

Sidney Lake Fish and Fish Habitat Investigations



Prepared For

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EXECUTIVE SUMMARY

Lake whitefish and broad whitefish are an important food source for Teslin Tlingit Council (TTC) citizens and their importance as a subsistence fishery has increased in recent years due to the decline in lake trout and Chinook salmon populations. Sidney Lake and the outlet stream to the Nisutlin River, located approximately 45 km north of the Alaska Highway on the South Canal Road, provides a subsistence fishing area where TTC citizens would go to harvest northern pike, Arctic grayling, and whitefish, specifically lake and/or broad whitefish. TTC citizens who frequent the Sidney Lake area have mentioned that there is an apparent lack of fish in Sidney Lake and the outlet stream in recent years. It has also been documented by local knowledge holders that increased beaver activity in the outlet stream has increased and subsequently changed stream morphology. EDI was retained to conduct a fish and fish habitat investigation as well as collect traditional knowledge via interviews with TTC citizens to try and determine what is occurring in Sidney Lake.

Fish and fish habitat investigations were conducted in September 2022 by EDI with assistance from TTC. Trap netting was used as the primary method to target juvenile and adult whitefish species expected to be present within Sidney Lake. This method has not been used extensively in the Yukon to date; however, it was chosen due to the potential to minimize fish mortalities and injuries compared to conventional fishing methods such as small mesh gillnetting. Limiting fish mortalities during the whitefish investigation was an important consideration for TTC during planning of the study. A total of 24 trap sets were completed during the September fish sampling. Length frequency distribution and Von Bertalanffy Growth Models (VBGM) were used to analyze fish sampling data. Fish habitat assessments included a combination of ground truthing and aerial surveys via drone to document fish habitat conditions. Several local knowledge holders were interviewed in conjunction with TTC to gain an understanding of the presence of fish species in the Sidney Lake area, as well as the status of the lake outlet and stream that connects to the Nisutlin River.

A total of 37 northern pike and 21 lake whitefish were caught via trap netting. Captured lake whitefish were all similar in length with no juveniles captured or observed during sampling. Various sizes of northern pike were captured with a limited number of larger individuals and very few juveniles. The VBGM for northern pike in Sidney Lake, fit poorly and none of the biologically relevant parameters (asymptotic length [L_{∞}], growth coefficient [k], and age at length 0 mm [t_0]) were statistically significant. The most likely explanation is that an insufficient number of older fish (>12 years) were captured in Sidney Lake. The VBGM for Lake Whitefish in Sidney Lake (2022) fit poorly, and only the asymptotic length (L_{∞}) was identified as statistically significant. Similar to northern pike, there was an insufficient number of older fish (>13 years) captured for the model to fit well.

A fish habitat assessment was conducted in Sidney Lake and the outlet stream to the Nisutlin River. The outlet stream is characterized by pockets of exposed cobble, stagnant slow-moving pools, and narrow meandering braids. Several probable barriers to fish were noted along the outlet stream connecting Sidney Lake to the Nisutlin River. An old beaver dam (terrestrial vegetation growing from the dam walls) was observed approximately 700 metres downstream from the outlet of Sidney Lake. It is suspected that fish passage would only be possible at certain flows at this barrier. A more recently established beaver dam was also documented near the confluence with the Nisutlin River, further restricting fish passage.



Four TTC citizens who frequent the Sidney Lake area were interviewed in February 2023. The interviews provided information regarding historical species composition in Sidney Lake, as well as how the morphology of the Sidney Lake and the outlet stream to the Nisutlin River have changed over time. This information provided important historical context when evaluating the fish and fish habitat data collected in 2022.

The low number of lake whitefish captured combined with the absence of juveniles suggest that there is no regular recruitment occurring in Sidney Lake. It is speculated that this is a function of lack of available spawning habitat as well as the inability of fish to move freely in and out of Sidney Lake due to the barriers identified on the outlet stream during the fish habitat assessment. Spawning habitat may have been available prior to the morphological changes (i.e., increased beaver activity, reduction in flows in the outlet stream and increased water levels in Sidney Lake) to the outlet stream and Sidney Lake but has since been altered through natural changes. The observed northern pike physiology (i.e., long, and slender) may be attributed to the lack of available food sources in Sidney Lake. The lack of juvenile whitefish (which are known as an important food source for northern pike) as well as reduction in Arctic grayling populations within Sidney Lake and the outlet stream are potential contributors to northern pike condition.

It is recommended that additional fish and fish habitat sampling events be conducted in Sidney Lake. This may include a spring fish and fish habitat investigation in conjunction with traditional fishing timing, additional non-lethal (trap netting) sampling at different times of the year and more traditional knowledge interviews to continue to increase the historical knowledge of the area.



ACKNOWLEDGEMENTS

Special thanks to Philip Smith, Clara Jules, William Smarch, Sandy Smarch, and Tim Dewhurst Sr. for participating in the traditional knowledge interviews. Gillian Rourke and Stefan Howarth (TTC Lands and Resources Department) assisted with all components of this project and contributed substantially to the success of the work. TTC also donated the trap nets and camp gear to the project.

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TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 STUDY AREA 1

2 METHODS 3

2.1 TRAP NETTING 3

2.1.1 Data Analysis 5

2.2 FISH HABITAT ASSESSMENTS 5

2.3 TRADITIONAL KNOWLEDGE INTERVIEWS 6

3 RESULTS 7

3.1 TRAP NETTING 7

3.1.1 Von Bertalanffy Growth Models 9

3.1.1.1 Northern Pike 9

3.1.1.2 Lake whitefish 10

3.2 FISH HABITAT ASSESSMENT 11

3.3 TRADITIONAL KNOWLEDGE INTERVIEWS 14

4 DISCUSSION 15

4.1 LAKE WHITEFISH 15

4.2 NORTHERN PIKE 15

5 CONCLUSION 17

6 REFERENCES 18

LIST OF APPENDICES

Appendix A Photographs A-1

Appendix B Fish Data B-1

LIST OF TABLES

Table 1. Summary of trap netting effort (fine mesh, coarse mesh, and intermediate mesh) in Sidney Lake, September 2023. 5

Table 2. Von Bertalanffy Growth Model parameter estimates for Northern Pike in Sidney Lake (2022) and Nisutlin Lake (2021), and Lake Whitefish in Sidney Lake (2022). Significant values (*p*-value <0.05) are shown in bold. 9



