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An integrated assessment of the cumulative impacts of climate change and industrial development on salmon in Western BC

Stikine and Upper Nass
Current Social-Ecological Conditions Summary

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Credits

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Executive Summary

The purpose of this report is to provide summary information focused on historic and current ecological, cultural-socio, and human-based development for the Stikine and upper Nass watersheds. The objectives are to present categorized information at the watershed and major sub-basin level in order to provide context for the larger project – assessment of cumulative impacts in the Stikine and upper Nass areas.

The assessment of cumulative impacts in the Stikine and upper Nass areas is itself nested into a yet again larger study: *An integrated assessment of the cumulative impacts of climate change and industrial development on salmon in western British Columbia*. The project purpose is to address current and potential ecological, cultural, and social impacts and provide possible future solutions to negate or mitigate those impacts.

First Nations other than the Nisga'a – who have a treaty, the Nisga'a Final Agreement – have never relinquished rights to lands and resources within their territories. Within the Stikine and upper Nass area there are currently two permanent settlements: Iskut and Telegraph Creek, which are both Tahltan. The southern extent of the Stikine and upper Nass area is overlaid with Gitanyow, Gitxsan, Tsetsaut, and Nisga'a territories.

The Stikine and upper Nass project area covers 69,200 km^2 of the Stikine, Unuk, and upper Nass watersheds in northwestern British Columbia. The Stikine and upper Nass area is known for its high cultural values, biological diversity, species richness and intact environment.

Unuk watershed drains 3,885 km^2 of which approximately half is within British Columbia. Unuk River flows southwesterly from Unuk Lake for 105 km to Burroughs Bay, Alaska. The Unuk system is located wholly within the southern Boundary Ranges with long, cold, heavy snowpacks, and high winds in the winter while summer is generally cool and wet. The majority of the Unuk drainage is covered by icefields and glaciers. The Unuk watershed supports five salmon species: sockeye, pink, chum, Chinook, and coho and winter steelhead. Freshwater fish residents include cutthroat trout (anadromous), rainbow trout, three-spine stickleback, Dolly Varden and bull trout char. Fish presence and abundance is poorly documented for the Unuk River upstream of the border.

Stikine watershed is the third largest drainage in BC, draining approximately 52,000 km^2 and is only slightly smaller than the Skeena. Stikine watershed is comprised of coastal and interior physiographic subdivisions that reflect similar aspects of climate, physiography, and hydrology; these are the Boundary Ranges, Stikine Plateau, and the Skeena Mountains. The Stikine system supports five salmon species: sockeye, pink, chum, chinook, coho, and steelhead. Cutthroat trout, eulachon, and lamprey are the other anadromous species present. Rainbow smelt, eulachon, and longfin smelts are known in the estuary, but it is unknown if they spawn in BC waters. Green sturgeon and white sturgeon are noted as present, although knowledge is scant regarding their life histories and habitats in the Stikine drainage.

Sockeye, followed by coho and chinook, are the most abundant. Pink salmon spawn principally in Alaskan streams, though they also occur as far upstream as the Tahltan fisheries beyond

Telegraph Creek. Chum salmon are known to be present upstream as far as the Chutine River area. Coho are wide dispersed and spawn throughout the accessible streams Salmon support First Nation, commercial, and recreational sport fisheries, as well as wildlife, throughout the extent of salmon distribution.

The upper Nass watershed is comprised of the northwest Skeena Mountains, Nass Basin, and the southern edge of the Boundary Ranges. Northwest Skeena Mountains are subdivided by major drainage systems into semi-discrete mountain ranges that include Klappan range, Groundhog Range, Slamgeesh Range, Oweegee Range, and the Strata Range. The irregularly shaped Nass Basin occupies the landscape below 760 m elevation, and is mostly rolling valley floor terrain with the adjacent Skeena Mountains and Boundary Range mountains rising abruptly out of it. The Boundary Ranges are characterized by steep and rugged topography, and great range of relief.

The Nass is the fourth largest watershed in BC. Most of the streams draining the Boundary Ranges and the northwest Skeena Mountains are glacial and turbid, with sections of steep channels. Stream systems draining the Nass Basin mostly flow clear water. Upper Nass area supports five salmon species: sockeye, pink, chum, chinook, and coho, and steelhead, as well as the anadromous lamprey.

Salmon abundance and diversity have been driven down by Canadian and Alaskan coastal commercial mixed-stock net, fish traps, and troll fisheries. Management of all Nass basin salmon stocks is developed between Nisga'a Fisheries and Fisheries and Oceans Canada, and seasonally with Alaskan agencies, particularly regarding commercial fishery timing and salmon escapement goals. Nass sockeye are widely recognized for their distinctive migratory behavior, their unique types of spawning and juvenile rearing life histories, and their intimate connection with the Tsimshian, Nisga'a, Gitanyow, and Gitxsan First Nations and their cultures.

The study area encompasses eight ecosections and eight BEC zones. The Stikine and upper Nass area supports caribou, mountain goats, Stone's sheep, moose, grizzly and black bears, wolves and smaller mammals. One of the most exceptional biological features of the Stikine and upper Nass area is the large, intact mammal predator-prey system that exists in a relatively pristine environment. Wildlife inventories are conducted for species in the Stikine and upper Nass area by BC Ministry of Environment and local First Nations intermittently for caribou, moose, mountain goat, Stone's sheep, and grizzly bear and usually in response to management concerns.

A variety of natural disturbance factors have influenced the ecosystems of the Iskut-Stikine and upper Nass study area. The landscapes that exist today are the result of large and small-scale ecosystem processes. Large-scale events driven by climate, such as fire, glaciation, volcanic activity, snow and landslides, have formed the physical and biological features of the study area. Mountain pine beetle infestations are few. In the upper Nass, the western balsam bark beetle is a primary disturbance agent along with windthrow and a driving force of succession in subalpine fir forests.

The Stikine and upper Nass area is overlaid with Tahltan, Gitanyow, Gitxsan, Tsetsaut, and Nisga'a territories, cultural landscapes, and people. The rich resources of the Stikine and upper Nass territories sustained vibrant and wealthy aboriginal cultures and elaborate trading economies. The First Nations continue to occupy and use the lands and resources within their territories.

Resource harvesting practices and land use were complex and have become further complicated as industrial development and human use increases. There are expected direct, induced, and cumulative effects related to the large scale and rapid pace of industrial development. These effects include social, cultural, and environmental impacts, some of which are beneficial and others adverse. Given the often horrifying legacy of the last 100 years, finding the appropriate balance for future development in each First Nations world is challenging.

The Stikine and upper Nass area has extensive areas of wilderness, remote rivers, abundant wildlife and striking viewscapes, all of which provide excellent conditions for backcountry recreation and a strong local nature-based tourism sector. Each of the protected areas in the Stikine and upper Nass area were designated based on outstanding features such as predator/prey systems, or volcanic landscapes that conserve cultural and ecological values and ensure vital habitat remains intact.

There are numerous proposed and existing industrial development projects in the Stikine and upper Nass area including five proposed large scale open-pit mines, several proposed hydroelectric projects, some of which are under construction, and a number of transmission lines such as the Northwest Transmission Line. Timber harvest activities continue to fragment the landscape in the upper Nass.

Despite the need to better assess and manage cumulative effects, Canadian and BC government, and developers continue to be perplexed in regard to implementing cumulative impact assessments into project planning and environmental assessments in the Stikine and upper Nass area. To date, investigations considering potential cumulative effects have not been considered adequate to sustain the environment and people in the Stikine and upper Nass area.

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1.0 Introduction

1.1 Purpose

The purpose of this report is to provide summary information focused on historic and current ecological, cultural-socio, and human-based development for the Stikine and upper Nass watersheds. The objectives are to present categorized information at the watershed and major sub-basin level in order to provide context for the larger project – assessment of cumulative impacts in the Stikine and upper Nass areas.

The larger cumulative impact assessment project has two main objectives. The first is to conduct an assessment at the watershed scale of cumulative effects to aquatic and terrestrial ecosystems. The second objective is more strategic and operates at the provincial scale. The focus is to investigate and move forward recommendations on government and non-government collaborative decision making and environmental monitoring on a variety of temporal scales.

The assessment of cumulative impacts in the Stikine and upper Nass areas is itself nested into a yet again larger study: *An integrated assessment of the cumulative impacts of climate change and industrial development on salmon in western British Columbia*. This study is being conducted by the Bulkley Valley Research Centre and supported by the Gordon and Betty Moore Foundation. The project purpose is to address current and potential ecological, cultural, and social impacts and provide possible future solutions to negate or mitigate those impacts.

1.2 Context

At a high level, the historic and current ecological, cultural-socio, and human-based development for the Stikine and upper Nass watersheds covers a fairly significant extent of BC and First Nation territories. The Stikine and upper Nass areas have seen a relatively small amount of industrial development compared to areas to the south, in particular, the Highway 16 corridor.

In the present, relatively large amounts of mining and energy development activities are proposed or in the construction phase. These activities proposed by private business and facilitated by BC government are driven by the world market conditions and a strong investment climate. This has resulted in a resurgence of mineral exploration, and provincial mineral and energy policies that accommodate mine and hydroelectric development. There are anticipated direct, indirect, and cumulative effects to social, cultural, and environmental factors and aspects related to the scale and pace of proposed industrial development.

It is important to note that First Nations other than the Nisga'a – who have a treaty, the Nisga'a Final Agreement – have never relinquished rights to lands and resources within their territories. Within the Stikine and upper Nass area there are currently two permanent settlements: Iskut and Telegraph Creek, which are both principally Tahltan. The southern extent of the Stikine and upper Nass area is overlaid with Gitanyow, Gitxsan, Tsetsaut, and Nisga'a territories.

These First Nations exclusively used, occupied, and managed the Stikine are upper Nass area long before the assertion of Crown sovereignty. The rich resources of the area sustained vibrant cultures and an elaborate trading economy. It is important to emphasize that from the First Nations perspective, the landscape is considered a complex traditional use site area, embedded with their aboriginal knowledge. The First Nations regard themselves as part of the land, one with it: the animals, the fish, the plants, and their ancestors, whose spirits inhabit it. Out of the natural landscapes, First Nations fashioned a cultural landscape that closely interacted with nature. It is clear that aboriginal management of land and resources maintained diverse and healthy ecosystems at the advent and incursion of Euro-Canadians in the mid 1800s.

Figure 1. View southeast across Nass Lake to northwest Skeena Mountains.

Euro-Canadians driven by fur trade markets and gold and mineral seekers only started to penetrate the area in the mid-1800s and were essentially transient in nature. By the turn of the 19th century, few settlers resided in the area other than traders at Telegraph Creek and those operating and maintaining the Yukon Telegraph Line. This influx of non-natives created intense competition for furs and fur-rich territories, changing the nature of indigenous cultural relationships among Tahltans, Gitanyow, Gitxsan, Tsetsaut, Nisga'a, and Sekani peoples.

With the expansion of non-natives into the Stikine and upper Nass territories, the past 150 years have been tumultuous for First Nations. Depopulation due to introduced diseases was chaotic, horrifying, and deeply affected cultural structures. Forces of colonialism produced deep and enduring social injustice, undermining and suppressing culture and governance structures and stifling First Nation identities. Human suffering was great and has left collective scars in First Nation memories.

Development history has been relatively moderate since the 1960s. Forestry activities slowly crept northward to the Meziadin area; Cassiar mine constructed the road to Stewart to enable trans-shipment of asbestos ore; and the present day Highway 37, which bisects the Stikine area was completed to Highway 16 in 1975. The BC Rail Dease Lake extension penetrated the area in the mid 1970s; however, it was abandoned leaving a legacy of ongoing environmental impacts. In the last two decades, several short-lived mines have operated in the Stikine area and include Eskay, Snip, and Johnny Mountain, all of which produced significant amounts of wealth.

As a civilized society, we need to conduct development and honour obligations to our First Nations better than we have in the past. It is important that the proposed mining and hydroelectric development be clearly thought out and potential ecological, cultural, and social impacts be minimized at the project level. Recognition that additional development in the Stikine and upper Nass area can represent high cost to social, cultural, and environmental values has led to investment in this study.

Despite the need to better assess and manage cumulative effects, they continue to perplex project planning and environmental assessments in the Stikine and upper Nass area. To date, investigations considering potential cumulative effects have not been considered adequate to sustain the environment and people in the Stikine and upper Nass area.

1.3 Approach

The Stikine and upper Nass project study area covers 69,200 km^2 of the Stikine, Unuk, and upper Nass watersheds in northwestern British Columbia. The Stikine and upper Nass area is known for its high cultural values, biological diversity, species richness and intact environment.

The information in this report was researched from a variety of scientific, technical, and cultural literature, websites, and interviews. Interviews were conducted with First Nations and local experts in fields such as fisheries, wildlife, and ecosystems. The data and information assisted in identifying information gaps and providing the overview presented herein.

Figure 2. View across Tahltan River to Tahltan.

2.0 Stikine–Unuk Area

2.1 Environmental Setting

2.1.1 Geography

The Stikine area is a complex mosaic of climate, landforms, and aquatic features in northwestern British Columbia. For the purposes of this assessment of cumulative effects, discussion of the Unuk River and its tributaries are included in the Stikine area. Stikine and Unuk River mouths and estuaries are located in Alaska.

Unuk watershed drains 3,885 km^2 of which approximately half is within British Columbia. Unuk River flows southwesterly from Unuk Lake for 105 km to Burroughs Bay, Alaska. The Unuk system is located entirely within the southern Boundary Ranges with long, cold, heavy snowpacks, and high winds in the winter while summer is generally cool and wet. The majority of the Unuk drainage is covered by icefields and glaciers. Just north of the border, Unuk River is forced to the east side of the valley by a blocky lava field; this 7.5 km reach is known as the Second and Third Canyons and is protected as the Border Lakes Provincial Park. Dissected cinder cones located in Canyon Creek, west of Unuk River are the source of this lava flow.

From Third Canyon upstream 15 km to Sulphurets Creek, the Unuk is relatively wide (100 to 800 m), extremely braided, and receives flows and sediment from South Unuk River, and Harrymel and Sulphurets creeks. Upstream of Sulphurets Creek, the river diminishes in discharge, retains more large woody debris (LWD), and is relatively confined. Storie Creek confluence is generally accepted as the upstream limit to anadromous fish due to velocity barriers. For the next 20 km, the river is entrenched until it opens up into the headwater basin shared by the Ningunsaw River and Teigen Creek.

Figure 3. View across upper Unuk River to Johns Peak.

Stikine watershed is the third largest drainage in BC, draining approximately 52,000 km^2 and is only slightly smaller than the Skeena watershed. Stikine watershed is comprised of coastal and interior physiographic subdivisions that reflect similar aspects of climate, physiography, and hydrology; these are the Boundary Ranges, Stikine Plateau, and the Skeena Mountains. The coastal portion includes the Boundary Ranges of the Coast Mountains where summits typically range from 2,000 to 2,600 m in height and drain rapidly to 10 m at the Alaska boundary. The outstanding mountain features are the massive number of glaciers and extensive glacial erosion. Generalized bedrock geology is clearly presented in Souther, Brew, and Okulitch (1979). The Boundary Ranges are bisected by the north trending Stikine and Unuk rivers; view across the Unuk is shown in Figure 3.

The Boundary Ranges create an area with unique geological, climatic, and biotic qualities. Within the area, the main landform influences are glaciation, volcanic activity, and alluvial erosion and deposition. The ranges are characterized by steep and rugged topography, and great range of relief. The Boundary Ranges merge into the Tahltan Highlands in the Stikine River area at the Chutine River; in Iskut River area, the Boundary Ranges merge into the Skeena Mountains in the Bob Quinn Lake–More Creek area. The Tahltan Highland forms a transitional mountain belt separating the Boundary Ranges from the more subdued topography of Klastline and Spatsizi plateaus to the east (Fenger and Kowall 1992). The highland is bisected by Stikine River and Mess Creek and dissected by drainage systems varying in depth and width with sharp peaks rising to approximately 2,500 m in elevation. The Iskut River valley forms the eastern boundary between the Highland and the Skeena Mountains. The Highlands are illustrated in Figure 4 below that shows Nightout Mountain located northwest of the confluence of Schaft–Mess creeks as viewed from Mount Edziza.

Figure 4. View of Nighout Mountain from Mount Edziza.

Glacier-clad Mount Edziza Peak rising to 2,790 m is a great shield volcano that dominates all mountains in the study area and forms a portion of the volcanic and lava flows extending southward to Unuk River called Stikine Volcanic Belt. Mount Edziza is the largest in a group of volcanic centers that cut diagonally across the Cordillera of northwest BC (Yagi and Souther 1974). Mount Edziza's shield volcanoes are built almost entirely of fluid lava flows. Figure 5 shows the view north across the post-glacial Eva Cone and the Desolation Lava Field to Buckley Lake. Figure 6 shows the view north across Coffee Crater and Tencho Glacier.

Figure 5.

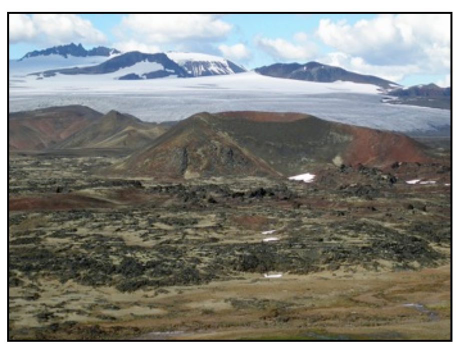

Figure 6.

Map 1. Map of Stikine and Upper Nass study area.

Lava flows from the Edziza volcanic complex shaped adjacent landscape features including the well-known Stikine Canyon, the Spectrum Range, and the Mess Creek Escarpment that forms the west-central flank of the complex (Souther 1992). Other volcanic features exhibited on the volcanic complex from the five distinct eruptive periods include lava domes, calderas, cinder cones, stratovolcanos, subglacial mounds, and lava formations such as the Big Raven.

Recent volcanic activity is recorded at Mount Hoodoo located on the lower Iskut; Iskut at Canyon Cone; and at the head of Tuya River. The Tuya River volcanoes are flat-topped, steep-sided, and rise dramatically above the plateau level as shown in Figure 7. The Iskut Canyon Cone is a stratovolcano roughly 1 km in width and 200 m in height located south of Iskut River and close to Forrest Kerr Creek. Lava flowed roughly 20 km downstream to Snippaker Creek, and Iskut River Canyon is incised down through the lava flow as shown in Figure 8.

Figure 7. View across Tuya Lake to Tuya Butte.

Figure 8. View upstream on Iskut lava flow.

Stikine Plateau encompasses the interior portion of the watershed and breaks out into four physiographic subdivisions: Tahltan Highland, Klastline Plateau, Spatsizi Plateau, and the southern Nahlin Plateau. Stikine Plateau is an erosion landform rather than one built up by deposition of sedimentary or volcanic materials. Klastline Plateau is a relatively small area bounded on the west by the Klastline River and its headwater lakes – Mowdade, Mowchilla, Kakiddi and Nuttlude – to the north by the Grand Canyon of the Stikine and in the east by the Todagin and lower Klappan drainages.

The Klastline plateau includes the upper Iskut lakes chain – Natadesleen, Kinaskan, Eddontenajon, and Kluachon lakes – which bisects the plateau as shown in Figure 9. Well-developed cirques have dissected and scalloped the plateau, and in many of these locales, large rock glaciers have developed. The rolling, unwooded uplands are similar to Spatsizi Plateau where they are widespread.

Figure 9. View south down Eddontenajon Lake that bisects Klastline Plateau.

The southern portion of Nahlin Plateau includes the Tahltan and Tuya rivers which flow into the Stikine River. Nahlin Plateau is dominated by Level Mountain, a great shield volcano whose unwooded mass rises to 2,165 m at Meszah Peak. Tahltan River bisects the plateau, which is lightly dissected north of the river. South of Tahltan River, Ryder (1984) notes the long scarp extending from Mount Barrington to beyond Dodjatin Mountain that rises abruptly for more than a thousand meters above the Stikine valley lowlands.

Spatsizi Plateau extends from the lower Klappan River eastward to include the upper Stikine watershed except for the upper drainages of Spatsizi, Ross, and Stikine rivers that finger into the Skeena Mountains. The plateau is composed of wide drift-filled valleys and rolling uplands reduced in elevation and variable relief by alluvial erosion and glacial activity. Alpine glaciation has sculptured higher elevation peaks and ridges. Figure 10 shows the view west across Mink Creek and Coldfish Lake. Figure 11 shows the view downstream on Stikine River from Edozadelly Mountain across the Metsantan and Chukachida confluences to the Stikine Range.

Figure 10

Figure 11.

The Spatsizi Plateau was extensively used by Tahltans, with their major community at Metsantan Lake as shown in Figures 12 and 13. Portions of Stikine headwater tributaries, mainly the upper Pitman and upper Chukachida, finger into the Stikine Ranges; however, the spatial extent is minor and precludes discussion in this report.

Figure 12. View from Lawyers Pass to Metsantan La

Figure 13. View east to Metsantan graveyards with the village in the upper left.

Northwest Skeena Mountains overlay the south central section of Stikine watershed and include: the Eaglenest Range; the upper drainages of Spatsizi, Ross, and Stikine rivers; the Klappan watershed; and Todagin, Burrage, and minor tributaries draining westward into the upper Iskut River. The northwest Skeena Mountains are distinctive and characterized by being largely formed by folded sedimentary rocks with infrequent areas of volcanic intrusives.

Typically, rock structures are extremely complex, though open folds predominate in the Eaglenest Range. Holland (1976) notes western portions of the Klappan Range are underlain with lava flows, which spread eastward from Mount Edziza vents. Most elevations lie between 1,800 and 2,000 m; however, Nation Peak in the Eaglenest Range rises to 2,360 m. Valley bottoms lie between 750 and 1,200 m and are drift filled.

Figure 14. View north across northwest Skeena Mountains.

2.1.2 Climate

Stikine and Unuk watershed climate varies considerably and is presented here in a general manner due to the lack of recording weather stations that could potentially characterize the varying climate regimes. Long and short-term data is available for Wrangell (10 m asl), Bronson Creek (10 m asl), Telegraph Creek (335 m asl), Dease Lake (800 m asl), Bob Quinn Lake (609 m asl), and Todagin Creek (899 m asl). The climate at a broad level is broken out into marine in the southwest coastal portions to continental in the northeast interior zone with transitional zones between the two. As well, climatic longitudinal and elevation gradients are located throughout the watershed due to influences such as mountain ranges, valley confluences, rain shadows, and wind conditions, resulting in varying climates and micro-climates.

The dominant features of the coastal climate are frequent Pacific frontal systems combined with orographic lifting, resulting in abundant annual precipitation averaging 2,400 mm (BC Hydro 1981). The maritime climate causes cool summers with moderate rainfall, and mild winters with annual mean temperatures near -2.5 °C at Bronson Creek on the lower Iskut River. Winter snowpacks average 2 to 3 m on lower Stikine River, with freezing usual at the mouth of the estuary. At high elevations on the Stikine River, moist Pacific air pushes up the valley moderating the continental air. The degree and extent of the moderating coastal influence diminish quickly in an easterly direction and with elevation.

Precipitation reaches a maximum in the fall and early winter, generally in October and November, with intense cyclonic storms from the Northeast Pacific moving across the coast (Environment Canada 2013). These storms, particularly if warm rain-on-snow events, can cause severe and sudden flooding. Inflow and outflow winds can be concentrated and funnelled in the lower valley bottoms, especially in the Iskut and Stikine rivers. Arctic air frequently surges down main valleys bringing bitter winter temperatures and also a see-saw battle with coastal air that brings snow.

On the Stikine, there is a noticeable climate transition in the Devils Elbow–Chutine area, where annual precipitation diminishes rapidly from the Chutine River (~700 mm) upstream to Telegraph Creek, which has a unique climate. Long-term weather records indicate average annual precipitation of 320 mm, with 126 mm falling during the May to September season. Mean July maximum and minimum temperatures are 22.6 °C and 8.9 °C respectively. Mean January maximum and minimum temperatures are -11.6 °C and -19.3 °C respectively. Observed temperatures range from 35 °C to -42 °C. Snow depths are least at low elevations between Telegraph Creek and Tanzilla River and micro-climate areas such as Hyland Post.

Figure 15. View upstream on Stikine River across Chutine River.

Generally, locations upstream of Telegraph Creek on the Stikine and Bob Quinn on the Iskut receive relatively little precipitation. Figure 16 shows the 2,500 mm isohyet on Unuk River at the Alaska–BC border connected to the 2,500 mm line at lower Scud River. The steep precipitation gradient from the coast to the interior is clearly shown. Within Figure 16, note the extent of Stikine Plateau receiving less than 600 mm mean annual precipitation. Figure 16 shows the location of the thirteen Water Survey of Canada hydrometric stations active in the late 1970s.

On the Iskut River, the coastal interior transition starts in the McLymont–Forrest Kerr area (1,700 mm), with precipitation decreasing to Bob Quinn Lake, where the annual average precipitation totals 596 mm, of which typically 73% is rainfall (Environment Canada AES 2013). Bob Quinn possesses a micro-climate due to its close proximity to the Iskut–Ningunsaw confluence. In the upper Iskut, temperatures are generally colder with less precipitation. The drier interior sections are influenced by a continental climatic regime characterized by long, cold winters, and short, cool summers. Thermal inversions are common in mid-elevation plateau locations with cold air pooling in valley bottoms.

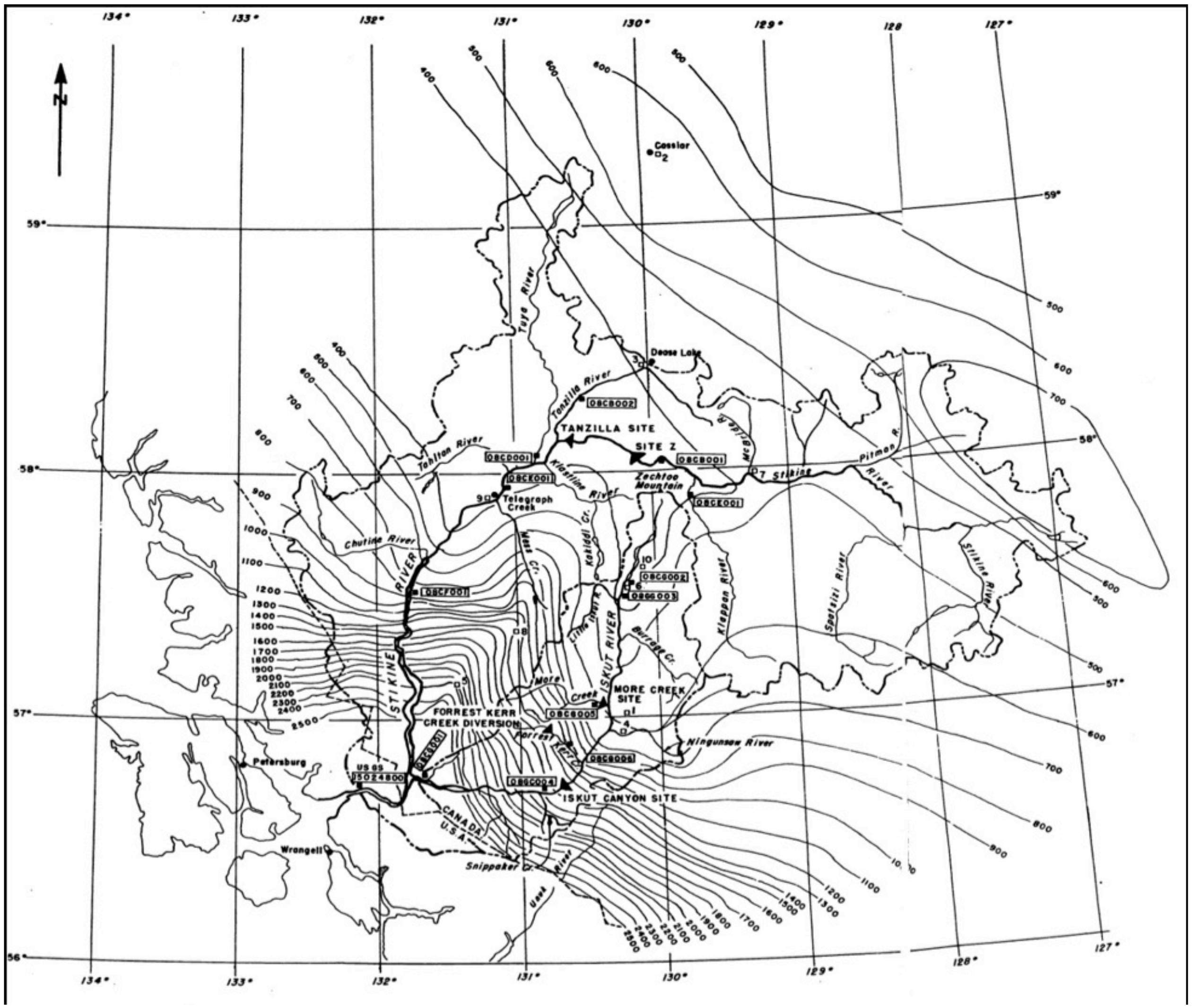

Figure 16. Stikine and Unuk rivers map showing isohyets in mm (BC Hydro 1981).

2.1.3 Hydrology

Stikine watershed drains an area of 52,100 km^2 with the river flowing west and south from its headwaters in the northwest Skeena Mountains to the ocean just north of Wrangell, Alaska. The Iskut River flows 210 km from Zechtoo Mountain north of Iskut to the Stikine River 11 km upstream of the border and drains 9,380 km^2. For this background report, only surface water runoff is discussed other than noting major groundwater flows in the lower Stikine and Iskut rivers and in Mess Creek particularly near Schaft Creek confluence.

Surface water hydrologic regimes in Stikine and Unuk basins reflect physiography, climate, geology, and vegetation processes in complex interactions involving the atmosphere, inflow, storage on land, and outflow to the ocean. The cycle consists of three principal phases: precipitation, evaporation, and surface and groundwater runoff. Two hydrologic regimes predominate in Stikine basin: 1) Major peak floods in the upstream, interior portion of the drainage are due to spring snowmelt; 2) In downstream coastal influenced portions of the basin, major runoff peaks are a result of rainfall and rain-on-snow events in the fall.

The Boundary Ranges have many icefields, glaciers, and snowpacks, which have an impact on spring freshets. Much of this mountain range was formed from granitic intrusions and have been subject to many glacial erosion events. Groundwater is often limited except in valley bottoms where sediment has been deposited. The typically narrow valleys with steep side slopes tend to result in rapid runoff whether it is from precipitation or ice and snowmelt.

In the Boundary Ranges the typical hydrological regime is divided into four main flow periods consisting of spring freshet, summer, fall, and winter. In coastal sections and other high elevation locations, the heavy precipitation and cold temperatures lead to annual snowfalls that exceed annual snowmelt rate. Permanent ice fields result with the generation of glaciers that flow down adjacent valleys. Spring freshet flow rates are closely linked to elevation gradients and the timing of warm air temperatures.

In the Boundary Ranges the annual peak flows may occur in the spring due to snowmelt. Summer flows can remain significant due to glacial melt and represent a large portion of total basin runoff. Summer flows vary and sudden weather-related flow fluctuations can appear. Fall flows are typically low to moderate, especially if freezing levels are low; these are frequently the clearest flows due to limited high elevation melt water and sediment transport. However, fall flows often generate peak flows due to intense warm rain events. Winter freezing conditions yield low flows generated mostly from areas of wetland and groundwater. Most streams located in the Boundary Ranges are under ice from November to April though timing may vary with climactic conditions.

The Water Survey of Canada, Station 08DD001 (Unuk River) is located 3 km upstream of the Alaskan border with the data shown in Figure 17. Station 08DD001 recorded flow from 1960 to 1996 for the 1,676 km^2 upstream of the border. The hydrograph is of interest due to the Unuk basin being wholly within the Boundary Ranges. Note that the fall flood peak discharge events are almost double the maximum spring freshet flows. The yellow line shows mean annual flow with the spring freshet occurring from June to mid-August.

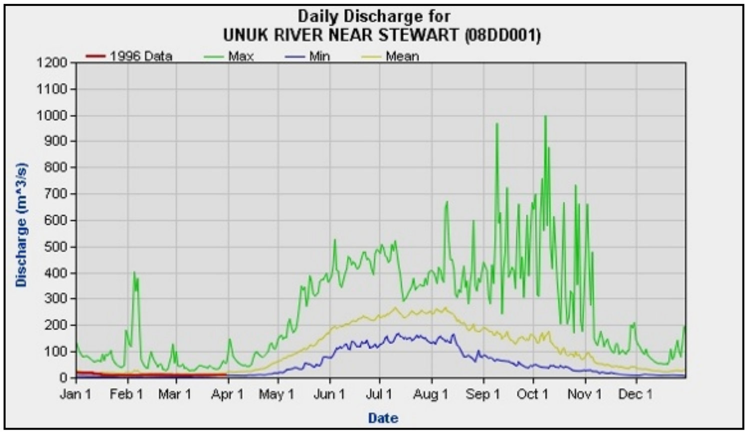

Figure 17. Hydrograph showing hydrometric data for Unuk Rover from 1960 to 1996, when it was discontinued.

Approximately seven lakes are frequently impounded due to glacial ice-damming and periodically outburst with spectacular floods. These lakes are located at upper More Creek, Flood Glacier, Mud Glacier, Porcupine River, Scud River, and in the upper Yehiniko system. As the Stikine, Unuk, and Iskut rivers transect the Boundary Ranges, steeply sloping tributaries from the mountains carry large sediment loads emanating from glacial erosion, landslides, and avalanches.

A rain shadow effect caused by the Boundary Ranges limits the amount of moisture carried from the coast by the prevailing west winds. The Tahltan Highland and Stikine Plateau portions of the basin have a similar but moderated hydrologic regime with the spring freshet being the most common peak flood event of the year. Fall precipitation events can generate large annual peak flows but they are infrequent. Figure 18 shows data from Stikine River at Telegraph Creek – Station 08CE001 with recorded flow from 1954 to 2011 for the 29,000 km^2 drainage upstream of Telegraph Creek. Note that the major time of discharge is the spring snowmelt period with significantly smaller flows in the fall.

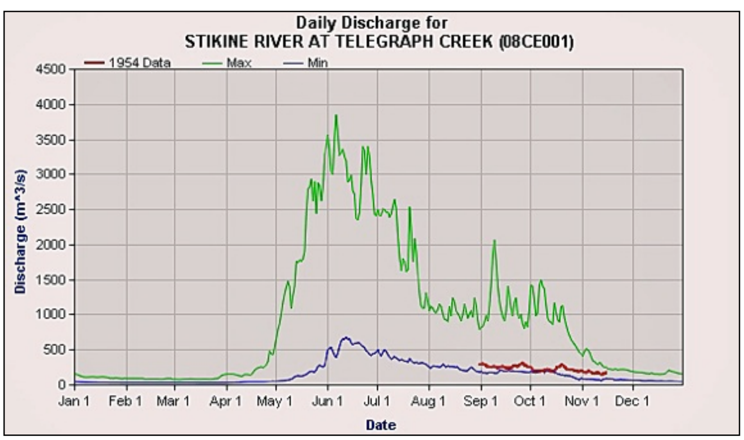

Figure 18. Hydrograph showing mean hydrometric data for Stikine River at Telegraph Creek from 1954 to 2013.

BC Hydro (1981) reports a unit runoff of approximately 450 mm for the Stikine basin upstream of Klappan River. The Klappan drainage is wetter with a unit runoff of ~600 mm due to its location within the northwest Skeena Mountains. The area north of Stikine River drained by the Tuya and Tanzilla rivers has the lowest runoff values of roughly 300 mm. Tahltan Highlands, particularly the Mess, Yehiniko, and Chutine basins, are transitional in nature with unit runoff of about 1,200 mm.

For the Iskut basin, BC Hydro (1981) reports similar unit runoff results. Annual average unit runoffs are: upstream of Natadesleen Lake – 410 mm; between Natadesleen and Snippaker Creek, excluding More and Forrest Kerr basins – 1,280 mm; between Snippaker and Johnson River gauge – 2,480 mm; upstream of More Creek confluence – 1,870 mm; and upstream of Forrest Kerr confluence – 2,230 mm.

Since the mid 1960s, Stikine Basin streamflow records from a number of hydrometric stations have been continuously maintained. Hydrometric station locations are shown on Figure 15. As shown in Table 1 below, some stations were of a short duration; eleven stations were discontinued in the 1990s due to funding re-allocations. Presently, two stations are active: Iskut River below Johnson River and Stikine River at Telegraph Creek. These stations can be viewed in real time from the internet: http://www.wateroffice.ec.gc.ca/index_e.html.

Table 1. Hydrometric station in Stikine basin.

