Morice-Nanika Sockeye Recovery Plan

Morice Lake - Nanika River outlet. M.Bahr 2000

Backgrounder

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Cover: Nanika River outlet into Morice Lake; view northward. Photo Credit: M. Bahr 2000.

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Preamble

This backgrounder has been prepared for the Morice–Nanika Sockeye Recovery Plan (MNSRP) planning table, a Wet'suwet'en Fisheries and Department of Fisheries initiative. The MNSRP process provides a framework for aboriginal, government, industry, and public groups to work together towards stock recovery. The purpose of this report is to describe biophysical, fisheries, cultural, and land use current conditions in relation to Morice–Nanika sockeye.

The Morice–Nanika sockeye stock is the largest sockeye run in the Bulkley Basin. The Wet'suwet'en, whose territory overlies the Bulkley Basin, have fished Morice–Nanika sockeye stocks at Hagwilget and Moricetown Canyons and at numerous terminal sites for at least six thousand years. Morice–Nanika sockeye restoration is significant and a priority to the Wet'suwet'en.

Since the mid-1950s, Morice–Nanika sockeye abundance has fluctuated at levels below historical escapements and lower than lake production capacity. Constraints to sockeye production are thought to stem from a complex mix of interrelated problems, including the high exploitation rates in the Alaskan, Canadian, and First Nation fisheries and low production from the ultra-oligotrophic Morice Lake. The uncertain effects of climatic variability may be also exacerbating sockeye productivity in the freshwater and marine realms. Variations in salmon returns due to climate and or harvesting can have strong impacts on sockeye nursery lake productivity in systems where adult salmon carcasses are important nutrient sources.

As in other Skeena sub-basins, social, political, and economic factors influence the status of fish and habitat in the Morice Watershed. For example, one or more of these factors may influence the rate of development of forest harvesting, resulting in riparian, in-stream, or associated cumulative effects within the watershed, or on the other hand, these factors may preclude development with protected area status. The social, political, and economic factors may influence management of the fish resource, such as planning and setting harvest timing and exploitation rate. These factors can also affect the location, timing, and focus in regard to fish sustainability or watershed restoration planning.

Concerns regarding Morice–Nanika sockeye abundance have been voiced since the mid-1950s, primarily by the Wet'suwet'en and Department of Fisheries and Oceans (DFO), though their approaches to stock restoration have differed. Escapement records indicate that prior to 1954, spawner returns were apparently strong with an annual 1940s average of 70,000 sockeye (Cox-Rogers 2000). Since 1954, a forty-year period of marked decline showed annual average returns of between 1,700–9,000 fish. Escapement increased in the 1990s to an annual average of 32,000 sockeye, although since 1998, average escapements have decreased to less than 6,000 fish.

Since the mid-1950s, DFO has made efforts to identify the cause of the decline and to rebuild the sockeye stock. The Morice–Nanika Sockeye Recovery Plan offers an opportunity to link sectorial efforts that may be disconnected at the watershed and coastal levels. This collaborative approach requires a high degree of coordination and planning. The high social, cultural, and economic values of Morice–Nanika sockeye are significant enough that there is strong interest in rebuilding the population and restoring any critical habitat components.

Morice Watershed Planning Processes

Within Morice–Nanika Watershed, there are currently other land use plans or planning processes that are inclusive or semi-inclusive of fish and fish habitat. The four major planning processes include the Morice Lands and Resource Management Plan, the Wet'suwet'en Territorial Stewardship Plan, the Morice and Lakes Innovative Practices Agreement, and the Morice Watershed Fish Sustainability Plan.

The Wet'suwet'en Territorial Stewardship Plan (WTSP) is an initiative being developed by the Office of the Wet'suwet'en on behalf of the thirteen Wet'suwet'en Houses. The purpose of this plan is to support the Wet'suwet'en as stewards of their traditional territories, a portion of which overlie the Morice Watershed. The WTSP is a tool based on natural and cultural features that can be used to make balanced resource stewardship decisions, help create economic development, and communicate Wet'suwet'en ecosystem management, cultural knowledge, and values. Major objectives include bridging Wet'suwet'en traditional knowledge and values and the structure of contemporary resource management processes through criteria and indicators. The WTSP will effectively improve opportunities for Wet'suwet'en values and aspirations to be integrated into resource planning and development and facilitate a transitional approach to territorial management and resource stewardship.

The Morice Land and Resource Management Plan (LRMP) was initiated and led by the Ministry of Sustainable Resource Management with land use recommendations completed and publicly presented in 2004. Currently, the recommendations and various substantive issues are being discussed with the Office of the Wet'suwet'en and changes are expected before the LRMP is signed. The sub-regional land use recommendations include creating three categories of land use designations with accompanying management directions for the LRMP area: General Resource Management Zones, Area Specific Resource Management Zones, and Protected Areas.

The General Resource Management Zone, which encompasses 65% of Crown land, incorporates management statements that will provide direction to sustain communities, the economy, and ecosystems in the plan area. The Area Specific Resource Management Direction, which encompasses 29% of Crown land, addresses spatially explicit objectives that are unique to a given area. Protected Area Management Direction, which applies to 6% of crown land, applies to all protected areas and provides spatially explicit guidance to specific areas. All of these three categories include objectives, measures/indicators, targets, and management statements.

Of interest to the Morice–Nanika Sockeye Recovery Plan are recommended land use designations adjacent to Nanika River and Morice Lake. The lower two-thirds of Nanika River is overlain with area specific management objectives developed to address the distinct aquatic, riparian, fish, and wildlife values. The upper reach of Nanika River is overlain with protected area status. The majority of the landscape draining into Morice Lake is to be managed to reflect the important ecological and recreation values, with no timber harvesting, road, and settlement development activities.

The Morice and Lakes Innovative Practices Agreement is a partnership among seven regional forest licensees to develop socially acceptable plans and practices, which will enhance basic drivers of timber supply, maintain environmental values, implement innovative approaches, affect policy, and transfer learning. The central objective is to develop and implement Sustainable Forest Management Plans (SFMPs) for the Morice and Lakes Timber Supply Areas (TSAs). The Morice SFMP dovetails closely to the Morice LRMP and alongside those management directions, a suite of thirty-four indicators will give planning, implementation, monitoring, and evaluation direction to operational Forest Stewardship Plans (Tesera 2003).

The Morice Watershed Fish Sustainability Plan (WFSP) is a federal and provincial initiative (BC MELP and FOC 2001) that has been led by Community Futures Development Corporation Nadina (CFDC Nadina). The purpose of this planning process is to sustain robust fish populations and fully functioning aquatic ecosystems in the Morice Watershed. Major objectives include providing fish and fish habitat resource information on the watershed scale and developing plans that ensures conservation of fish populations and aquatic ecosystems. The Morice WFSP recommends implementation of action plans and monitoring strategies that include research, monitoring, stock assessment, modelling, and best management practices addressing land use management, habitat rehabilitation, and fisheries management.

The Morice Watershed Restoration Program (WRP) was a provincial initiative to restore the productive capacity of fisheries, forest, and aquatic resources that had been adversely impacted by past forest harvesting practices. Aquatic and upland restoration efforts were halted in 2001, due to a change in provincial government policies, but interim restoration plans (IRP) were established that delineated restoration objectives and future priority restoration work plans.

Other plan processes, which in the future could potentially influence or affect the Morice–Nanika Sockeye Recovery Plan, include industrial Forest Stewardship Plans from the tenured licensees within the watershed. Forest Stewardship Plans are expected to describe licensee forest development activities within the framework directions stated in higher-level plans such as SRMPs and LRMPs. What these plans contain and how they will be implemented will need to be reviewed from a fisheries perspective to ensure fish values are maintained.

As noted above, numerous natural resource planning processes are underway at the watershed or finer scale in Morice Watershed that will affect, or be affected by Morice–Nanika Sockeye Recovery Plan activities. Building relationships and identifying ideas and products through planning activities can achieve efficiency in timeframes, content, and participation, and as well, can potentially provide more complete assessment and solutions to complex habitat related problems. The collaboration of fish protection and restoration priorities across plans could provide unique opportunities for funding, priorities, and implementation.

Environmental Setting

Location

The Morice Watershed is located in west-central British Columbia southwest of Houston. The watershed is bounded to the west by the Telkwa River and Zymoetz River drainages, and to the east and south mainly by Nechako River tributaries. To the north the watershed is bounded by the Bulkley River drainage.

Hydrology

The Morice Watershed is part of the Bulkley River basin, which is fed by streams originating in both the Interior Plateau and glacier fields of the Coast Mountains. From the outlet of Morice Lake, the Morice River flows northeastward 80 km to join the Bulkley River near Houston, B.C. The Bulkley River flows 150 km northwestward to enter the Skeena River at Hazelton, BC. Although the Morice is the larger tributary at the fork of the Bulkley River near Houston, the Bulkley River name is used for the tributary that flows westward along the travel route to the interior.

The Morice River is a sixth order stream with a catchment area of 4,349 km^2 that comprises the southwestern portion of the Bulkley River Watershed. Elevations range from approximately 2,740 m at the southwestern border to 560 m at the Bulkley confluence. Morice Lake at 764 m elevation is the largest lake in the system and is the origin of Morice River. Major tributaries include: Atna River, Nanika River, Thautil River, Gosnell Creek, Lamprey Creek, Owen Creek, and Houston Tommy Creek.

Morice Lake, view southward of outlet and north arm.
Bustard & Associates.

Annual discharge peaks at 250 to 550 m^3/s during the early summer snowmelt season and after the occasional fall frontal storm; however, much of the flow is buffered by storage in Morice Lake. Morice River represents 86% of the Bulkley River flow at the Bulkley–Morice confluence, with a mean annual flow of 118.1 m^3/s (DFO 1984). Mean annual discharge of 15 to 25 m^3/s is typical at late winter low-flow conditions (Gottesfeld and Gottesfeld 1990). Morice River at the lake outlet (WSC Station 08ED002) has a mean annual discharge of 77 m^3/s.

The contribution of high elevation snowmelt and ice melt runoff is important in maintaining adequate summer water levels in the mainstem and side channels of Morice and Nanika Rivers. There is a steep precipitation gradient from west to east, as well as from the high alpine to the valley bottom country. Annual total precipitation ranges from at least 2,000 mm in the Coast Mountains to under 500 mm along the lower Morice River.

