Clowhom Project Water Use Plan

Fish Productivity Monitoring

Implementation Year 5

Reference: COMMON-2

Fish Productivity Monitoring Year 5 Data Summary 2011

Study Period: September 2011

D.J. Bates
FSCI Biological Consultants
Sechelt, BC

And

O. Coombes
Resource Management
Shíshálh Nation
Sechelt, BC

May 19, 2012

Executive Summary

The Clowhom Lake Fish productivity monitoring study was developed and initiated in 2006 to assess and track changes in fish productivity. This planned monitoring program was in response to identified data gaps and knowledge of the reservoir ecology that may limit decision-making processes under the WUP.

It is speculated that fish productivity had decreased following the impoundment of Clowhom Lake in 1956. This decrease may be a result of loss in productive littoral habitat, but little data exists to support this hypothesis. As a result a 20-year monitoring plan designed to track change in fish productivity through sampling of rearing populations was developed and implemented in 2006 with sampling to occur every 2 years throughout the 20-year study.

In 2011, the first phase of 5-year period of fish sampling was completed. Results for each sample period have been presented in earlier documents (*Bates*, 2007 and 2009, B*ates and Paul*, 2011) but have been summarized and compared together in this summary.

Results of the 2006, 2008 and 2010 surveys along with habitat data on Clowhom River (2009) have not adequately addressed the management questions identified in the Clowhom Water Use Plan (WUP). Additional data analysis, in particular the ELZ coupled with the managed drawdown schedules will allow a better understanding of the results. This analysis is still pending.

As a result of low catch data and continued un-answered questions, recommendations for the next phase of sampling are proposed. In particular three key recommendations are presented.

1. Increase fish sampling both spatially and temporally. Sample numbers in the last phase is low and key species and age class data missing. Presently the limited sampling will result in low power but given the project length will result in a long data set. It is suggested that increasing sample size would improve the l expected low power, improving the end result.

2. Qualify and quantify key habitats for salmonid life history in tributaries to Clowhom Lake and lower Clowhom River. Young-of-the-Year salmonids are noticeable absent in lake capture data. As a result, salmonid use of habitats by age class and the importance of these habitats for reservoir recruitment are poorly understood.

3. Include sampling of water chemistry and water quality parameters into bi-annual sampling protocols in order to better understand potential nutrient limiting factors and possible influence on fish productivity in the Clowhom Reservoir.

Table of Contents

List of Figures

Page

List of Tables

1.0 Introduction

In 2006, the Sechelt First Nation and BC Hydro began the first year of a 20-year monitoring program documenting fish productivity in the Clowhom Lake reservoir. The monitoring program was implemented following recommendations made during the water use planning (WUP) process to address key data gaps that hampered decision-making processes. In an earlier study by *Bruce* (2004) a decrease in reservoir productivity was reported following the impoundment and creation of Clowhom Lake in 1956. As a result of the earlier results, BC Hydro developed the fish productivity-monitoring program, addressing concerns and bottlenecks to production and potential means of improving fish populations by testing changers in operations.

The monitoring program addresses specific management questions that include:

- Does fish productivity change through time following the WUP implementation?
- Is any observed change correlated with changes in effective littoral zone changes?
- Is the population of salmonids in Clowhom lake recruitment limited and what role does the river play?
- If no change is observed what is the reason for the decline initially?
- Do operation based solutions exist for the reservoir that would benefit fish productivity?

The purpose of this report is to collate and present data collected from the first 3 sample periods of the fish productivity monitoring study. Using the results presented inferences are made and recommendations for changes to the second phase of the monitoring study are presented.

2.0 Study Area

The Clowhom Lake is a 745-ha reservoir located at the head of Salmon Inlet northeast of Sechelt BC. The creation of the reservoir occurred in the 1950's with the construction of the Clowhom Falls dam and the flooding of two smaller lakes resulting in the present day impoundment. **Figure 1** shows the location of Clowhom Lake in relation to Sechelt BC.

The study area for this project includes the entire reservoir with 9 pre-selected sampling locations. These locations correspond to sites reported by *Bruce* (2003) and *Bates* (2007, 2009) and represent both the upper and lower portion of the reservoir. **Figure 2** shows the fish sampling locations in the Clowhom reservoir.

3.0 Methods

3.1 Fish Sampling

Fish collection was completed in the specific sample years (2006, 2008, and 2010) using a two-person field crew. Samples were collected in late summer between the end of August and the end of September using floating and sinking gill nets and “Gee” minnow traps. The gill net configuration was consistent with the mesh sizes recommended for lake inventory by the B.C. Resource Inventory Committee (*RIC*, 1998) and *Bruce* (2003).

Three net strategies were employed; floating; sinking and drift sets. The floating and sinking sets were anchored near the shoreline and oriented perpendicular to the lake edge. The drift net was released perpendicular to the lake mid-line or e-line and allowed to move with the wind and lake current(s). All net sampling was restricted to 3-hour soak times to minimize salmonid mortality. All captured salmonids were retained for detailed biometric data collection.