LIST OF FIGURES

Figure 1. Length frequency histogram for lake whitefish captured in Sidney Lake in September 2022 (n = 21).....7

Figure 2. Length frequency histogram for northern pike captured in Sidney Lake in September 2022 (n = 37).....8

Figure 3. Von Bertalanffy growth model for northern pike captured in Sidney Lake during September 2022 (fin rays only; n = 33)..... 10

Figure 4. Von Bertalanffy growth model for lake whitefish captured in Sidney Lake during September 2022 (fin rays only; n = 18)..... 11

LIST OF MAPS

Map 1. Overview of Sidney Lake.....2

Map 2. Sidney Lake Trap Netting Locations4

LIST OF PHOTOGRAPHS

Photo 1. Beaver dam approximately 700 m downstream of the Sidney Lake outlet..... 12

Photo 2. Outlet stream flowing through the wetland near the confluence with the Nisutlin River..... 13

Photo 3. Confluence of the Sidney Lake outlet stream with the Nisutlin River. Note the beaver dam just before the last bend in the stream. 13

Photo 4. Aerial photos from 1973 (left) and 1993 (right) of the east back bay on Sidney Lake (Geo Yukon 2023). Note the changes in extent of water in the back bay and size of channel connecting the bay to the lake. 14

Photo 5. Northern pike captured during sampling in September 2022. 16



LIST OF APPENDIX PHOTOGRAPHS

Appendix Photo 1.	Pocket of exposed gravel downstream of the inactive beaver dam on the Sidney Lake outlet stream on September 16, 2022.....	A-2
Appendix Photo 2.	East bay and upstream section of the outlet stream on September 12, 2022.....	A-2
Appendix Photo 3.	Stagnant pools separated by height of land downstream of the inactive beaver dam on the outlet stream on September 12, 2022.....	A-3
Appendix Photo 4.	Aerial view of a trap net set in Sidney Lake on September 12, 2022.....	A-3



1 INTRODUCTION

Lake whitefish and broad whitefish have been, and continue to be, an important food source for Teslin Tlingit Council (TTC) citizens. As populations of other critical food species in the Teslin Traditional Territory decline (such as lake trout and Chinook salmon), citizens have been relying on whitefish as an integral part of their diet. Local knowledge has indicated that Sidney Lake and the stream that flows down to the Nisutlin River was a subsistence fishing area where TTC citizens would go to harvest northern pike, Arctic grayling, and whitefish, specifically lake and/or broad whitefish. However, in recent years there has been an apparent lack of fish in Sidney Lake and in the outlet stream. TTC citizens who frequent the Sidney Lake area have mentioned that there has been increased beaver activity on the outlet stream which connects the lake to the Nisutlin River.

EDI was retained by TTC to conduct a fish and fish habitat investigation in Sidney Lake. The specific objectives of the Sidney Lake whitefish investigations were to:

- Interview local knowledge holders to compile information on fish presence in Sidney Lake and the stream connecting the lake to the Nisutlin River,
- Complete fish habitat assessments and fish sampling in Sidney Lake and the outlet stream downstream to the Nisutlin River,
- Use non-lethal fish sampling methods (trap netting) to determine if adult and/or juvenile whitefish are currently present in Sidney Lake, and if so in what numbers, and
- Produce a technical report that summarizes methods and results, as well as recommendations for additional studies and/or follow-up field activities.

1.1 STUDY AREA

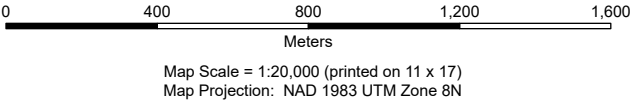
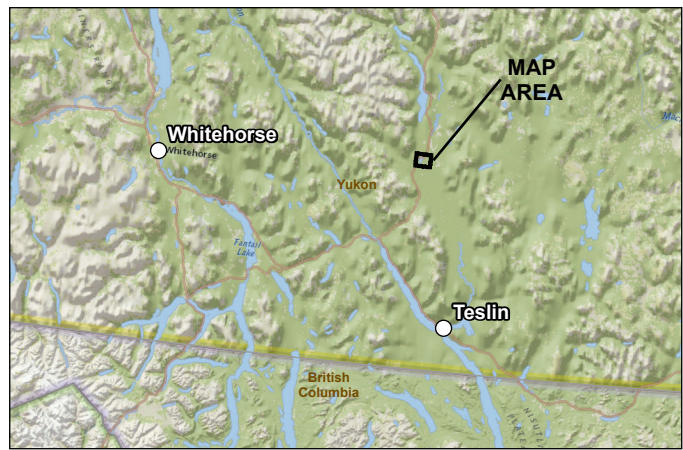
Sidney Lake is located adjacent to the South Canol road, approximately 45 km north of the South Canol road junction with the Alaska Highway. The lake has an approximate area of 1.60 km, including the east connected bay (Map 1). The outlet stream that connects Sidney Lake to the Nisutlin River is approximately 2.2 km in length and flows through a mature spruce and pine forest. A large wetland area is present near the lower section of the outlet stream before the confluence with the Nisutlin River.



Map 1 - Overview of Sidney Lake

Teslin Tlingit Council

- Legend
- Primary Road



- Data Sources
- Inset Basemap, National Geographic World Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
 - Main Basemap, World Imagery: Maxar

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2 METHODS

2.1 TRAP NETTING

Trap netting was used as the primary method to target juvenile and adult whitefish species expected to be present within Sidney Lake. This method has not been used extensively in the Yukon to date; however, it was chosen due to the potential to minimize fish mortalities and injuries compared to gillnetting. Limiting fish mortalities during the whitefish investigation was an important consideration for TTC during the planning of the study.