Four large lakes, Morice, Nanika, Kidprice, and McBride, provide most of the lake storage in the Morice system. Morice Lake lies in a deep trench between the Morice Range to the west and Tahtsa Range to the east. Morice Lake at 764 m elevation is surrounded by glaciated mountains that drop steeply into the lake from elevations ranging from 1,200 to 2,000 m. The glaciated mountains with cascading streams and sharply inclined shores are a conspicuous feature of the lake basin except in the northeastern portion.

The lake is 42 km in length and averages 2 km in width in the south arm and 3 km in width through the north arm. Morice Lake is characterized by two large, deep basins in the southern and northern arms with maximum and mean depths of 236 m and 100 m respectively. The lake has a surface area of 96 km^2 draining a basin area of 1,872 km^2. Morice Lake is relatively cold, with an average summer seasonal surface temperature of 8.15 C^0 (Shortreed and Hume 2004). Assuming that the inflow equals the outflow, the theoretical flushing rate for Morice Lake is 4.36 years (Cleugh and Lawley 1979); however, Shortreed *et al.* (2001) report a water resident time of 3.8 years.

Nanika River outlet, Morice Lake.
M. Bahr 2000.

The two main lake tributaries are Nanika River and Atna River. Nanika Watershed has a catchment area of 895 km^2 yielding a mean annual flow of 36.6 m^3/s that contributes about 50% of the total water inflow into Morice Lake. Nanika River at the outlet of Kidprice Lake (WSC Station 08ED001) has a mean annual discharge of 29.6 m^3/s, with 82% or 732 km^2 of the watershed lying upstream of this point. The three main lakes, Nanika, Kidprice, and Stepp Lakes occupy another trenched valley approximately ten km east of Morice Lake and drain via the Nanika River to Morice Lake. This chain of lakes lies in a proportionally deep and steep-sided valley formed by the surrounding mountains that range from 1,800 to 2,400 m.

Nanika Lake has a maximum depth of 222 m with a mean depth of 81 m. The surface area is approximately 31 km^2. The shallow water area is infrequent due to the generally steep-sided shores. The flushing rate is calculated to be 4.4 years. Kidprice Lake has a surface area of approximately 7 km^2 with a maximum depth of 47 m and a mean depth of 29 m. The flushing rate is calculated to be about 114 days (Cleugh and Lawley 1979).

Kidprice Lake.
D. Bustard.

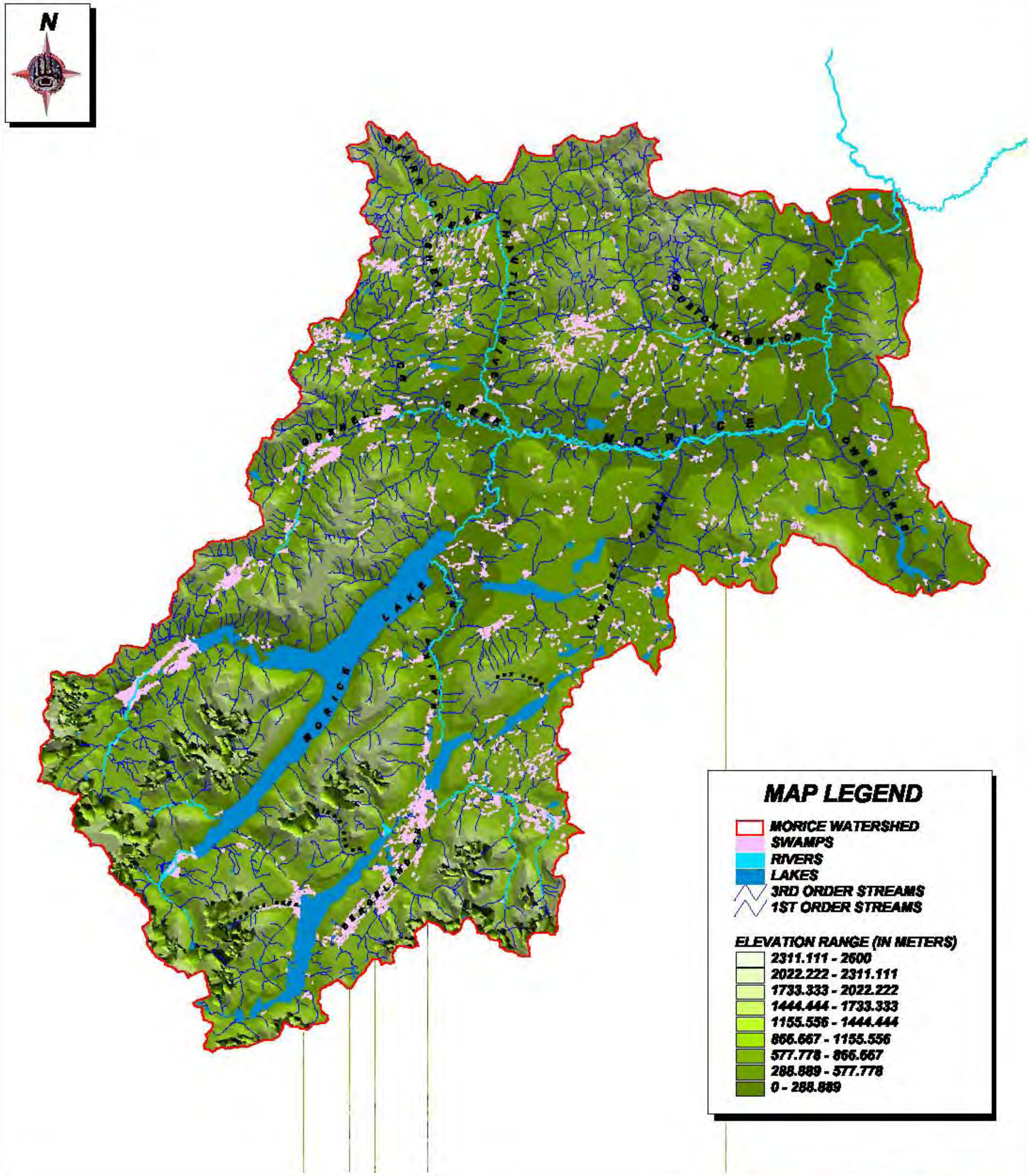
The Atna River drains 243 km^2 consisting for the most part of glaciated mountains in the Kitimat and Morice Ranges. Atna Lake lying at 774 m elevation has a surface area of approximately 5 km^2 and has a maximum depth of 60 m (Envirocon 1984b). Atna Lake possesses glacial drainage characteristics shown by the generally very turbid water that is due to the glacial silt discharged from the Atna River. The lake outlet area is relatively clear, which is attributed to silt deposition and spring fed streams.

Atna Lake, view southwest.
M. Bahr 2000.

The Morice River, downstream of Morice Lake, has several large tributaries including the Thautil River, Gosnell Creek, and Houston Tommy Creek, which drain mountainous areas. Two lake-headed tributaries, Owen Creek and Lamprey Creeks, drain Nadina Mountain and southern plateau areas. McBride Lake, a relatively large lake situated on the Nechako Plateau, drains into Morice Lake just north of Nanika River. Tributary stream descriptions can be found in Wet'suwet'en Treaty Office (1996), Mitchell *et al.* (1998), BCCF (1999), and Bustard and Schell (2002).

Water Quality

Forests, water, fisheries, wildlife, and humans are linked together by the hydrologic cycle. Water connects land, air, plants, and animals while flowing throughout the various watershed ecosystems. Water appears as rivers, streams, lakes, ponds, wetlands, as well as underground storage. Water quality is defined as the natural physical, chemical, and biological characteristics of water. Water quality criteria are guidelines that address the acceptable range of conditions, and usually relate to safe levels for a given water use, or particular kinds or classes of water use. Setting water quality objectives involves taking the set of criteria and adapting it to a specific body of water.



MORICE - NANIKA SOCKEYE RECOVERY PLAN

10 0 10 20 30 Kilometers

MAP SCALE - 1:550,000

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For example, water quality objectives or guidelines are applied to drinking water, fish and aquatic life, agricultural pursuits, mining activities, and forest development. Province-wide ambient water quality criteria include pH, substances that degrade water quality such as nutrients, algae, and particulate matter, low level toxic substances and high level toxic substances, such as cyanide, PCBs, and metals, and microbiological indicators of risks to humans (fecal coliforms, *Giardia*). Other common criteria include dissolved oxygen, total suspended solids, water stage, and biochemical oxygen demand (BOD).

Processes that affect water quality in forested streams are underpinned by the hydrologic cycle. Water acts as a carrier of materials and energy between the atmospheric and terrestrial portions of the system and the stream. Runoff and streamflow in a small, undisturbed forested watershed are primarily the result of water flowing through the forest soil, rather than over it (Harr 1976). Weather conditions and natural landscape processes cause turbid and high water conditions that affect water quality. How water quality is affected in relation to land use activities, particularly forest development, is not well understood or documented for the watershed. Major concerns include the integrity and importance of small streams, hydrologic change, temperature change, sedimentation, and effects to the physical stream structure.

Critical to the review and understanding of water quality is long-term data, which is essential in detecting changes or trends in water quality. Water quality data for Morice Lake and Nanika River is available since the 1960s. The most extensive studies to date were conducted during the Kemano Completion research by Envirocon (1984a) and Cleugh and Lawley (1979), which included water temperature, groundwater hydrology, food-frequency analysis, and modelling. Stockner and Shortreed (1979) conducted a limnological program in 1978 on Morice Lake to determine the potential for the Lake Enrichment Program.

Wilkes and Lloyd (1990) sampled water quality in the lower Morice River from 1983 to 1987 and reported water quality as excellent. Morice River water is soft; the pH is near neutral, while mean alkalinity, a measure of pH buffering capacity, is low. Morice River water is typically very clear, although Total Suspended Solids (TSS) readings can be high during freshets. Nutrient levels throughout much of the watershed are extremely low, in many cases less than the detection limits (Remington 1996).

