Salmon Spawning Report 2010
Morrison Watershed

A Baseline Study Prepared for:
Lake Babine Nation

Funded by: Pacific Booker Minerals

Prepared by: Alana K. Dickson, Dec. 2010

Summary

Lake Babine Nation welcomes economic growth and development within their traditional area. It is the concern of the chief and council that economic diversity occurs with environmental responsibility. Pacific Booker Minerals has been engaged in mineral exploration within the traditional territory of the Lake Babine Nation, in the Morrison Watershed and has proposed a copper/gold mine along the south-eastern shore of Morrison Lake. (Figure 1.0)

Morrison Watershed is a significant contributor to salmon spawning and rearing habitat in the Babine Watershed, contributing between 3.5% of the Sockeye population (Gottesfeld, 2002) and 6 % of the total Coho population (Bustard, 2004).

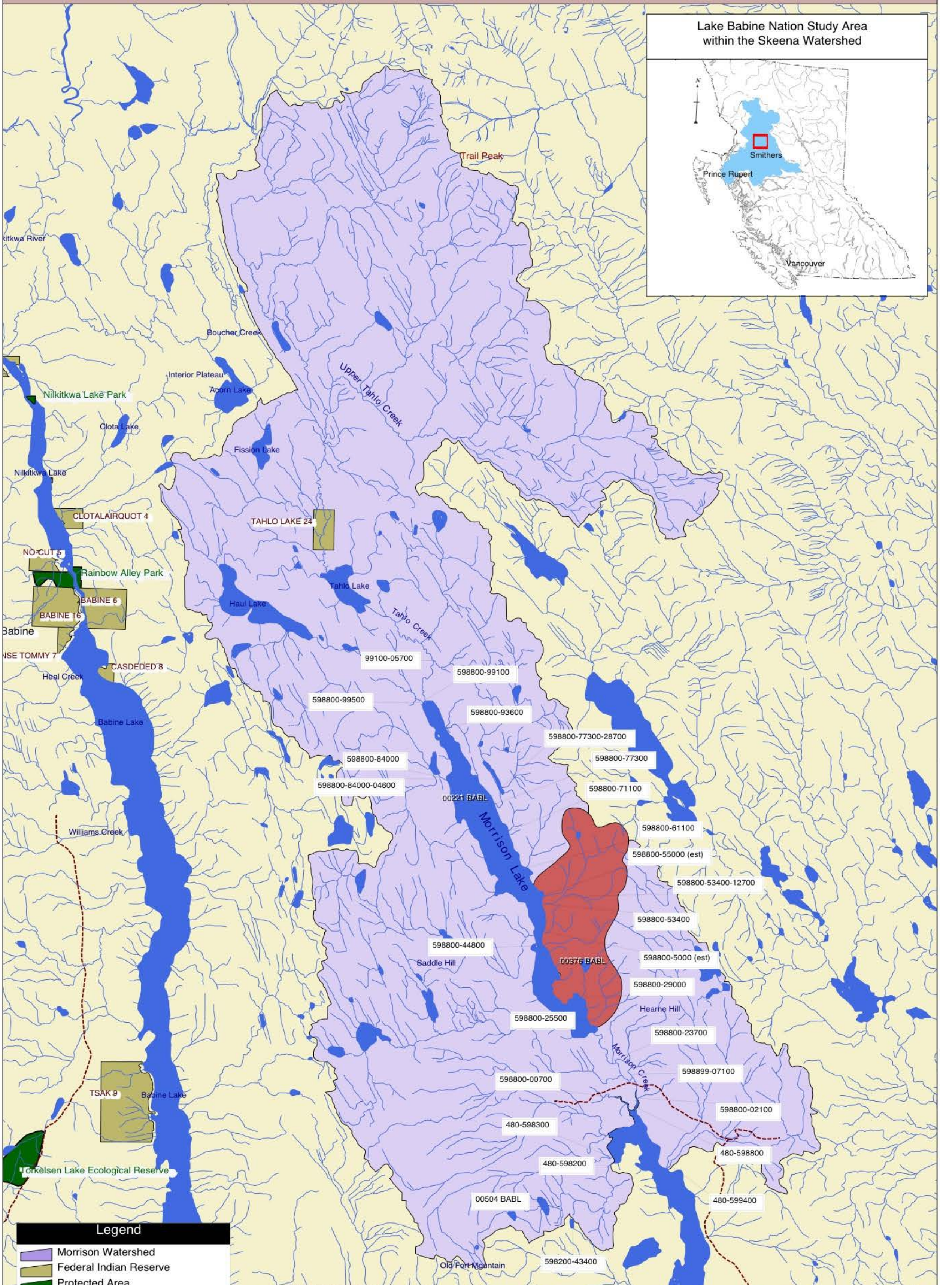
During this study the middle and late Sockeye populations and the Coho population were observed two times a week along Morrison Creek. Spawning locations for the middle and late run populations for both species were observed and recorded throughout the entire length of Morrison Creek. It was observed that spawning redds were prominent at the outlet of tributaries, including dry tributaries with associated ground water flow.

Coho and Sockeye spawning was also observed and recorded late in the spawning season on lower Tahlo Creek. Lower Tahlo Creek, that part below Tahlo Lake, provides excellent spawning habitat that is reduced by multiple beaver dams from outlet of Tahlo Lake to the outflow at Morrison Lake. Multiple beaver dams were observed on the majority of Morrison Watershed tributaries and contributed to low water.

Shore line spawning observation along the mine footprint in Morrison Lake identified potential spawning habitat and recorded redds observed on and contiguous to the gravel fans of tributary outflow. Shoreline redd observation was limited to one meter in depth as visibility was reduced by the dystrophic nature of the lake.

Stream hydrology was observed and determined to be the significant limiting factor to salmon success in the Morrison watershed. Inadequate water flow was observed to delay spawners from reaching Morrison Lake and upper spawning tributaries.

Map A: Morrison Watershed



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Introduction

Background

Lake Babine Nation commissioned this study in September 2010 in response to proposed construction of an open pit copper/gold mine along the south-eastern shore of Morrison Lake by Pacific Booker Minerals. The objective of this project is to support understanding of the role of the Morrison watershed regarding salmon productivity, to identify barriers to spawning habitat.

Salmon are biologically, ecologically, culturally and economically important to the Morrison Watershed. Management success depends on thorough, documented understanding of anadromous populations and their habitat parameters within the Morrison Watershed. It is with this understanding that potential impacts to habitat can be identified and evaluated.

Figure 1: Proposed Mine Site, SE Shore of Morrison Lake, September 27th 2010.

Setting

Morrison Lake is located 35 km north of Tachet, and approximately 102 km north of Burns Lake. Old Fort, a seasonal residence for Lake Babine Nation and a historical community is the closest village, located 12 km south-west of the proposed mine. Fort Babine, at the head of the Babine River is approximately 22 km north-west. See Map A: Morrison Watershed.

The Morrison watershed lies in a parallel valley on Cordillera Occidental in Northern British Columbia and drains into Babine Lake. Repeated glaciations during the Pleistocene epoch formed the wide valley of the Morrison watershed. Here Sockeye, Kokanee and Coho evolved with the ebb and flow of ice and glacial melt (Wood, Bickham et al, 2008).

Hydrology

The Morrison Watershed is one of four main sub-basins of the Babine Lake drainage system and comprises just under 500 km2, approximately 7% of the overall Babine Watershed (Levy and Hall, 1985). Elevations range from 1,890 m in the southern Bait Range to 712 m at Babine Lake. The lakes and streams above Morrison Creek provide a network of fisheries habitat, supporting anadromous and non-anadromous stock.

Morrison Lake is a long narrow lake, with a maximum depth of 60 m and a surface area of 1325 ha. There are over a dozen tributaries, many with small lakes, flowing into Morrison Lake and at least as many tributaries providing subterranean flow. Main tributaries include Haul Creek, Tahlo Creek, 44800, 53400, 84000, and 47500. Several tributaries are within the proposed mine foot print.

Haul Creek is fed by Haul Lake, with a maximum depth of 29 m and a surface area of 303.7 ha. Tahlo Creek is fed by Tahlo Lake, having a maximum depth of 19 meters and a surface area of 152.22 ha (FISS database). Tahlo Lake is fed by Upper Tahlo Creek with a complex drainage network including Fission Lake and several smaller unnamed lakes and by Guitar Creek which stems from Guitar Lake.

Figure 2: Tahlo Lake, Morrison Watershed, 2010

Average precipitation recorded at Topley Landing – the closest Environment Canada station – for 1971 to 2000 is 533 mm per year. This includes an average 306 mm of rainfall and 227 cm of snowfall. Rainfall is highest in June and July with an average of 50 mm per month while May, August, September and October all average 40 mm per month.

Within Morrison watershed, surface freshwater is stored and flows through a myriad of wetlands, ponds, lakes, streams and creeks. Groundwater storage is complex; however, groundwater flows provide substantial volume to surface flows. Morrison Creek was gauged by Water Survey of Canada at Station 08EC008 located at the outlet of Morrison Lake between 1965 and 1970 for 6 years of record as shown in Figure 3 below. The Morrison system is dominated by snow-melt. Peak discharge typically occurs in May and June due to snowmelt with average flows between 15 and 20 m^3/s. Discharge then decreases into the fall with moderate increases due to autumn rains, early snowmelt, or rain-on-snow events. Minimum discharges on average are under 5 m^3/s and typically recorded in January through April prior to spring snowmelt. Note the diminished flows recorded from July through January.