Stikine Basin Hydrometric Stations					
Station Name	**Station Number**	**Years of Record**	**Drainage Area (km2)**	**Real Time Station**	**Active**
STIKINE RIVER ABOVE BUTTERFLY CREEK	08CF001	1971-1995	36,000		
STIKINE RIVER ABOVE CHOQUETTE RIVER	08CF002	1983-1984			
STIKINE RIVER ABOVE GRAND CANYON	08CB001	1957-1995	18,800		
STIKINE RIVER AT TELEGRAPH CREEK	08CE001	1954-2013	29,000	YES	YES
STIKINE RIVER BELOW SPATSIZI RIVER	08CA002	1980-1995	7,690		
STIKINE RIVER NEAR WRANGELL	08CF003	1984-2011	50,900		
TUYA RIVER NEAR TELEGRAPH CREEK	08CD001	1965-2013	3,550		
TANZILLA RIVER NEAR TELEGRAPH CREEK	08CB001	1958-1968	1,600		
CHUTINE RIVER BELOW BARRINGTON RIVER	08CE004	1990-1995			
KLAPPAN RIVER NEAR TELEGRAPH CREEK	08CC001	1962-1995	3,550		
KLAPPAN RIVER AT HEADWATERS PLATEAU	08CC003	1987-1998	17		
SPATSIZI RIVER NEAR THE MOUTH	08CA001	1980-1995	3,400		
PITMAN RIVER NEAR THE MOUTH	08CA003	1980-1995	2,730		
ISKUT RIVER ABOVE FORREST KERR CREEK	08CG007	1981-1985	6,290		
ISKUT RIVER ABOVE SNIPPAKER CREEK	08CG004	1966-1995	7,230		
ISKUT RIVER AT OUTLET OF KINASKAN LAKE	08CG003	1964-1998	1,250		
ISKUT RIVER BELOW JOHNSON RIVER	08CG001	1964-2013	9,500	YES	YES
MORE CREEK NEAR THE MOUTH	08CG005	1971-1994	844		

Large sediment loads mostly from glacial activity result in braided river morphology and unstable island and bar deposits in the multiple channels. On Stikine mainstem, this condition occurs mostly in the 135 km downstream of Chutine River to the border, wherein the dissected floodplain ranges 2 to 5 km in width and is confined by the steeply rising valley sidewalls.

For the Iskut River, similar unstable channel sediment conditions exist downstream of Ningunsaw River to Volcano Creek and from Snippaker Creek downstream to the mouth. The reach downstream of Snippaker Creek is shown in Figure 19 during late-summer low flow conditions.

Figure 19. View downstream of Bronson Creek over Iskut River showing the mutli-channel sediment storage reach.

2.2 Fish and Habitats[1]

2.2.1 Unuk System Fish & Habitats

The Unuk watershed supports five salmon species: sockeye (*Oncorhynchus nerka*), pink (*O. gorbuscha*), chum (*O. keta*), Chinook (*O. tshawytscha*), and coho (*O. kitsch*) and winter steelhead (*O. mykiss*). Freshwater fish residents include cutthroat trout (anadromous; *O. clarkii*), rainbow trout (*O. mykiss*), three-spine stickleback (*Gasterosteus aculeatus*), Dolly Varden (*Salvelinus malma*) and bull trout char (*S. confluentus*). Fish presence and abundance is poorly documented for the Unuk River upstream of the border.

The Unuk system is located entirely within the steep and heavily glaciated southern Boundary Ranges, and therefore is very turbid. Unuk estuary is located 40 km downstream of the border, and approximately 70% of the drainage is located in BC. One km north of the border, the canyon Creek lava flow has forced Unuk River to the east side of the valley and also created Border Lake (Tripp 1987). The impinged 7.5 km mainstem reach is known as the Second and Third Canyons and constitutes Reach 4. Reach 5 extends upstream 15 km to Sulphurets Creek and also receives flow from South Unuk River and Harrymel Creek. Reach 5 ranges 100 to 800 m in width, shows less than one percent gradient, and has a gravel-sand-cobble substrate (Hawthorn *et al.* 1984).

Reach 6, extends 29 km upstream of Sulphurets Creek to the headwater Unuk Lake. In this reach, flow is diminished, the channel is confined to a single thread, and is entrenched upstream of Storie Creek. The Storie Creek confluence is generally accepted as the upstream limit to anadromous fish due to velocity barriers.

The three major tributaries, South Unuk River, Sulphurets Creek, and Harrymel Creek, along with Canyon Creek, Boulder Creek, Fewright Creek, and King Creek, supply sediment-laden turbid flows. Fish can access lower reaches of these creeks; however, habitat is limited by the predominantly large bed textures and moderate gradients.

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[1] Refer to Appendix III for a tabulated summary of aquatic species with conservation concerns.

Figure 20. View downstream on Unuk River to Border Creek confluence.

Fish presence in Unuk mainstem includes coho and sockeye to Coulter Creek, chinook to Harrymel Creek, chum to South Unuk River, cutthroat to Storie Creek, and Dolly Varden through to Unuk Lake. Given the turbid water, fish enumeration is difficult.

Clearwater tributaries include Border Creek, Coulter Creek, and three unnamed tributaries that are accessible to salmon. Border Creek and Lake are thought to be the most productive salmon habitats in the system, supporting sockeye, pink, chum, chinook, and coho spawning due to the clear water, moderated temperature, and gravel substrate. Side channels and floodplain wetlands are thought to be significant and productive fish habitat, especially for rearing; however, no known surveys have been conducted.

Coulter Creek supports sockeye, coho, and Dolly Varden. South Unuk River supports coho and Dolly Varden. Sulphurets and Boulder creeks support Dolly Varden char. Storie Creek confluence is generally accepted as the upstream limit to anadromous fish due to mainstem velocity barriers. There are data gaps around the upstream extent of chinook spawning; whether sockeye are spawning in the mainstem or only in clearwater tributaries and groundwater influenced, off channel habitats; and the apparent absence of lamprey (*Lampetra* sp.)and whitefish (*Prosopium* sp.) known to be commonly present on adjacent streams.

2.2.2 Stikine System Fish & Habitats

The Stikine is the largest of the six transboundary river systems originating in Canada and flowing into the sea through Southeast Alaska. Approximately 98% of the Stikine system drainage area is located in BC. Many of the clear water tributaries originate on the Stikine Plateau, but are blocked by canyons with velocity barrier conditions or natural falls. Most of the streams draining the Boundary Ranges and Tahltan Highland are glacial, turbid, and have sections of steep channels.

The Stikine system supports five salmon species: sockeye, pink, chum, chinook, coho, and steelhead. Cutthroat trout, eulachon, and lamprey are the other anadromous species present.

Rainbow smelt, eulachon, and longfin smelts are known in the estuary, but it is unknown if they spawn in BC waters. Green sturgeon and white sturgeon are noted as present, although knowledge is scant regarding their life histories and habitats in the Stikine drainage.

The freshwater fish assemblage includes cutthroat trout (anadromous), rainbow trout, mountain whitefish, Dolly Varden char, bull trout char, burbot (*Lota lota*), Arctic grayling (*Thymallus arcticus*), lake trout (*S. namaycush*), lake chub (*Couesius plumbeus*), longnose sucker *(Catostomus catostomus),* kokanee (*O. nerka*), coastrange sculpin (*Cottus aleuticus*), prickly sculpin (*C. asper*), slimy sculpin (*C. cognatus*), and three-spine stickleback. Mountain whitefish (*Prosopium williamsoni*) is the common resident fish, followed by Dolly Varden.

2.2.2.1 Stikine System Salmon Populations and Their Habitats

All five species of Pacific salmon spawn in the Stikine system. Sockeye, followed by coho and chinook, are the most abundant. Pink salmon spawn principally in Alaskan streams, though they also occur as far upstream as the Tahltan fisheries beyond Telegraph Creek. Chum salmon are known to be present upstream as far as the Chutine River area. Coho are wide dispersed and spawn throughout the accessible streams Salmon support First Nation, commercial, and recreational sport fisheries, as well as wildlife, throughout the extent of salmon distribution.

Table 2. Stikine salmon presence and distribution.

\

Streams	Sockeye	Chinook	Coho	Chum	Pink	Steelhead
Stikine Mainstem	✓	✓	✓	✓	✓	✓
Katete River	✓	✓	✓	✓	✓	✓
Kakati Lake Creek	✓	✓	✓			
Boundary House Slough	✓		✓			
Tasakili River		✓	✓	✓	✓	
Barge Creek	✓	✓	✓	✓	✓	
Poly Lumber Creek	✓		✓			
Great Glacier River		✓				
Warm Springs Creek			✓			
Blanchard Creek	✓	✓	✓			
Foodplain Lake # 1	✓		✓			
Unnamed Creek #1			✓			
Patmore Creek	✓	✓				
Unnamed Creek #2	✓		✓			
Fowler Creek			✓			
Unnamed Slough #1	✓		✓			
Andismith Creek	✓		✓			
Unnamed Slough #2						
Porcupine River	✓	✓	✓			
Anuk River	✓	✓	✓			
Jack Wilson Creek	✓	✓	✓		✓	
Unnamed Slough #3	✓	✓	✓		✓	

Streams	Sockeye	Chinook	Coho	Chum	Pink	Steelhead
Unnamed Creek #3		✓	✓			
Flood River	✓					
Unnamed Creek #4			✓			
Christina Creek	✓	✓	✓	✓	✓	
Unnamed Creek #5			✓			
Scud River	✓	✓	✓			
Cone Mountain	✓		✓			
Unnamed Creek #6			✓			
Jones Lake Creek	✓		✓		✓	
Oksa Creek		✓	✓			
Jonquette Creek			✓			
Unnamed Creek #7						
Butterfly Creek		✓	✓			
Cinema Creek			✓			
Kasha Creek			✓			
Klootchman Slough		✓	✓			
Julian Creek	✓		✓			
Dokdaon Creek		✓	✓			✓
Missusjay Creek	✓	✓	✓		✓	
Kirk Creek	✓	✓	✓		✓	
Chutine River	✓	✓	✓	✓	✓	✓
Helveker Creek		✓	✓			
Snipper Creek			✓			
Arrival Creek	✓	✓	✓			
Yehiniko Creek		✓				
Shakes Creek	✓	✓	✓		✓	✓
Tsikhini Creek	✓	✓			✓	
Bodel Creek		✓				
Brewery Creek		✓			✓	
Winter Creek (4 Mile Cr)		✓			✓	
Dodjatin Cr (6 Mile Cr)	✓	✓			✓	
Mess Creek (Mestooa)		✓				
Tahltan River	✓	✓	✓		✓	✓
Beatty Creek		✓			✓	✓
Little Tahltan River	✓	✓	✓			
Tuya River	✓	✓	✓		✓	✓

Table 2 notes Stikine salmon presence with no differentiation in regard to spawning or rearing. Tributaries of major streams are not listed except for Tahltan River due to abundance and high values. The majority of salmon spawning areas are represented; however, small and infrequently used spawning areas may be overlooked. Due to mostly turbid water conditions in Stikine, Iskut, and their tributaries, observing fish can be difficult. Adult coho are notorious for the under-estimation of distribution and abundance due to their late-timing and adverse observation conditions, including turbidity and ice cover. Similarly, steelhead spawning in the spring during high water conditions renders observations difficult. In years of large pink salmon runs, spawning may occur at numerous sites typically not utilized. Pink and chum salmon production is minor in the BC portion of the watershed. Table 3 below shows Iskut drainage salmon presence.

Table 3. Iskut salmon presence and distribution.

Streams	Sockeye	Chinook	Coho	Chum	Pink	Steelhead
Iskut Mainstem	✓	✓	✓	✓	✓	✓
Shangles Slough			✓			
Caralin Creek		✓	✓	✓		
Inhini River	✓	✓	✓		✓	
Hoodoo River	✓		✓	✓		
Zippa Creek		✓	✓			
Unnamed Slough #1	✓		✓	✓		
Craig River	✓	✓	✓	✓	✓	✓
Raven Creek	✓	✓	✓			
Unnamed Creek #1	✓	✓	✓		✓	
Unnamed Creek #2	✓		✓		✓	
Jekill River	✓	✓	✓			
Twin River	✓	✓	✓			
Bronson Creek	✓	✓	✓			
Verrett River	✓	✓	✓	✓	✓	✓
Unnamed Creek #3 (Bugleg)	✓	✓	✓	✓		
Snippaker Creek	✓		✓			

Salmon escapement data are considered estimates and indicators of trends. Exceptions to this are the enumeration weir counts at Tahltan Lake and on the Little Tahltan River. Catches in the Kakwan Point and lower Stikine test fisheries give aggregate abundance indices for the Stikine River.

Estimates of total stock abundance are complex due to four components: spawning escapement; Tahltan in-river food, social, and ceremonial (FSC) catch; Canadian in-river commercial catch; and American in-estuary and coastal commercial catch. Tahltan Fisheries operate an enumeration weir at Tahltan Lake that provides the one tight indicator of abundance; the fence is shown in Figure 21.

Figure 21. Tahltan Fisheries enumeration fence located at the outlet of Tahltan Lake.

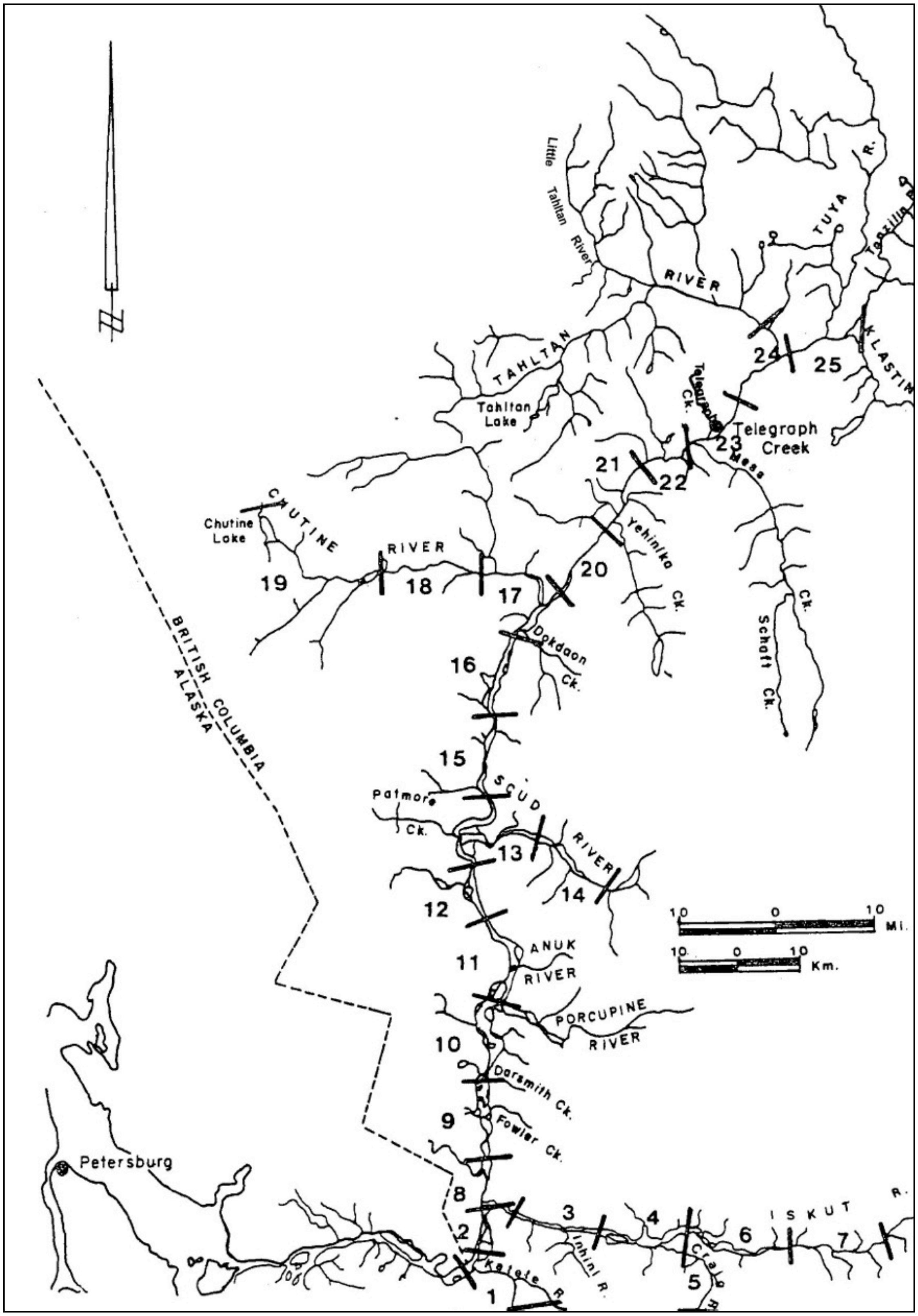
Salmon presence is a strong part of Tahltan cultural and community values and identity. Tahltan Nation considers sockeye, chinook, and coho the most culturally important salmon species. Salmon management includes programs jointly developed and monitored by Tahltan Fisheries, Fisheries and Oceans Canada, Alaskan Department of Fish and Game (ADFG) under the Pacific Salmon Treaty (PST), and through the Joint Transboundary Technical Committee (TCTR) of the Pacific Salmon Commission.

Stikine River sockeye, coho and chinook salmon are monitored through various annual programs to determine total salmon stock sizes, assess core stock abundance, and ascertain the proportion of wild sockeye and enhanced sockeye returns. These stock assessment programs are detailed for Stikine chinook, coho, and sockeye in an annual integrated fisheries management plan and other plans available for download at: http://www.pac.dfo-mpo.gc.ca/consultation/yukon/index-eng.htm.

The first Stikine salmon cannery was built in 1887 about 12 km upstream from the mouth; the second was built in 1889; a third was opened in Wrangell in 1912. Salteries, mild curing stations, and fresh fish dealers developed operations in Wrangell that serviced independent fishers. Despite the size of the Stikine system, the lack of accessible clearwater systems spawning and rearing grounds prevents the Stikine from supporting salmon populations as large as those in the Skeena and Nass basins.

Chinook

Stikine River chinook abundance is in the top tier of Southeast Alaska (SEAK) and northern BC chinook populations and is the largest producer in SEAK. This is considered a recovery from the depressed abundance levels of the 1970s and is due to conservation measures established with the PST in 1985. Prior to that time, chinook were poorly known, and data pertaining to biological characteristics was insufficient to support commercial fisheries, which had declined by 50% from mid-1950s catch levels. Currently, Stikine chinook status is considered slightly below long-term average levels; this is related to diminished ocean survival and relatively warm ocean temperatures. Figure 22 shows overall Stikine escapement, Little Tahltan River escapement, and Canadian and total catch (after Johannes 2011).



Map 2. Map showing Stikine River, major tributaries and fishing features.

Stikine chinook abundance is determined from the long-term counting weir located at Little Tahltan River that is used as the index site for Stikine chinook escapement (Pacific Salmon Commission 2005). From 1979 to 2002 chinook aerial enumeration surveys were conducted but were discontinued as results were inconsistent with Little Tahltan counts and catch and test fishery estimates (Bernard 1999). ADFG (2007) reports a coded wire tagging (CWT) program that collects data on Stikine chinook marine survival, distribution, and production. Salmon management and enhancement plans are available from Pacific Salmon Commission Joint Transboundary Technical Committee: http://www.psc.org/publications_tech_techcommitteereport.htm#TCNB/TCTR.

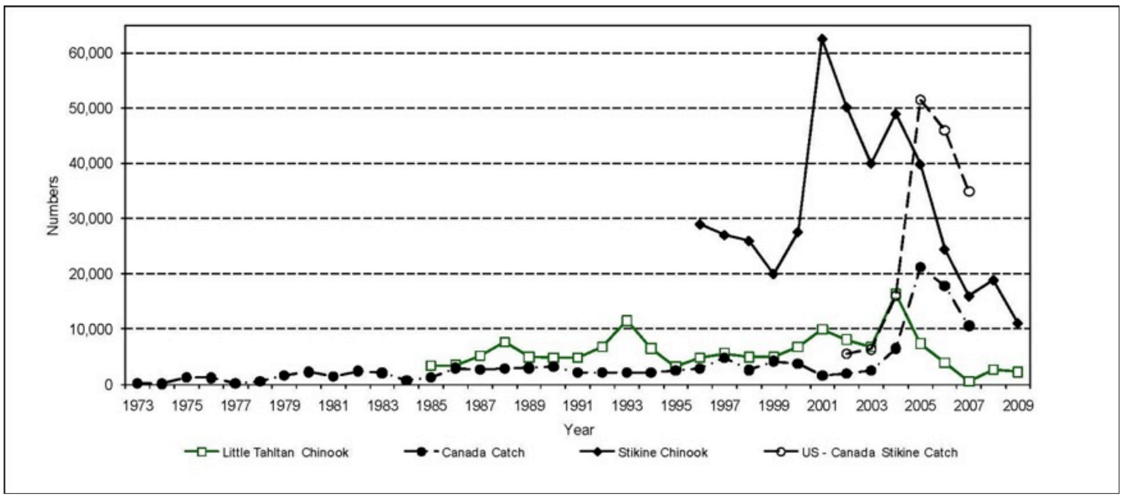


Figure 22. Graph showing Stikine chinook aggregate escapement, Canadian catch, overall catch and Little Tahltan River escapement.

Chinook distribution extends from the estuary to the Stikine–Tuya confluence with chinook spawning and rearing in major and minor tributaries. Major chinook producers are Little Tahltan River, Tahltan River, Tuya River, Chutine River, Katete River, Shakes Creek, Beatty Creek, and Christina Creek. Chinook distribution on the Iskut mainstem extends upstream at least to the Snippaker Creek confluence with major spawning in Craig and Verrett rivers and the mainstem; lower Craig River is shown in Figure 23.

Figure 23. View upstream on lower Craig River chinook spawning grounds.

Little Tahltan River is the largest chinook stock and represents an average of 21% of Stikine chinook with a range from 16 to 34% during the 1996 to 2006 period (Pacific Salmon Commission 2009).However, these percentages are variable; a chinook radio telemetry project conducted in 2005 indicated that three stock groupings represented 62% of total chinook escapement (PSC 2012). Tahltan River represented 41%, Little Tahltan River represented 13%, and Stikine mainstem between Butterfly Creek and Flood River exhibited eight percent of Stikine chinook. Chinook juveniles are for the most part found rearing in the Stikine and Iskut mainstems with only minor presence in back channels or upper tributaries.

The Little Tahltan River stock is typically composed of at least 95% large chinook (>660 mm mefl) with three years of ocean growth (age 1.3). On average, the run consists of 11% age-4, 46% age-5 and 42% age-6 Chinook; other ages include age-3 and age-7 which make up the remainder. The total estimated number of terminal Stikine Chinook age-4 in 2011 was 6,331 fish; age-5 was 14,790 fish; and age-6 was 8,108 fish (PSC 2012a). Between 1996 and 2011, the chinook run size averaged 44,093 fish annually ranging from 16,073 in 2009 to 89,615 in 2005.

Other than stream blockage clearing and a flow control on the Tahltan River since 1959, there are no known chinook enhancement activities within Stikine watershed; however, numerous private non-profit hatcheries operate in coastal SEAK. Management conflicts include assessment and predictive capabilities that are limited by poor escapement estimates in the mainstem and tributaries other than Tahltan River. Chinook originating from Stikine River are likely to be intercepted by various mixed-stock fisheries in SEAK.

In the Stikine there are two chinook run-timing groups. Chinook destined for the Little Tahltan, Chutine, mainstem, and other tributaries enter the Stikine generally around June 9th, while chinook destined for the Iskut River and its tributaries, Craig and Verrett Rivers, enter around June 30th (Pahlke and Etherton 1999). Chinook in the Stikine drainage are a mix of age 1.3 (preponderance of males) and age 1.4 (preponderance of females), with an overall preponderance of age 1.4. The differences in run timing are likely sufficient to recognize two conservation units (CU), but a final management decision was deferred due to habitat considerations.

Sockeye

Sockeye salmon are the most culturally and commercially valuable of the Stikine salmon. Sockeye salmon, one of the larger SEAK–BC transboundary sockeye stocks, are widely distributed throughout the accessible portions of Stikine River and its tributaries. Stikine sockeye are widely recognized for their distinctive migratory behavior, unique types of spawning and juvenile rearing life histories, and intimate connection with the Tahltan and their culture. Stikine sockeye are broken into three basic freshwater life history types: lake rearing, stream rearing, and sea rearing.

For the purpose of management, which includes research and monitoring, Stikine sockeye are subdivided into four stock groups as follows:

- Wild Tahltan stock – originating in Tahltan Lake;

- Enhanced Tahltan stock – sockeye broodstock from Tahltan Lake and subsequently back-planted as fry;
- Enhanced Tuya stock – Tahltan Lake sockeye broodstock and subsequently back-planted as fry to Tuya Lake;
- Stikine mainstem stock – all other natural sockeye stocks in the Stikine including lake, stream, and slough spawners and rearing juveniles are managed as a conglomerated aggregate.

Since 1989, Stikine sockeye have been the focus of a major ongoing enhancement program that involves collection of sockeye eggs taken from broodstock at Tahltan Lake; incubation and raising to the fry stage and thermal marking at Port Snettisham Incubation Facility near Juneau; and release as hatchery fry into Tuya Lake and/or Tahltan Lake.

Stock assessment information is essential to managing fisheries in a sustainable manner. The awareness of timing, extent, and variables of salmon returning through coastal mixed-stock fisheries is required to ensure that adequate numbers of spawners avoid adverse impacts and sustain populations. The difficulty in enumerating spawners in the Stikine system, most of which is glacially turbid, limits the ability to manage the sockeye as a resource. Surveys and assessments up to 1980 assumed Tahltan Lake was the major producer of sockeye in the Stikine drainage with as much as 90% of the population spawning there (Bergmann 1978). In the late 1970s, BC Hydro proposed a series of hydroelectric developments on the Stikine and its major tributary, the Iskut River.

McCart and Walder (1982) reported on studies assessing the potential impacts that indicated there was more sockeye spawning elsewhere in the drainage, particularly in the turbid, glacial-fed waters of the mainstem and many tributaries.

Figure 24. View west across Tahltan Lake.

Figure 25. View across Stikine multi-channels.

Identification of and differentiation among these non-Tahltan lake sockeye stocks were achieved by using scale pattern, otolith structure, electrophoresis, parasite markers, egg size and egg mass patterns, and later, micro-satellite DNA markers.

Craig (1985) reported that scale pattern analyses alone during 1979 to 1984 indicated a large stock of non-Tahltan sockeye, which averaged 54% (range of 38 to 69%) of sockeye production.

From 1996 to 2005, Erhardt (2009) reported that sockeye returns to Tahltan Lake comprised 44% of the total in-river sockeye run; mainstem proportion was 37%, and Tuya Lake 19%.

Further investigations in the mid to late 1980s focused on the stock composition of in-river returning adults and rearing habitats including lake, river, and sea. Sea-type and river-type sockeye were distinguished by their scale and otolith structure. Wood *et al.* (1987) indicated that sea-type sockeye were not found in areas with access to rearing lakes, but comprised 15.4% (range 2 to 55%) of spawners in tributaries most associated with lakes. Size frequency data suggest sea-type sockeye in the Iskut River migrated to the estuary at a mean weight of 1 g, whereas river-type sockeye juveniles migrated primarily as yearlings with a mean weight of 3 g. Lake-type sockeye emigrating from Tahltan Lake as 1+ smolts (97% of emigrants) averaged 3.6 g in 1985 (Wood *et al*. 1987).

These results indicate a sizeable variation of adult and juvenile sockeye life histories and the utilization of quite different habitats. Although the rearing environments within the watershed differ radically, the relative productivity of each habitat appears to remain relatively constant. These differing types of spawning and rearing environments illustrated in Figures 24 and 25 were mapped in 2007 and 2008 by Tahltan Fisheries (Erhardt and Connor 2010). Figure 25 shows the multi-channeled mainstem section near Chutine River confluence. Erhardt (2009) reported that Tahltan Lake sockeye spawning distribution and habitats were mapped and limnological baseline conditions recorded in order to increase awareness and enable comprehensive planning, assessment, and monitoring activities.

Erhardt and Connor (2010) conducted GIS-based mapping that included salmon distribution and critical habitat, and identified data gaps. This ArcGIS map product with linked attribute tables increases easily retrievable knowledge and is updatable to integrate future science findings and Tahltan Knowledge. The mapping product not only provides a “quick reference” guide to documented critical salmon habitats but also a “time-saving” link to the more detailed data associated with specific sites, such as timing, flow, substrate, and visibility for the 437 recorded salmon spawning locations.

Most Stikine sockeye spend between one to three years in the ocean before returning to freshwater to spawn and die in late summer or early autumn. Tahltan Lake spawners move into the river by the end of June and peak throughout July depending on discharge conditions. McCart and Walder (1982) note that these sockeye apparently pass upstream from the border relatively quickly with an average 22 day swim. Returning adults arrive at Tahltan Lake in mid-July with typically 50% of the run passing through by August 6th, and by mid-August, 90% of the run passing through the counting weir located at the outlet of the lake on Johnny Tashoots Creek.

Erhardt (2009) reported Tahltan Lake is dimictic with a minimum depth of 23 m and a maximum depth of 47 m. The lake is multi-basined, scattered with small islands, and possessing extensive littoral zones. Sockeye hold in the lake for four to six weeks as they sexually mature. The majority of spawning occurs from September 1st to 30th, and spawning distribution is shown in Figure 26, wherein sockeye observations are displayed as graduated circles based upon estimated abundance.

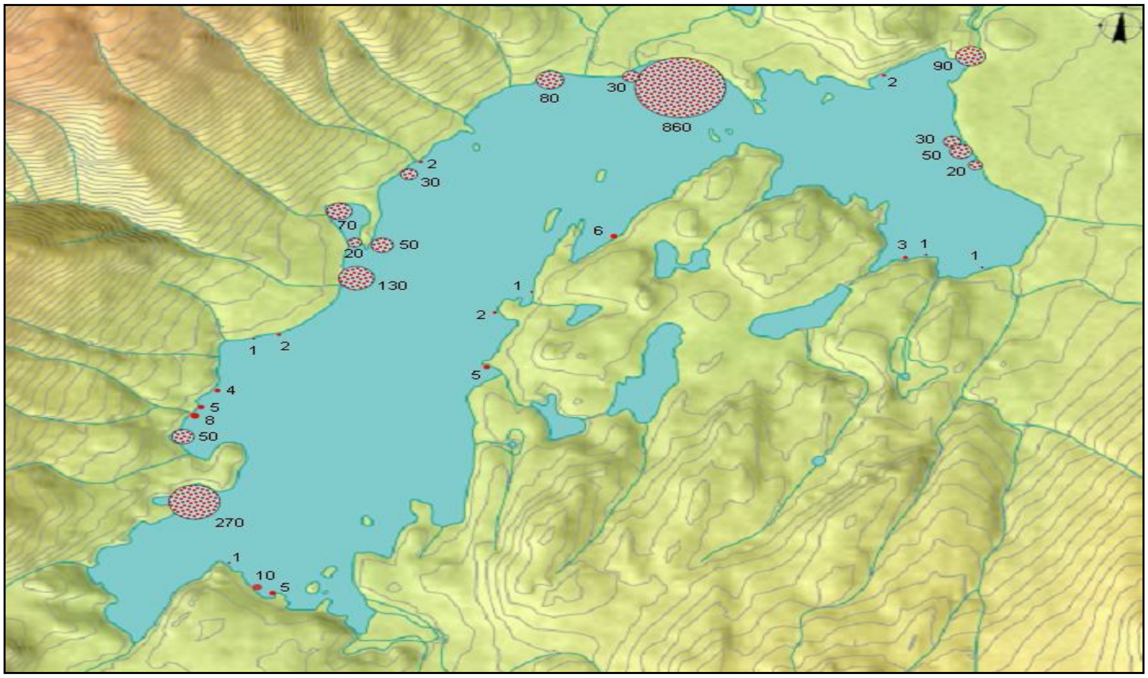


Figure 26. Tahltan Lake sockeye spawning distribution (Erhardt 2009).

Stikine fisheries are managed to arrangements outlined in Annex IV, Chapter 1 of the Pacific Salmon Treaty (PST), which includes the Stikine Enhancement Production Plan (SEPP). The SEPP is designed to produce 100,000 returning adult sockeye salmon per year. Since 1989, a relatively large-scale enhancement program has collected Tahltan Lake sockeye eggs, incubated and raised thermally marked fry at Port Snettisham Hatchery, and released hatchery fry into Tuya Lake and/or Tahltan Lake. Port Snettisham Hatchery was specifically built for sockeye salmon due to the IHN Virus and the need to mitigate outbreaks.

Tuya Lake is deep with a mean and maximum depth of 23 m and 54 m respectively and currently is oligo-mesotrophic. Fish presence in Tuya Lake prior to outplant of Tahltan Lake origin sockeye fry in 1991, included lake trout, bull trout, burbot, long nose sucker, slimy and prickly sculpin, and Arctic grayling. Since sockeye fry outplanting, Beere (2002) noted the establishment of a kokanee population and an unknown disease apparently impacting a small portion of the Arctic grayling population. Mathias (2000) stated that salmon stocking did not reduce total zooplankton biomass in Tuya Lake, but caused notable trophic restructuring that could have influenced nutrient availability.

Moore and Schindler (2004) predicted that in barren lakes stocked with sockeye fry, outmigrating smolts acts as net exporters of lake nutrients through biomass-sequestered nutrient losses. Selbie *et al.* (2011) mass balance models supported this hypothesis, estimating net salmon-mediated nitrogen (up to 452 kg N year-1) and phosphorus (up to 78 kg P year-1) exports in all years following stocking in Tuya lake. However, these losses are minor, relative to its large euphotic volume.

Lake ecosystem responses to fish introductions can be further complicated when species with diverse life histories, such as anadromous Tahltan sockeye, are stocked, owing to simultaneous "bottom up" (e.g., nutrient controls) and "top down" (e.g., planktivory) influences on lake food webs (Schindler *et al.* 2003). Selbie *et al*. (2011) integration of fisheries modelling, monitoring, and paleolimnological data indicated that salmon introductions to Tuya Lake have reduced biological nutrient availability and primary productivity. Given the limited pelagic food web productivity, Tuya Lake is not a viable candidate for salmon introductions due to the effects of climate warming and subsequent unforeseen complexity in ecosystem stress responses. No adult sockeye salmon have returned to Tuya Lake since outplanting was commenced in 1989, due to three barrier falls in the lower reach close to Stikine River. The extent of impacts to the Tuya Lake ecology needs to be clearly documented and rectified.

Potential impacts from the back planting of sockeye fry into Tahltan Lake are not clearly understood. Wood *et al.* (1993) indicated that spawning habitat was limited in the lake and noted that average incubation success decreases quickly as spawning escapements increase. Wood *et al*. (1993) suggested that 20,000 females would be an appropriate escapement target. Hyatt *et al.* (2005) concurred with that conclusion and suggested a somewhat lower escapement limit, due to analysis results indicating that when escapement exceeded 10,000 females, egg-to-smolt survival was substantially reduced.

Typically, river spawners migrate upstream several weeks behind Tahltan Lake spawners and have a much shorter holding period before spawning. Sockeye start spawning along the margins of the Stikine and Iskut and in their tributaries in the second week of August, peak from mid to late September depending on the location, and are generally done by the first week of October, with timing variability in differing populations (McCart and Walder 1982, Northwest Enhancement 1985). Productive spawning sites along the mainstems appear to change annually.

Major tributaries and habitat that support sockeye spawning, in order of relative abundance, include in-channel and off channel mainstem areas, Scud River, Verrett River and Slough, Chutine River, Craig River, Bronson Slough, Porcupine Slough, and Christina Creek. Johannes (2011) described annual aerial survey counts from 1984 to 2007 of these sockeye river spawning stocks and abundance and proportions are shown in Figure 27.

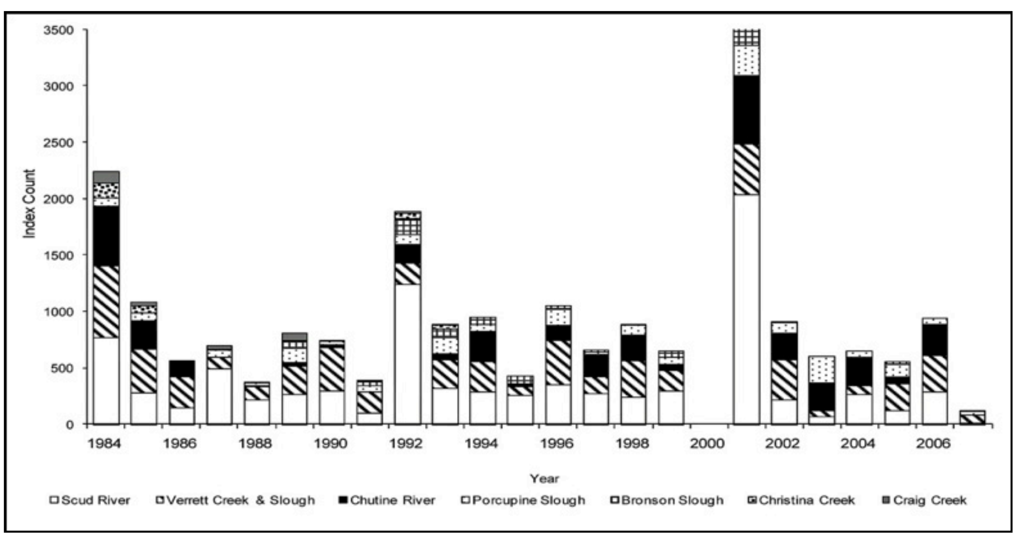


Figure 27. Graph showing major Stikine sockeye river spawner stocks, 1984 to 2007.