Dykens and Rysavy (1998) sampled water quality in Fenton and Shea Creeks as part of the Skeena Region operational inventory. Sedimentation, channel morphology, water quality, and stream productivity parameters were assessed. Results for Fenton Creek, a third order stream, showed high concentrations of surface fines and an unbalanced benthic invertebrate community due to development activities. Shea Creek, a fifth order lake fed tributary of Gosnell Creek, showed excellence in all parameters. Bahr (2002) sampled water temperature with twenty-five water temperature loggers positioned throughout the drainage for an eighteen-month period.

Finnegan (1995) sampled water temperature at McBride and Owen Creeks, Morice River, and an offchannel area at km 21 (Bustard's Pond) and has six temperature sites with year round data, a portion of it daes back to 1994. A preliminary evaluation of water temperature in the watershed shows that lake headed tributaries such as Lamprey, Owen, and Shea Creeks are typically two to four degrees warmer than glacial headed tributaries such as upper Gosnell

Creek, Thautil River, and Crystal Creek. Bahr's data (2002) suggests that Morice River warms as it flows downstream from Morice Lake with maximum temperatures showing on the lower Morice River.

Bustard (1986) assessed stream protection practices in the Morice TSA. Sediment from roads, due to both construction and inadequate maintenance, was cited as the main impact from logging activities in Morice Watershed streams. Overall, the watershed generally has good water quality; however, during flood events or streambank failures, water quality is compromised, due to the nature of individual tributaries. These tributaries, Thautil, Houston Tommy, and Gosnell that discharge into Morice River, and Glacier (Redslide) that drain into Nanika River have active sediment sources. Water quality issues in the watershed have been relatively moderate and are related to forestry development.

Morice Lake Limnology

In 1944 and 1945, the Fisheries Research Board conducted limnological studies in Morice Lake that included bathymetry, surfaces and sub-surface temperatures, water transparency, fish species and abundance, and plankton studies. These studies are described in Alderdice and Foerster (1944), Brett (1945), and Brett and Pritchard (1946). Plankton studies identified two species of Cladocera, (*Bosmina longispina* and *Daphnia longispina*) and two species of Copepoda (*Cyclops sp.* and *Epischure sp.*). Plankton haul station locations are not recorded, but species and densities are included in Anonymous (1948).

Limnological surveys on Morice Lake were conducted from 1961 to 1965, as a component of the Nanika River Rehabilitation Program (Crouter and Palmer 1965). The limnological surveys included temperature data, Seechi disc observations, and sampling relative densities of zooplankton (Palmer 1986). As part of the Kemano II environmental studies, the Fisheries and Marine Service initiated a program during 1974–75 to inventory the existing water chemistry, phytoplankton, zooplankton, zoobenthos, and the morphometry of Morice Lake; this program was reported on by Cleugh and Lawley (1979).

Morice Lake is dimictic with mixing in the spring and fall, and stratified in the summer and winter. The lake has a relatively small amount of littoral zone, low inorganic nutrient levels, low phytoplankton biomass, and low zooplankton biomass. Morice Lake is considered ultra-oligotrophic with spring overturn phosphorus concentration of 1 μg/L (Shortreed *et al.* 2001). Morice Lake shows high dissolved oxygen content that ranges from 90 to 100% and cool water temperatures. Inflowing streams to the lake have a cooler mean temperature than the lake (Cleugh and Lawley 1979).

Surface temperature observations show that at any time, the shallow north end of the lake is warmer than the south end, though temperatures at 50 m depth throughout the lake show little difference. Thermal stratification tends to be weak with deep mixing common throughout the year (Stockner and Shortreed 1979); this is attributed to strong prevailing winds circulating the lake waters. Shortreed *et al.* (2001) reported that Morice Lake had a deep euphotic zone (19.8 m), a thermocline depth of 25.8 m, a cool epilimnion, a large hypolimnion, and a 7.00pH. Thermoclines tend to be deeper and stronger towards the outlet of the lake.

In the summer, the lake is glacially turbid in the south and Atna Bay arms, but the glacial gradient tends to comparatively clear water near the outlet (Simpson *et al.* 1981). Palmer's (1986) data indicated that monthly Seechi disc observations during 1961–65 were most often double the depth in May and June than in July, August, and September. Stockner and Shortreed (1979) samples showed a mean Seechi depth of 5.6 m.

Cleugh and Lawley (1979) indicated that the northern section of the lake (Station 3) near Nanika River was the most productive for seasonal phytoplankton biomass that was closely linked to increased temperature values. Biomass values reached 300mg/m^3 only once in September and ranged to a low of 26 mg/m^3 during the winter with chrysophyta, a golden brown algae, being predominant. The relatively high biomass is likely due to nutrient input from Nanika River (Cleugh and Lawley 1979). Overall, this indicated very low phytoplankton productivity in Morice Lake.

Cleugh and Lawley (1979) noted that since measurable quantities of NH_3, NO_2, NO_3, OP, and TP were generally close to or below analytical detection limits, it was reasonable to assume that nutrients are a major limiting factor within Morice Lake. During the survey, only Nanika River contributed any significant supply of TP. Morice Lake is poor in zooplankton, both in number of species present and the total amount of each species, which appears to decrease from the northern to the southern end of the lake (Cleugh and Lawley 1979). Information in regard to species and distribution by station and depth is discussed in Cleugh and Lawley (1979).

The mean abundance of benthos in Morice Lake was 1680/m^2 with a much greater abundance of benthic invertebrates in the littoral zone (3366/m^2). Chironomids constituted approximately 50% of the benthic invertebrates of Morice Lake, and 66% of these occurred in the upper 25 m. In most cases, the dominant species was a midge, *Heterotrissocladius,* with densities ranging from 6000/m^2 close to Nanika River outlet to 42/m^2 at 231 m depth (Cleugh and Lawley 1979).

Shortreed and Hume (2004) reported on monthly limnological surveys conducted in Morice Lake during 2002 and 2003. Physical and biological observations were similar to past studies. Chlorophyll (CHL) concentrations were relatively low at 0.44 µg/L with a homogenous vertical CHL profile. Morice Lake productivity appeared to be limited primarily by P loading, although its short growing season, cool temperatures, and unstable epilimnion no doubt play a role in its extreme oligotrophy (Shortreed and Hume 2004). They report that the average zooplankton biomass in Morice Lake was relatively high (648 mg wt/m^2) given its ultra-oligotrophic status. The cladoceran *Holopedium* made up 39% of this biomass and was the predominant prey; 60% by number, in juvenile sockeye stomachs. Other common prey (by number) was the small cladoceran *Eubosmina* (22), the copepod *Diacyclops* (14), and *Daphnia* (1). Age 0 sockeye densities were low at 160/ha.

Morice Lake Fertilization

In the late 1970s, the Lake Enrichment Program was initiated by the Fisheries Research Branch with funding provided by the Salmon Enhancement Program. One of the major goals was to increase returns of adult sockeye by adding nutrients into oligotrophic lakes where juvenile sockeye production is apparently food-limited. Pre-fertilization assessments were split into limnological and lacustrine fish evaluations. Stockner and Shortreed (1979) reported on chemical, physical, and biological results, while Rankin and Ashton (1980) documented zooplankton abundance and species composition. Simpson *et al.* (1981) reported on the juvenile sockeye assessment that was conducted by echo sounding and trawling. Other species were sampled by gillnet, and in late summer, adult sockeye spawners were visually enumerated.

Morice Lake was fertilized in 1980 on a weekly basis during the growing season by a DC6 aerial tanker with aqueous solutions of ammonium nitrate and ammonium phosphate. Costella *et al.* (1982) documented post-fertilization results that showed Morice Lake responded positively to fertilization with chlorophyll increased from 0.79 μg/L to 1.18 μg/L, a 35% increase in phytoplankton biomass, as well as a 60% increase in zooplankton biomass.

Nanika River is the only tributary to contribute measurable phosphorous into Morice Lake. In the northern portion of Morice Lake, the water chemistry, the relative greater phytoplankton production, and increased zooplankton feeding on littoral phytoplankton, are substantially influenced by nutrient supply received from the Nanika River (Cleugh and Lawley 1979). This pattern reflects the cold temperature, the low nutrient levels, and the relatively small littoral zone of Morice Lake.

Redslide–Nanika confluence.
M. Bahr 2000.

Marine–Derived Nutrients

Pacific salmon returning as adults from the sea to spawn and die provide the link between the marine and freshwater environment. Pacific salmon accumulate over 90% of their biomass during the marine phase of their life cycle (Groot and Margolis 1991). Considerable research has highlighted the important role of anadromous salmon in importing marine–derived nutrients (MDN) to freshwater and riparian ecosystems. These subsidies are thought to support diverse food webs and increase the growth and survival of juvenile salmon during their freshwater residency (Scheuerell et al. 2005).

^{13}C and ^{15}N at their natural abundance level have been used as stable isotopes tracers to determine trophic associations and nutrient dynamics in a variety of terrestrial and aquatic ecosystems (Larkin and Slaney 1996). Nitrogen and carbon in spawning salmon contain higher proportions of the heavier isotopic form of both elements than N and C imported to streams from other sources (Kline *et al.* 1990). Therefore, stable isotope analysis provides a means of tracing the salmon–derived N and C through the trophic system of their spawning streams.

Decreased availability of salmon carcass material can significantly reduce the nutrient influx to streams, diminishing productivity. The resulting decrease in juvenile fish size can reduce overwinter and marine survival, reducing the number of returning adults and further reducing stream and lake productivity (Bilby *et al.* 1995). The abundance of spawners is critical to maintenance of fish populations rearing in streams and lakes. Runs of adult fish may continue to decline, returning fewer nutrients to already nutrient deficient streams and lakes, particularly if combined with overfishing of a now less productive stock. Thus a negative feedback loop from nutrient–food chain impacts can be very significant to lake and stream rearing species. Understanding MDN loss may help to explain the continuing decline of Morice–Nanika sockeye. MDN loss may not be from sockeye alone. Changes to coho distribution and numbers may also have contributed; for example, changes to McBride Creek access affecting coho, and fewer coho in the Atna system.

