Studying Populations of Harvested Fish Species in the Travaillant Lake System, Northwest Territories

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Tetlit Gwich'in Renewable Resource Council
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INTRODUCTION AND BACKGROUND INFORMATION

The Travaillant Lake system, located entirely within the Gwich'in Settlement Area (GSA), is one of the most culturally and traditionally important areas within this region. In recent years, in light of proposed industrial development and exploration that may threaten the aquatic environment within this system, Travaillant Lake has become the focus of fisheries related studies which have attempted to collect important information on subsistence fish species within this system.

In anticipation of increased hydrocarbon activities within the Mackenzie Valley, a project to identify information and research gaps associated with oil and gas exploration, development and transmission in the Mackenzie Valley was carried out in 2003. The Travaillant Lake system was identified as an area of special concern because it is close to the proposed Mackenzie Valley Pipeline, it is culturally and ecologically important to the Gwich'in people, and there is a lack of baseline information on its fish resources. The Gwichya Gwich'in, historically the primary users of this area, view the proposed Mackenzie Valley Pipeline as a serious environmental threat that could harm fish populations and the quality of water in the Travaillant Lake system, through the addition of contaminants, increased sedimentation and erosion, and increased access to this otherwise remote lake. Although it is currently not known what impacts, if any, pipeline construction may have on fish resources in the Travaillant Lake system, to protect these fish populations from the potential impacts we require a better understanding of the biology of these fish. Accelerated exploration and development in the Mackenzie Valley, in general, has intensified the need to gather information on the fish resources throughout this region before development occurs, and especially in the Travaillant Lake system.

In response to the aforementioned knowledge gaps and the general lack of baseline information regarding the biology of harvested fish species, especially broad whitefish (whitefish) and lake whitefish (crooked backs), within Travaillant Lake, the current study was initiated to gather information on the biological characteristics and general status of fish resources in the Travaillant Lake system, with an emphasis on key harvested species. The main objectives of this study are to determine baseline population status and develop reliable indicators of population abundance (the numbers and different types of fish) and mortality rates of key harvested fish species (lake whitefish and broad whitefish) in the Travaillant Lake system and to identify and determine the relative abundance and species composition of other species within the lake system. With future monitoring, such information will allow us to detect subsequent changes that may occur from changes in harvest levels and environmental disturbance in relation to proposed pipeline development in this region of the north.

MATERIALS AND METHODS – WHAT WE DID

Study Area

The Travaillant Lake system, located east of the Mackenzie River Delta, is a large system of lakes, including Travaillant Lake, that are drained by the Travaillant River (Figure 1). All water in this system eventually flows into the Mackenzie River, via the Travaillant River, 75 km east of the hamlet of Tsiigehtchic. The Travaillant River originates in the Lost Reindeer Lakes where it flows south through Fish Trap Lake and

Woodbridge Lake before entering the north end of Travaillant Lake. Approximately 3 km north of Travaillant Lake, the river widens, flow decreases and the bottom of the river becomes dominated by silt and mud.

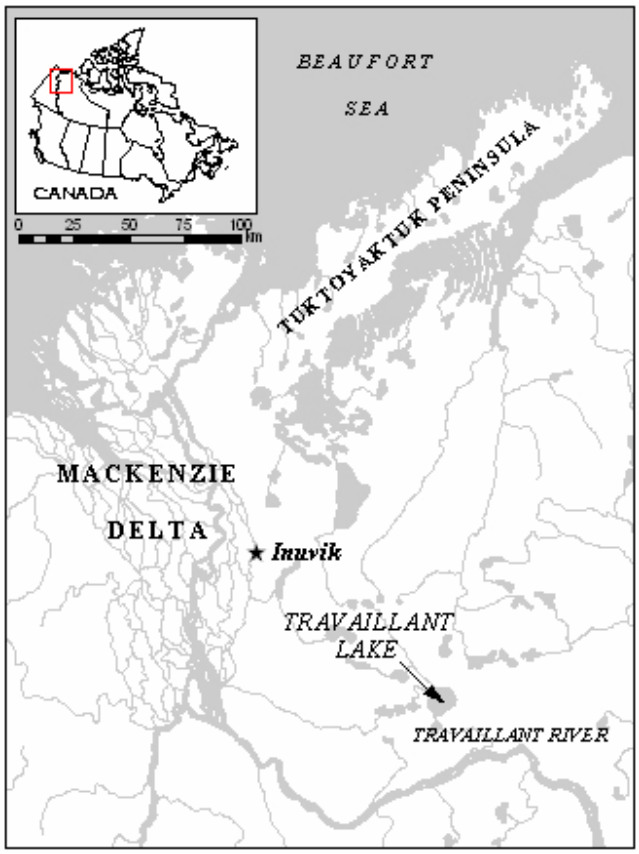

Figure 1. The Mackenzie Delta and Travaillant Lake.

As the Travaillant River flows from Travaillant Lake south, there is a short, highly meandering section before it enters the north end of Andrew Lake. The streambed in this section is comprised of fine silt and mud except for a short section dominated by gravels near the outlet of Travaillant Lake. The River leaves the east side of Andrew Lake, flows east, south and then west, prior to entering the Mackenzie River. Before entering the Mackenzie River there is large change in elevation, and at this point the river straightens and flow increases as it flows towards the confluents. Travaillant Lake itself is a circular lake measuring 12 km from north to south and 10 km from east to west. It is the largest lake located within the Gwich'in Settlement Area and is historically the most culturally important lake in the area. In the past this lake has supported subsistence fisheries for broad whitefish, lake whitefish , lake trout (trout), northern pike (jackfish), burbot (loche) and Arctic grayling (blue fish).

