Hotsprings. With Terrace being a **regional center** for northwest British Columbia, the Hotsprings attracts both local and regional visitors. There are in the range of 200,000 annual visitor units to the parks in the Lakelse Watershed each year (Lakelse Watershed Society, 2010).

"Terrace and other BC residents made up approximately 64% of all visitors to the Terrace Visitor Centre in 2008" (Community Tourism Plan, 2009).

Section 11.2. Comparable Hotsprings Development

The **Chena Hotsprings**, located 56.5 miles from **Fairbanks, Alaska**, offers a successful example of a similar sized and geographically comparable hotsprings. In addition to being a locally popular hotsprings, they have developed a wide range of accessory activities that attract international tourists. These activities include dogsledding, horseback riding, hiking, horse and sleigh, remote romantic yurts, staying in exclusive accommodation, snowmobiling, soaking in attractive natural rock pools, and eating fresh organic local food from their own greenhouses.

When we saw the information on this hotsprings, all the ideas we had for the Lakelse Hotsprings came into place. The activities are feasible to do in the Terrace area and look like a lot of fun. The buildings, though, and the pool designs would not be classy enough to attract international tourists. We, instead, looked at Beaver Creek Ski Resort in Colorado and the Fairmont Banff Hotsprings in Alberta to attract wealthy clients to come to the hotsprings (they wouldn't necessarily need to be wealthy people but could be people who would budget for special events, i.e. weddings, family reunions, special celebrations, conferences, if the facilities were attractive enough).



Beaver Creek Ski Resort, Colorado – health and wellness centre

www.chenahotsprings.com – located near Fairbanks, Alaska

Greenhouses at Chena Hotsprings are supported by geo-thermal heating and supply fresh vegetables year round to the resort.

Section 11.3. Potential Impacts

If the recommendations of the report are implemented, the redesigned resort would have a multi-faceted impact on the surrounding area. As a key iconic facility, the resort would provide an **added draw** to the region and benefit all of the area's tourism operators. The resort would provide an entrepreneurial venue for some of the many local **health and wellness** professionals. The construction of the resort would add value to local, natural building materials. The design of the resort would showcase **local artistic talent** as well as construction expertise. Our local college trains these types of professionals through The Freda Diesing School of Northwest Coast Art as well as the Timber Frame Craftsman program.

Having a world class resort at the southwest corner of Lakelse Lake would add incentive for having a **healthy natural ecology** around the resort, as well as of the lake itself. The impact of the more intense use of the resort property would be offset by having a community sewer and water system. The cost of the system would be more affordable, as it would be shared by more or higher value users. The exiting new opportunities for recreation provided by the ***Flow Rider***, or a similar activity, would provide a new recreational opportunity for local youth.

In order for a northern community such as ours to survive over the long term, we need to retain and attract **youth**. The flow rider would help people stay more active and healthy. A key attraction at the resort would draw more people as it would make the resort more than just a regular swimming pool. The secluded high end lodging and pools would bring outside visitors and the associated money to our area; this could offer them a **home base** for other tourism activities in the region. A separate **RV** parking area, within walking distance to the lake and the hot springs, would attract RV tourists and provide a reason for Alaska bound travelers to drive up through our area, rather than further east. **Greenhouses** heated by the surplus heat could provide fresh produce to locals, as well as fine fresh ingredients for the resort dining experience.

Section 11.4. Recommendations

A new Hotsprings development should be constructed with **local materials and local talent** to get the most benefit for the economy. Buildings should be above the floodplain and far enough from the highway in order to give a **peaceful atmosphere** with a view of the lake. The resort should showcase natural surroundings rather than traditional built landscaping. In order to maintain a **secluded setting**, follow the Lakelse Lake Zoning Bylaw No. 57, CII site area requirement that states "the minimum site area required shall be 100 hectares."

The resort should attract **international tourists**, as well as locals- in particular youth. The **youth** are very important to the sustainability of Terrace and it is vital that special efforts are made to retain them here. In regards to keeping the youth here, it is very important that the Hotsprings has some kind of special attraction to set it apart from the local swimming pools in Kitimat and Terrace. The **Community Tourism Plan of 2009** also makes note of this-

Develop and assertively market at least one "outstanding" "iconic" attraction or product – a "hook" that will draw visitors to Terrace.

Jigokudani_Hotsprings_in_Nagano,_Japan

Naturally constructed rock pools with both secluded pools and public pools.

Chena Hotsprings, Alaska

Geothermally heated green-houses that could supply organic fresh produce to both the resort and local markets.

Recreation would be very important for the Lakelse Hotsprings to be able to attract both international and local tourists across all age groups.

Something like a ***Flow Rider*** would be an excellent attraction to youth where they could just watch or participate. A *Flow Rider* would attract youth who snowboard as it mimics surfing and both are board sports.