Morice Lake sediment core analysis that showed stable isotope natural abundance data would be useful for various purposes. Sockeye salmon abundance can be reconstructed from stable nitrogen isotope analysis of lake sediment cores as returning sockeye transport significant quantities of N, relatively enriched in ^{15}N, from the ocean to freshwater systems. In addition, Cladocera fossil abundance counts from sediment cores can show past salmon abundance trends. Temporal changes in the input of salmon-derived N, and hence salmon abundance, can be quantified through downcore analysis of N isotopes. Relationships between Morice–Nanika sockeye populations and climatic change could be determined as well. Nutrients from the 1986 fire east of Morice Lake could also be investigated as to input significance.

Geography

The Hazelton Mountains within the Morice Watershed are comprised of a complex group of small ranges: the Telkwa Range, the Morice Range, and the northern portion of the Tahtsa Range. Relief is relatively high in these ranges, with rugged peaks partially covered in glacial ice. The mountainous portions of the watershed are underlain by Mesozoic sedimentary and volcanic rocks, intruded by isolated stocks and small batholiths of granitic rock from the Cretaceous age (Holland 1976). The Coast Mountains (Kitimat Range) on the western edge of the Morice Watershed are underlain by granitoid rocks of the Coast plutonic complex.

The Nechako Plateau extends into the northern and eastern portions of the watershed, with elevations largely below 1500 m. Over much of the Nechako Plateau, Tertiary lava flows cover the older volcanic and sedimentary rocks of the Takla and Hazelton Groups and intrusive rocks of the Tertiary age. The fluvial and surficial geomorphology of the watershed is strongly influenced by its recent glacial history. Ice from the Coast Ranges flowed easterly across Nechako Plateau depositing a legacy of glacial drift that is widespread with most bedrock obscured (Holland 1976).

The predominant biogeoclimatic zone, Sub-Boreal Spruce (SBS), covers most of the lowland coniferous forests in the watershed. Subalpine fir and hybrid spruce are the major tree species; subalpine fir stands tend to dominate older, high elevation stands and moister sections of the zone. Due to a relatively intense natural and aboriginal fire history, lodgepole pine seral stands are extensive, particularly on stream terraces and south aspect slopes. These stands are now hit or are threatened by the mountain pine beetle infestation that is active throughout Morice Watershed.

Small areas of grassland and shrub-steppe are found on warm, dry sites scattered along the Morice River, Owen Valley, and occasionally in other major tributaries. The SBS zone merges into the Engelmann Spruce-Subalpine Fir (ESSF) zone at higher elevations ranging from 900 to 1300 m, depending on local topography and climatic conditions.

The ESSF zone possesses a shorter, cooler, and moister growing season, with continuous forests passing into subalpine parkland at its highest elevations. Subalpine fir is dominant, with lesser amounts of lodgepole pine and white spruce hybrids in drier or fire-influenced areas. The Coastal Western Hemlock (CWH) zone characterizes the low elevation sites along the southern sections of Morice Lake, as well as the Atna drainage, reflecting the close proximity of maritime moisture from the coastal Kildala and Kemano drainages. Major tree species in the CWH are western hemlock, amabilis fir, and subalpine fir (Banner *et al.* 1993).

Stream Channels

The Morice River mainstem is 80 km in length with a very low gradient (<0.2%) and no obstructions to anadromous fish passage over its entire length. Several studies in the early 1990s conducted by Gottesfeld and Gottesfeld (1990) and Weiland and Schwab (1992) involved the Morice River channel and floodplain history, as well as elucidating the patterns and processes of channel change. Reach one extends from the outlet of Morice Lake to the Thautil River and is a single-thread channel with a stable channel configuration. The substrate is mainly cobble with some gravels, deep pools, rock outcrops, and steep banks. A moderate amount of instream cover is provided by logjams and debris in the lower section of Reach 1 (Envirocon 1980).

Morice River, reach 2.
M. Bahr 2000.

Reach two extends from the Thautil River downstream to Fenton Creek confluence. This reach is characterized as a wandering gravel bed river with one to several channels, frequent channel changes, gravel bars, forested islands, eroding banks, log jams, and a network of seasonally flooded channel remnants over the floodplain (Weiland and Schwab 1992). The bedload of Reach two is coarse (over 97% is coarser than 2 mm), consisting mostly of gravel and cobbles. Cobble lithologies show that the Thautil River provides as much as 98% of Reach two bedload (Gottesfeld and Gottesfeld 1990). Reach three of the Morice River; from Fenton Creek to the Bulkley River confluence, is a single thread channel that maintains a relatively stable channel configuration. The variable substrate is composed of silt to boulders to bedrock with low amounts of instream cover.

Morice River, reach 3.
M. Bahr 2000.

Nanika River is 23 km in length from Morice Lake to Nanika Falls and is commonly divided into four reach zones. Reach one is approximately four km in length, and is multi-channelled, with a floodplain often exceeding 400 m in width. Reach two is confined with a mostly deep, straight channel. Reach three is a multi-channelled reach with numerous islands, gravel bars, and side channels set into a floodplain sometimes wider than 400 meters. Reach four is largely a confined reach with deep fast flows, with Nanika Falls (11 m), a barrier to anadromous fish, at its head.

Nanika River, reach 2, eight km upstream from the mouth.
M. Bahr 2000.

Lower Atna River, flowing between Atna Lake and Morice Lake, is two km in length and widens in sections to form two small lakes (Envirocon 1984b). The upper lake is shallow with a comparatively wide sedge band along its northern shore. The lower lake is steep-sided. Between the lakes are two waterfalls, three and four meters high respectively. These falls are a partial barrier to fish passage for some species; however, salmon can negotiate them.

Upper Nanika River, reach 4.
M. Bahr 2000.

Summary stream channel profiles for the Morice Watershed are clearly described in Mitchell *et al.* (1998). Mountainous valleys throughout the watershed have glacio-fluvial fans that were mostly constructed during deglaciation. These fans are now more or less active with building or down cutting zones in or adjacent to the stream channel. Fan stability is dependent on two key factors: the delivery of water, and the supply and delivery of sediments to the fan.

Forest development activities influence snow accumulation, snowmelt, and water movement, which in turn influence erosion potential and sediment movement. Given the natural tendency of streams in British Columbia to increase their geomorphic response to disturbance as sediment progresses downstream (Church *et al.* 1989), it is likely that the sediment supply and movement have increased throughout the watershed.

Sediment moved by Morice River includes fine suspended material such as silts or clays carried throughout the year, and coarse bedload such as gravels, cobbles, and boulders, which are only carried during flood flows in the spring and fall. Suspended sediment may adversely affect fish, but has no influence on stream channel stability unless there is large-scale mobilization of fine sediment on a fan. Mobilization of coarse bedload material during floods can cause channel erosion and changes in channel location determining channel stability.

Sediment producing cutbank, Thautil River

Bedload material is also classified according to whether the sediment sources are external or internal to the river. External sediment is derived from tributaries, landslides, or failing streambanks. In a stable river system, external sediment input is equal to the sediment output at the lower end of the reach. Both internal and external sediment can be stored within the reach for significant periods. Internal sediment is derived from the stream channel and floodplain erosion. Where sediment input and output for a reach does not balance, then changes occur to internal sediment storage to regain a dynamic equilibrium for the river.

Morice and Bulkley Rivers confluence

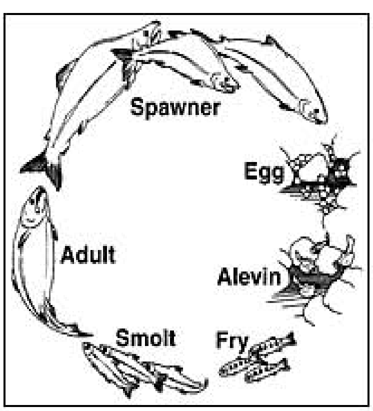
Fisheries Values and Resources

The Morice Watershed is a biologically rich river system that has considerable and varied high value fish habitat. The watershed is a major producer of chinook, pink, sockeye, and coho salmon, and steelhead trout, which are fished by the aboriginal, commercial, and recreational fisheries. Freshwater fish present in the system include rainbow, lake, and cutthroat trout, Dolly Varden and bull trout char, whitefish, lamprey, burbot, sculpins, suckers, chub, and shiners. Bustard and Schell (2002) provided an excellent, comprehensive description of Morice fish populations' status, their key habitats by species and life stage, as well as limiting factors to production and species information gaps.

Constraints to sockeye production are thought to stem from a complex mix of interrelated problems. Morice–Nanika sockeye stock returns have been fluctuating at lower than historic escapement levels that are likely a result of the high exploitation rates in the Alaskan, Canadian, and First Nation fisheries, potentially poor early marine survival, low productivity in Morice Lake, or a combination of the above. The survival of the sockeye salmon population is a serious concern. Bull trout, which are abundant in this watershed, have been identified as a species of provincial concern. The fish community contributes to the ecology, nutrient regime, and structural diversity of the drainage.

Pacific salmon, *Oncorhynchus* spp., have been and continue to be intricately connected to the cultural history and economy of the Morice Watershed and the Wet'suwet'en for thousands of years. The salmon provide strong cultural, economic, and symbolic linkages for the Wet'suwet'en, and as well, supports recreational anglers and commercial fisheries.

A key theme of Pacific salmon is that they are anadromous and semelparous, meaning they spend a portion of their life in the ocean and return to freshwater to spawn, after which they die. Their habitat includes the freshwater watershed of origin and a large portion of the Northeast Pacific Ocean.



Each fall, drawn by natural forces, salmon return to the rivers, which gave them birth. Once the salmon reach their spawning grounds, they deposit thousands of fertilized eggs in the gravel. Each female, with a male in attendance, digs a redd. By using her tail, the female creates a depression in which she releases her eggs. At the same time, the male releases a cloud of milt. When the female starts to prepare her second nest, she covers the first nest with gravel that protects the eggs from predators. This process is repeated several times until the female has spawned all her eggs.

Adult salmon die following their long journey and spawning. Their carcasses provide nourishment and winter food for birds and wildlife, and provide nutrients to the river for the next generation of salmon and other fish. As the salmon eggs lie in the gravel they develop an eye and over months, the embryo develops and hatches as an alevin. The alevin carries a yolk sac that provides food for two to three months. Once the nutrients in the sac are absorbed, the free-swimming fry must move up and emerge into the water.

