Spawning Assessments of Rainbow Trout in Four Tatlatui Park Lakes

By

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Abstract

During August 11-18, 2001, rainbow trout spawning assessments were conducted in tributaries to four lakes in Tatlatui Park to determine if rainbow trout spawning occurs within cooler inlet streams, as well as warmer outlets to the large lakes above Tatlatui Lake. A total of 29 sample sites on 14 streams resulted in a total of 123 rainbow trout being sampled. Sampled streams with temperatures greater than 11º had juvenile rainbow trout while the absence of juvenile trout in sampled streams that had temperatures of less than 11ºC indicates that stream temperature is a limiting factor. During the survey 0+ rainbow trout fry (mean length of 33 mm) with visible egg sacs were beginning to emerge at Stalk Creek (inlet to Kitchener Lake), the outlet of Lower Stalk lake, and Rognass Creek (outlet of Kitchener Lake), all of which had temperatures between 15-18º C.

As a result of our findings, there is an increased concern over the affects of angling pressure and wading in areas where the late emerging fry were noted. Timoshina (1972), Stonecypher et al. (1994), Dodge et al. (1971), Johnson et al. (1989) and Hubert (1995) have all shown that delayed embryonic development as a result of cold temperatures results in high mortality of eggs. Roberts and White (1992) report that mortality rates of trout eggs are as high as 96% when redds are waded upon twice a day.

To ensure that the reproductive capacity of Tatlatui rainbow trout is managed correctly it is recommended that key spawning areas be spatially delineated and temporally characterized, to facilitate management decisions.

Acknowledgements

The Ministry of Water, Land and Air Protection biologists involved in the "Spawning Assessments of Rainbow Trout in Four Tatlatui Lakes" would like to thank; Bob Henderson of Tatlatui Wilderness Adventures Ltd. and staff for their great hospitality, valuable local knowledge, and support of the project, Altoff Helicopter Services Ltd., Jamie Alley, for providing technical support and an extra hand where needed, and finally the Habitat Conservation Trust Fund for funding the project.

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1.0 Introduction

Tatlatui Provincial Park is located 247 km north of Smithers (Figure 1), encompassing the Firesteel River watershed (105,829 ha). The park lies within the Polar climatic zone (Osmond-Jones et al, 1977), which consists of the boreal white spruce (BWBS), Engelmann spruce-subalpine fir (ESSF) and alpine tundra (AT) biogeoclimatic zones (Medinger and Pojar 1991).

The Firesteel River, above cascades located 32 km downstream of Tatlatui Lake, supports what are thought to be a unique and potentially vulnerable monoculture population of rainbow trout (*Oncorhynchus mykiss*). Studies indicate that this population belongs in the "colonized–North Coast" phylogenetic group, (McCusker et al 2000), which is thought to have originated from the Queen Charlotte Island refugia. The Firesteel River below the high gradient cascades supports a variety of fish species common to arctic drainages.

The primary recreational activities within the park boundaries are guided angling and hunting, with three guides utilizing the same fishing locations on a rotational basis. Through previous scale analysis (Osmond-Jones 1977) and conversations with the local guides, it is thought that rainbow trout populations in the park exhibit low growth rates, and it has also been speculated that rainbow trout recruitment is limited to lake outlet streams. Limited rainbow trout recruitment may make the existing fish population susceptible to hooking mortality or stress, and if recruitment is limited to outlet areas where angling is concentrated, impacts from wading may result in decreases in recruitment as angling pressure increases. Additionally, where seasonal temperatures are lower than normal, coupled with delayed freshet, year class recruitment failures are a possibility. Information important to understanding the ecology of this rainbow trout population is vital to the management of the park's recreational activities, and has yet to be resolved.

Between the periods of August 11-18, 2001, Water, Land and Air Protection fisheries biologists, with funding from Habitat Conservation Trust Fund (HCTF), completed surveys of potential rainbow trout spawning areas on inlets and outlets of Tatlatui, Kitchener, Stalk and Trygve lakes; the outlet of Tatlatui lake was not surveyed due to previously completed surveys. The primary objective of the surveys was to determine if the limiting factor to recruitment in inlets streams is stream temperatures. Electro-fishing, snorkelling, and aerial videography, were used to determine whether rainbow trout recruitment is occurring in the inlets to the lakes, to assess whether habitat would be suitable for spawning and rearing of juvenile rainbow trout, and to complete an inventory of key juvenile emergence and rearing areas.

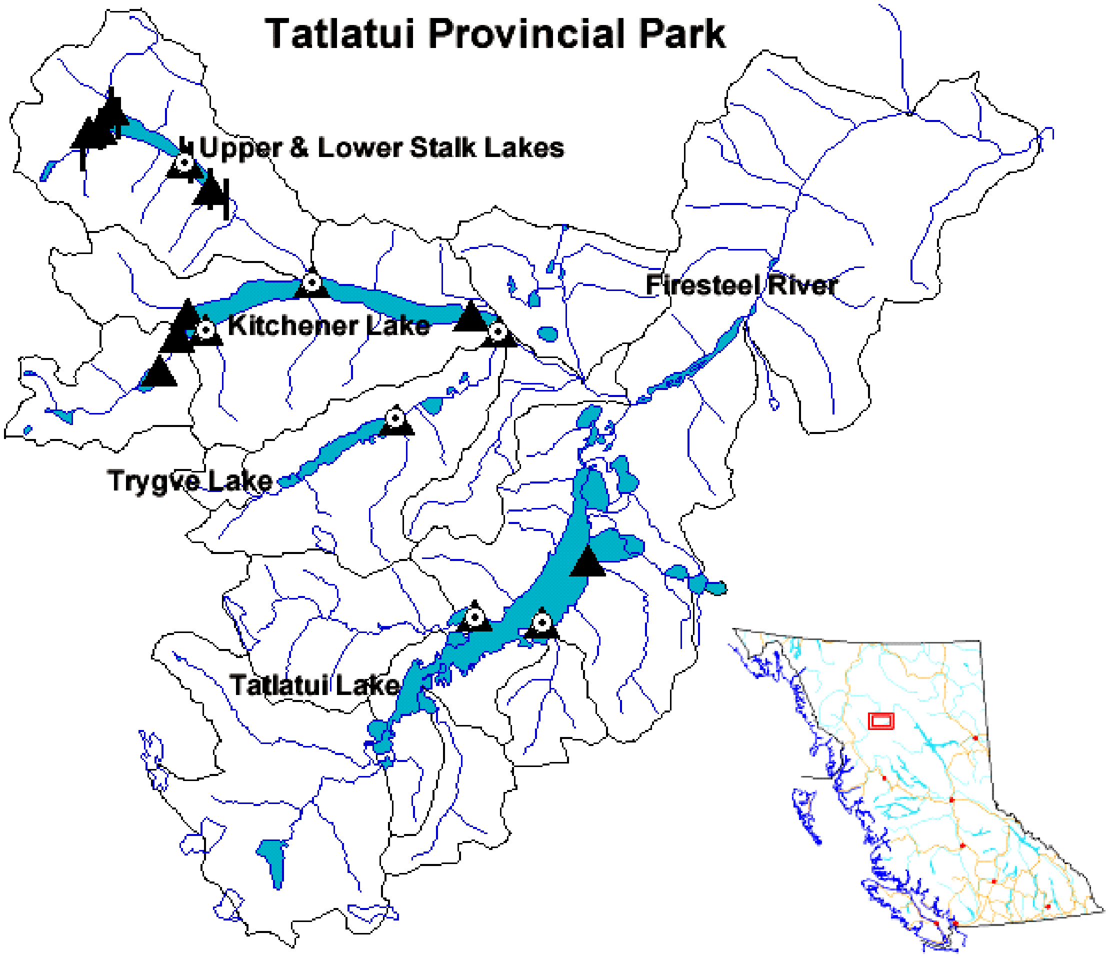


Figure 1. Rainbow trout sample locations within Stalk, Trygve, Kitchener, and Tatlatui Lakes. ▌snorkel sites, ▲ electrofishing, Circle with dot are angling locations.

2.0 Assessment Methods

Pre-field activities involved reviewing previous Tatlatui Park fisheries information (Osmond-Jones et al. 1977) and maps to; identify key tributary systems, assess gradient criteria, and develop a general workplan to economize on helicopter travel and focus efforts on areas that may have a higher probability of supporting rainbow trout.

Each selected stream was initially surveyed from the air and a video record was made. This facilitated the determination of the upstream extent of potential spawning and rearing habitat, and also provided a record of any potential barriers, or limiting factors to production. All sample sites and potential fish barriers were geo-referenced with a Garmin™ XL 12 channel GPS, and later plotted using desktop GIS tools. Each stream that was selected as a potential spawning system was then walked to visually assess and note potential spawning and rearing habitat prior to electro-fishing, and to determine general channel stability.

To determine if rainbow trout were using the selected tributaries for spawning, surveys for juvenile rainbow trout were conducted using a Smith-Root 12B-POW electroshocker. Electro-fishing efforts were primarily directed towards the main stream channel, channel margins, off-channel ponds, and side-channels of inlets and short streams between lakes. Shocking effort and settings were recorded at each site. The amount of effort was dictated primarily by the presence of usable habitat; efforts were made to ensure that a minimum of 100 linear metres was shocked at each site, and extended for another 100 metres if no fish were caught.

Single pass snorkel surveys were used to determine presence-absence of rainbow trout on larger streams that had water clarity greater than 2 metres; channel widths were not measured on site, and expansion factors for population estimates were not determined for this survey. Angling gear was utilized to collect age and length data from adult rainbow trout congregating at major stream outlets and inlets, and to visually assess if the fish at stream mouths were post-spawning adults that may have recently dropped into the lake from the stream.