A total of 24 trap net sets were completed during the September fish sampling in Sidney Lake (Map 2). The trap nets are comprised of four sections, including the lead, heart/house, catch box or crib, and wings. Traps were set in various locations around the lake and were left to soak for approximately 24 hours. The lead is 45 m (150 feet) long and 1.8 m (6 feet) deep with 250 g weights spaced 81 centre intervals and black plastic floats with 482 g buoyancy spaced at 3 m intervals. The lead is tied off to shore such that the start of the lead is located as close as possible to the waters edge. When set, the lead extends perpendicular from the shoreline and is attached to the heart. The heart and house of the trap is designed to funnel the fish into the crib/catch box and has a roof to limit fish from swimming up and out of the trap. Once within the heart of the trap, fish swim through a tunnel (funnel shaped) and into the crib/catch box where they are unable to escape. Wings attach to either side of the trap head and when pulled taut, are situated at approximately a 45-degree angle to the lead. Anchors are attached to either wing and the catch box bridle (king anchor) and pulled taut to hold the trap and wings in place. The coarse mesh traps are constructed of 57 mm (2.25 inch) mesh on the lead and top/bottom of the house and heart with 44 mm (1.75 inch) mesh on the remainder of the head and crib/catch box. The fine mesh traps are constructed of 38 mm (1.50 inch) mesh on the lead and top/bottom of the house and heart with 19 mm (0.75 inch) mesh on the remainder of the head and crib/catch box. The third type of trap net used was constructed from 210/10 green knotless nylon material of 19 mm (0.75-inch) stretch mesh with dimensions measuring 2 m x 2m x 2m with 5 m long wings and a 50 m long tapered lead. This trap is intermediate in mesh size relative to the fine and coarse mesh traps (EDI Environmental Dynamics Inc. 2021). A summary of effort for each trap type is provided below in Table 1.

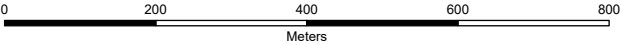
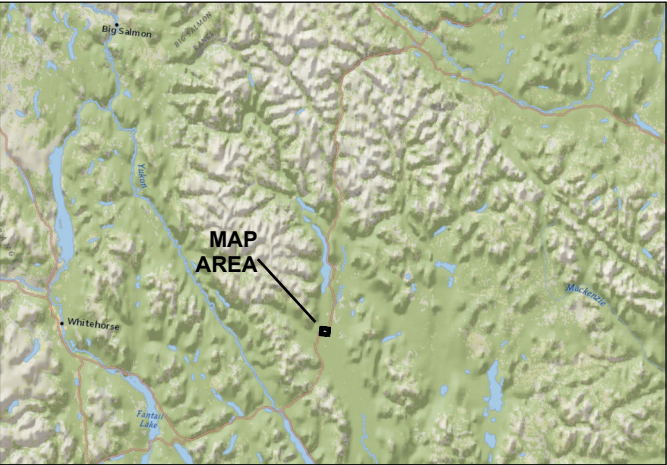
Information recorded for each trap set included: mesh type (coarse, fine) set and pull date and time, status at pull, length of leader in water, depth at start of leader, distance from leader start to shoreline, water depth at the trap heart, angle to shoreline, lakebed material, amount of cover present, surface water temperature, and weather/wind conditions. Trap set durations ranged from 19.3 to 23.9 hours with an average duration of 22.3 hours. Upon retrieval of the traps, fish were removed from the catch box, identified to species, and measured for fork length. Non-lethal aging structures (fin rays and/or scales) were collected from each individual prior to release.



Map 2 - Sidney Lake Trap Netting Sites

Legend

- Trap Netting Locations
- Primary Road



Map Scale = 1:10,000 (printed on 11 x 17)
Map Projection: NAD 1983 UTM Zone 8N

Data Sources

- Inset Basemap. National Geographic World Map: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
- Main Basemap. World Imagery (Clarity): Source: Esri, Maxar, Earthstar Geographics, IGN, and the GIS User Community
- Main Basemap. World Imagery: Maxar

Disclaimer

EDI Environmental Dynamics Inc. has made every effort to verify this map is free of errors. Data has been derived from a variety of digital sources and, as such, EDI does not warrant the accuracy, completeness, or reliability of this map or its data.

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Table 1. Summary of trap netting effort (fine mesh, coarse mesh, and intermediate mesh) in Sidney Lake, September 2023.

Site ID	Trap Soak Time (hours)		
	Fine Mesh	Coarse Mesh	Intermediate Mesh
TN-1 COARSE		19.3	
TN-2 FINE	19.7		
TN-3 COARSE		20.1	
TN-4 FINE	20.6		
TN-5 INTERMEDIATE			20.3
TN-6 COARSE		23.5	
TN-7 FINE	23.4		
TN-8 COARSE		23.1	
TN-9 FINE	23.1		
TN-10 INTERMEDIATE			22.7
TN-5 COARSE		23.9	
TN-1 FINE	23.4		
TN-4 COARSE		23.6	
TN-11 FINE	23.1		
TN-12 INTERMEDIATE			23.0
TN-3 COARSE-2		23.4	
TN-1 FINE-2	23.4		
TN-8 COARSE-2		21.9	
TN-13 FINE	22.2		
TN-14 INTERMEDIATE			22.1
ALL COMBINED	178.9	178.8	88.1

2.1.1 DATA ANALYSIS

To evaluate fish data collected in Sidney Lake length frequency distributions were developed for both lake whitefish and northern pike. Individual growth, based on length-at-age data can be useful information when developing stock assessments on which may eventually used for fishery management decisions. The most commonly used growth curve for length-at-age data is the Von Bertalanffy growth models (VBGM). For northern pike and lake whitefish, VBGM were fit to fork length (mm) data to investigate the rate of fish growth.

2.2 FISH HABITAT ASSESSMENTS

Fish habitat assessments were conducted to gain an understanding of fish habitat and note any obstructions to fish passage between Sidney Lake and the Nisutlin River. The outlet stream was walked by field crews over a two-day period, while aerial imagery was recorded for the entirety of the stream from the outlet of Sidney Lake downstream to the Nisutlin River via DJI Mavic mini drone. Field crews recorded information on stream morphology, visual observations of flow, and any potential barriers to fish passage.



2.3 TRADITIONAL KNOWLEDGE INTERVIEWS

Several local knowledge holders were interviewed in conjunction with TTC to gain an understanding of the presence of whitefish species in the Sidney Lake area, the status of the lake outlet and stream that connects to the Nisutlin River, historical activities, observations over time, harvest levels, general use of the area, and the presence of other fish species. This information was used in conjunction with the scientific data collected to document the current conditions in the project area to help determine what actions could be required for restoration.



3 RESULTS

3.1 TRAP NETTING

A total of 58 fish were captured in 20 overnight trap sets during sampling in September 2022. Set durations ranged from 19.2 hours to 25 hours with an average of 22.6 hours. Northern pike were the most frequently captured species with 37 individuals followed by lake whitefish with 21 individuals. Captured lake whitefish were all similar in length with no juveniles captured or observed during sampling (Figure 1). Various sizes of northern pike were captured with the majority being in the 450 mm to 600 mm fork length range, and a small number of larger individuals captured (Figure 2). Very few ($n=3$) juvenile pike were captured in the trap net sets and observed during the sampling event.