In addition to gill net sets, Gee® minnow traps were used to sample near shore habitats. Minnow traps were set in groups of 5 and baited with borax preserved chum salmon roe. The trap bait was contained in "perforated" film containers in order to prevent consumption by captured fish. Traps were then set at mid-day and allowed to fish over night for a 24-hour period.

All sample locations were flagged along the lake shoreline and UTM coordinates determined with a Garmin handheld GPS receiver. Sample locations remained the same in each sample year. Locations are highlighted on **Figure 2** and **Table I** reports the targeted set times and gear used for each location.

Table I: Type and set times for the sampling gear used to collect fish samples in the Clowhom Lake Reservoir for the fish productivity study.

Site ID	**UTM**		**Gear**	**Duration**	
	Northing	**Easting**		**Type**	Time
A	5508579	461286	Float GN	Day	3:00
B	5509613	461887	Sink GN	Day	3:00
C	5509915	461774	MT	Night	24:00
D	5510722	462958	MT	Night	24:00
E	5510961	464552	Float GN	Day	3:00
F	5511065	467434	Sink GN	Day	3:00
G	5510897	467399	MT	Night	24:00
H	5512518	467991	MT	Night	24:00
I	-	-	Drift GN	Day	3:15

Note: GN = gillnet and MT minnow traps (5)

3.2 Fish Biometrics

All captured fish were enumerated and recorded by collection method. Captured salmonids were identified to species; the fork length measured to the nearest millimeter (mm) and wet weight nearest 0.1 gms were measured (*Bates*, 2007; 2009). Scale samples were collected from representative size ranges of each species following standard scale collection methodology and placed on glass microscope slides. The scales were then

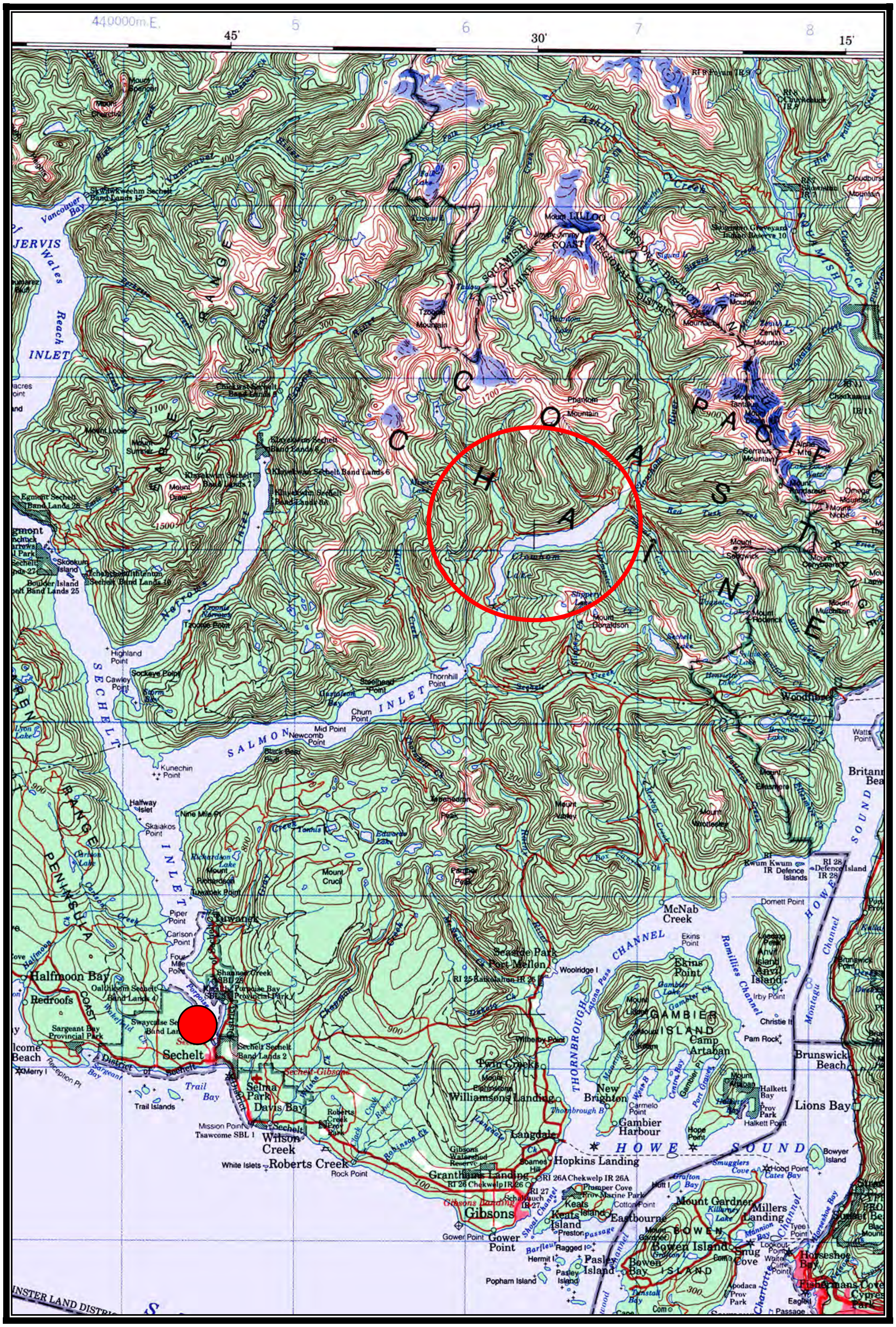


Figure 1: Location of Clowhom Lake (red circle) in relation to Sechelt (red dot), BC.