At sites where surveys were conducted, stream temperatures were noted, site locations were geo-referenced by GPS, notes on habitat where captured using digital voice recorder and later transcribed to paper; present flow conditions, and vegetation types were also noted.

All fish sampled were anesthetised using a clove oil: ethanol ratio of 1:10, mixed with water at a concentration of 40mg/L (Anderson et al 1997). Fish were measured for length to ± 1 mm, and weighed to ± 0.1grams with an Ohaus® Model CT 600™ electronic balance. Scales were taken from a sub-sample of fish and aged by Birkenhead Scale Analyses.

3.0 Results

Within 14 streams, a total of 29 sample sites were sampled for fish presence using angling, electrofishing, snorkel methods, or a combination thereof (Table 1). A total of 123 rainbow trout out of 183 observed fish were sampled (Table 2). According to aging analysis results, fish sampled ranged from age 0+ to age 6+; summary statistics for each age are presented in Table 2. Length frequency histograms (Figure 2) for pooled data show the distribution of all fish sampled. The data presented in Figure 3 show all 0+ data (3A) from sampled fish compared to data from electrofished young of the year that were in the sac-fry stage(3B). Figure 3A also shows the range of lengths for 0+ rainbow trout in the sample data, illustrating the difficulties of providing accurate scale analysis where scale formation is delayed due to late emergence of rainbow trout fry, or where growth is very slow, causing crowding of circuli and making annuli distinction difficult. Length frequencies by age are presented in appendix III**.** Log transformed length plotted as a function of age indicates a positive relationship (R^2 = 0.8975), but a considerable amount of overlap of lengths between age classes 0+ and age 1+, and age 3+ to age 6+ (Figure 4) suggests that seasonal growth is variable, or that larger samples are required.

A total of 5 streams (sample sites STK_EL2, STK_EL4, KIT_EL5, KIT_EL6 and TRY_EL1) were confirmed as supporting spawning activities based on the presence of age 0+ rainbow trout. Unnamed stream at site TAT_EL3 was 14ºC at the time of survey and had an abundance of juvenile rainbow trout with 7 sampled fish aged at 0+ and one aged at 1+ (most likely 1+ and 2+), indicating a high likelihood that this stream supports a spawning run. Results from unnamed stream "Airplane Bay" at site TAT_EL2 are inconclusive. The stream was 11ºC at the time of survey, appears to have good rearing and spawning habitat, and 1+ juvenile rainbow trout were observed at the mouth. It may be possible that "Airplane Bay" stream supports a spawning run that exhibits a slightly later emergence than the other streams, or more likely, provides fry recruitment during warmer years. The remaining 7 streams where sampling was conducted are considered to be too cold to support spawning activities.

In addition to sites sampled, the remaining inlets along each of the lakes were viewed by helicopter, and based upon limiting factors such as high glacial turbidity, lack of suitable spawning substrate or partial and full barriers, were determined to have a low probability of being rainbow trout spawning streams. If aerial surveys were inadequate to determine whether a stream would support fish, ground surveys were undertaken to confirm observations.

Table 1. Summary of catch results for electrofishing, snorkelling, and angling.

Location	Effort	Temp ºC	No of Fish	Life Stage	Comments
HEW_EL 1		~10	0		
HEW_EL 2		~10	0		
STK_EL 1		~14			
STK_EL 2	394 sec	14	13	Juvenile	
STK_EL 3	124 sec	14	3	Juvenile	Lower Stalk Lake shore
STK_EL 4	394 sec	15	19	Juvenile	Stream margins
KIT_EL 1	599 sec		2	Immature	1 fish from lake
KIT_EL 2	289 sec	16	2	Juvenile	Off-channel pond
KIT_EL 3	216 sec	7	0		
KIT_EL 4	170 sec	8	0		Lakeshore backwaters
KIT_EL 5	327 sec	15	13	Sac-fry	Side channel to Stalk Cr
KIT_EL 6	399 sec	16	16	15-0+, 1- 1+	Caught in shallow riffles.
KIT_EL 7	290 sec	15	5	Juvenile	Two ponds shocked
TRY_EL 1	143 sec	18	19	Juvenile 0+	Stream margins.
TAT_EL 1	259 sec	9	0		2- 6cm fish turned.
TAT_EL 2	254 sec	11	0		6 fish observed
TAT_EL 3	632 sec	14	9	Juvenile	1+ or 2+ juveniles
HEW_S1	2782 m	~10	12	Adults	Visibility < 2m
STK_S1	1186 m		14	7 juvenile/7adult	
STK_S2	500 m	14	7	Adults	Stream between Stalk Lk
STK_S3	873 m	14		Adults	Visibility > 2m
KIT_AG1		15	11	Adults	
KIT_AG2		8	3	Adult	Inlet mouth
KIT_AG3		16	4	Adults	
STK_AG1		14	13	Adults	
TAT_AG1		11	5	Adults	
TAT_AG 2		9	6	Adults	
KIT_AG 6		16	5	Adults	Several released
TRY_AG1		18	8	Sub-adult	

EL = electrofishing, AG = angling, S = snorkelling.

Table 2. Summary statistics for pooled length data of Tatlatui rainbow trout sampled during Aug 11-18, 2001.

Age	0	1	2	3	4	5	6
Mean Length (mm)	32.85	64.78	136.50	311.00	362.80	381.43	432.17
SD	11.01	8.14	22.56	46.67	41.54	35.93	56.33
Number of Fish	73	18	12	2	5	7	6
SE	1.29	1.92	6.51	33.00	18.58	13.58	23.00

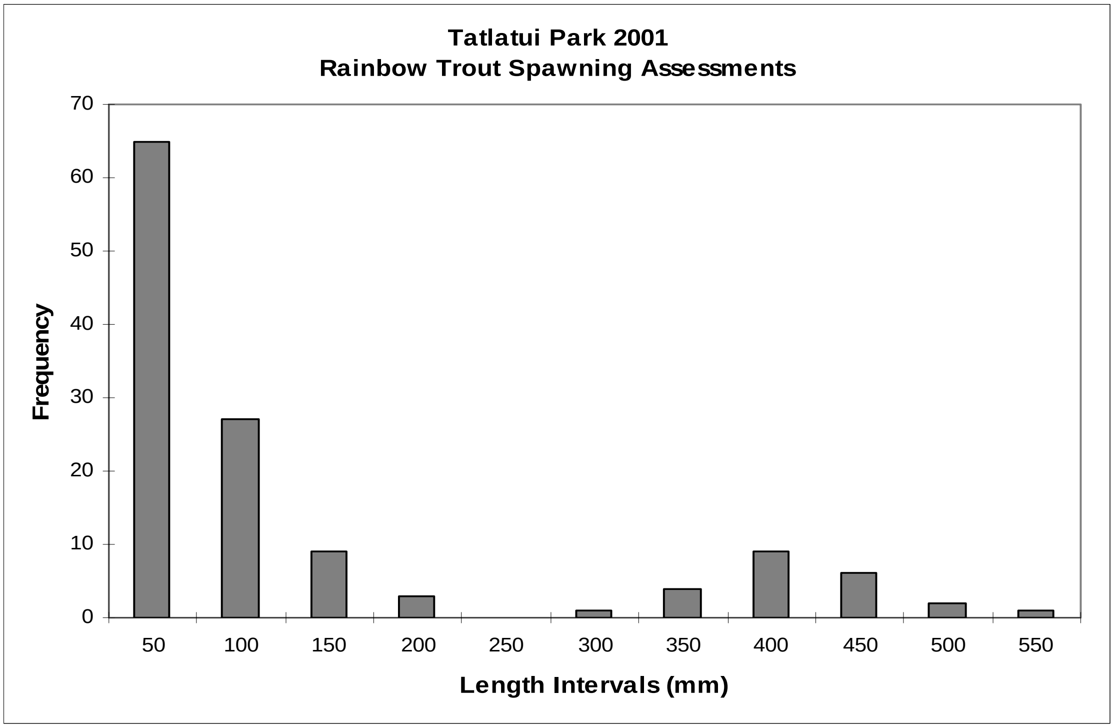
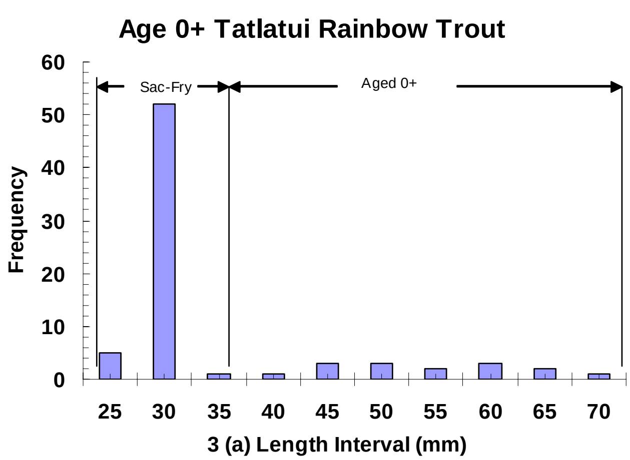


Figure 2. Length Frequency distribution of data pooled from all sites for electrofishing and angling in Tatlatui Park.



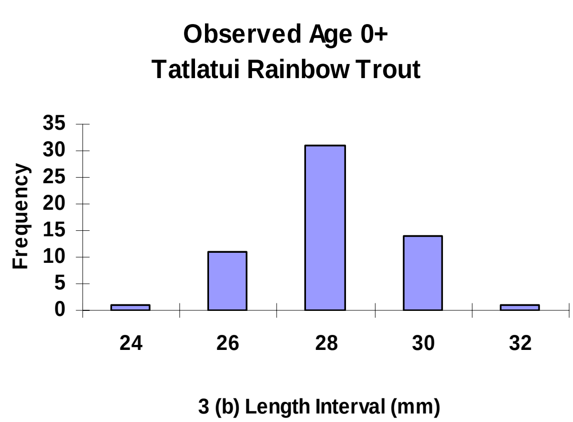


Figure 3. Age 0+ rainbow trout length frequencies showing observed and aged fish (Graph 3a) and length frequencies showing only observed sac-fry stage rainbow trout (Graph 3b).