The population structure of Stikine sockeye is complex due to the various lake, river, and sea life history types. Age information for Tahltan Lake wild and enhanced stocks shows 4_2, 5_2, 5_3, and 6_3 age classes though 4_2 and 5_2 are predominant. The relative abundance of various age groups among sockeye sampled at the Tahltan weir is known to be highly variable on an annual basis, though the number of age groups represented is fairly constant. Little is known regarding age class information and annual variability for river spawners, and the data is considered preliminary. McCart and Walder (1982) sampled sockeye adults on the mainstem upstream of Chutine River, with the results showing a wide range of age groups. The most common groups were 4_2 (39%) and 5_2 (29.4%) with 2_1 (1.2%), 3_1 (11%), 3_2 (6.3%), 4_1 (3.1%), 4_3 (0.4%), 5_3 (5.5%), and 6_3 (4.3%).

Stikine sockeye terminal run sizes for the 1982 to 2011 period averaged 166,318 fish; for the 2002 to 2011 period the terminal run size averaged 203,532 sockeye (PSC 2012). PSC (2012) reported on in-river catch, marine catch, escapement, and terminal run size, which excludes marine catches outside Districts 106 and 108. Stikine River in-river fisheries from 1982 to 2011 averaged 46,240 sockeye caught. Marine catch in the coastal mixed stock fishery from 1982 to 2011 averaged 54,641sockeye caught, for an annual average catch of 100,881 sockeye. Average annual escapement from 1982 to 2011 is 65,437 sockeye with an average exploitation rate of 60%.

Determining the stock origins of salmon catches has been the focus of coast wide research supported under the PST. Sockeye salmon caught in Northern Boundary Area (NBA) fisheries, including Noyes Island and Sumner Strait, comprise mixtures of Canadian and Alaskan stocks. Annual variations in numbers of salmon returning to stocks, and in the migration routes of these salmon through the NBA, make estimation of stock composition in fisheries imprecise and is complicated by mixed-stock fisheries of different populations, with potential adverse effects to adequate escapement.

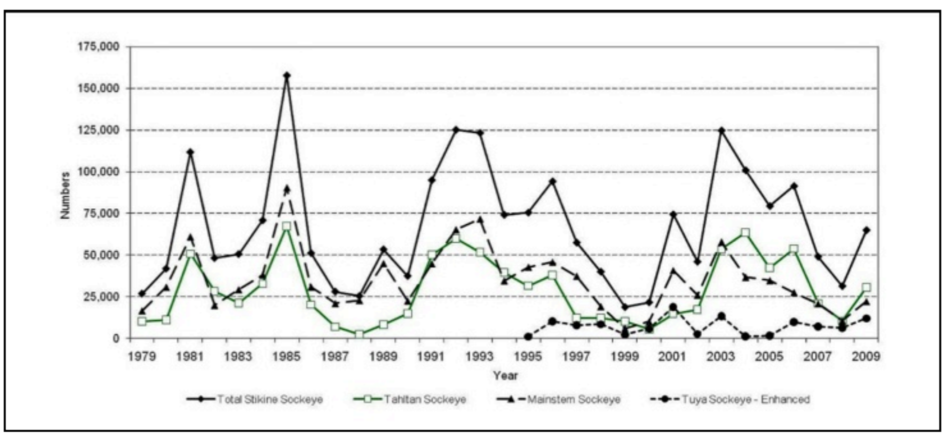


Figure 28. Graph showing escapement from 1979 to 2006 of total Stikine sockeye aggregate, Tahltan, Tuya and mainstem spawners (Johannes 2011).

The 60% exploitation rate may be considered suitable for highly productive enhanced stocks, but run timing overlapping with other Stikine wild sockeye salmon stocks will diminish abundance and the long-term maintenance of diversity within the aggregate sockeye stocks.

What this means is that enhancement within a mixed-stock fishery is incompatible with the conservation of wild salmon diversity; subsequently, there is a conflict with short-term economic interests and long-term conservation ethics. This is a problem because salmon conservation is not entrenched as a guiding principle in the PST; rather it is a consideration stated thus:

> *The Parties desire to maximize the harvest of Tahltan/Tuya sockeye salmon in their existing fisheries while considering the conservation needs of wild salmon runs.*[2]

Coho Salmon

Stikine coho are the most widely dispersed salmon throughout the mainstem and its tributaries and show the least amount of concentration into a few large productive stocks. Coho usually spend one to two winters in freshwater before migration to the ocean. Coho typically spawn in small headwater streams. They typically return as two or three year olds after spending one winter or about 16 months in the surface waters off the coast. Approximately half of Stikine coho remain in the coastal waters, while the other half migrate north off SE Alaska. Some males (jacks) return to spawn after only a few months at sea. Marine diets range from euphausiids and various plankton to squid and small fish such as herring.

Coho migrate into the Stikine River between late July and the end of September, as recorded by the coastal and test fisheries. Catches on the lower Stikine indicate coho moving up continuously from late August to late October. On the Iskut River, the run appears to move through mainly during September with the tail end by late-October. Stikine coho spawning presumably peaks in November.

Figure 29. View downstream on Stikine to Great Glacier showing coho sidechannel spawning habitat (G. Fiegehen).

[2] Pacific Salmon Treaty. Chapter 1: Transboundary Rivers. 3. (a) (1) (ii).

Major coho spawning populations include Katete River and tributaries, Porcupine Slough, Christina River, Scud Slough and River, Tahltan River, Chutine River, Inhini River, Craig River, Verrett River, and Bronson Slough. Coho spawning is also located in many unnamed groundwater-influenced streams, ponds, and sloughs; however, McCart and Walder (1982) noted they do not seem to utilize the sidechannels of Stikine and Iskut mainstems to the same extent as sockeye. Figure 29 shows Stikine River sidechannels utilized by spawning coho.

Coho juveniles are located throughout accessible streams supporting anadromous fish in all water types and temperatures and tend to occupy small tributaries off the Stikine and Iskut mainstems. Northwest Enhancement (1985) caught very small buttoned coho fry in mid-August, suggesting an abnormal behaviour pattern of incubation or very late spawning.

Current stock assessment primarily utilizes catch from the lower river test fishery catch and expands that count in relation to sockeye abundance. This expansion is based on the assumption that coho and sockeye escapement is comparable. There is a lack of reliable escapement and marine survival data for Stikine coho. Poor understanding of spawning and rearing distributions make it difficult to note indices of abundance. Enumerating adult coho escapement is difficult due to the relatively late-season run timing, their holding patterns, and their propensity to spawn in small stream or back channel habitats, which are often iced over.

Figure 30. View northeast across lower Scud River fan.

The PST interim escapement goal for Stikine coho is 30,000 to 50,000. This number of coho is likely small, but the only indicator of coho run strength has been the magnitude of the terminal area and in-river catches. With a peak terminal catch of 125,700 in 1941, and annual average commercial catches noted by Walker and Brown (1971) from 1951 to 1970 of 38,700 coho (range 6,100 to 78,900), it appears that coho stocks are very depressed.

Pink and Chum Salmon

Few pink and chum salmon enter the Canadian portion of Stikine to spawn. Pink salmon generally arrive in the Stikine as determined by the lower river test fishery during the second week in July and continue into mid-August. Pink adult migration is overlapped by the later part of the sockeye run and the early portion of the coho run. Chum timing is similar to pink timing but with the peak two weeks later. There is little data showing Stikine pink and chum abundance.

Pink distribution extends upstream past the Little Tahltan River weir to spawn in low numbers. There are approximately 30 known pink salmon spawning grounds in Stikine and Iskut rivers and their tributaries. The majority of pink and chum salmon spawning locations are small and moderately interspersed areas and pockets, many of which are noted in Table 2 and 3.

Chum spawner distribution extends upstream to approximately 23 km on Chutine River. The major known chum spawning areas include Chutine River mainstem, the Katete River (South Fork and Geoffrion Creek), and the unnamed tributaries near Inhini and Hoodoo rivers.

Steelhead

Stikine watershed streams support both sea-going and resident populations of steelhead. There is little information regarding Stikine steelhead generally and specifically. Lough (1980) conducted an overview survey of Tahltan River steelhead following the introduction of a Canadian commercial fishery in the lower Stikine during the late 1970s. There is insufficient data to evaluate biological characteristics. Small run sizes typical of most steelhead stocks may be more susceptible to poor land management practices and overharvest than larger stocks.

The anadromous populations are known as steelhead, and freshwater residents as rainbow trout. But there are no genetic, morphological, and morphometric differences other than their life history strategies (Burgner *et al.* 1992). There are known summer-run populations of steelhead in the Stikine, though anecdotal information suggest that Craig River supports a winter run. The summer-run steelhead spend the fall and winter in rivers or lakes, usually not far from their spawning areas. The gonads mature during this residence. If Stikine streams support winter-run steelhead, they are likely limited to the lower reaches. Spawning in both groups takes place in the spring, generally in May and June.

Steelhead fry emerge in late-August and September and spend between one and four winters in fresh water. Lough's (1980) results indicate that most Tahltan River steelhead spend three (77%) or four years (23%) in fresh water before migrating to the sea; however, the sample size was small. Most steelhead smolts migrate to sea in the spring during the annual snowmelt flood. Lohr and Bryant (1999) reported that most SEAK steelhead spend one to three years in the ocean before returning to freshwater.

Unlike other Pacific salmon species, steelhead are iteroparous – they can spawn more than once. Shortly after spawning, kelts migrate back to the ocean and may return the following year. Repeat spawners are less common, usually less than 10%.

In-migration timing to lower Tahltan River is noted by Lough (1980) as late September and this is confirmed by Tahltan and sport angler catches. Steelhead tend to stack in the limited holding water in the lower Tahltan River and the reach downstream of Little Tahltan River confluence. Tables 2 and 3 above list nearly a dozen streams supporting steelhead spawning; however, the list is considered incomplete. BC WLAP (2002) notes the five separate steelhead stocks in the Stikine River and presumes they are healthy.

Figure 31. View upstream of lower Chutine River across steelhead spawning grounds; Barrington Mountain in Background.

Major known spawning locales include Tahltan River, Tuya River, Chutine River, and Craig River. Schell (1999) sampled Chutine for steelhead, but the small sample size result was inclusive as to whether steelhead or resident rainbow trout were present.

The number of steelhead intercepted and caught by incidental commercial coastal and lower in-river fisheries is unknown. Backtracking on the in-migration timing at lower Tahltan River, peak timing for steelhead moving through lower Stikine River would be approximately the first to second week of September. This would coincide with the peak of US pink salmon mixed-stock fishery and the tail end of sockeye and early coho Canadian in-river fisheries. Steelhead immigration timing, life history characteristics, and incidental commercial catch knowledge is insufficient to manage steelhead conservation.

2.2.2.2 Tahltan Salmon & Freshwater Fishery

The Tahltan aboriginal salmon fishery formed the principal foundation of the economy and was of the greatest economic importance. Allbright (1984) noted that the large, predictable runs of anadromous salmon provided a reliable resource for the Tahltan people. Large quantities of salmon, which ascended the major rivers in annual runs, were dried and stored for future use. Anadromous chinook, coho, sockeye, chum, pink, and steelhead stocks were typically harvested and processed close to their spawning grounds.

Using ethnographic information and archaeological data, Allbright (1984) reconstructed the use of Tahltan prehistoric fishing sites on the upper Stikine River. In the yearly round of seasonal activities traditionally engaged in by the Tahltan people, summer and winter fishing villages located along major salmon producing streams were occupied for longer periods of time and by larger groups of people, than other seasonally occupied sites. The intensity and range of activities carried out at these sites render them more visible in terms of archaeological remains.

A thorough understanding of the subsistence strategies enabled a preliminary reconstruction of Tahltan fishing and fisheries sites as shown in Figure 32.

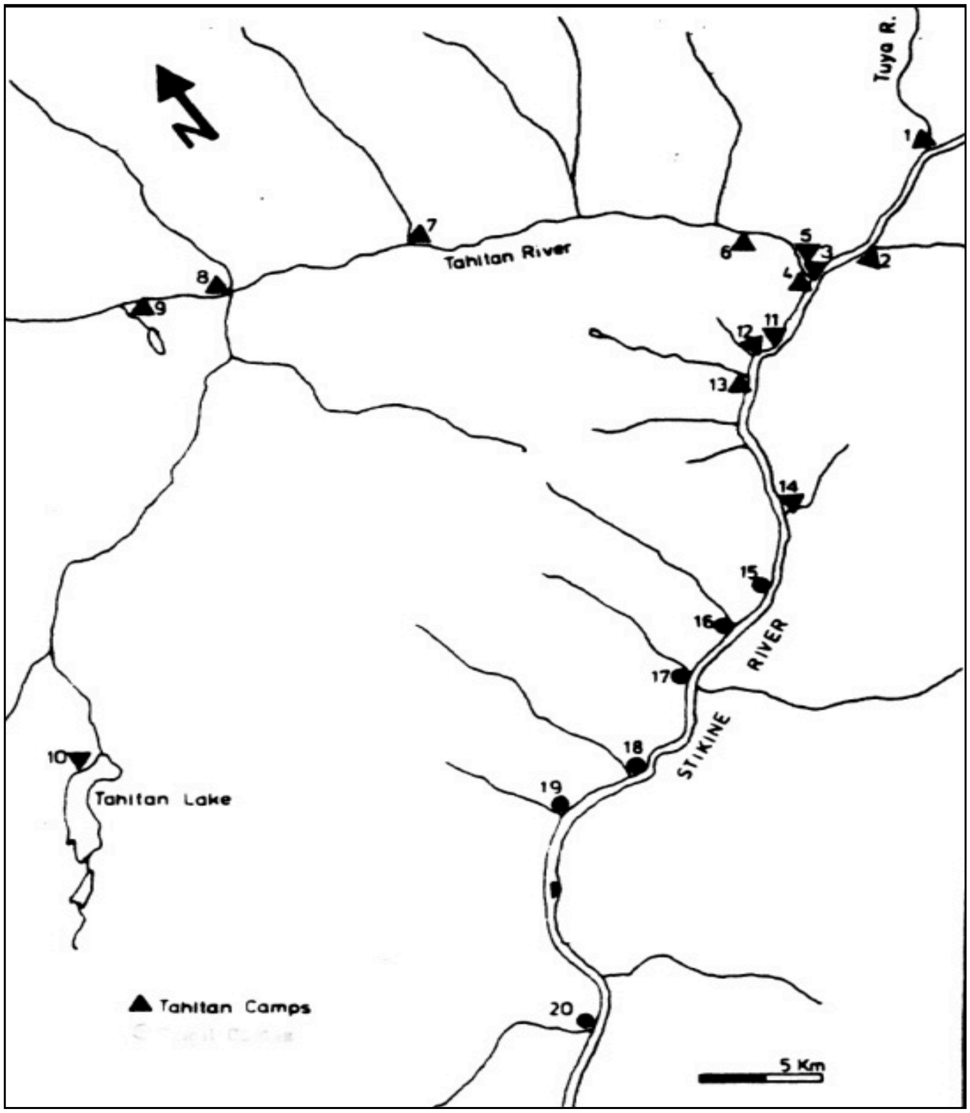


Figure 32. Some of the 33 Tahltan fishing camps in the Stikine drainage (Allbright 1984).

An important part of the Tahltan salmon economy was the storage of dried salmon on a massive scale in order to provide food and to ensure sufficient trade. Thorman (n.d.) records the many fish storage pits along the major rivers:

> *There are not less than fifteen hundred of these pits from Chich`an ahda to the Tuya River, all not far removed from the banks of the river. In the Chich`an ahda area there are as many; along the Tahltan River Canyon up to and including Tahltan Lake they are equally numerous.*

The Tahltan salmon economy carries into the present with major fishing at Tahltan River, Nine Mile creek, Six Mile Creek, Four Mile Creek, Tuya River, and other mainstem sites. Fish processing is principally by smoke, air, canning, and freezing.

Figure 33. Tahltan smokehouse (G. Fiegehen).

Figure 34. Typical pole set net (G. Fiegehen).

2.2.2.3 Stikine System Freshwater Fish and Their Habitats

Relative to salmon, information is sparse on resident (non-anadromous) freshwater fishes in Stikine basin stream and lake habitats. Much of the watershed is poorly known and may contain populations of special interest or status that are now unknown. Ecological and life history information that permits good conservation planning is simply not available.

There are 15 known species of freshwater fish in the Stikine system (McPhail and Carveth 1993). The freshwater fish assemblage includes cutthroat trout (anadromous), rainbow trout, mountain whitefish, Dolly Varden char, bull trout char, burbot, Arctic grayling, lake trout, lake chub, longnose sucker, kokanee, coast range sculpin, prickly sculpin, slimy sculpin, and three-spine stickleback. Mountain whitefish is the most common resident fish, followed by Dolly Varden. It is unknown if green sturgeon and white sturgeon are present in BC upstream of the estuary.

There are three resident freshwater fish species of conservation concern: cutthroat trout, Dolly Varden, and bull trout. Cutthroat trout are blue listed by the BC Conservation Data Centre (CDC) as a species of concern, as are Dolly Varden char. Bull trout, actually a char, are also blue listed as a species of concern by the BC CDC, as well as by COSEWIC, due primarily to limited global distribution and threatened status in the southern part of their range in the U.S.

The Stikine freshwater fish assemblage is divided into two major communities; an upper basin and lower basin separated by the Grand Canyon. The majority of purely freshwater species are confined to the upper watershed and are of mixed origins. For example, Arctic grayling and burbot likely originate from the Yukon drainage (McPhail and Carveth 1992). Stikine River is the point at which freshwater fishes from the north displace the Columbia River fish fauna (McPhail and Lindsay 1986).

Stikine River drainage upstream of the Grand Canyon supports rainbow trout, mountain whitefish, Dolly Varden char, bull trout char, burbot, Arctic grayling, lake trout, longnose sucker, and prickly sculpin in a variety of different habitats. The middle Iskut River, upstream of the Iskut Canyon to the 43 m high Cascade Falls, which debouches from Natadesleen Lake, supports a slightly different fish community composed of rainbow trout, mountain whitefish, Dolly Varden char, and bull trout char. The upper Iskut drainage, considered as upstream of Natadesleen Lake including the headwaters, supports a unique monoculture population of rainbow trout.

The Stikine watershed is one of the last large Pacific drainages where freshwater fish can be easily angled in pristine wilderness settings. Tahltans from Iskut, Telegraph Creek, and surrounding communities fish intensively on a year-round basis. Freshwater fishing is the best known tourism activity, especially along Highway 37, and is of provincial and international significance. This recreational fishery supports numerous tourism businesses such as fishing guides, fish camps and lodges, transportation services, and sport fishing, and provides an important recreational opportunity for local residents.

2.2.2.4 Stikine Salmon Interactions

Salmon are a critical structuring component of marine and freshwater ecosystems as sources of nutrients and energy. The health and long-term well-being of Stikine salmon is inextricably linked to the existing diverse and productive freshwater, estuarine, and marine habitats. Stikine salmon have a critical function in these aquatic and terrestrial habitats and ecosystems. In the marine ecosystem salmon provide nutrients for top predators such as sea lions and killer whales. In freshwater, they provide food to people, transport marine nutrients inland, and sustain terrestrial animals. As such, salmon are a keystone species underpinning entire ecosystems, including humans.

A wide range of fish and birds are known to prey on juvenile salmon; however, this has not been studied in detail within the Stikine drainage. Principal fish species that are known to predate on juvenile salmon within the Stikine River drainage are Dolly Varden char, rainbow trout, and older juvenile salmon such as coho. Principal bird species predating on juvenile salmon are eagles, gulls, ravens, mergansers, kingfishers, and terns. Returning adult salmon provide nutrition to a wide range of predators/scavengers including grizzly and black bears, wolves, mink, and otter.

2.3 Stikine Flora

2.3.1. Ecosystem Classification

Boreal, sub boreal, subalpine, and alpine vegetation dominate the landscapes of the Stikine area. Cold winters, short growing seasons and poorly developed soils are a factor in the distribution and composition of vegetation communities. Natural disturbance factors including (but not limited to) fire, insect and disease, also affect patterns of vegetation across the landscape. A diversity of plant ecosystems ranges from dry grasslands at 300 m elevation in the Stikine River Grand Canyon area to lichens and robust alpine plants at 2,000 m elevation (Ministry of Environment 2000). Lower elevation forests are composed of spruce and pine with subalpine fir dominating at higher elevations (Ministry of Environment 2000).

The Ecoregion Classification System describes areas of similar climate, physiography, hydrology, vegetation and wildlife potential (Demarchi 2011). Biogeoclimatic Ecosystem Classification (BEC) uses climate, topography and soils to classify vegetation patterns into biogeoclimatic zones or subzones (Meidinger and Pojar 1991, Banner *et al.* 1993). The study area encompasses eight ecosections[3] and eight BEC zones[4] (Anonymous 2000).

Ecosections found within the Stikine area include the Boundary Ranges, Southern Boreal Plateau, Stikine Plateau, Northern Skeena Mountains, Eastern Skeena Mountains, Tahltan Highland, Cassiar Ranges, and the Tuya Range.

Table 4. BEC zones within the Stikine and upper Nass area (adapted from Pojar *et al.* 1983)[5].

BEC Zone	Distribution in Study Area
Coastal Western Hemlock (CWH)	Lower elevations in western part of Coastal Mountains
Interior Cedar Hemlock (ICH)	Along middle Iskut and Stikine River drainages east of Coast Mountains; along Bell-Irving and lower Nass drainages
Mountain Hemlock (MH)	Primarily above CWH
Boreal White and Black Spruce (BWBS)	Stikine Plateau
Sub-Boreal Spruce (SBS)	Along Stikine drainage between Stikine Plateau and Coast Mountains; along upper Nass River valley
Spruce Willow-Birch (SWB)	Stikine Plateau; Cassiar Mountains; primarily above BWBS
Engelmann Spruce Subalpine Fir (ESSF)	Primarily east of the Coast Mountains above SBS and ICH
Alpine Tundra (AT)	Upper elevations throughout

2.3.2 Stikine Watershed Forests

The BWBS zone occupies Stikine Plateau valley bottoms and other lowland and montane areas east of the Coast Range from 500 to 1000 m in elevation. The BWBS occurs in the Iskut River upstream of Durham Creek, and on the Stikine upstream of Glenora, in Tahltan and Tuya rivers country, and in the Klappan and Spatsizi. Forests are dominated by white spruce (*Picea glauca*), lodgepole pine (*Pinus contorta)* and trembling aspen (*Populus tremuloides*) with minor amounts of subalpine fir (*Abies lasiocarpa*), black spruce (*Picea mariana*), balsam poplar (*Populus balsamifera ssp. balsamifera*), and paper birch (*Betula papyrifera*) Dominant soils are moderately developed Brunisolic Gray Luvisols and Dystric Brunisols with Hemimors more than 10 cm thick (Pojar *et al.* 1983). Forest productivity is limited by the harsh climate.

The SWB zone occurs on gently rolling plateaus to steep mountain slopes lying above the BWBS and ranges to subalpine elevations between 900 and 1600 m. Forest canopies consist primarily of white spruce and subalpine fir. The SWB occurs in higher elevation valley bottoms such as the upper Klappan, upper Spatsizi, and upper Stikine as shown in Figure 35. At lower elevations, forests with open to closed canopies consisting of white spruce with variable

[3] Detailed information regarding ecosections is available through the BC Ministry of Environment.
[4] Detailed information regarding BEC zones is available through the BC Ministry of Forests and Range Research Branch and refer to *BEC Zones of the Cassiar Timber Supply Area* (Pojar *et al.* 1983).
[5] Refer to Appendix I for a detailed map of BEC zones across the Stikine and upper Nass study area.

amounts of lodgepole pine, trembling aspen and black spruce are common; above that, subalpine fir is dominant. High elevations in the SWB zone consist of tall deciduous shrubs, mainly scrub birch (*Betula glandulosa*) and willows (*Salix* sp.)

Figure 35. Typical SWB forest on the valley bottom in upper Stikine.

A mosaic of shrubs, fens and Altai fescue grasslands occur in some broad, high elevation valley bottoms such as the Kluayetz shown below in Figure 36, as a result of cold air ponding; on lower slopes coniferous forest frame these areas and shrubs higher upslope. Soils are predominantly moderately developed (Humo-Ferric Podzols and Eutric [high pH] and Dystric [low pH] Brunisols with Hemimors and Mormoders; Pojar *et al.* 1983).

Figure 36. View east across Kluayetz Creek showing Altai fescue grasslands.

Small areas at elevations of 150 to 900 m along the middle Iskut and Stikine rivers are ICHvc (very cold) and ICH wv (wet, very cold) subzones. On the Iskut, the ICH extends from McLymont Creek upstream to Durham Creek including low elevations in the Forrest Kerr, More, and Ningunsaw valleys. On the Stikine, the ICH extends from and includes low elevation areas in Scud River upstream to Dokdaon Creek. Western hemlock (*Tsuga heterophylla*) form extensive old growth forests; hybrid Sitka and white spruce (*P. sitchensis x glauca*) occur on rich, moist sites as shown in Figure 37. Black cottonwood (*Populus trichocarpa*) and hybrid spruce form floodplain forests and lodgepole pine, trembling aspen and paper birch form seral forests in burned areas, especially near Bob Quinn Lake (Pojar *et al.* 1983).

Figure 37. Typical ICH forest in the lower Iskut.

Small patches of SBS zone are situated at low elevations (50 to 900 m) along Stikine and Klastline rivers, and Kakkidi and Mess creeks. In the Stikine, the SBS extends from Glenora downstream to Dakdaon Creek and encompasses low elevation in Chutine, Barrington, and Yehiniko valleys. The forests are primarily made up of hybrid white spruce (*P. glauca x engelmannii*), subalpine fir, black cottonwood, paper birch and to a lesser extent, lodgepole pine and trembling aspen. One distinguishing feature of this zone is the presence of Devil's Club (*Oplopanax horridus*), which is absent in the BWBS zone (Pojar *et al.* 1983).

The ESSFmc (moist cold) and ESSFwv (wet, very cold) subzones occupy areas primarily east of the Coast Mountains in the Tahltan Highlands and northwest Skeena Mountains ranging in elevation from 750 to 1250 m above the ICH and SBS zones. The ESSFwv (wet, very cold) forests consist mainly of subalpine fir with minor occurrences of mountain hemlock (*Tsuga mertensiana*), hybrid white spruce and western hemlock with understories dominated by heath.

Closed canopy forests turn into subalpine parkland at higher elevations where a mosaic of tree clusters and open areas of heath and wetlands occur. Dominant soils are Ferro-Humic Podzols with Hemihumimor humus forms that are 5 to 15 cm thick. In the ESSFmc (moist cold) subzone, forests are made up of primarily subalpine fir, hybrid white spruce and lodgepole pine as shown in Figure 38. Soils are typically Humo-Ferric Podzols and Podzolic Gray Luvisols with Hemimor humus forms that are 2 to 7 cm thick (Pojar *et al.* 1983).

The CWHwm (wet maritime) subzone overlies lower coastal elevations (0 to 450 m) west of the Coast Mountains crest in the Stikine, Iskut and Unuk river valleys. Closed forests dominated by western hemlock and/or Sitka spruce are most common, minor occurrences of subalpine fir is also common in many stands.

Figure 38. Typical ESSF forest.

Sitka spruce is plentiful in valley bottoms and alluvial terraces, with red alder (*Alnus rubra*) and paper birch interspersed in alluvial forests. Black cottonwood stands occupy floodplain areas. Soils are typically moderately well-drained Humo-Ferric Podzols with Hemimor and Mormoder humus forms (Pojar *et al.* 1983).

The MH zone occupies subalpine elevations (400 to 1100 m) above the CWH. At lower elevations dense subalpine forests consist mainly of mountain hemlock with less frequent but still significant occurrences of western hemlock. Spruce and subalpine fir are common along drainages and yellow cedar (*Chamaecyparis nootkatensis*) may occur near the BC-Alaska border above the Stikine River. At higher elevations, forests are dominated by mountain hemlock and subalpine fir. Predominant soils are Podzols and Folisols (Pojar *et al.* 1983).

The AT covers high elevation areas (1100 to 1600 m) on mountain slopes and plateaus and is distributed widely throughout the study area. The AT zone is defined as treeless however, subalpine fir are common in stunted or krummoltz form, and to a lesser extent white spruce, mountain hemlock, scrub birch and willows. Alpine vegetation is composed of herbs, bryophytes andlichens; the grassy, Altai fescue and lichen community is very extensive, especially on the high alpine plateaus (Pojar *et al*. 1983).

2.3.3 Rare and At Risk Plants and Plant Communities

Plants and plant communities present in areas with harsh and/or extreme environmental conditions are often highly sensitive to physical damage (Ministry of Environment 2000). Species exhibiting one or a combination of rare, sensitive, and threatened are of interest. Lichens, an important food source for caribou, are a good example of a species highly sensitive to physical disturbance. Lichens are slow growing and especially vulnerable to damage during summer when they are dry, therefore recovery following disturbance could take 50 to 100 years (Ministry of Environment 2000).

Among many others, whitebark pine (*Pinus albicaulis*), a provincially blue-listed and federally endangered species, is present in the area. Also of note are the grasslands that exist on the Spatsizi Plateau. Appendix II lists rare and at risk plants; plant communities are numerous and can be found on the Ministry of Environment BC Species and Ecosystems Explorer website at: http://a100.gov.bc.ca/pub/eswp/search.do?method=reset.

Grasslands

Haeussler (2007) notes rare low-elevation grasslands consisting of slender wheatgrass (*Elymus trachycaulus*) in the Stikine River valley along the banks of the Grand Canyon, and Stikine tributaries such as the Klastline, Tahltan, Tanzilla and Tuya rivers. These grasslands are critical habitat for species such gartersnakes (*Thamnophis sp.*) and remnant populations of mule deer (*Odocoileus hemionus*). They also support xerophytic plants and insects not present anywhere else in the watershed. Fire is another major factor in maintaining grasslands. Short and long term changes in climate can affect fire regimes, consequently threatening or benefitting the health and existence of rare grasslands.

2.4 Stikine Wildlife

The diversity of ecosystems within the Stikine area support a variety of regionally and provincially significant species. Among many of the species present are a range of wildlife including grizzly bear (*Ursus arctos*), caribou (*Rangifer tarandus*), mountain goat (*Oreamnos americanus*), Stone's sheep (*Ovis dalli stonei*), moose (*Alces americanus*), wolverine (*Gulo gulo*), wolf (*Canis lupus*), and fisher (*Martes pennanti*). There are numerous bird species, relatively rare amphibians and rare plant communities, all of which contribute to the rich biodiversity of the area (Peyton 2011). Callison (2002) notes Stikine River Grand Canyon has yielded fossil discoveries and vegetation not found elsewhere in the watershed.

Wildlife inventories are conducted in the Stikine area by BC Ministry of Environment and local First Nations for caribou, moose, mountain goat, Stone's sheep, and grizzly bear on a sporadic basis and usually in response to management concerns. There is a need for ongoing wildlife research studies in order to determine population status and trends, particularly in regard to changing climate and the potential risks from proposed development in northwestern BC. First Nations typically have a realistic and up to date perspective on wildlife abundance and condition.

2.4.1 Caribou

Caribou (*Rangifer tarandus*) are delineated by Environment Canada (2012) into three separate variants: Northern mountain, southern mountain, and boreal populations. The Northern Mountain population is comprised of 36 local populations in Yukon, Northwest Territories, and northwestern British Columbia. Two main herds of caribou inhabit the Stikine area: the Spatsizi herd and the Mount Edziza herd. The Spatsizi herd occupies the Upper Stikine area and is BC's largest population of woodland caribou. The Mount Edziza herd populates areas on and around Mount Edziza (Ministry of Environment 2000).

Caribou are one of the most important Tahltan wildlife species being a main food source and as a cultural icon. Historically, caribou populations were contiguous in northern BC; however, general abundance and distribution have declined over the last century. Spalding (2000) indicates habitat fragmentation, overhunting and increased wolf predation due to an influx of moose in the early 1900's are all likely attributed to this decline. Currently, the northern mountain caribou population is provincially blue-listed (CDC 2013). During winter, caribou feed on terrestrial and arboreal lichens on either low elevation forest plateaus or high elevation alpine slopes (Seip 1996). Varied feeding patterns and winter habitat is a function of snow conditions and availability of terrestrial lichens (Johnson et al. 2004). Johnson et al. (2004) note caribou forage for terrestrial lichen in low elevation pine forests with lower snow depths and high lichen biomass; however, increases in snow depth and snow hardness limit cratering, thus driving caribou to alpine slopes to feed on arboreal lichens. Figure 39 illustrates valued caribou habitat within the Iskut-Stikine watershed.

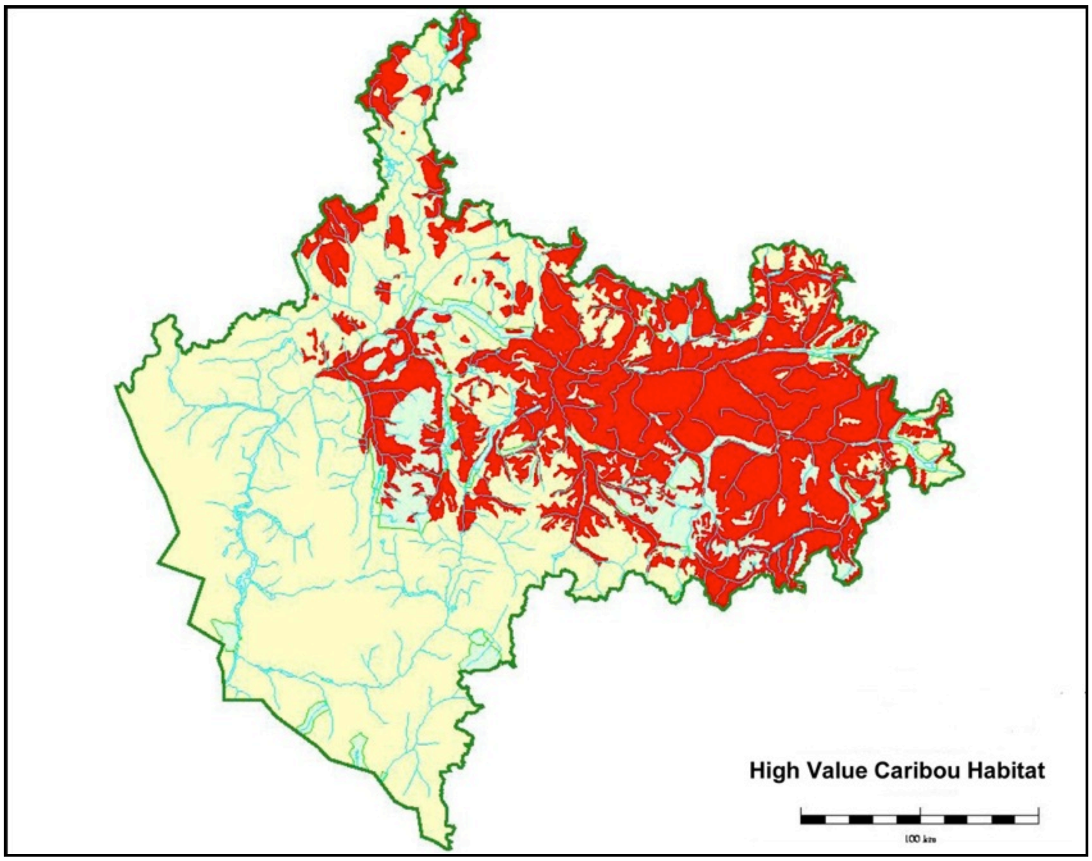


Figure 39. High value caribou habitat in the Stikine watershed (adapted from Anonymous 2000).

In spring, cows typically travel relatively great distances alone to reach calving grounds, one distinguishing feature of caribou from other large ungulates that travel in nursery groups (Ministry of Environment 2000). A wide variety of habitats are used for calving; however, cows will often forgo low elevation nutrient-rich sites for higher elevations and less optimal food sources as a predation avoidance strategy. Caribou cows will usually birth one calf in late May to early June. Throughout summer, caribou forage on emergent vegetation in a variety of habitats and typically in fall, cows, calves, and bulls migrate to sub-alpine and alpine rutting grounds. Main caribou predators are wolf, grizzly bear and wolverine (Ministry of Environment 2000, MacLean 2008).