Melissa McPherson and Julie-Ann Andre checking net and ovaries being removed from a whitefish

Fish Capture and Biological Sampling

Traditional knowledge concerning timing of freeze-up and physical characteristics of the area were used to help plan field logistics such as where to place field camps, where to set nets and timing of sampling in order to coincide with fish runs. Fieldwork was conducted between July 31 and August 10 and October 10-21, in conjunction with a broad whitefish radio tagging study. Three locations were sampled within the system: Travaillant Lake was sampled in the open water season to obtain information on the fish community and population structure within the lake; Travaillant Rivers North and South were sampled in fall to obtain information on unique stocks of lake and broad whitefish that are believed to use these areas for spawning. A summer sample and a fall sample were required for the population analysis as many of the biological characteristics recorded will be very different depending on the season.

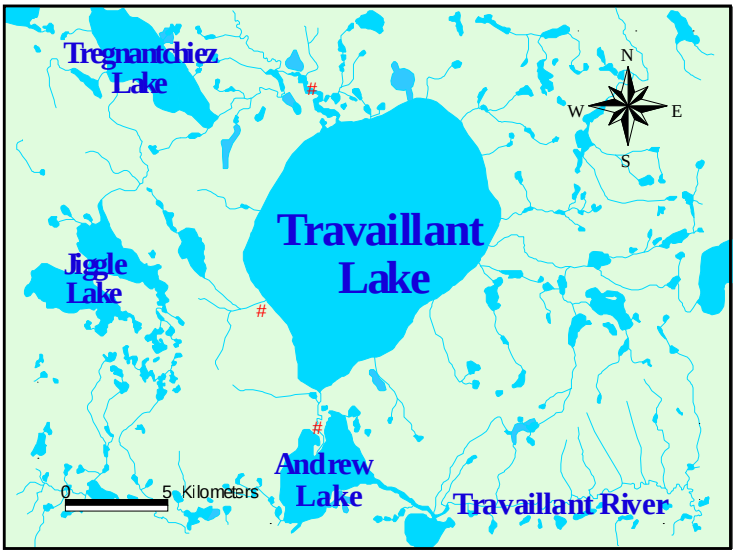

Figure 2. Map of sampling locations (represented by red dots) in the Travaillant Lake system

All fish during 2004 were captured using experimental gill nets with mesh sizes ranging from 25.4 mm (1-inch) to 127.0 mm (5-inch). The varying mesh sizes allowed for the capture of a representative sample of species and sizes within species. In the summer (July 31 to August 10) gill nets were set at various locations along the southwest shore of Travaillant Lake (Figure 2). The mesh sizes were randomly arranged in the following order; 50.8 mm (2-inch), 76.2 mm (3-inch), 101.6 mm (4-inch), 25.4 mm (1-inch) and 127.0 mm (5-inch). The net was checked approximately every 24 hours, at which time all captured fish were removed, separated by mesh size in which they were captured and brought to the sampling station for analysis and collection of biological characteristics.

In October, fish were captured at two locations within the Travaillant River; one site upstream of Travaillant Lake and one site downstream of the lake between Travaillant Lake and Andrew Lake (Figure 2). The same gill nets were used for the fall analysis, however, due the limited size of the fishing area within the river individual panels of each mesh size were fished separately for approximately one hour at a time, rather than combined to form a single gang. The locations and order in which the panels were fished were randomly selected.

To obtain reliable estimates of catch-per-unit effort (how many fish are captured in a certain period of time) the net type (mesh size), set time (when the net was set), lift time

(when the net was checked) and soak times (how long the net was in the water) were recorded and additional information, including location data such as position (determined by GPS), time of year, time of day, net depth, water temperature, weather and other environmental conditions was also recorded for each net set.

For all captured fish, fork length (length from the tip of the nose to the fork in the tail), gonad weight (weight of the gonads), round weight (total weight of the fish), sex (male or female), maturity and general health or appearance were recorded. The first two fin rays from the left pelvic fin of each fish were taken and stored in sample envelopes to be archived for future aging or genetic analysis. Saggital otoliths (ear bones) were removed from all broad whitefish, lake whitefish, lake trout and cisco species and cleithra (bone near the lower jaw) were removed from all northern pike for future aging. Stomach contents were either recorded or preserved for further analysis. Ovaries (eggs) of all fall sampled lake whitefish and broad whitefish were collected and preserved for fecundity analysis (counting the total number of eggs) and muscle tissue samples of all fall sampled fish were archived for potential use in future studies. Broad whitefish and lake whitefish captured during this study were cleaned, frozen and distributed amongst the community of Tsiigehtchic.

Broad whitefish caught in net and Andy Andre checking the net at the Travaillant River North sampling location

RESULTS AND DISCUSSION – WHAT WE FOUND OUT

Fish Species Composition – What Types of Fish Were Captured and How Many

A total of seven different fish species were captured in the gill net catches during the 2004 study (Table 1, Figure 3). Summer sampling within Travaillant Lake proper yielded catches dominated by lake whitefish (36.7%), cisco species (28.3%) and broad whitefish (27.0%), with smaller catches of northern pike (4.8%), lake trout (2.9%) and inconnu (0.3%; Figure 3).

Table 1.Names and numbers of fish captured in the Travaillant Lake system in 2004.