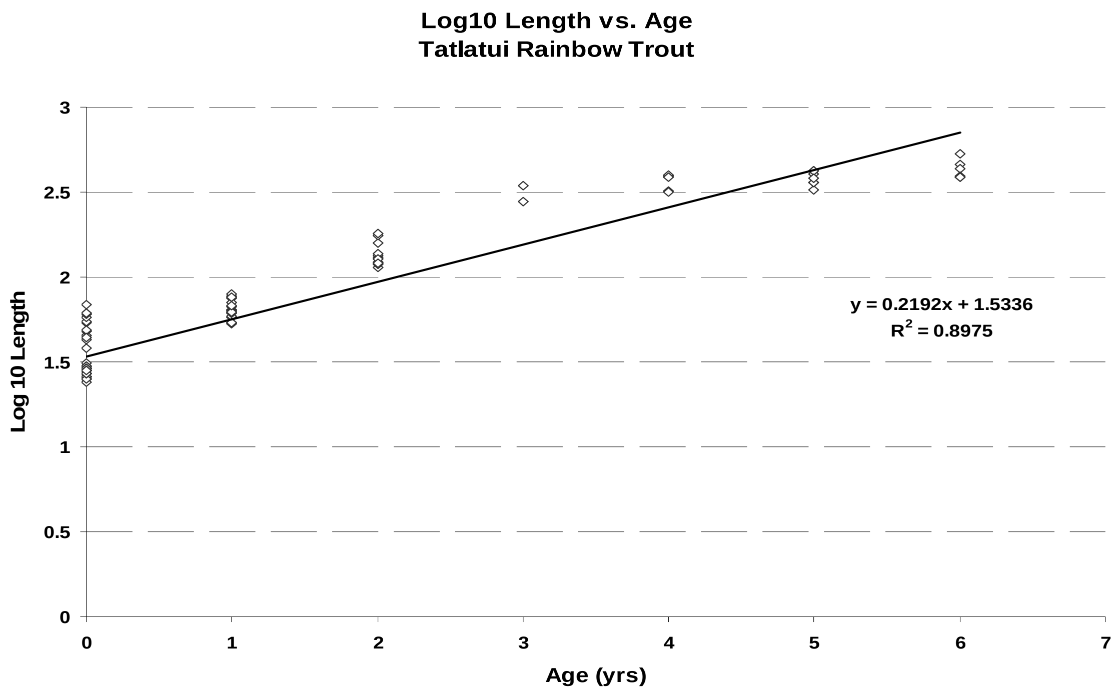


Figure 4. Log $_{10}$ Length at Age for Tatlatui Park rainbow trout sampled during August 11-18, 2001.

3.1 Stalk Lakes Sample Sites:

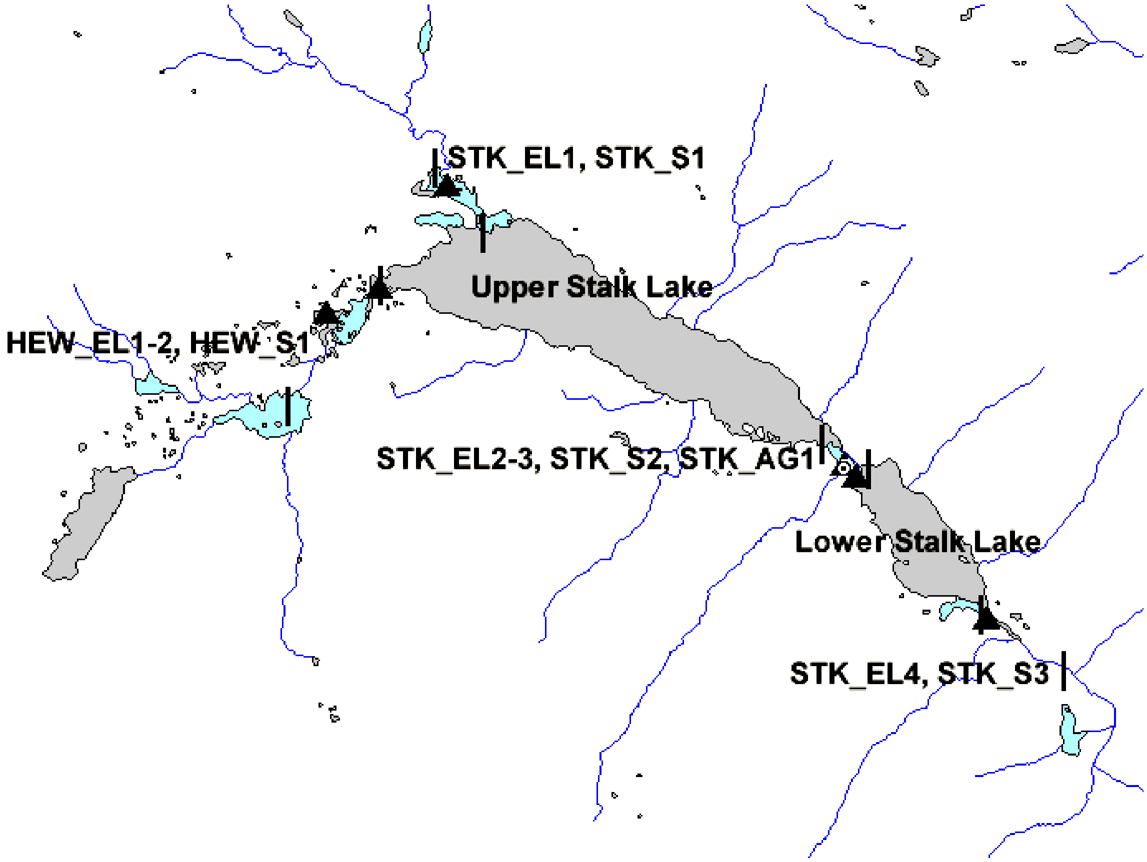


Figure 5. Stalk Lakes sample locations.

Upper Stalk Lake – Stalk Creek Inlet: 239-821700-57100-72500

Two inlets along upper Stalk Lake were electrofished and snorkelled (Figure 5, Table 1). Stalk site STK_S1 (Photo plate 1 and 2, Appendix I), located at the northwest corner of Stalk Lake was snorkelled for 1186 metres. Visibility while snorkelling was approximately 2 metres. The average channel width through the surveyed reach, discounting off-channel ponds, is 8.2 metres, ranging from 3.6 to 14.7 metres. The stream is generally characterized as having a low width to depth ratio, numerous undercut banks, deep pools, little to no instream large woody debris and very small mobile gravels along the lower reach. The occasional glacially deposited boulder is also noted as instream cover. Bank velocities during the survey appear to be moderate with evidence of localized hydraulic scour.

During the swim, 7 juvenile rainbow trout, estimated age 2+ (100-120 mm) were observed in side channel habitat with little to no flow. Seven adult rainbow trout were observed in the main stream channel (Table 1). Electrofishing (STK_EL1) was conducted along the inlet mouth with no success. Water temperatures in the side channels were approximately 14º C, which was warmer than the mainstem.

Hewett Creek: 239-821700-57100-96600

Hewett Creek (Figure 5), located along the western corner of upper Stalk Lake, was surveyed by snorkelling over a length of 2,782 metres (HEW_S1), and electrofished at sites HEW_EL1 and 2 (Photo plates 3 and 4, Appendix I).

The average channel width through the surveyed reach is 6.7 metres, ranging from 2.2 to 23.3 metres. Several braided sections were noted through the surveyed reach. The water visibility at the time of survey was initially estimated to be 2 metres but deteriorated to less than 2 metres as a result of disturbance of sediment by swimming activities; water temperatures were estimated to be around 10-12ºC.

Snorkel surveys resulted in 0 juvenile rainbow trout and 12 adult rainbow trout ranging from 20-50 cm (average 35-40 cm) being counted over 2,783 meters. Most adult fish noted were encountered in the steeper cobble-boulder section of the surveyed reach. No rainbow trout were noted in the lower section of the snorkel survey, despite having good pool habitat with the occasional large boulder and an abundance of undercut banks.

Electrofishing at two sites resulted in 0 fish being captured. HEW_EL1 was characterized as off-channel pond habitat that was connected to the main channel (Figure 5). In relative terms, water temperatures were generally warmer in the off-channel ponds as compared to the stream temperatures. Electrofishing at site HEW_EL2, the mouth of the inlet, resulted in no fish being captured. The stream mouth was characterized as being a shallow depositional zone of fine sands and silt. The channel at this point was very shallow, with some braided sections as the stream entered the lake.

Lower Stalk Lake: 239-821700-57100-72500:

Sites (STK_S2, STK_AG1, STK_EL2-3), located at a 500 metre section of stream between upper and lower Stalk Lake were snorkelled, angled and electrofished (Figure 5).

The average channel width through the surveyed reach was 37.2 metres, ranging from 15.8 to 76.6 metres Water visibility at the time of the survey was greater than 2 meters. The water temperatures at the time of survey was 14º C.

Snorkel surveys resulted in 7 adult and 0 juvenile rainbow trout observed over 500 metres of mainstem. The adult rainbow trout lengths were estimated to be 30-50 cm, with a 35 cm average length. The upper portion of the swim resulted in low densities of trout, increasing at localized areas of increased gradient where substrate changed from sand to cobble, or cobble-gravel. The highest densities of fish were located at the point where the stream entered the lower lake. The fish at the lake mouth were not included in the snorkel counts. It was also noted that numerous fish at this site were infested with what appeared to be *Salmincola spp* parasites.

