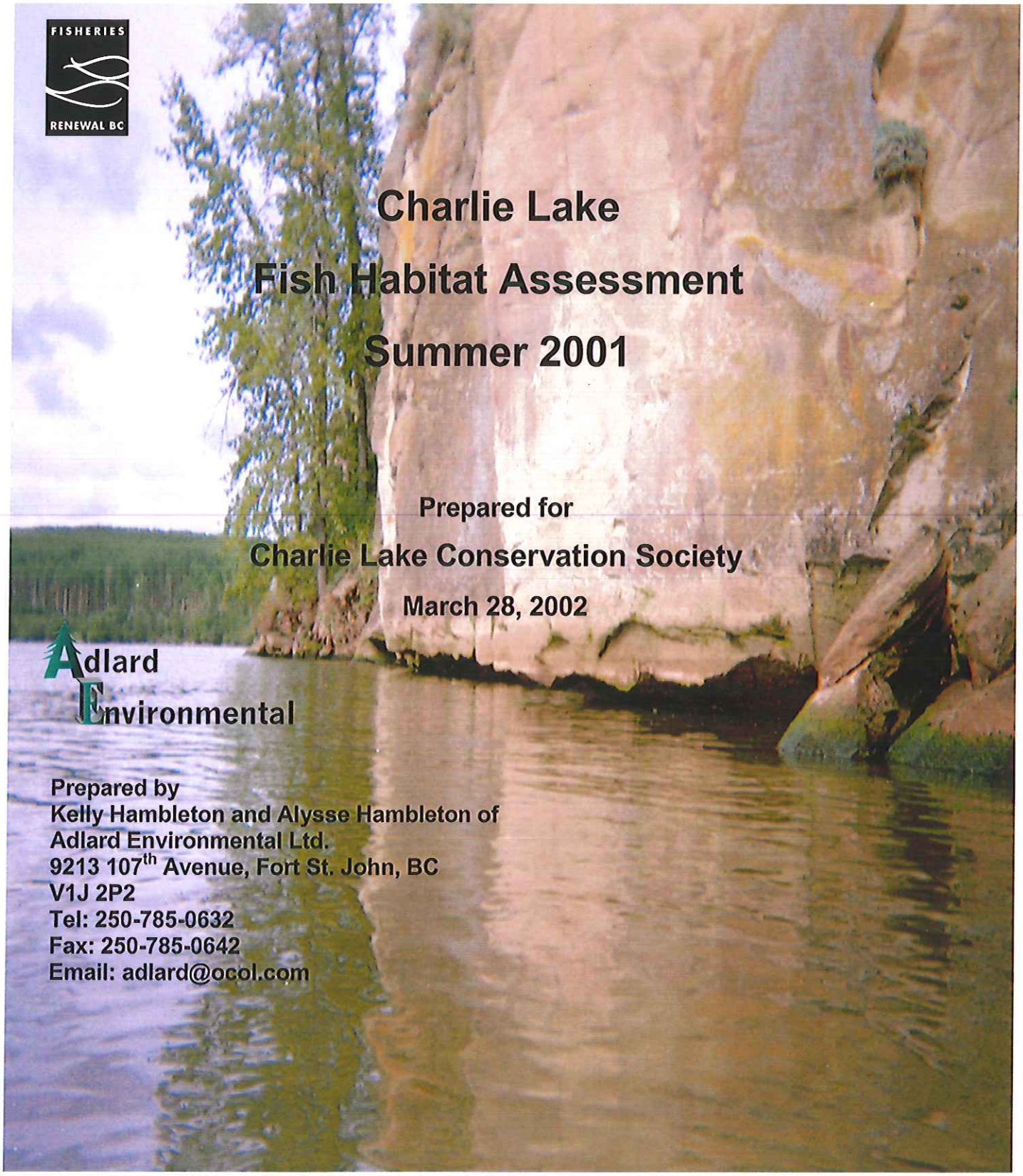


FISHERIES RENEWAL BC

Charlie Lake
Fish Habitat Assessment
Summer 2001

Prepared for

Charlie Lake Conservation Society

March 28, 2002

Adlard Environmental

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1. Executive Summary

Adlard Environmental and Charlie Lake Conservation Society worked together to conduct a fish inventory and habitat assessment of Charlie Lake. Work commenced in early July and continued until the beginning of October. Fish sampling was quite successful overall and the habitat assessment revealed many areas of current and future concern for slumping.

This study found five species of sport fish; yellow perch (*Perca flavescens*), walleye (*Stizostedion vitreum*), northern pike (*Esox lucius*), burbot (*Lota lota*), and white sucker (*Catostomus commersoni*), while only one species of forage fish, spottail shiner (*Notropis hudsonius*), were caught.

Spottail shiner dominated the 35,987 fish caught, both overall and per unit effort. Of the sport fish caught, yellow perch was by far the most abundant (3,223) with the next closest being white sucker (437). Juvenile perch dominated the majority of sites sampled and these populations were concentrated in several highly productive sites. These high numbers most likely distorted the statistically correlations to the other sport fish found. The overall dissemination of both sport fish and forage fish in individual bays led us to conclude that population distribution may be related to the health of the available fish habitat.

Fish habitat assessment was analyzed through both shoreline mapping and individual site evaluation along Charlie Lake. Slumping of shoreline was mapped with a GPS unit and quantified into three degrees of severity. Plant species, and abundance as well as percent cover at individual sites was recorded and used to evaluate the potential for future slumping at those sites.

Acknowledgments

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2. Introduction

The Charlie Lake basin is a critical watershed in the Fort St. John region. It supplies water for ranchers, farmers and is the main area for regional recreation such as boating, fishing, camping and other water sports. Charlie Lake has been influenced in recent years by urban and agricultural developments. These developments have resulted in increased water levels, due to the flow regulator at the Stoddard Creek outlet, and increased nutrient loading from commercial fertilizers, leaky sewage systems, manure inputs and shoreline erosion. Changes in natural fish species, due to recent and historical fish stockings for recreational pursuits have also affected Charlie Lake. Natural recruitment of local fishes has declined in recent years and the sustainability of many critical species is of local concern. The possible causes of recruitment failure include impassable barriers at the Stoddard Creek outlet, increasing cultural eutrophication, siltation as well as certain incompatible recreational activities. Some alarming trends for freshwater fauna have been linked to extensive habitat deterioration caused by sediment loading and organic pollution from land-use activities, stream fragmentation and flow regulation by dams, interactions with exotic species and toxic contaminants from municipal and industrial sources (Dynesius and Nilsson, 1994). This study looks at fish quantity, site productivity and lakeshore characteristics in order to assess the stability of the fish populations and areas of concern regarding lakeshore quality.

3. Study Area

Charlie Lake is a naturally eutrophic lake located approximately 9 kilometers northwest of Fort St. John. The lake is 20 kms long, more than 1 kilometer wide, has a surface area of 1820 hectares (Peace River Regional District, 2000) and a mean depth of 5 meters (Nordin, Pommen, 1985). The lake is located in a watershed area that drains an area of 298 kilometers (Nordin, Pommen, 1985). The major drainage for the lake is Stoddard Creek that enters the lake at the north and leaves at the south. In addition, there are two permanent creeks (Coffee and Roper) and a number of ephemeral tributaries that feed into the lake. The water levels of Charlie Lake can fluctuate up to a meter throughout the year, with peak flows occurring in May and minimum flows occurring in December (Nordin and Pommen,

1985). The watershed lies within the Boreal White and Black Spruce (BWBS) biogeoclimatic zone, with the moist and warm one (mw1) variant (Delong et al. 1990). The Climate is characterized long very cold winters, and short growing seasons (Delong et al. 1991). The majority of the forested areas surrounding the lake are dominated by *Populus tremuloides* Michx. (trembling aspen) with some small stands dominated by *Picea gluaca* (Moench) Voss (white spruce). The overstory, the understory and lakeshore vegetation present is consistent with the BWBS biogeoclimatic zone. Soils are dominated by heavy clay developed on glacial tills with rocky outcrops occurring at the higher elevations (Nordin and Pommen, 1985).

3.1. History

3.1.1. Fish Stockings

There have been many historical fish stockings of Charlie Lake. The first took place in 1933 when 100,000 rainbow trout (*Onocorhynchus mykiss*) eggs from Paul Lake, which had been reared at Loon Creek hatchery, were introduced into Charlie Lake (anonymous, 2002). Trout stocking was attempted again in 1947 with 100,000 trout fingerlings and a third time in 1949 with 20,000 trout fingerlings, both which had been hatched and reared at the Pennask Lake Hatchery (anonymous, 2002). In the early 1950's walleye (*Stizostedion vitreum*) and northern pike (*Esox lucius*) were introduced and in 1962 large mouth bass (*Micropterus salmoides*) were introduced with little success (anonymous, 2002). In 1981, 2750 yellow perch (*Perca flavescens*) fingerlings and 750 adults were moved from Swan Lake to Charlie Lake. (Euncher, 1995). In 1986, approximately 75,000 forage fish including *Notropis hudsonius* (spottail shiner), *Catostomus catostomus* (longnose sucker), *Couesius plumbeus* (lake chub), *Platygobio gracilius* (flathead chub), *Richardsonius balteatus* (redside shiner), *Percopsis omiscomaycus* (trout perch), *Culeae inconstans* (brook stickleback), yellow perch and *Lota lota* (burbot) were stocked into Charlie Lake after previous attempts to locate any historic forage fish populations failed (Euncher, 1995).

Brook stickleback, *Semotilus margarita* (northern pearl dace) and *Chrosomus eos* (northern red belly dace) have been recorded historically (prior to 1980) in the lake (Hammond 1986)

although none were found during a fish assessment done by R.J. Hammond (1986). Recent beach seines found only large numbers *Notropis hudsonius* (spottail shiner) leading us to believe that the majority of the introduced species did not survive.

3.2. Urban Development

3.2.1. Stoddard Dam

A gravel dam with a regulated flow was built across South Stoddard Creek in 1968 and was maintained until 1981 when an earth fill dam was constructed with a flow regulator and a fish ladder. Since the dam was built, local residents have noticed a dramatic increase in the lake level with estimates as high as 0.9 meters. Interestingly, there has never been official municipal or provincial monitoring of lake level since the dam's construction and all evidence has been provided through personal communications and observations with local lake residents. Increased water levels have greatly impacted the available fish spawning areas in Charlie Lake.

There has been a noticeable decline in the biomass of aquatic vegetation since the Stoddard Creek Dam was built (Bob Ohland, personal observation, 2001). Aquatic vegetation, which at one time covered the majority of Charlie Lake's shoreline, is now sparsely distributed with the exception of the Stoddard Creek entrance and exit as well as some of the larger bays such as Darnell Bay and Sunnyside Beach. This can be viewed as either beneficial or detrimental. The loss of vegetation has increased the appeal of Charlie Lake for recreation and aesthetics but it has, in turn, decreased fish habitat and spawning areas.

3.2.2. Urbanization and Agriculture

Urbanization of Charlie Lake and its watershed has increased in the past 30 years. Permanent residences have increased dramatically in the Charlie Lake area, as has the use of the lake for recreation and fishing. As of 1980, private land accounted for greater than 80% of the watershed and approximately 40% of the watershed had been cleared for agricultural purposes (French and Carmichael, 1999).

In addition, French and Carmichael (1999) found that average C, N and P concentrations,

specific conductance and turbidity values were greater in Stoddard Creek than they were in Charlie Lake. Due to this fact Stoddard Creek increases the concentration of these values in Charlie Lake instead of diluting them (French and Carmichael, 1999).

Urban development on the lake is concentrated into three main areas. In the south, two residential corridors stretch along either side of Charlie Lake. One corridor is located in the north. The two corridors in the south extend from the boat launch at the southern tip of the lake to Beatton Park, on the east side, and north of Golf Course point, on the west side. The northern corridor extends from the inflow of Stoddard creek south. Urbanization of Charlie Lake has a two-fold effect. First, increased development has reduced natural lakeshore vegetation, increased recreational activities, increased pollution (nutrient input, accidental spills etc.) and increased siltation through exposed soil and increased runoff. Second, population increase in the area creates more concern for the health of the lake. Projects such as the education project done by CLCS are essential in informing people of their effect on the health of the lake.