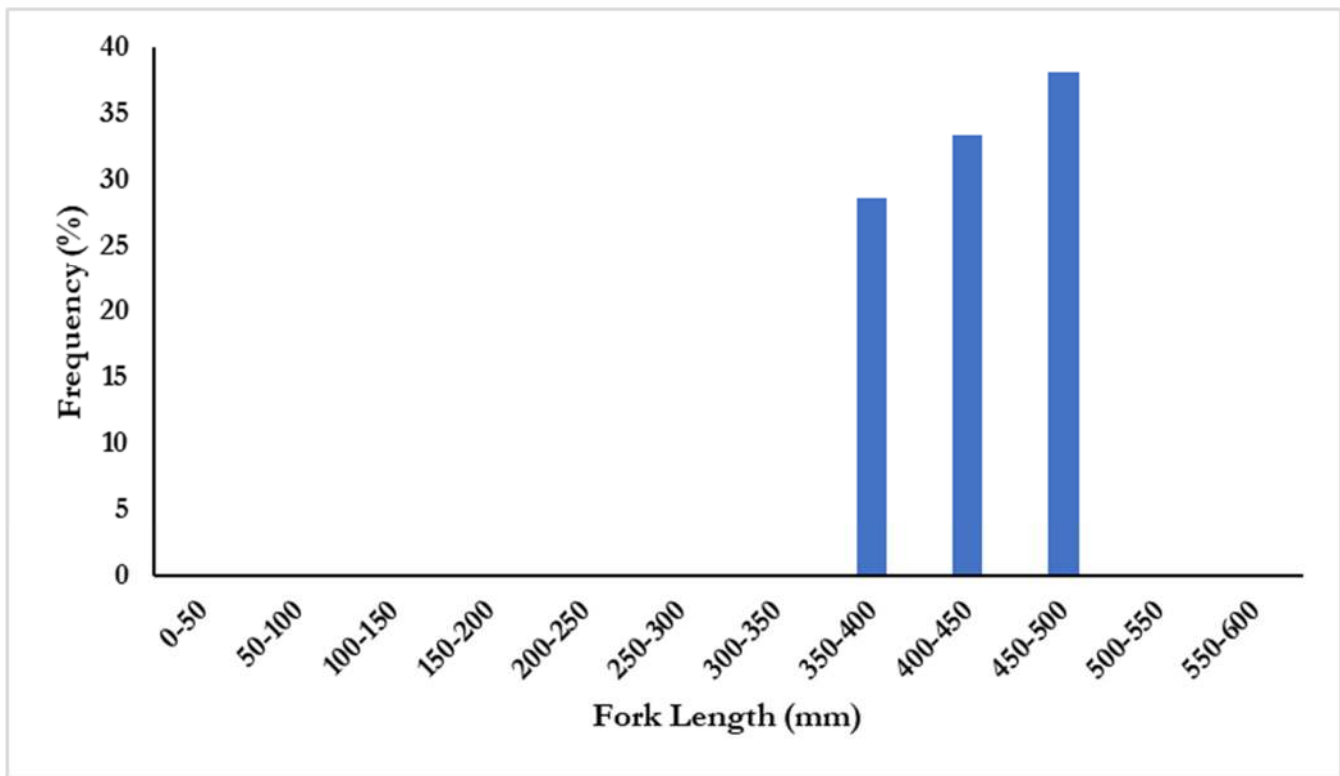


Figure 1. Length frequency histogram for lake whitefish captured in Sidney Lake in September 2022 ($n = 21$).

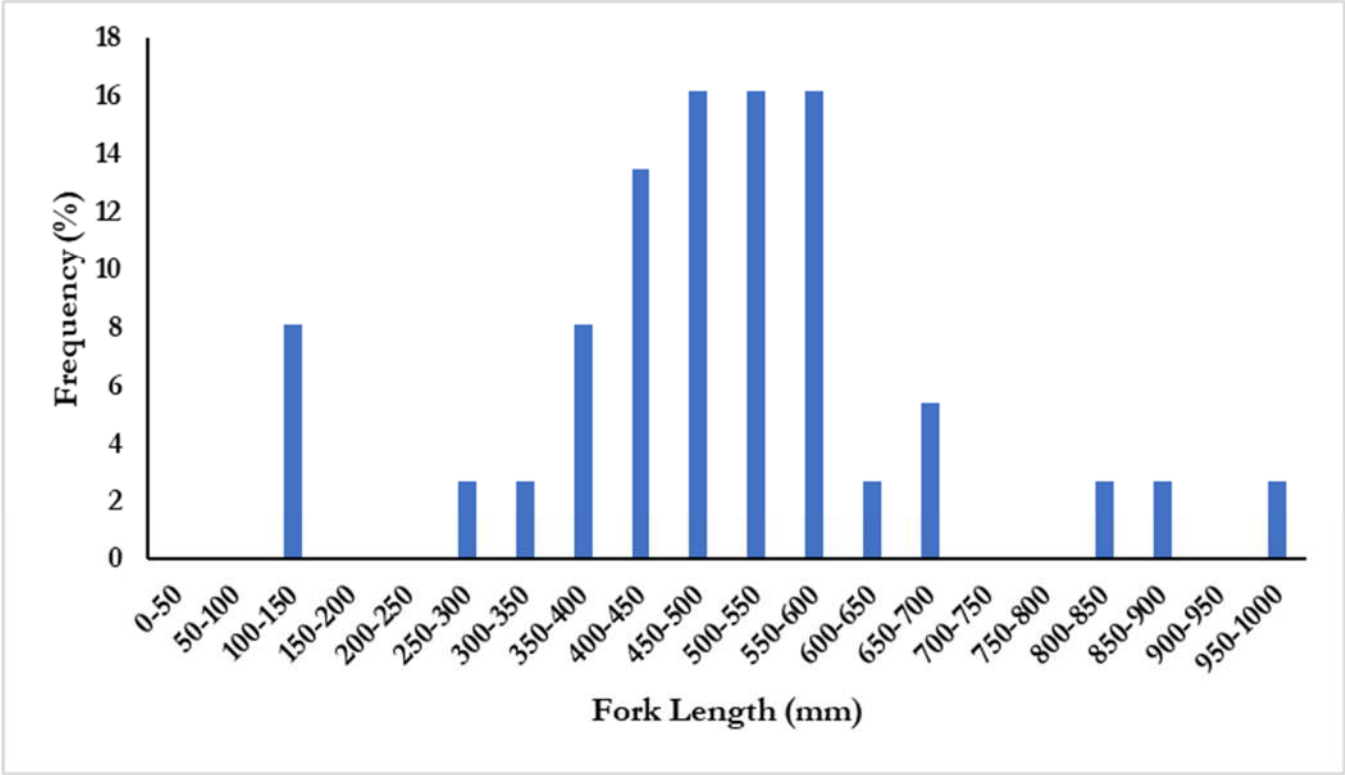


Figure 2. Length frequency histogram for northern pike captured in Sidney Lake in September 2022 (n = 37).