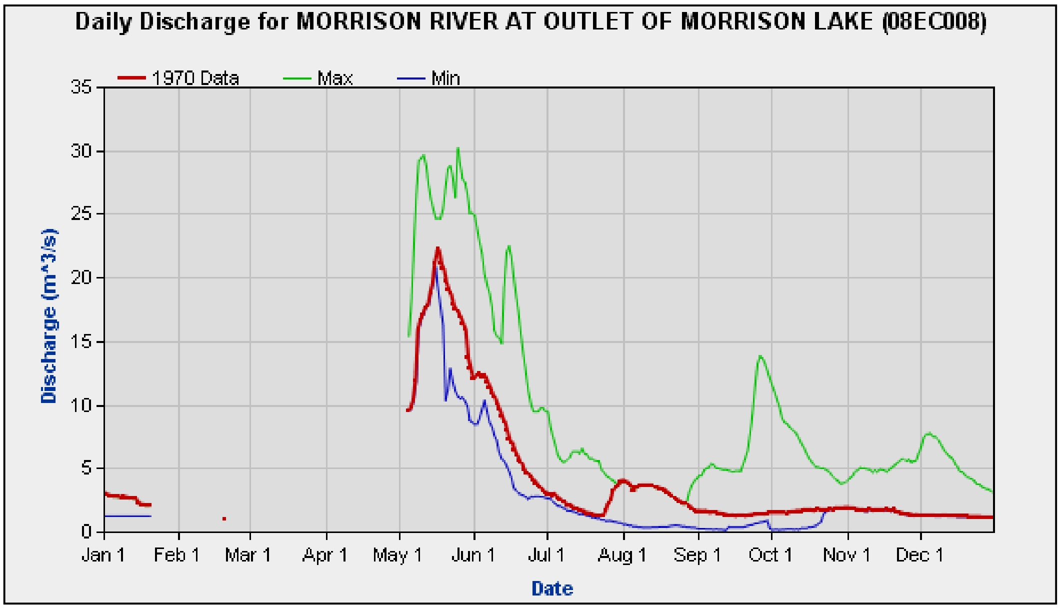


Figure 3: Daily Discharge for Morrison Creek, 1965-1970

Average annual flows, especially late summer flows, have declined in Nechako Plateau since the 1930s as recorded by Babine and Bulkley rivers hydrometric stations. These low flows decrease the ability of Coho and Sockeye adults to reach spawning areas. Price et al., 2001, predict a continuing decline in summer precipitation in the interior portion of Skeena watershed for the next 70 years.

Limnology

Limnology is the study of the physical, biological and chemical properties of freshwaters. Major studies assessing limnology and fisheries ecology in Morrison Watershed include those completed by:

McMahon (1948), wherein Morrison Lake was the subject of in-depth study from 1945 to1948 relating to the development of a sockeye enhancement program as part of the Fisheries Research Board of Canada's Skeena River Investigation;

Shortreed *et al.* (1998) conducted sampling in order to determine the current productivity and sockeye rearing capacity using the rearing capacity model (PR model) for Morrison Lake;

Bustard (2004, 2005) conducted comprehensive fisheries studies for the proposed mine development by Pacific Booker Minerals;

Rescan conducted limnology studies in Morrison Lake between 2006 and 2008 that are reported in Klohn Crippen Berger (2010). Rescan's studies included bathymetric, general and chemical characteristics, sediment quality, phytoplankton, zooplankton, and benthic invertebrates.

McMahon's 1948 study focused on the suitability of Morrison Lake for sockeye enhancement. McMahon intensively investigated Morrison Lake limnology, the plankton community, fish populations and life histories including predation factors, and benthic organisms. He estimated that an annual average of 27,500 sockeye spawners entered the Morrison system from 1945 to 1948. Due to the lack of smolt migration information, McMahon was unable to determine the how many of the sockeye juveniles reared in Morrison Lake, as compared to the progeny that dropped down to rear in Babine Lake, as well as the ratio of Tahlo Sockeye fry rearing in Morrison and/or Babine lakes. McMahon shows Morrison Lake to be a multi-basin lake – the north basin, which is relatively small with depths not more than 20 m, the central basin is the largest with over 60 m in depth, the south basin includes approximately 25% of the total lake size with depths to more than 20 m.

Bustard's 2004 and 2005 studies indicate Morrison Lake has slightly alkaline pH values ranging between 7.2 and 7.8 and an average conductivity of 60µs. The euphotic zone, the uppermost layer of lake water with sufficient light for active photosynthesis, has limited depth averaging 4.2 m due to the high dissolved organic components contributed unequally by tributaries.

Importantly, Morrison Lake is a stratified lake subject to high surface summer temperature of 20^{o}C with a thermocline between 4 and 7 meters in depth. The thermocline is the area between the warmer surface area known as the epilimnion and the deeper, colder, and relatively undisturbed region known as the hypolimnion. Summer water temperatures below the thermocline are approximately 5^{o}C. Winter and summer stratification is an important phenomenon for salmonid fry rearing.

Shortreed *et al.* (1998) note that Morrison Lake provides a good physical habitat for sockeye fry with a large, average size of 4.3 gram for age-0 fall fry indicating ample food resources. Phytoplankton biomass (chlorophyll) is second relative to ten other studied Skeena sockeye nursery lakes, but because of the rapid light attenuation, mean daily photosynthetic rate is about average for the study lakes. Total sockeye fry biomass was 39% of the maximum predicted by the PR model. This is due to relatively low sockeye adult escapement. Shortreed *et al.* recommend increased fry recruitment through increased adult escapements as the most effective way to restore Morrison Lake Sockeye stock.

Anthropogenic History of the Morrison Watershed

First Nations

For at least 12 000 years First Nations peoples in the Babine Lake area have built a culture centered on the harvest of anadromous fish. They developed successful fishing weirs that provided ample salmon for winter survival without impact on future salmon stocks. Salmon was dried and Salmon grease, a highly valued product for winter survival was rendered. Salmon was still the main diet of Lake Babine First Nations peoples in the 1970's.

Dried salmon was also traded, east with the Sekani villages and west with the Psimpseans of the Pacific coast. Salmon and wildlife associated with the salmon runs continues to be significant to Babine First Nations peoples today.

The first written records from the Lake Babine area were by D.W. Harmon and James McDougall of the North West Company. On Jan 30th 1812 Harmon and McDougall traveled over frozen lakes from Stuart Lake to Babine Lake. They recorded coming across 5 First Nations Villages in the Babine area with a total population of approximately 2000. In 1822 the Hudson Bay Company established a trading post at the top of Babine Lake between the two northern arms. Initially the post was known as Kilmaurs or Kilmers and was valued for its steady supply of Sockeye salmon which was traded to other forts as far South as Alexandra on the Fraser River (R.B Roberts, 1962).

Figure 4: Old Fort, Lake Babine, BC

Kilmaurs became known by the name Old Fort after the Hudson Bay Company moved the trading post to the head of the Babine River. By the early 1900's Babine Sockeye stocks were diminishing and officers from the Dominion of Fisheries made annual trips to Babine Lake. In the 1904 report by Fisheries officer H. Helgesen, Chief Atio states that prior to Cannery activity in the lower reaches of the Skeena he could not see the water below his weirs, aka barricades, so plentiful were the sockeye, even spilling out onto the banks. It was also noted that in the past weirs were built along most of the smaller tributaries into Babine watershed as well and were always abundantly stocked, year after year, even 3 to 4 weirs on one stretch of river did not stem the flow of Sockeye into their spawning grounds.

The Babine Salmon Hatchery

Fisheries officer Helgesen mentions the remains of numerous weirs on a large creek, 25 miles north of Old Fort, referring to Morrison Creek. He states that the Ominica miners informed him of a great quantity of salmon in this creek that season. A quote from the 1908 Commissioner of Fisheries Report states: "This stream has its source in Morrison Lake. From that lake to Babine Lake the stream is three and one half miles long and about 300 yards wide. Most of the salmon which enter it pass to the upper lake and the stream beyond. All the way up I saw salmon in great numbers. They were particularly plentiful for the last quarter of a mile. I did not go above the lake. The Indians, however, told me that in the streams above there were other smaller lakes that afford a great many miles of fine spawning grounds – the best and most extensive of any of the tributaries of Babine Lake." LBN member Verna Powers recalls her grandmothers' stories of her favorite area to fish for Coho along creek 47500.

To help meet the fishing interests of the Pacific coast Babine Hatchery was established in 1907, 1 km below the outflow of Morrison Lake. In its first year of operation, April 1908 Babine Hatchery released 4 663 000 fry. Officer Pretty describes low autumn water levels and carcasses littering the bottom of the river. Babine Hatchery operated until 1936, when it was shut down due to government cutbacks.

Figure 5: Babine Hatchery at the Outlet of Morrison Lake, 1935

Built with an eight million sockeye egg capacity, Babine Hatchery released a total of 170 953 598 sockeye fry into the Morrison watershed during its 28 years of operation. An additional 5.5 million fertilized eggs and twenty five million “fingerlings” or yearlings were released. Eggs were obtained primarily from Morrison Creek and supplemented intermittently with eggs obtained from the Babine River, Fulton, Morrison, Perrie, Pinkut, Tachek and Tahlo Creek as well as from the Stuart Lake hatchery (Babine Lake Hatchery: Source and Distribution table, date unknown).

Sockeye were pushed up the creek by the native fisheries crew walking up the creek and corralled between three barricades to be caught in hand nets. While this method generally captured the required number of sockeye it was reported by A. Forsyth in 1912 that much damage to previously created redds would occur and alternate methods needed to be considered. Eggs were collected, stirred with roe then gently rinsed and left to harden for two hours. Once they were packed into shallow stackable trays in back–pack boxes, protected with moss, they were transported by boat up to Morrison Creek where the 80 pound packs were shouldered 2 miles up the creek by the first nations crew.

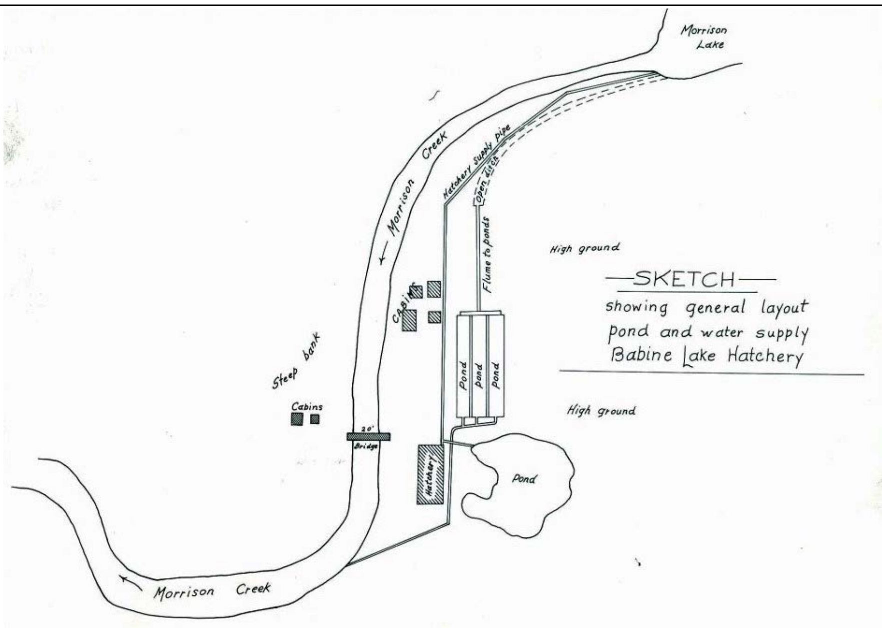


Figure 6: Sketch of the Layout of Babine Hatchery, Morrison Creek.