4. Methodology

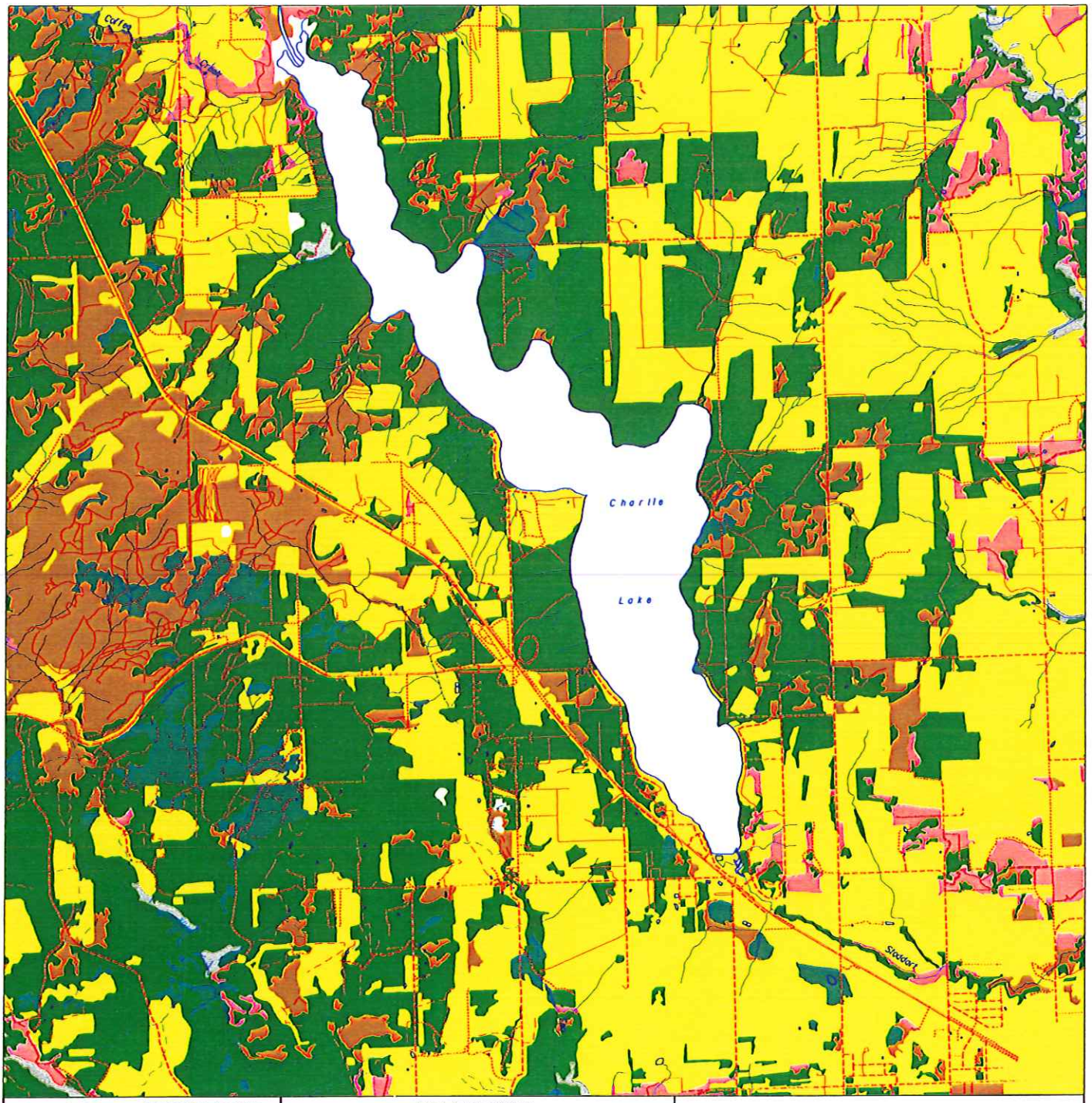
4.1. Fish Assessment

4.1.1. Sampling

The first component of the study was an assessment of the fish populations of Charlie Lake. Local resident, Bob Ohland, provided a detailed map showing prime fishing locations and rearing habitat. This map was used in conjunction with historical topographic maps and analysis by R.J. Hammond (1986) to determine the most effective areas to sample juvenile populations of fish. The historical topographic maps show all the natural nutrient sources, such as tributaries, and feeding grounds for many fish (i.e. weed beds). The final factor determining location of sampling effort was depth of lake. As seining is difficult and unreliable in deep water we concentrated our efforts in the shallow areas of the lake. With all these factors taken into account, the majority of the sites occurred in the natural bays of Charlie Lake. Figure 1 shows the locations of each sample bay. A total of

10 sample areas were determined around the lake with the majority of the sampling occurring in the northern half of the lake due to bay location and fish habitat. Each sample area was sampled for one complete day with random sampling occurring at several locations around the bay.

The lake was traversed using a 12-foot aluminum boat with a Honda 5 horsepower 4-stroke motor. Prior to sampling the motor was turned off and oars were used to navigate the bay. This was done to reduce the movement of fish away from the sample area. Using an eighteen-meter seine net, chest waiters and two individuals, the net was pulled out perpendicular from the shore to chest waiter limit by one person and then moved parallel to shoreline to collect fish. The net was then brought back to shoreline to close the collection area. At each sample location all fish were identified and separated into sport fish or non-sport fish. The sport fish were then aged, into three classes; fry, juvenile and adult. The adults were measured for total body length and fork length. Each having one scale removed for exact aging. All fry and juvenile had their body length individually measured. Estimates on body length were done for forage fish recording only the maximum length and the minimum length. For the purpose of this paper, sport fish will be defined as fish that have recreational, commercial or economical value such as walleye, northern pike, white sucker, burbot and yellow perch. Non-sport fish, such as spottail shiner, were defined as forage fish.



Mapsheet Reference: 94A025/026/035/036

Adlard Job Number: 2001-010

Location: Charlie Lake

Date Compiled: March 22, 2002

Scale 1: 80 000

MAIN ROAD
SECONDARY ROAD
TRAIL
LAKE
STREAM

REFERENCES

CLAY BANK	124 HECTARES
INPUT AND NEAR	2863 HECTARES
AGRICULTURE LAND	11271 HECTARES
OPEN RANGE	759 HECTARES
URBAN	37 HECTARES
CONIFEROUS	855 HECTARES
DECIDUOUS	10881 HECTARES

FOREST COVER TYPES SURROUNDING CHARLIE LAKE

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4.1.2. Creel Survey

The second part of the fish assessment involved a volunteer creel survey. Two methods were used to complete the creel survey. The first methods consisted of creel packages, containing all necessary tools (tweezers, envelopes, measuring tape, survey form), paper work and a return envelope, which were handed out to local residents who expressed interest in participating in the survey. Figure 2 shows the form use in the creel survey. For the second method, we approached anglers while on the lake and asked for specific information including species caught, hours of angling, length of fish caught, and scale samples. Anglers were approached, at random, in bays that were being sampled during that day.

4.2. Habitat Assessment

4.2.1. Terrain

The second component of the study was to conduct a habitat assessment of the lake. Habitat is an integral part of lake productivity and recreational enjoyment. The assessment was done to quantify current lake conditions such as slumping, vegetative cover, and aquatic vegetation and shoreline characteristics. A Trimble™ GPS unit was used to map areas of the lake with heavy slumping, aquatic vegetation and verify tributary positions on the lake. This information was entered and assessed in the Microstation™ mapping program. Terrain information was collected at each seining point including aspect, gradient, plant species abundance (ocular) and cover, coarse woody debris (CWD), both on shore and on lake bottom, benthic (lake bottom) attributes and bank stability.

Survey Information

Date:_____

Started fishing at _____am/pm. Stopped fishing at _____am/pm.

Weather conditions: _____

Angler and Party Information

Number of anglers in group:_____

Angler	Angler Origin (please ✓ for each angler in party)			
	BC	AB	Other Canadian Province	Resident of Another Country
1				
2				
3				
4				
5				
6				

What type of gear did you use?_____

Were you fishing from a boat or the shore?_____

Where on the lake were you fishing?_____

	Poor				*Excellent*
Angler rating of fishing quality: (circle one)	1	2	3	4	5

Enjoyed angling: Yes _____ No _____ Indifferent _____

On average, how many times a year do you fish at Charlie Lake? _____

Angler comments:

Figure 2. Creel survey Form.

4.2.2. Slumping

The Charlie Lake Conservation Society (CLCS) has expressed concern regarding the shoreline stability of Charlie Lake. There have been reports of increased slumping along the shore. This component of the study investigated quantified the level of slumping for the lakeshore. Additionally, the lakeshore was mapped and the linear area of active slumping was compared with the total lakeshore.

Fluctuating water levels, removal of shoreline vegetation, beaver activity and prevailing winds all contribute to shoreline erosion. Banks are dominated by heavy clays overtop of glacial tills that are very sensitive to erosion and need the protection of lakeshore vegetation. This causes increased incidence of landslides and slumping into the lake. The areas were classified into one of three levels of slumping:

Level One: Level one (Figure 3a) rating is for areas with little or no concern. These areas are typically flat and well vegetated. It includes areas with undercut banks and rock cliffs that are stable, and show no signs of slumping and are in protected areas such as the tips of bays.



Figure 3a. Level 1 slumping.

Level Two: Level two (Figure 3b) rating is reserved for areas of concern typically with lakeshore slopes of 10% and greater. These currently show little signs of slumping but due to slopes and soil characteristics they are possible areas of concern for the future.



Figure 3b Level 2 slumping.

Level Three: Level three (Figure 3c) rating is assigned to areas that are currently slumping. Slumps ranged from small movements to large landslides and typically appear in areas with direct contact to weather processes of the lake.



Figure 3c Level 3 slumping.

These levels were assigned based on habitat data collected in seine areas. An ocular estimate of slumping was determined from the boat in areas not sampled for fish.

5. Fish Species Summary

5.1. Northern Pike (*Esox lucius*)

Northern Pike (Figure 4) are a highly rated game fish throughout the north. They are circumpolar and can be found in fresh water from Alaska to the Atlantic. Pike generally prefer relatively shallow, weedy and clear waters of lakes and to a lesser extent, rivers (Nelson and Paetz, 1992). They are large fish and have been known to reach lengths of greater than 1.2 meters with weights in excess of 18 kg. Spawning occurs just after ice break (early May on Charlie Lake) in areas of shallow water (generally less than 30cm) with a well-established vertical structure (Hatfield et al., 1972). They are broadcast spawners (releasing eggs and sperm into the water column) and no parental care is provided to eggs or fry. Typical spawning areas are shallow marshes connected to lakes or flooded vegetation in shallow bay with a temperature ranging from 3-24.2 degrees Celsius.

Rapid temperature changes and increased silt loads resulted in heavy pike embryo mortality. In addition, silt deposition of 1mm a day was found to produce a mortality rate of 97% in pike eggs (Hassler, 1970). Pike need some sort of vertical structure in spawning area for eggs and larvae (up to a week old) to remain attached to so as to prevent them from falling into the deep silt and areas of low oxygen concentrations. Juveniles are sensitive to light and remain hidden in the vegetated shorelines. Dissolved oxygen is considered an important variable affecting over wintering survival of adult and juvenile northern pike (Skip 1982).

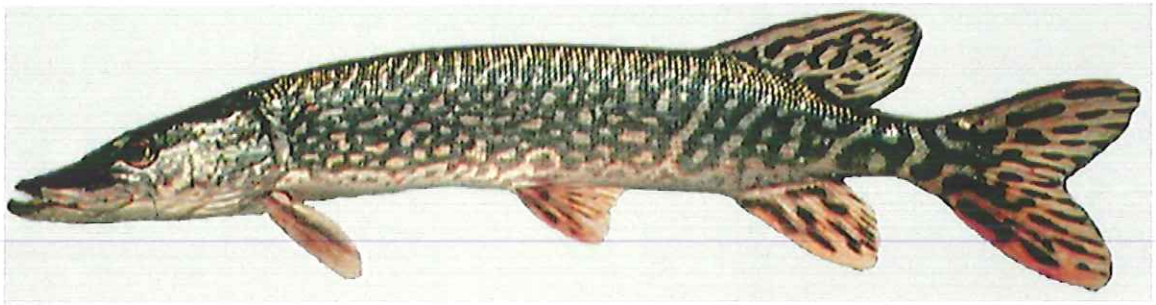


Figure 4. Northern Pike.