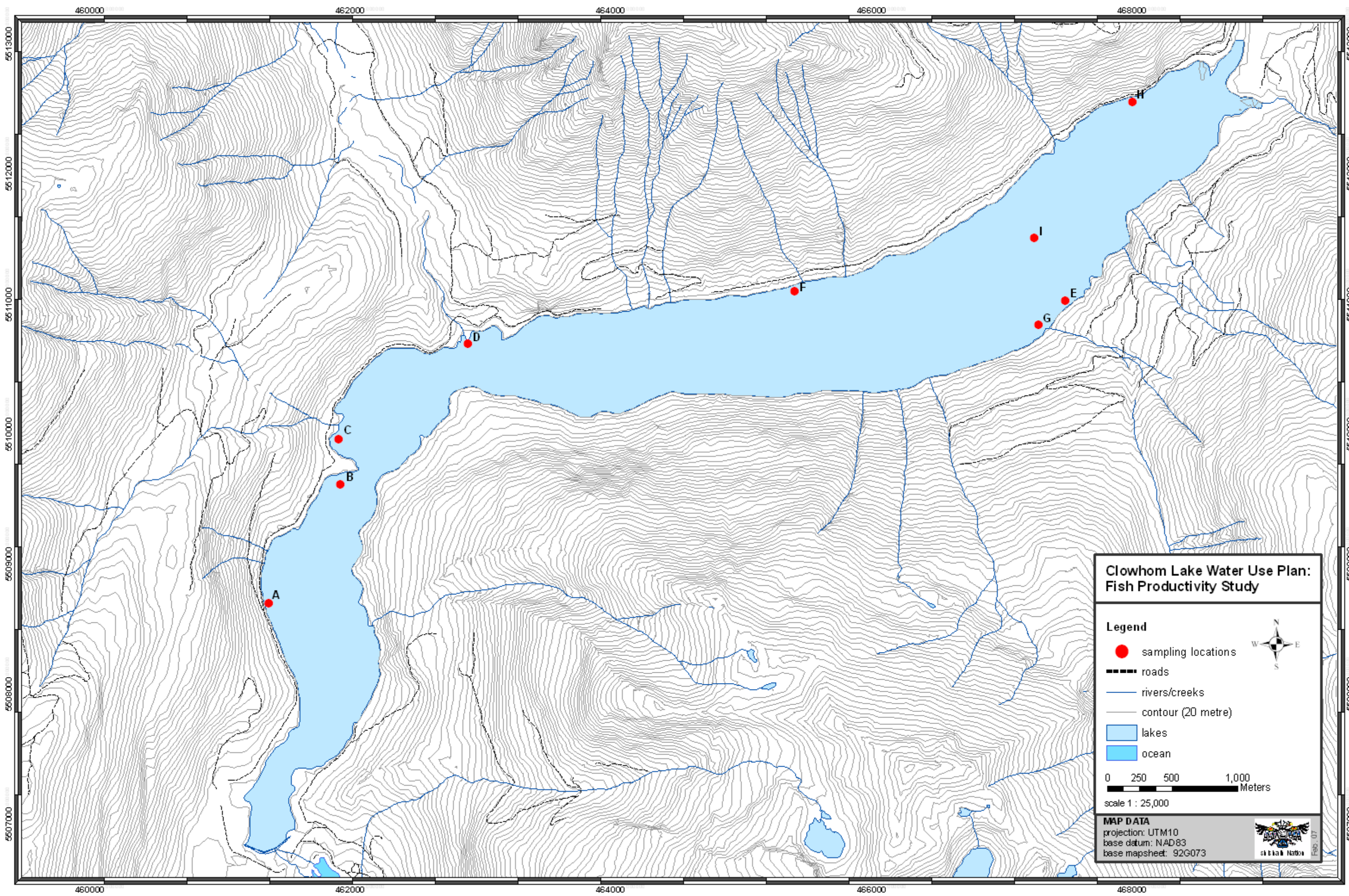


Figure 2: Sample locations selected for the gill net and minnow trapping of fish within Clowhom Reservoir. Each location is identified along the shoreline with flagging tape (*Bates*, 2007).

compressed with another slide, labeled and stored for future reading. Live fish (those in the Gee traps), were also identified and enumerated then released unharmed. All dead fish collected in gill nets were retained and returned to the lab. Dead fish (gill net captures) were dissected and stomachs of each fish removed and opened for examination of the contents

3.3 Scale Analysis

Each sample year scales from captured salmonids older than young-of-the-year were collected and sandwiched between glass microscope slides. The scale was then reviewed under a dissecting microscope and a smear selected for clarity. The representative scale(s) was then photographed using a digital camera mounted on the microscope and the image stored as a JPEG file. Images were later read on a desktop computer.