Depending on the species, fry may live in fresh water for a year or more, or may go downstream to the sea at once; this varies by species. Fry ready to enter salt water are called smolts. Young salmonids stay close to the coastline when they reach the estuary. After varying lengths of time, the smolts move out into the open ocean, and, depending on the species, spend from one to four years eating and growing in the Northeast Pacific Ocean. Then they return to their home streams to spawn and die.

The data source for this report for salmon stock status is the Salmon Escapement Database System (SEDS) maintained by DFO (DFO 2003). This data set consists of a variety of annual spawning ground observations of census areas collected since 1950. The data quality varies from observer to observer and place to place. While appreciating the great value of the data records, non-fence counts can only be utilized as indicators of general trends and at best reflect relative abundance rather than actual values. SEDS data is the best available and exceeds the quality of data available for steelhead, trout, and other non-anadromous, freshwater species. In general, the number of stocks counted increased from 1950 to 1990 and declined after 1992.

Chinook Salmon

Chinook salmon are the largest single salmon stock in the Morice Watershed, contributing approximately 30% of the total Skeena system chinook escapements in the 1990s. In the past, this stock has constituted as much as 40% of the total Skeena River chinook escapement (Fisheries and Oceans Canada 1984). In the late 1950s, an estimated escapement of 15,000 Morice River chinook spawners was recorded. From 1960 through to the mid 1980s, an average of 5,500 spawners returned, after which chinook spawner escapement increased significantly, reflecting lower exploitation rates in the US and Canadian chinook fisheries subsequent to the Pacific Salmon Treaty agreement ratified in 1985. From the mid-1980s to 2002, Morice River chinook escapement has fluctuated, though the trend has been an increase with annual returns averaging more than 15,000. Recent returns have been more modest possibly due to increased ocean harvest or lower early ocean survival.

Adult chinook salmon begin their migration into the Morice River system about mid-July and spawn from August to October; peak spawning was observed to be mid-September, with die-off by mid-October by Shepherd (1979). Spawning principally occurs in the upper 2 km of the Morice River downstream of the lake outlet. Most of the riverbed at this site is characterized by a series of large gravel dunes mostly orientated perpendicularly to the direction of flow (FOC and MoE 1984). The dunes are constructed by chinook during redd excavation. Scattered minor spawning also occurs downstream to Lamprey Creek and in the Nanika River.

The majority (65%) of Morice chinook spend one year plus (sub-2) in freshwater with 35% (sub-1) spending less than one year. Chinook return mainly as four or five-year-olds as shown by the 85% returns in 1973 & 1974. In comparison with other Skeena chinook stocks, Shepherd (1979) reported that Morice River produces more six-year-olds than other systems in the Skeena (12% average versus 3% average) and fewer two and three-year-olds (3% versus 17%).

Chinook dunes, upper Morice River.
M. Bahr 2000.

Chinook fry migrate or are displaced downstream upon emergence from the gravel between mid-April and early-July, though typically peak emergence is in late-May to early-June. Downstream smolt movement occurs between mid-April and mid-August, though it appears to peak in early June. Upstream fry movements begin in mid-July, peak in mid-August, and end in early September (Shepherd 1979). Survey results Smith and Berezay (1983), and Envirocon (1984b) indicate that chinook fry overwinter throughout most of the Morice River mainstem. However, the reach between Thautil River and Owen Creek, with abundant side channels and log debris, is considered the most productive rearing area.

Pink Salmon

The Morice pink salmon run is significant among Skeena pink producing systems. The odd-year pink run to the Morice River has been expanding since construction of the Moricetown Canyon fishway in 1951 and the removal of key rocks by blasting at Hagwilget Canyon in 1958. Pink salmon were first seen in the lower Morice River in 1953 and had reached Owen Creek by 1961, and Gosnell Creek by 1975 (Shepherd 1979). From the mid-1980s to the mid-1990s, pink escapements were usually over 50,000 and often over 100,000 fish. By the mid-1980s, this steady expansion of range saw pinks infrequently colonizing Nanika River spawning grounds.

Adult pink salmon usually migrate upstream into the Morice system in late August to early September. Pink spawning is reported to take place through September (DFO 1991b) with over 90% of the escapement spawning in Reach 2 (Thautil to Lamprey) side channels. Small numbers of spawners have also been observed at Gosnell Creek, Nanika River, and in the mainstem downstream of the lake. Winter observations of pink redds in heavily utilized side channels indicate that dewatering of redds, and probable losses of eggs and alevins with reduced flows, occurs more often at these sites than in the deeper main channel spawning areas (Envirocon 1984b). Upon emergence from gravels, pink fry migrate directly to the ocean, returning to spawn as two-year-old fish.

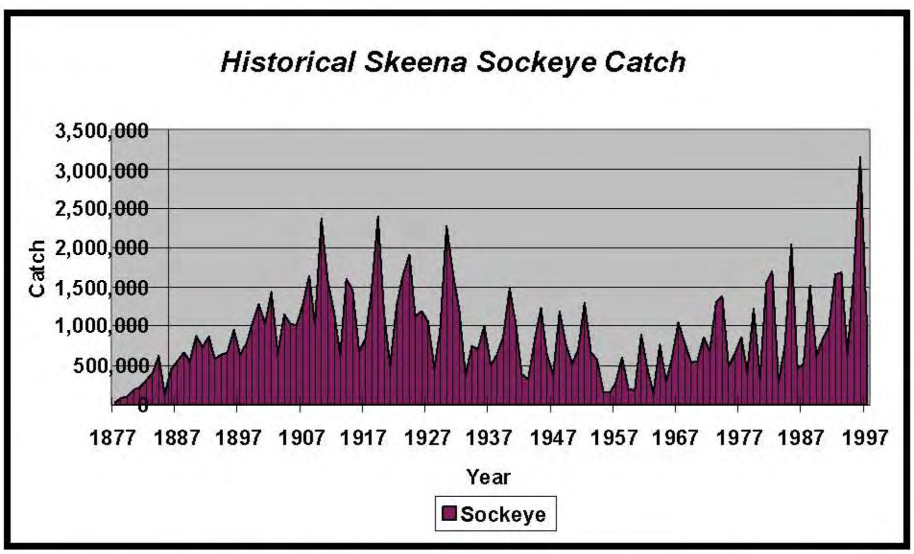
Chum Salmon

The Department of Fisheries of Canada (1964) reported that a small number of chum utilize the lower Morice River, but very little is known regarding their distribution. Kussat and Peterson (1972) noted that the chum escapement had never been enumerated, but observations indicate that the population numbers only a few hundred fish. Shepherd (1979) noted that he did not observe chum salmon in the Morice system. Bulkley River chum localities are not listed in the SEDS database. At Moricetown Canyon, located about 100 km downstream of the Morice River, no chum were observed from 1992 to 1995, with only three in 2001.

Sockeye Salmon

Morice–Nanika sockeye are the most important sockeye stock in the Bulkley Basin. The loss of this important fish resource greatly concerns the Wet'suwet'en. Wet'suwet'en Fisheries and DFO have both been implementing management actions to secure greater Morice–Nanika sockeye escapements. Wet'suwet'en Fisheries have for the most part foregone their terminal food fish harvesting; since 2001, they have procured food fish from the coastal commercial fishery. DFO has focused on reducing the exploitation rate on the Morice–Nanika harvests.

Historically, sockeye returning to the Morice Watershed numbered on the order of 50,000 to 70,000 fish and comprised as much as 10% of the total Skeena River escapement (Brett 1952). The average annual escapement estimate for the 1940s was 70,000 fish (Cox-Rogers 2000). In 1954, the population collapsed, and the following twenty-year period, 1955–1975, saw an average annual return of 4,000 sockeye to the watershed (FOC 1984). Average annual returns in the 1980s were 2,500 fish, while the annual average returns in the 1990s were 21,500 fish.



Aggregate Skeena sockeye catch between 1877 and 1997.

In 1951, fishways were constructed at Moricetown Falls. In 1959, rock removal was conducted at Hagwilget Canyon. The Nanika River Rehabilitation Program was established in 1961 to improve juvenile production and was carried through to 1965. Protective regulations to the commercial fisheries were not considered practical due to the coincidental early and middle Babine sockeye timing. During the 1970s, Morice–Nanika sockeye studies were conducted under the auspices of the Kemano Completion Project (Shepherd 1979).

Morice sockeye are among the earliest sockeye to reach the Skeena, passing through the commercial fishery in late-June to mid-July with a peak in the first week of July (Cox-Rogers 2000). Peak migration of sockeye salmon past the Alcan counting tower near Owen Creek occurred in early to mid-August (Farina 1982). Shepherd (1979) noted that Nanika River peak spawning occurs during the third week of September.

The main sockeye run usually holds in Morice Lake before ascending the Nanika River to the 3 km reach downstream of Nanika Falls where the principal spawning ground are located (Robertson *et al.* 1979). Morice Lake sockeye adults utilize scattered spawning grounds at the south end of the lake, but the main beach spawning occurs for 3 km north of Cabin Creek (Vernon 1951, Bustard and Schell 2002). Scattered beach spawning also takes place on the west and east shores in the central portion of the lake (Hancock *et al.* 1983). Studies of beach spawners in Atna Lake during 1980 indicated estimates of approximately 400 sockeye spawners (Envirocon 1984b). Brett (1949) notes sockeye spawning grounds located in Gosnell Creek. Bustard and Schell (2002) mapped all known sockeye river and lake spawning locations; the following map is adapted from their project.

Nanika Falls.
M. Bahr 2000.

Nanika River sockeye spawning grounds are the only ones in the Morice system that have had consistent escapement estimates since the 1950s. Accurate beach spawning counts along Morice and Atna Lake shorelines are difficult due to turbidity and depth. Bustard and Schell (2002) suggested that Morice Lake beach spawning sockeye may comprise a significant component of the Morice sockeye run during some years. This is now backed up by the Moricetown Canyon mark–recapture program that shows 35% of the total sockeye spawn in locations other than Nanika. Many of these are thought to be Morice Lake beach spawners.

Following emergence, sockeye fry emigrate from spawning beds into Morice Lake from late-May to late-July, usually coincident with peak annual flows (Shepherd 1979). In contrast with other Skeena sockeye stocks, which spend one year in freshwater, over 85% of Nanika River sockeye spend two years in Morice Lake, and 90% return as four- (2.2) and five- (2.3) year-olds (Shepherd 1979).