5.2. Walleye (*Stizostedion vitreum*)

Walleye (Figure 5) are an important sport and commercial fish species in North America with excellent tasting white flesh. They spawn in the shallows of lakes, streams and rivers shortly after ice break up. In Charlie Lake spawning typically peaks in mid to late May (Nelson and Paetz, 1992). Walleye are broadcast spawners and provide no parental care to eggs or fry. The preferred spawning habitat for walleye are gravel shoals with a slight current to provide incubating eggs with oxygen. Johnson (1961) studied the survival of walleye eggs and found that lowest survival rates were on soft mud and silt, moderate survival rates on fine sand and highest survival rates on a gravel substrate. Ideal spawning currents range between .73 and .91m/s with juveniles preferring low velocity currents (Nelson and Paetz, 1992). Eggs hatch in 12- 18 days but remain unable to swim for five days as they absorb their egg sacks. During this time they are susceptible to silt levels and oxygen concentrations as they remain on stream or lake bottom. Once mobile they move to deep water for increased food levels and predator avoidance. As they grow they their food

source changes from zooplankton to insects and fish and they become increasingly photonegative. They move to deeper waters and coming to shore only at night. Walleye as a species are highly resilient to many environmental conditions, which accounts for their ability to survive in Charlie Lake.

Charlie Lake has relatively high turbidity averaging 4.6 NTU (nephelometric turbidity unit) and low water quality (average secchi disk reading of 1.5 m) (French and Carmichael, 1999). The high turbidity levels of Charlie Lake are a concern for incubating eggs and newly hatched fry as it dislodges and moves them to areas of unfavorable growing conditions (deep silt and areas of low oxygen concentrations).

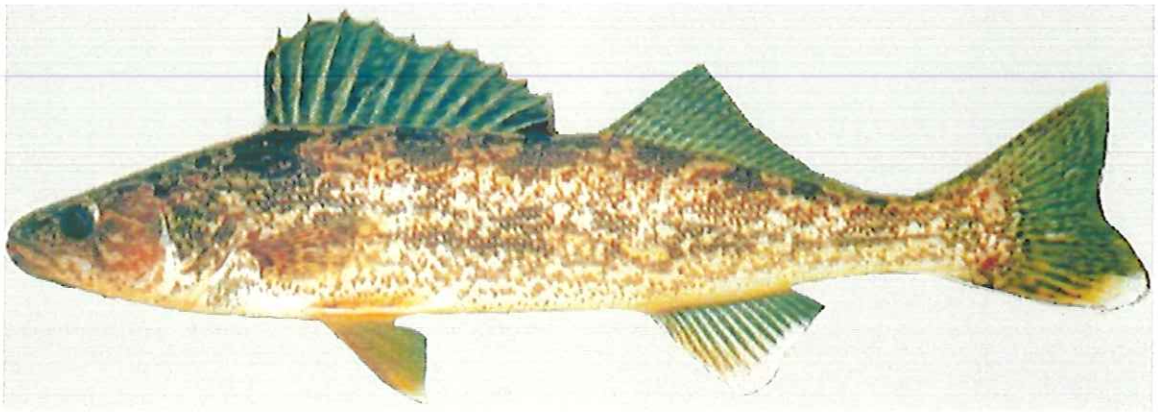


Figure 5. Walleye.

5.3. Yellow Perch *(Perca flavense)*

Yellow perch (Figure 6) are not the most popular sport fish, but they are one that most anglers catch. They are a common catch of ice fishermen and their flesh is firm and very good tasting. Yellow perch occur across North America and have been introduced into many lakes and drainages in the north. They live in both lakes and streams although they are more abundant in lakes and backwaters of large rivers than they are in swift-flowing streams. The young are most abundant in areas of aquatic vegetation. The preferred habitat of adult yellow perch is shoreline areas of clear lakes and ponds with moderate amounts of

aquatic vegetation.

Yellow perch spawn soon after ice-out in April and early May with the later spawn times occurring further north. The temperature only needs to reach 7° C (45° F) to induce spawning. They build no nest, and there is no parenting of the eggs or young. Males reach sexual maturity at 2-3 years old and females at 3-4 years old. These adult perch move to shallow, weedy areas of lakes or into slower protected areas of a stream (Paulsen, 2002). A single female may lay 10,000-200,000 eggs, depending on her size and health. Egg sacs are usually extruded in a few minutes to several hours time over aquatic vegetation or submerged brush or over sand, gravel, or rubble substrates (Sublette et al, 1990). The eggs are deposited at night at water depths of 1.0 to 3.7 m. Spawning occurs in low current velocities (5 cm/s); velocities above 25 cm/s are known to fragment egg strands (Sublette et al, 1990). The eggs (embryos actually) hatch in about 2 weeks and shortly afterwards migrate to the open water of the lake or drift downstream to pools or backwaters. Yoy stay in the open water until they are about 25 mm (1 in) long and then migrate into weedy areas near shore. Yellow perch are tolerant of low oxygen levels, enduring concentrations as low as 0.3-0.4 ppm at cooler temperatures; concentrations below 3.1 ppm are lethal at a temperature of 26°C (Sublette et al, 1990).



Figure 6. Adult Yellow Perch.

5.4. **White Sucker** (*Catostomus commersoni*)

The white sucker (Figure 7) is a widely distributed fish occurring across North America. White sucker inhabit lakes, streams, and rivers with logs, brush, or other of cover as preferred habitats. White suckers are benthic and their diets include a variety of aquatic insect larvae, water fleas, side swimmers, snails, clams, algae, other plant matter, detritus, and fish eggs (Paulsen, 2002).

Spawning occurs in spring to early summer in water depths of less than 30 cm over a variety of substrates, beginning when water temperature reach about 10°C. Later spawning times occur in the northern ranges. The fish move to the shallows of the lakes or into stream headwaters and use areas that have a gravel or coarse sand bottom to spawn in. There is no nest made and the eggs go without care from the parents. Spawning normally takes place at night, starting at dusk. Depending on her size, a female will lay 20,000-50,000 eggs. Water velocities at spawning sites vary from 14-90 cm/sec (Sublette et al, 1990). Eggs are self-adhesive and need moving oxygenated, low silt water to survive. The embryos develop for 5-10 days before hatching, depending on water temperature. It takes another 1-2 weeks before yoy leave the gravel and drift downstream.



Figure 7. White Sucker.

5.5. **Burbot** (*Lota lota leptura*)

Two subspecies of burbot, (Figure 8) *Lota lota lota* and *Lota lota leptura*, occur circumpolar in fresh waters (Ford et al., 1995). They are generally not targeted as a commercial species and have limited commercial value but are likely to gain in popularity due to pressure on traditional sport fish and to the palatability (Nelson and Paetz, 1992). Currently they are taken as incidentals while fishing for the more popular sport fish.

Burbot spawn at night in the winter from January to May. They usually spawn under ice although it is not needed. Burbot can spawn in both rivers and lakes. Sometimes, burbot spawn in rivers only to return to lake for rearing and growing. Egg incubation time is variable depending on the temperature with the shortest incubation time occurring in warm temperatures and long incubation times occurring at colder. The ideal spawning substrate for burbot is sand gravel or cobble material to allow a slight flow of oxygenated water to bath the eggs (Ford *et al.*, 1995). Eggs are demersal, non-adhesive and buoyant due to a large drop of oil in the egg. The larvae retain this buoyancy and move through the water column with their small fins. Since the eggs and larvae are very buoyant, they are very susceptible to strong currents. Currents, as little as 8cm/s, can dislodge burbot eggs and move them away from favorable spawning areas (Chen, 1969).

Juveniles are typically found in the littoral regions of a lake feeding mainly on insect larvae. They prefer a rock and gravel substrate with a large amount of cover but will use sandy areas covered in weeds as well as submerged coarse woody debris or undercut banks. In general, the warmer the water is, the deeper the burbot will be.

Burbot have been found to tolerate a wide range of environmental conditions. All age classes can tolerant high salinity levels and have an upper temperature tolerance range of 23.3 degrees Celsius. The main limiting factor appears to be oxygen concentrations (Chen, 1969). Davis (1975) stated that oxygen levels of 7.25 mg/l should be maintained to sustain healthy juvenile and adult populations.

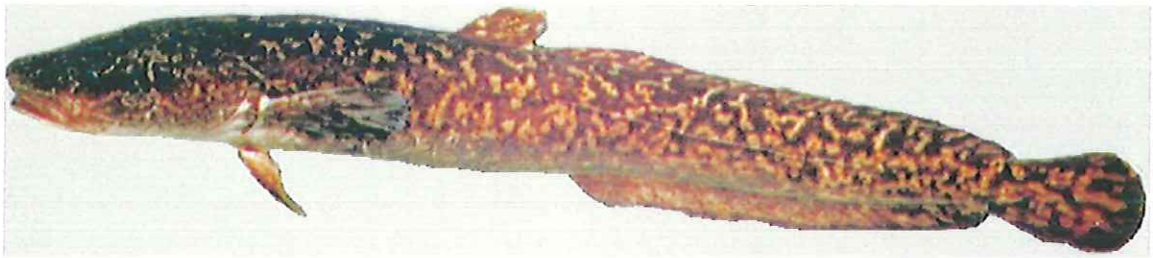


Figure 8. Adult Burbot.

5.6. Spottail Shiner (*Notropis hudsonius*)

The spottail shiner (Figure 9) occurs in a broad band from the Mackenzie River in northwest Canada to the St. Lawrence River and south to the Missouri drainage and southern Illinois. Spottail shiners occur in a variety of habitats from large lakes and rivers to small streams and seem to do best in clear waters. They forage on aquatic insects, larvae, zooplankton and some plant material.

The life history of the spottail shiner has not been thoroughly studied. Spawning appears to take place in June or July over sandy bottom and at the mouths of streams where the fish assemble in large aggregations. Ovarian egg counts range from 100 to 2,600 depending on size of the female. The maximum size of spottail shiner is 7 to 10 cm depending on habitat. Over all there appears to be a lack of information regarding spottail shiner but it is assumed that they are prey for walleye, burbot, northern pike and the occasional yellow perch.



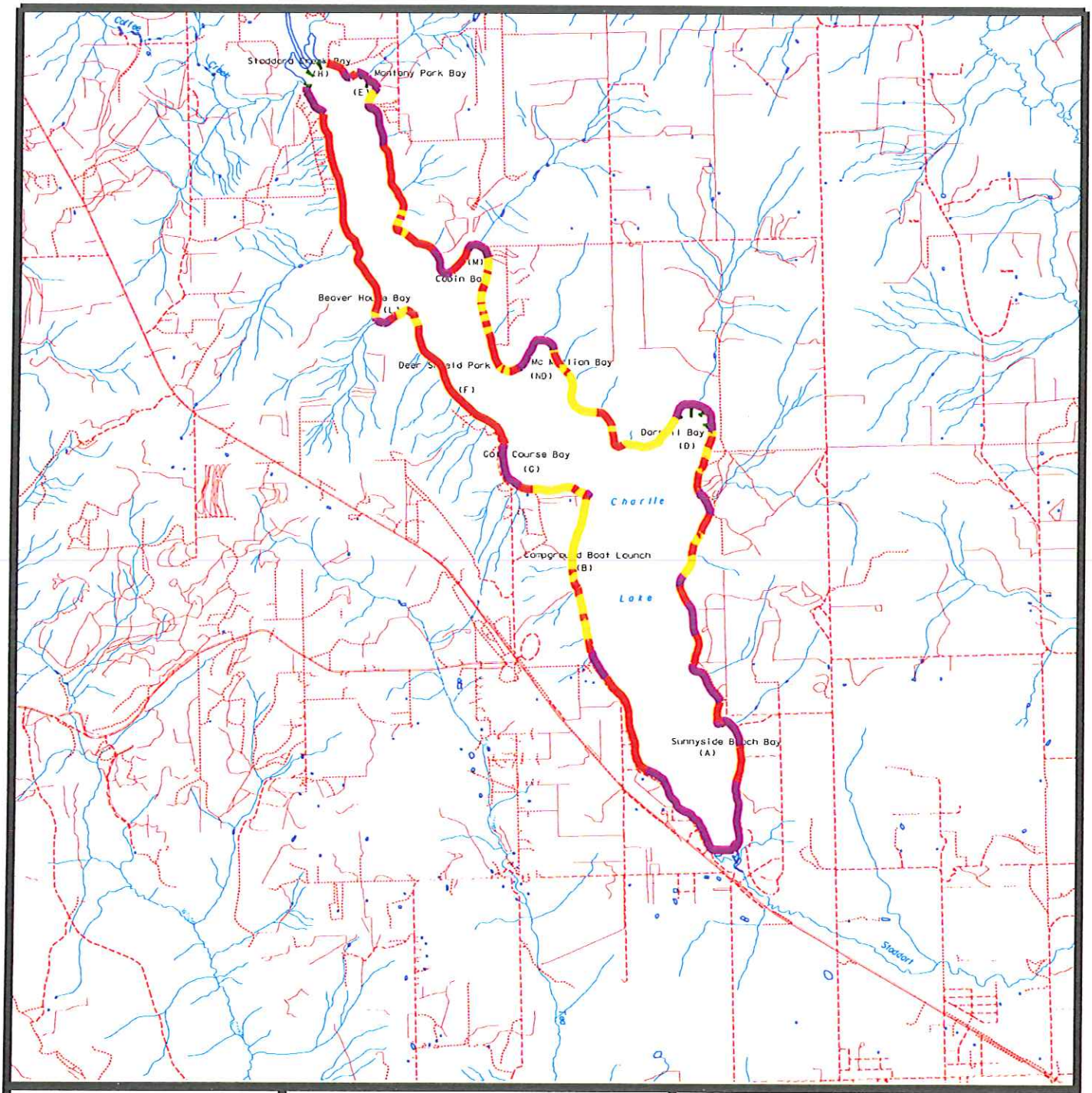
Figure 9. School of Spottail Shiner.