According to Environment Canada (2012), the Spatsizi and Edziza populations are estimated at 3000 and 175 individuals respectively; population status and trends are unknown. Presently, the two herds are thought to have few major threats as there is limited access to them and their ranges are within protected areas. Minor threats and a chronic stressor are the high amounts of seasonal air traffic, particularly helicopters supporting mineral exploration. It is vitally imperative that caribou movement between seasonal ranges are not impeded by access. For example, the BC Rail Klappan road constructed, and then abandoned, severely impacted the southern Spatsizi herd, which to date has not recovered.

BC Ministry of Environment wildlife records indicate caribou surveys were conducted in 1985, 2006 and 2010. In 1985, 235 caribou were recorded at Caribou Mountain and 458 caribou were recorded at the Marion/Tomias. In 2006, 151 caribou were recorded at Mount Edziza while in 2010, 671 caribou were recorded in the Spatsizi area. A multi-year caribou and moose telemetry project was carried out from 1999 to 2001 to determine seasonal habitat use and movements, herd productivity and herd structure. Results from this project can be acquired from the Ministry of Environment, Skeena Region office in Smithers, BC.

Additional surveys results were retrieved from the Ministry of Environment's BC Species Inventory Web Explorer (http://a100.gov.bc.ca/pub/siwe/search_reset.do). The 1998/99 assessment at Level Mountain indicated a population estimate of 1538 caribou. The data indicates surveys were conducted in 2002/03 at Mount Edziza and Level Mountain; however, population estimates are not available.

2.4.2 Stone's Sheep

In BC, Stone's sheep (*Ovis dalli stonei*) are distributed down the interior side of the Coast Mountains from the Yukon border south to Mount Edziza and Spatsizi Plateau Parks, and eastward into the Cassiar, Omineca, Muskwa, and northern Rocky Mountains (Ministry of Environment 2000b). Stone's sheep are found on remote mountainous terrain and alpine meadows, using steep slopes and grass knolls with adjacent cliffs as escape terrain (MacLean 2008).

Distribution within the Stikine area includes Todagin Plateau and the Tsatia Mountains, which form Todagin Wildlife Management Area (WMA), the northern part of the Eaglenest Mountains, the Gladys Lake Ecological Reserve, and many locales on the Spatsizi Plateau such as along Marion Creek and the south facing slopes near Hyland Post (Ministry of Environment 2000). Smaller bands of sheep are scattered south of the Spatsizi River, east of Dawson River, around upper Duti River and in traces around Tatlatui Provincial Park (Ministry of Environment 2000). Figure 40 shows high value Stone's sheep habitat within the Stikine watershed as adapted from Anonymous (2000).

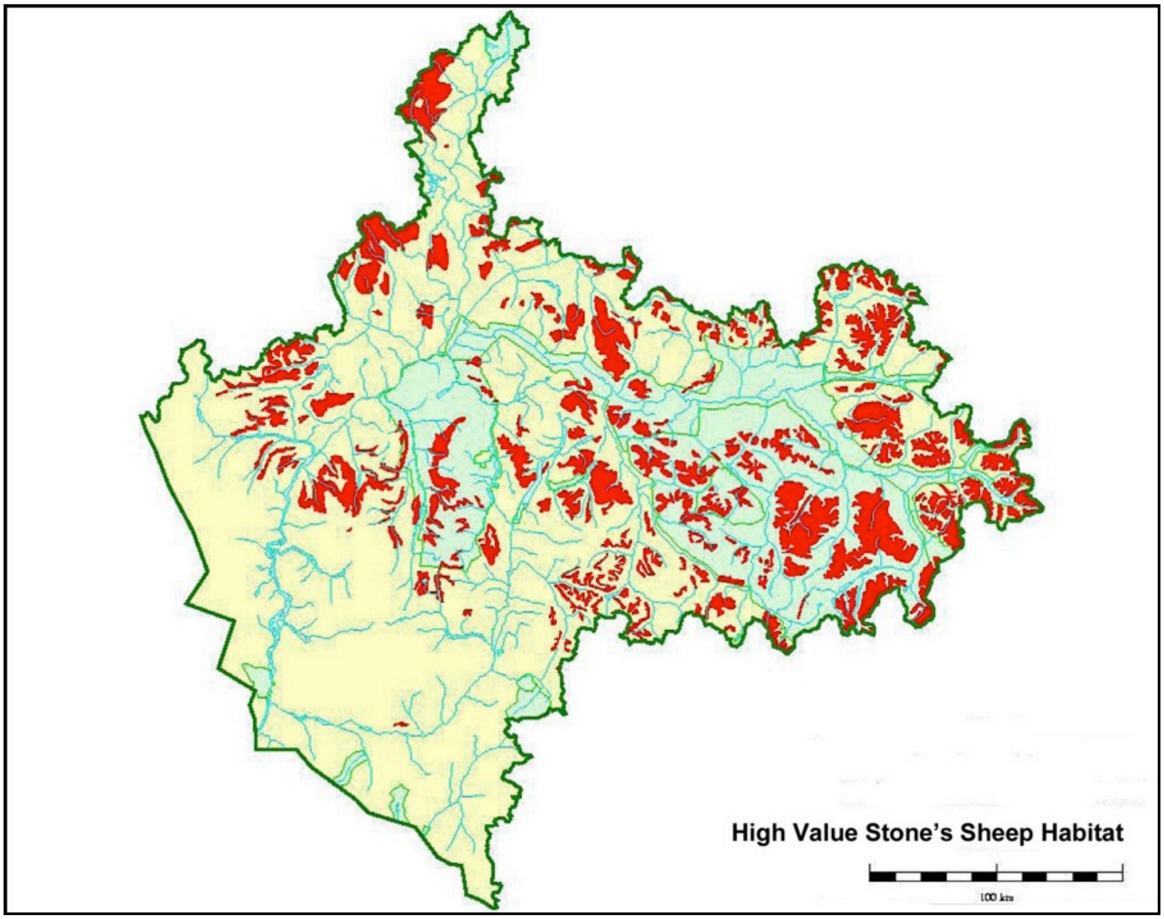


Figure 40. High value Stone's sheep habitat in the Stikine watershed (adapted from Anonymous 2000).

Ewes and rams live in separate social groups with the exception of late fall/early winter, when they gather for rutting period. Over winter, Stone's sheep typically inhabit windswept south or west facing slopes or ridges in alpine or sub-alpine areas 1500 m to 2200 m in elevation where they can graze on grasses, sedges, lichens and forbs (Ministry of Environment 2000b). Wind is a key component of winter sheep habitat as it moves snow from slopes exposing forage food. In spring, ewes leave yearlings and social groups to move onto rugged cliffs in preparation for birth; a ewe will typically produce one lamb (MacLean 2008).

Social groups will form again following lambing and move onto low elevation sites of 1200 m to 1500 m to feed on emergent forbs, willows and poplars. Gradually over summer, Stone's sheep drift up into higher alpine habitats areas and forage on sedges, forbs and willows. Wolves are the main predator of Stone's sheep; however, coyotes, wolverines, black bears and Golden Eagles will prey opportunistically on vulnerable adults or lambs (Ministry of Environment 2000b).

Figure 9. Stone's sheep on Todagin South Slope.

Todagin WMA supports a high-density population of Stone's sheep that appears to be at a stable population level since the 1980s, which is rare in British Columbia (MacLean 2008). Todagin sheep status is anticipated to diminish due to the Red Chris mining activity that is impeding their seasonal and dispersal movement eastward. Surveys conducted in Spatsizi Plateau Park in 1993 and 1994 indicated a relatively stable population; however, survey comparisons between 1988 and 1999 of the Marion Creek/Hyland Post population indicated a possible decline (Ministry of Environment 2000). Stone's sheep need baseline studies and annual monitoring in order to conserve this incredible resource.

BC Ministry of Environment wildlife records indicate Stone's sheep inventories were conducted from 1962 to 2002 in the Todagin area showing an overall stable population estimate confirming McLean's (2008) population trend. In 1988, 560 sheep were recorded in Spatsizi, and in 2002, 168 sheep were recorded in the Klastline area. The BC Species Inventory Web Explorer indicates surveys were conducted in 2006 around Schaft Creek, and 2007 in the Klastline area; however, inventory data and population estimates were not available for those surveys.

2.4.3 Mountain Goat

Approximately one half of the global mountain goat (*Oreamnos americanus*) population lives in BC, with nearly half in the Skeena Region (Mountain Goat Management Team {MGMT} 2010). In general, distribution of mountain goats has remained the same over the past 300 to 400 years. Mountain goats have always been important to First Nations in the Stikine area. The ability of mountain goats to subsist in areas of high precipitation and snowy alpine winters puts them as the only ungulates in many areas of the Stikine.

A wide variety of rugged mountainous terrain such as canyon walls, rocky cliffs and talus slopes host large populations of mountain goats. Generally mountain goats are found in snow covered sub-alpine and alpine areas for more than half the year (MGMT 2010). Though generally confined to prominent, steep mountainous areas, mountain goats are found in river canyons such as those found in the Stikine Grand Canyon and satellite rock outcrops. Mountain goats inhabit comparable terrain to Stone's sheep, though typically goats are often found on steeper, more precipitous sites for predator avoidance. On the Todagin South Slope, goats and sheep share the same terrain and frequently use the same mineral licks. Figure 42, adapted from Anonymous (2000) shows the high value habitat in the Stikine watershed.

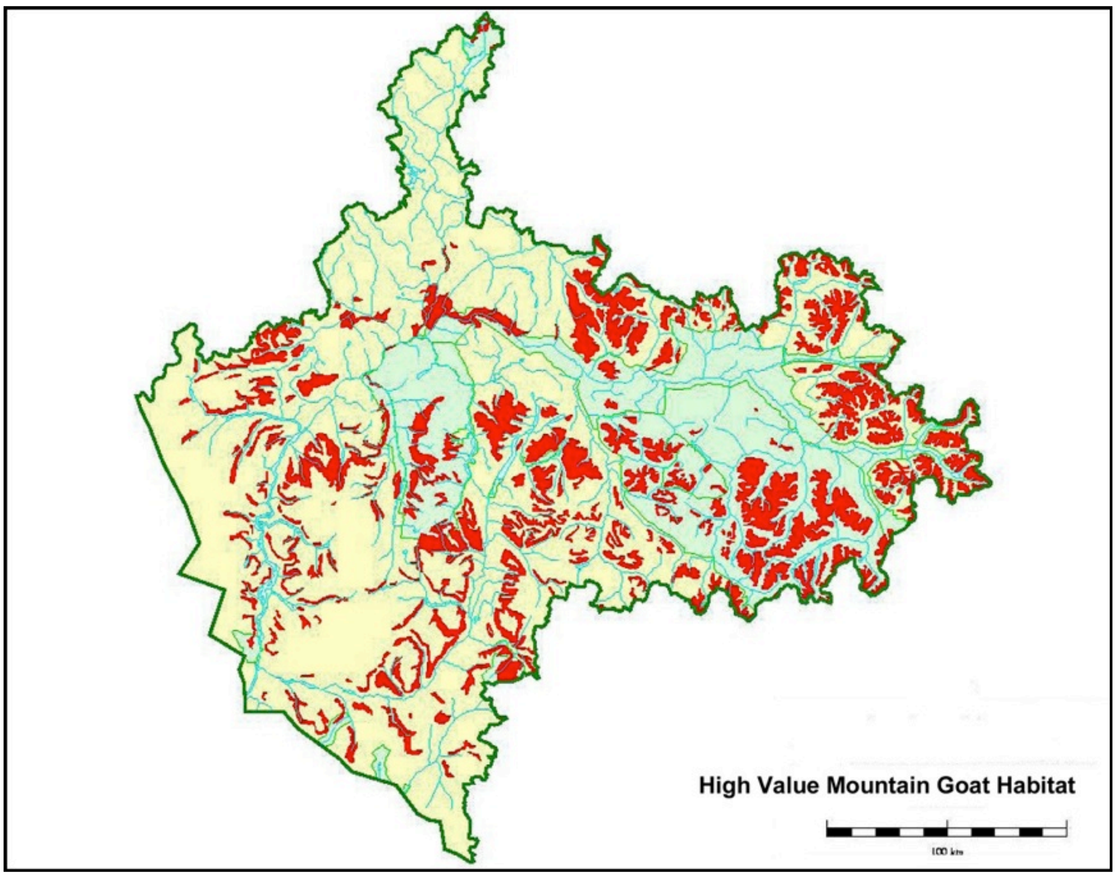


Figure 42. High value mountain goat habitat in the Stikine watershed.

Escape terrain and winter habitat are the most critical factors for mountain goats. Winter habitat is typically south or west facing, windswept slopes where forage food is exposed and escape terrain is adjacent. Escape terrain refers to cliffs and ledges that are almost inaccessible to predators. Mountain goats are typically apprehensive to travel more than 400 m to 500 m away from escape terrain, though often move into the forest in winter (MGMT 2010). Mountain goats are generalist herbivores that feed on grasses, forbs, shrubs, deciduous and coniferous trees.

Between mid-May and mid-June, female goats (nannies) travel to secluded cliffs or ledges to give birth, typically producing one kid (Ministry of Environment 2000c). In spring, goats use low elevation forage sites abundant with new spring vegetation growth and in summer will travel for several kilometers to locate salt licks, a supplement to mineral-poor alpine vegetation. Nannies and billies (male goats) live in close proximity, but in separate groups (billies are often solitary or in small groups) and although they are not a territorial species will defend a small personal space around them.

Rutting period for mountain goats occurs in late fall to early winter (Ministry of Environment 2000c, Mountain Goat Management Team 2010). Grizzly bears, wolves, wolverines, and black bears are the main predators of mountain goats, and Golden Eagles are a threat to kids. Avalanches carry relatively moderate amounts of goats with avalanche run out zones often the first spring feeding areas for grizzly bears.

A stable estimated population of 16,000 to 35,000 mountain goats are thought to occupy the Skeena Region (MGMT 2010). Between 1993 and 2003, mountain goat abundance in the Todagin WMA has diminished. MacLean (2008) attributed decreased abundance to past hunting pressures and current mineral exploration activity. The status of populations outside of the Todagin WMA in the Stikine and upper Nass area are unknown at this time (Ministry of Environment 2000).

In 1981, inventory surveys conducted by Ministry of Environment recorded 121 goats, 15 of which were kids on Klastline Plateau. In 1996, 62 goats – 42 of which were kids were recorded in the Stikine River Canyon. In 2004, inventories associated with Galore Creek recorded737 adult and 149 kid goats in the lower Stikine and lower Iskut. In spring 2006 goat survey, results indicated a 76:16 adult/kid ratio, while the summer survey recorded a 115:14 adult/kid ratio at Schaft and Mess creeks. Collingwood observed a range of 694-818 goats in 2007 in Spatsizi Park.

In addition to the aforementioned, BC Species Inventory Web Explorer indicates surveys were conducted from 1979 to 2002 in Todagin area, 2010 at Iskut and mid-Iskut by AltaGas, and in Todagin WMA for ongoing studies related to the proposed Red Chris mine. In 2011, the Galore Creek area and the Kinaskan Lake area in 2012 were surveyed; however, results were not available.

2.4.4 Moose

Moose (*Alces americanus*) have a seasonally widespread distribution across a large part of the Stikine area. Since the 1920's, distribution and abundance of moose greatly increased in northern BC. Seip and Cichowski (1994) hypothesize this increase in moose supported greater numbers of wolves, and potentially increasing predation, especially on caribou. Moose use a variety of habitats from valley bottoms to higher elevation mountainous terrain (Ministry of Environment 2000d).

Moose forage on early successional deciduous trees and shrubs while later successional forests provide security and thermal cover as well as access to forage during winter (Ministry of

Environment 2000d). Moose typically migrate between winter and summer ranges often travelling considerable distance; however, some remain in the same general valley area year round with movement limited to elevation. Moose are adapted with long legs to areas of deep snow but depth and density of snow most frequently determines seasonal movement and winter ranges.

Moose spring range is usually an extension of their winter range. In late winter, but occasionally early spring, cow moose will seek out a secluded calving area typically at low elevation close to water. Calving typically occurs between early May and early June and one cow typically produces one calf. During summer, moose occupy all habitat types including the alpine. Summer forage consists mainly of aquatic vegetation such as burweed, horsetail and submerged pondweed present in wetter habitats such as wetland complexes (Ministry of Environment 2000d). Moose are a semi-solitary species and will generally only form small groups during the September to November fall rutting season. However, young bulls often travel together and aggregates of moose are frequent, especially during the winter and likely due to food and predation factors. Autumn moose range consists of upland scrub and subalpine habitat. Figure 43 shows relatively large areas of high value habitat in the Stikine watershed; smaller areas of high value habitat, particularly winter range such as near the Bob Quinn–Ningunsaw and Todagin Plateau are not mapped.

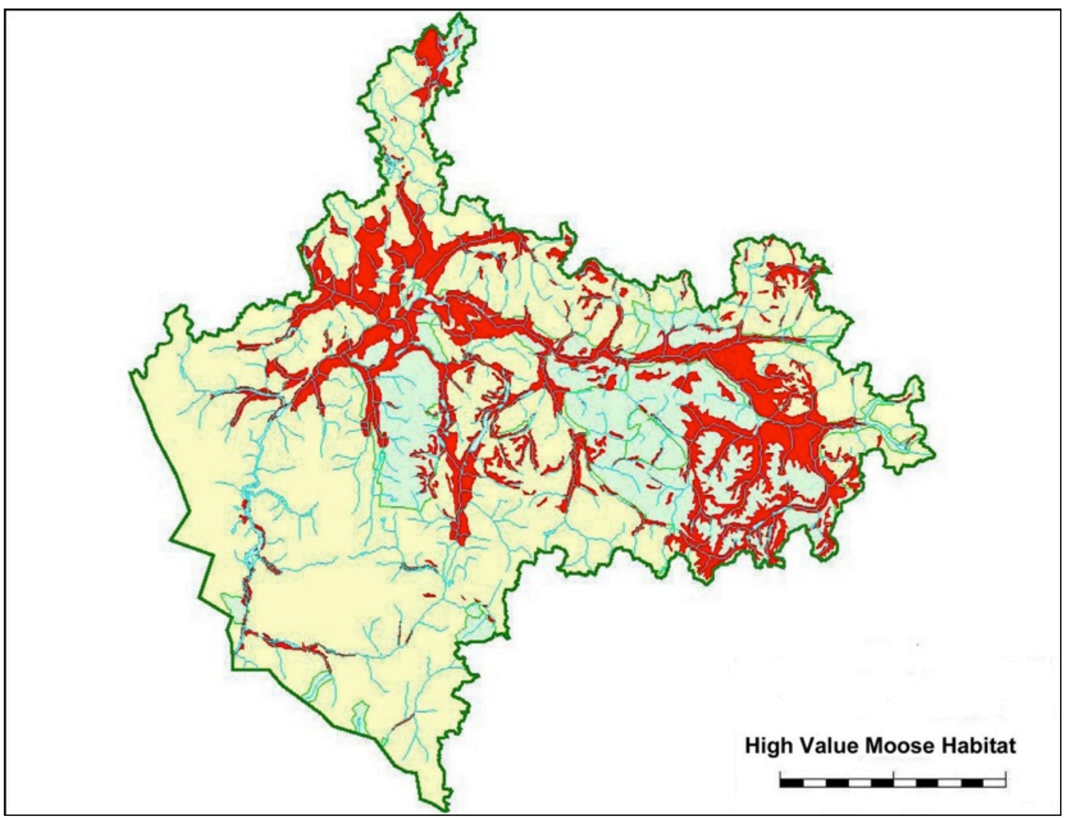


Figure 43. High value moose habitat in the Stikine watershed

Winter forage is essential and largely comprised of willow; red-osier dogwood, cottonwood, paper birch, aspen, falsebox and highbush cranberry are also common (Ministry of Environment 2000d). In addition to browsing on trees and shrubs, moose will strip bark from willows and poplars. The main predators of moose are grizzly bear and wolf. In the Stikine watershed, the current moose abundance trend are is thought to fluctuate around general stability.

Ministry of Environment survey records show for moose abundance were conducted in 1990 in lower Stikine - 29 moose observed and on Spatsizi Plateau the estimated moose population was 1912 with a 36 calves:100 cows ratio. In 2000/01, there were 154 moose recorded in the Klappan; in the Stikine-Morchua area– 122 moose were observed, while in 2006 in Schaft and Mess creeks, 314 moose were recorded. In 2010, 44 moose were recorded in the Klappan; 48 moose were recorded in the Morchua area; 98 moose were observed in Tuya-Level Mountain area. BC Species Inventory Web Explorer indicates surveys were conducted in 2010 throughout the Todagin WMA and in Schaft Creek and the Kinaskan Lake areas in 2012. More detailed results from these surveys can be acquired from the Ministry of Environment Skeena Region office in Smithers, BC.

In late September 2009, Tahltans established blockades directed towards BC resident hunters due to the high numbers of moose harvested. This resulted in BC Ministry of Environment and Tahltan Wildlife shortening the hunting season and conducting hunter harvest monitoring at Game Check stations located at the Highway 37 and Ealue Lake road junction and at the Stikine River boat launch. Comparatively smaller numbers of hunters were evident than in the preceding five years. Numbers of bull moose harvested in the upper Stikine totalled 38 with most of these from the Pitman area. Numbers harvested in the Klappan totalled 23 bull moose. The vast majority of these moose had all edible parts retrieved.

2.4.5 Grizzly Bear

Grizzly bear (*Ursus arctos)* were once one of the most widely distributed mammals on the planet and in North America they were found from the west coast as far south as northern Mexico and as far east as the Great Plains and Hudson Bay. Presently, they occupy approximately only half this historic range and in BC, grizzly bear inhabit over four fifths of the province (Ministry of Environment 2002). Grizzly bear play an important ecological role in their environment through seed dispersal, nitrogen cycling by digging for roots and bulbs, as well as distributing salmon carcasses in riparian areas and forests, and regulating prey populations as part of intact predator-prey systems.

Grizzly bears are currently provincially blue-listed and ranked by COSEWIC as a species of Special Concern (CDC 2013). Habitat use and range is generally based on age, sex, and population levels of grizzly bears over the landscape (Maclean 2008). Grizzly use a variety of habitats including but not limited to estuaries, valley bottoms, deciduous and coniferous forests, and alpine areas. Figure 44 shows high value grizzly bear habitat within its boundaries adapted from Anonymous (2000). Smaller areas of high value habitat are not shown on the map, nor are moderate value habitats that support suitable numbers of bears.

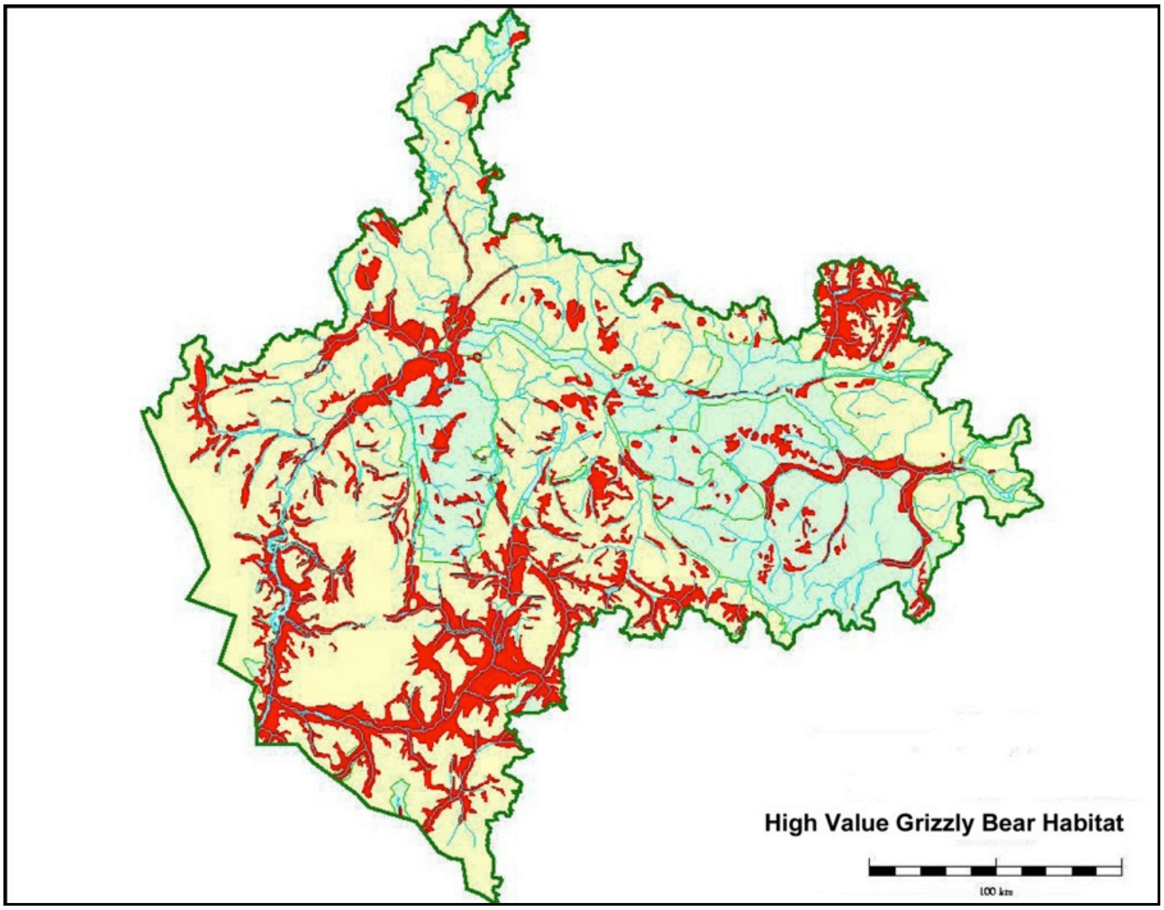


Figure 44. High value grizzly bear habitat in Stikine watershed.

Grizzly bear distribution within the Stikine watershed is broken out into coastal and interior populations with seasonal habitat type and forage behaviour differences. There are remarkable populations in the coastal areas including the lower Iskut, lower Stikine, Unuk, and Chutine. See Anonymous (2000) for area specific management directions and research priorities. In interior boreal areas, the Spatsizi, Klappan, Pitman, upper Stikine, and Tsatia support significant grizzly bear populations and high value predator-prey relationships, though not all of these areas have specific management directions nor research priorities.

In spring and early summer, both coastal and interior bears feed on emergent vegetation in estuaries (coastal), valley bottoms, scavenging on carrion in avalanche chutes, and habitats supporting grasses, rushes, sedges, and horsetails.

In late summer and fall, grizzly bears inhabiting salmon ecosystems will feed on salmon carcasses as well as green vegetation and berries. Interior bears without access to salmon streams will prey and scavenge on alpine rodents, moose, caribou and mountain ungulates (MacLean 2008). Coastal grizzly bears go into hibernation from early November to mid-April; interior bears from mid-November to late-April (Ministry of Environment 2002).

Figure 45. Sow and three yearling cubs at Kinaskan Lake.

Grizzly bears breed from May to early June, with implantation of the embryo occuring only after females (sows) enter hibernation. Sow grizzly bears have low reproductive rates as they do not sexually mature until at least five or six years of age, and only produce a litter every three years on average (Ministry of Environment 2002). A litter typically consists of one to three cubs, usually born between January and February. The mother will nurse her cubs until they all emerge from the den in late May. Cubs remain with their mother for approximately two years though this can range upwards to five years (Ministry of Environment 2002).

The 2012 population estimate for grizzly bears in BC is 15,000, with the Stikine area having some of the highest densities province-wide (Ministry of Forests, Lands and Natural Resources Operations 2012b). Major threats to grizzly bear populations are land and resource use and development.

2.4.6 Grey Wolf

Grey wolves (*Canis lupus*), hereafter called wolves are highly adaptable generalists who can occupy any habitat that supports viable prey populations (Ministry of Forests, Lands and Natural Resource Operations 2012c). Wolves were distributed globally, although have now been extirpated from most of the US, Mexico and western Europe. In Canada, wolves still occupy historic ranges with the exception of Newfoundland, where they were extirpated by 1911. Although wolves were extirpated from the Kootenay and Thompson areas in the 1970's, they have since re-colonized and are widespread across BC. As top predators, wolves play an important role in structuring predator-prey systems.

Wolves also present a controversial and polarized debate between those who see them as a symbol of BC's wilderness heritage and those who see them as threats to game species, agriculture and livestock interests, and human safety (Ministry of Forests, Lands and Natural

Resource Operations 2012c). In Northern BC, wolf distribution is strongly associated with the distribution of moose, caribou, and salmon.

Wolves are opportunistic predators that inhabit any area abundant with prey and will adjust their diet according to local conditions. Wolf populations are naturally regulated by prey abundance and social behaviour such as packs and territories (Ministry of Environment 2000). Main food sources consist of adult and juvenile ungulates, smaller prey,and salmon in season. In the Stikine area, wolves prey on caribou, moose, Stone's sheep, mountain goats, deer and other smaller mammals (Ministry of Environment 2000).

Wolves live in packs consisting of a breeding pair and one to two year old offspring. Pack size appears to be related to primary prey; packs in Northern BC that feed on moose are larger than those in other parts of the province that feed on deer. When subadults leave their natal pack they may become solitary, this often occurring during breeding season. Breeding occurs in late-winter and litters of four to seven pups are born in April or May; it is usually only the alpha female that breeds within each pack. Most yearling pups disperse from the pack following winter Ministry of Forests, Lands and Natural Resource Operations 2012c).

Estimated population densities determined for Northern BC have ranged from 10 to 44 wolves per 1000 km2. Wolf population estimates in the Skeena region based on density and prey mass are 2300 to 4600, and 1550 to 2100 individuals respectively Ministry of Forests, Lands and Natural Resource Operations 2012c). Threats to wolf populations include hunting pressure (on wolves as well as prey species), habitat degradation and destruction as a result of human development.

2.4.7 Other Wildlife

Recorded inventory of wildlife in the Stikine area other than those aforementioned are limited and/or incomplete. The Stikine Country protected areas fall within the boundaries of the Stikine area, thus relevant information on expected and observed species is shown in Table 5 below and more detailed information is available in the Stikine Country Protected Areas Background Report (Ministry of Environment 2000).

Table 5. Summary of other wildlife species in Stikine Country protected areas.

Species Occurrence	Mount Edziza Park and Zone	Stikine River Park	Spatsizi Park and Gladys Ecological Reserve
Mule deer	+	+	+
Black bear		+	+
Wolverine	+	+	+
Coyote		+	+
Lynx	+	+	
Red fox	+	+	+
Fisher		+	
River otter		+	
Mink		+	

Species Occurrence	Mount Edziza Park and Zone	Stikine River Park	Spatsizi Park and Gladys Ecological Reserve
Marten		+	
Short-tailed weasel		+	
Least weasel		+	
Snowshoe hare	+	+	+
Porcupine		+	+
Beaver	+	+	+
Hoary marmot	+		+
Arctic ground squirrel	+		+
Muskrat	+	+	+
Bushy-tailed wood rat			+
Red squirrel	+	+	+
Least chipmunk	+	+	+
Meadow vole	+	+	+
Long-tailed vole			+
Mountain heather-vole			+
Boreal red-backed vole			+
Tundra red-backed vole	+	+	+
Siberian lemming			+
Northern bog-lemming			+
Western jumping mouse			+
Deer mouse	+	+	+
Navigator shrew			+
Cinereus shrew			+
Wandering shrew			+
Little brown bat			+
Western spotted frog			S
Northwestern toad			+
Northern wood frog			+
Long-toed salamander			S

+ = recorded occurrence, S = suspected occurrence.

Mule deer

Mule deer are at the northern boundary of their range in the Stikine area and are limited by climatic factors, primarily snow depth. Most deer occurrences are in rain shadow areas, typically on moderately steep, south facing, low elevation slopes that readily shed snow but also commonly flat ground. and/or coniferous forests where the canopy intercepts snow and reduces snow cover (Hatler 1987). Small herds of mule deer have been observed along Klastline River, Spatsizi River near Hyland Post, south-facing slopes along Stikine River mainly west of Highway 37, Bob Quinn, and the lower Klappan River (Ministry of Environment 2000, Henderson 2006).

Birds

There is very limited information on bird species in the Stikine and upper Nass area. Ministry of Environment (2000) notes there are 170 confirmed species occurring in the Stikine Country protected areas[6]. It is important that more extensive and detailed bird inventory surveys be conducted in the Stikine and Upper Nass areas as a baseline for future changes in the environment.

2.4.8 Rare and At Risk Species

According to the most recent records from BC Conservation Data Centre (CDC 2013) for the Skeena-Stikine (Bulkley and Cassiar) Forest Districts, there are seven fishes, two amphibians, 19 birds, five large mammals, four small mammals and 19 invertebrates provincially blue or red listed. Refer to Appendix IV for a summary of all provincially listed species within the Stikine area.

[6] Refer to the Ministry of Environment (2000) Background Report for a full listing of species known to occur in the Stikine Country Protected areas.

3.0 Upper Nass Area

3.1 Environmental Setting

3.1.1 Geography

The upper Nass area is comprised of the northwest Skeena Mountains, Nass Basin, and the southern edge of the Boundary Ranges. Each of these physiographic areas is unique in landscape structure, climate, soils, and hydrology. The upper Nass area is the upper portion of the Nass watershed, but excludes the Cranberry and adjacent small drainages as depicted in Map 3.

The northwest Skeena Mountains are distinctive and largely formed by complex folded and faulted sedimentary rocks with reclining outlines. As such, they lie entirely within the sedimentary Bowser Basin. Northwest Skeena Mountains are subdivided by major drainage systems into semi-discrete mountain ranges that include Klappan range, Groundhog Range, Slamgeesh Range, Oweegee Range, and the Strata Range. Figure 46 shows the view downstream on upper Bell Irving River through the Rochester Fire to the Oweegee Range.

Figure 46. View downstream on upper Bell Irving across the Rochester Fire to Oweegee Range.

Glaciation was heavy, with ice originating here, then flowing northward or southward to coalesce with other moving ice. Many small pocket alpine glaciers persist, especially in the northwest portion between the upper Bell Irving and upper Nass mainstem. The peaks and ridges present a serrate and jagged profile that has developed under intense glaciation. The highlands are characterized by high rugged mountains and a moist, coast/interior transition climate. Typically the valley bottoms are characterized by drift cut through by the stream network.

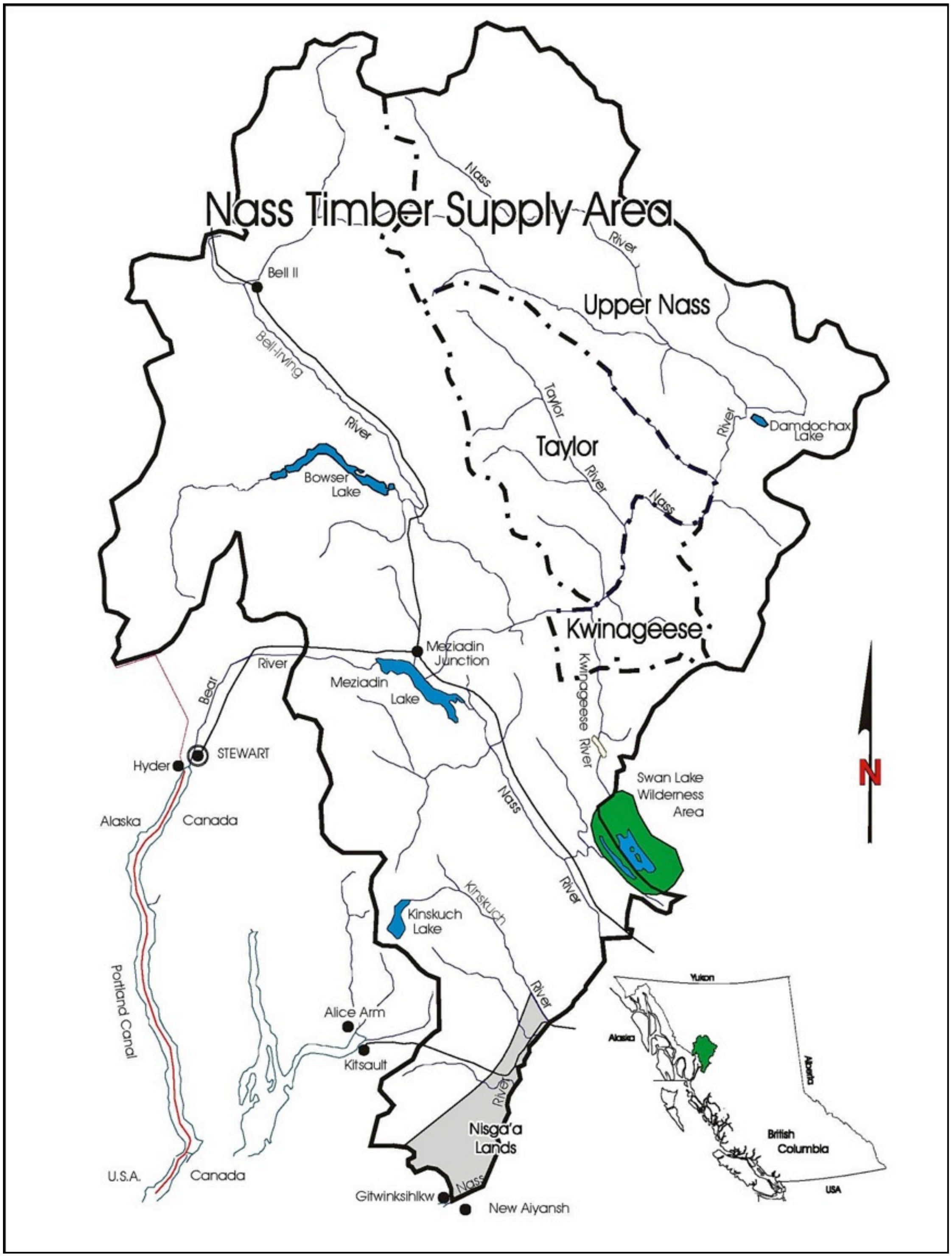
The Boundary Ranges form the western extent of the upper Nass watershed and drain into the Bell Irving River and the Nass River downstream of Meziadin. The Longview Range, Snowslide Range, Meziadin Mountains, and the Cambria Range are separated from the northwest Skeena Mountains by the Bell Irving and Nass valleys as shown in Figure 47. The Boundary Ranges are characterized by steep and rugged topography, and great range of relief. The outstanding mountain feature is the massive amount of glaciers and glacial erosion.