		Summer	Fall North	Fall South		
Common Name	**Scientific Name**	**Dead Sampled**	**Dead Sampled**	**Dead Sampled**	**Released**	**Total**
broad whitefish	*Coregonus nasus*	84	200	162	2	448
lake whitefish	*Coregonus clupeaformis*	114	3	193	5	315
cisco	*Coregonus spp.*	88	0	0	0	88
lake trout	*Salvelinus namaycush*	9	0	0	0	9
northern pike	*Esox lucius*	15	0	0	10	25
Arctic grayling	*Thymallus arcticus*	0	1	0	0	1
inconnu	*Stenodus leucichthys*	1	0	0	0	1
Total		311	204	355	17	887

The fall catches differed between sampling locations, and was different from the composition observed in the summer catches. At the north sampling site in the Travaillant River, the catch was dominated by broad whitefish (98.0%), with minor catches of lake whitefish (1.5%), and Arctic grayling (0.5%; Figure 3). Conversely, catches in the south end of the Travaillant River were dominated by both lake whitefish (53.0%) and broad whitefish (44.5%) with occasional captures of northern pike (2.5%; Figure 3). The observed differences in species composition may be attributed to the location of the nets and/or the seasons of netting. In particular, the presence of lake and broad whitefish in fall catches within the Travaillant River is not surprising given that both species typically spawn within rivers in the fall. The low numbers of lake whitefish in catches at the north Travaillant River sampling site were unexpected, but may be related to differences in spawning run timing in the north and south Travaillant Rivers or may indicate that lake whitefish do not regularly use the north inlet for spawning. However, the 3 lake whitefish that were captured at the north Travaillant River site were all in spawning condition suggesting that spawning does take place in this part of the system

and that our sampling coincided with either the beginning or end of the lake whitefish spawning run.

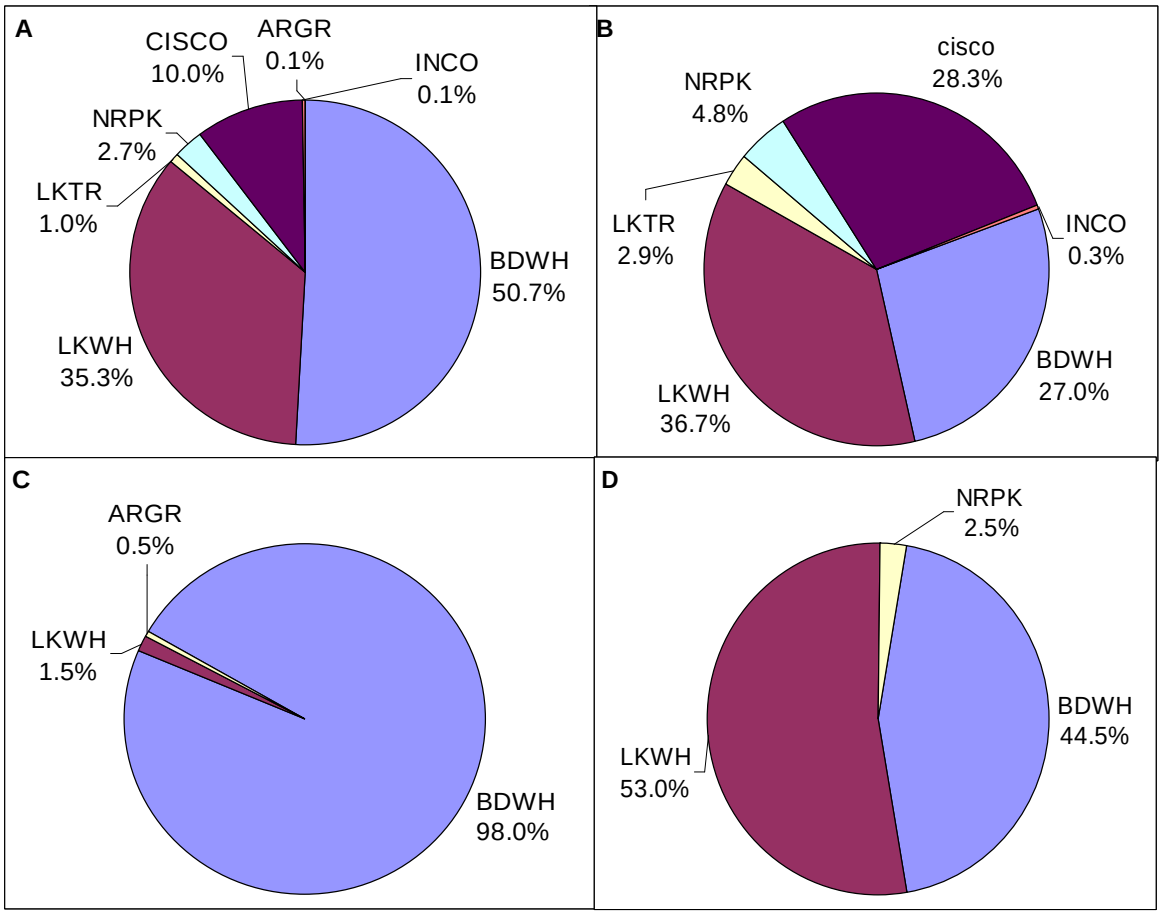

Figure 3. Species composition of the gill net catches from (A) all locations combined (B) Travaillant Lake in summer, (C) Travaillant River North in fall and (D) Travaillant River South in fall. BDWH = broad whitefish, LKWH = lake whitefish, NRPK = northern pike, LKTR = lake trout and INCO = inconnu, ARGR = Arctic grayling.

Catch Per Unit Effort – How Many Fish Are Caught in a Certain Period of Time

During summer sampling in Travaillant Lake, the average daily Catch Per Unit Effort (CPUE) was highest for lake whitefish, cisco and broad whitefish, ranging from 4.66 to 7.22 fish/45.7m net/24 hours. This means that you can expect to catch between 4.66 and 7.22 fish every 24 hours in a 45.7 m net. Catch rates were much higher during the fall sampling period in the Travaillant River, particularly at the north site where average daily CPUE for broad whitefish was 1008.68 fish/45.7m net/ 24 hours. At the south site CPUE was 98.44 and 140.98 fish/45.7 m net/ 24 hours for broad and lake whitefish respectively. The higher CPUE in fall is a result of the high concentration of spawning fish that move into this river to spawn at this time of year and this shows why migratory species are so vulnerable to over-harvest by fisheries during their spawning migrations.