6. Results

The numbers of young of year (yoy) and juvenile fish in Charlie Lake caught during sampling was larger than expected. Of the total 35,987 fish caught 32,179 or 89.4% were spottail shiners, 3,223 or 8.9% were yellow perch, 437 or 1.2% were white sucker, 134 or 0.4% were walleye and the rest were northern pike (9 fish caught) and burbot (5 fish caught). Table 1 below lists the Bays, the identifiers for each bay, number of fish caught in each bay and the number of times the bay was seined. Figure 10 shows the geographical location of each bay on Charlie Lake.

Table 1: Bay Identifiers and total fish caught.

Bay	Bay	Total Fish	Total sport fish	Total forage fish	No. times sampled
M	Cabin Bay	3147	160	2987	2
L	Beaver House Bay	55	11	44	2
E	Monteny Park Bay	10078	788	9290	2
H	Stoddard Creek Bay	7176	1950	5226	2
G	Golf Course Bay	3380	230	3150	2
A	Sunnyside Beach Bay	8266	565	7701	2
ND	McMillian Bay	477	38	439	1
B	Campground Boat Launch	749	34	715	1
D	Darnell Bay	2603	11	2592	1
F	Deer Shield Park	56	21	35	1
Total		35987	3808	32179	



Mapsheet Reference: 94A025/026/035/036
Adlard Job Number: 2001-010
Location: Charlie Lake
Date Compiled: March 12, 2002

Scale 1: 80 000

REFERENCES

	Percent of shoreline
SLUMPING	
AREA OF CERTAIN	16 %
AREA OF POSSIBLE CERTAIN	57 %
AREA OF NO CERTAIN	27 %
WEED BED	0.24 km²
MAIN ROAD	
SECONDARY ROAD	
TRAIL	
LAKE	

CHARLIE LAKE SLUMPING AND WEED BED LOCATIONS

Adlard Environmental
9213 107th Ave.
Fort St. John, BC
V1J 2P2
Tel: 250.785.0632
Fax: 250.785.0642

6.1. Forage Fish

There had been concern about lack of forage fish and low numbers of juvenile sport fish having an effect on future fish populations. Seven species of forage fish were stocked in 1986 to ease this concern. Of these 7 species stocked, only spottail shiners were caught in 2001.

6.1.1. Spottail Shiner

There was a total of 32,179 spottail shiners caught during all seine sampling. Figure 11 shows spottail shiners seined by bay. The greatest productivity was found in the Monteny Park Bay followed by Sunnyside Beach, Stoddart Creek Bay, Golf Course Bay, Cabin Bay and Darnell Bay. These bays showed signs of high productivity. The remaining bays had low productivity.

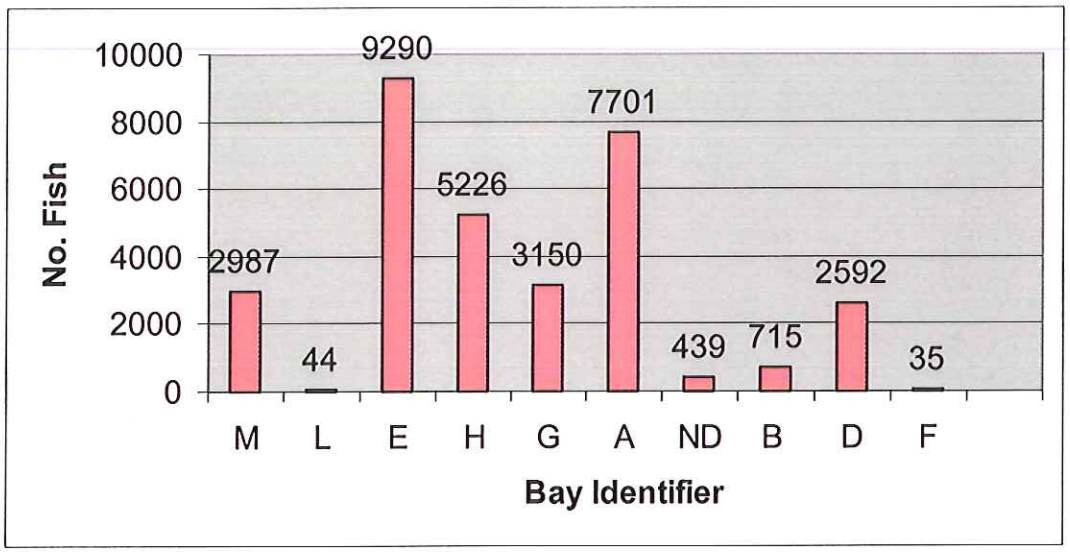


Figure 11. Total Spottail Shiners per bay.

6.2. Sport Fish

Figure 12 shows the total number of sport fish caught at each bay. The 2 bays closest to the Stoddard Creek inlet have the highest numbers of sport fish recorded (1950 and 788).

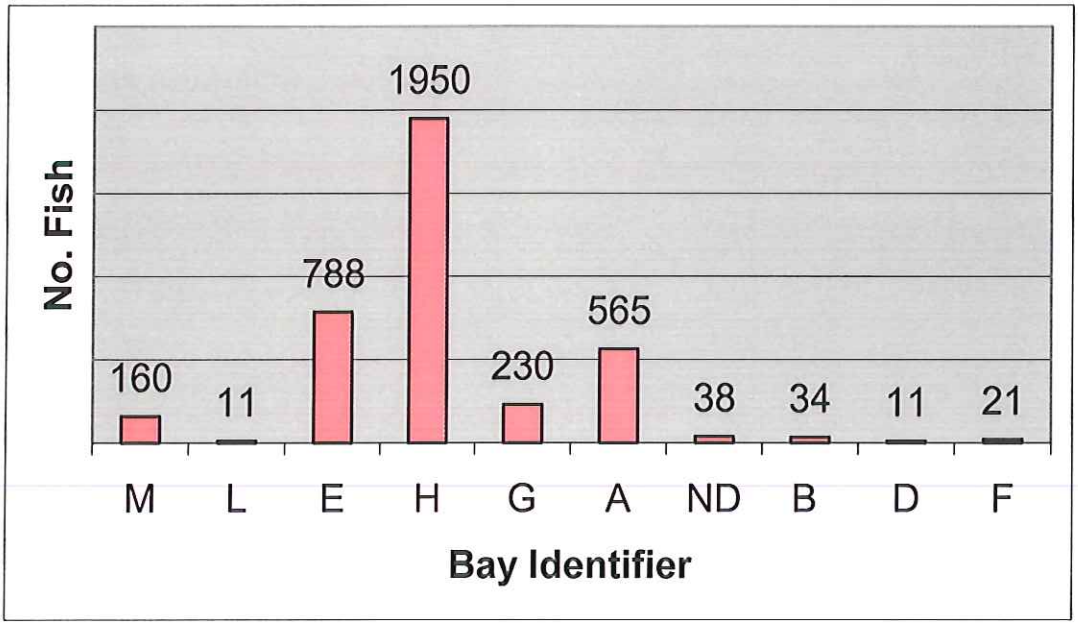


Figure 12. Total Sport fish per Bay.

Figure 13 compares the total fish caught with the total sport fish caught in each bay. The graph shows that forage fish constitute the majority of fish in Charlie Lake while sport fish constitute a very small proportion.

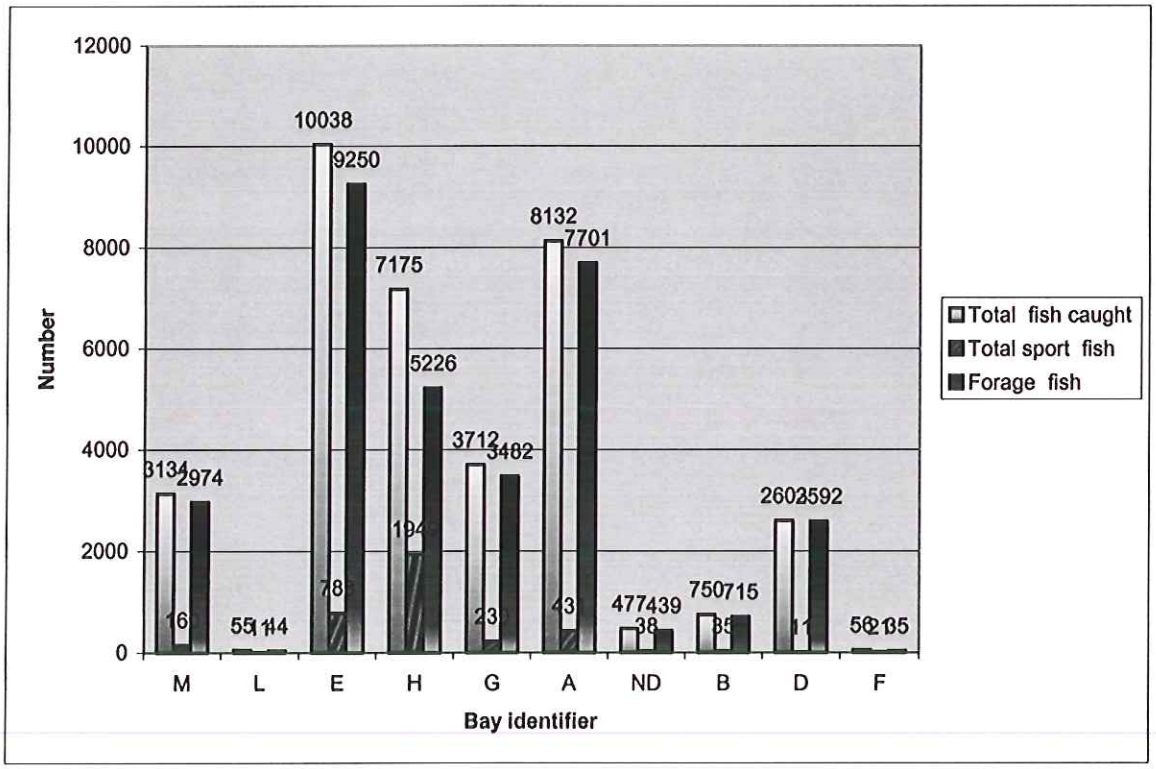


Figure 13. Comparison of total sport and forage fish per bay.

6.2.1. Walleye

A total of 134 walleye were caught for all sampling efforts. All of these were caught during the first round of seining and made up 3.5% of the total sport fish catch and 0.37% of the total fish caught. Figure 14 shows the number of walleye caught by bay for the 2001 sampling season.