Angling (STK_AG1) was conducted over the same stretch of water that was snorkelled as well as the stream mouth, resulting in 13 adult rainbow trout being captured. The average size and age of fish captured by angling was 394.5 mm (range 278-530 mm) and 5+ (range 3+ to 6+) respectively.

Electrofishing was conducted at two sites (STK_EL2 and STK_EL3). Site STK_EL2 was located along a small side channel adjacent to the snorkel site. The site was characterized as a shallow channel having mixed gravel and sand substrate, moderately slow flows, and a small beaver dam (Photo Plate # 5, Appendix I). Sampling efforts were focused above and below the beaver dam, with the beaver dam acting as a stop net; the majority of fish caught were in close proximity to the dam.

At STK_EL2, a total of 13 juvenile rainbow trout were captured (Photo Plate # 7, Appendix I). The average length and weight of fish was 67 mm (48-121 mm) and 4.2 grams (1-20.5 g) respectively. Aging results indicate 8 of the 13 fish captured were 1+, 3 were 0+, one 2+, and one not aged. The aged 0+ fish sampled were larger (mean length 55.3mm) than the sac-fry sampled at the downstream site (STK_EL4), or at the other sites, suggesting that these fish were 1+ and that scale analysis does not allow for detection of the first annuli after cold, late freshets. Alternatively, there may be a remote chance that spawning and fry emergence at this site is earlier than the other sites and exhibit growth advantages.

At STK_EL3, (Photo Plate # 6, Appendix I) sampling efforts were directed along the lake shore where the stream entered lower Stalk Lake. Three rainbow trout were sampled at STK_EL3, with the average length and weight being 61mm (53-68mm) and 2.6 (1.9-3.3g) grams respectively.

Lower Stalk Lake Sites: Stalk Creek: 239-821700-57100-72500:

At the outlet to lower Stalk Lake, snorkel surveys (STK_S3) were conducted over 873 m (Table 1, Figure 5, Photo Plate # 8, Appendix I), and electrofishing (STK_EL4) was conducted along the outlet stream margins that were too shallow for snorkelling.

The average channel width, through the surveyed reach is 22.1 metres (14.6 to 33.3). At the time of survey the water temperature was 14-15º C, and water visibility was greater than 2 metres. The surveyed reach is characterized by mixed gravel-cobble substrate covered in moss and trailing filamentous algae. The stream gradient starts as a broad flat section increasing to approximately 1% as the stream width became more confined and the channel morphology shifted to riffle-pool.

Snorkel surveys resulted in 7 adult and 0 juvenile rainbow trout being counted. A considerable amount of quality fish habitat was noted as being vacant during the swim; only the prime feeding areas were occupied by trout.

Electrofishing along shallow stream margins of the outlet resulted in 19 rainbow trout being caught and sampled. All fish were caught tight against the stream banks in shallow areas of emergent vegetation (*Carex spp*.). All but two fish were too small to take scale samples from; having recently emerged, they were still at sac fry stage, with a small number of fish starting to button up. Of the fish sampled, the average length of 0+ fish (n = 17) was 27 mm (23-29 mm); the 1+ age (n = 2) group was 54 and 63 mm, weighing 1.5 and 2.7 grams respectively.

3.2 Kitchener Lake Sample Sites:

A total of 7 electrofishing (KIT_EL1-7) and 4 angling (KIT_AG1-4) sites were sampled in 5 inlets and the outlet (Rognass Creek) of Kitchener Lake (Figure 6, Table 1).

Kubicek Creek: 239-821700-57100-97000:

Sample site KIT_EL 1 is the northernmost stream located at the west end of Kitchener Lake. The sampled reach was characterized as a clear, low velocity, meandering channel, flowing through a black spruce-meadow area with recent beaver activity. The substrate, comprised of small and medium gravels, appeared to be moderately mobile, with gravel deposits near the stream mouth.

At site KIT_EL1, 599 seconds of electrofishing resulted in two fish turned by electrofishing along the lower portion, one fish was captured at a small beaver dam location near the inlet to the lake (Figure 6, Photo Plates 9 and 10, Appendix I). The fish sampled was 118mm in length and weighed 13.3 grams. Scale analysis indicates that the fish was age 2+. No fish were captured in the upper portion of the site. No other fish were observed in the stream above the beaver dam area.

Unnamed Inlet 239-821700-57100-99500

Sample sites KIT_EL2 and 3 are located at the southwest end of Kitchener Lake, south of sample site KIT_EL1 (Figure 6, Photo Plate 11, Appendix I). The reach where sampling was conducted is characterized as a low gradient, meandering channel having clear deep flows, with numerous off channel ponds and side channels. The substrate consists of mixed sand and gravel, with the occasional cobble or boulder. Water temperatures in the off-channel habitat at the time of survey were 16ºC, the stream temperature above the ponds at KIT_EL 3 was 7º C. No limiting factors to spawning or rearing were noted in the surveyed reaches.

Electrofishing was conducted along a backwater pond (KIT_EL2), in which several juvenile fish were observed. The pond margins were too soft to wade, and with clear water, shocking observed fish was difficult. Two juvenile rainbow trout were captured with 289 seconds of effort directed at visible fish. One 138 mm, 30.7 gram fish was aged at 2+, the other, 38.8 gram fish was aged at 3+.

At site KIT_EL3, 216 seconds of shocking above and below a beaver dam resulted in no fish being captured or observed (Photo Plate # 13, Appendix I). This site was characterized by cold water temperatures (7º C), and a substrate comprised of small and medium gravel with a high content of fines (40-50%).

Unnamed Inlet 239-821700-57100-96600

Sample sites KIT_EL4 and KIT_AG2 are located along the southern shore at the west end of Kitchener Lake (Figure 6). The reach sampled is characterized as moderate gradient, with small to medium gravel substrate. At site KIT_EL4, 170 seconds of electrofishing effort (Table 1) along lakeshore backwaters resulted in no rainbow trout being captured. Angling at the lake mouth resulted in 3 adult rainbow trout (Photo Plate # 14, Appendix I) being captured (Table 1). The stream temperature at the time of survey was 8º C, indicating that this stream may be too cold during key rainbow trout spawning periods to provide a source of rainbow trout recruitment to the lake.

Stalk Creek (Kitchener Inlet): 239-821700-57100-72500

Sample sites KIT_EL5 and KIT_AG1 are located midway along the north shore of Kitchener Lake (Figure 6) where Stalk Creek enters the lake (Photo Plate # 17, Appendix I). The stream is characterized as being clear, moderately high velocity with gradients of approximately 1.5%. The substrate near the lake consists of small gravel, increasing to cobble and gravel where the gradient increases upstream. The lower portion of the surveyed reach appears to have good spawning and juvenile rearing habitat, while the habitat upstream of the surveyed reach has a greater proportion of rearing habitat, suitable to both adults and juveniles.

At site KIT_EL5, 327 seconds of electrofishing effort resulted in 12 age 0+ and 1 age 1+ rainbow trout being captured along small side channels entering Kitchener lake; mean length of pooled age 0+ fish was 33.8 mm (25-43 mm), while mean length of sac-fry was 26.1 mm (n =8). Angling at the lake mouth, to 100 metres upstream resulted in 11 adult rainbow trout being captured (Photo Plates 15 and 16, Appendix I, Table 1). Electrofishing was conducted along the stream margins and along shallow side channels that drained into the lake. The water temperature of the stream at the time of the survey was 15º C.

Rognass Creek (Kitchener Outlet):

Sample sites KIT_EL6 and KIT_AG 3 are located along the east end of Kitchener Lake (Figure 6,Photo Plate # 18, Appendix I). The outlet is characterized as a broad, shallow, low gradient and low velocity stream for the first 200 metres. The substrate consists of small gravels and sand, interspersed with cobbles and boulders along the deepest part of the channel. The stream margins are vegetated by emergent sedge (*Carex*) and *Equisetum* species, with small patches of aquatic vegetation. Downstream of the lake influenced reach, the gradient of Rognass Creek increases sharply, with the substrate size increasing to boulder cobble. Water temperature at the time of the survey was 16º C.

At site KIT_EL6, 399 seconds of electorshocking effort along the right stream margin, shallow riffles and small alcoves resulted in fifteen 0+ and one 1+ age rainbow trout. Angling in the mainstem of the outlet resulted in 4 adult rainbow trout being sampled. All of the 0+ rainbow trout were in the late sac fry stage with a mean length of 28.4 mm (27-30 mm), with a few fish showing signs of buttoning up, suggesting that fry emergence was just beginning. The age 1+ fish was 64 mm.

Unnamed Creek: 239-821700-57100-40700

Sample site KIT_EL7 is located along the north shore of Kitchener Lake, just west of Rognass Creek (Figure 6, Photo Plate # 19-20, Appendix I). Two small beaver dams are located near the stream mouth with no discernable flows upstream of the second dam. At the lake mouth the stream is noted as having very slow flows, dense aquatic vegetation over a bottom of silt and large basaltic cobble and boulders. Above the beaver dams, the stream meanders through a wetland area surrounded by spruce forest, and then dissipates into several small groundwater sources. Spawning habitat in this stream appeared to be non-existent, with rearing habitat being good, but access being limited by beaver dams. Water temperature at the time of survey was 15º C.

At site KIT_EL7, 290 seconds of shocking effort along areas that were safe to wade, resulted in 5 juvenile rainbow trout being captured at the mouth and above the beaver dam. One age 0+ (54mm), 3 age 1+ (54-74 mm) and 1 age 2+ (127 mm); the age 0+ fish is much larger than newly emerged fish caught at other sites suggesting an error in the scale analysis.