The high concentration of fish moving through a restricted corridor allows these species to be easily targeted at various locations along their migratory routes. The CPUE in Travaillant Lake was lower because fish are likely utilizing this habitat for summer feeding and are thus more evenly distributed in space

Table 2. Mean catch per unit of effort (number of fish caught per 24 hours in a 45.7 m experimental gillnet (25.4-127 mm)) by location and species.

Species	Travaillant Lake Summer	Travaillant River North Fall	Travaillant River South Fall
broad whitefish	4.66	1008.68	98.44
lake whitefish	7.22	14.4	140.98
cisco	4.69	-	-
lake trout	0.57	-	-
northern pike	0.88	-	1.21
Arctic grayling	-	6	-
inconnu	0.06	-	-

The Travaillant River as it flows between Travaillant Lake and Andrew Lake. In the background is Andrew Lake.

Biological Evaluation

Broad whitefish

Length Frequency – What are the Different Lengths of the Fish That Were Caught?

The fork length (length from the tip of the nose to the fork in the tail) frequency distributions for all broad whitefish captured in 2004, are presented in Figure 4. For figures showing frequency distributions, the height of the bars indicate the number of fish in a certain range. In Figure 4, the height of the bars show how many fish are between certain fork lengths (for example between 110 and 120 mm), and the higher the bar indicates that there are more fish within that range. Broad whitefish captured in Travaillant Lake during summer ranged from 110 to 520 mm (4.33 to 20.5 inches) in fork length and had an average size of 334.5 mm (13.7 inches) in fork length. The fall sample of spawning broad whitefish captured from the north Travaillant River ranged from 389 to 511 mm (15.3 to 20.1 inches) with an average length of 431.6 mm (17.0 inches). Although experimental nets were used, we only captured mature spawning fish at this site. The fall sample of fish captured in the south sampling site on the Travaillant River during 2004 were of a larger size with an average 442.6 mm (17.4 inches) compared to those captured in the north Travaillant River, but also showed a wider range of sizes from 278 to 550 mm (10.9 to 21.7 inches).

Age Frequency - What are the Different Ages of the Fish That Were Caught?

The age frequency distributions for broad whitefish captured in 2004 are presented in Figure 5. The broad whitefish collected in Travaillant Lake during summer ranged in age from 3 to 17 years with an average age of 9.7 (Figure 5a). The fall samples of spawning broad whitefish captured in the Travaillant Rivers north and south were generally older (average age, Travaillant River north 12.5 years, Travaillant River south 13.2 years) than those captured in the lake during summer, due to the low numbers or complete absence of juveniles (Figure 5), (Figure 5b, c).

The Travaillant River at the north sampling site a few kilometers upstream of Travaillant Lake

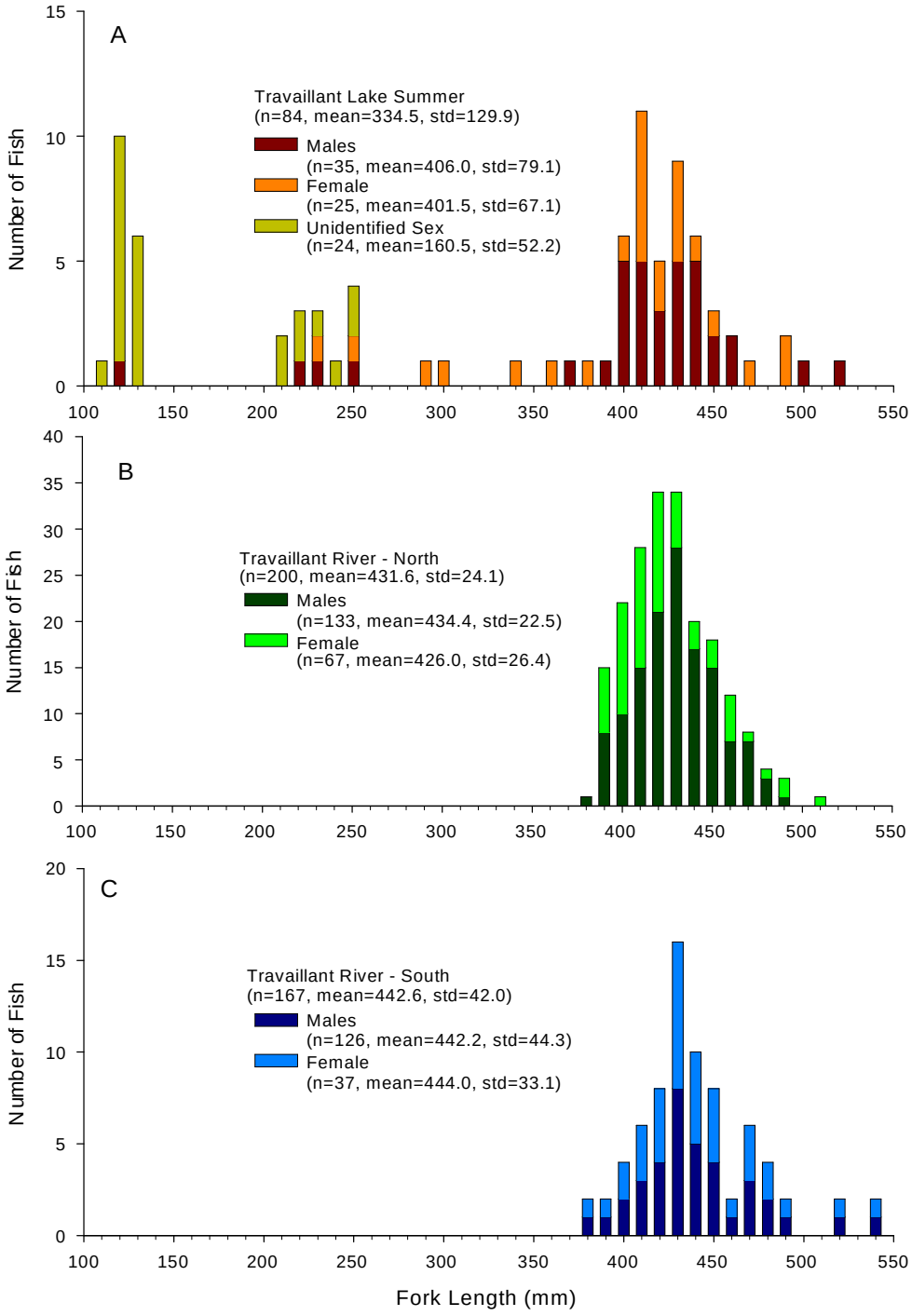

Figure 4. Length frequency distributions of broad whitefish collected in A) Travaillant Lake during summer, B) Travaillant River North in fall and C) Travaillant River South in fall.