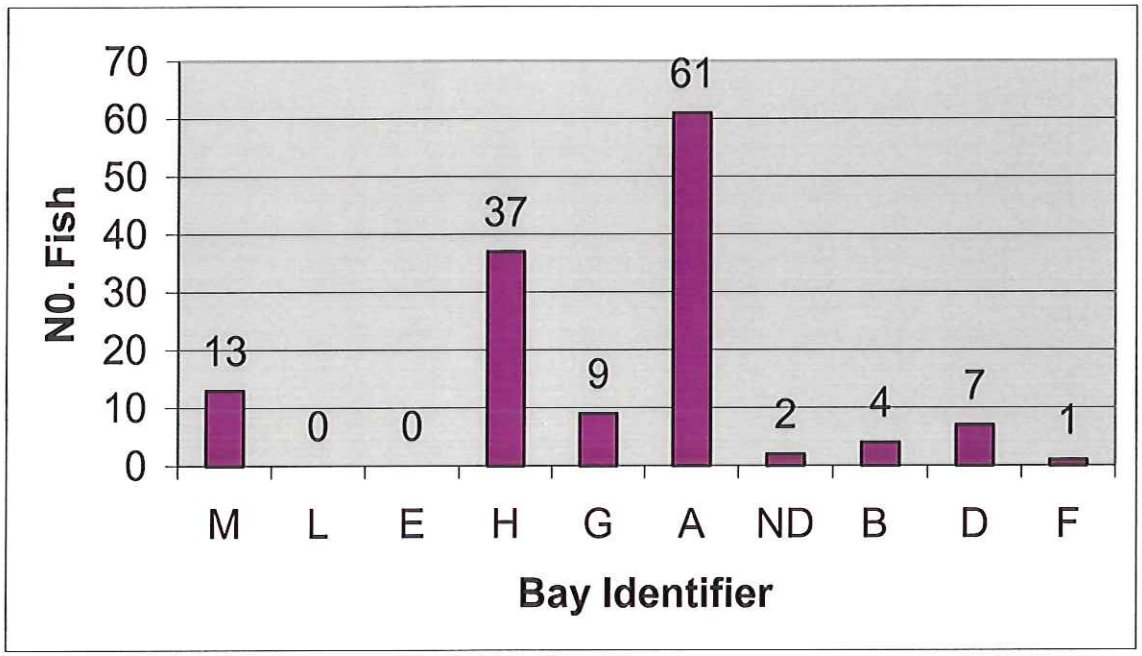


Figure 14. Total Number of walleye caught.

Young of the year and juvenile walleye of all sizes were caught in Charlie Lake. The average length of the walleye sampled was 75mm with the minimum length recorded 30mm and the largest walleye measuring 143mm. Figure 15 illustrates the number of walleye caught in each age class (by length) and the bay they were caught in.

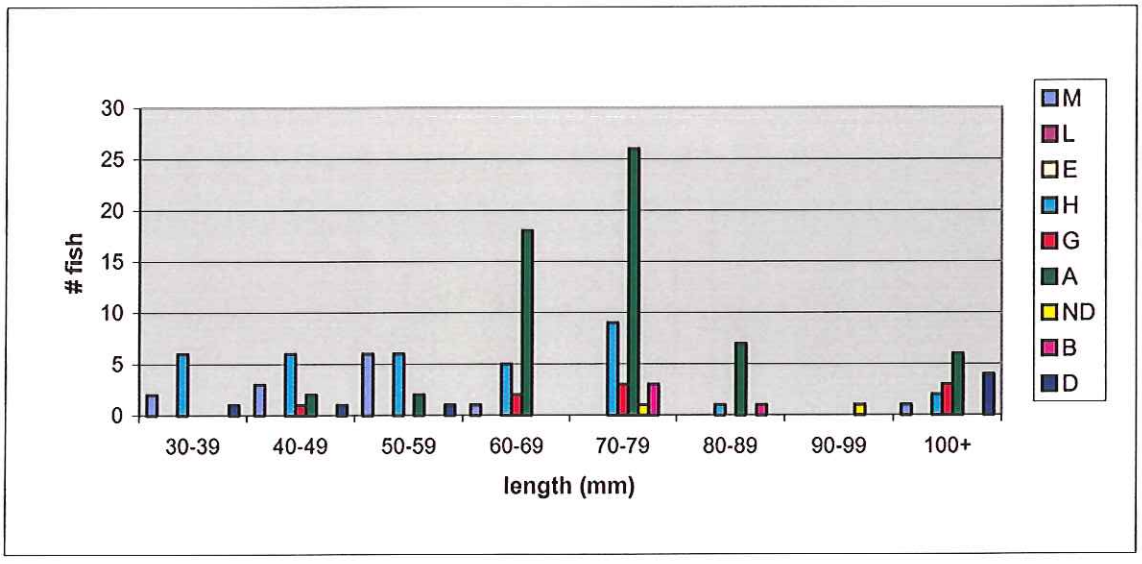


Figure 15. Walleye length per Bay.

6.2.2. Yellow Perch

Yellow perch was the second largest total catch of both sample sets. Perch made up 84.6% of the sport fish catch and 8.9% of the total catch. Figure 16 shows the number of perch caught by bay.

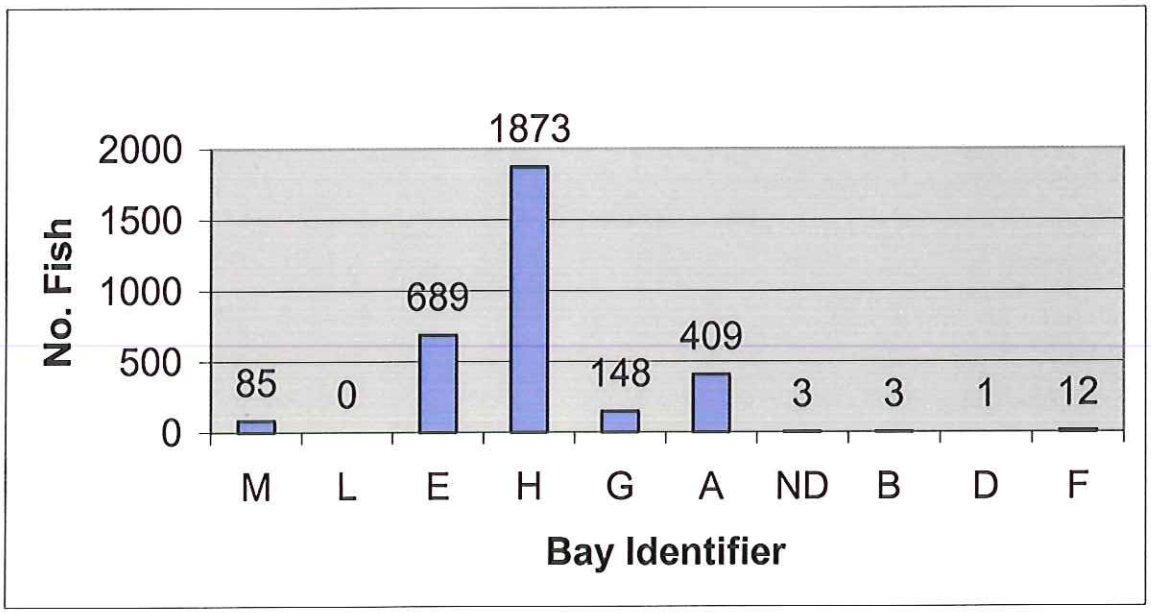


Figure 16. Number of perch caught per bay.

Yellow perch from young to adult were caught with the average length, for both seines, being 65mm. The largest perch caught was 25cm (adult) and the smallest perch was 20 mm. Figure 17 shows the different sizes of perch and the sample bays.

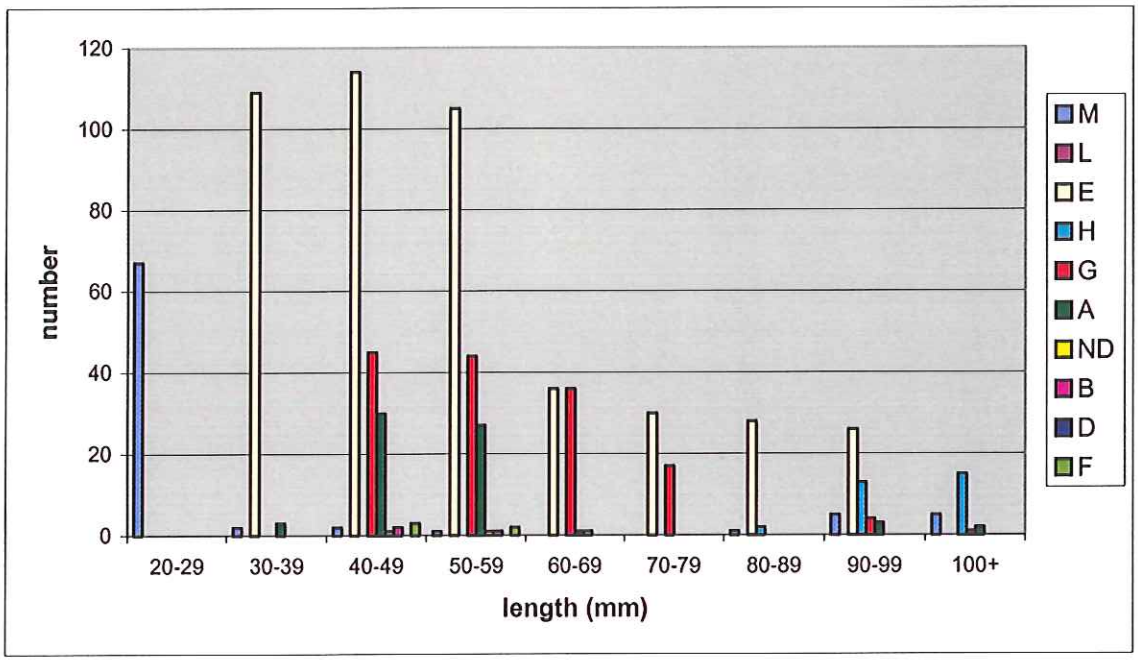


Figure 17. The length of perch per bay.

6.2.3. White Sucker

White sucker made up 11.4% of the sport fish catch and 1.2% of the total catch. Figure 18 shows the number of white sucker caught and the bay of origin.

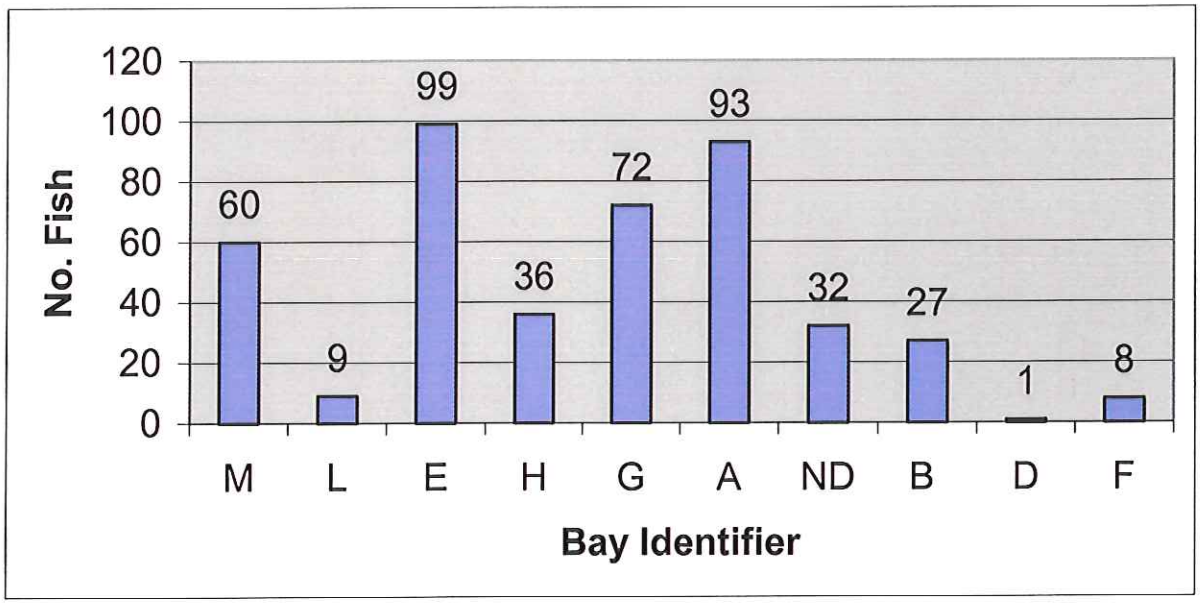


Figure 18. Total number of Suckers caught per bay.