3.1.1 VON BERTALANFFY GROWTH MODELS

VBGM were fit to fork length (mm) data of variously aged northern pike and lake whitefish in Sidney Lake (2022). Nonlinear least square regression was used and parametrized for the VBGM: $L_t = L_{\infty} \times (1 - \exp(-k \times (t - t_0)))$, where L_t is the length at age t , L_{∞} is the asymptotic length, k is Brody's growth coefficient, and t_0 is the age at which length is 0. Parameters were initially approximated and then selected through an iterative process. Parameter values are provided for each species at each location with associated confidence intervals.

Table 2. Von Bertalanffy Growth Model parameter estimates for Northern Pike in Sidney Lake (2022) and Nisutlin Lake (2021), and Lake Whitefish in Sidney Lake (2022). Significant values (p -value < 0.05) are shown in bold.

VGBM Parameters	Ageing Method	n	Estimate	Std. Error	95% Confidence Interval	Test Statistic (t)	p -value
Northern Pike – Sidney Lake 2022							
L_{∞}	Scales	33	2057.81	1484.96	-974.88–5090.50	1.39	0.18
t_0	Scales	33	-1.02	1.29	-3.66–1.62	-0.79	0.44
k	Scales	33	0.05	0.05	-0.05–0.14	0.96	0.35
Northern Pike – Nisutlin Lake 2021							
L_{∞}	Fin Ray	86	921.39	45.66	840.76–1036.03	20.18	< 0.0001
t_0	Fin Ray	86	-0.90	0.19	-1.34–0.57	-4.83	< 0.0001
k	Fin Ray	86	0.18	0.02	0.13–0.22	8.43	< 0.0001
Lake Whitefish – Sidney Lake 2022							
L_{∞}	Fin Ray	19	545.54	179.37	165.30–925.78	3.04	0.01
t_0	Fin Ray	19	-4.27	8.28	-21.83–13.29	-0.52	0.61
k	Fin Ray	19	0.14	0.22	-0.32–0.60	0.64	0.53

3.1.1.1 Northern Pike

The VBGM for Northern Pike in Sidney Lake (2022) fit poorly, and none of the biologically relevant parameters (asymptotic length [L_{∞}], growth coefficient [k], and age at length 0 mm [t_0]) were statistically significant (Table 2). This was the result of a nearly linear relationship between (scale) age and fork length. One possible reason for this is that the maximum fork length is reached at ages older than northern pike caught in the current study (i.e., greater than 12 years old). These results are very different from the VBGM for northern pike in Nisutlin Lake (2021), where a clearer asymptote was identified from (fin ray) ages 10 to 16 (maximum fork length = 921.39 mm; Table 2). In this model, all biologically relevant parameters were statistically significant. The differences between VBGMs in Sidney Lake and Nisutlin Lake are not due to different ageing techniques. In fact, the relationship between fin ray ages and fork length for northern pike at Sidney Lake resulted in an exponential curve, which is farther from biological plausibility (Figure 3). The most likely explanation is that an insufficient number of older fish (> 12 years) were captured in Sidney Lake.

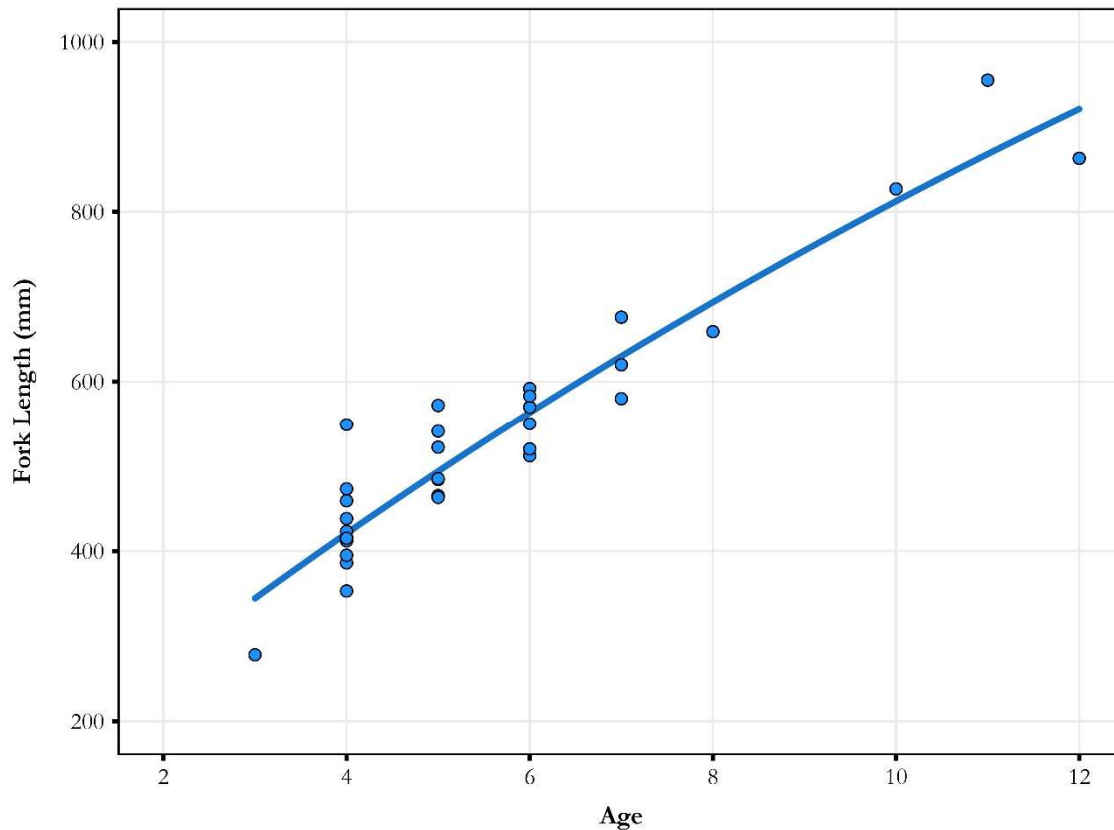


Figure 3. Von Bertalanffy growth model for northern pike captured in Sidney Lake during September 2022 (fin rays only; $n = 33$).