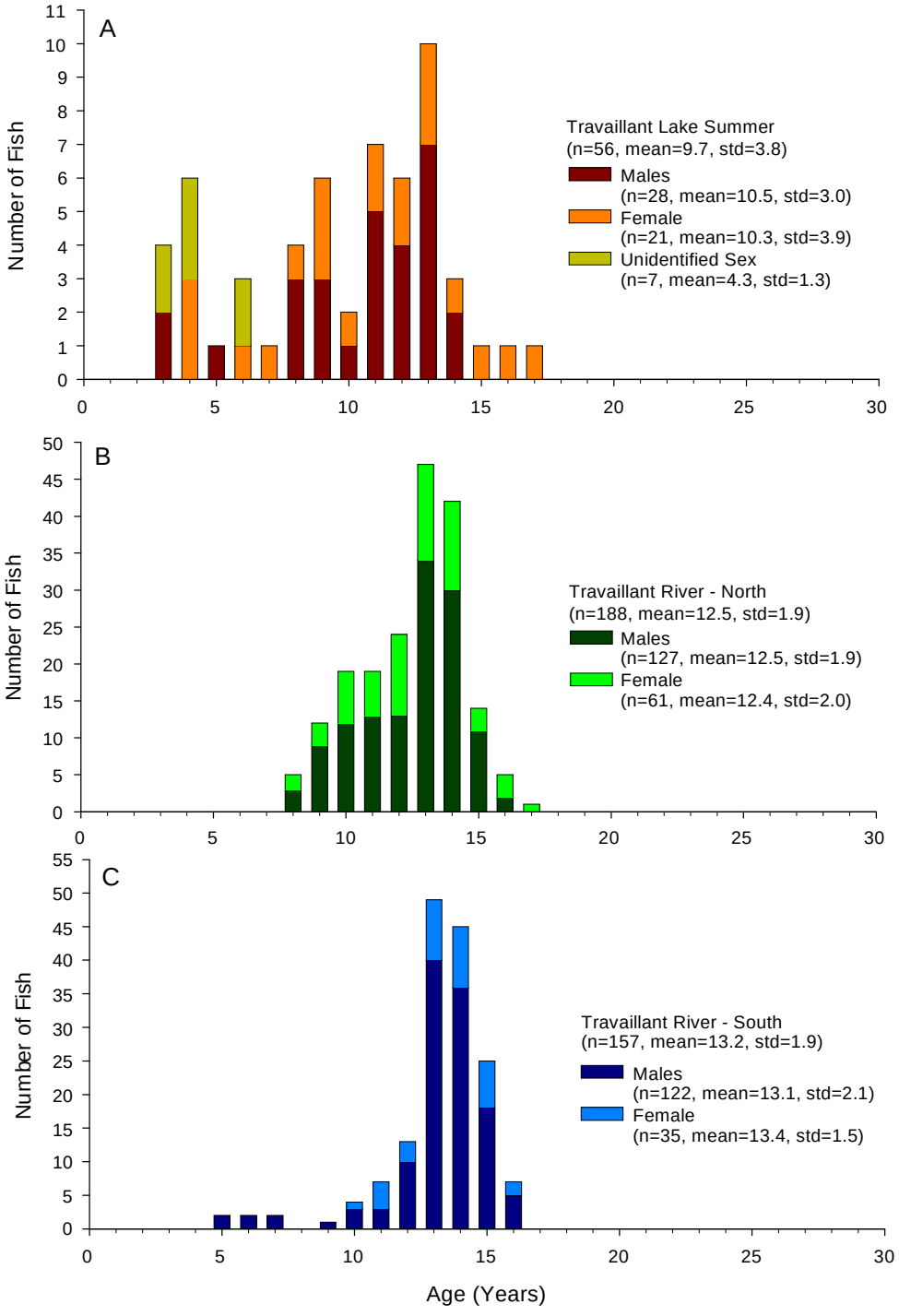

Figure 5. Age frequency distributions of broad whitefish collected in A) Travaillant Lake during summer, B) Travaillant River North in fall and C) Travaillant River South in fall.

Age and Size at Maturity - How Big and Old are the Fish When They Can First Spawn?

Minimum age at maturity (how young a fish is when it is first able to spawn) was the same in the summer sample from Travaillant Lake and the fall sample from Travaillant River north with both males and females first reaching maturity at age 8. This means that both females and males captured in Travaillant Lake or the Travaillant River North would be able to spawn for the first time when they are 8 years of age. Size at first maturity in these two locations was 397 mm (15.6 inches) for males and 418 mm (16.4 inches) for females captured in Travaillant Lake and 405 mm (15.9 inches) for males and 413 mm (16.3 inches) for females captured at the Travaillant River North sampling site. Broad whitefish in the fall sample from Travaillant River South had a later age at first maturity of 9 and 10 years for males and females, respectively. Size at maturity for this location was 429.5 mm (16.9 inches) for males and 470 mm (18.5 inches) for females, respectively.