In the spring twenty five percent of the fry were released into a man-made pond destined for Morrison Creek. The remaining fry were transported up Morrison Lake to “the mouths of creeks with suitable food supplies” on a modified pontoon scow with screens fastened to each end which provided 6 – 8 inches of continuous flow en route up Morrison Lake (Tony Southgate, 1979)

On September 19th, 1912 Fisheries Overseers A. Forsyth and T.G. Wynn visited the Babine Hatchery during its 5th year of operation. They reported extremely low water levels such that even with augmentation of deeper channels by the hatchery employees the salmon were still unable to enter Gordeau Lake (aka Morrison Lake). During this visit Forsyth and Wynn note the presence of “quite a few steelhead” and are informed that the Coho have a very good run in Morrison Creek as well.

Traditional environmental knowledge, TEK, describes a rock ladder built in the lower end of Morrison Creek where the river ran wide and shallow. The rock ladder was described as several jetties of rocks alternating from the sides of the river towards the center to provide a deeper, slower channel for the salmon to swim up. It is estimated to have been built between 1901 and 1913. There is no evidence of this ladder now, but there is a rock barricade just below the site of the ladder. This barricade is lined with black plastic and wooden gates and boards are evident along the bank.

The site of the Babine Fish Hatchery is now covered in wide spaced Aspen and mature Birch. Three proximal hauling roads attest to the logs used by the hatchery and an old intake pipe and outflow culvert are still evident at the edge of the creek. It was observed that though the intake is mapped on the bottom left side of Morrison Lake it is currently approximately 100 meters below the lake, suggesting a decrease in the level of Morrison Lake.

Morrison Creek Coho Enhancement and Escapement Monitoring 1999-2004

Due to the decline in upper Skeena Coho the Department of Fisheries and Oceans initiated the Coho enhancement program along Morrison creek from 1999 to 2004. Coho escapement was monitored in the fall with the use of a temporary fence near the mouth of Morrison Creek. Wild fry inventories were conducted to determine fry densities. These inventories determined that the fry densities were moderate to high in Morrison Creek but low in Tahlo Creek. Coho eggs were incubated at the Fulton Hatchery facility and the emergent fry were seeded into 3 sections of lower Tahlo Creek, given the available habitat at Tahlo.

Fish Values

The Morrison Watershed, specifically Morrison Creek and Tahlo Creek, is identified in the Morice Land Resource Management Plan as having high fisheries values for wild Sockeye, Coho and Rainbow trout.

Sockeye

Brood Populations

The Babine watershed accounts for 90% of the Sockeye in the Skeena watershed. This population is supported by enhancement programs at Pinkut, and Fulton. Wild (not enhanced) Sockeye are found in 25 other streams in this watershed (Bustard, 2004). Morrison Sockeye are wild and arrive from mid August to late September after a 15-36 day residency time in Babine Lake. Sockeye from the Morrison watershed exhibit a four year anadromous life cycle, rearing for 1 year in Morrison Lake prior to their ocean journey and returning at age four.

Morrison Lake has an estimated sockeye fry density of 377 fry/ha, approximately one half of the lakes rearing capacity (Shortreed et al.1998). As a result of ample zooplankton, these fry are large enough to depart for their ocean journey as one year olds. Larger smolt size directly corresponds to increased ocean survival and length of ocean rearing is directly correlated to increased size and fecundity. (Woods, Bickham et al, 2008)

Spawning time is inheritable and is triggered by stream temperatures. Within a watershed there are three populations of Sockeye: early tributary spawners, lake tributary spawners and lake outlet spawners. These populations are large enough that some interbreeding between population broods occurs.

Genetic and Environmental Determination

Sockeye utilize several strategies to maximum genetic reproduction depending on the environment and genetic structure. The most common strategy is evidenced by anadromous Sockeye which migrate to the ocean. Ocean reared sockeye have larger food sources and consequently gain size which is associated with an increased number and size of eggs. Larger females are therefore preferred mates and are paired by larger males that can successfully defend their redds. However, increased size and fecundity comes at a risk of decreased survival related to the length, hazards and impediments involved with the journey to the ocean and predation in the ocean.

Figure 7: Anadromous and Residual Male Sockeye, Morrison Creek, 2010

A percentage of the male sockeye population will not travel to sea. These residual sockeye may have both the genetic predisposition for lake rearing and an inherent knowledge of the energy required to travel to the ocean. Residual males return to spawn in the Morrison system at 3 years old and actively participate in fertilization. Their chances of successful reproduction are reduced by their smaller size; larger males are more successful at defending larger females. If in a particular year there are high incidences of residual males, reproductive probability decreases further and is limited to smaller females.

Kokanee

Kokanee are residual male and female non-anadromous Sockeye that express a low inheritable genetic tendency to travel to the ocean. Their reproductive strategy does not involve an ocean journey but lake rearing. The consequence of this strategy is a significant decrease in size which places them at a competitive disadvantage for feeding. Feeding adaptations such as an increase in gill rakers allow Kokanee to utilize smaller prey. (Wood, C.C. &Foote, C.J. 1996)

Kokanee often spawn after Sockeye, an inherent trait for redd survival. Kokanee redd development is unlikely to impact Sockeye redds, where as larger sockeye use more force and create deeper redds which would disturb shallow Kokanee redds. Non anadromous Kokanee could theoretically interbreed with their anadromous sockeye relatives but like residual male sockeye are limited by the size pairing phenomenon. (Foote, C.J. et al 1989)

Coho

Coho are the last salmonids to enter spawning waters late in the fall, spawning from October to November when water levels are higher and water temperatures fall around 5.5^{o}C. Coho spawn in a diverse range of habitats, but are known to use small creeks further up the watershed than other salmon. Inclement autumn weather, higher water levels and decreased accessibility to smaller creeks make Coho spawning observations more difficult than Sockeye.

The Babine River, Fulton River and the Morrison watershed comprise the majority of Coho spawning habitat within the Babine watershed (Gottesfeld 2002). Coho fry from Babine watershed rear for two years in fresh water prior to their journey to the ocean where they will spend just over 1 year off the south eastern coast of Alaska. Babine Coho are 3.3 years of age when they return to spawn. Returns have been depressed since the 1970’s and are a high conservation concern (Bustard, 2004).

Chinook

Chinook are also known as Spring, King, and Tyee and are the largest of the Pacific Salmon. They have been infrequent users of Morrison Creek but have been recorded as recently as 1999 and 2000 in the field notes from the Department of Fisheries and Oceans Coho Project records.

Indigenous Fish Species of Morrison Watershed

Species identified in the Morrison watershed include Kokanee, Cutthroat trout, Burbot and Whitefish, Northern pikeminnow, Peamouth chub, Longnose and Largescale sucker, Prickly Sculpin, Lake chub, longnose dace, Redside shiner and two char species; Dolly Varden and Lake Trout. Comparative abundance and life history information describing Morrison Lake fish populations was presented in Bustard, 2005. Below are brief comments on Salmonid fry associated predator species.

Lake Trout are slow growing and can live more than 40 years, occupying the hypolimnic strata of lakes in the summer. Sockeye fry make up 33% of stomach contents. (McMahon. 1948) but Lake Trout have been caught with fish just 5 cm less than their own length in their mouths. This species is a regional concern due to its slow growth rate and late age of maturity.

Burbot are commonly referred to as Ling or Freshwater Lingcod because of their resemblance to ling cod. They are found in freshwater lakes and streams, occupying the deep hypolimnic strata of lakes. Their diet includes whitefish, kokanee, juvenile salmon, and suckers.

Rainbow trout populations are diverse in habitat, found in streams or lakes. Some populations utilize both water bodies, motivated by food abundance. Within the Morice TSA there are three lakes with piscivorous (fish eating) rainbow trout populations: the Nechako Reservoir, Babine Lake, and Nadina Lake (MLRMP, 2007). In Morrison Watershed rainbow trout are reported in higher numbers during salmonid spawning, attracted by eggs.

Large numbers of Mountain Whitefish are found in Morrison Watershed. Mountain Whitefish resemble Rainbow trout with a smaller head, larger fins and larger scales. They are bottom feeders, eating insect larva, eggs, and smaller fish.

Salmon Spawning Survey

Method

Observers walked the length of Morrison Creek from Morrison Lake to the outflow at Babine Lake two times per week. Salmon numbers and salmon redds were recorded and locations plotted with the Garmin GPSmap 76. Stream monitoring commenced on September 23rd and concluded on October 28th due to high water and high redd concentrations. From October 28th until November 15th Coho observations were made from the logging bridge across Morrison Creek from 8:00 am until 15:30 pm twice a week.

A modified hydrological flow was determined by measuring the width of the flow of water over the width of the stream from bank to bank. 10 sites were predetermined for flow assessment to provide representation of the various reaches along Morrison Creek. These areas included wide shallow areas with steeper gradients, wide deeper sites with low gradients, corners with deep pockets, corners with even stream bottoms, narrow stretches and the arms where the stream diverges and then converges. Overall the frequency of lower gradient, straight areas measured was greater than any other stream presentation. Data was collected weekly until Oct 12 when the presence of spawning redds precluded crossing at many locations.

Visual counts were preformed on Tahlo Creek and Haul Creek near the end of Coho spawning season; Tahlo Creek, November 1st and November 8th, Haul Creek Nov 8th and 18th. Tahlo Creek has a dark tannic colour and stream hydrology was near 82% with many troughs and pools. Consequently observation of Coho was limited to jumping Coho and predation remains.

Shoreline spawning habitat in the mine footprint was assessed by boat access. Due to the tannic nature of Morrison Lake observation was limited to less than 1 meter depth. Shoreline was assessed for clean cobbles ranging in size from small gravel to 10 cm boulders. These locations were recorded as potential spawning habitat and we returned to these locations to monitor and record the location of any redds.

All tributaries into Morrison Lake were accessed by boat October 8th, and November 4th with exception of the three tributaries along the south-eastern shore of Morrison Lake which were accessed by foot September 28th and November 22nd. In many locations along lake shore and tributaries Culturally Modified Trees were encountered. If time permitted these trees were photographed, tagged and recorded with the Garmin GPSmap 76.