3.1.1.2 Lake whitefish

The VBGM for Lake Whitefish in Sidney Lake (2022) fit poorly, and only the asymptotic length (L_{∞}) was identified as statistically significant (Table 2). However, the confidence intervals for that estimate were very wide. Similar to the VBGM for northern pike in Sidney Lake, the VBGM for whitefish was fairly linear and did not identify a maximum fork length (Figure 4). The most likely explanation is that an insufficient number of older fish (> 13 years) were captured at Sidney Lake.

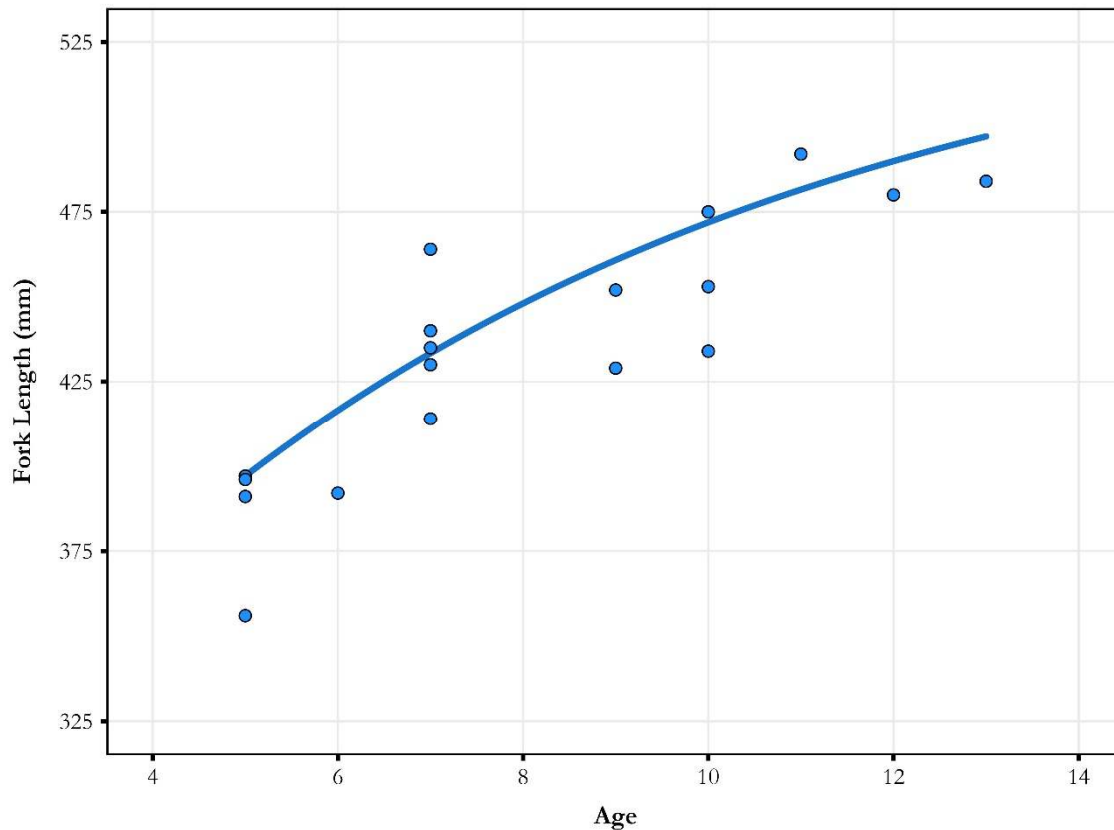


Figure 4. Von Bertalanffy growth model for lake whitefish captured in Sidney Lake during September 2022 (fin rays only; n = 18).

3.2 FISH HABITAT ASSESSMENT

The first 250 m of the outlet stream was walked by field crews on September 12, with the remaining stretch of stream was walked on September 16. General stream morphology included slow moving flow through a relatively undefined channel, overgrown with aquatic and terrestrial vegetation and instream woody debris. Approximately 700 m downstream from the outlet of Sidney Lake field crews observed an old beaver dam about 15 m wide and 1.5 m in height (Photo 1). Observations suggest that the dam has been inactive for a number of years as there was terrestrial vegetation growing from the dam walls and no signs of recent beaver activity.



Photo 1. Beaver dam approximately 700 m downstream of the Sidney Lake outlet.

Immediately below the dam, flow was confined to a small channel with various pockets of exposed cobble approximately 4 cm in diameter on the banks of the stream (Appendix Photo 1). Pockets of exposed cobble suggest the stream has undergone change over time and/or has different levels of flow during certain times of the year. Below the cobble pockets, the stream shifts back to slow moving flow that was observed in the upper sections. Within this section are various stagnant pools. Field crews noted that the conditions in the pools were likely anoxic due to the presence of a strong odour of decaying organic matter. Below the stagnant pools, the stream flows through a large wetland with scattered mud flats and shallow pools (Photo 2). The stream channel in this section is characterised by narrow, meandering braids which converge at the southern end of the wetland, adjacent to the Nisutlin River. The stream then flows south through a forested area before connecting with the Nisutlin River. Recorded aerial imagery shows a more recently constructed beaver dam just before the confluence (Photo 3).

A number of barriers to fish passage occur along the outlet stream connecting Sidney Lake to the Nisutlin River. It is highly unlikely that fish passage would be possible through the inactive beaver dam 700 m downstream of the lake, during the flow levels observed by field staff in September 2022. The density of the dam from years of inactivity and terrestrial vegetation growth in addition to slow moving flow would limit the ability of fish to swim over and/or through the dam. However, if flow levels are higher during other times of the year it may be possible for fish to travel upstream of the dam. The stagnant pools located downstream of the inactive beaver dam would also prohibit fish passage. Heights of land between pools force the small amount of flow in the stream to go subsurface (Appendix Photo 3). Though like the beaver dam, it may be possible for fish to navigate these pools during higher flow events.



Photo 2. Outlet stream flowing through the wetland near the confluence with the Nisutlin River.



Photo 3. Confluence of the Sidney Lake outlet stream with the Nisutlin River. Note the beaver dam just before the last bend in the stream.