Figure 47. View across the relatively wide Bell Irving River valley to the Snowslide Range.

The irregularly shaped Nass Basin occupies the landscape below 760 m elevation, and is mostly rolling valley floor terrain with the adjacent Skeena Mountains and Boundary Range mountains rising abruptly out of it. Ice flowed down the Nass Basin repeatedly, smoothing the relief, and draining at various times through the Kispiox, Cranberry–Kitwanga, and Nass valleys.

During the Pleistocene, ice completely covered this landscape, causing erosion and a residual layer of drift over the majority of the basin. Nass Basin fingers into the surrounding mountains: from Cranberry River downstream on the Nass, up the Bell Irving to Bell 2, and up the Nass including the Kwinageese country and lower Taylor River. Meandering streams, wetlands, and hundreds of small lakes occupy the valley floor with many of them supporting anadromous fish. Figure 37 shows the view north across Brown Bear Lake and the rolling valley floor.

Figure 48. View north across Brown Bear Lake.



Map 3. Upper Nass watershed (within Nass TSA).

3.1.2 Climate

The upper Nass watershed climate varies considerably and is presented here in a general manner due to the lack of recording weather stations that could potentially characterize the varying climate regimes. Long-term data is available for Stewart (7.3 m asl) and Nass Camp (290 m asl), and short-term data is available for Cranberry (500 m asl), Van Dyke (296 m asl), and Bell Irving (398 m asl).

Stewart records an annual average of 1,842 mm of precipitation per year with 571 cm falling as snow. Average summer temperatures are 15 °C with average winter temperatures of -3.7 °C. Nass Camp receives total annual precipitation of 1,067 mm, of which 300 cm falls as snow. Average summer temperatures are 16 °C with average winter temperatures of -5.5 °C.

The climate at a broad level is broken out into coastal maritime in the Stewart area to the continental transitional zone at Damdochax Lake. As well, climatic longitudinal and elevation gradients are located throughout the watershed due to influences such as mountain ranges, valley confluences, rain shadows, and wind conditions that result in varying climates and micro-climates.

The dominant feature of the coastal climate is frequent Pacific frontal systems combined with orographic lifting, resulting in increasing annual precipitation at higher elevations. The maritime climate results in cool summers with moderate rainfall, and mild winters with annual mean temperatures near -3.7 °C. Winter snowpacks average 3 to 4 m in depth at Bell 2 crossing and 2.5 to 3 m depths at Nass Lake in the headwaters. Warm, moist Pacific air pushes up the Nass and Bear rivers moderating the climate and passing by transition into continental air. The degree and extent of the moderating coastal influence diminishes quickly in an easterly direction and with elevation. The northwest Skeena Mountains and the Boundary Ranges trap cold Arctic air that also rushes down the valleys leading to the coast.

Precipitation reaches a maximum in the fall and early winter, generally in October and November with intense cyclonic storms from the Northeast Pacific moving across the coast (Environment Canada 1993). These storms, particularly if warm rain-on-snow events, can cause severe and sudden flooding. Inflow and outflow winds can be concentrated and funnelled in the lower valley bottoms, especially in the Bell Irving and Nass rivers valleys. Arctic air frequently surges down main valleys bringing bitter winter temperatures and also a see-saw barometric pressure battle with coastal air that brings snow. In the Boundary Ranges and Skeena Mountains snow may start accumulating in September and persist until June, with subsequent, deep snowpacks.

3.1.3 Hydrology

Surface water hydrologic regimes in the upper Nass basin reflect physiography, climate, geology, and vegetation processes in complex interactions involving the atmosphere, inflow, storage on land, and outflow to the ocean. The two hydrologic regimes that predominate in upper Nass basin are:

- major runoff floods generated by spring snowmelt of the accumulated snowpack;
- major peak runoff resulting from rainfall and rain-on-snow events in the fall.

Upper Nass area drains an area of 16,000 km^2 with the Nass River flowing southward from its headwaters in the northwest Skeena Mountains to the ocean at Portland Canal. The 16,000 km^2 includes all basin drainage downstream to Gitlakdamix except for the 786 km^2 Cranberry subbasin. Bell Irving River, draining 5,655 km^2, is the largest tributary to Nass River joining 176 km upstream from the ocean. The few large lakes include Bowser and Meziadin; relatively small lakes include Nass, Damdochax, and the many small lakes south of Meziadin lying east and west of Nass River.

The Nass River flows 394 km from Nass Lake in an irregularly meandering single channel form that is slight to moderately entrenched for the vast majority of its course to New Aiyansh. Other than at or downstream of tributary confluences, floodplains are infrequent. Lipsconesit Canyon, located downstream of Vile Creek, is 1.75 km in length and frequently captures and stores massive amounts of trees, plugging the canyon until a high water event or fire cleans them out. Bell Irving River flows from its source in the Klappan Range just south of Tumeka Lake in a single thread channel to the Nass, except for the 12 km reach near Bell 2, where it forms a gravel bed multi-thread section of islands, side channels, and back channels.

Water Survey of Canada operates one real time hydrometric station in the upper Nass drainage – Station 08DB001, Nass River at Shumal Creek. Surprise Creek at Meziadin Lake station is still active; the other six hydrometric stations were discontinued in the mid-1990s. Discharge for Nass River at Shumal Creek hydrometric station from a 77 year record is shown in Figure 49. Note the peak flows during October from heavy precipitation or rain-on-snow events.

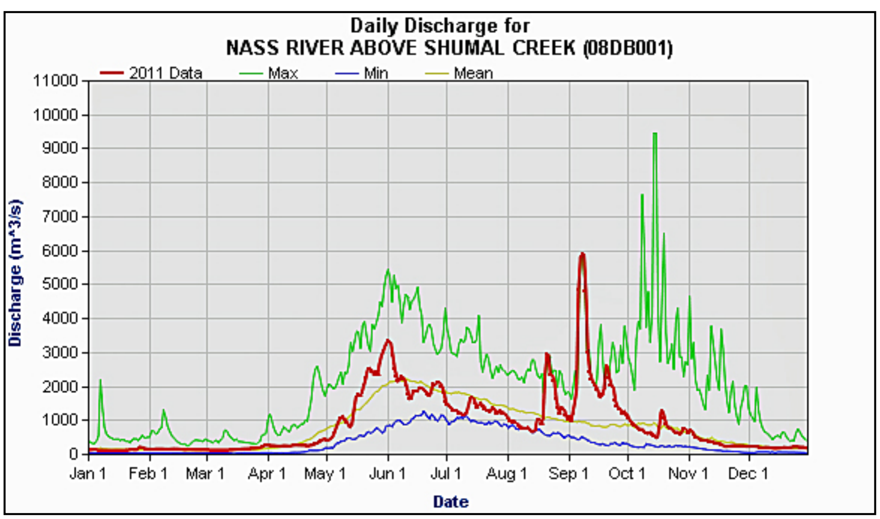


Figure 49. Daily discharge for Nass River at Shumal Creek.

Major tributaries draining the Boundary Ranges include: Bell Irving River, Bowser River, Meziadin River, White River, Kinskuch River, and Kwinatahl River. The Boundary Ranges have many icefields, glaciers, and high snowpacks, which have an impact on spring freshets. In the Boundary Ranges the typical hydrological regime is divided into four main flow periods: spring freshet, summer, fall, and winter. The heavy precipitation and cold temperatures lead to annual snowfalls that often exceed annual snowmelt rate. Permanent ice fields result with generation of glaciers that flow down adjacent valleys. Spring freshet flow rates are closely linked to elevation gradients and the timing of warm air temperature and may be the annual peak flows.

Nass River bisects the Skeena Mountains and separates the southern Boundary Ranges from the Kitimat and Nass ranges. Major tributaries draining the Skeena Mountains into the Nass include: Taylor River, Kotsinta Creek, Muskaboo Creek, and Konigus Creek; these streams all flow southeastward.

Summer flows vary with weather-related events causing sudden flow fluctuations. Fall flows are typically low to moderate, especially if freezing levels are low; these are frequently the clearest flows due to limited high elevation melt water and sediment transport. However, the fall period often generates peak flows due to intense low pressure warm rain events. Winter freezing conditions yield low flows generated mostly from areas of wetland and groundwater. Most streams located in the Boundary Ranges are under ice from November to April, though times may vary with climactic conditions.

Figure 50. View across Meziadin Lake (Nass Basin) to Boundary Ranges mountains.

A rain shadow effect caused by the Boundary Ranges limits the amount of moisture carried from the coast by prevailing winds. The Skeena Mountains and Nass Basin portions of the upper Nass have a similar but moderated hydrologic regime with a substantial spring freshet; the fall peak is the flood event of the year.

Large sediment loads mostly from glacial, landslide, and avalanche activities result in a split or braided river morphology with unstable island and bar deposits in multiple channels. These conditions occur in Snowbank Creek downstream of Teigen Creek, Bell Irving River downstream of Rochester Creek, on lower Muskaboo River, upper Bowser River, Lower Treaty Creek, and lower Shumal Creek. The multi-channelled section of upper Bowser River is shown in Figures 51.

Figure 51. View downstream on upper Bowser River and Bowser Lake.

3.2 Upper Nass Fish and Habitats[7]

The Nass is the fourth largest watershed in BC. Most of the streams draining the Boundary Ranges and the northwest Skeena Mountains are glacial and turbid, with sections of steep channels. Stream systems draining the Nass Basin mostly flow clear water. Upper Nass watershed supports five salmon species: sockeye, pink, chum, chinook, coho and steelhead, as well as the anadromous lamprey and cutthroat trout.

Freshwater fish residents include, kokanee, rainbow trout, Dolly Varden, bull trout char, mountain whitefish, burbot, lake chub, peamouth chub (*Mylocheilus caurinus*), pikeminnow (*Ptychocheilus* sp.), redside shiner (*Richardsonius balteatus*), three-spine stickleback, largescale sucker (*Catostomus macrocheilus*), longnose sucker, prickly sculpin, and coastrange sculpin. It is unknown whether white and green sturgeon (*Acipenser medirostris*) are present in the watershed. Interestingly, lake trout and lake whitefish are present in the Skeena system but unknown in the Nass.

3.2.1 Upper Nass Salmon Populations & Habitats

All five species of Pacific salmon spawn in the upper Nass system. Chinook and coho are the most widely dispersed and present into the lower headwater streams. Sockeye are by far the most abundant salmon and relatively widely dispersed. Chum presence and distribution is very limited in the upper Nass system. Pink salmon migrate through the lower section of the drainage and historically have been recorded in Brown Bear Creek with occasional presence in Meziadin River. Steelhead distribution is throughout and into the lower headwater tributaries.

Salmon abundance and diversity have been driven down by Canadian and Alaskan coastal commercial mixed-stock net, fish traps, and troll fisheries. The commercial salmon industry developed around Nass estuary beginning in 1881, with the abundant sockeye salmon runs supporting six canneries by 1918; salmon canning operations continued until 1945 (Todd and Dickson 1970, Ginetz 1976). Incidental catch of pink, chum, chinook, and coho was canned and some chinook are reported to have been mildly cured and dry salted.

The fishing boundary was located at Greenville but was moved downstream 10 km in 1929, and a further 10 km downstream in 1936. By the mid-1940s, gillnetters from the Fraser and Skeena were fishing the approaches to Nass River. Since then, there has been a massive increase in the ability to catch salmon due to technology – boats, power drums and blocks, improved net fibers, and electronic gear.

In 1955, Northwest Power proposed a hydroelectric scheme on the Nass system, with the main dam and powerhouse located 18 km upstream of Gitlakdamix and a storage dam on Bell Irving River downstream of the Bowser, and another storage dam on the Nass downstream of Meziadin confluence (Withler 1956). This proposal stimulated the Department of Fisheries and

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[7] Refer to Appendix III for a tabulated summary of aquatic species of conservation concern within the study area.

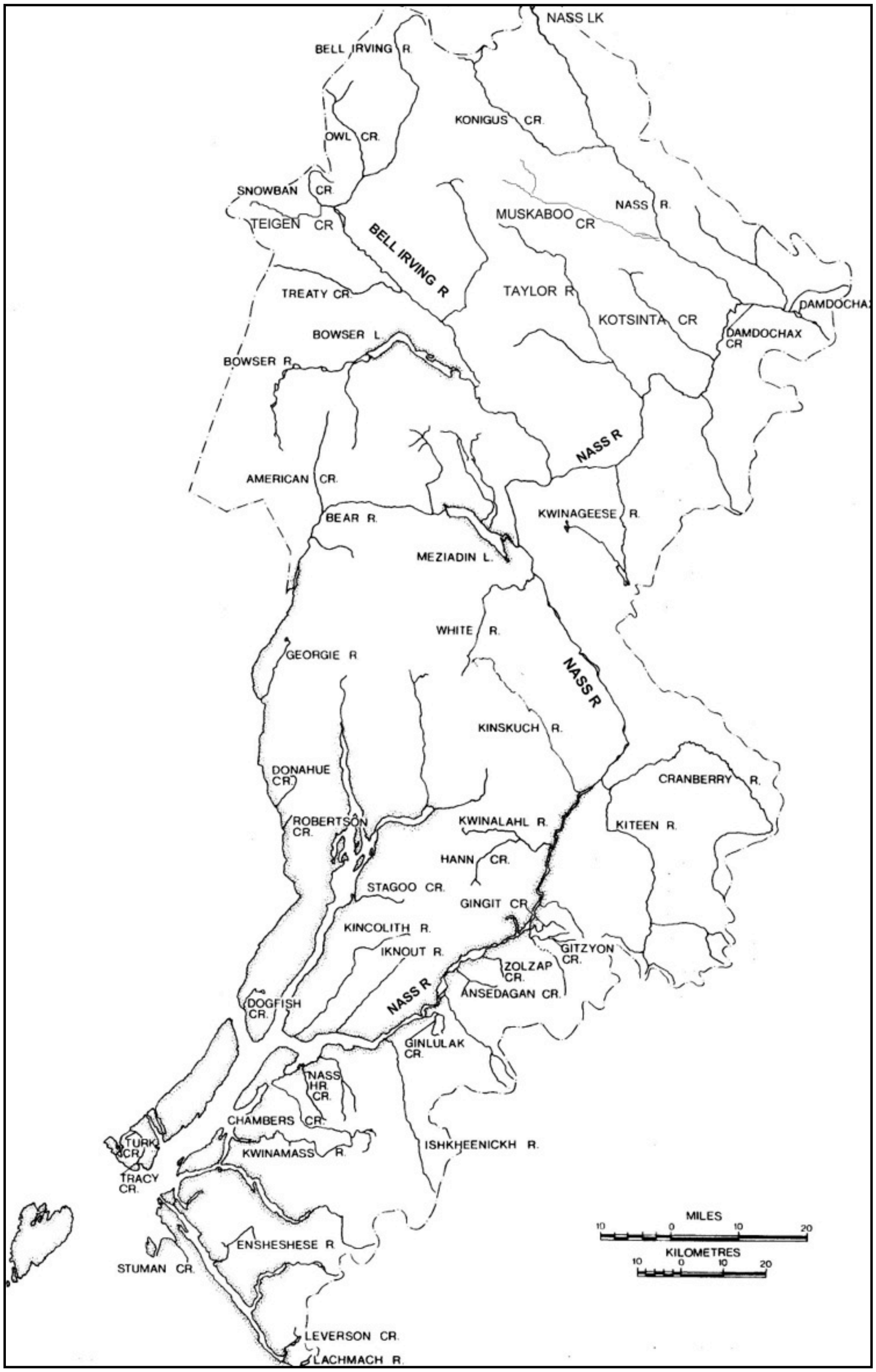
Oceans to conduct extensive surveys in the upper Nass system during 1956 and 1957 focusing on salmon timing, magnitude, distribution, and the commercial fishery (DFO 1958).

These surveys, supported by foot, boat, vehicle, and air, determined the basic outline of upper Nass salmon distribution. Two fishwheels were operated near Gitlakdamix for tagging purposes, with spawning ground surveys were conducted at Meziadin, Kwinageese, and Damdochax lakes. These surveys constituted the first solid escapement counts other than the Meziadin fishway enumerations. Since then, various other major salmon surveys have filled in information gaps, but ongoing escapement monitoring programs mostly touch on the high points, and the abundance and health of stocks of conservation concern are essentially unknown.

Figure 52. Chinook holding at Damdochax Lake outlet.

Most salmon species and stocks are depressed relative to the historic pre-commercial fishery abundance. Up to the mid-1950s, the freshwater environment was protected by inaccessibility and the absence of industrial development. Since then, road construction and maintenance, logging activities, tourism, sport fishing, and general human influx have created adverse impacts to the integrity of salmon habitats.

Management of all Nass basin salmon stocks is developed between Nisga'a Fisheries and Fisheries and Oceans Canada, and seasonally with Alaskan agencies, particularly regarding commercial fishery timing and salmon escapement goals. The Nisga'a has Nass sockeye allocations established by the Nisga'a Final Agreement and by a 25 year renewable harvest agreement. Salmon management and enhancement plans are available from Fisheries and Oceans Canada: http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.htm. Stock assessment updates for the period 2007 to the present are available from: ftp://ftp.lgl.com/Nass%20Stock%20Assessment%20Updates/.


NASS LK
BELL IRVING R.
KONIGUS CR.
OWL CR.
SNOWBAN CR
TEIGEN CR
BELL IRVING R
MUSKABOO CR
NASS R.
TREATY CR
TAYLOR R
KOTSINTA CR
DAMDOCHAX CR
BOWSER L.
BOWSER R.
NASS R
AMERICAN CR.
KWINAGEESE R.
BEAR R.
MEZIADIN L.
WHITE R.
GEORGIE R
NASS R
KINSKUCH R.
DONAHUE CR
CRANBERRY R.
ROBERTSON CR.
KWINALAHL R.
KITEEN R.
HANN CR.
STAGOO CR.
GINGIT CR
KINCOLITH R.
IKNOUT R.
GITZYON CR.
ZOLZAP CR.
NASS R
ANSEDAGAN CR.
DOGFISH CR.
GINLULAK CR.
NASS HR CR.
CHAMBERS CR.
TURK CR.
KWINAMASS R.
ISHKHEENICKH R.
TRACY CR.
MILES
10 0 10 20
KILOMETRES
10 0 10 20
ENSHESHESE R
STUMAN CR.
LEVERSON CR.
LACHMACH R.

Map 4. Nass watershed streams.

3.2.1.1 Chinook

Upper Nass basin supports significant chinook stocks and is a large north coast producer. Nass chinook are the largest salmon species and have the most complex and diverse life histories. Most chinook spawning occurs in August and September in larger tributaries, on tributary alluvial fans in the mainstem, or downstream of large lake outlets. Chinook are commonly characterized by their stream or ocean life history variations. Stream-type chinook typically spend the first one or two years in fresh water before migrating to sea, while ocean-type chinook juveniles emerge from the gravel and typically have a limited freshwater phase of 60 to 150 days, before migrating out to sea.

By the early 1960s, there were serious concerns regarding chinook abundance. Nass River chinook abundance recovered from the depressed abundance levels during the 1950s to 1970s period, due to conservation measures established with the PST in 1985. Prior to that time, chinook were poorly known and biological characteristics data was insufficient to support commercial fisheries. Escapement was essentially unknown and relative abundance was only known from catch. Winther (2009) shows Nass chinook escapement and terminal run from 1977 to 2009 as shown in Figure 53.

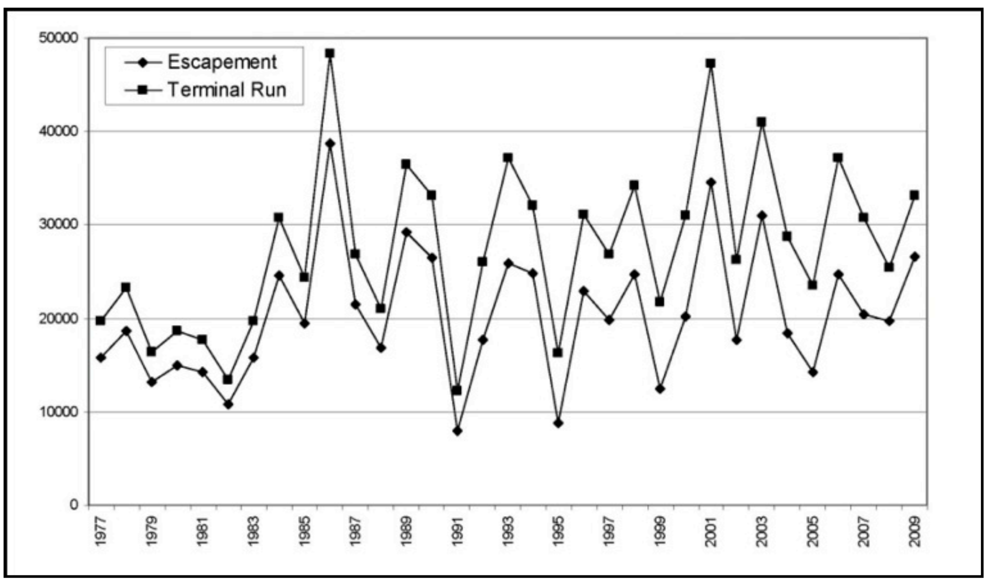


Figure 53. Nass chinook escapement and terminal run 1977 to 2009.

Upper Nass chinook abundance is determined from the long-term Meziadin fishway count, up to six fishwheels and tagging stations located on the lower Nass, foot and aerial count surveys, and the fish weir located on the upper Kwinageese River shown in Figure 55.

Figure 54. Nisga'a fishwheel in lower Nass.

Figure 55. Upper Kwinageese R counting weir.

Chinook distribution extends from the estuary to the headwaters of Teigen Creek in the Bell Irving system; to the headwaters of Damdochax Creek; and to unknown upstream locations on Muskaboo Creek. Koski *et al.* (1996) reported on an extensive radio-tagging and escapement survey describing chinook populations and distribution.There are 16 known tributaries with chinook presence; the major chinook producers are Cranberry River (not included in this study area), Kwinageese River, Meziadin River, Bell Irving system, Teigen Creek, and Damdochax Creek, which is shown in Figure 56.

Figure 56. View downstream on Damdochax to Nass confluence.

The upper Nass chinook aggregate stock is typically composed of almost 50% age five fish. On average, the aggregate consists of 3% three year olds, 30% four year olds, 19% age six; and less than 1% age seven chinook as shown in Figure 57 (Winther 2009).

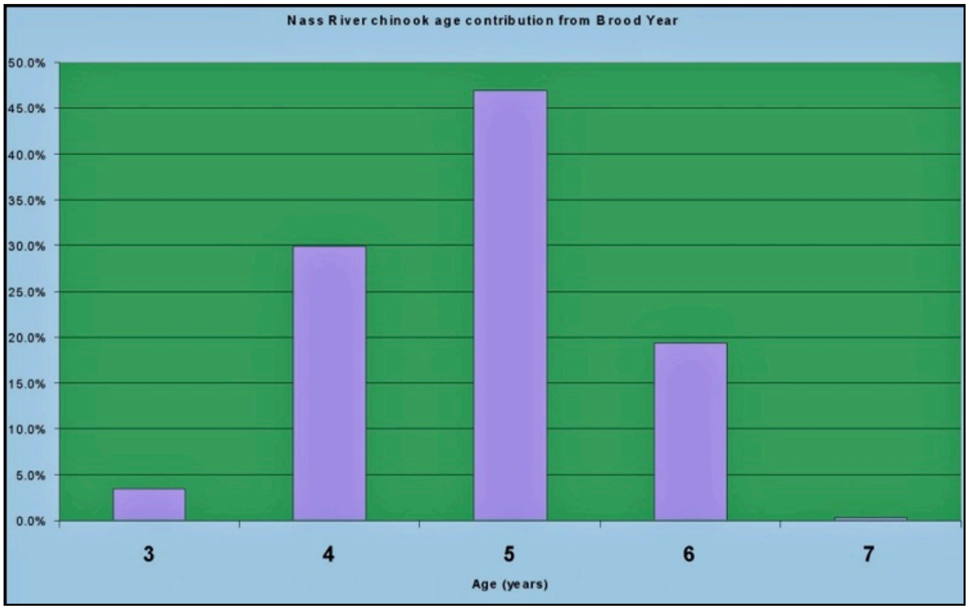


Figure 57. Graph shows Nass chinook age structure.

Two life history types of chinook are found in the upper Nass system. From 1964 to 1966, Godfrey (1968) indicated that 58% of Nass chinook spawners were ocean-type fish and only 42% were stream-types; however, these percentages can vary year-to-year, likely depending on spawning locations. Generally, the main Nass chinook smolt seaward movement occurs in April and May, followed by a secondary extended emigration continuing through to September.

Koski *et al.* (1996) reported that chinook salmon begin to enter the Nass River in early June and continue to enter until mid September, with the peak period of entry being highly dependent on the particular stock; this timing varies of course with late, large snowmelt events. Chinook typically arrive at their spawning grounds in Damdochax Creek in mid-August and at their spawning grounds in Teigen Creek (shown in Figure 58) in late August to early September, and normally hold and court for one to two weeks prior to spawning.

Figure 58. View across chinook spawning grounds in the mid to lower Teigen Creek. Note KSM's Seabee Camp, center foreground.

3.2.1.2 Sockeye

Sockeye salmon are culturally and commercially the most valuable of the Nass salmon. Sockeye salmon are widely distributed throughout the accessible portions of Nass River and its tributaries, but the abundant and productively resilient Meziadin Lake stock is by far the dominant stock. Nass sockeye are widely recognized for their distinctive migratory behavior, their unique types of spawning and juvenile rearing life histories, and their intimate connection with the Tsimshian, Nisga'a, Gitanyow, and Gitxsan First Nations and their cultures.

Nass sockeye production is one of the largest in BC following the Fraser, Skeena, and Barkley Sound systems. The eight upper Nass sockeye stock life histories are complex given population structures; lake, river, and sea type juveniles; timing; genetics; and habitat/ecosystem disparities among clearwater and glacial systems. The major sockeye systems are Meziadin, Bowser, Damdochax, and Kwinageese. Recent escapements to Meziadin have been near target, depressed for Damdochax, uncertain for Bowser, and fish passage improvement measures have strongly increased Kwinageese sockeye escapement; total escapement and catch from 1985 to 2012 (Alexander 2012) is shown in Figure 59.

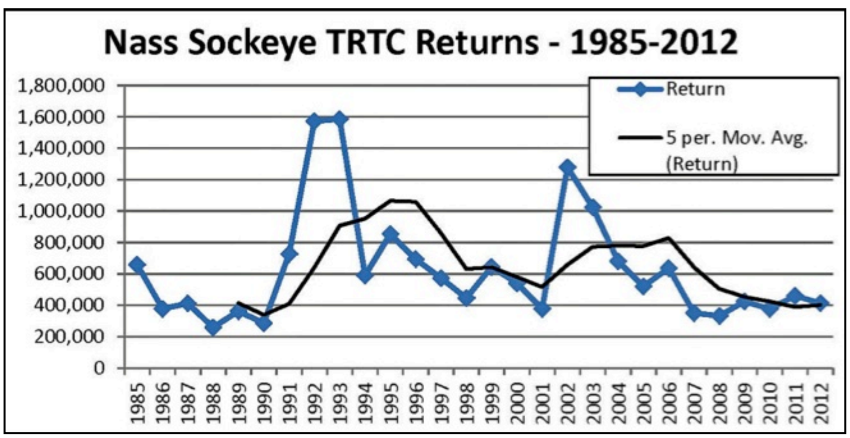


Figure 59. Graph shows total returns of Nass sockeye.

Nass sockeye are organized into CUs vis-a-vis the federal Wild Salmon Policy. Upper Nass sockeye lake type Conservations Units include: Meziadin Lake, Bowser Lake, Kwinageese Lake, Fred Wright Lake, Damdochax Lake, and Oweegee Lake. The upper Nass river-type CU includes sockeye from Brown Bear Creek, Tchitin River, Cranberry River, and presumably Teigen Creek.

The population structure of upper Nass sockeye is complex due to the various lake and river life history types with adult spawners returning at ages two to seven years and juveniles migrating to the ocean shortly after emergence or rearing in lakes or streams for one or two years prior to smoltification. Major studies reviewing or contributing to understanding Nass sockeye biology and stock status include Todd and Dickson (1970), Henderson *et al.* (1991), Rutherford *et al.* (1994), Koski *et al.* (1996), Beacham and Wood (1999), Bocking *et al.* (2002), and Hall *et al.* (In

Prep.). Upper Nass sockeye abundance is determined from the long-term Meziadin fishway count, up to six fishwheels and tagging stations located on the lower Nass, foot and aerial count surveys, and the fish weir located on the upper Kwinageese River.

Meziadin aggregate sockeye escapement has been recorded continuously since 1964. A small fishway was constructed in 1913 at a series of falls – Victoria Falls to improve access to the lake. In 1965, a vertical slot fishway was constructed and a concrete sill installed at the lower falls to help direct all sockeye through the fishway (Bocking *et al.* 2002); these are shown in Figures 60 and 61. Sockeye spawn in the main tributaries to Meziadin Lake including Hanna Creek, Tintina Creek, and Surprise Creek. Lakeshore spawning also occurs, but little data exists.

Figure 60. Meziadin fishway count station.

Figure 61. View upstream to Victoria Falls.

Sockeye arrive at Meziadin River fishway in early July and continue into late September with spawning typically from September through November. The dominant feature of the Meziadin sockeye stock complex is their stability in maintaining abundance. Since 1950, sockeye escapement returns have averaged 163,400. Meziadin Lake is glacially influenced but is considered clearwater. MacLellan and Hume (2011) conducted a hydroacoustic survey in 2009; their results indicated 1,024 fish were caught and all but one was juvenile sockeye. Daphnia is most important to the diet of juvenile, but *Diacyclops* sp., *Eubosmina* sp. and insects also play a significant role in maintaining the lake's rearing capacity.

Figure 62. Hanna Creek sockeye spawners.

Tchitin River flows glacially turbid and supports sockeye spawners. Little information exists about this stock; four escapement counts showed an average of 340 sockeye from a range of 200 to 500 fish. Brown Bear Creek is a clearwater tributary located in the Nass Basin with drainage from many headwater lakes. Sockeye spawn in Brown Bear Creek from the Nass confluence upstream for 0.5 km to an impassable 5.2 m falls. Escapements have averaged 200 fish, Gitanyow Fisheries recorded 1,240 sockeye from three surveys in 2009. Brown Bear sockeye rear in the Nass River for either one or two years.

Kwinageese River, a clearwater tributary, supports substantial sockeye spawning in the upper and lower river and Bonney Creek. Rearing occurs in Kwinageese Lakes and Fred Wright Lake with one and two year old smolts (Johannes *et al.* 1994). Rutherford *et al.* (1994) reported two and three year residence in the ocean for Kwinageese sockeye, though jacks are relatively common. Kwinageese sockeye are a stock of concern (DFO 2012).

Bowser Lake is a glacial body of water draining approximately 70 km^2 of Boundary Range icecap and glaciers. Sockeye are thought to be all shore spawners but heavy turbidity obscures escapement observations, and abundance estimates correlated with test fishery sampling results leave uncertainty. Johannes *et al.* (1994) reported juveniles rear in the lake for one or two years in nearly equal proportions.

Oweegee Creek is a clearwater tributary fed by numerous lakes, of which Oweegee Lake is the largest. Sockeye spawning occurs in lake tributaries and in Oweegee Creek. Fish passage is occasionally hampered by low flows, leaving insufficient water across the fan at Bell Irving River. Beaver dams prevalent in the flat, low-lying country frequently increase fish passage difficulty. Escapement counts likely reflect the fish passage conditions, and smolt emigration surveys appear to occur relatively late as the Oweegee system is warm water with smolts typically moving out early.

Figure 63. View north across Oweegee Lake.

Figure 64. View to mouth of Oweegee Creek, center left in backchannel.

Teigen Lake is the headwater of Teigen Creek, a tributary of Snowbank Creek. Sockeye spawners were noted in the past by Tahltans and the long-time trapper Matt Teigen. Recent surveys typically record a handful or less of sockeye spawners; the present stock condition is rated as high risk of extirpation.

Damdochax Creek, headwatered by Damdochax and Wiminasik lakes, is a clearwater system supporting sockeye spawning mostly in streams and occasionally lakeshores. The escapement estimate record is relatively long, and visual count estimates are considered reliable. Since 1950, average escapement has been 4, 970 sockeye from a range of 500 to 20,000 fish. Sockeye rear in both Damdochax and Wiminasik lakes. Johannes *et al.* (1994) reported 90% of juveniles typically rear for one year with 10% rearing for two years.

3.2.1.3 Coho

Coho salmon are widely dispersed salmon throughout the upper Nass with approximately four major and many smaller populations in the system. Coho typically spawn in headwater streams. Coho usually spend one to two winters in freshwater before migration to the ocean. Coho typically spawn in small headwater streams. They typically return as two or three year olds after spending one winter or about 16 months in the surface waters off the coast (Bocking and Peacock 2004). Marine diets range from euphausiids and various plankton to squid and small fish such as herring.

Coho migrate into the Nass River between late July and the end of September as recorded by the test fisheries and Meziadin River fishway. Catches on the lower Nass indicate coho moving up continuously from late August through to the tail end in late October, with coho spawning presumably peaking in November.

Prior to 1992, other than the long term record from Meziadin River, there was little reliable information on upper Nass coho. Enumerating adult coho escapement is difficult due to the relatively late-season run timing, their holding patterns, and their propensity to spawn in small stream or back channel habitats, which are often iced over. Presently, Zolzap Creek is providing data on Alaskan harvest, escapement, and harvest rates, while the Nisga'a fish wheels are providing minimum coho escapement estimates for the upper Nass River. The uncertainty with coho escapement estimates, which are poor, is complicated by the lack of knowledge regarding which streams support spawning.

In the upper Nass system, moderate numbers of coho are present in Nass basin streams and especially widespread in the White River and Kwinageese systems. In the Skeena Mountains, upstream of Kwinageese, the Nass mainstem is moderately entrenched from downcutting, and this factor makes for frequent steep and difficult fish passage or blocked fish passage into mainstem tributaries depending on water levels. Damdochax system is the only exception, where coho presence is prevalent and widespread. Fish distribution and fish habitat inventories conducted in this section of the upper Nass include: Applied Ecosystem Management (2001); Tripp Biological (1995); Van Schubert (1999), and Triton (1994).

It is puzzling why anadromous fish do not move up the Nass mainstem past the two moderate drops upstream of Muskaboo Creek in Reach 17; it is hypothesized there is a lack of suitable spawning and rearing habitat upstream. Similar rock sill drops, but double the height in the upper Skeena downstream of Kluatantan River, allow coho, chinook, sockeye, and steelhead passage. The first and second mainstem drops are shown in Figures 65 and 66.

Figure 65. 1st drop Nass mainstem.

Figure 66. 2nd rock sill drop on Nass mainstem.

In the Bell Irving system, the mainstem is lightly entrenched and the valley bottom is relatively wide, allowing relatively more fish migration into tributaries than in the Nass mainstem upstream of Kwinageese. Bell Irving system was surveyed at the reconnaissance level by SKR (1998), and their results indicated coho presence in 10 tributaries out of the 23 sampled with salmonid present. Major Bell Irving coho systems include the mainstem, Bowser, Treaty, Taft, Oweegee, Snowbank, and Teigen. The SKR (1998) age structure analysis, resulting from a large scale sample and length frequency histograms and representative habitat types, indicated all coho rear for a year and then emigrate downstream.