MAP LEGEND

- *ADULT MIGRATION & HOLDING*
- *SOCKEYE SPAWNING AREAS*
- *CREEKS*
- *SWAMPS*
- *WATERBODIES (RIVERS & LAKES)*

NANIKA - MORICE SOCKEYE SPAWNING GROUNDS

NANIKA - MORICE SOCKEYE RECOVERY PLAN

0 1.5 3 6 9 12

Kilometers

MAP SCALE - 1:175,000

SKEENA FISHERIES COMMISSION

G.I.S. DEPARTMENT

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PREPARED BY: L. WILLIAMS
DATE: JUNE 13, 2005

Sockeye smolts migrate out of Morice Lake from late April to August with a peak migration in May (Shepherd 1979, Smith and Berezay 1983). Smolts feed and physiologically adapt to the ocean environment in the Skeena Estuary before typically travelling northward, where they spend one to three years in the North Pacific foraging on amphipods, fish, squids, and euphausiids (Burgner 1991). Shepherd (1979) suggested that the larger two-year-old smolts might have a higher marine survival rate. Atna Lake sockeye studies indicate that this stock also spends two years in freshwater, but most returned after spending three years in the ocean (Envirocon 1984b).

Shortreed *et al.* (1998, 2001) confirmed these earlier studies reporting that age-0 fall fry are the smallest (0.8g) in any sockeye nursery lake in BC. Sockeye stomachs were <30% full and contained mostly bosminids, a less than ideal food source, which indicates extreme oligotrophy. The large percentage of two-year-old smolts in Morice Lake is also indicative of its low productivity. Shortreed *et al.* (1998, 2001) and Cox-Rogers *et al.* (2004) conclude that Morice Lake is largely fry-recruitment limited with not enough spawners, and is an excellent candidate for nutrient additions. Given the lake's large size, there is the potential for large increases to its sockeye stock.

Stockner (2003) notes that with respect to salmon, the decline of phosphorus nutrients began in the early part of the twentieth century during times of over-fishing. During that time, many of the nutrients were being put into cans and were not available to replenish the environment. The primary reduction of phosphorus and other nutrients in steams, lakes, and estuaries can be attributed to the decline of fish populations.

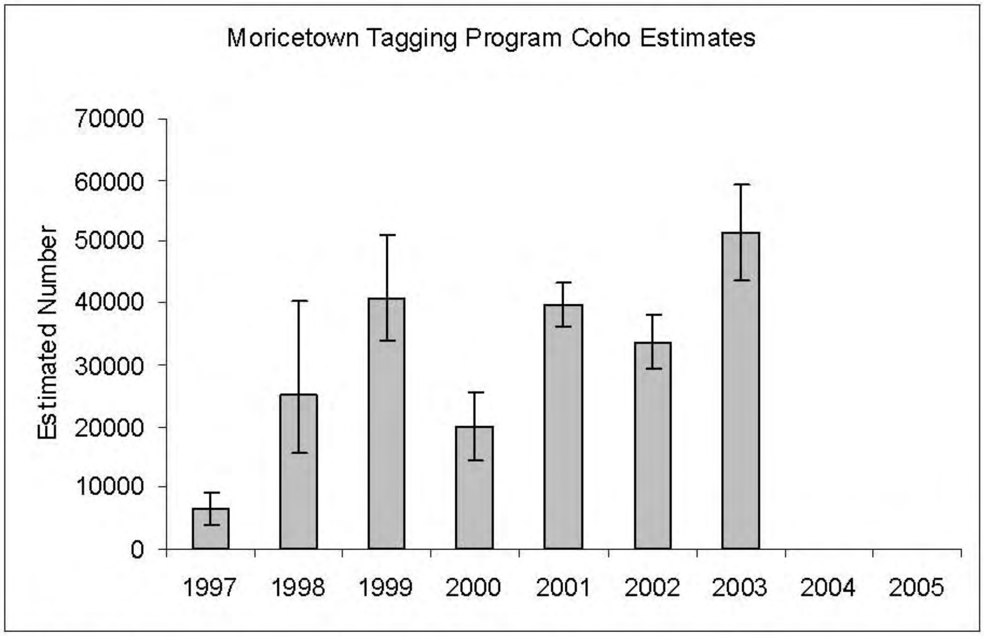
Over the past 20 years, the Department of Fisheries and Oceans has been experimenting with artificially increasing production of sockeye through lake fertilization. These efforts mitigate some of the losses of nutrients that are no longer available to populations with depressed escapements. Results of fertilization research provide strong evidence that an external nutrient source to oligotrophic lakes, equivalent to the nutrient influx from returning spawners, is needed to maintain lake productivity.

In recent years, studies have shown that climate is a significant factor in the survival of salmon. Climate and ocean conditions together form a large part of the background conditions on which salmon return to spawn. Within Morice Lake, sediments are the chemical and biological indicators that can reconstruct past sockeye salmon abundance. The response of Pacific salmon to future climatic change is uncertain, but will likely have large impacts on the economy, culture and ecology of the Skeena Basin. Sediment core analysis could enlighten past salmon abundance variability and focus research necessary to better predict future responses.

The return of Morice River sockeye escapements to desired levels will require multiple strategies that will be established in the Morice–Nanika Sockeye Recovery Plan.

Coho Salmon

Morice River system coho contribute approximately 6% to Skeena coho escapement as a whole. In reviewing SEDS data (DFO 2003), a declining trend from the 1950s to the present is apparent in coho populations for the Morice system. The decline is in absolute numbers as well as relative to the overall Skeena escapement. The highest ten-year period of abundance in escapement numbers, the 1950s, showed an annual average escapement of 10,700 fish. In the 1970s, the average annual escapement was approximately 4,300 fish. The escapement dropped to 518 fish in the 1980s, and remained low in the 1990s with an escapement of 672 fish. Recently, returning coho spawners appear to have increased.



Total coho escapement above Moricetown Canyon since 1997

Coho enter the Morice system in mid-August through to mid-September, generally holding in the mainstem and in Morice Lake, and then, depending on water flow conditions, move with fall freshets into the tributaries to spawn. Coho spawning in Morice River prefer the spawning grounds downstream of the lake outlet and Reach 2 sidechannels from Lamprey Creek to Thautil River (Envirocon 1980, Finnegan 2005).

In years of below average streamflows, typically the only tributary streams with adequate flow for coho access and spawning are Gosnell Creek, the Thautil River, and Houston Tommy Creek. In most years, other preferred tributaries for spawning include Owen Creek, Lamprey Creek, McBride Creek, and Nanika River. McBride Creek is a key spawning area that is no longer easily accessed by coho. Finnegan (2005) reports that recently Owen Creek appears to be utilized mostly for juvenile recruitment. Documented spawning areas occur in all tributary streams of the Morice River (Shepherd 1979); however, this is likely to depend on adequate adult escapement and fall freshets coinciding with the late October and November spawning period.

Gosnell Creek, prime coho rearing.
Bustard & Associates.

Coho fry emergence extends from April to July. Juveniles are widely distributed throughout the Morice mainstem, as well as in most of the tributaries and lakes in the system during years of suitable recruitment. Rearing in these streams occurs for one to two years. Habitat preferences are well defined and include side channels, side pools, ponds, and sloughs, with instream cover providing an important key habitat component (Shepherd 1979, Envirocon 1980). Overwintering coho prefer side channels, which makes them susceptible to reduced winter flows and cold temperatures that may result in dewatering and freezing of their winter habitat. This is a major constraint for coho smolt production in the Morice River, as significant mortalities have been documented (Bustard 1983). Changes to coho access into McBride Lake may also be significant.

Steelhead

The Bulkley–Morice likely accounts for at least half of the total escapement of Skeena steelhead in recent years based on population estimates for the Bulkley River (Mitchell 2001) and test fishery data from the Tyee Test Fishery. The significant summer steelhead run of the Morice system moves into the river in mid-August and continues into the autumn (Whately *et al.* 1978). Overwintering appears to occur throughout the mainstem (Lough 1981), particularly downstream of Gosnell Creek, with evidence that steelhead also utilize Morice Lake (Envirocon 1984b). With the exception of Gosnell Creek, tributaries do not support overwintering steelhead due to insufficient discharge (Envirocon 1980, Tetreau 1999).

Steelhead spawning coincides with an increase in Morice River snowmelt flows that are typically in late-May to early June. Results from Envirocon (1980, 1984b) sampling surveys indicate widespread spawning distribution through the mainstem and tributaries. According to SISS maps, critical spawning habitat is in the upper Morice River and in scattered downstream pockets to the Thautil confluence, the lower reach of Gosnell Creek (DFO 1991), as well as Nanika River. Bustard and Schell (2002) key spawning tributaries are Shea Creek, Owen Creek, upper Thautil River, and upper Lamprey Creek. Repeat spawners among Morice River steelhead comprise 6.6% of the total returns, with females outnumbering male repeat spawners by a ratio of 2:1 (Whately *et al.* 1978).

Thautil–Gosnell confluence.
M. Bahr 2000.

Steelhead fry emergence in the Morice mainstem occurs primarily between mid-August and mid-September, while emergence in some tributaries may occur as early as late-July, due to earlier spawning and warm water temperatures. Tredger (1981-87), Bustard (1992 and 1993), and Beere (1993) described juvenile steelhead fry and parr distribution, densities, and size estimates from a network of index sites. Most Morice steelhead remain in freshwater for three (24%) or four (70%) winters prior to smolting, which is a longer freshwater residency time than the six other summer-run steelhead rivers studied in the Skeena system (Whately 1978). Rearing occurs throughout the mainstem and tributaries. Thautil River and Owen, Lamprey, and Gosnell Creeks account for most of the steelhead fry (85%) and parr (75%) sample catch (Envirocon 1984b).