Scale analysis was consistent with the iterative fashion reported by *Bruce* (2003) and the age is reported using the convention n+ values where the 'n' denotes the age and the '+' a partial year.

3.4 Fish Data Analysis

Captured fish were reported by catch type and catch-per-unit effort (CPUE). The CPUE for each sample year were then compared to one another along with the CPUE reported in Bruce (2003). Similarly, length, weight and condition coefficients was summarized and compared between sample years for each species and age class. Condition coefficient (CC) was calculated using:

$$\text{Condition Coefficient (CC)} = \text{weight (gms)} \times \text{length (cm)}^{-3} \times 100$$

4.0 Results

4.1 Fish Capture

A total of 159, 96 and 119 fish were caught in 2006, 2008 and 2010, respectively. These catches broke down further with salmonids representing 11.3%, 22.9% and 24.4% of the total and the balance in each year non-salmonid catches. **Table II** provides the salmonid and non-salmonid species captured in the first quarter of the fish productivity monitoring study. All non-salmonid species were caught along the shoreline in minnow traps.

Table II: Species captured in Clowhom reservoir in 2006, 2008 and 2010.

Salmonids		Non-salmonids	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Cutthroat Trout (CCT)	*Oncorhynchus clarki*	Prickly sculpin (CAS)	*Cottus asper*
Rainbow Trout (RB)	*O. mykiss*	Three-spine stickleback (TSB)	*Gasterosteus spp.*
Kokanee (KO)	*O. nerka*		

Total catch is also separated by capture method and the catch reported by sample location (**Table III**). All dead fish caught in the gill nets were retained for dissection.

Table III: Summary of catch by sample location, gear type and sample year in Clowhom Reservoir.

Site	Gear Type	Species	Number		
			2006	2008	2010
A	Floating GN	Rainbow Trout	0	3	11
A	Floating GN	Kokanee	0	1	0
B	Sinking GN	Rainbow Trout	1	0	0
B	Sinking GN	Cutthroat Trout	2	3	3
B	Sinking GN	Kokanee	0	1	0
C	MT	Prickly Sculpin	20	6	13
C	MT	Stickleback	1	5	14
D	MT	Prickly Sculpin	30	4	3
D	MT	Stickleback	0	0	24
E	Floating GN	Rainbow Trout	2	9	9
E	Floating GN	Cutthroat Trout	0	2	0
E	Floating GN	Kokanee	0	0	3
F	Sinking GN	Cutthroat Trout	2	1	2
G	MT	Rainbow Trout	6	2	1
G	MT	Prickly Sculpin	17	7	0
G	MT	Stickleback	1	0	8
H	MT	Rainbow Trout	4	0	0
H	MT	Prickly Sculpin	70	52	2
H	MT	Stickleback	3	0	26
H	MT	Rainbow Trout	1	0	0
I	Drift GN	Kokanee	1	0	1

4.2 Fish Biometrics

Nose to fork length and wet weight data were compiled and applied to the appropriate age classes in 2006, 2008 and 2010. **Tables IV**, **V** and **VI** summarize the length-at-age, wet weights and condition coefficient data for the three species of salmonids captured. **Figure 3** shows the weight versus length relationship for each salmonid species caught and **Figure 4**, a comparison of the condition coefficients by species and year.

The salmonid capture in 2010 was the largest number at 29. This compared to a capture of 23 in 2008 and 19 in 2006. Generally, increase in capture may be a reflection of the increased soak times used in 2010. It should be noted that in 2010 the reservoir was drawn down for emergency repairs. This may have resulted in easier capture of salmonids if the fish were congregated at higher densities at the sample sites.

Catch per unit effort was calculated for each sample year. This varied from a low of zero to high of 6.42 in the gill net. Minnow trapping proved less successful with the majority of trapping efforts yielding no salmonid catches to a high of 0.25 in 2006. Catch per unit effort, expressed as fish caught per hour is presented in **Figure 5**. The top graph shows the gill net catch while the lower the minnow traps results. These CPUE are only for the salmonid species. Non-salmonids are not presented.

Table IV: Summary of length-at-age data for the salmonids caught in Clowhom Reservoir in 2006, 2008 and 2010.

Rainbow Trout length (mm)									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	-
1+	7	112	6.6	4	131	12.6	3	108	4.0
2+	4	167	14.8	8	168	14.6	7	151	10.8
3+	0	-	-	2	208	14.1	6	191	14.0
4+	3	243	8.2	0	-	-	3	260	17.3
5+	0	-	-	0		-	1	300	-

Cutthroat Trout length (mm)									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0		-	0	-	-
1+	0	-	-	2	154	19.8	0	-	-
2+	0	-	-	1	180	-	0	-	-
3+	1	282	-	3	306	41.9	3	261	9.5
4+	3	334	39.3	1	390	-	2	306	1.4
5+	0	-	-	0	-	-	0	-	-

Kokanee Salmon length (mm)									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	
1+	1	177	-	0	-	-	2	172	17.7
2+	0	-	-	1	135	-	2	195	7.1
3+	0	-	-	1	202	-	0	-	-
4+	-	-	-	-	-	-	0	-	-
5+	-	-	-	-	-	-	0	-	-

Table V: Summary of wet weight data for the salmonids caught in Clowhom Reservoir in 2006, 2008, 2010.