Observations

Morrison Creek and Tahlo Creek Stream Description

Morrison Creek and Tahlo Creek are the main salmon spawning grounds in the Morrison system.

Morrison Creek

Morrison Creek extends from Babine Lake upstream for approximately 7 km to Morrison Lake and consists of two prominent reaches. The lower reach extends into Morrison Arm of Babine Lake creating a wetland of high habitat value. There were no beaver dams along the length of Morrison Creek during this study but an occupied beaver lodge was present at the outflow near Morrison Arm. Riparian vegetation is 80% coniferous and 20% deciduous. Both reaches have areas of various substrate and depth. Banks on both reaches are low and rocky with the exception of a steep cut bank at the end of the first reach and slopes distal to the shore at the end of the second reach as seen from Figure 15.

Figure 7: Upper Reach of Morrison Creek, Nov. 11 2010

Table 1: Morrison Creek. Reach Description from Babine Lake to Morrison Lake. Oct 18, 2010

Reach	Description	Estimated length (m)	Gradient (%)	Ave. Width (m)	Ave. Depth (cm)	Substrate
1st	Sinuous	2800	0.5	14	38	65% gravel 20% cobbles and boulders 15% fines
2nd	Sinuous	4200	1.2	12	48	64% cobbles and boulders 22% gravels 14% fines

Figure 8: First Reach in Morrison Creek, Sockeye Swimming Upstream. Oct 6 2010

Tahlo Creek

Lower Tahlo Creek extends from Morrison Lake upstream for approximately 5 km to Tahlo Lake. Lower Tahlo is a broad creek running faster than Morrison Creek with a steeper gradient through-out its 6 prominent reaches. Riparian vegetation is 90% coniferous and 10% deciduous. No less than 9 beaver dams were found along the length of Lower Tahlo from the inlet to the outflow at Morrison Lake.

Figure 9: Tahlo Creek, Reach 2 and Reach 3

Table 2: Lower Tahlo Creek. Reach Description from Morrison Lake Upstream to Tahlo Lake. Nov.1 2010

Reach	Description	Estimated length (m)	Gradient (%)	Ave Width (m)	Depth (cm)	Substrate
1st	Sinuous with channels 2 large beaver dams	960	1.2	16	30	70% gravel 15% cobbles and small boulders 15% fines
Reach	**Description**	**Estimated length (m)**	**Gradient (%)**	**Ave Width (m)**	**Depth (cm)**	**Substrate**
2nd	Sinuous gorge	780	2.6	5	unknown	65% large boulders 20% cobbles 15% bedrock
3rd	straight	300	2.1	9	27	65% small boulders and cobbles 25% gravel 10% fines
4th	Sinuous	500	1.6	15	30	70% gravel 15% cobbles and small boulders 15% fines
5th	Sinuous and broad with beaver dams	2600	1.5	80	unknown	25% cobbles and boulders 55% gravel 20% fines
6th	straight	1280	2.1	14	46	70% boulders 30% gravel

Figure 101: Tahlo Creek Reach 4 and Reach 5

Hydrology

The Morrison Lake drainage system is a snow-melt dominated system. Trail Peak in the southern Bait Range and the surrounding hills, including Hearn Hill on the western side of Morrison Lake provide the principal contribution to water flow. Morrison watershed has a history of low water vulnerability. As a snow-melt dependant system, alterations in temperature, precipitation and canopy cover directly affect water levels. This study year was the second of a series of two dry summers compounded by low snowfall levels. The resulting low volume flow in Morrison Creek postponed sockeye spawning by 10 to 14 days.

Figure 11: Sockeye in Shallow Channel Morrison Creek. September 27 2010.

During the period of this study Morrison Creek hydrology was measured as a ratio of width of stream flow over stream bed width. Rains and light snow in the charging area produced a steady increase in the hydrologic ratio from 29.1% on September 23rd to 70.15% by October 12th. This data is represented in the graph below.

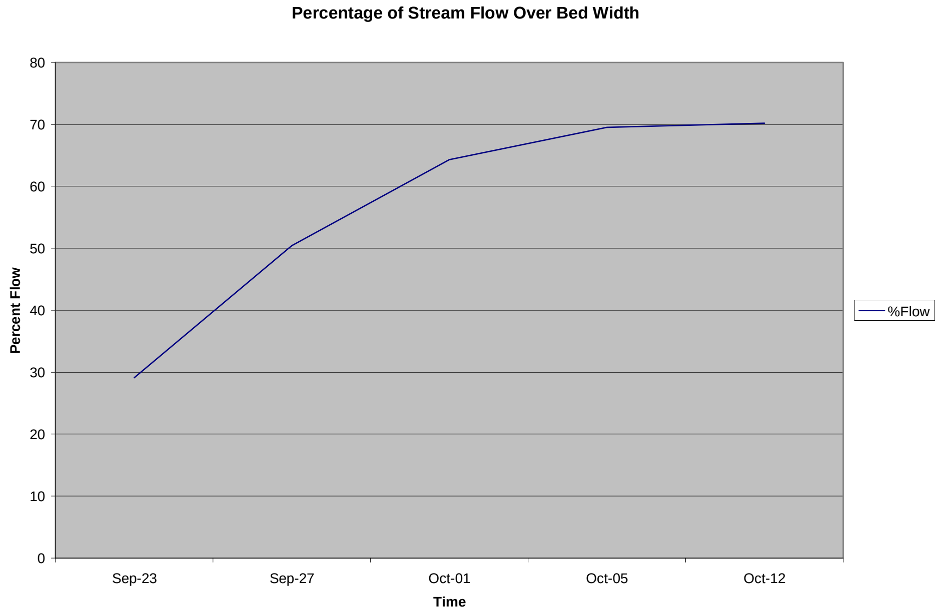


Figure 12: Modified Hydrology Graph.

The flow of tributaries into Morrison Lake and Morrison Creek was observed several times during this study. The presence of at least one beaver dam was noted on every tributary. In several locations these dams completely obstructed surface stream flow during periods of low water volumes.

Table 3: Morrison Lake Tributaries, Observed Flow 2010

No surface flow Nov 8	Restricted flow Nov. 8	Reestablished Flow Nov 18
Haul Creek	25500	Haul Creek
77300	47500	71900
59300	50000	
29000	71100	
55000	84000	
71900		

The flow of tributaries into Morrison Creek during October of this study was observed to be low or completely dry. Tributary 02100 remained dry until Oct 18th 2010, Tributary 10000 and 07100 remained low until the Oct 22nd.

In the recent past beaver dams forced Haul Creek into Tahlo Creek approximately 100 meters upstream from the outlet into Morrison Lake. With this in mind we searched the lower reach of Haul for diversion access and observed a dammed side channel with no flow entering into Tahlo Creek. By November 18th Haul creek flow was observed as a one meter width stream into Morrison Lake which the beavers were in the process of re-damming.

Figure 13: Haul Creek Outlet, Morrison Lake, Nov 18 2010.

Groundwater flow was observed on the last day of this study as a result of freezing temperatures which produced 3 inches of ice on Morrison Lake on November 22nd. Four kilometers of shoreline, adjacent to the proposed pit and rock dump were surveyed on the ice. The highest temperature recorded that day was -14.6^{o}C. There were 5 stream related ground water fans observed on the ice and 2 lengthy shore line ground water occurrences. The ground water fans formed on the ice related to streams but not directly at stream outflows, usually within 100 meters of the stream. The fans were observed to be actively increasing in breadth during that day. Shoreline ground water accumulated on the ice in multiple fans and was associated with drainage of Booker and Ore Lakes and with drainage near Pacific Booker Minerals southern property peg. These multiple fans grew in depth during the day.

Figure 14: Ground Water. Fragmented Stream 29000. SE Shoreline, Morrison Lake. Nov 22, 2010

Figure 15: Ground Water. Fragmented Stream, 29000. 50m N of Figure 22. 11:00 am Nov 22, 2010

Figure 16: Ground Water. Fragmented Stream 29000, 1:30 pm Nov 22, 2010

Figure 18: Ground Water. Morrison Lake Shoreline Flow near Pacific Booker Minerals southern corner survey peg. Nov 22, 2010

Sockeye

The Early Sockeye run began in mid August and was met with low water levels in Morrison Creek. This early brood population heads to Upper Tahlo Creek, which cools early, having no lake water influence and arrived at Tahlo prior to commencement of our study leaving little evidence of its passage. However, Lake Babine Nation Fisheries recorded 152 Sockeye in Morrison Creek on August 12th and 101 on August 24th . See Table 4 (MacIntyre per. Comm). A summer thunderstorm lasted from August 24th until August 28th and provided increased flow to Morrison Creek. On September 7th a flight count recorded 11 Sockeye in Upper Tahlo where as 1 015 Sockeye were observed in Lower Tahlo. See Table 5 (MacIntyre per. Comm).

Table 4: Sockeye Count, Morrison Creek. Donna MacIntyre, Lake Babine Nation Fisheries, 2010

Date 2010	Aug. 12	Aug. 24	Sept. 7	Sept. 17	Sept. 28	Oct 1
Number of Sockeye	152	101	840	3600	1300	1380

Table 5: Sockeye Count, Lower Tahlo Creek. Donna MacIntyre, Lake Babine Nation Fisheries, 2010

Date 2010	Sept. 7	Sept. 17	Oct. 1
Number of Sockeye	1015	1060	448

Table 6: Middle and Late Brood Population. Morrison Creek, 2010

Date 2010	Sept. 23	Sept. 27	Oct. 1	Oct. 5	Oct. 6	Oct. 8	Oct. 12	Oct. 18	Oct. 21	Total
Number of Sockeye	3267	1555	1200	278	321	208	97	18	9	6953

Table 7: Estimated Total Sockeye Escapement, Morrison Watershed. 2010

Early Brood	Mid and Late Brood	Total Sockeye
3179	6953	10132

Figure 17: Sockeye Morrison Creek, 2010

The second run of Sockeye in Morrison Creek is expected to appear in early to mid September and spawns in streams with lakes in the headwaters, such as lower Tahlo Creek which cools down slower. It was observed that this run schooled in the deeper waters near the outlet of Morrison Creek from as early as September 20th (McIntyre 2010, Finnegan 2010, pers. Comm.) waiting for increased stream flow. We observed approximately 3 500 sockeye marshaled in the lower reach of Morrison Creek on September 23rd. Rain arrived September 25th and 26th and provided sufficient volume for sockeye to pass, still with elevated exposure to predators. A modest percentage of these sockeye spawned along Morrison Creek notably at tributary outlets and above the outflow of Morrison Creek. Though many of the tributaries did not run until closer to the end of October groundwater flow was continuous. For spawning locations see Map 2: Observed Salmonid Spawning Morrison Watershed, 2010

Sockeye in the late run were prodigiously large and arrived just prior to and along with the early Coho run in the beginning of October. These late Sockeye spawned along the length of Morrison Creek from Morrison Lake down to the Bridge, but not below the bridge where numerous mid run redds were located. Unlike the observations recorded during the comparative Coho enhancement program, which reported significant Sockeye and Coho spawning below the counting fence in the bottom quarter of Morrison Creek, our study observed a complete use of available habitat throughout the entire stream, with greater redd concentrations in the middle third where tributary influence was greater. Map C: Morrison Creek Sockeye Spawning, presents areas observed with abundant Sockeye redd development.