3.2.1.4 Steelhead

Nass watershed supports one of the larger stocks of summer run steelhead in BC. Nevertheless, the distribution, timing, and life history characteristics are poorly known and much of the information has been acquired from sockeye and chinook studies. Many spawning areas or general locales are known anecdotally from sports fishers and a few from telemetry studies. Unlike salmon, steelhead catch records are considered unreliable.

Parken (1997) described Nass River steelhead life history characteristics And noted steelhead spawning and rearing in the upper Nass basin are exclusively summer run fish while the lower Nass supports various winter steelhead runs. Alexander and Koski (1995) reported on telemetry results including steelhead distribution. Steelhead spawners are thought to be widely dispersed throughout the upper Nass and the major known populations are Kwinageese, Damdochax, Meziadin, Bell Irving, especially Teigen Creek, and the Taylor system to a lesser degree,. Steelhead may be potentially present overwintering and spawning throughout the Nass mainstem (and possibly upstream of Muskaboo and Konigus creeks) and in the Bowser system, though few data are available pertaining to these areas.

Juvenile rainbow/steelhead surveys results are generally inconclusive due to the difficulty in distinguishing or separating juvenile resident rainbows and juvenile anadromous steelhead. Adult escapements estimates and trends are supported by the DFO Nass test fishery located at Monkley Dump on the lower river and operating since 1963; up to six Nisga'a fisheries fishwheels operating on the Nass since 1992; the Meziadin River fishway counts; BC Ministry of Environment and Nisga'a genetic studies; and Nisga'a radio telemetry studies.

Koski and English (1996) reported on the status of Nass River steelhead including interceptions in the Alaska and Canadian commercial fisheries and the in-river food fisheries and documented commercial bycatch of summer run steelhead have led to conservation concerns. There is no known total record of Nass steelhead catch or rate of exploitation. Data does not exist to permit an assessment of upper Nass steelhead or their stock status. Koski and English (1996) noted: 1) there has been an unknown reduction in the size of the Nass steelhead stock; 2) the unknown exploitation rate is too high to permit recovery of the steelhead population to its previous size.

Figure 67. View across Fred Wright Lake to Kologet Mountain.

3.3 Upper Nass Flora

3.3.1 Ecosystem Classification and Forest Types

Coastal interior, sub boreal, subalpine, and alpine vegetation dominate the landscapes of the upper Nass area. A large percentage of the Boundary Ranges and northwest Skeena Mountains are above treeline, though most of the Nass Basin is forested. Cold winters, short growing seasons, and poorly developed soils are a factor in the distribution and composition of vegetation communities. Natural disturbance factors including fire, insect and disease, avalanches, and landslides affect patterns of vegetation across the landscape. A diversity of ecosystems ranges from coastal rainforests to lichens and alpine plants at high elevations.

The Ecoregion Classification System describes areas of similar climate, physiography, hydrology, vegetation and wildlife potential (Demarchi 2011). The upper Nass area encompasses three ecosections including the Boundary Ranges, Western Skeena Mountains, and the Nass Basin. The Biogeoclimatic Ecosystem Classification (BEC) uses climate, topography and soils to classify vegetation patterns into biogeoclimatic zones or subzones (Meidinger and Pojar 1991). The upper Nass area encompasses six BEC zones as shown in Table 6.

Table 6. BEC zones within the upper Nass area (adapted from Pojar *et al.* 1983)[8].

BEC Zone	Distribution in Study Area
Coastal Western Hemlock (CWH)	Minor amounts at lower elevations up to Tchitin Creek
Interior Cedar Hemlock (ICH)	Bell-Irving and lower Nass drainages
Mountain Hemlock (MH)	Small amounts primarily above CWH
Sub-Boreal Spruce (SBS)	Damdochax–Slowmaldo, upper Nass valley from Muskaboo to Konigus, and Bell Irving valley from Rochester to Craven Creek
Engelmann Spruce Subalpine Fir (ESSF)	Above SBS and ICH
Alpine Tundra (AT)	Upper elevations throughout

3.3.2 Upper Nass Area Forest Types

The largest amount of upper Nass area forests are represented by the ICH zone, which covers from Gitlakdamix in the south northward throughout most of the Nass Basin. The ICH fingers up Nass mainstem lowlands to Muckaboo Creek and includes the lower Damdochax drainage. It also fingers up the Bell Irving valley bottom to north of Bell 2 and through the Snowbank Creek to join the ICH in the lower Iskut. Western hemlock (*Tsuga heterophylla*) form extensive old growth forests; hybrid Sitka and white spruce (*P. sitchensis x glauca*) occur on rich, moist sites.

[8] Refer to Appendix I, Map 6 for a detailed map of BEC zones across the upper Nass area.

Black cottonwood (*Populus trichocarpa*) and hybrid spruce form floodplain forests and lodgepole pine, trembling aspen and paper birch form seral forests in burned areas, especially near the Nass–Bell Irving confluence. The ICH supports high productivity pine mushroom ground with the sites located in the Kinskuch and Brown Bear areas; OESL (2000) describes pine mushroom ecology and productivity. Natural stands and clearcut plantations in the Nass Basin have been severely damaged by Dothistroma needle blight, which is thought to have emerged and driven by changing climate (Welsh *et al.* 2009).

Figure 68. Dothistroma in an ICH natural stand upstream from the Nass-Bell Irving confluence

Small patches of the SBS zone are situated at elevation above the ICH and below the ESSF zones. This SBS represents interior transition forests with locations at the Damdochax–Slowmaldo area, in the upper Nass valley from Muskaboo to Konigus, and in the Bell Irving valley from Rochester to Craven Creek. The forests are primarily composed of hybrid white spruce and subalpine fir, with black cottonwood, paper birch, lodgepole pine, and trembling aspen on floodplain and disturbed sites.

The ESSF zone occupy areas primarily east of the Boundary Ranges, ranging in elevation from 750 to 1250 m above the ICH and SBS zones. ESSF forests consist mainly of subalpine fir with frequent mountain hemlock, hybrid white spruce, and western hemlock with the understory dominated by black huckleberry, blueberry, false azalea, bunchberry, and mosses. Closed canopy forests turn into subalpine parkland at higher elevations where a mosaic of tree clusters and open areas of heath and wetlands occur. (Banner *et al.* 1993).

The CWH zone overlies the ICH in a thin strip on the north bank of the Nass from Gitlakdamix upstream to Tchitin River. The CWH is typified by closed forests commonly dominated by western hemlock and Sitka spruce with infrequent occurrences of subalpine fir in many stands. Sitka spruce is plentiful in valley bottoms and alluvial terraces, with red alder and paper birch interspersed in alluvial forests and typically cottonwood stands occupy floodplain areas.

The MH zone occupies subalpine elevations (400 to 1100 m) above the CWH in the Kwinatahl and north to Tchitin River. These subalpine forests consist mainly of mountain hemlock with less frequent occurrences of western hemlock. At higher elevations, forests are dominated by mountain hemlock and subalpine fir.

The AT covers high elevation areas (1100 to 1600 m) on mountain slopes and plateaus and is distributed widely throughout the study area. The AT zone is defined as treeless however, subalpine fir are common in stunted or krummoltz form, and to a lesser extent white spruce, mountain hemlock, scrub birch (Betula glandulosa) and willows. Alpine vegetation is composed of herbs, bryophytes, and lichens (Pojar *et al*. 1983).

3.4 Upper Nass Wildlife

The mosaic of landscapes across the upper Nass area are known for supporting a great diversity and abundance of wildlife. Wildlife composition has been modified due to forestry activities that have altered habitats across much of Nass Basin forest including the Kwinageese and area and low elevation portions of the Bell Irving valley adjacent to Highway 37. The majority of ungulate wildlife abundance is constrained by the amount of high quality over wintering habitat.

Key issues of concern regarding wildlife include access and lack of wildlife status and trends. Wildlife population abundance is not well known with only occasional inventory surveys conducted that are mostly related to proposed development or critical management concerns. The lack of wildlife population status and trends leaves potential risks from climate change, development, and wildlife management such as hunting – all being affected by inadequate baseline and status trends. Highways and resource access roads have bisected valley bottom habitats and fragmented lowland and mid-elevations habitats.

There are few caribou in the upper Nass area and these few usually consist of pre-calf cows wandering in from the Spatsizi herd to the Mt. Gunanoot southward to the Groundhog Range area to drop calves in early June. Caribou were common in subalpine areas up to seventy years ago; Pedology (1986) did record a summer sighting of caribou near the Bell Irving-Craven confluence and likely passing through from Sweeney Pass. There are no known instances of Stone's sheep in the upper Nass.

3.4.1 Mountain Goat

Goats are common and widespread at moderately high to high elevations throughout the upper Nass area. Mountain goats have always been important to First Nations in the Stikine and upper Nass area. Goats generally appear to be sparsely populated in the southwestern sections due to deep and lengthy snow cover. Escape terrain and winter habitat are the most critical factors for mountain goats. Winter habitat is typically south or west facing, windswept slopes where forage food is exposed and escape terrain is adjacent. Escape terrain refers to cliffs and ledges that are almost inaccessible to predators. Mountain goats are typically apprehensive to travel more than 400m to 500m away from escape terrain, though often move into the forest in winter (MGMT

2010). Mountain goats are generalist herbivores that feed on grasses, forbs, shrubs, deciduous and coniferous trees. Nass goat winter range mapping based on a GIS-based habitat suitability index is shown in Figure 69 adapted from Vanderstar (2007).

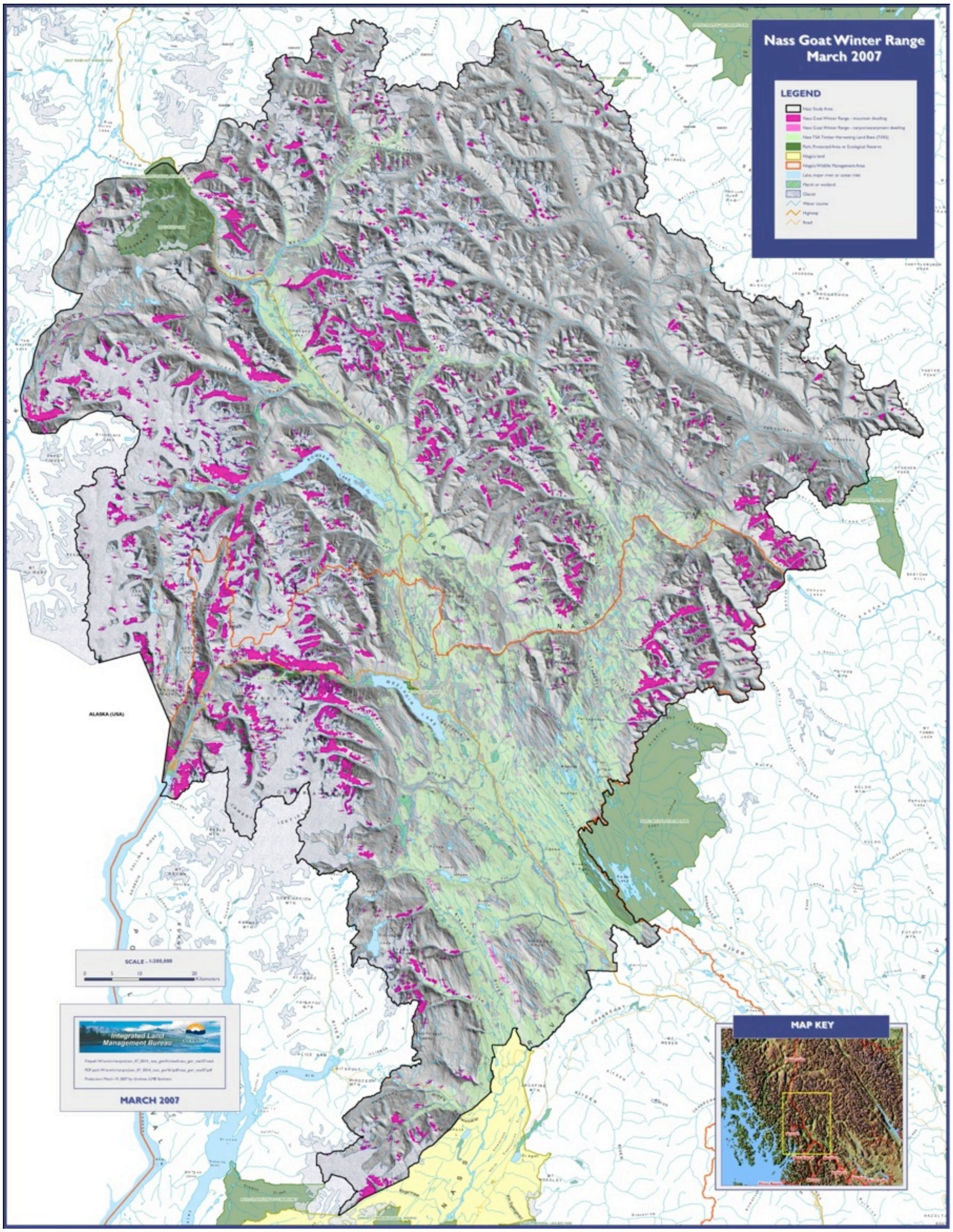


Figure 69. Goat winter range in upper Nass area (adapted from Vanderstar 2007).

Between mid-May and mid-June, female goats (nannies) travel to secluded cliffs or ledges to give birth, typically producing one kid (Ministry of Environment 2000c). In spring, goats use low elevation forage sites abundant with new spring vegetation growth and in summer will travel for several kilometers to locate salt licks, a supplement to mineral-poor alpine vegetation. Nannies and billies live in close proximity, but in separate groups with billies often solitary or in small groups.

Rutting period for mountain goats occurs in late fall to early winter (Mountain Goat Management Team 2010). Grizzly bears, wolves, wolverines, and black bears are the main predators of mountain goats, and Golden Eagles are a potential threat to kids.

A stable estimated population of 16,000 to 35,000 mountain goats are believed to occupy the Skeena Region (MGMT 2010).

3.4.2 Moose

Moose are widespread across BC with a substantial number of them inhabiting the upper Nass area. In the 1920's, distribution and abundance of moose greatly increased in the upper Nass area. Moose use a variety of habitats from low elevation valley bottoms to higher elevation mountainous terrain. Moose forage extensively on early successional deciduous trees and shrubs that colonize sites following timber harvest activities. Later successional forests provide security and thermal cover as well as access to forage during winter (Ministry of Environment 2000d). Moose typically migrate between winter and summer ranges, however some remain in valley bottoms year round. Moose are adapted with long legs but depth and density of snow determines seasonal movements.

In winter, moose tend to occupy river valleys that cut through plateaus, burned and logged areas, and wetland complexes (Ministry of Environment 2000d). To meet winter energy needs, winter forage is largely willow, red-osier dogwood, cottonwood, paper birch, aspen, falsebox and highbush cranberry. In addition to browsing on trees and shrubs, moose strip bark from willows and poplars.

Moose spring range is usually an extension of their winter range. In spring, cow moose will seek out a secluded calving area typically at low elevation close to water. Calving occurs between early May and early June and one cow typically produces one calf (Ministry of Environment 2000d). During summer, moose occupy all habitat types including the alpine. Summer forage consists mainly of aquatic vegetation such as burweed, horsetail and submerged pondweed present in wetter habitats such as wetland complexes (Ministry of Environment 2000d). Moose are a solitary species and will generally only form small groups (if any) during the fall rutting season (September to November). Autumn moose range consists of upland scrub and subalpine habitat. Main predators of moose are grizzly bear and wolf (Ministry of Environment 2000d).

Moose in BC have an estimated population of 17,000, 40 percent of which inhabit northern BC (Ministry of Environment 2000d). Currently there is a decline in moose populations in the Nass Wildlife Area, particularly north of Gitanyow. The combination of forestry practices and intensive harvest by hunters have led to considerable concern about the moose population in the Nass Wildlife Area (Demarchi 2000). Survey results between 1997 and 2010 indicate a 70 percent decline in the Nass Wildlife Area (Ministry of Forests, Lands and Natural Resources Operations 2012).

3.4.3 Grizzly Bear

Grizzly bears were once one of the most widely distributed mammals on the planet. In North America and presently, they occupy approximately only half this historic range (Ministry of Environment 2002). In BC, grizzly bears inhabit over four fifths of the province, still occupying most of their historic range. Grizzly bears play an important ecological role in their environment through seed dispersal, nitrogen cycling, and as part of intact predator-prey systems.

Grizzly bears are currently provincially blue-listed and ranked by COSEWIC as a species of Special Concern (CDC 2013). Distribution of grizzly bears is related to the amount of quality food in an area, thus densities are typically highest in areas with abundant food sources (Demarchi and Johnson 2000). Habitat use and range is generally based on age, sex and population levels of grizzly bears over the landscape. Grizzly use a variety of habitats including but not limited to estuaries, valley bottoms, coniferous forests and alpine meadows. Information regarding distribution within the Nass watershed is limited. Figure 61 shows high value grizzly bear habitat within its boundaries adapted from Anonymous (2000).

In the upper Nass, grizzly bear density is high in the vicinity of Meziadin Lake, along Hanna, Tintina, Surprise and Strohn creeks, and near the Meziadin River fishway. Denning sites on Mount Hoeft and Mount Priestly have also been observed (Demarchi and Johnson 2000). Demarchi and Johnson (2000) reported on the Nass Wildlife Area grizzly bear population study; grizzly bear presence was noted as: 38.6% in the AT zone, 33.3% in the MH zone, and 28.1% in the ESSF zone.

Substantial quantities of high-quality food are essential for grizzly bears to support daily energy requirements, particularly in late summer and fall when accumulating fat reserves for winter denning (Demarchi and Johnson 2000). Subsequently, high concentrations of grizzly bears are observed along streams during salmon spawning seasons (coastal influences areas), on alpine and subalpine slopes when berries are plentiful, and when interfacing with human settlements, scavenging at garbage dumps and landfills (Demarchi and Johnson 2000).

The upper Nass area includes coastal and interior influenced ecosystems, therefore it is important to note that seasonal habitat type and forage behaviour differs between coastal and interior grizzly bears. In spring and early summer, both coastal and interior bears feed on emergent vegetation in estuaries (coastal), valley bottoms and avalanche chutes including grasses, rushes, sedges, and horsetails. Scavenging on carrion is also common (Demarchi and Johnson 2000).

In late summer and fall, grizzly bears inhabiting salmon ecosystems will feed on salmon carcasses as well as green vegetation and berries; interior bears without access to salmon streams will supplement their vegetative diet by preying and scavenging on alpine rodents, moose, caribou and mountain ungulates (Demarchi and Johnson 2000, MacLean 2008). Coastal grizzly bears go into hibernation from early November to mid-April, interior bears from October to May (Ministry of Environment 2002).

Grizzly bears breed from May to early June, with implantation of the embryo occuring only after females (sows) enter hibernation. Sow grizzly bears have low reproductive rates as they do not sexually mature until at least five or six years of age, and only produce a litter every three years on average (Ministry of Environment 2002). A litter typically consists of one to three cubs, usually born between January and February. The mother will nurse her cubs until they all emerge from the den in late May. Cubs remain with their mother for approximately two years though this can range upwards to five years (Ministry of Environment 2002). Major threats to grizzly bear populations is road access, and land and resource development.

3.4.4 Grey Wolf

Grey wolves (Canis lupus) hereafter called wolves are highly adaptable generalists who can occupy any habitat that supports viable prey populations (Ministry of Forests, Lands and Natural Resource Operations 2012c). Wolves were distributed globally, although have now been extirpated from most of the US, Mexico and western Europe. As top predators, wolves play an important role in structuring predator-prey systems (Ministry of Forests, Lands and Natural Resource Operations 2012c). In Northern BC, wolf distribution is strongly associated with the distribution of moose.

Wolves are opportunistic predators that inhabit any area abundant with prey and will adjust their diet according to local conditions. Wolf populations are naturally regulated by prey abundance and social behaviour such as packs and territories (Ministry of Environment 2000). Main food sources consist of adult and juvenile ungulates and smaller prey. In the upper Nass area, wolves prey on moose, mountain goats, deer and other smaller mammals (Ministry of Environment 2000).

Wolves live in packs consisting of a breeding pair and one to two year old offspring. Pack size appears to be related to primary prey; packs in Northern BC that feed on moose are larger than those in other parts of the province that feed on deer. When subadults leave their natal pack they may become solitary, this often occurs during breeding season. Breeding occurs in late-winter and litters of four to seven pups are born in April or May; it is usually only the alpha female that breeds within each pack. Most pups disperse from the pack following winter once they are yearlings Ministry of Forests, Lands and Natural Resource Operations 2012c).

Estimated population densities determined for Northern BC have ranged from 10 to 44 wolves per 1000 km2. Wolf population estimates in the Skeena region based on density and prey mass are 2300 to 4600, and 1550 to 2100 individuals respectively Ministry of Forests, Lands and Natural Resource Operations 2012c). Threats to wolf populations include hunting pressure (on wolves as well as prey species), habitat degradation and destruction as a result of human development.

3.4.5 Other Wildlife

Black Bear

Black bears occur throughout the forested portion of the upper Nass area at a relatively high abundance level. Black bears are more abundant on the interior side of the area and more common at low than high elevations. Black bears typically hibernate in the base of hollow trees or a den dug in the ground. Denning is usually between late October and mid to late April. Alluvial sites along all major rivers and tributaries are important black bear habitats in spring and summer.

Mule deer

Mule deer are at the northern boundary of their range in the upper Nass area and are limited by climatic factors, primarily snow depth. Most deer occurrences are in rainshadow areas, typically on moderately steep, south facing slopes that readily shed snow and/or coniferous forests where the canopy intercepts snow and reduces snow cover (Hatler 1987).

4.0 Ecosystem Dynamics and Processes

Stikine and upper Nass ecosystems are dynamic entities that experience constant biotic and abiotic changes. Ecosystem dynamics is defined as: those intrinsic ecological functions through which an ecosystem becomes self-regulating, self-sustaining, and capable of recovery from external forces; for example, changes from major storm events. These intrinsic processes may cause continual change in biotic composition and structure at specific localities. Collectively, these changes represent internal flux, rather than substantive and permanent alteration of the ecosystem regionally.

Ecosystem processes are the physical, chemical, and biological actions or events that link organisms and their environment and include decomposition, production, nutrient cycling, and fluxes of nutrients and energy. The natural ecosystems in the Stikine and upper Nass area are diverse due to major climate systems – warm, moist northeast Pacific air and Interior and Arctic air masses – and a diversity of landforms including the ice-clad Boundary Ranges, the dry plateaus, and the heavily forested northwest Skeena Mountains and Nass Basin.

These varying landforms support salmon, freshwater resident fish, high number of wildlife species, and many types of forests, wetlands, and dry country vegetation resulting in globally significant biodiversity that we/society need to be responsible for. Natural disturbances, predator-prey interactions, and long distance movements by salmon and wildlife contribute to the richness of the Stikine and upper Nass areas. Continued resource development in Northern BC tests the resistance and resilience of ecosystems, thus it is crucial to understand what dynamics and processes are main drivers of ecological integrity and how we can conserve them.

4.1 Climate Change

Climate change is a new driver of ecosystem dynamics and processes. Pojar (2010) notes global warming and concurrent changes in temperature and precipitation are expected to continue through this century as greenhouse gas concentrations increase. A crucial difference between past climatic changes and the present event is the speed at which the current episode is expected to proceed.

For Stikine and upper Nass ecosystems, the change is readily visible in warmer winter temperatures, earlier snowmelt, and extreme storm events. The change is readily visible in diminishing glaciers and in forests with pine mountain beetle mortality, Dothistroma needle blight causing pine mortality or setback, willow stem borer repeatedly attacking willows, and dieback in poplars. Changes in other ecosystems such as freshwater aquatic environments are not so easily observed. Two fundamental questions requiring answers and related to the spatial and temporal aspects of climate change are:

1. What is the general projected impact on Stikine and upper Nass forest and vegetation communities, on fish and wildlife and their habitats, and on their ecosystem distribution?
2. What is the speed or rate with which these changes are expected to occur?

4.1.1 Tree Diversity & Climate Change

Climate change will likely have the following consequences for trees in the Stikine and upper Nass forests. Trees with the races or genotypes best suited to future conditions will definitely survive. However, this depends on many factors including: rate of climatic change in relation to the length of tree generation time exceeding the adaptive capacity of many long-lived conifers; and the fast rate of climate change will likely result in extreme climatic events with anticipated genetic erosion or loss.

Adaptive capacity could be exceeded due to: 1) conifer populations are locally adapted and climate change causes conditions to deteriorate throughout the tree's range, not just at the margins as we are observing today; for instance, temperature and moisture tolerances could be exceeded; 2) mortality induced climate change including temperatures, insects, or disease could result in loss of genetic diversity; 3) the rate of change is too fast to allow adaptive response by long-lived species.

4.1.2 Fish & Climate Change

Salmon life histories are complex due to use of differing ecosystems to reproduce in freshwater and to rear in freshwater and the ocean. Effects of climate change on salmon populations are intimately linked to their habitats, particularly temperature regimes and marine and freshwater food webs. Understanding the relationships between climate and fish populations is challenging due to our lack of knowledge regarding present natural environmental changes before understanding changes resulting from human-induced climate change.

As shown in Sections 2 and 3 of this report, fish are highly valued by cultures and society and generally measured by relative abundance estimates. All fish have limits to their abundance. In the upper Nass, salmon abundance is considered natural, while in the Stikine, natural abundance is supplemented by enhanced fry outplants. Salmon abundance fluctuates naturally due to near-shore and offshore marine and freshwater habitat conditions linked to food web productivity, predation, and temperatures, which affect the prior two factors.

We know there are shifts in productivity and carrying capacity in the northeast Pacific Ocean exhibited by variable distribution and size of salmon on multi-year, multi-decadal, and long-term scales. Global climate change models have been developed to help understand changes in climate systems. These models predict that a doubling of CO_2 will be associated with a 2–4 ^{o}C increase in air temperature over the northeast Pacific Ocean. Hinch *et al* (1992) Salmon are likely to be the first affected by increase in water temperature because they spend the majority of their lives in the surface waters. Surface waters will warm more quickly than deep waters.

Hinch *et al* (1992) constructed an energetic model to explore the rate of energy accumulation (growth) occurring every month during the oceanic phase of life for an average Fraser River sockeye salmon. The energetics model results show that as ocean temperatures warm in response to increasing concentrations of atmospheric CO_2, Fraser River sockeye will become lighter. Lighter sockeye will have fewer and smaller eggs, and may lower reproductive value (Healey 1987).

Additionally, smaller sockeye salmon run the risk of not having enough energy reserves to complete their river migration and spawning, especially in increased stream temperatures. Sockeye could likely adapt by increasing their ocean residency times to put on more weight or shift their oceanic distribution northward. However, this could put them to greater risk of predation, disease, or increase competitive interactions with other salmon stocks. In relation to Stikine and upper Nass salmon, climate changes to their physical environment are likely to generally have impacts on the aggregate rather than individual fish stocks. The relevant spatial scales will likely be regional and sub-regional except where basin or sub-basin terrestrial and/or aquatic systems have been modified or stressed and are not integral.

4.2 Predator-Prey Relationships

One of the most exceptional biological features of the Stikine and upper Nass area is the large, intact mammal predator-prey system that exists, particularly in the upper Stikine, in a relatively pristine environment. Mountain goats, Stone's sheep, caribou, and moose, the four large ungulates inhabiting northwestern BC, are all exist present. Main predators of these ungulates consist of wolves, grizzly bears and black bears, wolverines, lynx, coyotes, and Golden Eagles are known to prey on very young ungulates and occasionally on adults (Ministry of Environment 2000).

The dynamics of diverse predator-prey systems such as this are complex in nature. Population fluctuations in any one species, predator or prey, can directly or indirectly affect population numbers of other species in the system. Prey populations in predator-prey systems typically have lower numbers than those without predators and limited by food availability. Prey populations in predator-prey systems are not limited by food and habitat requirements, however they are still vital components and must be available in suitable amounts. Habitat requirements are a function of food preference, environmental conditions and predator avoidance strategies (Ministry of Environment 2000).

In the Stikine and upper Nass area, predators are the primary factor in regulating ungulate populations. Historically, fluctuations and distribution of prey populations as well as management efforts have played a key role in the structure of current population numbers and distribution (Ministry of Environment 2000). Prior to 1900, moose were absent in northwestern BC, and caribou likely co-existed with small populations of wolves (Bergerud and Elliot 1986). Moose began colonizing BC in the early 1900s and peaked along with caribou populations in 1933.

Bergerud and Elliot (1986) note wolf populations followed the expansion of moose across BC and as a result there was a decline in caribou and moose populations. Declines in moose and caribou numbers continued until 1949, when a large-scale wolf-poisoning program was initiated in most of BC and carried out until 1962. Following the implementation of the wolf-poisoning program, ungulate populations rose until about 1968 and then began to decline again. For more than three decades there have not been any significant predator management programs in place in northwestern BC and as a result predator-prey systems seem to have stabilized (Ministry of Environment 2000).

Two main predator-prey systems operating in the Stikine and upper Nass area are bisected by Highway 37: one is centered around the Stikine Plateau (east of Highway 37) and one around Mount Edziza (west of Highway 37). Several contiguous protected areas within Stikine and upper Nass area are key to keeping these predator-prey systems intact.

Spatsizi Plateau is home to one of the largest, most intact predator-prey systems in BC. The Todagin Wildlife Management Area hosts the largest lambing herd of Stone's Sheep in the world, and BC's largest concentration of woodland caribou gather in the Spatsizi for the rut. Thriving populations of mountain goats, bears, moose and wolves also inhabit the area. The Spatsizi region contains some of the most spectacular wildlife populations in BC and exemplifies a healthy, intact predator-prey system, remnant of that which once dominated the all of North America. The diversity and numbers of wildlife in the Stikine area are of global importance (Davis 1994, Anonymous 2000, Ministry of Environment 2000).

4.3 Natural Disturbance Factors

Ecosystem resistance and resilience are key in the recovery processes following natural or anthropogenic disturbances. Natural disturbances are defined as any biotic or abiotic event (e.g. wildfires, insects, disease, avalanches, debris torrents, extreme weather) that disturbs the structure, composition and/or function of an ecosystem (Parminter 1998). Disturbance is followed by succession, a series of observed changes in structure and composition of an ecosystem over time.

A variety of natural disturbance factors have influenced the ecosystems of the Stikine and upper Nass study area. The landscapes that exist today are the result of large and small-scale ecosystem processes. Large-scale events driven by climate, such as fire, glaciation, volcanic activity, snow and landslides, have formed the physical and biological features of the study area (Ministry of Environment 2000). Fire is the most prominent landscape-level disturbance factor influencing ecosystem composition and structure in the Iskut-Stikine portion of the study area Less common events such as insect infestations, windthrow, forest diseases and mass wasting also contribute to ecosystem composition and structure, however only on a moderate to small scale (Ministry of Environment 2000).

In BC, natural disturbances are classified in a system based on frequency and severity of disturbance events such as fire, wind, insects and disease. The Forest Practices Code Biodiversity Guidebook (Province of British Columbia 1995) defines five Natural Disturbance Types (NDTs):

- NDT1: ecosystems with rare stand-initiating events
- NDT2: ecosystems with infrequent stand-initiating events
- NDT3: ecosystems with frequent stand-initiating events
- NDT4: ecosystems with frequent stand-maintaining fires
- NDT5: alpine tundra and subalpine parkland

Table 7 below summarizes NDTs in the Stikine and upper Nass area :

Table 7. NDTs and corresponding BEC zones in the Iskut-Stikine/Upper Nass study area.

Natural Disturbance Type (NDT)	BEC Zone
NDT1	AT; MH; CWH; ICH; ESSF; BWBS
NDT2	SBS; SWB; ESSF
NDT3	SBS; SWB; BWBS
NDT5	AT; MH

4.3.1 Fire

Fire has been the most influential natural disturbance factor affecting distribution and development of vegetation in the Stikine and upper Nass area (Parminter 1983); though more so in the Stikine than the Nass. Fire is often necessary for certain plants and plant communities to persist in the environment. All trees in the area are adapted to fire in one way or another. For instance lodgepole pine has serotinous cones which require fire to release seeds. Fire is fundamental in maintaining healthy grasslands by preventing the encroachment of coniferous trees.

Type (e.g. ground, surface or crown), intensity (amount of energy released), severity (overall effect of fire on the ecosystem), frequency (number of fires per unit time on a particular site), and time since the last fire event have a significant effect on the composition of boreal forest ecosystems. Parminter (1983) notes similar effects occur in higher elevation and transitional (coast to interior) areas, but with longer time intervals between fire events. Many of the forest stands in the study area still have not reached the climax stage of succession which is often not reached due to the frequency of fire events. Fire types are variable and depend on local conditions.

The majority of fires in the coastal–transition and interior forests of the Stikine and upper Nass area are caused by lightning strikes, which can be high intensity crown fires. Lightning-caused fires have been recorded throughout the entire study area since 1942, concentrated mainly to the east of Highway 37 (Parminter 1983).

Human-caused fires have been most common adjacent to preferred travel routes, such as the Stewart-Cassiar (Highway 37), Telegraph Creek highways. These fires may be unintentional or planned, the latter to optimize forage and browse production for wildlife (mainly large ungulates) as well as domestic livestock (Parminter 1983). The big fires years throughout the Stikine and upper Nass were 1958 and 1963. Major fires in the upper Nass area include the Damdochax Burn, the Taylor Fire, and the Nass–Bell Irving Fire.

Between 1950 and 1982 there were 589 known fires in the Stikine area of which 202 were lightning caused, 163 were miscellaneous known causes (mainly range burning), 161 were recreation caused, and the remaining were generally due to resource and industrial development (e.g. railroads, logging, road construction). During that period, over 650,000 hectares of land were burned, of which 500,000 hectares were burned by wildfires (Parminter 1983). The most well-know fire in the Stikine is the Iskut Fire that burned in 1958. Lightning-caused wildfires occur most frequently in the summer months (June to August) with a peak in July. Fires caused by range burning peak in May, whereas recreation related fires peak in July.

In the last decade, there have been few occurrences of major fires in the Stikine and upper Nass area; however between 1999 and 2011 there were several fire events each covering significant areas of land (greater than 100 hectares; 1999, 2004, 2009 and 2010; Wildfire Management Branch 2013). Fire events are most frequent in the BWBS zone within the study are; these fires are larger than in other BEC zones, are commonly stand-replacing events, and can cover thousands of hectares in size. Frequency of fires in the SWB and ESSF zones are less, in some areas only occurring every 400 to 500 years. Events in both the SWB and ESSF may originate within the zone spread from lower elevation sites. Fires in the AT zone are generally small and low intensity, relatively infrequent and likely originate at lower elevations.

Interviews with Tahltan Elders indicate that that Tahltans occasionally used fire primarily as a wildlife habitat treatment, and secondarily, to assist in hunting practices and enhance berry production (Ministry of Environment 2000). Two Elders recollect a fire set on Level Mountain and other Elders recollect burning to manage wildlife habitat and berry production, indicating that there were Tahltan families using fire for resource management (Ministry of Environment 2000).

4.3.2 Insects

Although mountain insects such as mountain pine beetle (*Dendroctonus ponderosae*) and spruce beetle (*Dendroctonus rufipennis*) have caused extensive and catastrophic damage to many forests throughout BC, it does not appear that they have significantly affected the Iskut-Stikine and upper Nass area (Ministry of Environment 2000). This is likely due to climatic conditions, the area currently being at or beyond the northern extent of its range, as well as the composition and age-classes of forest ecosystems (Ministry of Environment 2000). Mountain pine beetle infestations were observed in trace amounts; however, recent surveys were limited due to weather conditions (Westfall and Ebata 2012)

Aerial surveys of the Stikine and upper Nass area, confirmed that western balsam bark beetle (*Dryocoetes confuses*) was the most common forest insect detected. Balsam bark beetles are prevalent throughout northern British Columbia (Ministry of Environment 2000). In the upper Nass area, the western balsam bark beetle is a primary disturbance agent (along with windthrow) and driving force of succession in subalpine fir forests. As well, Henigman *et al.* (2001) notes green windthrow is a preferred host for the western balsam bark beetle. This resource can be scarce thus beetles will also infest bug-killed blowdown and live, standing trees greater than 90 years old.

Long-term and even intense short-term changes in climatic conditions may result an optimal environment for certain forest insects. If long-term climate conditions in the Stikine and upper

Nass area become warmer and drier, increased levels of forest insect activity may result (Ministry of Environment 2000).

4.3.3 Wind

Forests in the Stikine and upper Nass area have the potential to create small to moderate sized windthrow areas through strong winds (Ministry of Environment 2000). Currently there is little to no information available on the extent and distribution of windthrow in the Stikine and upper Nass area.

4.3.4 Other Disturbances

There is limited information regarding small-scale natural disturbance processes (e.g. forest diseases, wildlife activity, soliflucation) in the Stikine and upper Nass thus only Dothistroma Needle Blight will be discussed. Due to scope and temporal boundaries of this report, detailed discussion on other small scale processes is precluded.