Rainbow Trout Wet Weight (gms)									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	-
1+	7	14.9	2.45	4	25.6	5.91	3	14.4	0.50
2+	4	48.1	12.9	8	52.6	13.5	7	39.2	7.80
3+	0	-	-	2	97.5	15.8	6	76.1	14.0
4+	3	155.5	28.51	0	-	-	3	182.9	19.6
5+	0	-	-	0		-	1	268.9	-

Cutthroat Trout Wet Weight (gms)									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	-
1+	0	-	-	2	34.6	10.9	0	-	-
2+	0	-	-	1	56.1	-	0	-	-
3+	1	189.4	-	3	246.1	79.7	3	180	6.59
4+	3	386.8	105.8	1	515.4	-	2	270.7	32.53
5+	0	-	-	0	-	-	0	-	-

Kokanee Salmon Wet Weight (gms)									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	
1+	1	62.2	-	0	-	-	2	56.30	14.85
2+	0	-	-	1	28.3	-	2	89.05	14.78
3+	0	-	-	1	99.8	-	0	-	-
4+	-	-	-	-	-	-	0	-	-
5+	-	-	-	-	-	-	0	-	-

Table VI: Summary of condition coefficients for the salmonids caught in Clowhom Reservoir in 2006, 2008 and 2010.

Rainbow Trout Condition Coefficient									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	-
1+	7	1.05	0.12	4	1.12	0.08	3	1.14	0.11
2+	4	1.01	0.08	8	1.09	0.06	7	1.13	0.05
3+	0	-	-	2	1.08	0.04	6	1.09	0.05
4+	3	1.08	0.10	0	-	-	3	1.04	0.10
5+	0	-	-	0		-	1	1.00	-

Cutthroat Trout Condition Coefficient									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0		-	0	-	-
1+	0	-	-	2	0.93	0.06	0	-	-
2+	0	-	-	1	0.96	-	0	-	-
3+	1	1.12	-	3	0.99	0.19	3	1.00	0.08
4+	3	1.04	0.17	1	0.87	-	2	0.95	0.11
5+	0	-	-	0	-	-	0	-	-

Kokanee Salmon Condition Coefficient									
	2006			2008			2010		
Age	**n**	**Mean**	**SD**	**n**	**Mean**	**(SD)**	**n**	**Mean**	**SD**
0+	0	-	-	0	-	-	0	-	
1+	1	0.84	-	0	-	-	2	1.09	0.04
2+	0	-	-	1	1.15	-	2	1.20	0.06
3+	0	-	-	1	1.21	-	0	-	-
4+	-	-	-	-	-	-	0	-	-
5+	-	-	-	-	-	-	0	-	-