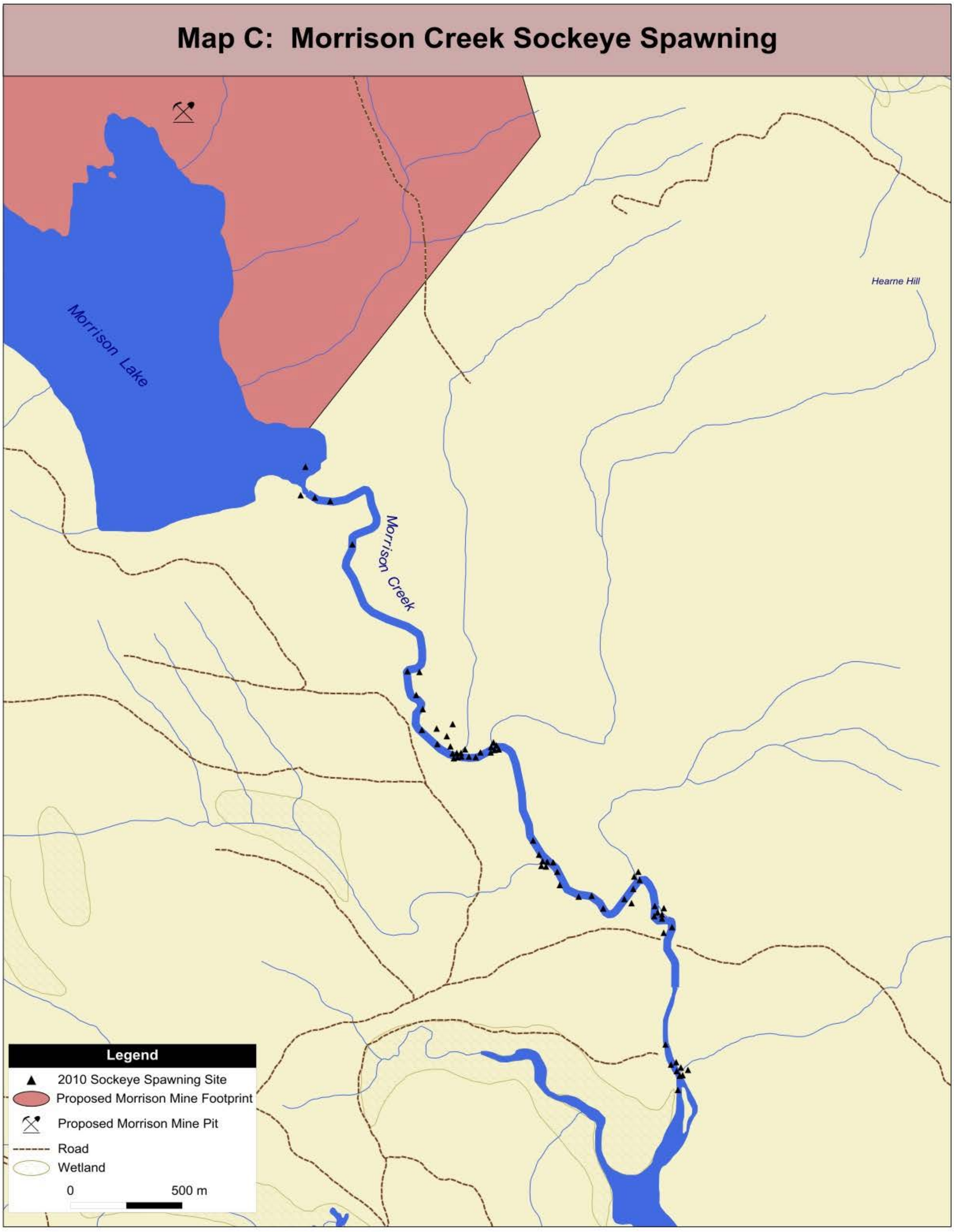

Map C: Morrison Creek Sockeye Spawning
Hearne Hill
Morrison Lake
Morrison Creek
Legend
2010 Sockeye Spawning Site
Proposed Morrison Mine Footprint
Proposed Morrison Mine Pit
Road
Wetland
0
500 m

Figure 18: Late run Sockeye Circle an Early Coho. Morrison Creek. October 2010

A total of 6 953 middle and late run Sockeye were counted between September 23rd and October 21st. Observation of redds and spawning pairs produced an estimated Sockeye escapement in Morrison creek of 1200 - 1800 brood Sockeye with the majority of observed Sockeye continuing to Lower Tahlo Creek. These results are consistent with observations for years 1993 and 1974 but are a less common event than a higher Morrison Creek to Lower Tahlo spawning ratio which is more frequently observed. See Figures 28 - 30 below. The estimated total Sockeye escapement for all brood populations during 2010 was 10 132.