Indigenous Freshwater Fish

Freshwater species and documented populations inhabiting the Morice drainage include rainbow trout, bull trout, lake trout, Dolly Varden, mountain whitefish, pacific lamprey, longnose dace, burbot, redside shiner, lake chub, longnose and largescale suckers, and prickly sculpin (FISS 2003). Resident freshwater fish information for the watershed is relatively abundant in relation to many Skeena sub-basins. This is mainly due to the extensive surveys associated with the proposed Kemano II project. Nevertheless, parts of the drainage are poorly known and may contain populations of special interest or status that are presently unknown or undocumented. Ecological and life history information that permits good conservation planning is only partially available. Bustard and Schell (2002) informatively described the major freshwater species life histories, population status, distribution, and key habitat factors and issues.

Resident rainbow trout are associated with a number of the larger lakes in the Morice system, particularly Morice, Owen, and Nanika-Kidprice lakes system upstream of Nanika Falls (Bustard and Schell 2002). Tredger (1981) noted that rainbow trout populations are present in upper Lamprey Creek and Lamprey, Phipps, and Bill Nye Lakes.

Dolly Varden are the most widely distributed fish species in the Morice Watershed and dominate the catches in many of the smaller tributaries (Bustard and Schell 2002). Dolly Varden are also present in many of the larger lakes throughout the system such as Owen, Lamprey, Shea, and the Nanika-Kidprice lakes system. Dolly Varden tends to achieve relatively low densities in most Morice stream systems. Length frequency information collected by Bustard in the Gosnell (1999) and in the Thautil (1997) showed that less than 2% of the total samples exceeded 150 mm in length. The studies in these two stream systems suggested that most spawning occurs from mid-September into October.

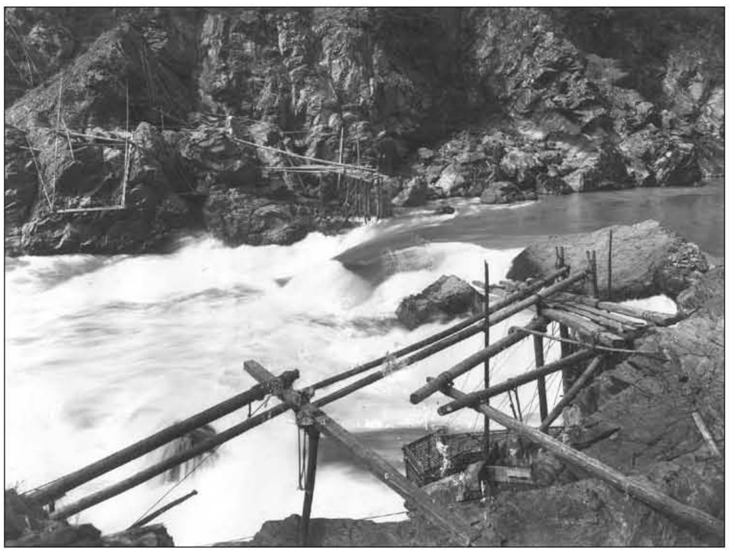
Studies separating Dolly Varden and bull trout in the Morice Watershed have been principally conducted by Bustard in the Thautil (1997) and the Gosnell (1999) and by Bahr (2002). Bahr conducted radio-telemetry studies in the drainage to determine habitat areas utilized by bull trout. Ninety-three adult bull trout were captured and implanted with radio transmitters, which allowed identification of staging, spawning, and overwintering areas. These fish demonstrated a preference for cold water systems, spawning in tributaries. The migration to spawning areas coincided with a decrease in tributary water temperature and discharge. In total, 182 bull trout were captured, measured, and sampled. Ages of fish ranged from 0 to 14 years. DNA was extracted and analyzed for allele variation to determine population structure within the watershed.

Kokanee are reported in Morice Lake (FISS 2003) and in Shea Lake (DeGisi and Schell 1997). Lake trout are present in Morice, Owen, Atna, and McBride Lakes. Mountain whitefish presence is noted in Morice, Atna, Shea, Owen, and Lamprey Lakes (Applied Ecosystem Management 2001). Bustard and Schell (2002) reported that the highest concentrations of juvenile and adult whitefish appear to be in the Morice mainstem, and use of the tributaries appears to be minor. Pygmy whitefish are reported in Owen and Morice Lakes, and lake whitefish are known in McBride and Morice Lakes. Pacific lamprey are abundant and widely distributed throughout the drainage with concentrated spawning occurring in Lamprey Creek, Owen Creek, and Morice River (Envirocon 1984b).

Fisheries

First Nations Traditional Use

First Nations traditional occupation and use of the Morice Watershed is extensive and estimated to have been over a period of at least 6,000 years (Allbright 1987). Morice River Watershed territory is held by three Wet'suwet'en clans: Gilseyhyu, Laksamshu, and Gitumden. Seven House territories from these clans overlie the Morice drainage, with traditional use generally covering the landscape. The cultural infrastructure existing throughout the watershed is comprehensive, particularly before large-scale industrial forestry activities were initiated in the 1960s.



Hagwilget Canyon fishing platforms.
BC Archives.

Wet'suwet'en traditional salmon fisheries within the Morice drainage are not well documented; however, Naziel (1997) recorded approximately twenty site locations. These included concentrated sites on the Morice River, many of which were adjacent to tributary streams, as well as dispersed sites located on tributary lakes and streams. Rabnett *et al.* (2001) documented traditional fishing sites at Morice Canyon (Tsee Gheniinlii), Morice–Owen confluence (Bii Wenii C'eek), and Morice Lake outlet (Lheet lii'nun teezdlii). Undoubtedly, many more sites on the mainstem and tributaries exist; however, few archaeological and cultural heritage studies have been conducted.

Morice–Nanika sockeye were a large part of the aboriginal food fishery. Hagwilget Canyon and Moricetown Falls were the sites of major native food fisheries. Traditionally, sockeye salmon were mostly harvested in basket traps and dipnets, but these were banned in 1935 (Palmer 1964). Gaffing was then introduced as the legal fishing method and used primarily up until the mid-1990s. The current decline of Morice–Nanika sockeye due to high exploitation rates, as well as ocean and lake productivity issues, has deeply impacted the Wet'suwet'en First Nation.

Since 2001, the Wet'suwet'en have not directed a food fishery on the Morice–Nanika sockeye stocks. The Native Brotherhood of BC, in association with the United Fisherman and Allied Workers Union, north coast gillnet groups, and fish processing companies have supplied the Wet'suwet'en with 8,000 sockeye (Joseph 2005) since 2001. With this cooperation, reduced harvest rates on the Nanika sockeye stock may be addressed at the terminal fishery (river) level in a way that is more difficult to achieve in the mixed stock fishery.

Moricetown Canyon.

Recreational Fisheries

The Morice River Watershed with its many tributaries and lakes provides valuable sport fishing opportunities to residents and non-residents. Provincially, the Morice River is one of the most significant streams for steelhead angling enthusiasts. Coho, chinook, and steelhead are fished seasonally. The sports fishery directed towards steelhead is intensive and includes angling effort on the Bulkley River for Morice system steelhead. Further angler pressure is applied to Morice steelhead when other popular steelhead fishing rivers such as the Kispiox and Zymoetz become silty or dirty with fall storm floods.

Rainbow trout, lake trout, and Dolly Varden are also actively angled, particularly in Morice and other headwater lakes. Aspects of the Morice sport fishery have been noted by Pinsent and Chudyk (1973), and Fennelly (1963), with Lewis (2000) touching on steelhead angling. Angler-use surveys were conducted by Remington *et al.* (1974), Whately *et al.* (1978), and Envirocon (1980). The Morice River is designated as Class II waters requiring both a Classified Water License and, if applicable, a Steelhead Stamp from September 1 to October 31. Seasonal fishing and gear restrictions also apply.

Enhancement Activities

Enhancement activities in the Morice Watershed have been ongoing for centuries according to Wet'suwet'en elders, particularly in regards to fish access and passage issues. The present Moricetown Canyon fishway was constructed in 1951. Concerns regarding the low number of returning Nanika sockeye in 1955 led to the decision to remove obstructions in Hagwilget Canyon. The canyon rocks were blasted in 1958, effectively eliminating the aboriginal fishery in the canyon.

The continuing decline of the Nanika sockeye population, with escapements of less than 1,000 fish for the three consecutive years of 1957 to 1959, initiated the Nanika River Rehabilitation Program. This program, designed to improve Nanika sockeye juvenile production, led to the construction of a pilot hatchery on the lower reach of Nanika River. In operation from 1960 to 1965, the hatchery was not successful, probably due to the use of transplant stock from Pinkut Creek in the Babine system. The selected stock was unsuitable, with emergence three to four weeks early in relation to suitable fry rearing conditions, differences in Pinkut adult life history (largely 1.2 and 1.3 fish), and the small size and thinness of Pinkut fry compared to Nanika sockeye fry (Shepherd 1979). The hatchery was closed in 1965 pending evaluation of returns.

Morice Lake was aerial fertilized in 1979 and 1980, and although the project was not comprehensively followed up, preliminary results indicated that phytoplankton increased 35%, while zooplankton levels went up 60% (Shortreed *et al.* 2001).

Studies to assess steelhead enhancement opportunities in the Morice Watershed were undertaken from 1980 to 1983 (Tredger 1981). The stocking of the Morice River system began in 1983 with 70,000 summer steelhead fry released above barriers (locations unknown) and in underutilized areas. In 1984, this program continued with an additional 62,000 fry released (FOC & MoE 1984). In 1985, 3,900 steelhead fry were released, while 21,000 were released in 1986 (FISS 2003). The majority of fry releases were to the Morice mainstem, Gosnell Creek, and Houston Tommy Creek. A post-stocking cost-benefit assessment suggested the program be terminated.

In 1983, 850 chinook smolts from Morice brood stock were released into Morice River; this is the only known chinook enhancement project (DFO 2002b). Coho enhancement included the two off-channel developments close to Owen Creek, which were largely unsuccessful, and coho fry and smolt outplants. These outplants in 1999 and 2000 totalled 36,000 releases into Owen Lake.

Development Activities

Principal land use and development activities in the Morice Watershed result from forest development, with minor mineral, transportation and utilities, and settlement concerns.