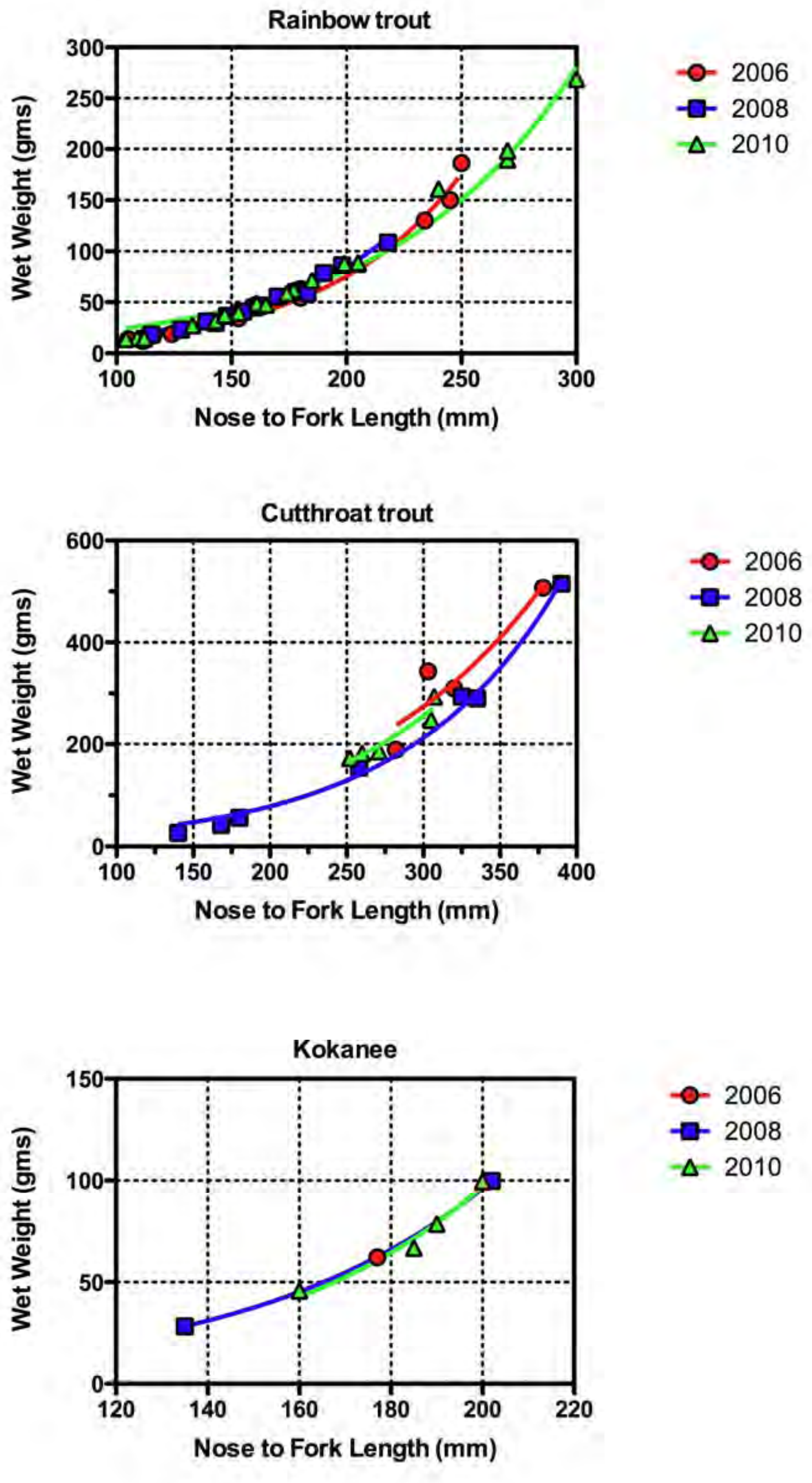


Figure 3: Length versus weight relationships for salmonids captured in Clowhom Reservoir in 2006, 2008 and 2010.

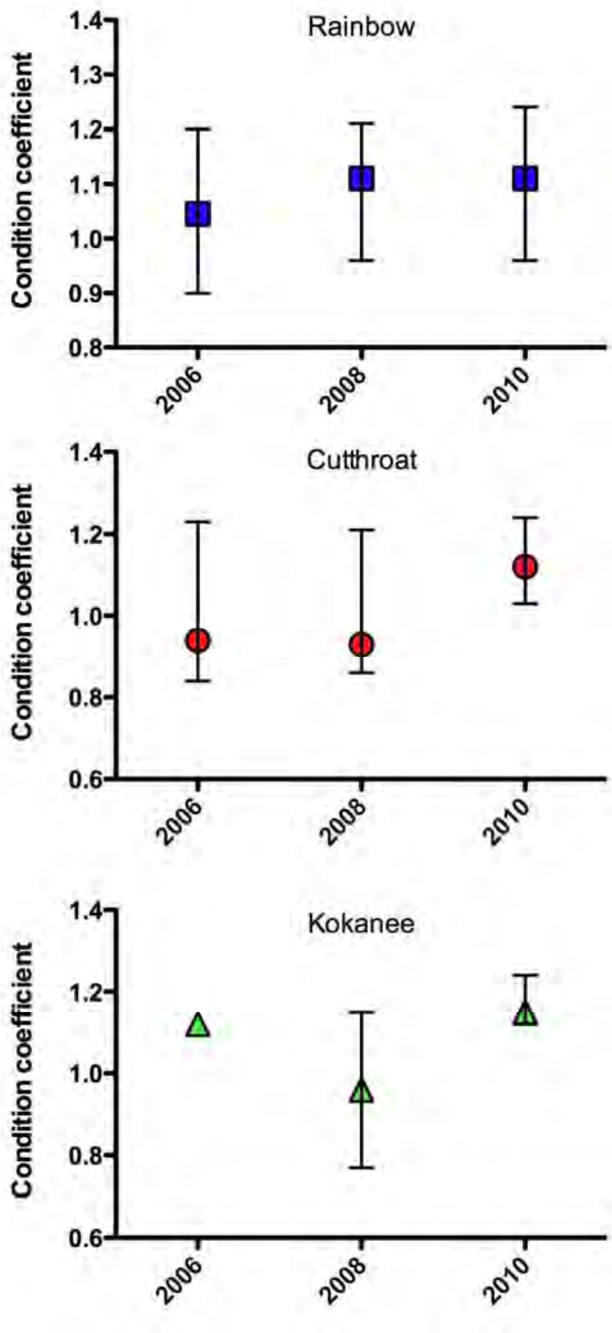
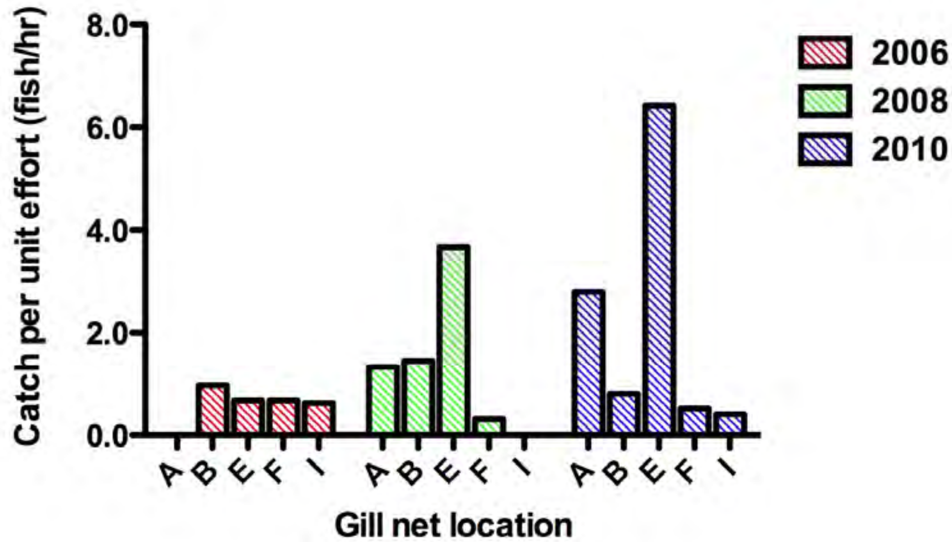