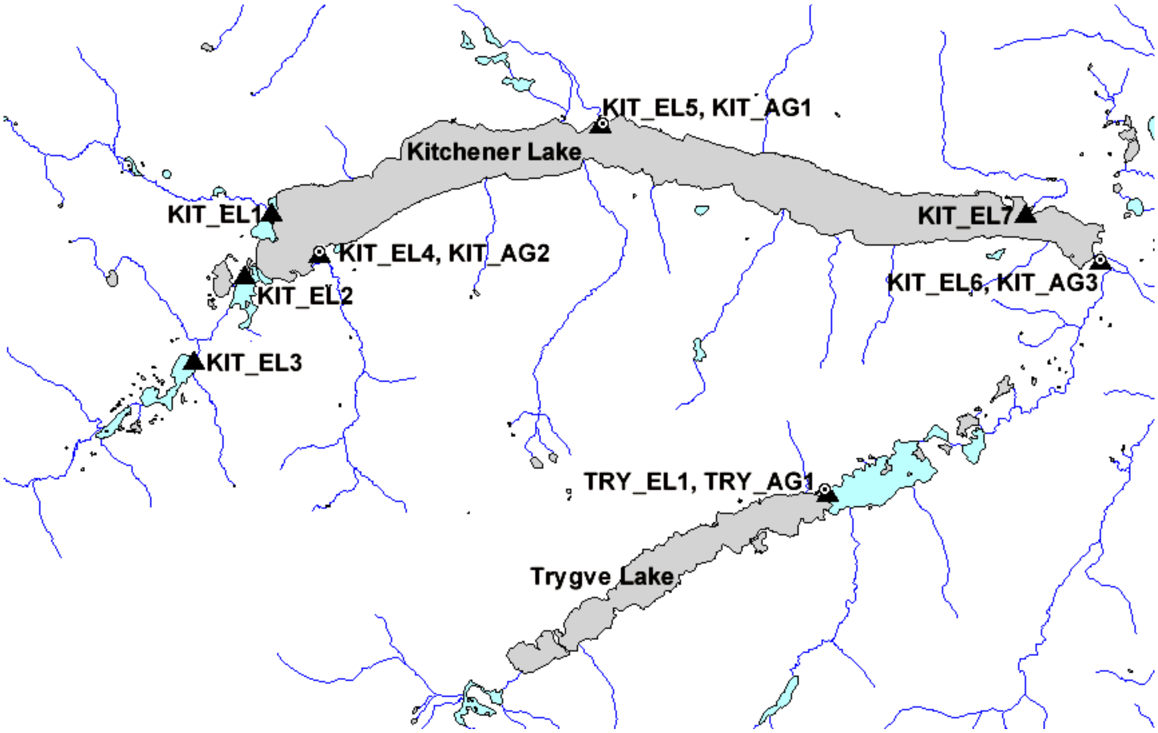


Figure 6. Kitchener Lake and Trygve Lake sample locations.

3.3 Trygve Lake Sample Sites:

Angling and electrofishing were conducted along the outlet of Trygve Lake; all inlets to Trygve lake were assessed to be either poor fish habitat due to glacial turbidity and cold water, or the inlet was found to be a seepage area (Figure 6).

Trygve Creek-239-821700-57100-32100:

Sites TRY_AG1 and TRY_EL1 are located at the outlet of Trygve lake (Figure 6, Photo Plates 21-22, Appendix I). The outlet is a medium sized, low gradient, very clear, meandering stream with good undercut bank, pool and boulder cover. Overhead cover from vegetation is minimal. Temperatures recorded at the time of survey were 18º C. Spawning or rearing habitat does not appear to be a limiting factor; both exist in abundance.

At the outlet of Trygve Lake (Trygve Creek), 8 sub-adult (age 2+) rainbow trout were captured by angling with very small flies; mean length and weight was 136.5 mm (114-181mm) and 28.5g (15.8-63.6) respectively. Due to the size of the stream, angling proved to be more effective than electrofishing for the larger fish that were in mid-stream pool and riffle habitat. Electrofishing along stream margins for a total of 143 seconds resulted in a total of 19 young of the year (0+) rainbow trout with a mean length of 27.9 mm (25-31 mm).

3.4 Tatlatui Lake Sample Sites:

Three electrofishing sites and two angling sites at three inlets were sampled for rainbow trout juvenile and adults (Figure 7). Of the three sites electrofished, juvenile rainbow trout were only caught at TAT_EL3 (Figure 7, Table 1), although juvenile fish (older than 0+) were observed at each sample location.

Unnamed Creek "Jenkins" 239-821700-80900:

Site TAT_EL1 and TAT_AG2 is located along the middle southeast side of Tatlatui Lake (Figure 7, Photo Plate # 23, Appendix I). This unnamed creek appears to have moderately good spawning and rearing habitat along the lower reaches, but compared to other inlets flowing into Tatlatui lake, the stream temperature at the time of survey was much cooler (9º C), suggesting that the thermal regime is not suitable for spawning fish. The stream has clear flows, a substrate of gravel and some cobble, and an abundance of large woody debris. Upstream fish migration is limited due to a full barrier upstream.

At TAT_EL1, 259 seconds of shocking from the stream mouth to approximately 100 metres upstream resulted in no fish being captured, with 2 fish of approximately 60 mm being turned near the stream mouth.

Angling (TAT_AG2) at the lake mouth resulted in 6 adults being captured with several other hooked and lost (Table 1). The average length captured was 392.2 mm (360-420 mm), with three fish aged at 5+, two at 4+, and one unable to be aged.

Unnamed Creek "Airplane Bay" 239-821700-88200:

Sample sites TAT_EL2 and TAT_AG 1 are located along the middle portion of the north shore of Tatlatui lake (Figure 7). This creek is characterized as a moderately large clear stream that becomes braided as it enters the lake. The depositional zone at the mouth of the stream indicates that the stream has moderately high bedload; large sediment deposits at the mouth and several small channels upstream until the gradient increases and the channel becomes more confined suggests that this reach is unstable.

Snorkel swims were not conducted along this creek. Water temperatures at the time of survey were 11º C, which are cooler than where recently emerged fry were found, but warmer than those streams were no fish were noted.

At TAT_EL2, 254 seconds of shocking resulted in no fish being captured, although 6 juvenile fish that were larger than 0+ fish caught at other inlets, were visually observed (Table 1) along shallow side channels of the stream near the lake mouth.

Angling at the lake confluence resulted in a total of 3 adult rainbow trout being captured with several other being hooked and lost. No fish were angled from the stream above the lake confluence.

The presence of what would appear to be age 1+ trout, and the moderate stream temperatures suggests that this stream may have rainbow trout recruitment. During this survey, emergence appeared to be occurring around 15º C, suggesting that this stream should be revisited at a later date when stream temperatures are warmer.

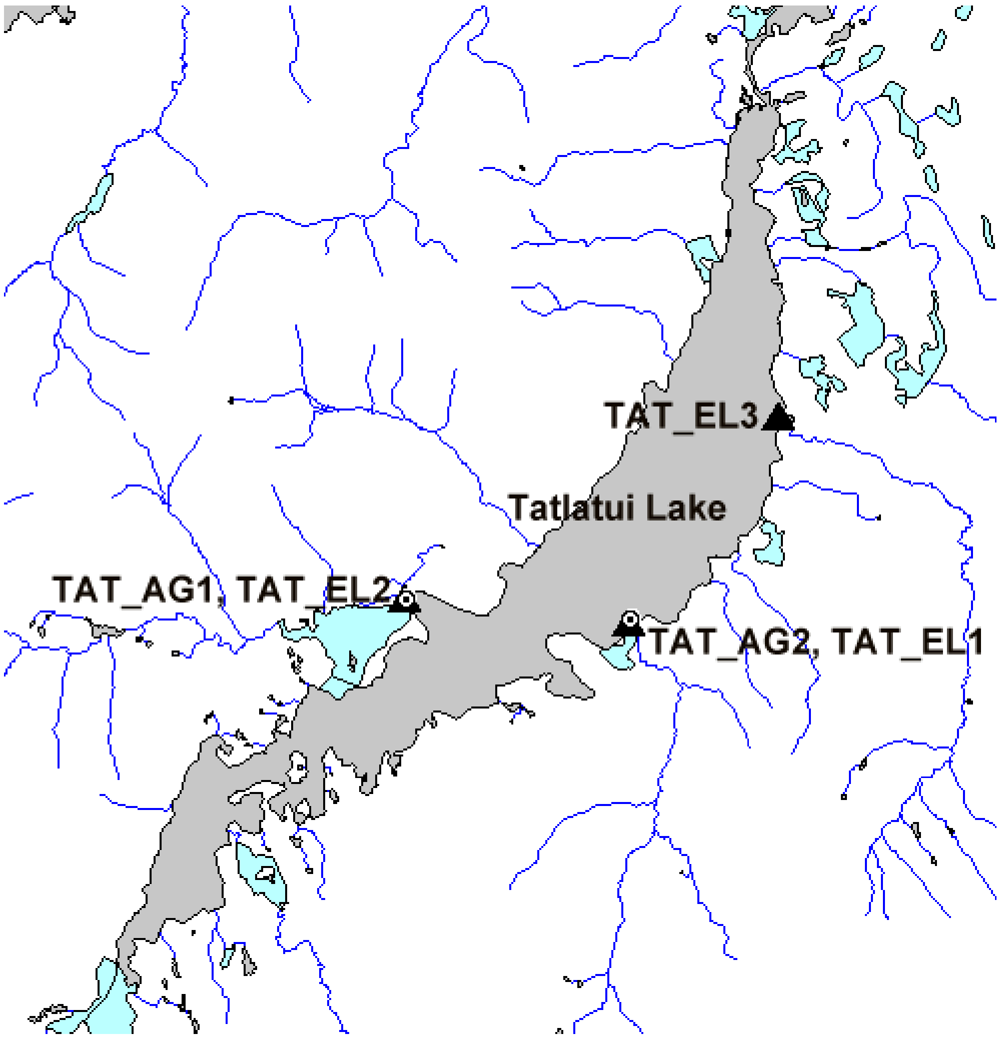


Figure 7. Sample sites located along Tatlatui Lake.