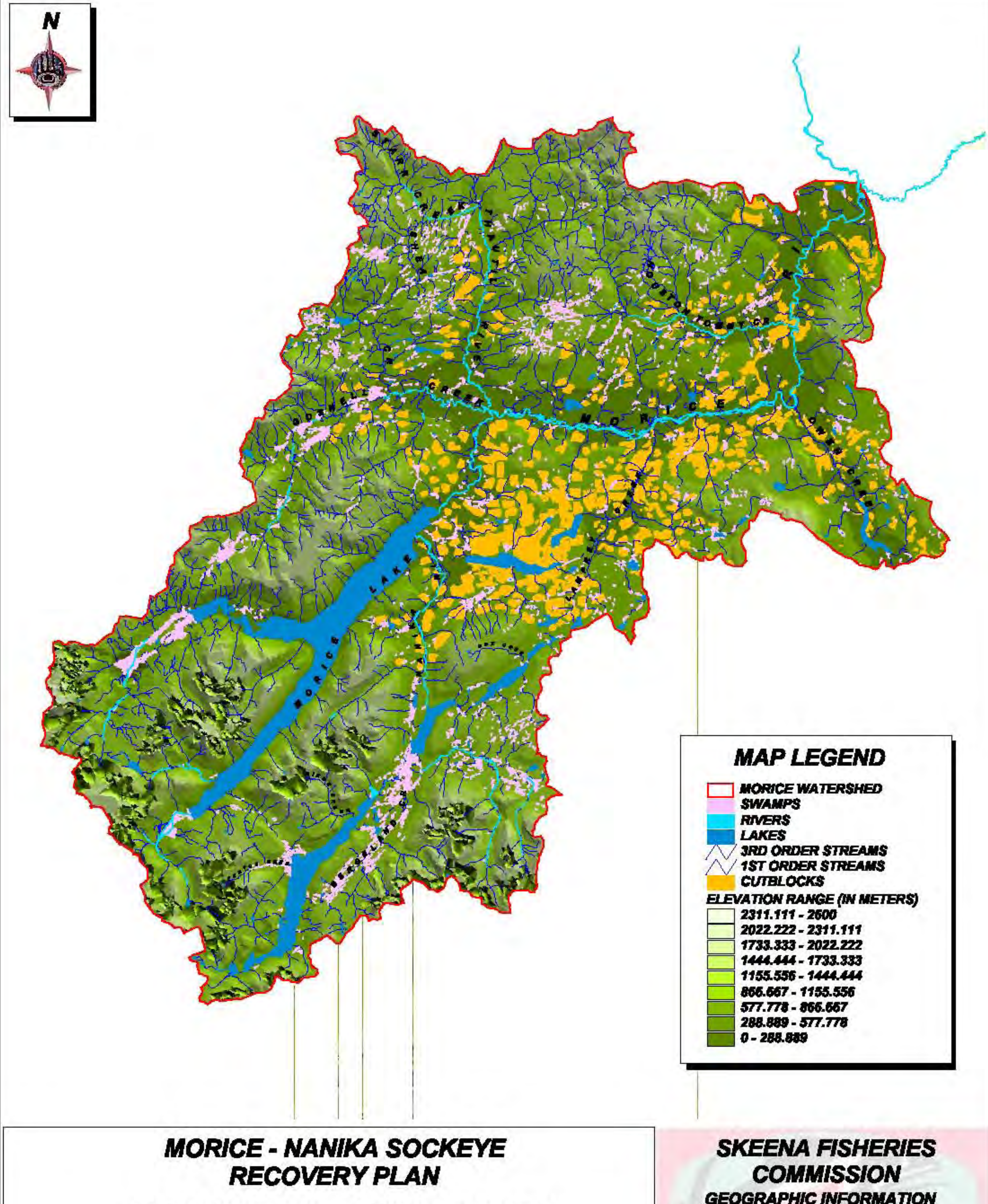
Forest Resource Development

The foundations of the permanent forest industry were laid by tie hackers, who cut small amounts of lodgepole pine for railroad ties at the lower end of the Morice Watershed from 1925 through the Depression years. Following World War II, there was a great demand for lumber; however, most of the logging was centered in the Bulkley Valley and in the Buck Creek area (Hols 1999). The Morice River Road from Houston to Morice Lake was constructed from 1954 to 1958. Logging started shortly thereafter, with sawmills located at Collins and McBride Lake and the lumber trucked to Planer Row in Houston. Three small operators cut timber off the road on Morice Mountain, and a small mill operated at Owen Flats.

By the mid-1960s, Bulkley Valley Pulp and Timber had bought up many small mills and their attached timber quotas; then they built a new mill in 1970, the predecessor of the current Canfor mill. Prior to 1968, logging in the Morice was mainly conducted off trails, creating herringbone patterns. By 1968, clearcut logging became dominant, utilizing the easily accessible timber stands located adjacent to the Morice River Road. Years of planning by Weldwood and Eurocan resulted in the opening of Houston Forest Products in 1978 (Hols 1999).

In 1983, the Swiss Fire burnt 18,000 ha on both sides of the Morice River, precipitating three years of intensive salvage operations. Logging operations in the 1980s were widespread, with intensive development in the Morice North area (Chisholm Lake). The 1990s saw the initial development of the Morice West area with continued widespread operations throughout the mid portions of the watershed. In the recent past, development has been targeting beetle infestations, with timber extraction from many, small infested areas, though rapid expansion of beetle activity has now taken place. Recent timber harvesting in the Morice West area has focused on the Gosnell, Thautil East, and Shea drainages.

The Morice Watershed Restoration Program was initiated in 1994 when SKR conducted assessment work on Cedric, Lamprey, Fenton, and Owen Creeks (Saimoto 1994). Saimoto found that about half the sites examined had been impacted by roads or cutblocks in some manner. An overview assessment was conducted by the Wet'suwet'en Treaty Office (1996), and then followed by a detailed assessment in 1997 (Mitchell *et al.* 1998). The British Columbia Conservation Foundation (BCCF 1999) conducted a detailed assessment on the Nanika and Lamprey sub-basins. These assessments of logging-related damage to fish habitat led to a small number of site works, which were principally implemented to alleviate fish passage problems at Fenton Creek and an unnamed creek at 28 km on the Morice West Road, as well as for some minor riparian rehabilitation (Ministry of Forests 2001).



MORICE - NANIKA SOCKEYE RECOVERY PLAN

MORICE WATERSHED SHOWING FORESTRY

10 0 10 20 30 Kilometers

MAP SCALE - 1:550,000

SKEENA FISHERIES COMMISSION

GEOGRAPHIC INFORMATION SYSTEMS DEPTARTMENT

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COMPLETED BY: L. WILLIAMS
DATE: MAY 30, 2005

In summary, forest development activities within the Morice Watershed have involved progressive road development on the relatively good ground in most tributary valleys. Clearcutting activities have primarily focused on harvesting the medium volume, solid, high value pine and spruce stands.

Mineral Resource Development

Mineral exploration activities have been moderately extensive in the Morice Watershed; however, economic considerations and mining circumstances have resulted in only one productive mine, the Silver Queen property. Substantial amounts of money and effort have been spent on developing this silver, lead, and zinc deposit located east of Owen Lake, but a sustainable mining operation has yet to be developed there.

Recent mineral exploration activity consisting of a drill program and an induced polarity geophysical survey is centered at the Lucky Ship molybdenum property that is located on the ridge between Nanika River and Morice Lake. Molybdenum mineralization is associated with a rhyolite plug that cuts through Hazelton Group volcanic, pyroclastic, and sedimentary rocks. The Lucky Ship was discovered by prospectors in 1956 and was explored intermittently by Amax, and later Canamax from the late 1950s to the early 1980s. This development is being spurred by the current high price of molybdenum.

Transportation and Utilities

A network of easily accessed roads developed by the forest sector lies in most tributary valley bottoms and extends onto the majority of plateaus. These gravel roads branch from the main road, the Morice-Owen Road, which connects with Highway 16 west of Houston. Many of these roads lie on top of traditional Wet'suwet'en trail infrastructure. The trail routes followed the easy ground that connected trade routes, home places, and resource gathering locales. In 1929, the trail from Owen Lake to Francois Lake was hacked out as a winter sleigh road, and then was further developed into a wagon road to facilitate mineral development.

In 1954 to 1958, the BC Forest Service constructed the Morice River Road from Houston to the Collins Lake–McBride Lake area. The most remote portion of the road, built in 1958 to Morice Lake, was not originally part of the plan, but was built for fire crew access when the 10,000 ha Clore Fire broke out (Smith 2002). The road to Morice Lake was then used for access to a hatchery on Nanika River.

The building of the Morice River Road and the many subsequent smaller access roads opened a new timber supply area, with many small bush mills appearing throughout the area. The Morice–Nanika, Lamprey, Nado, Morice West, and the Cedric branch roads were constructed in 1961.

Since 1996, Huckleberry Mine, located 120 km southwest of Houston, uses the Morice–Owen Road daily to haul ore to Stewart. A BC Hydro transmission line serving the mine was constructed in 1997 and for the most part closely follows the road right-of-way.

Improvements and upgrades on the Morice–Owen Forest Service Road (FSR) occurred in 1978 and 1997, with the latter accommodating the greatly increased traffic to Huckleberry Mine site. In 1990, the Morice River West FSR was extended, crossing the Morice River and Gosnell Creek.

Population and Settlement

Historically, Wet'suwet'en people resided at various village sites and home places throughout the watershed, but in the early 1950s, lifestyles changed and many Wet'suwet'en moved into the Bulkley Valley. Less than twenty people currently reside in the watershed and few seasonal workers "camp out," with the majority of workers traveling into and out of Houston.

Located 4 km east of the Morice–Bulkley confluence, Houston is home to approximately 4,000 people (Stats Can 1996). This community is heavily dependent on the forest resource, with minor amounts of agriculture and mineral resources contributing to the economy (Horn 2001). Population growth trends are projected to be stable; however, closure or downsizing of major industrial or public sector operations would have a significant impact upon the population. The forest sector, which is based on two mills located in Houston, directly employs approximately 600 people and indirectly employs approximately 800 people (Regional District of Bulkley–Nechako 1998).

Huckleberry Mine, using Houston as its base community, directly employs 205 people and indirectly employs another 200. The majority of the Bulkley Valley bottomlands are used for agriculture, primarily livestock production. While agriculture's direct contribution is no longer particularly significant, it has given the Houston area a relatively stable base of economic activity over the years.

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