Figure 4: The condition coefficient for salmonids captured in Clowhom Reservoir in 2006, 2008 and 2010. Values shown are the median and range of coefficients.



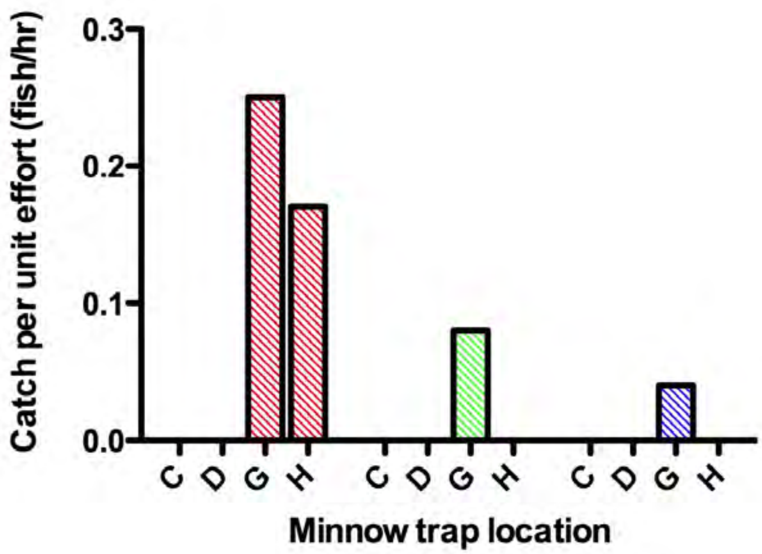


Figure 5: Catch per unit effort (CPUE) in each year of Clowhom Reservoir sampling. The top graph shows the CPUE for gill netting, while the lower the minnow trapping results.

4.3 Scale Analysis

Representative scale samples collected from salmonids in each year photographed and archived as digital images. Age classes reported above represent the results of examination of these scales.

4.4 Stomach Analysis

In each year (2006, 2008 and 2010) stomach samples from net mortalities were examined. Results were consistent with those reported by *Bruce* (2003). **Table VII** summarizes the identifiable principle food groups identified from stomachs of salmonids.

Table VII: Summary of prey items identified in the stomach of salmonids captured in Clowhom Reservoir.

Species	**Type of Prey Reported**				
	Empty	**Plankton**	**Insects**	**Fish**	**Other**
Rainbow Trout	2010	-	2006 2008 2010	-	2010
Cutthroat trout	2008	-	2006	2006 2008 2010	-
Kokanee	2006 2008 2010	-	-	-	2008

5.0 Discussion

The completion of the 2010 sampling year closed the first quarter of the 20-year monitoring cycle. Results from the three sampling periods while variable, appear to not be significantly different. .

The purpose of the monitoring study is to address a series of management questions. It was noted that operations of the reservoir has been modified to reduce the minimum drawdown. The intent was to reduce the impacts to littoral areas and by association productivity that may impact fish production in the reservoir.

While the management drawdown has been modified, it has been noted that emergency drawdowns have likely exceeded this minimum value and as was witnessed in 2010 the severe nature of the exposure of littoral areas likely has a detrimental effect on the function of these areas. Presumably this will be evident from the ELZ metric once the data from the littoral productivity study is analyzed.

Whether this type of unplanned event occurs again in the future is unknown. What is relatively certain is that extreme drawdowns like those witnessed possibly negates the benefits of reducing the minimum drawdown listed under the WUP and that without a consistent level range, minimizing littoral exposure, changes attributed to “new” reservoir management may be difficult to ascertain.

The second management question regarding correlation to changes in fish production and littoral area performance is difficult given the limited data collected.