Unnamed Creek 239-821700-73900:

Sample site TAT_EL3 (Photo Plate # 24, Appendix I) is located along the northern portion of south shore of Tatlatui lake (Figure 7). This unnamed creek is a moderate sized stream with a very light tannin colour. The surveyed reach has an abundance of quality spawning and rearing habitat, gravel sizes suitable for spawning, off-channel habitat, large woody debris, deep pools and good overhead cover. At the time of survey the water temperature was 14º C.

A total of 632 seconds of shocking effort resulted in 9 juvenile rainbow trout captured (Table 1); 7 were aged through scale analysis at 0+, with a mean length and weight of 53.7mm (45-69 mm) and 1.8 g (0.9-3.3 g) respectively. One 76 mm, 1.81g fish was aged at 1+. Based upon the size of observed sac-fry that were emerging at other sites, the age 0+ trout from scale analysis are most likely age 1+. The majority of fish were caught along small side channels, but several fish were visually observed in pools and in higher velocity currents where the shocker was ineffective. In addition to the fish observed in the main stream channel, groups of juvenile fish were observed in the current, where the stream enters Tatlatui Lake; none of the visually observed fish appeared to be young of the year rainbow trout. Angling and snorkel counts were not conducted in this stream.

Given that the stream temperatures at the time of survey was 14º C and the fish aged at 0+ are most likely to be age 1+, the probability of this stream providing recruitment is high and may require further investigation. Streams where emergence was beginning were 15º C or warmer.

4.0 Discussion

Unusually cool spring and summer temperatures resulted in later than normal spring freshets, contributing to what appears to be a later than normal fry emergence. Based upon the findings of this survey, all streams that were colder than 11º C, noted as having poor habitat, high glacial silt content, or permanent barriers below useable spawning habitat, are considered as having a low probability of supporting rainbow trout recruitment. Changes in stream temperature should be monitored over the study area to determine if non-spawning stream designations as a result of this survey are consistent and accurate over a broader range of seasonal temperature regimes, and to develop a predictive emergence model that takes into account changes to environmental variables.

Scale analysis results from this survey are highly variable over the study area and do not provide conclusive results, but there appears to be accelerated growth patterns during year 3 and 4, suggesting that juvenile fish may be emigrating from streams to the lakes around year 3 and spawning around age 4.

Of all the streams surveyed, only streams that are lake headed provide clear evidence of rainbow trout spawning activity with young of the year (0+) rainbow trout being captured. The thermal influence of the upstream lake and the stability of the stream channels provided by the buffering capacity of the upstream lakes appear to be key physical processes driving rainbow trout recruitment within the park waters. Insect activity was also noted as being more prevalent at the lake outlets, as were stream channel stability indicators.

Using the 0+ sac fry as a benchmark length, the coefficient of determination (R^2 = 0.8975) for log length at age regression formula appears to support age class differentiation (Figure 4), but due to questions around the accuracy of aging results, the data appears to violate assumptions that age measurements were made without error. When the samples are broken into age cohorts, as a function of sample size, the data is not normally distributed (Appendix III), suggesting that there is insufficient data to provide a more rigorous analysis of length at age at this point.

The data show that the standard error increases with fish length when categorized by age (Table 2). The increasing trend of the variance around the age data is expected to get larger as fish size increases due to differential growth, but is most likely compounded by the questionable accuracy around aging due to delayed annuli development. Numerous fish that were aged 0+ did not correspond with the size of known 0+ fish (emergent fry) observed, and therefore the error rate would be expected to be similar for older fish. Questions around the accuracy of the aging result for 0+ fish were brought up by the contractor hired to age the fish; supporting the visual observations by field staff.

Without sampling fry at the stage observed, errors in scale analysis would not have been questioned.

The presence of external parasites on rainbow trout located in Upper Stalk Lake appears to be unusually high, suggesting that the stress of catch and release angling at the current rate may be contributing to a higher incidence of parasitism and subsequently a higher mortality rate than what might occur under undisturbed conditions. During the survey, there did not appear to be any evidence that trout were suffering from external injuries, signs of wear or external abnormalities as a result of angling pressure and repeated catch and release. Discussions with Mr. Henderson suggest that the level of parasitism has remained constant over time and that our observations were not unusual.

During the duration of this survey, young of the year juvenile rainbow trout captured in the outlet streams were just starting to emerge; numerous fish (based upon the presence of incomplete yolk-sac absorption) were thought to have been pre-maturely removed from the gravel as a result of shocking efforts, suggesting that later sampling of inlets may be required during years where later than normal freshets occur. Alternatively, emergence of sac stage fry may be environmentally driven, i.e. the fry tend to emerge as a function of a threshold in stream temperature or some other variable such as decreased interstitial oxygen, despite current developmental stages. Unusually late freshet conditions can result in subsequently delayed spawning, egg development and fry emergence. This raises several concerns or issues that require further investigation.

- Emergence periods at such a late time in the season would indicate that scale development may not occur in the first year, increasing the possibility of errors in scale analysis and subsequently, errors in all life history length at age analysis. Jensen and Johnsen (1982) found that for brown trout and Atlantic salmon in cold rivers, scales did not begin to appear until fish were 35-38mm and 33-34mm respectively. Chilton and Beamish (1982) also suggest that if fish growth is very slow or non-existent, scale growth may be minimal or non-existent, or that crowding of annuli may make age determination very difficult.

- The level of predation on late emerging fry is unknown. With what appears to be localized spawning areas that are closely related to adult feeding areas, late emergence of fry may be more susceptible to cannibalism unless sufficient off-channel habitat exists to allow segregation of life stages. All fry were caught tight against shallow stream banks, suggesting that predation may not be prevalent. No stomach analyses of larger fish were collected at areas of fry emergence.

- Late emergence of fry is known to increase mortality rates of year class cohorts; for rainbow trout it has been found that the periods of sensitivity around embryo development are highest around 98 to 99 accumulated temperature units (ATU) at incubation temperatures of 9.3 and 10.4ºC respectively (Johnson et al. 1989). Leitritz and Lewis (1976) as cited by Johnson et al. (1989) stated that the tender stage for steelhead embryos (*Oncorhynchus mykiss*) extends from about 48 hrs after fertilization until the eyed stage is attained in about 15 days or 167 ATU's, at 10.7º C. Roberts and White (1992) indicate that the effects of anglers wading on trout eggs and pre-emergent fry twice a day throughout development kills up to

96% of eggs and pre-emergent fry, and that single pass wading just before eggs hatched killed up to 43%. Roberts and White's (1992) results show that mortality was highest from the eyed to the start of hatching stage (52-72 %), followed by the start of hatching to the start of emergence (35-69%). Wading related mortality was therefore lowest for green eggs and highest during the eyed stage.

- If Tatlatui rainbow trout embryos hatch at a range of 300 to 375 ATU (approximately 45-50 days) and emerge from the gravel during mid-August (observed dates) at approximately 600 ATU's (approximately 80 days) it may be possible that key rainbow trout spawning areas are being affected by wading anglers. The angling season opens July 1, which would theoretically coincide with embryonic development being at the late eyed stage to the beginning of the hatch, or approximately 200-250 ATU.

- If mortality of 0+ cohorts is higher than expected as a result of late emergence and, or angler related activities, it is important to determine what affect the mortality rates have on the population as a whole.

    - Does late emergence result in lower survival of fry but higher growth rates for surviving fish due to decreased competition?
    - Does the late emergence provide energetic benefits to mature fish that may cannibalize young of the year?
    - If impacts occur from anglers, is it reducing the overall quality of the angling experience as a result of less fish?
    - If areas were further protected from impacts by anglers, will the theoretical increase in survival increase numbers of adult fish, reducing the overall health and mass of individual fish through competitive interaction, or will the voids of vacant habitat be filled?
    - Will increased adult numbers reduce the optimal energetic allocation for gonad development, or will there be an overall benefit to the population in terms of health and fish numbers?

5.0 Conclusion

To provide accurate estimates of mortality, fecundity, and specific growth rates, aging structures collected in northern climates such as Tatlatui Park should be evaluated for accuracy. Results from this survey clearly indicate that slow growth during the first season may confound scale analysis due to the lack of scale development in young of the year rainbow trout, especially during cool seasons. Possible validation techniques would include the collection of a secondary ageing structure for comparison, and or adopting other techniques such as radiometric/isotope analysis. Alternatively, specific growth rates and age at length could be determined by using mark and recapture techniques, and utilizing local guides to collect and supply the data. Subsequent to the validation, it should be possible to calibrate existing scales to an appropriate level of confidence and provide managers with more accurate picture of life history traits for northern populations or rainbow.

Sampling should be conducted throughout the summer to account for the potential for later spawning events where results from inlet spawning surveys are inconclusive.

It is important to determine to what extent guided anglers may be affecting key spawning locations. Rainbow trout spawning locations, as determined through this assessment, should be clearly delineated and mapped. The time in which rainbow trout start spawning and the time in which emergence begins should be clarified, recorded and compared to ambient stream and air temperatures. Analysis of the temperature data may serve to develop a "best management practices" approach to managing the fishery. From a management perspective it is important to understand whether embryonic development at key spawning areas is being affected by wading anglers, or if fry are being preyed upon in sufficient numbers to be of concern. Additional benefits to determining residence time on the spawning grounds could include an estimate of the spawning population size and extrapolating the data to estimate total population, and mortality rates.

Where key spawning sites coincide with high angler use and it has been determined that impacts are occurring, spawning sites should be protected by either limiting angler use through extended closure dates, by the creation of "no wading zones", or by determining and allocating additional opportunities to guide outside the park boundaries. If areas are protected from wading, it is important to monitor the results to help determine the effectiveness of management decisions, and to better understand the population dynamics that occur in Tatlatui Park.