White suckers in Charlie Lake had an average length of 67mm. The maximum length was 139mm and the minimum was 25mm. Figure 19 shows the size and number of white suckers in each bay seined.

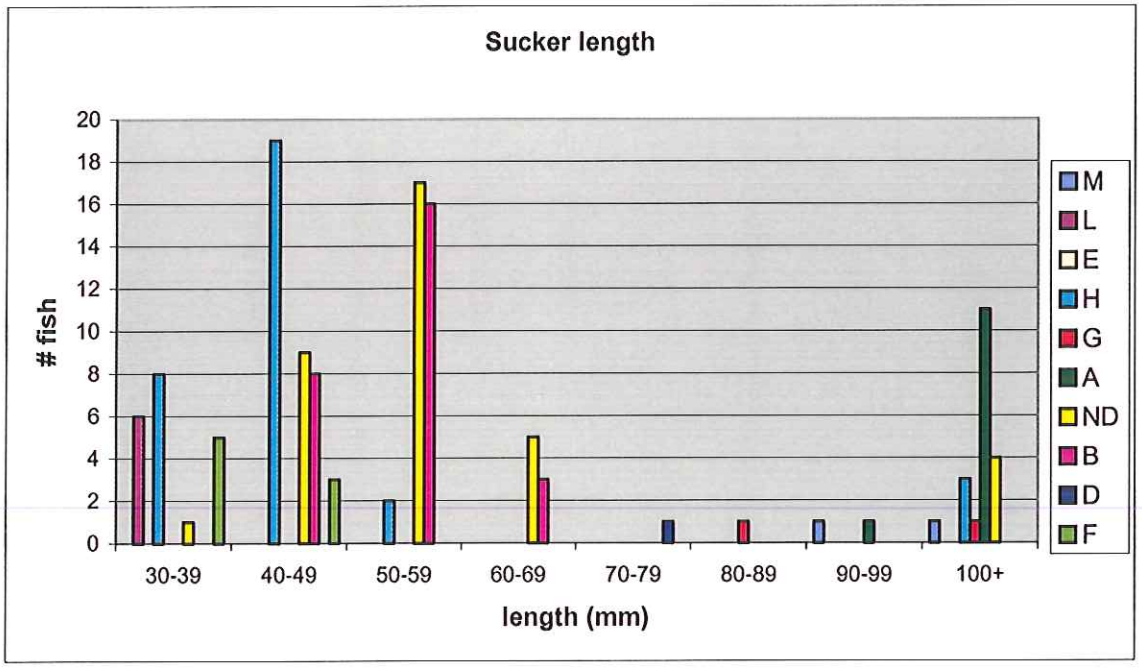


Figure 19. The Length of white sucker per bay.

6.2.4. Northern Pike

There were very few pike caught in either of the sampling sessions and no young of the year or juveniles were caught. A total of nine adults were caught in both sample sessions with an average length of 528.3 mm. Four were caught during the summer sample and 5 were caught during the fall sample. The sample seems to show that the northern pike came closer to shore as the water got colder but the sample size is too small to be positive.

6.2.5. Burbot

Very few burbot were caught during the two rounds of sampling. There was a total of 5 burbot caught. The average length was 111 mm long. Three of the burbot caught were young of the year and the rest were over a year old.

6.3. Statistical analysis

Statistical analysis was done using analysis of variance (ANOVA) to determine if piscivore distribution was dependent on spottail distribution. In addition walleye and perch populations were compared to determine if a relationship existed. When analyzed both walleye ($F(14,1)= 365$, $p=.041$) and yellow perch ($F(22,1)= 375$, $P= .041$) were found to be dependent on the distribution of Spottail shiners. They were shown to be associated 100% ($R^2= 1.0$ for walleye and perch) of the time with spottail shiners. The burbot and northern pike sample sizes were too small to run statistics accurately and white sucker was shown to be statistically unrelated with spottail shiners ($F(21,1)= 0.135$, $p=.987$).

Walleye were found to be correlated with perch ($F(8,4)=738$, $p=.000$) and associated 99% ($R^2= .99$) of the time. Figures 20 and 21 illustrate the ANOVA analysis of walleye and yellow perch with spottail shiner.

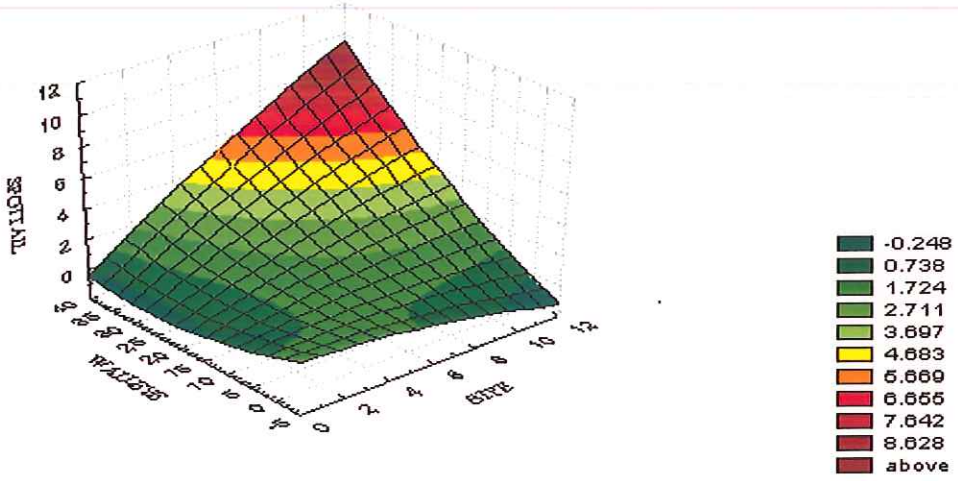


Figure 20. Walleye vs. Spottail by site.

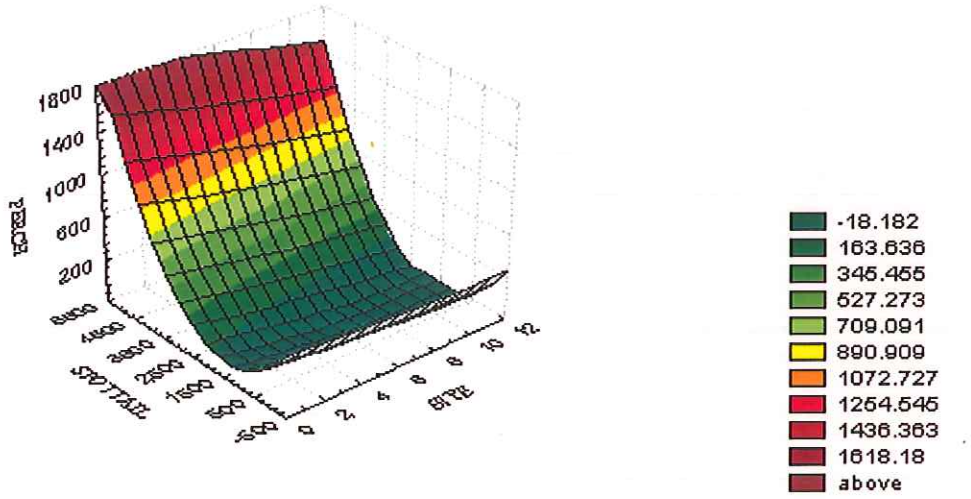


Figure 21. Yellow Perch vs. Spottail by site.

6.3.1. Creel Survey Results

A total of 18 packages were given out and 1 package was returned. Due to the lack of response there was not enough data to analyze. There are three possible reasons for the lack of response to the survey. First, the forms were never filled out. Second, there was no real incentive to complete them. Third, there was a lack of fish caught and since there was no data to report they were not returned. In addition, the data received was not complete and errors were entered on the forms. For a more detailed description of the problems associated with the creel survey refer to 6.1.2 under *Limitations of Methods* in Conclusions.

6.4. Habitat

6.4.1. Sample Bays

A total of ten areas were sampled on Charlie Lake. These ten sites were all classified as high and medium productive sites by Hammond (1986), and by local fisherman Bob Ohlund. Each bay was sampled at least once with 6 of the bays being sampled twice.

Table 2. Habitat Summary.

Bay/site	Bay	CWD		Shoreline Vegetation	Aquatic Vegetation	Lake Bottom		Slope
		% Shoreline	% Lake bottom	% Cover ocular	Present (Yes/No)	Texture	Depth	%
M	Cabin Bay	31.7	1.8	3.9	No	Silt rock	2.2	14.5
L	Beaver House Bay	40.0	2.1	22.2	No	Silt rock	2.0	12.4
E	Monteny Park Bay	34.4	1.7	18.3	Yes	Silt	1.4	6.9
H	Stoddard Creek Bay	46.3	2.3	27.5	Yes	Silt	1.8	8.0
G	Golf Course Bay	28.1	1.1	44.3	No	Silt	1.0	3.4
A	Sunnyside Beach Bay	3.8	0.1	13.2	Yes	Silt	1.6	3.8
F	Deer shield Park	18.4	1.3	19.9	No	Clay stones	2.0	6.7
ND	Mcmillian Bay	31.9	1.5	29.0	No	Silt pebbles	1.8	6.3
B	Campground Boat launch	17.1	1.5	29.8	No	Silt	2.7	10.9
D	Darnell Bay	21.1	1.3	46.3	Yes	Silt	1.4	11.2

Table 2 shows a habitat summary of each bay sampled on Charlie Lake. The numbers are averages, of the data collected, of the entire bay for both samples. Lake Bottom CWD and depth were done on a scale of 0 to 3 with 0 being none and 3 being high amounts of CWD or deep water. Lake bottom texture corresponds with the dominant substrate in the bay. It should be noted that each bay did have a component of coarse material below the accumulation of silt.

6.4.1.1. Darnell Bay (D01-9)

This is the largest bay on Charlie Lake located just north of Beatton Park. It is one of the few bays with a large amount of aquatic vegetation and shoreline cover. In addition many types of waterfowl and songbirds were sighted around the bay and a bald eagle was seen flying low over the water on several occasions. The bay has a relatively stable shoreline, with the exception of either point, which have undercut banks. This is a surprise due to the large amount of wave action that occurs in the bay. This may be attributed to the relative shallow slopes (maximum of 15%) and the large amount of natural vegetation (averaging 80% cover and overhang) covering the shoreline compared to the slopes and cover of either point having a maximum slope of 30% and an average cover of 20%. In addition, there is little development within the bay, which contributes to the slope integrity.

Figure 22 shows the eastern side of Darnell Bay. Notice the large amount of cover provided by the willow and the aspect of the tip of the bay.



Figure 22. Eastern shore of Darnell bay.

6.4.1.2. McMillan Bay (ND01-6)

McMillan Bay is a small bay north of Darnell Bay. It is almost completely undeveloped with only a small, dilapidated cabin and a few snowmobile trails near the shore. There were visual sightings of many different types of wildlife in the bay including 3 beavers, 2 bald eagles, many bird nests on the cliff and a variety of waterfowl including golden eyes, loons and mallards. Large rock cliffs (Figure 23) and coniferous stands dominate the west side of the bay and the east side is dominated by moderately sloped (5-15%) aspen stand. The tip of the bay is a shallow sandy beach with a considerable amount of coarse woody debris and human garbage blown onto the shore. Throughout the bay there is little vertical structure (in the form of CWD and aquatic vegetation) on the lake bottom. The bay has low levels of silt accumulations on lake bottom although there are some areas of deep clay and organic matter. The bay has little cover (average of 10%) sheltering the shoreline and a high level of slumping on the east side of the bay.



Figure 23. Cliffs of Western McMillan Bay.