Figure 19: Sockeye Escapement Estimates. Morrison Creek, 1950-2009

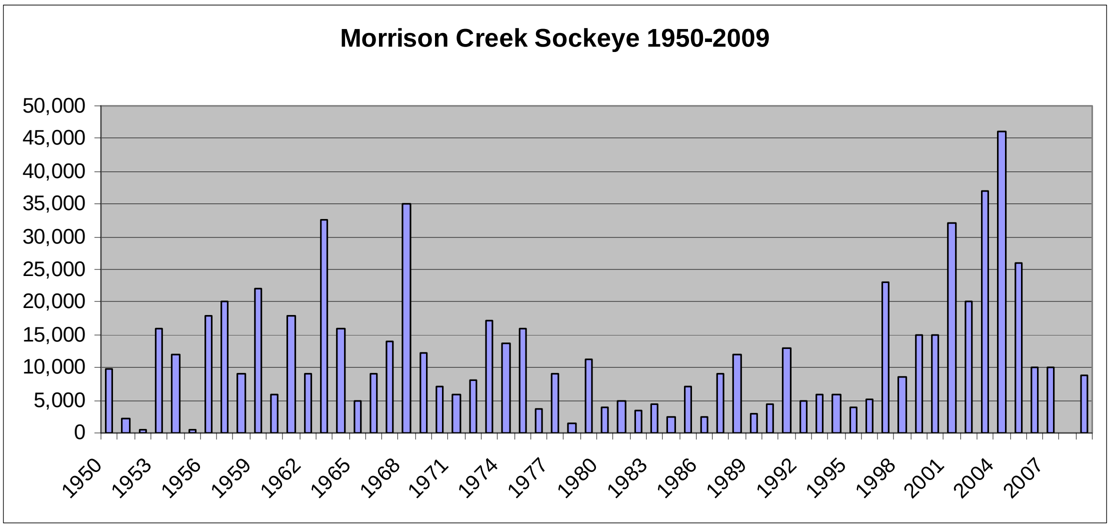


Figure 20: Sockeye Escapement Estimates. Lower Tahlo Creek, 1950 - 2009

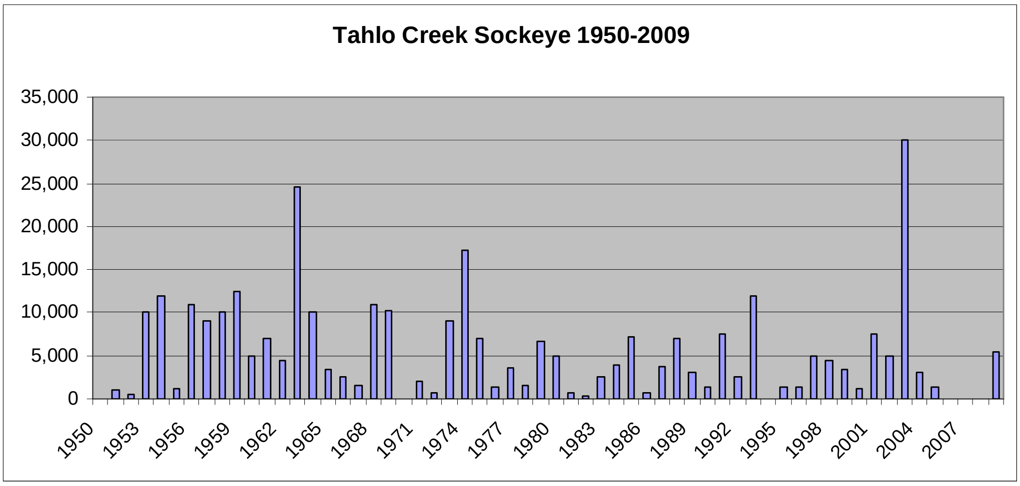
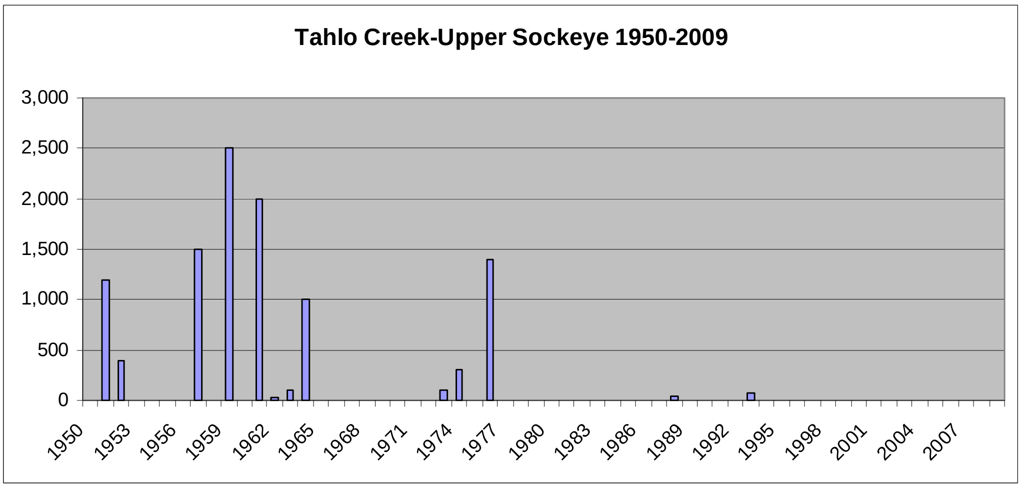
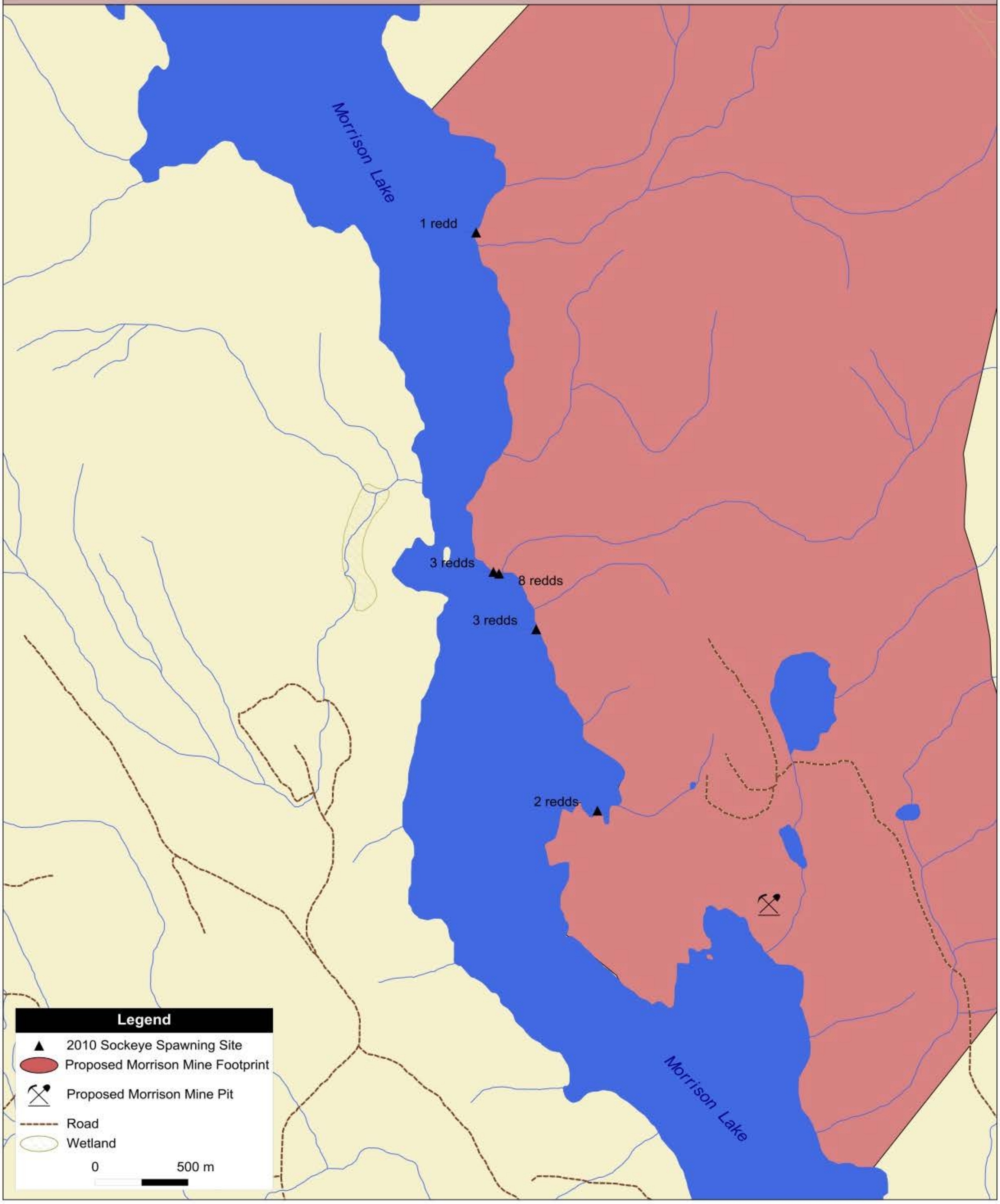


Figure 21: Sockeye Escapement Estimates. Lower Tahlo Creek, 1950 - 2009



Historically Sockeye have been observed spawning along the Shore of Morrison Lake to a limited extent (Bustard, 2004 and McMahon, V.H. 1948). With a focus on the shoreline within the mine footprint, Sockeye spawning was observed at several locations associated with tributary input. See Map D Morrison Lake Sockeye Spawning. Shoreline spawning visibility was limited to approximately 1 meter in depth but sites that were observed were more obvious than expected. Clean mixed gravel, tributary flow and down stream flow were common characteristic of redd locations on the shoreline.

Map D: Morrison Lake Sockeye Spawning



Residual Male Sockeye

During this study a large number of residual males accompanying the middle brood population were observed. The percentage of residual males remains constant with-in a population. Though they accompany this calendar years adults they are a percentage of the brood adults expected next year. Thus the high number of residual males indicates a large brood population next year. The residual males were observed acting as reproductive sneaks, trailing females and circling around as spawning pairs created redds.

Kokanee

Kokanee were observed schooled with the mid-run Sockeye population waiting for an increase in stream flow. They accounted for approximately 5% of the observed Sockeye and a minority spawned in Morrison Creek. The majority of Kokanee entered Morrison Lake within days of access and very few were observed after October 6th.

Coho

The arrival of 11 Coho in Morrison watershed was observed on October 1st, staging at the outflow of Morrison Creek. In the first week of October the average width of flow of Morrison Creek was less than 65% of the average bed width. The initial Coho run observed was staggered, dotting the stream by the 6th of October. When we returned to observe Coho on the 12th, Jack Hooper, local guide outfitter, reported a “good number” of Coho had arrived at Tahlo Creek, yet still very few were evident in Morrison Creek.

The Coho exhibited a higher energy level than the Sockeye and traveled upstream with greater speed and determination, covering 200 and 300 meter stretches in less than one minute. Coho were observed resting in deep pools and troughs, as well as pairing off and spawning. Morrison Creek charged with large schools of Coho in mid October. On October 18th a school of 97 was observed waiting below the log jam above the bridge and on October 22nd a school of 70 swam under the bridge at eight in the morning followed an hour later by a school of 42. The last Coho observed swimming under the bridge was on Nov 11th. By November 22nd Morrison Creek was frozen.

Observer accuracy was inversely correlated to stream depth. The tannic colour of Morrison Creek reduced visibility as stream depth increased and provided deep pools and deep channels along the creek.

Table 8: Coho Count per Day, Morrison Creek, 2010

Date 2010	Oct. 1	Oct. 5	Oct. 6	Oct. 8	Oct. 12	Oct. 18	Oct. 21	Oct. 22	Oct. 28	Nov. 11	Total
Coho	11	10	12	3	63	199	377	141	181	5	1002

Table 9: DFO Enhancement Project Coho Counts, Morrison Creek.

Date	1999	2000	2001	2002	2003	2004
Coho	448	269	904	675	450	2046

Coho residency time and bi-weekly observation during spawning allowed accurate spawning observation and location recording. Historic records by Hancock et al. 1983 and Diversified Ova Tech 1999 document the lower 1 km as a key spawning location, however this was not observed during this study. During this study period spawning was recorded along the full length of Morrison Creek except immediately below the outflow of Morrison Lake and favored areas with tributary input. See Map E: Morrison Creek Coho Spawning for location of areas in Morrison Creek with high concentrations of Coho spawning redds. Coho spawning started with water temperatures of 5.5°C by Oct 21st and were completed by November 15th with a water temperature of 1.1°C, an indicator of imminent freeze-up.

Many Coho remained in Morrison Creek to spawn but without a series of counting fences it was difficult to determine the total Coho population that passed into the Morrison system due to their high rate of travel and the deep pools available to hide in.