Dothistroma Needle Blight is a defoliating forest disease caused by the fungus *Dothistroma septosporum*. This disease infects and kills pine needles of all ages reducing photosynthetic capabilities (McCulloch and Woods 2009). Dothistroma Needle Blight was first discovered in northwest BC in 1999 and has since spread exponentially (Brouwer and Jobb 2007). It is currently the most important forest health issue in the ICH zone of northwest BC with significantly damaged areas in the Nass TSA (Brouwer and Jobb 2007). Dothistroma needle blight damage has also been observed in the CWH zone of the Nass, Kalum and Kispiox TSAs (Brouwer and Jobb 2007).

Damage caused by Dothistroma Needle Blight in northwest BC has doubled nearly each year between forest health survey years; although infection continues to spread, the most recent surveys indicate a decrease in area affected since 2008 (2008 was the peak of infected areas to date; Brouwer and Jobb 2007, Westfall and Ebata 2012). Changes in climatic conditions resulting in an increase in weather conditions favourable to Dothistroma Needle Blight (warmer and drier) and extensive stands of lodgepole pine are likely causes of rapid and intensive infestation of this disease (Brouwer and Jobb 2007). Management strategies are currently being developed and implemented in northwest BC, however it was increased damage was anticipated in 2012 due to the very wet growing season (Westfall and Ebata 2012).

5.0 Human Environment

5.1 Cultural Overview

British Columbia is an area of extreme environmental diversity. A landscape carved by glaciers and tread upon by the earliest peoples of North America. This land of rugged mountains, temperate rain forests, subarctic tundra and pristine lakes and rivers, facilitated the emergence of equally unique and diverse First Nation groups. By utilizing the natural resources available to them, the native peoples of BC were able to survive and flourish for thousands of years prior to European contact.

Moreover, this area encompasses a landscape between two distinct culture areas and the First Nations that occupy this land exhibit cultural traits common to both the Northwest coast and Western subarctic. Examination of these cultural traits will illustrate the profound connection First Nations have to the land and how this connection manifests itself through their cultures.

5.1.1 Ethnographic Descriptions

Canada's First Nations are categorized by language families and culture areas. These broad definitions provide anthropologists and archeologists a convenient means for distinguishing between the innumerable First Nation groups and sub groups that comprise Canada's Native population. Within Canada eleven language families and six culture areas have been defined based on the linguistic and cultural similarities that exist between groups (McMillian and Yellowhorn 2004). British Columbia encompasses three of Canada's six culture areas; the Northwest coast, Western subarctic and Interior Plateau.

Canada's culture area classifications were first employed by Clark Wissler. Wissler found that groups occupying areas with access to the same resource; such as salmon, exhibited similarities in their social organization and culture. These cultural patterns could also be transmitted between neighboring groups through trade (McMillian and Yellowhorn 2004). While these anthropological classifications provide descriptive convenience they mask the variations present within each culture area. The lines that divide culture areas on a map ignore the broad sociocultural ties, which transcend classification, that link Aboriginal people across the continent. The First Nations that occupy the Cassiar Iskut-Stikine region are a perfect example of the cultural transmission and amalgamation that takes place between the bold lines of Canada's culture areas.

The Cassiar region is home to the Inland Tlingit Taku, Tahltan, Gitxsan, and Kaska-Dene Nations as shown on Map 5. These groups fall within the Northwest coast and Western subarctic culture areas and while a degree of variation does exist among them, they all share cultural elements.

5.1.2 The Cassiar Area: *Environmental Setting*

The Cassiar area lies in British Columbia's extreme northwest, dominated by the 640-kilometre long Stikine River (LeBlanc 1963). The Stikine River is the provinces fifth largest river and contains all five species of salmon. The area's rugged terrain combined with long cold winters made occupation and subsistence a difficult task for native groups. However, access to an abundance of salmon during their annual runs and the exploitation of a wide variety of resources allowed groups to survive the winter on food stores collected during the spring and summer months. The abundance of food was so great for groups living near salmon bearing waterways that they were able to flourish in much the same way as their Northwest coast neighbors.

5.1.3 Northwest Coast: *Cultural Elements*

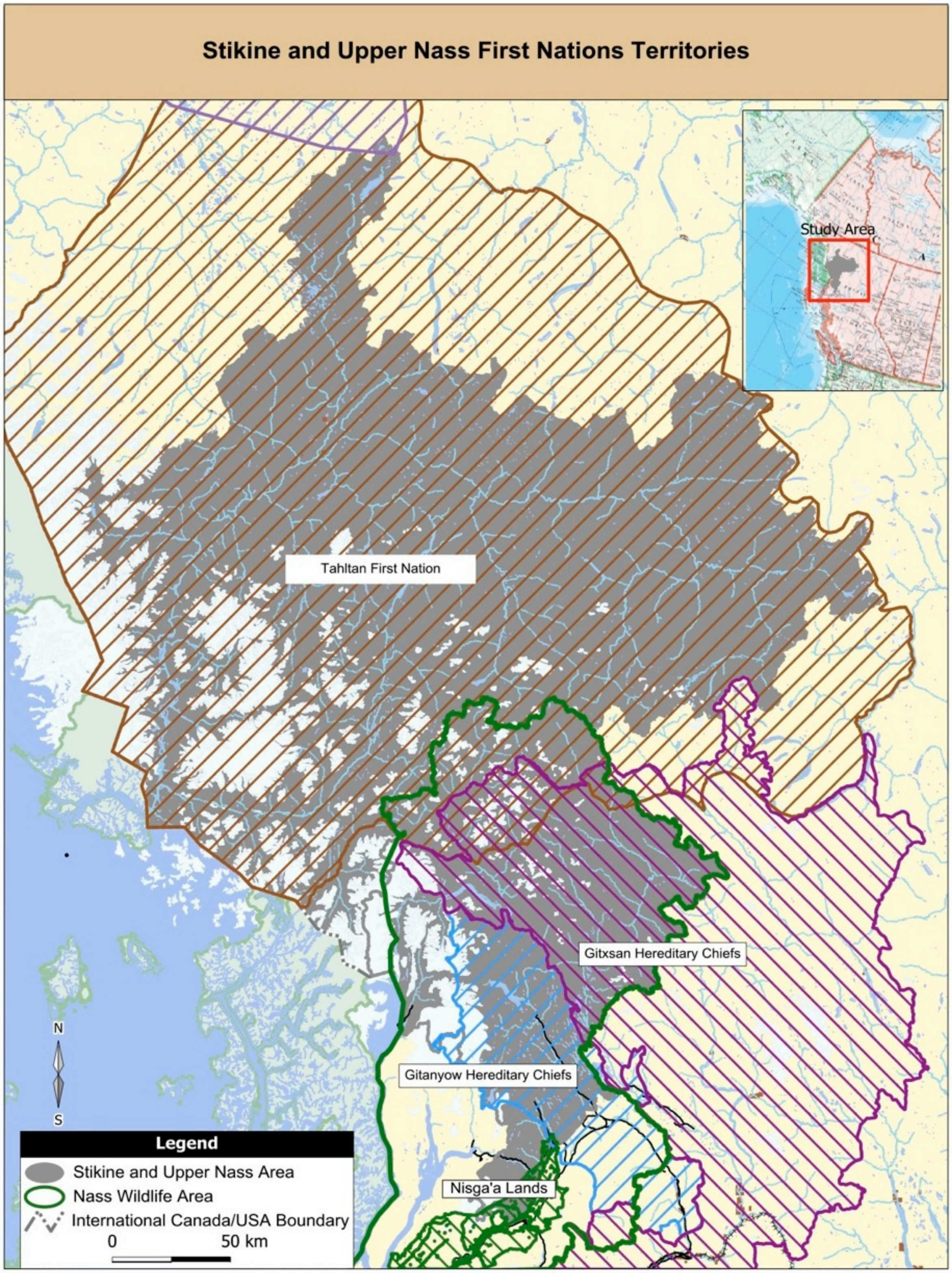
Northwest coast Native culture is characterized by large population densities, permanent settlements, rigid social organization, and the prolific use of wood as a building material (Budhwa 2009). First Nation groups with access to the sea exploited the abundant marine resources available to them, which in turn facilitated the emergence of highly complex societies. This social complexity arising from the exploitation of marine aquaculture could be compared to the use of agriculture in Mesopotamia and its role in the emergence of civilizations in Europe and Asia. With a reliable, abundant, and easily accessible food resource, coastal First Nations could engage in pursuits other than the gathering of food.

This specialization of labour resulting from a surplus of food, is reflected in the complex social organization of coastal groups, as well as, their elaborate wood art and ceremonies (McMillian and Yellowhorn 2004).

British Columbia's Northwest coast is known internationally for its native art. The cedar forest of BC's Northwest coast provided the basis for elaborate art and technologies that characterize Northwest coast people (McMillian and Yellowhorn 2004). Red wood cedar grows with a straight grain making it a near perfect medium for building shelters. Cedar bark could be used for weaving anything from toys for children, to clothing, nets for fishing, and large baskets used in the eulachon fishery (Laforet 1984). Cedar's use in Northwest coast art is prolific. The totem poles of the Haida are a perfect example of the complex artistry that characterizes the Northwest coast. This highly specialized art form, which depicts natural and supernatural beings carved into a standing cedar wood pole, is an artistic expression of the profound connection these First Nations people have with their land (Barbeau 1950).

The potlatch ceremony practiced by Northwest coast First Nations was central to maintaining their social hierarchy. These elaborate ceremonies involved the gathering of the entire community and the dispersal of wealth and food by high status individuals. Any event of social significance required a potlatch ceremony to validate its importance, including high status marriages, the birth of an heir, or the assumption of inheritance (McMillian and Yellowhorn 2004).

These feast ceremonies served as the political arena by which a house or chief could cement his social standing (Adams 1973). Potlatch ceremonies would begin in November and December after the gathering of food stores for the winter had ceased (De Laguna 1990). These ceremonies and indeed the entire social organization of coastal groups hinged on the gathering of massive amounts of food. This relationship between abundant food resources, increased social complexity, and potlatch ceremonies was repeated anywhere native groups were able to acquire a food surplus. This is especially true of groups living near salmon bearing waterways such as the Stikine River.



Map 5. First Nations Traditional Territories within the Stikine and upper Nass area.

Northwest Coast Culture Travels Upstream: *Cultural Similarities Between Coastal and Inland Groups*

Unlike other native groups occupying the Western subarctic culture area of Canada, the Cordilleran Athapaskan groups; such as the Talhtan of the Iskut-Stikine area, had access to salmon bearing rivers. Groups occupying this area made their homes along river systems where access fresh water, plant and animals foods were readily available (Budhwa 2009). Like their Northwest coast neighbors, Cordilleran Athapaskan groups maintained large permanent winter villages and enjoyed a more sedentary lifestyle than other Western subarctic groups. Their proximity to salmon bearing waterways was the primary factor in the emergence of cultural patterns similar to coastal groups.

The gathering of salmon during the spring and summer season, included a variety of fishing techniques including spears, nets, and various traps (DeLaguna 1990). While the men were engaged in fishing, women were given the important task of preserving and drying the salmon. The cycles of salmon runs dictated the economies of these groups and the lives of individuals (DeLaguna 1990). Houses, comprised of family units, were the main units of production and consumption of resources. Houses controlled territorial access to resources, which in turn, gave them power and control among their society. This correlation between access and control over resources and power within a society, mirrors the social organization of coastal groups. In both cases the internal social structure is intimately linked to the environments these groups inhabited (Rabnett 1990).

Cultural similarities between coastal and inland groups, is also a result of widespread trade among these neighboring groups. A vast network of trails connected native people together and facilitated the trade of environmentally specific resources; such as whale bone and eulachon oil. Trade allowed people to socialize and trade knowledge as well as goods, “Trade was personal, social and political. It mattered just as much whom you traded with as what you traded” (Crowe 1991). Many of these trade routes are known as “grease trails” a name deriving from the widespread trade of eulachon grease. Eulachon is a small fish prized for its oil. Eulachon oil or “grease” was a highly sought after commodity that helped to expand and accelerate trade between groups. During their annual runs eulachon bearing rivers became the “greatest aboriginal trading centers on the northern Northwest Coast” (Halpin and Seguin 1990).

With the arrival of Europeans in the late 18th century trade relationships between inland and coastal groups intensified. Trade between the coastal Tlingit and interior Tahltan resulted in the further adoption by this interior group of coastal cultural and social elements including potlatches and clan matrilineal moieties (McMillian and Yellowhorn 2004).

The European trade goods themselves also had a dramatic impact on native art. Metal carving tools gave native artists a greater degree of artistic expression. The increased complexity of native wood carving post-European contact is highly evident in the historical record. Art represented one’s wealth and status, and the increased complexity of art due to European trade goods resulted in an even more elaborate potlatch ceremonies. In some extreme cases, rather than dispersing wealth among their guests, chiefs would publicly destroy valuable objects. This was seen as the ultimate gesture of one’s immense wealth (McMillian and Yellowhorn 2004).

While potlatching did become a prominent feature of First Nations in the Stikine and upper Nass area, it never reached the same level of extravagance as it did on the Northwest coast.

5.1.4 Western Subarctic: *Cultural Elements*

Canada's Western Subarctic culture area stretches from the interior of Alaska to Hudson's Bay. Groups living in this area had to contend with long cold winters and the relative scarcity of resources in many areas. As with other culture areas, a great degree of cultural variation exists, from migratory hunters to the sedentary Cordilleran Athapaskan groups that occupy the Stikine and upper Nass area. Common among all these groups is the exploitation of a wide variety of resource for the purpose of subsistence. Although Cordilleran groups with reliable access to salmon runs enjoyed a considerably more comfortable lifestyle than the nomadic hunters of the subarctic plains, they also relied on a wide variety flora and fauna for survival. The collection of resources often occurred in an annual or seasonal cycle as with the salmon runs (Budhwa 2009).

Unlike their Northwest coast neighbors, inland groups were forced to leave their winter villages in the spring. Families would travel to their traditional fishing and hunting grounds and erect temporary settlements, comprised of plank walled huts and lean to's, while they focused on procuring enough food to last them the winter. In addition to fishing for salmon, Cordilleran groups also hunted a variety of terrestrial animals including caribou, mountain goats, sheep, moose, bears, and smaller game (McMillian and Yellowhorn 2004). Food animals also provided materials necessary for the construction of clothing, tools, and ornamentation (Rabnett 2000).

The variety of resources used by people occupying the Cordilleran range of the Western sub-arctic, is directly related to the environmental diversity of this area. The scarcity or

abundance of food at different times of year required these groups to develop a large variety of complex technologies for harvesting food (Rabnett 2000). In relation to groups occupying other culture areas, Western subarctic groups had the most complex and varied food gathering technologies (Oswalt 1976).

British Columbia's First Nations people were able to adapt and flourish in a multitude of different landscapes. BC's diverse environmental landscapes presented unique barriers to the subsistence and survival of native groups. The First Nations that occupy BC's Iksut-Stikine/Upper Nass area exemplify the ingenuity by which native people were able to adapt to their environment. The combination of cultural elements that comprise the Cordilleran Athapaskan cultures arose from the need to exploit a wide variety of resources. In addition to the environmental forces that shaped their culture, widespread trade of natural resources among neighboring groups also resulted in the adoption of cultural elements native to Northwest coast groups. In each case it was the particular environmental resources that directed the formation of First Nations cultures on the coast and inland. This correlation between environmental setting and cultural elements formed by the accessibility of particular resources illustrates the profound connection First Nations people have to their land.

5.2 Non-Aboriginal Historical Overview

The subject and spatial context is broken down into three historic development periods in the Stikine and upper Nass area since the mid-1800's including:

- 1850 to the late 1800's composed of fur traders and gold and mineral seekers;
- the late 1800's to the mid 1970's comprising construction of colonial structures, change in land and resource uses, and construction of access infrastructure;
- 1970's to the present composed mainly of forestry and mining activities.

For more in-depth discussion of the major historic periods the reader is directed towards Ball (1983) who provides an overview history to 1930; Hayward and Associates (1982), who considered environmental and social impacts to the proposed Iskut–Stikine hydroelectric development scheme; BC Ministry of Economic Development (1977) wherein the northwest BC resource base and social development are reviewed, and Bridges (2005) who conducted a social economic impact assessment on northwest BC mining projects and discusses communities and social impacts as well as selected developments and projected impacts.

5.2.1 Fur Trade

Russian, American, and European ships first arrived at the mouth of the Stikine River in 1799, and trade goods were distributed throughout the region prior to actual contact with European traders (Peyton 2011). Exploration during the early to mid-1800s was largely related to trapping for trade furs, thus attracting fur traders as the first Europeans to arrive in the Stikine and upper Nass area (Anonymous 2000, Ministry of Environment 2000). The Hudson's Bay Company operated in the Upper Stikine River area, while the Russian American Company handled maintained the Lower Stikine River.

In 1825 a treaty was signed between the Russians and British that defined boundaries between their territories. The Russians claimed the west coast inland as far as the summit of the Coastal Mountain range and the British claimed the interior (Ball 1983). It was another 20 years before Europeans moved up the Stikine River in the 1860s upon the discovery of placer gold near Telegraph Creek and Glenora. This discovery was the beginning of a 'boom and bust' pattern of population growth and resource development in the area (Anonymous 2000).

5.2.2 Telegraph Line/Trail

In 1866 the Western Union Telegraph Company planned to connect Europe and North America by a cable via the Bering Strait (named the Collins Overland Project). This project introduced the use of sternwheelers on the river, which carried telegraph wire and other construction materials to what is known as Telegraph Creek (Anonymous 2000, Ministry of Environment 2000). The installation of a wire from the United States to Telegraph Creek was as far as the project went, which was abandoned when a submarine transmission line had been deposited across the Atlantic (Anonymous 2000, Ministry of Environment 2000). Many of the men who were suddenly out of work in the late 1860s because of the cancelled telegraph project stayed in the area to prospect.

In 1900 the Collins Overland Project area surveyed was revisited, this time for a telegraph line connecting areas of southern BC to Whitehorse and Dawson City. Much of the same route was used in establishing the Yukon Dominion Telegraph trail, which operated until 1936 when wireless radio communication was adopted (Anonymous 2000, Ministry of Environment 2000). During the operation of the telegraph line, line cabins situated every 32km had to be manned and were serviced by pack trains from the Kispiox Valley (Ministry of Environment 2000).

5.2.3 Gold rush

Gold discovered on the Lower Stikine River in 1861 lead to the exploration of most of the Stikine drainage by 1878. From 1874 to 1876 the Cassiar gold rush attracted miners up the Stikine River to the Dease Lake area. The Dominion government became involved in development activity in the Stikine-Cassiar region by sending surveyors in to establish an All-Canadian route to the Yukon9. The main area used for travel would be the Telegraph Creek/Dease Lake corridor (Anonymous 2000, Ministry of Environment 2000).

Between 1897 and 1898 an estimated 6000 to 7000 people with herds of cattle, sheep and horses travelled to the Yukon gold fields through the Cassiar-Stikine region on the Teslin Trail. By 1899 the boom was over however, the establishment of Canadian sovereignty remained through the presence of a North West Mounted Police detachment on the Stikine River, a wharf and Indian Agent at Telegraph Creek (Ball 1983).

5.2.4 Hyland Post and Hyland Post Trail

In the 1920s, Hyland Post was established as a trading post by the Hyland brothers on the Spatsizi River. It represents the earliest European settlement in the Spatsizi area. The post was only used for a short time and abandoned by 1930. In 1948, Hyland Post was resurrected by Tommy Walker who started a guided hunting outfit in the area, which continues to be active today (Ministry of Environment 2000).

The Hyland Post Trail was a native trade and travel route likely established prior to European contact by aboriginal peoples and used between Caribou Hide and Telegraph Creek. The trail was later used by RCMP patrols, and continues to be used by guide-outfitters and recreationists (Ministry of Environment 2000).

5.2.5 Coldfish Lake Camp

Coldfish Lake camp/area on the Spatsizi Plateau has cultural importance to both aboriginal and non-aboriginal people. This area was important aboriginal hunting and fishing grounds, as it is close to a caribou migration route, and has ready access to fish in Coldfish Lake. Coldfish Lake

[9] This route became known as the Teslin Trail.

also became popular for hunting and fishing by visitors to the area when in 1948, Tommy and Marion Walker established a hunting outfit at Coldfish Lake on the Spatsizi Plateau (Henderson 2006). Coldfish camp was the base for the Walkers' hunting outfit until the guiding territory was sold in 1968. Coldfish Lake camp is now the owned by the Nature Trust with a 99-year lease given to BC Parks (Ministry of Environment 2000).

5.3 Historical Resource Development and Use

5.3.1 Hunting and Trapping

Hunting has always been an important sustenance activity for First Nations people in the Stikine and upper Nass area. Non-resident hunters began recognizing hunting values and opportunities following Andrew J. Stone's 1896 to 1902 expeditions to the area to collect specimens for the American Museum of Natural History. It was during these expeditions that he identified a number of 'new' species of sheep and caribou. In the early to mid-20th century, locally guided hunts in the Iskut-Stikine/Upper Nass area became a more prominent business (Ministry of Environment 2000).

Permanent guide-outfitting camps became a feature of the Spatsizi area after the Second World War in 1948 when the Walkers set up a permanent camp at Coldfish Lake and took over the abandoned Hyland Post. Other guide-outfitters established in the area at this time included the Love Brothers and Lee who had the territory in the Upper Finlay River (Ministry of Environment 2000). Currently there are many guide outfitter and trapline territories in the Stikine and upper Nass area (refer to Appendix V, Map 7 for a map of outfitter territories and traplines in the study area).

5.3.2 Mining

Prospecting and mining during successive gold rushes in the Stikine, Cassiar and Yukon regions were an important factor in the initial development of the Stikine area. Prospectors also brought diseases with them that decimated the Tahltan people of the Stikine area and disrupted their traditional lifestyle and trading patterns. Following the gold rush boom, Scannell (2012) notes a significant number of mines were developed in Iskut-Stikine area and adjacent drainages however many of these mines were abandoned due to a lack in mineral recovery or unprofitable exploration; many of these historic mine sites remain undocumented.

Prospecting and mineral exploration continued in the Stikine area following the gold rushes of the 19th century. The Groundhog coal reserves in the Klappan River were discovered in the early 1900s and a railway to them from Stewart was started in 1908, but only a few miles of track were ever laid. There was also extensive exploration related to the Groundhog coalfield in the upper Stikine and Finlay drainages (Ministry of Environment 2000). Since the 1980s four major mines have closed: Eskay Creek (Unuk drainage), Snip (Iskut drainage), Johnny Mountain (Iskut drainage) and Golden Bear (Shelsay drainage). There are several proposed mines and a considerable number of sites in the advanced stages of exploration (refer to Appendix 6 for current and proposed mines in the Stikine and upper Nass area).

5.3.3 Transportation

In 1923, a wagon trail was constructed from Telegraph Creek to Dease Lake allowing freight to be hauled by trucks. By 1928 the industrial movement was evolving and supply deliveries became common to and from the north. The Stikine River, Telegraph Creek and Dease Lake grew to be important transportation linkages between the south and northern interior of BC via steamboats and overland travel. Supplies brought in serviced miners, hunters and others attempting to exploit newly discovered natural resources (Ball 1983).

The construction of the Alaska Highway introduced a brief influx people between 1941 and 1942, and the Stikine River was used to transport heavy equipment and supplies (Anonymous 2000). In 1969 established means of river travel was replaced by float planes and helicopters (Peyton 2011). Highway 37 was slowly built southward starting in the late 1950s and officially opened in the early-1970s. Highway 37, which connects Highway 16 in the south with the Alaskan Highway in the Yukon, is the major infrastructure development in the study area. The highway is for the most part built on top of ancient Tahltan trails.

In the 1970s, BC Rail planned to extend a line from Fort St. James northwest to Dease Lake to promote trade and resource development in the Cassiar area; the railway was not completed but the grade and a bridge were constructed through the heart of the Stikine watershed (Ministry of Environment 2000). The rail grade enhanced access to the headwaters of the Stikine, Skeena and Nass rivers (Sacred Headwaters) thus facilitating exploration for miners, hunters and other outdoors enthusiasts (Bustard pers. com.10)

The B.C. Rail Dease Lake Extension was initiated in the early 1970s, but this project was abandoned in 1976 due to concerns regarding the lack of strategic planning, massive cost overruns, and environmental impacts, some of which persist into the present. The rail grade was constructed overtop of main trails, village sites, and graveyards.

Also during the 1970s, another population boom began as homesteaders from southern BC and the US settled into the Iskut-Stikine area Ministry of Environment 2000). Until the 1980s, most of the population, native and non-native, harvested game, fish and berries from the land in order to survive; today, subsistence continues to be an important way of life to the local populations Ministry of Environment 2000).

Presently, Highway 37 transportation amenities include services in Dease Lake, Kluachon Center, Bell 2 Lodge, and Tatogga Lodge, which offers seasonal services. The Bob Quinn highways maintenance camp was established in the early 1970s. Bob Quinn Airstrip was built adjacent to the highway in 1990—91. The Bell 2 commercial center was established in the early 1980s. Bell 2 Lodge, the site of an earlier highways camp, has a backcountry use tenure with heli-skiing the main activity and also offering seasonal guided sport fishing opportunities.

[10] Personal communication with Dave Bustard, December 3, 2012.

5.3.4 Forestry

Forestry practices began in the Upper Nass in the 1970s following the expansion of the Highway 37 corridor. A network of logging roads and cutblocks have heavily impacted the area. From the late 1980s through to the late 1990s clearcut forestry resulted in approximately 23 cutblocks south of the Bell 2 crossing, and 14 cutblocks developed in the Bob Quinn area. Since 2000, forestry development activities have occurred at a more relaxed pace due to market downturns, a lack of easily accessed merchantable timber, and the closure of the Port Edward pulp mill.

5.3.5 Energy

In 1955, Northwest Power proposed a hydroelectric scheme on the Nass system, with the main dam and powerhouse located 18 km upstream of New Aiyansh and a storage dam on Bell Irving River downstream of the Bowser, and another storage dam on the Nass downstream of Meziadin confluence (Withler 1956).

In the late 1970s, the Stikine-Iskut hydroelectric generation and transmission development was proposed. This concept envisioned two dams on the Stikine River and three dams on the Iskut River and tributaries to produce hydroelectric energy; however, the project was aborted due to local opposition, uncertain energy demands, and relatively high transmission costs.

A micro-hydro project on Hluey Lake in the Tanzilla River watershed, a tributary to the Stikine River, has recently been developed with involvement of the Tahltan First Nation. This project is one of the few industrial projects in the Cassiar area but is unlikely to have significant downstream effects on the Tanzilla and Stikine rivers (Ministry of Environment 2000).

In 2004, the BC Ministry of Energy, Mines and Petroleum Resources granted a lease to Shell Canada that enabled coalbed methane (CBM) exploration activities in the upper Klappan, upper Spatsizi, upper Nass, and upper Skeena areas. In 2004, Shell established and drilled three exploratory wells in the upper Klappan and Spatsizi drainages adjacent to the B.C. Rail grade. In December 2012 following a four-year moratorium, the BC government rejected any coal bed methane project development in the Sacred Headwaters area.

In 2005, the Northwest Transmission Line (NTL) was proposed by B.C. Government to increase mineral resource development. According to the governments of BC and Canada, the NTL is an important step towards building a powerline that has the potential to generate billions of dollars in capital investment, create thousands of new jobs, and open economic opportunities on a global scale in the Northwest (BC MEMPR 2009).

6.0 Recreational Values

6.1 Protected Areas

Designated protected areas are an important step in the conservation of highly valued ecosystem components and culturally significant sites. Protected areas also cultivate and instil stewardship and offer recreational opportunities. Within the Stikine and upper Nass area, there are a number of contiguous provincially designated areas shown in Map 1. These areas were identified and designated for their natural, cultural heritage and/or recreational values, in accordance with the Provincial Protected Areas Strategy. Logging, mining and hydroelectric development are prohibited in all Protected Areas (Anonymous 2000).

Each of the protected areas in the Stikine and upper Nass area were designated based on outstanding features such as predator/prey systems, or volcanic landscapes that conserve cultural and ecological values and ensure vital habitat remains intact. Table 8 summarizes protected areas found within the study area.

Table 8. Protected Areas within the Stikine and upper Nass study area.

Iskut-Stikine Protected Areas	Nass Protected Areas
Mount Edziza Provincial Park	Damdochax Protected Area
Spatsizi Plateau Wilderness Provincial Park	Ningunsaw Provincial Park
Stikine River Provincial Park	Ningunsaw River Ecological Reserve
Gladys Lake Ecological Reserve	
Kinaskan Lake Provincial Park	
Todagin South Slope Provincial Park	
Pitman River Protected Area	
Chukachida Protected Area	

While five protected areas, Mount Edziza, Stikine River, Spatsizi Plateau Wilderness, Todagin South Slope and Ningunsaw protect important habitat in the Stikine and upper Nass area, very little of the lower Stikine and upper Nass rivers and valley bottoms are protected, leaving critical wildlife habitat vulnerable to industrial and linear development (Ministry of Environment 2000).

6.2 Recreational Opportunities

The Stikine and upper Nass area has extensive areas of wilderness, remote rivers, abundant wildlife and striking viewscapes, all of which provide excellent conditions for backcountry recreation and a strong local nature-based tourism sector. Commercial backcountry tourism plays an important role in the local economy, after major mining projects. Recreational activities include hunting, trapping, and fishing, which are also important activities for the Tahltan people. Recreation opportunities that exist in the study area include hunting and wildlife viewing, hiking, river and lake paddling, mountain biking, fly-fishing, and horse trips in the remote backcountry. Sportfishing and hunting are the main economic drivers of recreational activity in the area. The scenery and visual quality along travel corridors in the area is highly valued, including areas along popular trails, roadways, and rivers used by recreationists (Anonymous 2000).

7.0 Current and Proposed Development

The Stikine and upper Nass study area holds highly valued natural resources, including large, intact wilderness areas, a great diversity of wildlife, high mineralization and potential for mineral development, and largely undeveloped timber resources with the exception of the upper Nass area. Despite being a remote wilderness are with high cultural and ecological values, there is an extensive amount of proposed and existing forestry, mining and energy development within the Stikine and upper Nass study area (refer to Appendix V, Map 8 for an overview of all current and proposed development in the study area).

7.1 Forestry

Forest development activities primarily involve road construction and logging in a progressive clearcut pattern. Since the early 1960s, forestry has and continues to be active in the upper Nass area northward to Meziadin Lake both east and west of Highway 37. In the mid-1980s to the late 1990s, logging in the Nass TSA was focused north of Meziadin to Bell 2, adjacent to Highway 37 in valley bottom good growing sites. However, there have been difficulties establishing new plantation crops, especially in the Bell Irving drainage (BC Ministry of Forests 1993).

Natural stands and clearcut plantations in the Nass Basin have been severely damaged by Dothistroma needle blight, which is thought to have emerged and driven by changing climate (Welsh *et al.* 2009). BC Ministry of Forests (2001) report timber inventories are uncertain as to volumes/ha, which may be overstated due to a variety of problems including balsam beetle outbreaks that may reduce the volumes by up to 20%. Logging occurred at an unsustainable and high rate of cut of approximately 0.5 million cubic meters per year. Since 2000, forestry development activities have occurred at a more relaxed pace due to market downturns, a lack of easily accessed merchantable timber, and the closure of the Port Edward pulp mill and more recently, the closure of the Eurocan pulp mill in Kitimat.

In the Iskut drainage, logging in the late 1980s through to 2000 resulted in approximately 14 cutblocks developed in the Bob Quinn area and 8 cutblocks in south of Natadesleen Lake. Recently, there has been logging activity around the Bob Quinn area and licensees are proposing forest developments north to the Kinaskan area.

The most recent volume of timber harvested per year in the Cassiar and Nass Timber Supply Area (TSA) are shown in Table 8 and 9. The Stikine portion of the study area falls into approximately two thirds of the Cassiar TSA, and the Nass TSA encompasses the entire upper Nass.

Table 8. Volume of timber harvested per year in the Cassiar TSA.

Tree Species	2012 Volume (m^3/year)	2013 Volume (m^3/year)
Balsam	21,571	7,548
Birch	133	n/a
Cottonwood	134	410
Hemlock	126,966	275

Tree Species	2012 Volume (m^3/year)	2013 Volume (m^3/year)
Pine	40,418	25,111
Spruce	112,011	32,489
TOTAL	**301,233**	**65,833**

Table 4. Volume of timber harvested per year in the Nass TSA.

Tree Species	2012 Volume (m^3/year)	2013 Volume (m^3/year)
Balsam	8,265	14
Cottonwood	239	169
Hemlock	7,868	57
Pine	540	589
TOTAL	**29,234**	**829**

7.2 Mining

Currently, there are no fully operational mines within the Stikine and upper Nass study area, however there are five proposed mines – Schaft Creek, Galore Creek, Red Chris, Mount Klappan Coal and Kerr-Sulphurets-Mitchell (KSM) – and at least 25 sites in the advanced stages of exploration. Other than Mt. Kalppan coal, these proposed mines are located in the “Golden Triangle” a copper-gold belt that in the recent pass has supported the Eskay, Johnny Mountain, and Snip mines. Figure 70 shows the general location of these proposed developments.

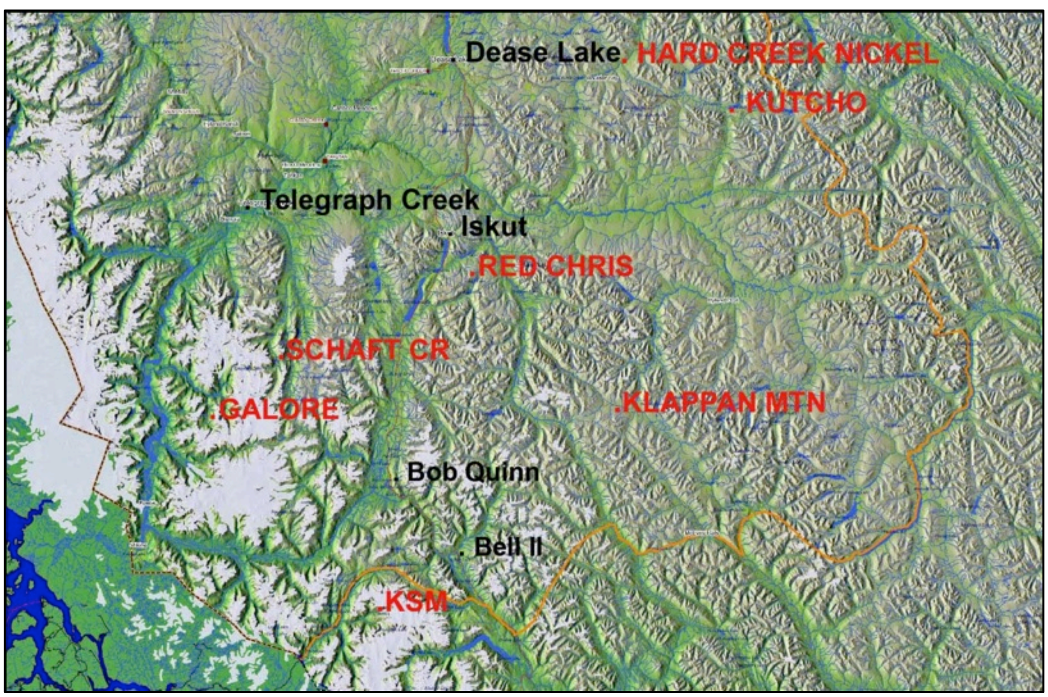


Figure 70. Location of currently proposed mines.

7.2.1 Schaft Creek Mine

Copper Fox Metals Ltd. has proposed the Schaft Creek project, a projected 150,000 tonnes per day open-pit copper-gold-molybdenum-silver mine located in Tahltan Nation territory. The proposed mine is located immediately west of Mount Edziza Provincial Park. RTEC (2008) notes that over a mine life of roughly 15 years, potential acid generating (PAG) waste rock dumps positioned on the Schaft Creek floodplain will likely become a major contamination source to the Stikine watershed. The relatively large proposed waste rock dumps are proposed to be located just right of the foreground in Figure 71, which illustrates Schaft Creek fan as it enters Mess Creek valley and also the massive amount of sediment generated by glacial action. Schaft Creek drains into Mess Creek, a tributary flowing into the Stikine River just downstream of Telegraph Creek. The project is located upstream in the Telegraph Creek Community Watershed, which supplies the domestic water for Telegraph Creek.

Figure 71. View southwest across Schaft Creek fan and floodplain.

Rabnett (2012 pers comm) noted mineral exploration and development and surveys conducted to support the environmental assessment application generated large amounts of helicopter traffic, which has heavily disturbed wildlife distribution and well-being, as well as disrupting the local guide outfitter operations. Rabnett (2012 pers comm) suggests that local and adjacent wildlife, especially the abundant populations in Mount Edziza Provincial Park will be displaced and diminished by the proposed mining activities leading to the question. The Schaft Creek mine concept is likely to be modified due to conservation issues concerning wildlife, which have protected areas status in Mount Edziza Park and PAG rock issues impacting the international PST that guarantees sockeye allocations to American and Canadian fishers.