6.4.1.3. Cabin Bay (M01-3 and 2M01-5)

Cabin Bay is a large, narrow bay located on the east side of the lake south of Montney Park. A small seasonal creek enters the bay at the northern tip and a cabin is present on the north east side of the bay. There is a beaver dam and many beaver slides present on the northwest side and many songbirds and Franklin gulls were observed around the bay. Large rock cliffs dominated by a coniferous over-story characterize the east side of the bay (Figure 24). The banks become increasingly unstable as they approach the southern tip of the bay with some large slumps occurring just south of the cabin. The water is deep and there is little cover in the form of overhanging shrubs or CWD on the shore or lake bottom. The tip of Cabin Bay is a shallow (Figure 25), nutrient rich with a moderately thick layer of organic debris and silt. The shore and lake bottom have a moderate amount of CWD (50%) although there is little to no vegetation present, both on lake bottom and shore, to provide protection for juvenile fish. The west side of the bay has deep water, steep slopes (average

of 30%) and a stable shoreline. The shoreline is very rocky and the herb layer extending to the waters edge helps maintain this stability. The rocky shoreline is evidence of the high amount of wave action on the west side of the bay and although the banks appear to be stable there are few trees or shrubs within 20m of the shore, which could cause problems in the near future.



Figure 24. Eastern shore of Cabin Bay.



Figure 25. Shallows of Cabin Bay.

6.4.1.4. East Bay (E01-4 and 2E01-5)

East Bay is located at the northeast end of the lake. It extends from the snowmobile cabin at Montney Park to the cliffs at the entrance to Stoddard Creek. This bay is an extremely productive bay with 2 large weed beds, a large sand bar (Figure 26) extending into the bay and numerous islands of cattails present around the edge of the bay. The bay is flat, with the exception of either point, and, other than the snowmobile cabin and some horse trails, undeveloped. There is a deep detritus layer, in addition to thick silt and clay, on the lake bottom. Willows and shrubs overhang into the water sheltering approximately 70% of the shoreline and the lake bottom is covered in a large amount of CWD. The shore near the snowmobile cabin is deep and rocky with a thin layer of silt on the lake bottom. There is a small amount of CWD (5%), on the shore and lake bottom, and overhanging vegetated cover (average of 10%). This is the only area in this bay with an unstable bank. Deep water, rocky shores and steep cliffs dominate the northern side of the bay. Due to the depth of the water and productivity of the rest of the bay, the northern area was not sampled. The

bay provides excellent feeding ground for the juvenile fish as the shallow waters of bay are highly productive and provide large amounts of cover and food. This bay however is a poor spawning areas for most fish with the exception of northern pike it is characterized by deep silts that provide little oxygen to incubating eggs (Figure 27).



Figure 26. Sandy Beach of East Bay.



Figure 27. Northern most seine in East bay (notice the high levels of algae).

6.4.1.5. Stoddard Creek Entrance (H01-3 and 2H01-5)

This sampling bay is located at the headwaters of Charlie Lake at the Stoddard Creek entrance. The bay is flat, with some cliffs on the east side, shallow and calm. The entire west side of the lake is developed and agricultural fields can be seen on the hills surrounding the bay. The bay is filled with cattails that create many small areas of calm shallow water (Figure 28) In addition, there is variety of aquatic vegetation throughout the bay. There is an extremely deep layer of decaying vegetation on the lake bottom as well as thick mats of algae. CWD levels are sporadic throughout the bay with some areas having many large pieces of wood while others had none. This bay is an excellent feeding ground for young of the year walleye, pike and perch as there is plenty of cover and food. It is also ideal feeding and spawning grounds for adult northern pike as there is a well developed vertical structure and plenty of cover to ambush prey (Figure 29). There was no sampling done into the Stoddard Creek itself but it can be assumed walleye, burbot and white sucker migrate up the creek to spawn. The bay itself is a poor spawning area for anything other than northern pike due to deep levels of silt and decaying organic matter. There is little

slumping throughout the area. This is attributed to shallow and calm waters of the bay as well as the large amount of vegetation protecting the shoreline.



Figure 28. Cattails in the Stoddard Creek bay (H).



Figure 29. A view from the east side of Stoddard Bay.

6.4.1.6. Beaver House Bay (L01-4 and 2L01-5)

Beaver House Bay or Louise Point Bay is located on the west side of the lake across from Cabin Bay. It is a small bay that was rated as moderate potential for forage fish by Hammond (1986). The bay is completely undeveloped with no evidence of any man made trails visible from the lake (Figure 30). There is a large beaver house in the southwest corner of the bay and the beaver was observed feeding along the shore. In addition, there was a large flock of Franklin gulls feeding in the center of the bay. The west side of the bay has slopes averaging approximately 20% and there are few trees within 15m of the shore. The levels of CWD are highly variable and there is little cover on the west side of the bay due to beaver activity. The shore and lake bottom consisted of heavy clay and silt with large rocks mixed in. The slope appeared relatively stable although the bank is beginning to undercut. The south part of the bay is well covered with trees and shrubs and is relative shallow. The water becomes deeper and overhanging vegetation increases closer to the point. Near the point on the south side of the bay, the lake bottom becomes less silty with only a thin layer of organic matter overlaying a pebble and gravel substrate. This is a fine place for walleye, burbot and perch to spawn, with plenty of overhanging vegetation for cover and some CWD for vertical structure. The currents could be a limiting factor in this area but no measurements were taken to validate this. Overall the productivity of the bay is moderate with a small area of fine walleye spawning habitat. High levels of algae build up on the southern shore and there is evidence of heavy slumping.



Figure 30 West Side of Beaver House Bay.

6.4.1.7. Shore North of Deer Field Park (F01-3)

Sample Bay F is located south of Louise Point to the first house on the west side (Figure 31). The area is has a mixture of conifer and deciduous overstory with an average slope of 10%. There is little sign of human development and many different types of songbirds and waterfowl were observed using the area. The sample area is a long straight stretch of the lakeshore, which provides little protection from the environment and weather. In addition, there are few places with any cover in the form of CWD or lakeshore vegetation and the vertical structure of the lake bottom is highly variable. The area has very little beach as the majority of the shore consists of banks from 0.5 to 2m high that are undercut and slumping into the lake. The lake bottom consists of deep clay with large rocks intermingled throughout which can be attributed to the large amount of slumping occurring on the shore.



Figure 31. Shores of sample area F.

Hammond rated the sample area, 1986, as an area of moderate productivity. From the sampling done this year we rated the area as a low productivity area because of poor substrate, lack of vertical structure and lack of fish.

6.4.1.8. Golf Course Bay (G01-3 and 2G01-4)

Golf Course Bay (Figures 32) is a large bay north of the golf course on the west side of the lake. Due to the lay of the land the bay is relatively sheltered from the strong winds that are characteristic of Charlie Lake. This bay is heavily populated on the west side and there are many private docks and boat launches. In addition there is a public boat launch and access point from the Lake Point golf course. The east point of the bay is a popular walleye fishing spot and the majority of walleye samples returned in the creel survey were collected at this point. The point of golf course bay provides excellent cover for adult walleye due to increased turbidity and deep waters. The southern shores of the bay lie on the edge of the golf course and are subjected to the impacts caused by it such as increased run off and decreased bank stability. The banks along the southern shore are extremely unstable and

show signs of continuous slumping into the lake. Slumps of up to 5m high were recorded. As to be expected the lake bottom on the southern part of the bay are deep silt and heavy clays. This substrate caused difficulties in seining due to problems walking on the lake bottom. The west side of the bay is heavily populated and is an area of heavy recreational use such as water skiing, power boating and fishing. The slope of the west side of the bay is generally low with an average of 10% and there is little evidence of slumping on the shoreline. The beach consists of cobble-sized rock that extend into the lake. The substrate of this part of the lake appears to be an excellent spawning area due to low levels of silt built up but the lack of vertical structure and the amount of recreational activity seriously impact the apparently good spawning area. In addition a large amount of garbage was pulled out of the lake including a rusty tire rim and half a fifty gallon metal barrel. The bay is a moderately productive bay with little CWD, cover and a large amount of slumping.



Figure 32. Shoreline north of the golf course.

6.4.1.9. Boat Launch Sample Area (B01-6)

The sample area was located from the boat launch at the Charlie lake campground to just south of Golf course point. The area is relatively undisturbed in the southern part of the sample although there is a golf course and a Petra Canada well on the northern part of the sample area. The water along the shore is generally deep and the average slope of the area is approximately 10%. The higher slopes occur closer to the golf course. The lake bottom in the south is rock with a thick layer of silt covering it and the lake bottom in the north is deep silt with a thick smelly detritus layer over top. This follows with the pattern of slumping observed in the sample area. The closer to the golf course the heavier the degree of slumping with the largest slumps occurring at the edge of the golf course. The lakeshore has a generally low level of CWD and shoreline cover although the entire shore is heavily vegetated. Overall this area is rated as moderately productive area based on the quantities of fish alone. The area has a poor substrate, deep water, little vertical structure and little protection from weather systems that frequent the lake. Figure 33 shows the southern end of the Golf Course Point and figure 34 shows the boat launch at Charlie Lake Campground.



Figure 33. Shore south of golf course point.



Figure 34. Boat Launch at Charlie Lake campground.

6.4.1.10. Sunnyside Beach (A01-3 and 3a01-5)

Sunnyside Beach is a small bay on the east side in the southern part of the lake (Figures 35 and 36). The bay is heavily populated and there is little natural vegetation left on the lakeshore. In addition the bay was filled with truckloads of sand to create the beautiful beaches that occur here. With the exception of the northern point Sunnyside beach bay is shallow and relatively flat (average slope is approximately 5%). Thee are a small weed bed near the creek entrance that supports a large amount of minnows, juvenile sport fish and a few adult northern Pike. There is little to no vertical structure or cover in this bay and the lake bottom is relatively free of silt accumulations. The substrate ranges from a sandy texture near the north of the bay to a cobble-sized substrate near the south of the bay. There is little evidence in the bay of any slumping with the exception of some undercut banks. This is attributed to the raised water levels rather than bank instability. Overall, this is a very productive bay and is very likely used as a spawning area. The sandy bottom and the amount of aquatic vegetation make this one of the best spawning areas found on the lake. Figure 26a shows the sandy beaches of the bay at the outlet of the seasonal stream.



Figure 35. Sandy Beaches of Sunnyside Beach.



Figure 36. Cliffs at the north end of Sunnyside Beach.

6.4.2. Slumping

The habitat assessment of Charlie Lake was done to determined current levels of slumping. Table two ranks lakeshore lengths according to severity as well as the average, maximum and minimum slump lengths recorded. The lengths of current slumping (level 3) were measured using a Trimble™ GPS unit to obtain exact areas of slumping. Areas of future concern (level 2) and areas of no concern (level 1) were assigned by an ocular estimation of the lakeshore. Current level 3(active slumping) slumping on Charlie Lake accounts for 19% of the total shoreline. Fifty five percent of shoreline was observed as a possible future risk (level 2) while 26% of the shoreline is of little to no concern (level 1). The average length of slumping recorded was 219 meters long and the maximum length of a slump was recorded as just over a kilometer long.

Table 3. Slumping Severity.

Slump length (m)	Level 1	Level 2	Level 3	Total shore length
Total	10117	20843	7232	38191.5183
avg.	601	550	219	
max.	3230	8953	1091	
min.	22	8	12	
% of shore length	26	55	19	

7. Discussion

Of the six species found in Charlie Lake, five are considered piscivore and only one is considered a forage species. Although this doesn't represent the complete fish species richness we can conclude that these 6 species are the dominant fish in the lake.

7.1. Fish Assessment

7.1.1. Fish

The numbers of fish caught in Charlie Lake suggest there are healthy populations of successfully reproducing spottail shiners, yellow perch and white sucker. These fish were caught in relatively large numbers at most sites sampled.

Spottail, being the only forage fish found in the lake, are assumed to be the foundation prey species for the piscivore of the lake. Statistical analysis was done using ANOVA to find if piscivore distribution was dependent on spottail distribution. We found there is definitely a relationship between spottail shiner and yellow perch and spottail shiner and walleye as they are found together 100% (R^2= 1.0) of the time. This says that either these fish are preying on the spottail shiner or that they prefer similar habitat.

We found larger than expected numbers of yellow perch in Charlie Lake. Healthy populations of juvenile and yoy yellow perch through out the lake although the majority of the numbers caught were in sample bay E (refer to figure 10).