Map E: Morrison Creek Coho Spawning

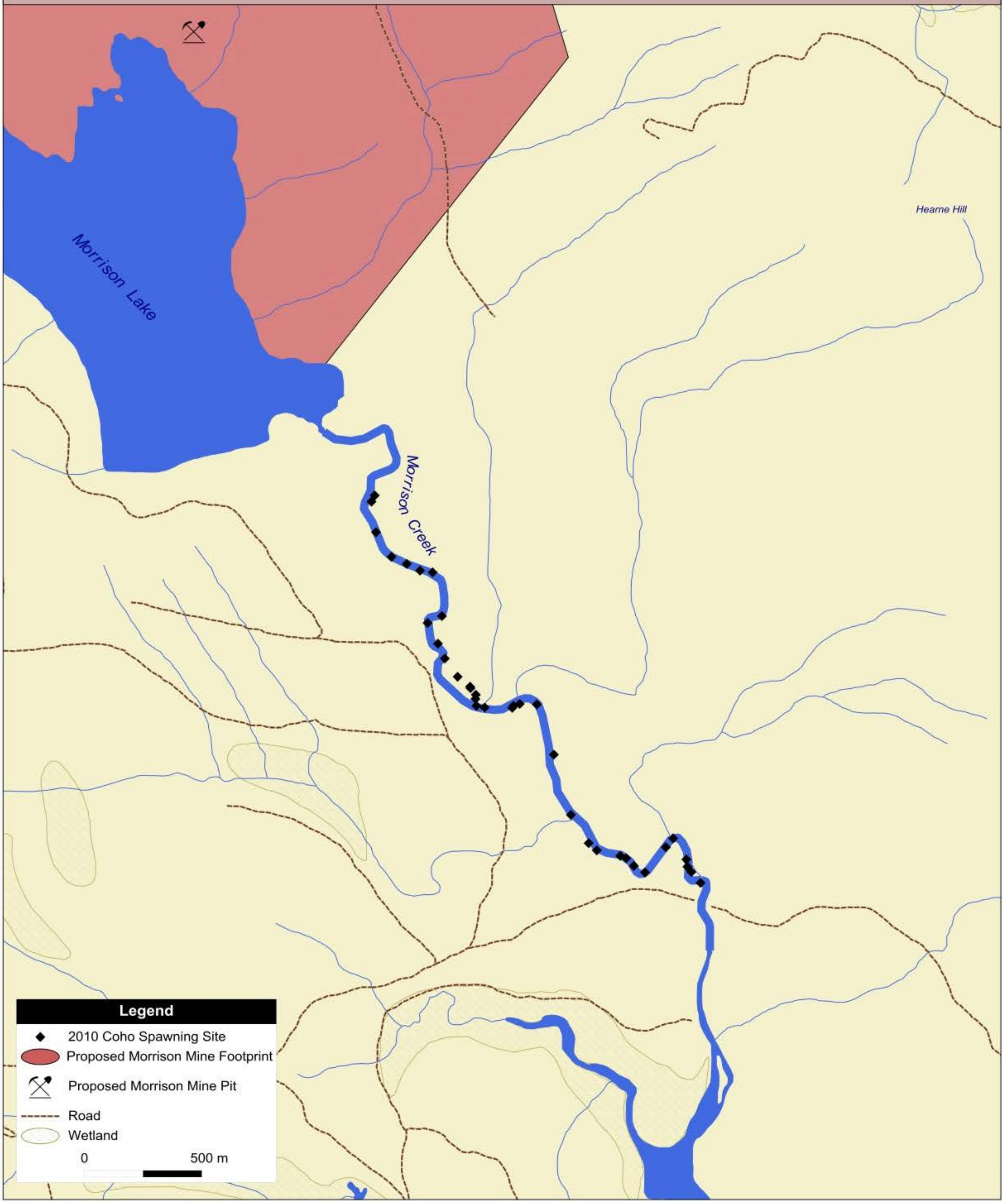
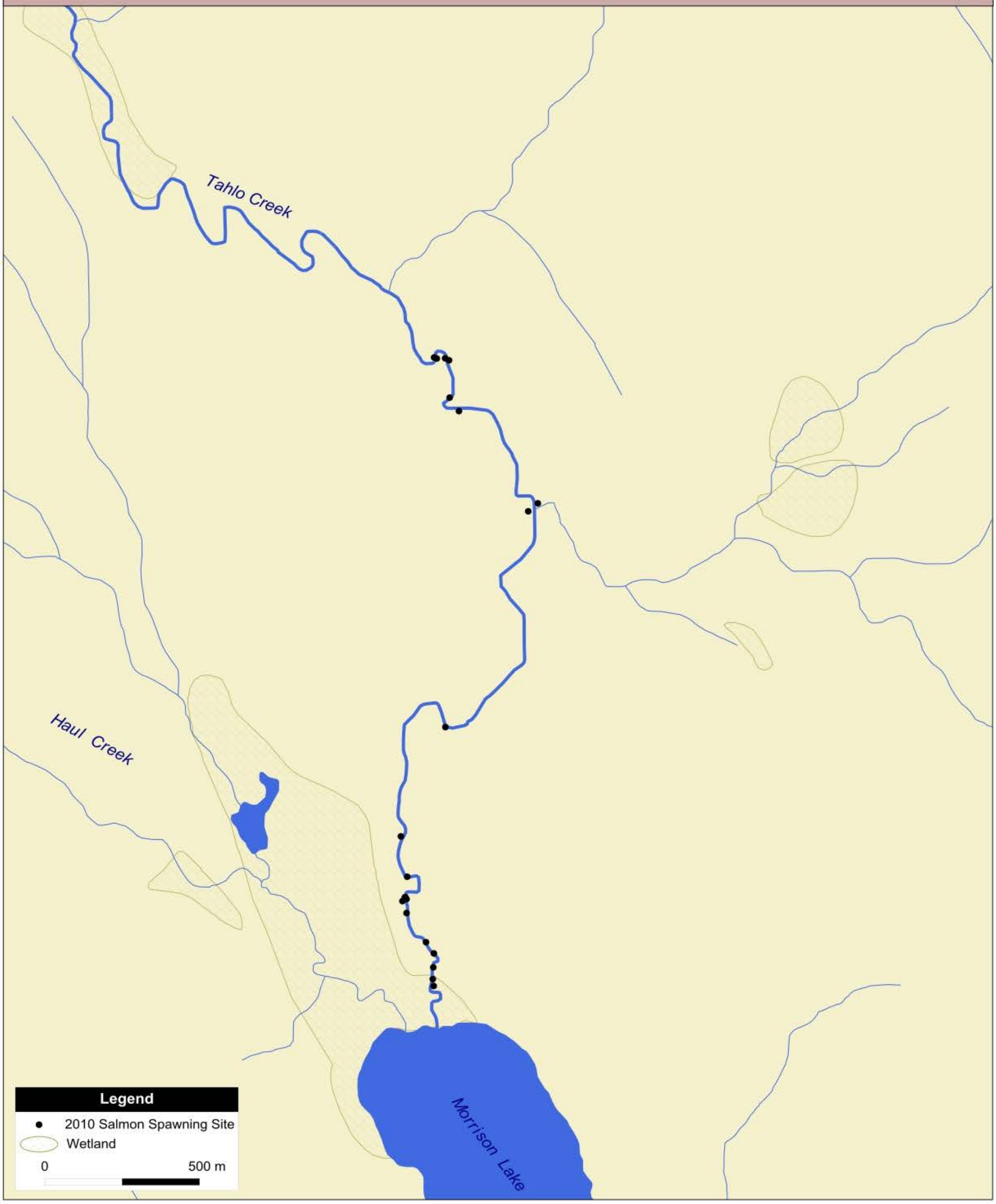


Figure 22: Ninety Seven Coho Below Log Jam. Morrison Creek, October 18, 2010

Lower Tahlo Creek

Observations of Lower Tahlo Creek commenced on November 1st and ended November 18th. Abundant redds were located in reaches 1 3 and 4. The redds were attributed to both species as indicated by the numerous Sockeye remains in the areas and the large number of lingering Coho spawners and Coho remains. See Map F: Tahlo Creek Spawning Sites for areas of high spawning redd concentrations.

Map F: Lower Tahlo Creek Salmon Spawning



Other Fish Species

Figure 23: School of Whitefish. Morrison Cr.

Mountain Whitefish were observed entering Morrison Creek, lagging 10 days behind the Sockeye. They occurred in schools between 30 and 110, with an average length under 8 inches. Commonly found downstream from spawning Sockeye the whitefish remained prevalent in Morrison Creek until the end of Sockeye spawning.

As Coho arrived small schools of Rainbow Trout entered Morrison Creek. These Rainbow ranged in size from 8 inches to 13 inches nose to fork length. The larger Rainbow were found in deep pools with Coho whereas smaller Rainbow were observed following Coho upstream.

Associated Wildlife

Low water levels exposed salmon to increased ease of predation by Grizzly bear, Black bear and Eagles. On our first day we recorded 41 mounds of Bear Scat. The scat consisted nearly completely of digested fish. As a result of two dry summers in a row this was a particularly poor berry year. No bear scat was found indicating berry digestion apart from rosehip remains in six of the piles. Bears preparing for hibernation are opportunistic eaters and low water levels in Morrison Creek provided excellent opportunity.

Along the shores and banks of Morrison Creek there exists a continuous network of bear trails. We often interrupted bears fishing and waited for them to lumber away or smelled them and saw their wet tracks over the larger cobbles. Whole salmon carcasses were seldom observed, the freshly dead consisting only of heads, gills, spines or a combination there of.

Figure 24: Juvenile Bald Eagles Watch Morrison Creek, 2010

Figure 25: Coho Salmon Remains, Morrison Creek. October 2010

Predation of spent Sockeye and Coho by bear and eagle was a common phenomenon and many remains were observed on shores. The few whole carcasses observed were the interrupted dinners of Bald Eagles, eyeless and marked by talons. Bald Eagles had several low water sites and spawning sites that they observed from nearby rocks or trees waiting for salmon to venture up. We observed an average of 16 Bald Eagles each trip down Morrison Creek, with more juveniles than adults and found two active nests, one in the Bay of Morrison Lake just above the outflow, and one at the end of Morrison Creek along the logging road. See Map G: Associated Wildlife of Morrison Watershed.