7.2.2 Galore Creek Mine

NovaGold Resources Inc on behalf of Galore Creek Mining Corporation (GCMC) has proposed a 65,000 tonnes per day copper-gold-silver mine located in Tahltan Nation territory. . The mine extraction, mineral processing, waste rock and tailings disposal sites and permanent camp facilities will be located in the Galore Creek valley. This glacially scoured U-shaped valley flows northwards to the Scud River, which in turn flows westward into the Stikine River. The Galore Creek valley is surrounded on three sides by high, rugged and ice-capped mountains of the Coast Range reaching elevations of over 2,000 m.

The proposed Galore Creek mine will potentially impact Galore Creek and Scud River, which flows into the Stikine River. CEAA (2007) notes the proposed mine will generate approximately 900 million tonnes of waste rock and approximately 475 million tonnes tailings over the course of an approximate 20-year lifespan, with roughly half being acid generating The Galore Creek developments are shown in Figure 72 (NovaGold 2013). Due to the massive amount of PAG waste rock and tailings, the tailings impoundment at the end of mine life will be approximately 2.6 km in length, 1.5 km wide and 200 m above the existing valley bottom. The 140 km long road and mostly adjacent transmission line are anticipated to bisect and fragment critical wildlife habitat.

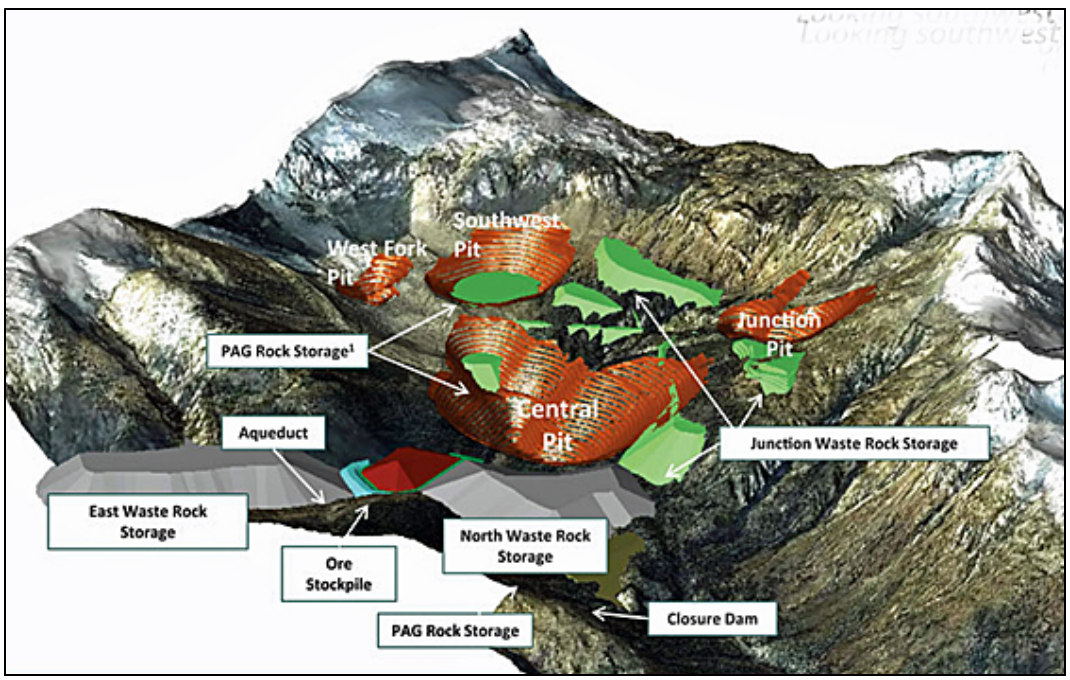


Figure 72. Proposed mine development in Galore Creek.

The Galore Creek project was approved by BC and Canada in early 2007. Approximately half the road was built in 2008; however the global economic downturn caused NovaGold to halt all development except for minor amounts of access road construction. In 2011, AMEC (2011) conducted prefeasibility report incorporating a mining and operating facility processing on average 84,000 tonnes of ore per day, with a nominal 95,000 tonne-per-day capacity. Highlights of the new proposed mine plan includes four open pits, a 13.6 km long tunnel to the transport crushed ore to a mill and tailings impoundment complex at Round Lake located in the headwaters of West More – Sphaler creeks. The Round Lake development will include a camp and 287 kV substation. The road and transmission line will follow the original route down Sphaler to porcupine River then to Galore Creek. Water management within Galore Creek watershed will be a major design challenge throughout the life of the mine, reclamation, and the flooded PAG waste rock facility. Given the new proposed mine design; a new environmental assessment process will need to be established. Currently, the NovaGold website (http://www.novagold.com/section.asp?pageid=22238) notes NovaGold is evaluating opportunities to sell all or a portion of its interest in Galore Creek.

7.2.3 Red Chris Mine

Imperial Metals Corporation has proposed a 30,000 tonnes per day open-pit copper-gold mine located 18 km southeast of the community of Iskut on Tahltan Nation territory on Todagin Plateau. Over the approximate 30-year life of mine, Imperial Metals (2013a) notes recovered metal in concentrate would total 2.08 billion lbs copper and 1.324 million oz gold. At the October 2010 monthly average metal prices, project payback is estimated at 1.87 years with a capital cost of C$443 million. This means enormous wealth will be generated for the remaining 25 years.

Mineable reserves are approximately 301 million tonnes at 0.359% copper and 0.247g/t gold (Imperial Metals 2012). The mine would generate roughly 183 million tonnes of tailings and 307 million tonnes of waste rock (Imperials Metals 2013). Tailings will be placed in the tailings facility dug out of Black Lake and the surrounding valley bottoms; Black Lake is shown in Figure 73 and adapted from Klabona Keepers (2006). Rabnett (2013 pers comm) notes high value terrestrial, aquatic, and human ecosystems, particularly in the Todagin drainage will be severely impacted and disrupted by mine infrastructure, operations, and associated hydrological alterations. Currently, the proposed Red Chris Mine has challenges with water management issues that are forestalling federal regulatory permits. For more detailed information, Imperial Metals presents comprehensive plans at: http://www.imperialmetals.com/i/pdf/2012-Red-Chris-43-101-Report.pdf.

Figure 73. View southwest across Black Lake (adapted from Klabona Keepers 2006).

Imperial Metals (2013b) recently announced it has entered into a Transmission Development Agreement with BC Hydro for the construction of a transmission line (NTL Extension) that will extend the 287kV Northwest Transmission Line (NTL) in northwest British Columbia from Bob Quinn to Tatogga, a distance of approximately 93 km.

The NTL Extension will be constructed by a subsidiary of Imperial. Upon completion, the NTL Extension will be acquired by BC Hydro. That portion of the costs which exceed $52.0 million will be borne by Imperial as its contribution to the NTL Extension in order to make the 287 kV service connection to the Red Chris Mine. In addition, Imperial will contribute to the cost of building the NTL through a special tariff approved by the BC Utilities Commission. The expected in service date for both the NTL Extension and the NTL is May 31, 2014. Construction will commence upon receipt of required permits (Imperial Metals 2013b).

Rabnett (2013 pers comm) notes there are public interest issues with the proposed transmission line including the following questions:

- The lack of an Environment Assessment review (Kathy Eichenberger-BC EAO) promised that when the NTL Environment Assessment was ongoing;
- The lack of understanding regarding the $130 million the federal government contributed to the NTL to move power to Iskut under the Green Infrastructure fund;
- Implications of BC Hydro not designing, not planning, and not implementing construction as is typical in BC;
- Public interest in regard to the proposed transmission line include: the location, environmental issues and concerns, social concerns, heritage issues such as impacts to the Telegraph Trail, and economic concerns such as what type of 287 kV service will be available north of Tatogga.

7.2.4 Mount Klappan Mine

Fortune Minerals has proposed the Mount Klappan coal project, an open-pit anthracite metallurgical coal mine located in the upper Klappan and in the heart of the Sacred Headwaters (TCC & ILMB 2008). The 15,000 ha licence to create this mine would in effect dismantle Mount Klappan within a few decades. The Mount Klappan coal project will cause major habitat fragmentation as well as other deleterious ecological effects. The Pembina Institute (2008) reports the exportation of Mount Klappan coal to produce steel proposed by Fortune Minerals could contribute 10.5 million tonnes of greenhouse gas emissions annually to the atmosphere. TCC & ILMB (2008) results indicate Tahltan use areas would be heavily impacted, wildlife values would be impacted and would not recover within the 50-year modeling interval, and estimated effects on surface hydrology around large footprint activities such as Mount Klappan would be difficult to manage.

7.2.5 Kerr–Sulphurets–Mitchell Mine

Seabridge Gold has proposed a large-scale open-pit and underground copper-gold-silver mine situated on Sulphurets Creek in the Boundary Ranges near the headwaters of Unuk River. The proposed mill complex and tailings facility is located on a tributary of Teigen Creek. The ore will be fed to a flotation mill which would produce a combined gold/copper/silver concentrate for transport by truck to the nearby deep-water sea port at Stewart, B.C. for shipment to a Pacific Rim smelter. The project is in the Environmental Assessment process, but the Application has not yet been made available on the BC EAO site. Access is proposed from Highway 37 close to Bell 2 for the tailings facility and access on the Eskay road, then crossing the Unuk River to gain access to the minesite.

Issues with the KSM project includes a lack of understanding how groundwater functions at the tailings impoundment, inadequate information regarding the underground mine plan, post-closure water management, and water quality characteristics from the water treatment plant. The Kerr–Sulphurets–Mitchell Mine (KSM) mine is expected to process 130,000 tonnes per day over a mine life of 55years. Rivers Without Borders (2011) notes that mineralized rock at the mine site has high sulfur content with a high probability for acid generation. Updated revised (2012) technical aspects of the proposed KSM Mine are available at: http://www.seabridgegold.net/ksm_engineer.php This project will pose a threat to water quality in two fish bearing river systems (Unuk and Bell Irving), fragment high-value grizzly bear and mountain goat habitat and increase industrial and marine traffic exponentially.

7.3 Energy

Currently there are at least 30 proposed and 16 existing industrial water licenses in the Stikine and Upper Nass areas as well as several proposed transmission lines including the NTL, Kutcho Creek, Forrest Kerr, Red Chris and the Connector to Galore Creek and KSM.

The AltaGas Iskut River hydroelectric project is located 40 km west of Bob Quinn Lake and consists of three separate hydroelectric facilities – Forrest Kerr, McLymont Creek and Volcano Creek – Forrest Kerr being the largest facility. The Forrest Kerr facility is a 195 MW run-of-river hydroelectric project with construction well underway. The facility will consist of a 15 m weir that dams a large portion of Iskut River and divert water through a 3 km tunnel as illustrated in Figure 74. To generate electricity, water will flow through turbines in an underground powerhouse and will be released into the river below the canyon.

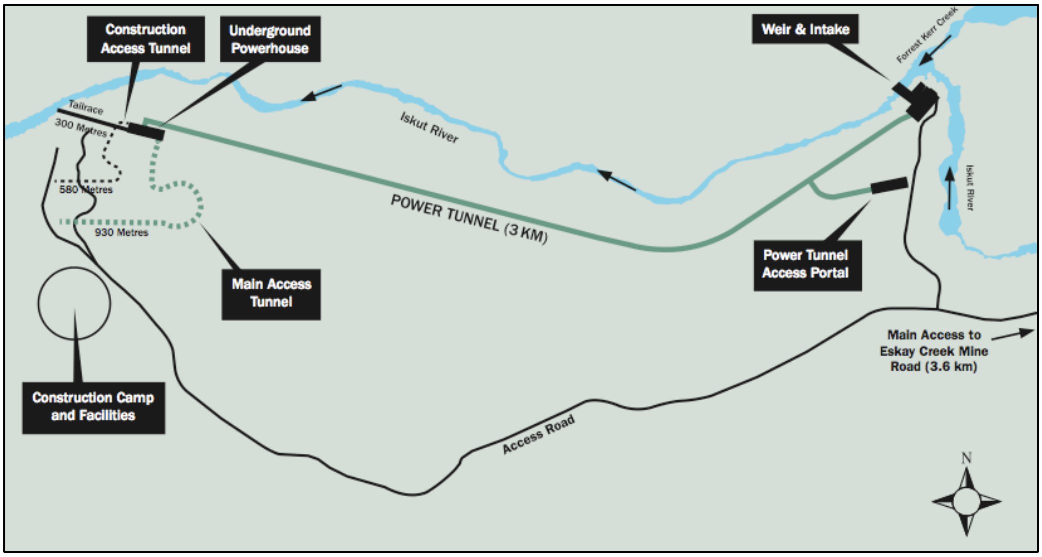


Figure 74. Forrest Kerr hydroelectric facility layout (adapted from AltaGas 2013).

It will deliver power to the grid at Bob Quinn Lake via the NTL. Rivers Without Borders (2011b) notes that construction of the tunnel at Forrest Kerr will generate 850,000 tonnes of waste rock which is untested for acid drainage potential. In addition to contamination by acid mine drainage, changes in flows may also impact salmon (specifically juveniles) and other aquatic species.

The AltaGas hydroelectric project will impact Iskut Canyon, lower Iskut River and as a result the Stikine watershed, and will contribute to cumulative effects in the broader region. This cluster of hydroelectric facilities acts as a catalyst for the construction of the NTL, consequently facilitating the potential for massive development in northwest BC, escalating cumulative impacts, and degrading valued ecological and cultural areas in the Stikine and upper Nass regions.

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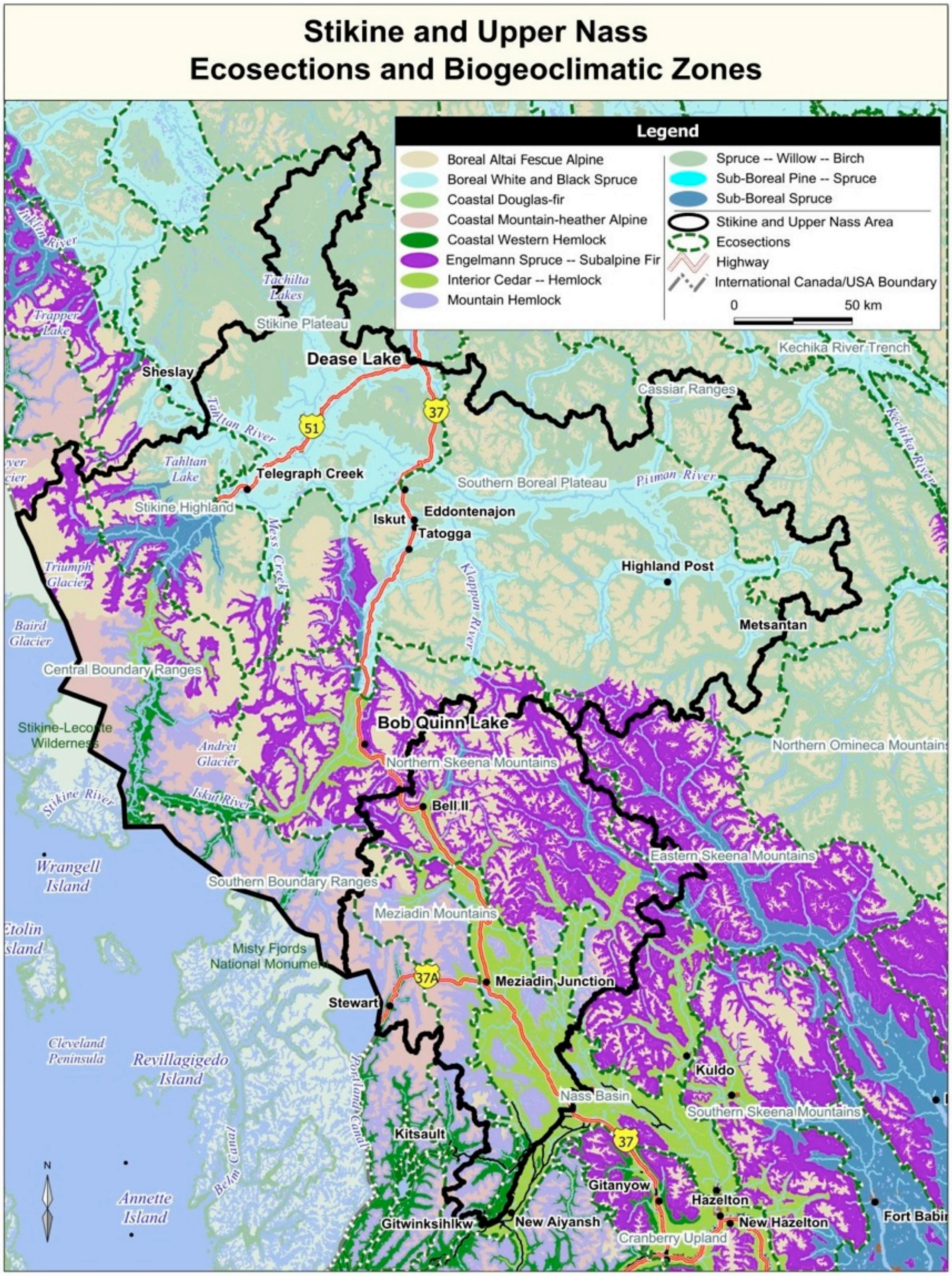
APPENDICES

Appendix I: Map of BEC zones within the Stikine and upper Nass study area.



Map 6. BEC zones within the Stikine and upper Nass study area.

Appendix II: Provincially-listed plant species that may be present in the Stikine and upper Nass study area.

Table A1. Provincially-listed vascular plants potentially occurring in Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Botrychium ascendens	upswept moonwort		Red	
Botrychium crenulatum	dainty moonwort		Blue	
Botrychium montanum	mountain moonwort		Red	
Botrychium pedunculosum	stalked moonwort		Red	
Botrychium yaaxudakeit			Blue	
Dryopteris cristata	crested wood fern		Blue	
Gymnocarpium jessoense ssp. *parvulum*	Nahanni oak fern		Blue	
Woodsia alpina	alpine cliff fern		Blue	
Pinus albicaulis	whitebark pine	E (Apr 2010)	Blue	1-E (Jul 2012)
Aphragmus eschscholtzianus	Eschscholtz's little nightmare		Blue	
Artemisia alaskana	Alaskan sagebrush		Blue	
Artemisia furcata	three-forked mugwort		Blue	
Astragalus umbellatus	tundra milk-vetch		Blue	
Callitriche heterophylla var. *heterophylla*	two-edged water-starwort		Blue	
Caltha palustris var. *radicans*	yellow marsh-marigold		Blue	
Castilleja hyperborea	northern paintbrush		Blue	
Chamaerhodos erecta ssp. *nuttallii*	American chamaerhodos		Blue	
Chrysosplenium wrightii	Wright's golden-saxifrage		Red	
Cicuta virosa	European water-hemlock		Blue	
Cornus suecica	dwarf bog bunchberry		Red	
Descurainia sophioides	northern tansy mustard		Red	
Diapensia obovata	diapensia		Blue	
Douglasia gormanii	Gorman's douglasia		Red	
Draba cinerea	gray-leaved draba		Blue	
Draba corymbosa	Baffin Bay draba		Blue	
Draba fladnizensis	Austrian draba		Blue	
Draba glabella var. *glabella*	smooth draba		Blue	
Draba lactea	milky draba		Blue	

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Draba lonchocarpa var. *thompsonii*	lance-fruited draba		Blue	
Draba lonchocarpa var. *vestita*	lance-fruited draba		Blue	
Draba palanderiana	Palander's draba		Red	
Draba porsildii	Porsild's draba		Blue	
Draba ruaxes	coast mountain draba		Blue	
Draba stenopetala	star-flowered draba		Red	
Draba ventosa	Wind River draba		Blue	
Epilobium davuricum	northern swamp willowherb		Red	
Epilobium hornemannii ssp. *behringianum*	Hornemann's willowherb		Blue	
Epilobium leptocarpum	small-fruited willowherb		Blue	
Erigeron uniflorus var. *eriocephalus*	northern daisy		Blue	
Eutrema edwardsii	Edwards wallflower		Blue	
Gentianella tenella ssp. *tenella*	slender gentian		Red	
Geum rossii var. *rossii*	Ross' avens		Blue	
Lomatogonium rotatum	marsh felwort		Blue	
Lupinus kuschei	Yukon lupine		Blue	
Micranthes hieraciifolia	hawkweed-leaved saxifrage		Red	
Micranthes nelsoniana var. *carlottae*	dotted saxifrage		Blue	
Micranthes razshivinii	large-petalled saxifrage		Red	
Micranthes tenuis	slender saxifrage		Red	
Minuartia arctica	Arctic sandwort		Red	
Minuartia elegans	northern sandwort		Blue	
Minuartia stricta	rock sandwort		Blue	
Montia bostockii	Bostock's montia		Blue	
Oxytropis campestris var. *davisii*	Davis' locoweed		Blue	
Oxytropis campestris var. *jordalii*	Jordal's locoweed		Blue	
Oxytropis maydelliana	Maydell's locoweed		Blue	
Oxytropis scammaniana	Scamman's locoweed		Blue	
Packera ogotorukensis	Ogotoruk Creek butterweed		Red	
Papaver alboroseum	pale poppy		Blue	

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Parrya nudicaulis	northern parrya		Red	
Pedicularis parviflora ssp. *parviflora*	small-flowered lousewort		Blue	
Pedicularis verticillata	whorled lousewort		Blue	
Penstemon gormanii	Gorman's penstemon		Blue	
Physaria arctica	arctic bladderpod		Blue	
Pinguicula villosa	hairy butterwort		Blue	
Plantago eriopoda	alkali plantain		Blue	
Polemonium boreale	northern Jacob's-ladder		Blue	
Polygonum humifusum ssp. *caurianum*	Alaska knotweed		Blue	
Potentilla biflora	two-flowered cinquefoil		Blue	
Potentilla elegans	elegant cinquefoil		Red	
Potentilla nivea var. *pentaphylla*	five-leaved cinquefoil		Blue	
Primula cuneifolia ssp. *saxifragifolia*	wedge-leaf primrose		Blue	
Ranunculus pedatifidus ssp. *affinis*	birdfoot buttercup		Blue	
Ranunculus sulphureus	sulphur buttercup		Blue	
Rumex arcticus	arctic dock		Blue	
Sagina nivalis	snow pearlwort		Blue	
Salix petiolaris	meadow willow		Blue	
Salix raupii	Raup's willow		Red	
Salix setchelliana	Setchell's willow		Blue	
Saussurea angustifolia var. *angustifolia*	northern sawwort		Red	
Saxifraga serpyllifolia	thyme-leaved saxifrage		Blue	
Senecio sheldonensis	Mount Sheldon butterweed		Blue	
Silene drummondii var. *drummondii*	Drummond's campion		Blue	
Silene involucrata ssp. *involucrata*	arctic campion		Blue	
Silene ostenfeldii	Taimyr campion		Blue	
Tephroseris frigida	purple-haired groundsel		Blue	
Tephroseris lindstroemii	northern groundsel		Blue	
Tephroseris palustris	marsh fleabane		Red	
Tephroseris yukonensis	Yukon groundsel		Blue	
Arctophila fulva	pendantgrass		Blue	
Carex adusta	lesser brown sedge		Red	

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Carex bicolor	two-coloured sedge		Blue	
Carex enanderi	Enander's sedge		Blue	
Carex fuliginosa ssp. *misandra*	short-leaved sedge		Blue	
Carex incurviformis var. *incurviformis*	curved-spiked sedge		Blue	
Carex krausei	Krause's sedge		Blue	
Carex lenticularis	lakeshore sedge		Blue	
Carex membranacea	fragile sedge		Blue	
Carex rupestris ssp. *rupestris*	curly sedge		Blue	
Carex tenera	tender sedge		Blue	
Eleocharis kamtschatica	Kamchatka spike-rush		Blue	
Festuca minutiflora	little fescue		Blue	
Glyceria pulchella	slender mannagrass		Blue	
Juncus albescens	whitish rush		Blue	
Juncus arcticus ssp. *alaskanus*	arctic rush		Blue	
Juncus stygius	bog rush		Blue	
Luzula confusa	northern wood-rush		Blue	
Luzula groenlandica	Greenland wood-rush		Blue	
Luzula kjellmaniana	Kjellman's wood-rush		Blue	
Luzula nivalis	arctic wood-rush		Blue	
Malaxis brachypoda	white adder's-mouth orchid		Blue	
Malaxis paludosa	bog adder's-mouth orchid		Blue	
Poa abbreviata ssp. *pattersonii*	abbreviated bluegrass		Blue	
Poa eminens	eminent bluegrass		Blue	
Poa pseudoabbreviata	polar bluegrass		Blue	
Potamogeton perfoliatus	perfoliate pondweed		Blue	
Stuckenia vaginata	sheathing pondweed		Blue	
Tofieldia coccinea	northern false asphodel		Blue	
Trichophorum pumilum	dwarf clubrush		Blue	

Table A2. Provincially-listed non-vascular plants occurring in the Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Amblyodon dealbatus			Blue	
Andreaea rupestris var. *papillosa*			Red	
Brachythecium trachypodium			Blue	
Bryhnia hultenii			Red	
Bryoerythrophyllum ferruginascens			Red	
Bryum arcticum			Red	
Bryum schleicheri			Blue	
Cinclidium arcticum			Blue	
Cynodontium glaucescens			Blue	
Dicranodontium asperulum			Blue	
Didymodon asperifolius			Blue	
Didymodon johansenii			Blue	
Encalypta brevicollis			Blue	
Encalypta brevipes			Blue	
Hygrohypnum alpestre			Blue	
Hygrohypnum alpinum			Blue	
Hygrohypnum polare			Red	
Hypnum holmenii			Blue	
Lescuraea saxicola			Blue	
Mnium arizonicum			Blue	
Myurella sibirica			Red	
Oreas martiana			Red	
Orthothecium strictum			Blue	
Orthotrichum pallens			Blue	
Orthotrichum pylaisii			Blue	
Orthotrichum rivulare			Blue	
Pleuroziopsis ruthenica			Blue	
Pohlia crudoides			Blue	
Pohlia elongata			Blue	
Pohlia sphagnicola			Blue	
Pohlia tundrae			Red	
Pohlia vexans			Blue	
Pseudobryum cinclidioides			Red	
Pseudocalliergon turgescens			Blue	
Psilopilum cavifolium			Red	
Racomitrium panschii			Red	
Racomitrium pygmaeum			Blue	
Schistidium atrichum			Red	
Schistidium boreale			Blue	
Schistidium pulchrum			Blue	
Splachnum vasculosum			Blue	
Steerecleus serrulatus			Red	

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Tayloria froelichiana			Blue	
Tetraplodon pallidus			Red	
Timmia norvegica			Blue	
Tomentypnum falcifolium			Blue	
Tortula leucostoma			Blue	
Tortula obtusifolia			Blue	
Tortula systylia			Red	
Ulota curvifolia			Blue	
Warnstorfia trichophylla			Blue	
Warnstorfia tundrae			Red	

Table A3. Provincially-listed fungi potentially occurring in the Stikine and Upper Nass study area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Nephroma occultum	cryptic paw	SC (Apr 2006)	Blue	1-SC (Dec 2007)
Pseudocyphellaria rainierensis	oldgrowth specklebelly	SC (Apr 2010)	Blue	1-SC (Jul 2012)
Sclerophora peronella	frosted glass-whiskers	DD (May 2005)	Red	

Appendix III: Provincially-listed aquatic species that may be present in the Stikine and Upper Nass study area

Table A4. Provincially-listed fish species likely occurring within the Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Acipenser medirostris	Green Sturgeon	T (May 1987)	Red	1-SC (Aug 2006)
Thaleichthys pacificus	Eulachon	T (May 2011)	Blue	
Coregonus nasus	Broad Whitefish		Blue	
Coregonus sardinella	Least Cisco		Blue	
Oncorhynchus clarkii clarkii	Cutthroat Trout, *clarkii* subspecies		Blue	
Salvelinus confluentus	Bull Trout	SC (Nov 2012)	Blue	
Stenodus leucichthys	Inconnu		Blue	

Table A5. Provincially-listed amphibians likely occurring within the Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Ascaphus truei	Pacific Tailed Frog	SC (Nov 2011)	Blue	1-SC (Jun 2003)
Anaxyrus boreas	Western Toad	SC (Nov 2012)	Blue	1-SC (Jan 2005)

Appendix IV: Provincially-listed vertebrate and invertebrate species in the Stikine and Upper Nass study area.

Table A6. Provincially-listed bird species likely occurring within the Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Dendragapus fuliginosus	Sooty Grouse		Blue	
Ardea herodias fannini	Great Blue Heron, *fannini* subspecies	SC (Mar 2008)	Blue	1-SC (Feb 2010)
Accipiter gentilis laingi	Northern Goshawk, *laingi* subspecies	T (Nov 2000)	Red	1-T (Jun 2003)
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	SC (Apr 2007)	Red	1-T (May 2003)
Falco rusticolus	Gyrfalcon	NAR (May 1987)	Blue	
Pluvialis dominica	American Golden-Plover		Blue	
Bartramia longicauda	Upland Sandpiper		Red	
Limnodromus griseus	Short-billed Dowitcher		Blue	
Limosa haemastica	Hudsonian Godwit		Red	
Phalaropus lobatus	Red-necked Phalarope	C (Jul 2011)	Blue	
Tringa incana	Wandering Tattler		Blue	
Brachyramphus marmoratus	Marbled Murrelet	T (May 2012)	Blue	1-T (Jun 2003)
Patagioenas fasciata	Band-tailed Pigeon	SC (Nov 2008)	Blue	1-SC (Feb 2011)
Asio flammeus	Short-eared Owl	SC (Mar 2008)	Blue	1-SC (Jul 2012)
Megascops kennicottii kennicottii	Western Screech-Owl, *kennicottii* subspecies	T (May 2012)	Blue	1-SC (Jan 2005)
Contopus cooperi	Olive-sided Flycatcher	T (Nov 2007)	Blue	1-T (Feb 2010)
Hirundo rustica	Barn Swallow	T (May 2011)	Blue	
Euphagus carolinus	Rusty Blackbird	SC (Apr 2006)	Blue	1-SC (Mar 2009)
Calcarius pictus	Smith's Longspur		Blue	

Table A7. Provincially-listed mammals likely occurring within the Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Zapus hudsonius alascensis	Meadow Jumping Mouse, *alascensis* subspecies		Blue	
Ochotona collaris	Collared Pika	SC (Nov 2011)	Blue	
Sorex tundrensis	Tundra Shrew		Red	
Myotis keenii	Keen's Myotis	DD (Nov 2003)	Red	3 (Mar 2005)
Gulo gulo luscus	Wolverine, *luscus* subspecies	SC (May 2003)	Blue	

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Martes pennanti	Fisher		Blue	
Ursus arctos	Grizzly Bear	SC (May 2002)	Blue	
Rangifer tarandus pop. 15	Caribou (northern mountain population)	SC (May 2002)	Blue	1-SC (Jan 2005)
Ovis dalli dalli	Dall's Sheep		Blue	

Table A8. Provincially-listed damselflies and dragonflies likely occurring within the Stikine and upper Nass study area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Enallagma hageni	Hagen's Bluet		Blue	
Tanypteryx hageni	Black Petaltail		Blue	
Somatochlora kennedyi	Kennedy's Emerald		Blue	

Table A9. Provincially-listed butterflies likely occurring within the Stikine and upper Nass study area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Erynnis afranius	Afranius Duskywing		Red	
Polites draco	Draco Skipper		Blue	
Parnassius phoebus	Phoebus Parnassian		Red	
Colias gigantea gigantea	Giant Sulphur, *gigantea* subspecies		Blue	
Colias hecla	Hecla Sulphur		Red	
Euchloe naina	Green Marble		Red	
Pieris marginalis guppyi	Margined White, *guppyi* subspecies		Blue	
Plebejus optilete	Cranberry Blue		Blue	
Boloria astarte distincta	Astarte Fritillary, *distincta* subspecies		Blue	
Boloria epithore sigridae	Western Meadow Fritillary, *sigridae* subspecies		Blue	
Oeneis jutta alaskensis	Jutta Arctic, *alaskensis* subspecies		Blue	
Oeneis polixenes yukonensis	Polixenes Arctic, *yukonensis* subspecies		Red	

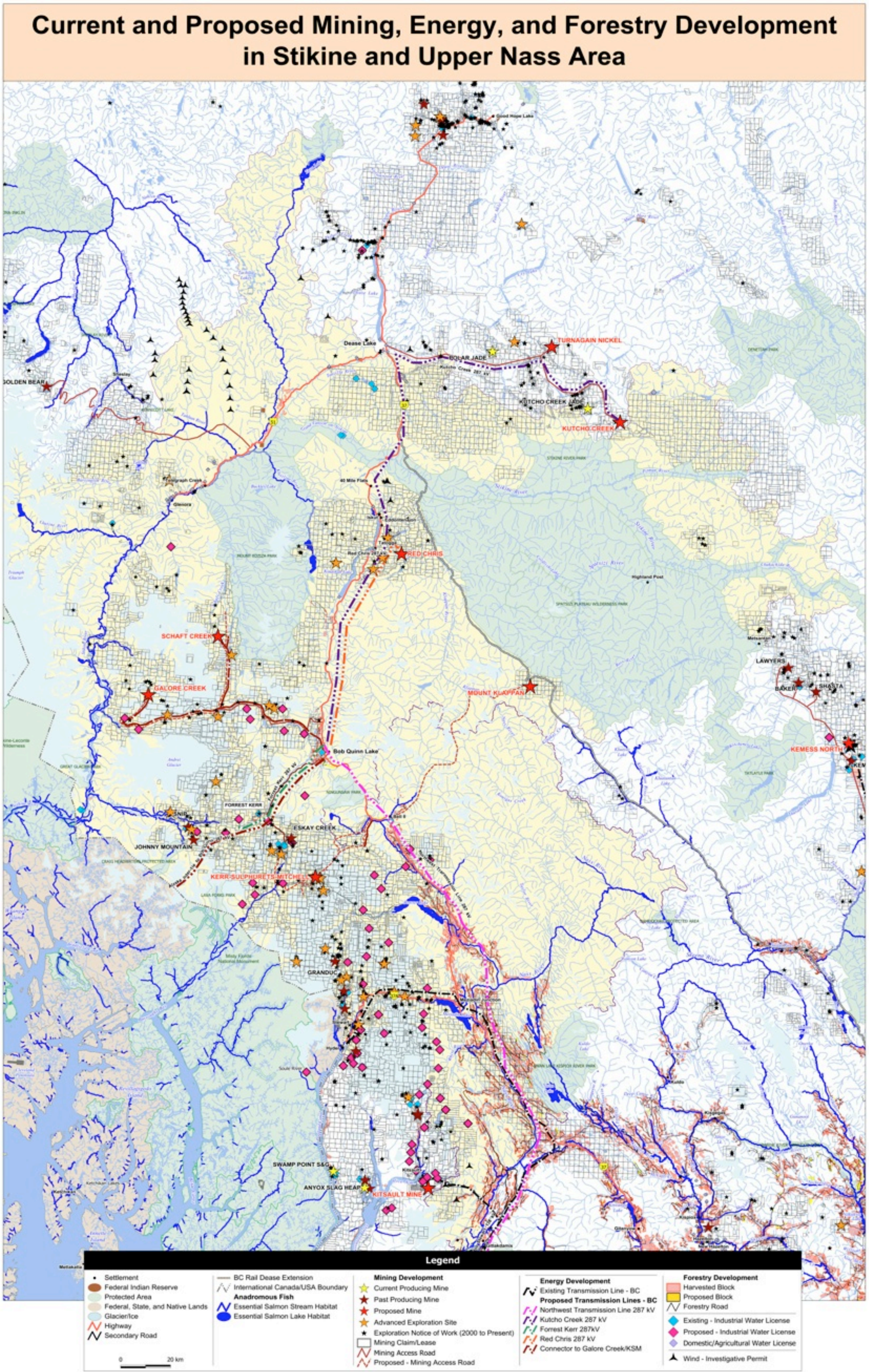
Table A10. Other provincially-listed invertebrate species potentially occurring within the Stikine and upper Nass area.

SCIENTIFIC NAME	ENGLISH NAME	COSEWIC	BC LIST	SARA
Haliotis kamtschatkana	Northern Abalone	T (May 2000)	Red	1-T (Jun 2003)
Fossaria truncatula	Attenuate Fossaria		Blue	
Pristiloma arcticum	Northern Tightcoil		Blue	
Pristiloma chersinella	Black-footed Tightcoil		Blue	

Appendix V: Hunting outfitter and trapline territories within the Stikine and Upper Nass study area.

Map 7. Map showing hunting outfitter territories and traplines within the Stikine and upper Nass study area.

Appendix VI: Current and proposed development in and surrounding the Stikine and Upper Nass study area.



Map 8. Map showing current and proposed development in the Stikine and upper Nass study area.