Table 3. Proportion of individuals categorized at different stages of maturity, for broad whitefish captured in A) Travaillant Lake and Travaillant Rivers B) North and C) South.

A)

	Female		Male	
Maturity	**n**	**%**	**n**	**%**
Immature	11	44.0	8	22.9
Mature	14	56.0	26	74.3
Spent/Resting	0	0.0	1	2.9

B)

	Female		Male	
Maturity	**n**	**%**	**n**	**%**
Mature	55	82.09	113	84.96
Running Ripe	12	17.91	20	15.04

C)

	Female		Male	
Maturity	**n**	**%**	**n**	**%**
Immature	0	0	6	4.7
Mature	2	5.4	17	13.4
Running Ripe	29	78.4	98	77.2
Spent/Resting	6	16.2	6	4.7

Stage of Maturity - How Many Fish in Each Stage of Maturity Were Caught?

Based on visual examination of gonads the majority of male and female broad whitefish captured in the summer sample from Travaillant Lake were juveniles or mature fish starting to come into spawning condition (Table 3a), while the fall samples from the

Travaillant River North and South were mainly mature or running ripe (eggs or milt running out of the fish) and about to spawn or spawning (Table 3b and c). A small proportion of the broad whitefish in the Travaillant River South sample were either juvenile or resting (not spawning in the current year).

Sex Ratio - How Many Males and Females Were Caught?

Male broad whitefish were generally more abundant than females. The ratio of males to females was 1.4:1 in the summer sample (n=60), 2:1 in the fall sample from Travaillant River north (n=200) and 3.4:1 in the fall sample from Travaillant River south (n=70).

Fecundity - How Many Eggs Did the Fish Have?

Fecundity (number of eggs per female) of broad whitefish collected from the Travaillant River north ranged from 15 444 to 74 435 with a mean fecundity of 28 076 eggs per female. Only two samples from the Travaillant River south were suitable for estimation of fecundity; estimates of 23 799 and 33 577 eggs were obtained.

Thomas Kendo recording information after sampling some fish

Lake whitefish

Length Frequency – What are the Different Lengths of the Fish That Were Caught?

The fork length (length from the tip of the nose to the fork in the tail) frequency distributions for all lake whitefish captured in 2004 are shown in Figure 6. The lake whitefish captured in Travaillant Lake during summer ranged from 201 to 526 mm (7.9 to 20.7 inches) in fork length, with an average of 334.5 mm 13.2 inches). The fall sample of

spawning lake whitefish captured from the Travaillant River South ranged from 144 to 478 mm (5.7 to 18.8 inches) in length, with an average length of 352 mm (13.9 inches).

Age Frequency - What are the Different Ages of the Fish That Were Caught?

The age frequency distributions for lake whitefish captured in 2004 are shown in Figure 7. Lake whitefish collected in Travaillant Lake during summer ranged in age from 5 to 26, with an average age of 12.2. The fall sample of spawning lake whitefish from the Travaillant River South ranged from 3 to 15 years of age with an average of 9 years.

Age and Size at Maturity - How Big and Old are the Fish When They Can First Spawn?

Lake whitefish in the summer sample from Travaillant Lake had a later age at first maturity of 9 and 10 years for males and females, respectively as compared to those from the fall sample in Travaillant River South, which first matured at age 8. This means that the fish at the three locations would be able to spawn for the first time when they are, 9 and 10 for males and females from Travaillant Lake, and 8 for both males and females at the south sampling location on the Travaillant River. Size at first maturity in these two locations was similar at 396 mm (15.6 inches) for males and 400 mm (15.7 inches) for females captured in Travaillant Lake and 396 mm (15.6 inches) for males 414 mm (16.3 inches) for females captured at the south site on the Travaillant River.

View from the helicopter looking down on the south sampling site on the Travaillant River