Figure 26: Bald Eagle Fishing Rock and Nest, Morrison Watershed, 2010

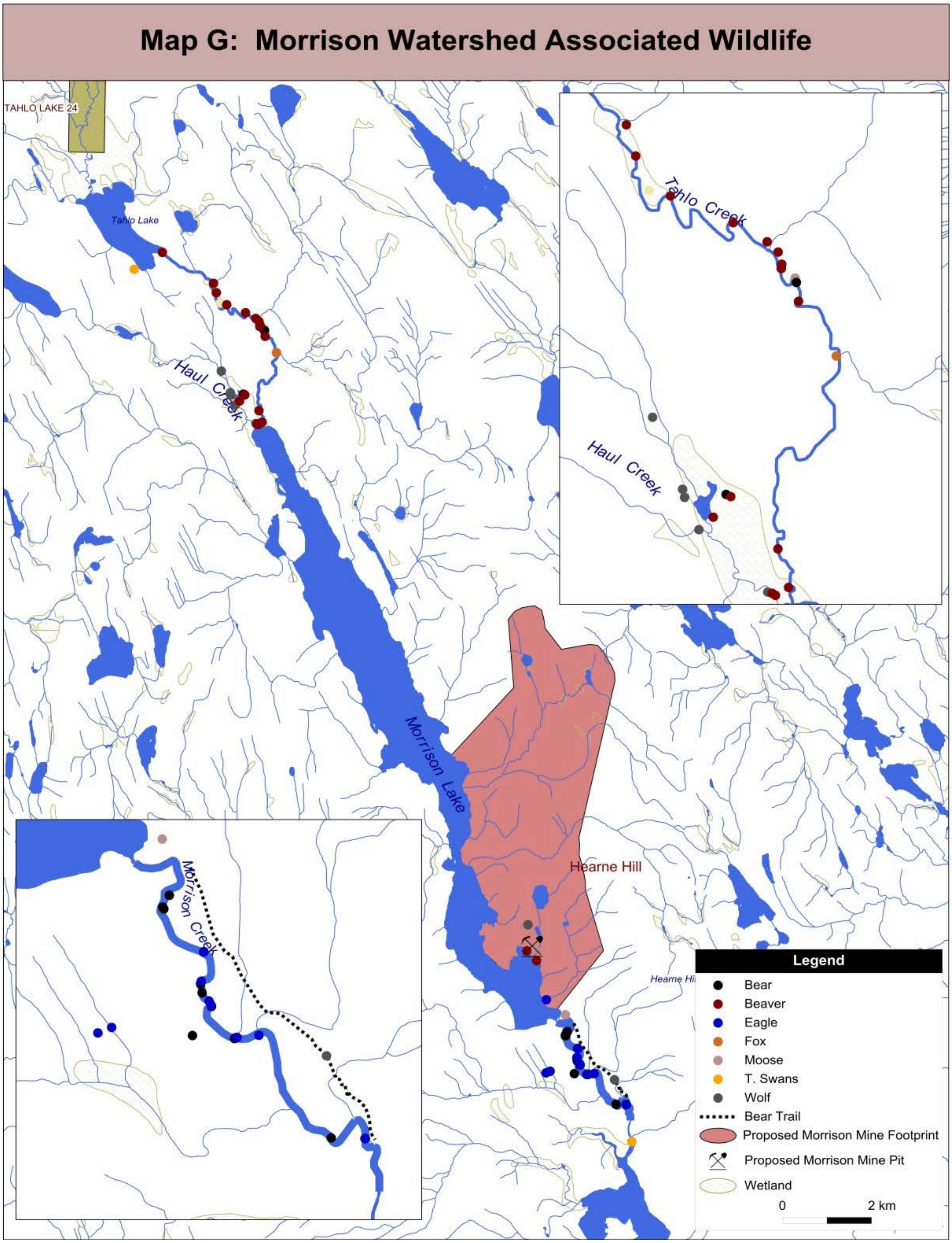
Wolf tracks and wolf scat were observed along Morrison creek, Tahlo Creek and the full length of Haul Creek. Many grouse and rabbit tracks were observed along these trails as well. Predation was exacerbated in Tahlo Creek by numerous beaver dams. Of over nine beaver dams, two created significant obstacles that required time and effort to overcome. Below these beaver dams water levels were low subjecting salmon to prolonged exposure to eagle and bear predation. Accumulated carcass remains were observed at several of the larger dams where the grass was packed down by bears.

Figure 27: Left Set Wolf Tracks, Right Set 83lb Golden Retriever.
Haul Creek November 2010

Figure 28: Bear signs, Tahlo Creek, November 2010

Beaver Dams contributed to the sedimentation and eutrophication of many tributaries in the Morrison watershed. It was observed that the large ponds created by the dams and beaver mud excavation activities have eroded stream banks. The 5th and 6th reaches of Lower Tahlo Creek are coated with fine red-brown soil sediment.

Figure 29: Beaver Dam, Tahlo Creek, Nov 1 2010


Map G: Morrison Watershed Associated Wildlife
TAHLO LAKE 24
Tahlo Lake
Haul Creek
Tahlo Creek
Haul Creek
Morrison Lake
Hearne Hill
Morrison Creek
Hearne Hi
Legend
Bear
Beaver
Eagle
Fox
Moose
T. Swans
Wolf
Bear Trail
Proposed Morrison Mine Footprint
Proposed Morrison Mine Pit
Wetland
0
2 km

High Valued Wetland Habitat

In addition to the staging area for returning spawners, the approximately 3 square kilometers of wetlands at the conflux of the Morrison Creek and Morrison Arm of Babine Lake represents significant ecological habitat. The fertile meadow provides moose calving and grazing grounds with succulent forage. Over 10 mineral licks were observed along the forested edge of the wetland. A vast network of trails along the forested edge and profuse droppings attested to frequent use. The wetlands provide transient residence to migratory birds including trumpeter swans, Canadian geese and Mountain Bluebird, all observed this fall. See Map *** Associated Wildlife of Morrison Watershed.

Figure 30: Conflux of Morrison Creek at Morrison Arm, October 2010

This area is a primary hunting location for Lake Babine Nation members, valued for both its historical hunting success and current success. Water volume and quality of water play an important role in wetland success.

Conclusions

An estimated total escapement of 10 132 Sockeye were recorded in the Morrison Watershed for 2010. During nine days of observations, over 4 weeks, 6 953 sockeye were recorded in Morrison Creek. Sockeye spawning was recorded along the length of Morrison Creek with greater redd concentrations in locations associated with ground and tributary flow.

During 10 days of observations over 6 weeks, 1002 Coho were recorded in Morrison Creek with high concentrations of spawning pairs recorded along the full length of Morrison Creek excluding the extreme upper and lower portions. As stream depth increased accuracy of Coho enumeration decreased due to the presence of deeper pools and troughs for Coho to hide in. Accuracy was further compromised by the increased rate of travel that Coho exhibited through Morrison Creek. Overall escapement estimates were low and could be improved with the erection of temporary counting fences and daily enumeration. It was interesting to note that a "large number of Coho" reached Tahlo Creek prior to initial detection in Morrison Creek.

Barriers to salmonid spawning observed during this study included naturally occurring negative hydrological equilibrium, beaver dams and predation. Low snow pack and low summer precipitation levels, exacerbated by accelerated spring freshet resulted in depressed hydrologic flow. Further flow restriction was observed as a result of multiple beaver dams on all of the tributaries in the Morrison Watershed with the exception of Morrison Creek which remained beaver dam free during the study. Access of the mid brood Sockeye population into the Morrison Watershed was delayed by low water at the outflow of Morrison Creek by approximately two weeks. Subsequently salmonid egg release and fry development will be delayed which results in compounded impacts on fry success and survival.

High wildlife values were observed during this study. During spawning season numerous predators were documented though-out Morrison Watershed. Grizzly bears and Bald Eagles dominated trails along Morrison Creek, Tahlo Creek and Haul Creek and were found along creek shores associated with easy fishing locations. Ease of predation by Bald Eagle and Grizzly bear was increased by low stream flow. Minor predation by coyote, wolf and fox was observed through out the Morrison Watershed with significant wolf presence along Haul Creek. Moose and migratory birds were observed with highest frequency in the wetland areas at the outflow of Morrison Creek and at Tahlo Lake.

Global climate change is currently impacting both healthy and compromised ecosystems. Climate change is expected to impact Morrison watershed with effects to species-level changes in range and abundance, life cycle and behavior, and genotype. The mountain pine beetle epidemic exemplifies initial climate change impacts as a result of warmer winters and longer growing seasons. The study area anticipates earlier snowmelt, warmer temperatures with increased stream temperatures and changes to water flow regimes. However, the anticipated impacts to salmon and freshwater fish are complex and not well understood. These uncertainties challenge current management approaches and require conservation-based and precautionary management of fish and aquatic resources in the Morrison and Babine watersheds.

Literature Cited

Arocena, J. M., Davison, A., 1996. Geochemistry of interstitial water and sediments for 0-3 cm layer of Hagan Arm, Babine Lake, British Columbia.

Bustard, D. 2004. Fisheries Background Studies Morrison Watershed. Prepared for Pacific Booker Minerals Inc.

Bustard, D. 2005. Fisheries Studies Morrison Watershed. Prepared for Pacific Booker Minerals Inc.

Climate Change Impacts and adaptation: A Canadian Perspective – Impacts of Fish, 2001. http://adaptation.nrcan.gc.ca/perspective/fish_3_e.php

Fish Wizard. 2005. http://pisces.env.gov.bc.ca

FISS. Fisheries Information Summary System. www.bcfisheries.gov.bc.ca/fishinv/fiss.html

Foote, C.J., Wood, C.C., and Withler, R.E., 1989. Biochemical Genetic Comparison of Sockeye Salmon and Kokanee, the Anadromous and Nonanadromous forms of Oncorhynchus nerka

Forsyth, A. & Wynn, T.G. 1913. The Spawning Beds of the Skeena, Report of the Commissioner of Fisheries

Fraser, C. 1948. Country of the Babines, Cariboo and Northwest Digest.

Levy, D.A. and K.J. Hall. 1985. A Review of the Limnology and Sockeye Salmon

Ecology of Babine Lake. Westwater Technical Report No. 27. Prepared for the

Westwater Research Centre, UBC in cooperation with B.C Ministry of Forests

Forest Service, Prince Rupert Forest Region.

A Brief Overview of Fish, Fisheries and Aquatic Habitat. 2003 Morice land and resource management plan. 2007.

MacIntyre, Donna. 2010. Personal comments and data. Lake Babine Nation Fisheries.

McKay, D.C.G. 1930. Babine Lake, Canadian Geographic Journal.

McMahon, V.H. 1948. A comparative limnological study of Lakelse and Morrison lakes, B.C. with a view to assessing the suitability of Morrison Lake for the propagation of sockeye salmon. MS. Thesis. University of BC.

Pretty, A.W., 1909. Commissioner of Fisheries Report, Forty-First Annual Report of the Department of Marine and Fisheries.

Price, D.T., et al. 2001. Transient climate change scenarios for high-resolution assessment of impacts on Canada's forest ecosystems.

Remington, D. 1995. Review and Assessment of Water Quality in the Skenna River Watershed, BC. Prepared for the Department of Fisheries and Oceans.

Roberts, R.B. 1962. Forts and Trading Posts of BC. Provincial Archives.

SKR Consultants Ltd. 2001. Reconnaissance (1:20000) Fish and Fish Habitat Inventory at Three Sub-basins in the Morrison Creek Watershed. Prepared for Houston Forest Products Co.

SKR Consultants Ltd. 2000. Reconnaissance (1:20000) Fish and Fish Habitat Inventory at Six Sub-basins in the Morrison Creek Watershed. Prepared for Houston Forest Products Co.

Shortreed, K.S., K.F. Morton, K. Malange and J.M.B. Hume. 2001. Factors limiting sockeye production in selected B.C. Nursery Lakes. Canadian Stock Assessment Secretariat Research Document 2001/098.

Southgate, A. 1979. Spawning Project was a good life in the 1930's. Tales of Old Babine.

Williams, J.T. 1904 Inspector Report, Dominion Fisheries.

Wood, C.C. & Bickham J.W. et al 2008. Recurrent evolution of life history ecotypes in sockeye salmon: implications for conservation and future evolution.

Wood, C.C. & Foote, C.J. 1996. Evidence for Sympatric Genetic Divergence of Anadromous and Nonanadromous Morphs of Sockeye Salmon.