- http://www.flowrider.com/
- More than your average pool – year round water fun.
- Keep youth in our area
- Employment
- Active recreation

To attract more tourists to the area, **link with local tourism operations** to showcase the Hotsprings as an international tourist destination. Terrace has a wide variety of tourism operators and a reputation for quality outdoor recreation.

The most successful destination developments were located in an area which provided a diversity of recreation opportunities, both planned and unplanned. Summer recreation activities included fishing, boating, and other water sports, while cross-country and downhill skiing were the winter sports most compatible with hot spring use." (Lakelse Lake Hot Springs Resort, 1980)

Partnerships with local businesses will expand recreation opportunities, including:

- Packages providing accommodation at the hotsprings and lift tickets to the ski hill
- Daily shuttle to the ski hill
- Heli-ski partnership opportunities
- Summer recreation services and activities such as fishing, hiking, tours, deep sea charters, glacier tours, and First Nations tourism businesses.

A healthy natural environment will increase the recreational quality at the Hotsprings. To attract international tourists, focus on the health and recreation benefits of the area.

To provide local employment opportunities, return to the historic business model of attracting visitors for **health and wellness retreats**. Terrace has a vibrant health and wellness industry and this could be transferred to the Hotsprings resort. Guest can enjoy the quality of the Hotsprings and choose from a selection of health and wellness services.

"We were completely booked from the first of May until the end of October. The only access to the area was by train to Terrace, then by Taxi to the north end of the lake, where you took a boat to the hotel. We had a great deal of repeat business. People came because they thought they benefited from the water" (The Way We Were, 1991).

"…advertizing his "spa" in the United States and the west coast, Johnstone kept the registrar of the small hotel full about seven months of the year" (Asante, 1972)

www.chenahotsprings.com – naturally designed pools for fitness and relaxation.

The primary use of hot springs should be for **tourism**. However, before the water from the pools is returned to the lake, it must be cooled and treated. There is an opportunity to use this water for the geothermal heating of **greenhouses** and the buildings associated with the resort.

Section 11.5. The Vision for 2060

In 2060 the Lakelse Hotsprings could be

- A **major economic contributor** to the region
- A **major international tourist destination** linked to other tourism activities such as skiing, fishing, heli-skiing, hiking; it could be the keystone to a viable regional ski hill, it could stabilize local employment by both direct jobs and support of local artisans and retail, it would lead to a new sector in this region specializing in the health and wellness industry. It could be a primary factor attracting and retaining young people in this area both due to employment opportunities, entrepreneurial activities and recreational amenities provided by the facility.
- In order to be successful, the **adjacent environment** to the Lakelse Hotsprings would need to be of international quality such as trail networks, water quality of Lakelse Lake, wildlife management, fishing opportunities, cultural attractions. This in itself necessitates planning at a regional level that prioritizes retention and enhancement of the natural environmental and regional cultural attributes of northwest BC.
- The Lakelse Hotsprings as an international hotsprings attraction would provide incentives for **upgrading of transportation access**, such as air transport (e.g. Westjet), which then would enhance other economic opportunities and activities in the area. It would also provide another important amenity for attracting and retaining professionals and young people.
- With the Hotsprings as the focus for **environmental management initiatives**, a sense of direction and a set of priorities would be provided for the recreational management of Lakelse Lake and the Lakelse River and their associated provincial parks and reserves.
- All of these initiatives would have **direct economic and recreational benefits** to the residents of the region who would be given access to these opportunities, but would also be able to achieve employment or business opportunities associated with the redeveloped Hotsprings.
- The **Northwest Community College** offers an array of programs that would complement this type of facility. An international resort at the Lakelse Hotsprings would tie into the culinary arts program with its emphasis on First Nations cuisine; the Freda Diesing School of Northwest Coast Arts, for both artisan development of the facility and high end unique works of art; and the timber frame crafts program for construction of the buildings.

In order to achieve this vision, the following has to happen

1. **Investment** on a sufficient scale must occur so that the facility can escape its current label as a small local facility and enter the realm of an international “place to go.”
2. **Other existing tourism ventures** which already attract international clientele such as fish guiding, heli-skiing, and Bell II, need to be involved from the onset drawing up packages that give internationally competitive opportunities.
3. From the beginning there must be a **buy-in by local and regional governments** as well as provincial ministries in order for the planning and execution of the project to be done in an environmentally, culturally, and economically sustainable fashion.

4. As per our proposal, a "green" **environmentally sustainable and sensitive development** is what is required to attract international clients who want a health, wellness, and superb recreational experience.
5. There is no point in redeveloping the Hotsprings as a common swimming pool facility that offers no special features and is exploitive of the environment. If we wish to plan into the future then this type of resort must be **sustainable at all levels**.

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- ***http://www.terracelibrary.ca/history1/pictures/hotspringswar.jpg***
- ***http://www.pentlandbiomass.com/***
- ***http://www.chenahotsprings.com/geothermal-power/***

http://www.hellobc.com/en-CA/HelloBCBlogs/BritishColumbia.htm

Resort buildings constructed with local materials and local art work