The presence of yoy perch is negatively related to juvenile perch abundance and positively related to adult perch abundance (Sanderson et al, 1999). The possible mechanisms responsible for this pattern include cannibalism by juvenile perch, reproduction potential in adults and competition between young of the year (yoy) and juveniles (Sanderson et al, 1999). Due to this relationship between age classes there are periods of age class domination in lakes. For example there are seasons with few yoy and many juveniles until the juveniles reach maturity when there will be few juveniles and many yoy. It is possible for a population explosion of adult perch in Charlie Lake that will suffocate any other species in it. One of the problems with perch is that they have a tendency to overpopulate, especially in lakes where too many of the larger sport fish have been harvested. Lakes with lots of "nuisance" small perch are called "perch lakes".

Walleye have been the dominant sport fish in Charlie Lake for many years. The creel survey did not supply us with any relevant information about the status of adult walleye in the lake but it can be assumed that they are breeding successfully due to presence of yoy. Although it should be noted that only walleye scales were returned. The populations and the sizes of walleye in the first round of sampling appeared healthy although the lack of walleye caught in the second round is cause for concern. The most probable mechanism,

according to literature reviewed, is that as juveniles mature they become increasingly photophobic and congregate in areas of cover or into deeper pools (Ford, 1995). The second round of sampling occurred during the day, in the fall, and therefore it may be assumed that the juveniles that had matured moved into deeper waters to avoid the daylight and, in turn, could not be seined. Another assumption is that the juvenile walleye didn't survive the summer. If this is the case the walleye populations in Charlie Lake is in serious trouble. The lake has moderate walleye habitat and there appears to ample amounts of food present ranging from zooplankton to prey fish species. Cannibalism is recorded to dramatically reduce juvenile walleye populations although when ample prey species are available it is low or nonexistent (McIntyre *et al*, 1987 in Ford *et al*, 1995). Schupp (1978) found walleye consuming young of the year yellow perch had substantially greater growth than walleye fed on invertebrates and small minnows. Enucher (1995) found that the majority of walleye in Charlie Lake fed primarily on invertebrates. It would be interesting to find if the walleye still fed on these invertebrates or if they changed their diets to the more nutritious yellow perch. Whatever the case, there appears to be ample food and cover to suggest that juvenile walleye are surviving into the winter. The lack of spawning areas on the lack is a concern for the future of walleye in Charlie Lake.

Northern pike is a species of concern for Charlie Lake as only adults were caught. This may be attributed to several reasons. First, there are no or very few juvenile pike in the lake. According to Nelson and Paetz (1992) juvenile pike frequent well vegetated shallow waters with plenty of cover. These preferred rearing habitats were seined thoroughly and since no juveniles were caught, there is the possibility of a lack of juveniles in the lake. The Stoddard Creek entrance is an excellent spawning and rearing area for northern pike and the fact that no juveniles were found in this area, is reason for concern. There has been a significant decrease in the amount of aquatic vegetation around the lake that is critical northern pike habitat and this could be linked to the lack of reproduction. Second, the juvenile pike were not present in the areas seined. Pike are known to prefer vegetated shallow areas, less than 4m, within a 100m of shore (Ford, 1995). The entire lake has a mean depth of 5m and seining at best can only reach a maximum of 12 meters into the

water there is a possibility that they were just not in the seine area.

White sucker is often considered a pest species because of its impact on sport fish. Johnson (1977) found that increased sucker populations had a detrimental effect on the yield of walleye and yellow perch by out competing them for food and feeding on their fry and eggs. It has been noted that mean annual yield of brook trout decreased by between 50-80% when in sympatry with white sucker (Johnson, 1977). The white sucker is an opportunistic feeder that has many different types of food sources. Saint-Jacques *et al* (1978) found that white sucker feed on the principal species in order to vie for dominance. This research shows that, due to this trait, white sucker has the ability to dominate any aquatic ecosystem. It is interesting to note that Hammond (1986) found no white suckers in the lake and that they were likely restricted to the tributaries. Beach seines, in summer and fall seasons, found a large number of suckers, total of 361, at sample sites. This increase in the sucker populations could have a detrimental effect on the other species in the lake. White sucker populations should be monitored in the future to assess the impact on the current walleye fishery.

Burbot are reproducing; although lack of numbers caught make it difficult to determine the health of the population in the lake. They were caught at random throughout the lake showing no preference for any particular habitats. It can be assumed that the number of burbot caught is not representative of actual population size since they are bottom dwellers and hide under rocks and other CWD. This means that sampling burbot with seine nets is very difficult. Due to the sample size collected, little information can be inferred about the status of burbot in Charlie Lake except that they are breeding and surviving. Three of the burbot caught were young of the year and the other 2 were over a year old.

7.2. Habitat

7.2.1. Slumping

The habitat assessment mapped the current areas of slumping on Charlie Lake. Appendix 1 shows slumping areas on the lake as well as areas of future concern. The map illustrates slumping, north of Golf Course Point, occurs on northerly aspects and on southerly aspects

to the south of the point. The mechanism most likely responsible for this is dominating weather patterns. Strong winds create large waves buffet the shore, eroding away the soft banks of the lake. Golf Course Point is a natural barrier that splits the lake. It protects the southern part of the lake from wind blowing from the north and the northern part of the lake from wind blowing from the south. This means that this point is affected by the wind patterns and associated wave actions on both sides. Due to this fact, Golf Course Point is an extremely sensitive area. In addition, the removal of lakeshore vegetation and boating near shore has increased the rate of slumping in this area.

7.2.2. Productivity

This study identified three areas on Charlie Lake that are highly productive. The most productive bay is the entrance of Stoddard Creek. Stoddard Creek Bay had such large numbers of fish there was difficulty counting them fast enough to prevent mortality. All species of fish, except burbot, were caught in this area with age classes ranging from yoy to adult. This bay is most likely the largest rearing ground on the lake supplying juveniles and yoy with ample food, cover and shallow water to flourish in. In addition, the bay allows access of the larger adults to possible spawning areas in Stoddard Creek.

The second most productive bay was Sunnyside Beach Bay. This small bay, with its sandy shores and small weed bed, had a fish count that doubled the other bays catch with the exception Stoddard Creek entrance. This is one of the few protected bays in the southern part of the lake and is the only one, in the south, that has any significant aquatic vegetation present. The third area is Darnell Bay. Darnell Bay is the third bay on the lake with abundant vegetation present in the water. Although the numbers of fish found here was relatively small compared to other bays, the structure provided is ideal for juvenile and yoy. This is a possible breeding ground for northern pike and if any juveniles are to be found in the lake they will probably be found here.

All the sample sites that had large fish catches also had shallow water and ample aquatic vegetation component. Efforts should be made to maintain the current amount of aquatic vegetation around the lake as the fish populations utilize it heavily. The current weed beds

have been GPSed and mapped for comparison in future studies (Figure 10).

There are two additional bays that are possible productive bays; McMillan Bay and Cabin Bay. McMillan Bay was classified in the Hammond report as a good area to transplant forage fish. Due to the lack of vertical structure and cover as well as low numbers of fish caught we classified the area as a moderately productive bay. The bay does have the potential as a moderately effective spawning area due to the substrate found on the lake bottom. Low levels of silt accumulation and a sandy lake bottom have been found (Hatfield et al., 1972, Nelson and Paetz, 1992, Ford et al., 1995) as effective spawning area for walleye, northern pike and burbot. Cabin Bay was considered a highly productive bay according to Hammond (1986) although recent seines did not confirm this. The bay is well protected, relatively undisturbed and is a moderately effective spawning area for walleye, and burbot due to the shallow water and the sandy shoreline. The high levels of silt on the lake bottom, the lack of vertical structure and the lack of cover are limiting factors on the effectiveness of the spawning area. These two bays would be ideal spots to construct spawning beds for walleye, as they are well protected and unpopulated.

7.3. Limitations of Methods

7.3.1. Beach seining

The beach seines were an effective way of capturing fish, from juvenile to adult, along and near the shore. The problems occurred in areas of deep water just off shore, in areas with heavy coarse wood debris and when sampling large numbers of minnows. The weight of the net caused problems during boat seining as it was difficult to fully extending the net in deep water. In addition, large amounts of coarse woody debris in the seine area resulted in poor seine hauls. To compensate for this, one person removed CWD while the other hauled in the net. If a haul was done unsatisfactory, the site was moved 50 meters in a random direction and re-sampled. Large numbers of fish caught also caused a problem due to limited space in the nets. There was trouble effectively counting and measuring each fish and fish were observed to lose scales. In rare instances, mortality did occur. In seines when large numbers of fish were caught the numbers and lengths were estimated to prevent injury. Also, due to mesh limitations the seine was unsuccessful in collecting specimens in

the early stages of development. These small fish were noted and identified if possible. Beach seining overall proved to be an effective way of sampling fish populations from the shore.

7.3.2. Creel Survey

The creel survey was based on the assumption that people who volunteered for the survey would participate. The creel survey turned out to be an ineffective sampling technique. The problems were numerous. First, the lack of response failed to adequately meet any objective set in the initial proposal. Of the 18 packages handed out only one was returned. Telephone numbers, addresses and times of day to contact individuals participating in the survey could have been helpful in improving response on the volunteer survey. In the future we suggest collecting data on the lake manually.

Second, recording errors or lack of recording in the survey and fish analysis forms cause problems in analyzing data. Inconsistent measurements were taken on fish samples with missing information on each. Fork length, sex, maturity and location on the lake were data fields frequently left blank. Approximately half the samples had errors in recording and in approximately 25% of the samples the species of fish caught was not recorded.

The other major problem with the creel survey was collecting on the lake. There was no time specifically allotted to the collection of creel data at the lake relying only on the random encounters with fishermen. Only people fishing in the bay being sampled that day were surveyed. This, in turn, led to little data being collected on the lake.

7.3.3. Lakeshore Habitat Assessment

Terrain information was collected at each site where seining was done. This may have produced a bias as terrain data was only collected at only those sites. This means that in some bays only 3 samples, chosen at random, were used to represent the terrain of that bay. In large bays such as Darnell B, this may not be truly representative of the bays true terrain features. This bias decreased as number of samples increased and became negligible in

bays that were seined twice. The second point for concern was the collection of the information. The terrain information was only collected at the lakeshore not from the outlying area. In order to reduce the bias from this source terrain information was taken at the top of steep slopes if there was any sign of bank instability in the surrounding area.

To help mitigate the biases caused by these factors a bay description was done from the middle of each bay that looked at prominent terrain features and areas of concern. This was used in conjunction with the sample data to provide an accurate description of each bay sampled.

8. Conclusions

Observations of lake bottom found that the majority of the lake bottom is covered with a moderate layer of silt. Areas of clear gravel are small and usually in areas of high turbidity. Aquatic vegetation is predominantly located at the Stoddard Creek entrance although small weed beds occur in Darnel and Sunnyside Bays. Slumping and erosion of the lakeshore has impacted potential spawning areas and water quality through increased siltation in the lake. There are downstream barriers on Stoddard Creek preventing natural recruitment of local fish and restricting spawning to either lake or upstream areas.

These facts constitute poor spawning areas for the sport fish in Charlie Lake. The creation of artificial spawning beds is a viable option for increasing sport fish fecundity, especially walleye, in the lake. This study identifies two bays as potential sites for artificial spawning beds. McMillan and Cabin bay are well-protected, productive bays with little urban development in them. To create a useful spawning bed, gravel should be set on the ice in the winter and allowed to fall to the lake bottom in the spring. Ford *et al* (1995) sites several studies that prove this is an effective option for increasing walleye reproduction.

Stocking of spottail shiner in Charlie Lake in 1986 was successful and the populations of walleye, white sucker, burbot and yellow perch appear to be healthy, as they are surviving long enough to reproduce. Due to the lack of juvenile northern pike caught it is

recommended that CLCS perform another study, in the future, to assess their status in Charlie Lake. In addition, monitoring perch and sucker populations in the lake would also be prudent.

Slumping around the lake is a concern as a large percent of the lake is currently slumping or at risk of slumping. Efforts should be made to protect sensitive areas on the lake by reducing lakeshore vegetation removal and limiting urban development. In the case of Golf Course Point and areas of existing development in danger zones, alternative methods of shoreline protection, such as log barriers, should be evaluated.

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