6.0 Literature Cited

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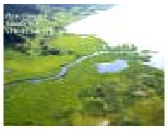
APPENDIX I

PHOTO PLATES

Appendix I – Final Report Photo Plate Index:



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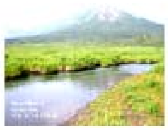

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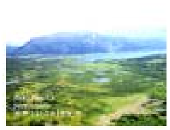

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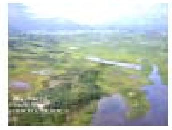

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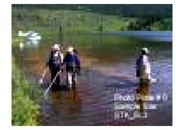

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Photo Plate 7- STK_EL2 Rb -108_70.tif

Photo Plate 8-STK_EL4-149_105.tif

Photo Plate 9 RB KIT_EL1-56_32.tif

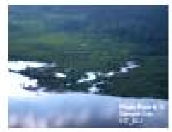


Photo Plate 10- KIT_EL1-62_38.tif

Photo Plate 11 KIT_EL2&3 61_37.tif

Photo Plate 12- KIT_EL2-59_35.tif

Photo Plate 13 KIT_EL3-63_39.tif

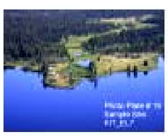
Photo Plate 14-KIT_AG2-117_78.tif

Photo Plate 15-KIT_EL5 Sac fry 128_89.tif

Photo Plate 16 -KIT_EL5-124_85.tif

Photo Plate 17-KITEL5 132_92.tif

Photo Plate 18-KIT_EL6-190_144.tif



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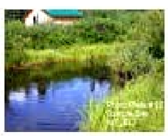

Photo Plate 20-KIT_EL7_202.tif

Photo Plate 21-TRY_EL1_210.tif

Photo Plate 22-TRY_EL1_204.tif

Photo Plate 23-TAT_EL1_227.tif

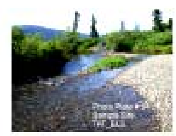

Photo Plate 24-TAT_EL3_260.tif


Photo Plate # 1
Sample Site:
STK_EL1 & STK_S1


Photo Plate # 2
Sample Site:
STK_EL1 & STK_S1


Photo Plate # 3
Sample Sites:
HEW_EL1,2 & HEW_S1


Photo Plate # 4
Sample Sites:
HEW_EL1, 2 & HEW_S1


Photo Plate # 5
Sample Site:
STK_EL2


Photo Plate # 6
Sample Site:
STK_EL3

Photo Plate #7
Rainbow Trout
STK_EL2


Photo Plate # 8
Sample Sites:
STK_EL4, AtK_S3


Photo Plate # 9
Rainbow Trout
KIT_EL1


Photo Plate # 10
Sample Site:
KIT_EL1


Photo Plate # 11
Sample Sites:
KIT_EL2,KIT_EL3


Coleman
Photo Plate # 12
Rainbow Trout
KIT_EL2


Photo Plate # 13
Sample Site:
KIT_EL3


Photo Plate # 14
Rainbow Trout
KIT_AG2


Photo Plate # 15
Sac Fry (Ventral)
KIT_EL5


1
2
3
4
Photo Plate # 16
Rainbow Sac Fry
KIT_EL5


Photo Plate # 17
Sample Sites:
KIT_EL5, KIT_AG1

Photo Plate # 18
Sample Sites:
KIT_EL6, KIT_AG3

Photo Plate # 19
Sample Site:
KIT_EL7


Photo Plate # 20
Sample Site:
KIT_EL7


Photo Plate # 21
Sample Sites:
TRY_EL1, TRY_AG1

Photo Plate #22
Sample Sites:
TRY_EL1, TRY_AG1


Photo Plate # 23
Sample Sites:
TAT_EL1, TAT_AG2


Photo Plate # 24
Sample Site:
TAT_EL3

APPENDIX II

DATA

NOTE: NS indicates "No Scale Taken"

NOTE: Bolded numbers indicate slide numbers (not scale envelope)

NOTE: Scale Condition Codes: 1= GOOD, 2 = POOR (dirty or questionable age), 3= Starting to regenerate (wide focus), 7 = Unreadable, 8= Missing, 9 = Regenerated (scale unreadable).

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NS	12/08/2001	TRY_EL1	RB	EL	29			0	0+		Sac Fry
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NOTE: NS indicates "No Scale Taken"

NOTE: Bolded numbers indicate slide numbers (not scale envelope)

NOTE: Scale Condition Codes: 1= GOOD, 2 = POOR (dirty or questionable age), 3= Starting to regenerate (wide focus), 7 = Unreadable, 8= Missing, 9 = Regenerated (scale unreadable).

Scale Envelope #	Date	Location	Species	Method	Length (mm)	Weight (grams)	Scale Condition Code		Age	K	Comments
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NS	11/08/2001	STK_EL4	RB	EL	27			0	0+		Not aged, assumed to be 0+ due to size; sac fry
NS	11/08/2001	STK_EL4	RB	EL	27			0	0+		Not aged, assumed to be 0+ due to size; sac fry
NS	11/08/2001	STK_EL4	RB	EL	28			0	0+		Not aged, assumed to be 0+ due to size; sac fry
NS	11/08/2001	STK_EL4	RB	EL	27			0	0+		Not aged, assumed to be 0+ due to size; sac fry
NS	11/08/2001	STK_EL4	RB	EL	28			0	0+		Not aged, assumed to be 0+ due to size; sac fry
35	13/08/2001	TAT_EL3	RB	EL	60	2.4	1	0	0+	1.11	14C, 632 seconds effort; based upon size of sac fry caught at other sites, age is more likely 1+
36	13/08/2001	TAT_EL3	RB	EL	45	1	1	0	0+	1.10	Slide 36
37	13/08/2001	TAT_EL3	RB	EL	48	1.2	1	0	0+	1.09	Slide 37
38	13/08/2001	TAT_EL3	RB	EL	49	1.7	1	0	0+	1.44	Slide # 38
39	13/08/2001	TAT_EL3	RB	EL	44	0.9	1	0	0+	1.06	Slide # 39
58	13/08/2001	TAT_EL3	RB	EL	61	2.2	1	0	0+		scale envelope
59	13/08/2001	TAT_EL3	RB	EL	69	3.3	1	0	0+		scale envelope
30	12/08/2001	**KIT_EL6**	RB	EL	**64**	**3**	**1**	**1**	**1+**	**1.14**	**Slide 30**
31	12/08/2001	**KIT_EL7**	**RB**	EL	**54**	**1.9**	**1**	**1**	**1+**	**1.21**	**Slide 31; KITEL7 15C/290 sec**
33	12/08/2001	**KIT_EL7**	**RB**	EL	**77**	**4.6**	**1**	**1**	**1+**	**1.01**	**Slide 33**
34	12/08/2001	**KIT_EL7**	**RB**	EL	**75**	**4.1**	**1**	**1**	**1+**	**0.97**	**Slide 34**
19	**11/08/2001**	**KIT_EL5**	**RB**	EL	**67**	**3.2**	**1**	**1**	**1+**	**1.06**	**Slide 19**
2	11/08/2001	STK_EL2	RB	EL	71	4.4	1	**1**	1+	1.23	Side Channel
3	11/08/2001	STK_EL2	RB	EL	58	2.4	1	**1**	1+	1.23	Side Channel

NOTE: NS indicates "No Scale Taken"

NOTE: Bolded numbers indicate slide numbers (not scale envelope)

NOTE: Scale Condition Codes: 1= GOOD, 2 = POOR (dirty or questionable age), 3= Starting to regenerate (wide focus), 7 = Unreadable, 8= Missing, 9 = Regenerated (scale unreadable).