3.3 TRADITIONAL KNOWLEDGE INTERVIEWS

Four TTC citizens who frequent the Sidney Lake area were interviewed in February 2023. Several themes can be summarized from the information collected from the interviewed knowledge holders. Fishing on Sidney Lake normally occurred during the May long weekend while ice was still present. Large, healthy broad (dull nose) whitefish were caught (and occasionally in the outlet stream) along with northern pike and suckers, while arctic grayling was caught in the outlet stream. Knowledge holders also mentioned observations of eggs in captured female whitefish in the spring. Small fish and/or juveniles were not commonly seen, however some were observed in the channel that connects the back bay/outlet to Sidney Lake. Arctic grayling were historically very plentiful and with large “big blue” individuals commonly caught. Northern pike were historically in really good condition with lengths ranging from about 2 to 3 feet.

Historically, the outlet stream had a sandy, gravelly bottom at the outlet of Sidney Lake. Flow was higher in the spring and slow moving during the rest of the year, while the lower sections of the creek were always slow moving. Over time the channel became blocked by vegetation and beaver activity. Beaver activity was observed to be off and on over years spent in the Sidney Lake area by knowledge holders. There were several years where citizens that frequented the Sidney Lake area recommended the clean up of the outlet stream, and the need for beaver trapping in the area.

Additionally, knowledge holders noted that water levels in the lake have changed over time as they are higher now than in previous years. These observations are supported by historical aerial photos taken over the past seventy years. The water levels in the lake observed in aerial photos from 1973 were much different when compared to aerial photos taken 20 years later in 1993 (Photo 4). The channel connecting the back bay on the east side of Sidney Lake to Sidney Lake proper had a much more defined channel in the past compared to more recent years and these changes are even more prevalent when comparing the 1993 water levels to present day (Appendix Photo 2).



Photo 4. Aerial photos from 1973 (left) and 1993 (right) of the east back bay on Sidney Lake (Geo Yukon 2023). Note the changes in extent of water in the back bay and size of channel connecting the bay to the lake.



4 DISCUSSION

4.1 LAKE WHITEFISH

The low numbers of lake whitefish ($n=21$) captured, combined with the absence of juveniles suggests that there is no regular (i.e., year after year) recruitment occurring in Sidney Lake. Spawning habitat quality and abundance and food availability for juvenile whitefish have been identified as factors important to early lake whitefish survival (Fudge and Bodaly 1984, Taylor and Freeberg 1984, Loftus and Hulsman 1986). These factors, in combination with the limited access to Sidney Lake from the Nisutlin River (Section 3.2), are probable reasons for the low recruitment and lack of juveniles present during the 2022 sampling.

Spawning habitat selection by lake whitefish can vary among lakes, depending on the quality and quantity of available habitat. Optimal habitat for lake whitefish spawning consists of unfragmented, deeply layered substrate, with a combination of large, medium, and small cobble/gravel that consists of deep crevices for adequate egg cover (Whitaker and Wood 2021). This type of habitat is limited in Sidney Lake, where most of the lake substrate is comprised of soft sediment and limited sections of sand. As mentioned above in Section 3.3, there used to be a gravelly bottom substrate at the outlet of Sidney Lake. This may have provided some spawning habitat historically, however, as water flow out of Sidney Lake was reduced (due to beaver activity in the outlet channel), finer substrates that typically are taken out of the system at high flows would have settled out onto the gravels. This change would increase the embeddedness (i.e., the degree to which fine sediments surround coarse substrates on the surface of a streambed) of the substrate, and reduce interstitial space, which is important for lake whitefish spawning. Given this potential change, it is suspected that the lack of available spawning habitat is no longer providing suitable spawning habitat in Sidney Lake. These findings, combined with the inability for adults to move from the Nisutlin River into the lake, are probable causes for the apparent low density of lake whitefish present in Sidney Lake.

4.2 NORTHERN PIKE

Of the northern pike caught in Sidney Lake, most were found to be long and slender (Photo 5), possibly indicating that food availability is limited in Sidney Lake. As discussed above, juvenile lake whitefish presence was also very limited in Sidney Lake. As an important part of northern pike diet, the lack of juvenile whitefish may be influencing the growth of northern pike in Sidney Lake, however, this could not be confirmed.

Arctic grayling were historically found within Sidney Lake and the outlet stream (Section 3.3), but no Arctic grayling were caught in Sidney Lake during the sampling in 2022. Historically, Arctic grayling may have been an important food source for northern pike in Sidney Lake. The lack of fish barriers would have allowed for adults, sub-adults, and juvenile Arctic grayling to move into and out of Sidney Lake. The immigration and emigration of fish into Sidney Lake is currently hampered by the potential fish barriers identified during the fish habitat assessment in the outlet stream to the Nisutlin River. Arctic grayling has evolved many strategies to meet the needs of life in harsh and uncertain environments. During their spawning migration, they move into small clear tributary streams during or just after spring breakup. Prior to any influence on the outlet

stream from beaver activity, the outlet stream may have provided spawning habitat for Arctic grayling. The loss of this potential spawning habitat, as well as the inability for most age classes of fish to enter Sidney Lake may be the cause for the lack of Arctic grayling in Sidney Lake, and food source for northern pike.

The trap netting in Sidney Lake also indicated very little presence of juvenile northern pike. The reason for this is unknown currently, as there is likely spawning habitat available for northern pike in Sidney Lake. Future sampling events targeted at juvenile fish may be worthwhile to determine why juvenile northern pike presence is so low.



Photo 5. Northern pike captured during sampling in September 2022.



5 CONCLUSION

Fish and fish habitat assessments were successful in documenting current conditions in Sidney Lake and the outlet stream that connects the system to the Nisutlin River. Low lake and broad whitefish capture, lack of available spawning habitat and an absence of juveniles suggests there is a lack of recruitment of whitefish in the lake. The exact reason is currently unknown but is speculated to be a result of morphological change (due to changes in the outlet stream) in the lake over time and the reduction of available spawning habitat. Further, the inability of certain life histories to access the lake at certain times of the year may be influencing fish physiology (i.e., majority of northern pike were long and slender) and presence in Sidney Lake. VBGM models of northern pike and lake whitefish support this theory, as results of the model could be related to the seeming lack of available food in Sidney Lake.

Historical observations from knowledge holders suggests that the Sidney Lake area has undergone morphological change, and species of fish that were once in the lake and stream in the past are no longer present today. Recommendations of local knowledge holders who participated in the traditional knowledge interviews included removing beaver dams on a regular basis, investigating water inputs to Sidney Lake, and determining where broad whitefish go at different times of the year.