The lake experiences multiple large fluctuations in stage that presumably influences littoral areas. While these may be outside the “normal” growth window it is expected to impact littoral area success. The sampling of salmonids has been a snap shot in time and may not provide a suitable sample size from which to extract meaningful information. Ideally sampling frequency would be increased both spatially and temporally, in improve the data on both species and age class structure. In many years only one animal was captured and in all years young-of-the year are noticeable absent.

The absence of young-of-the-year was highlighted in *Bruce* (2003) and it was suggested that this age class might be using areas other than the lake for rearing. This question remains un-answered. *Bates and Paul* (2010 reported efforts to document salmonid use in the lower reaches of the Clowhom River. It was hypothesized that juvenile salmonids remain in these areas and that lake recruitment occurred from these upstream sources. This question remains, as efforts of swimming and electrofishing the lower Clowhom River resulted poor estimates of salmonid use and no identifiable YOY.

While there is obvious use and available habitat, it still remains un-clear, the role Clowhom River plays in the recruitment to the lake.

Perhaps more likely recruitment contributors to Clowhom Reservoir are the numerous tributaries to Clowhom Lake. Many of these are small with short accessible reaches (*Bruce*, 2003) but no attempt has been made to determine the use for rearing or perhaps more importantly spawning. This information may be beneficial and should be included in future sample years.

6.0 Conclusion/Recommendations

The completion of the third season of salmonid sampling marked the end of the first 5-year rotation defined under the terms of Reference for this project. The result of this completion is the summary comparison of the results above. Given the long-term management objectives the following conclusion and recommendations are provided.

- Fish productivity, measured as relative abundance may not be appropriate without an increase in sampling effort that increases both spatially and temporally. The temporal change may help address questions of “unknown” age classes and scarce species.

The 2004 catch reported by *Bruce* (2003) and presumably prior to changes in the minimum drawdown under the WUP (49 versus 47) reported a total catch of 47 salmonids. This is compared to subsequent years where a low of 19 (2006) were captured to a high of 29 (2010). All lower than the pre-WUP change. As a result the question of whether the effort of sampling is adequate remains. Whether an increase in sampling intensity is warranted requires additional discussion, assuming that effort and resources are limited time may be better spent addressing other uncertainties.

- The correlation to littoral area performance is still being reviewed. Complicating the analysis is sudden “extreme” drawdown, similar to the one witnessed in September 2010. In this case sampling was adjusted to meet changes but extensive littoral areas were exposed for an extended period. What effect and how this may impede productivity remains un-answered.

  In this case it is unclear what the best course of action would be. It is imperative that those working on the WUP monitoring have open and direct dialogue with the operations end of the reservoir. This may at least help to explain observed anomalies in data results.

- Is the population in Clowhom Reservoir a reflection of operations management or a question of recruitment? This question is also still unanswered. The results presented show limited YOY numbers. In addition the lack of observed utilization of the Clowhom River suggest another factor, yet un-discovered is at play in the area. The obvious unknown is the contribution of all reservoir and lower Clowhom River tributaries on salmonid life history.

  In this case it is recommended that an attempt be made to sample and quantify using electrofishing methods, summer standing stocks in the “key” tributaries on the reservoir and river. Particular emphasis should be placed on the small tributaries of the Clowhom River below the 17-km bridge and streams along the north shore of the lake. Question of use for initial rearing remain but so too does the question of spawning habitats and effects of reservoir “flooding” on potential critical habitats.

- If no change is observed, what is the underlying cause? Efforts to date have focused on fish relative abundance and biometrics. In 2003, sampling included chemistry data. It appears this is the only year the data exists. It is possible, production, while influenced by the reservoir operations may have additional driving mechanisms.

  It is recommended that an effort to include water sampling in future monitoring. A poor understanding of the nutrient loading and dynamic exists for Clowhom Reservoir. This is a critical omission and should be included in future sampling and analysis. It is recommended that in subsequent years nutrients and possibly plankton sampling be included during scheduled sampling periods.

7.0 References

Resource Inventory Committee (1998) Reconnaissance Fish and habitat inventory: Standards and procedures. BC Ministry of Fisheries, Victoria, BC.

Bates, D.J. 2007. Clowhom Lake Water Use Plan. Fish Productivity Monitoring – Year 1 Data Summary. BC Hydro CLOW-WUP-Fish Productivity. Sechelt First Nation.

Bates, D.J. 2009. Clowhom Lake Water Use Plan. Fish Productivity Monitoring – Year 2 - Data Summary 2008. BC Hydro CLOW-WUP-Fish Productivity. Sechelt First Nation.

Bates, D.J and Paul, D. 2010. Clowhom Lake Water Use Plan. Fish Productivity Monitoring – Data Summary 2009. BC Hydro CLOW-WUP-Fish Productivity. Shíshálh First Nation.

Bates, D.J and Paul, D. 2011. Clowhom Lake Water Use Plan. Fish Productivity Monitoring – Year 3 - Data Summary. BC Hydro CLOW-WUP-Fish Productivity. ***FSCI*** Biological Consultants and Shíshálh First Nation.

Bruce, J., 2003. Results of fish studies – Clowhom Lake Water Use Plan. BC Hydro Technical Note Com-FTC-TN-001. Burnaby, BC.