Scale Envelope #	Date	Location	Species	Method	Length (mm)	Weight (grams)	Scale Condition Code		Age	K	Comments
5	11/08/2001	STK_EL2	RB	EL	79	5.7	2	**1**	1+	1.16	Side Channel; 1st annulus near the edge
6	11/08/2001	STK_EL2	RB	EL	59	1.9	1	**1**	1+	0.93	Side Channel
7	11/08/2001	STK_EL2	RB	EL	61	2.8	1	**1**	1+	1.23	Side Channel
8	11/08/2001	STK_EL2	RB	EL	64	2.7	1	**1**	1+	1.03	Side Channel
12	11/08/2001	STK_EL2	RB	EL	61	2.4	1	**1**	1+	1.06	Side Channel
13	11/08/2001	STK_EL2	RB	EL	63	2.8	1	**1**	1+	1.12	Side Channel
14	11/08/2001	STK_EL3	RB	EL	62	2.7	1	**1**	1+	1.13	Lake Shore/Temp 14 C
15	12/08/2001	STK_EL3	RB	EL	68	3.3	1	**1**	1+	1.05	Lake Shore/Temp 14 C
16	11/08/2001	STK_EL3	RB	EL	53	1.9	2	**1**	1+	1.28	Lake Shore/Temp 14 C; poor sample condition
22	11/08/2001	STK_EL4	RB	EL	54	1.5	1	**1**	1+	0.95	Slide 22
57	13/08/2001	TAT_EL3	RB	EL	76	5	1	**1**	1+		scale envelope
1	12/08/2001	TRY_AG1	RB	AG	121	15.8	1	2	2+	0.89	
2	12/08/2001	TRY_AG1	RB	AG	158	37.7	1	2	2+	0.96	
3	12/08/2001	TRY_AG1	RB	AG	175	50.8	1	2	2+	0.95	
4	12/08/2001	TRY_AG1	RB	AG	133	23.6	1	2	2+	1.00	
5	12/08/2001	TRY_AG1	RB	AG	129	21.5	1	2	2+	1.00	
6	12/08/2001	TRY_AG1	RB	AG	114	24.7	1	2	2+	1.67	high condition factor; probable measuring error
7	12/08/2001	TRY_AG1	RB	AG	181	63.6	2	2	2+	1.07	large growth in 3rd year; possible 3+ with very vague third annulus.
8	12/08/2001	TRY_AG1	RB	AG	123	20.2	1	2	2+	1.09	2nd annulus near scale edge.
44	08/08/2001	KIT_EL2	RB	EL	138	30.7	1	2	2+	1.17	
46	08/08/2001	KIT_EL1	RB	EL	118	13.3	1	2	2+	0.81	
16	11/08/2001	KIT_EL 7	RB	EL	127	19.6	1	2	2+	0.96	Slide in envelope.
11	11/08/2001	STK_EL2	RB	EL	121	20.5	1	2	2+	1.16	Side Channel
28	10/08/2001	KIT_AG1	RB	AG	344		2	3	3+		probably lacking 1st annulus, i.e. 4+
32	10/08/2001	STK_AG1	RB	AG	278		2	3	3+		probable lacking 1st annulus, i.e. 4+
45	08/08/2001	KIT_EL2	RB	EL		38.8	1	3	3+		
31	10/08/2001	STK_AG1	RB	AG	321		1	4	4+		vague 1st annulus
34	10/08/2001	STK_AG1	RB	AG	314		1	4	4+		
42	10/08/2001	STK_AG1	RB	AG	395		1	4	4+		
51	13/08/2001	TAT_AG2	RB	AG	396		1	4	4+		
52	13/08/2001	TAT_AG2	RB	AG	388		1	4	4+		
27	10/08/2001	KIT_AG1	RB	AG	402		1	5	5+		1st and 2nd annuli vague, with small growth
30	10/08/2001	KIT_AG1	RB	AG	359		1	5	5+		
38	10/08/2001	STK_AG1	RB	AG	324		1	5	5+		
40	10/08/2001	STK_AG1	RB	AG	421		1	5	5+		
47	13/08/2001	TAT_AG2	RB	AG	360		2	5	5+		large growth in 1st year; may be lacking 1st annulus (i.e. 6+)
48	13/08/2001	TAT_AG2	RB	AG	420		3	5	5+		
50	13/08/2001	TAT_AG2	RB	AG	384		1	5	5+		
33	10/08/2001	STK_AG1	RB	AG	388		1	6	6+		6th annulus on scale edge

NOTE: NS indicates "No Scale Taken"

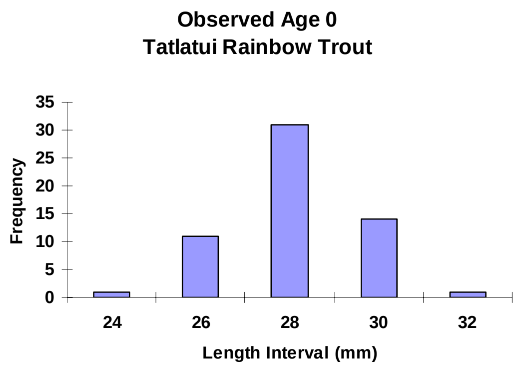
NOTE: Bolded numbers indicate slide numbers (not scale envelope)

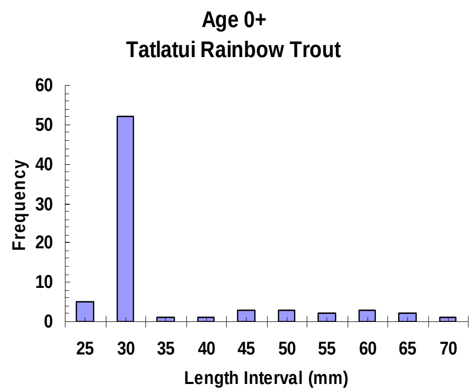
NOTE: Scale Condition Codes: 1= GOOD, 2 = POOR (dirty or questionable age), 3= Starting to regenerate (wide focus), 7 = Unreadable, 8= Missing, 9 = Regenerated (scale unreadable).

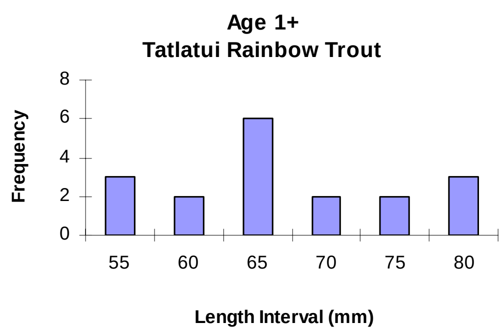
Scale Envelope #	Date	Location	Species	Method	Length (mm)	Weight (grams)	Scale Condition Code		Age	K	Comments
35	10/08/2001	STK_AG1	RB	AG	461		3	6	6+		6th annulus on scale edge
36	10/08/2001	STK_AG1	RB	AG	433		1	6	6+		6th annulus on scale edge; better on some other scales
37	10/08/2001	STK_AG1	RB	AG	395		1	6	6+		small growth per year
39	10/08/2001	STK_AG1	RB	AG	386		1	6	6+		Stalk lake narrows; otolith 6+
43	11/08/2001	STK_AG1	RB	AG	530		1	6	6+		vague 1st annulus; 6th annulus on scale edge
29	10/08/2001	KIT_AG1	RB	AG	435		9		n/a		
41	10/08/2001	STK_AG1	RB	AG	482		9		n/a		Questionable data (says 19inch ?); at least 5+
49	13/08/2001	TAT_AG2	RB	AG	405		9		n/a		at least 5+
4	11/08/2001	STK_EL2	RB	EL	67	3.1	7		n/a	1.03	Side Channel; all scales starting to regenerate; 0+ or 1+
60	13/08/2001	TAT_EL3	RB	EL			8		n/a		no scale envelope; no data

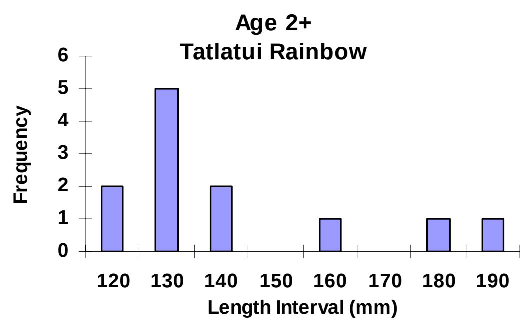
APPENDIX III

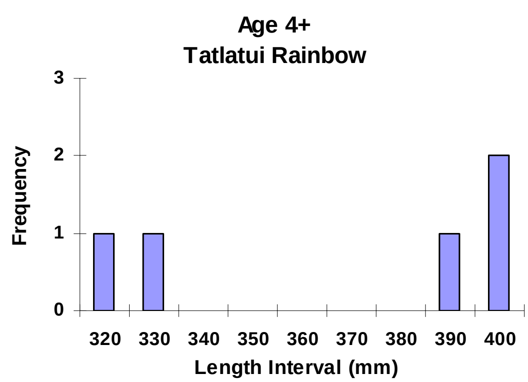
Length at Age Histograms

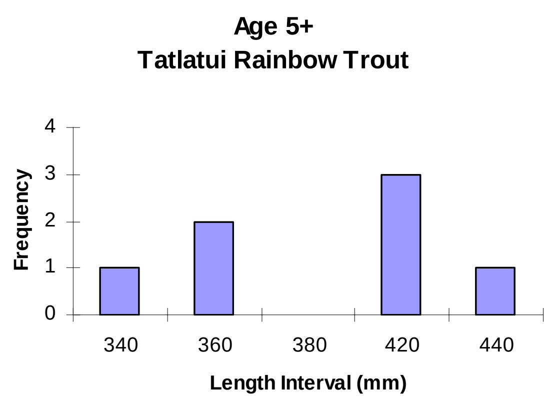

Observed Age 0
Tatlatui Rainbow Trout
Frequency
35
30
25
20
15
10
5
0
24
26
28
30
32
Length Interval (mm)

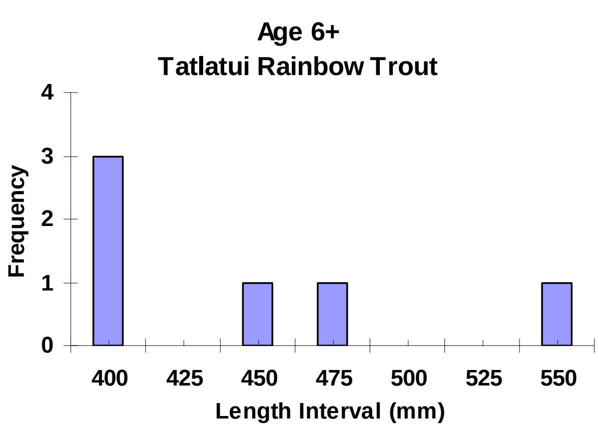

Age 0+
Tatlatui Rainbow Trout
Frequency
60
50
40
30
20
10
0
25
30
35
40
45
50
55
60
65
70
Length Interval (mm)


Age 1+
Tatlatui Rainbow Trout
Frequency
8
6
4
2
0
55
60
65
70
75
80
Length Interval (mm)


Age 2+
Tatlatui Rainbow
Frequency
6
5
4
3
2
1
0
120
130
140
150
160
170
180
190
Length Interval (mm)


Age 4+
Tatlatui Rainbow
Frequency
3
2
1
0
320
330
340
350
360
370
380
390
400
Length Interval (mm)


Age 5+
Tatlatui Rainbow Trout
Frequency
4
3
2
1
0
340
360
380
420
440
Length Interval (mm)


Age 6+
Tatlatui Rainbow Trout
Frequency
4
3
2
1
0
400
425
450
475
500
525
550
Length Interval (mm)

APPENDIX IV

Digital Data