Recommendations for future work in the Sidney Lake could include:

- Conduct fish and fish habitat investigations during the spring to coincide the time when TTC citizens would frequent the Sidney Lake area in past years, and determine if flows could allow fish passage from the Nisutlin River to Sidney Lake,
- Conduct additional non-lethal (trap netting) sampling at different times of the year (i.e., after ice off and summer months), and
- Interview more local knowledge holders that frequent the Sidney Lake area to continue to increase historical knowledge of the area.



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APPENDICES



APPENDIX A PHOTOGRAPHS



Appendix Photo 1. Pocket of exposed gravel downstream of the inactive beaver dam on the Sidney Lake outlet stream on September 16, 2022.



Appendix Photo 2. East bay and upstream section of the outlet stream on September 12, 2022.



Appendix Photo 3. Stagnant pools separated by height of land downstream of the inactive beaver dam on the outlet stream on September 12, 2022.



Appendix Photo 4. Aerial view of a trap net set in Sidney Lake on September 12, 2022.



APPENDIX B FISH DATA



Appendix Table 1. Fish capture data from sampling in Sidney Lake in 2022.

Set ID	Fish ID	Species	Condition	Fork Length	Weight	Ageing Structures Collected	Age (Fin ray)
TN-1 Coarse	1	NP	Released (good)	570	1170	SC, FR	6
TN-1 Coarse	2	NP	Released (good)	522	800	SC, FR	6
TN-1 Coarse	3	LW	Released (good)	365	630	SC, FR	-
TN-2 Fine	4	LW	Released (good)	435	990	SC, FR	-
TN-3 Coarse	5	NP	Released (good)	659	2180	SC, FR	7
TN-3 Coarse	6	LW	Released (good)	475	1890	SC, FR	10
TN-3 Coarse	7	LW	Released (good)	450	-	none	-
TN-3 Coarse	8	LW	Released (good)	429	1320	SC, FR	9
TN-3 Coarse	9	NP	Released (good)	416	450	SC, FR	3
TN-3 Coarse	10	NP	Released (poor)	327	-	none	-
TN-3 Coarse	11	NP	Released (good)	423	520	SC, FR	3
TN-4 Fine	12	LW	Released (good)	440	1130	SC, FR	7
TN-4 Fine	13	NP	Released (good)	549	1010	SC, FR	5
TN-5 Intermediate	14	LW	Released (good)	392	780	SC, FR	6
TN-5 Intermediate	15	NP	Released (good)	955	7150	SC, FR	9
TN-5 Intermediate	16	NP	Released (good)	484	720	SC, FR	4
TN-5 Intermediate	17	NP	Released (good)	485	850	SC, FR	4
TN-5 Intermediate	18	NP	Released (good)	124	-	none	-
TN-6 Coarse	19	NP	Released (good)	473	500	SC, FR	4
TN-7 Fine	20	LW	Released (good)	397	720	SC, FR	5
TN-7 Fine	21	LW	Released (good)	435	980	SC, FR	7
TN-7 Fine	22	NP	Killed (retrieved dead)	116	-	none	-
TN-8 Coarse	23	LW	Released (good)	452	1530	SC, FR	9
TN-8 Coarse	24	LW	Released (good)	492	1560	SC, FR	11
TN-8 Coarse	25	NP	Released (good)	541	1030	SC, FR	6



Set ID	Fish ID	Species	Condition	Fork Length	Weight	Ageing Structures Collected	Age (Fin ray)
TN-8 Coarse	26	LW	Released (good)	391	930	SC, FR	5
TN-8 Coarse	27	NP	Released (good)	592	1120	SC, FR	6
TN-8 Coarse	28	NP	Released (good)	572	1170	SC, FR	6
TN-8 Coarse	29	NP	Released (good)	512	830	SC, FR	5
TN-8 Coarse	30	NP	Released (good)	863	6050	SC, FR	10
TN-8 Coarse	31	NP	Released (good)	386	-	SC, FR	2
TN-9 Fine	32	NP	Released (good)	620	1570	SC, FR	7
TN-9 Fine	33	NP	Released (good)	465	710	SC, FR	4
TN-10 Intermediate	34	NP	Released (good)	459	570	SC, FR	3
TN-10 Intermediate	35	NP	Released (good)	104	-	none	-
TN-5 Coarse	36	NP	Released (poor)	353	280	SC, FR	2
TN-5 Coarse	37	NP	Killed (retrieved dead)	278	130	SC, FR	2
TN-1 Fine	38	LW	Released (good)	480	1560	SC, FR	12
TN-1 Fine	39	LW	Released (good)	434	890	SC, FR	10
TN-1 Fine	40	LW	Released (good)	464	980	SC, FR	7
TN-1 Fine	41	LW	Released (good)	484	1290	SC, FR	13
TN-4 Coarse	42	LW	Released (good)	414	1010	SC, FR	7
TN-11 Fine	43	NP	Released (good)	580	1120	SC, FR	6
TN-12 Intermediate	44	NP	Released (good)	583	1210	SC, FR	6
TN-3 Coarse (2)	45	NP	Released (good)	412	410	SC, FR	4
TN-3 Coarse (2)	46	NP	Released (good)	395	330	SC, FR	3
TN-3 Coarse (2)	47	NP	Released (good)	676	2200	SC, FR	6
TN-3 Coarse (2)	48	NP	Released (good)	438	550	SC, FR	4
TN-3 Coarse (2)	49	NP	Released (good)	520	790	SC, FR	5
TN-1 Fine (2)	50	NP	Released (good)	520	770	SC, FR	6
TN-8 Coarse (2)	51	LW	Released (good)	453	1280	SC, FR	10
TN-8 Coarse (2)	52	LW	Released (good)	430	950	SC, FR	7
TN-8 Coarse (2)	53	LW	Released (good)	396	820	SC, FR	5



Set ID	Fish ID	Species	Condition	Fork Length	Weight	Ageing Structures Collected	Age (Fin ray)
TN-8 Coarse (2)	54	NP	Released (good)	550	990	SC, FR	5
TN-8 Coarse (2)	55	LW	Released (good)	356	600	SC, FR	5
TN-8 Coarse (2)	56	NP	Released (good)	415	430	SC, FR	3
TN-13 Fine	57	NP	Released (good)	463	410	SC, FR	4
TN-14x	58	NP	Released (good)	827	4430	SC, FR	9