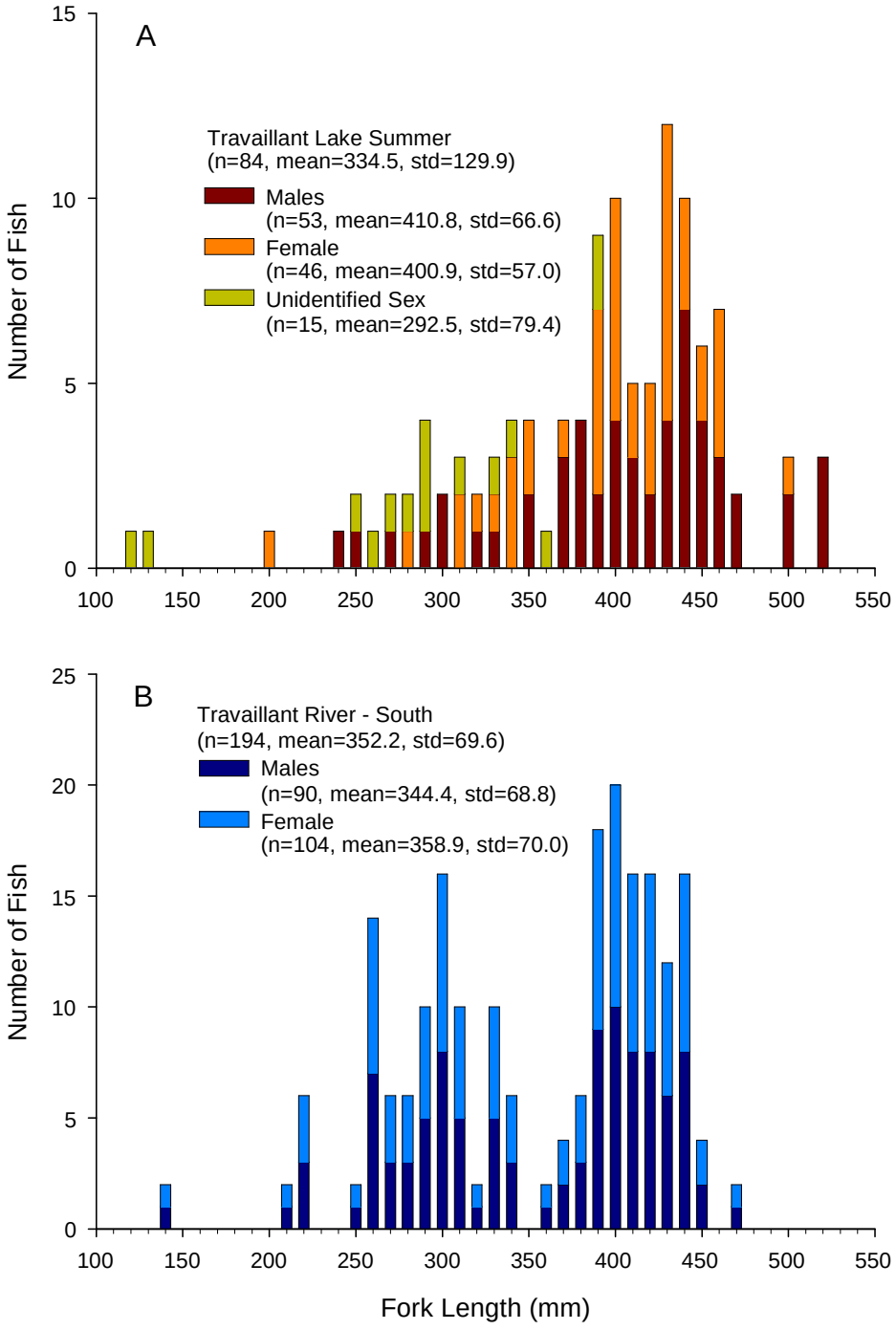

Figure 6. Length frequency distributions of lake whitefish collected in A) Travaillant Lake during summer and B) Travaillant River South in fall.

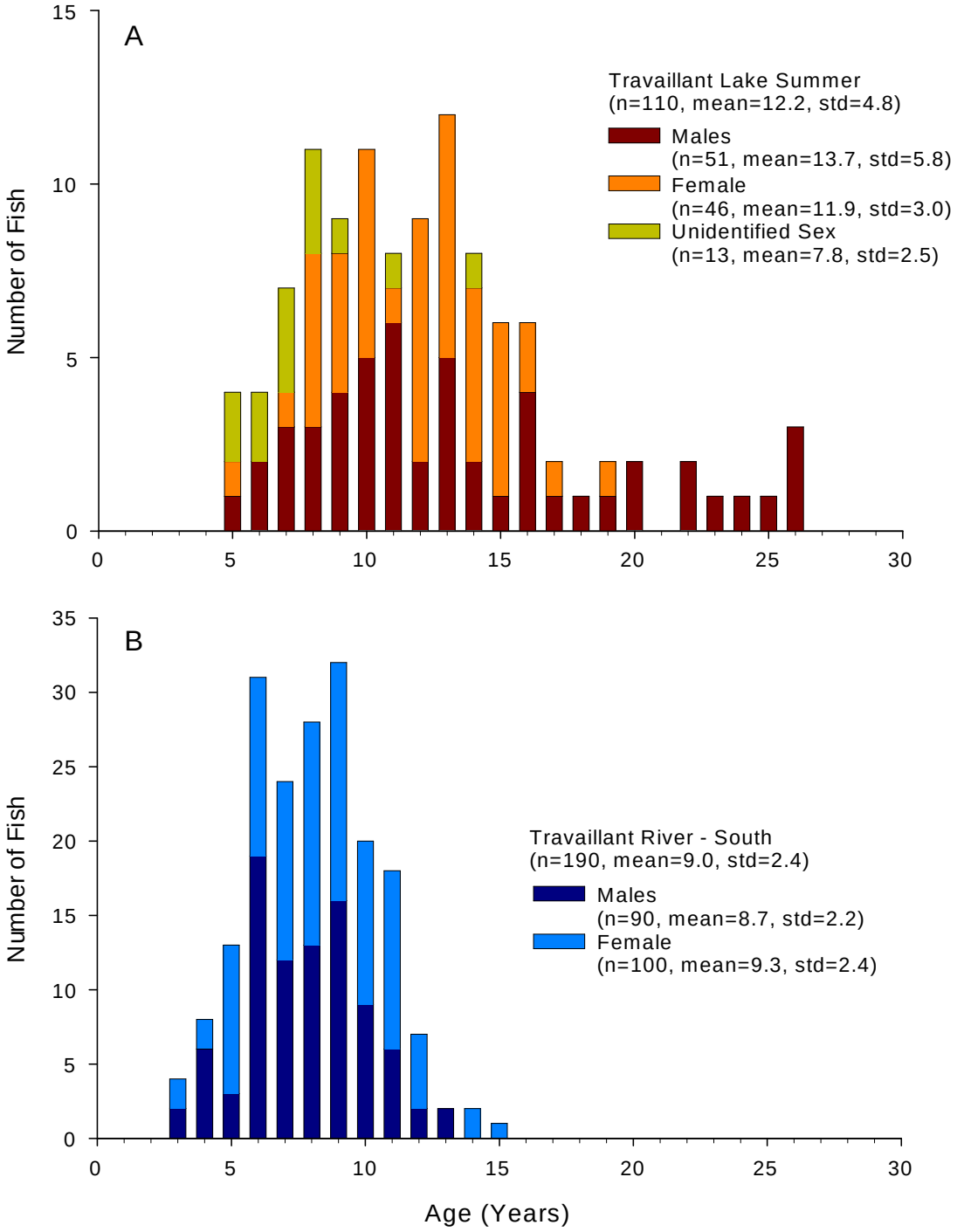

Figure 7. Age frequency distributions of lake whitefish collected in A) Travaillant Lake during summer and B) Travaillant River South in fall

Stage of Maturity - How Many Fish in Each Stage of Maturity Were Caught?

Based on visual examination of gonads, the majority of male and female lake whitefish captured in the summer sample from Travaillant Lake were juveniles or mature fish starting to come into spawning condition (Table 4a), while the fall samples from the Travaillant River South were comprised of mature or running ripe fish either about to spawn or spawning, juveniles and some spent/resting individuals (Table 4b).

Table 4. Proportion of individuals categorized at different stages of maturity, for lake whitefish captured in A) Travaillant Lake in summer and B) Travaillant River South in Fall.

A)

	Female		Male	
Maturity	**n**	**%**	**n**	**%**
Immature	19	41.3	15	28.3
Mature	24	52.2	37	69.8
Spent/Resting	3	6.5	1	1.9

B)

	Female		Male	
Maturity	**n**	**%**	**n**	**%**
Immature	45	43.3	45	50.6
Mature	46	44.2	30	33.7
Running Ripe	1	1.1	13	14.6
Spent/Resting	12	13.3	1	1.1

Sex Ratio - How Many Males and Females Were Caught?

The ratio of male to female lake whitefish in the summer sample (n=99) was 1.15:1 and in the fall river sample was 0.87:1 (n=194).

Fecundity - How Many Eggs Did the Fish Have?

Fecundity of lake whitefish collected from the Travaillant River South ranged from 14,863 to 47,266 with an average of 27,944 ± 8,192 eggs per female. Fecundity could not be calculated for the summer sample captured in Travaillant as no fish were in spawning condition and therefore ovaries were no saved.

Thomas Kendo with a northern pike (jackfish)

CONCLUSIONS AND FURTHER RESEARCH

There were a number of differences in the biological characteristics of broad and lake whitefish samples collected at different locations which could be an indication that there are multiple stocks of each species within the lake system. In the case of broad whitefish, we found that the mature component of the population (those fish that were spawning) showed variation with respect to length and age structure as well as age at maturity. Broad whitefish from Travaillant Lake and the Travaillant River North had similar biological characteristics and were generally smaller, younger and matured at an earlier age than those in the Travaillant River South. This result suggests that broad whitefish spawning in the Travaillant River North are part of the Travaillant Lake population, while those spawning in the Travaillant River South may be part of a separate stock that is either from the Mackenzie River, from Andrew Lake, or a mixture of both. The hypothesis of a separate stock in the Travaillant River South area is supported by the fact that all life history stages (with the exception of young of the year (YOY)) of broad whitefish were captured in our fall sample within the river, suggesting that broad whitefish are able to complete their lifecycle within this portion of the river system. Seine netting (where a small mesh net is swept through the water in attempt to

catch small fish or minnows) will be carried out in the Andrew Lake area during 2005 to confirm if YOY broad whitefish rear in the south part of the river system.

In contrast to the Travaillant River South, broad whitefish in the Travaillant River North were exclusively adult spawners suggesting that other areas of the Travaillant lake system, likely Travaillant Lake proper, are used to complete their lifecycle. The similarities among adults from Travaillant River North and Travaillant Lake, along with the presence of all life history stages (juveniles, resting adults and spawners) in Travaillant Lake suggests that the lake serves as a rearing (where fish grow) and feeding area for broad whitefish originating from the Travaillant River North spawning stock. This two stock hypothesis is further corroborated by evidence from recent radio telemetry studies conducted by the GRRB which have shown that nearly all (one exception) broad whitefish tagged in Travaillant Lake either remained in the lake or moved into the Travaillant River North in the fall presumably for the purpose of spawning. Broad whitefish tagged in the Travaillant River South in the fall either remained in the river or moved into Andrew Lake to over winter.

In the case of lake whitefish, very few fish were captured in the Travaillant River North, therefore comparisons could only be made among Travaillant Lake and the Travaillant River South. The mature component of the population in Travaillant Lake was comprised of larger, older and later maturing individuals as compared the Travaillant River South, suggesting that there may be two separate stocks. The presence of a variety of life history stages (juveniles, resting adults and spawners) in the Travaillant River South suggests that lake whitefish may be able to complete their entire lifecycle within this part of the river system, and may not need to use Travaillant Lake. Similarly, all life history stages (with the exception of spawning adults) occur in Travaillant Lake suggesting that lake whitefish may exist as a distinct closed population within the lake. It is not clear where lake whitefish from Travaillant Lake spawn. Although only 3 individuals were captured at the north sampling site, all were in spawning condition, suggesting that this area may serve as a spawning site for lake whitefish from Travaillant Lake. It is possible that the main spawning run occurred prior to our sampling period and that we only captured the end of the run. Alternatively, Travaillant Lake lake whitefish may spawn elsewhere. In either case, the lack of other life history stages in our samples at the north site suggests that, similar to broad whitefish, there is no established stock of lake whitefish in the north part of the river system. In 2005 we hope to extend the sampling period on the Travaillant River North to check for the presence of an earlier lake whitefish spawning run in this part of the system.

The use of experimental gillnets with a range of mesh sizes during 2004 provided a good representation of the fish community and individual fish populations as a whole. Detailed sampling for population analyses in different areas of the Travaillant Lake system has allowed us to better understand the biology and begin to characterize the range of variability that exist within broad and lake whitefish populations (stocks) in this lake system. These data will provide a good base from which to monitor future change, however further information collected over multiple years will be required to obtain robust estimates of population abundance and mortality. With future monitoring, such information will allow us to detect subsequent changes that may occur from changes in harvest levels and environmental disturbance in relation to proposed pipeline development in this region of the north. Such information is also crucial to co-management boards in determining safe harvest levels for these fish stocks.

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Field Crew at Travaillant River South (K. Howland, M. McPherson, L. Harris, J. Andre, A. Andre)