Clowhom Lake Project Water Use Plan

Clowhom Lake Littoral Zone Productivity Study

Implementation Year 6

Reference: COMMON-3

Study Period: 2006 - 2011

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Summary

The Clowhom Lake littoral zone monitoring study was initiated in 2006 to assess and track changes in littoral zone productivity through time. This change is expressed using an ELZ model based on periphyton accrual and biomass change over time.

The 2010 season was the culmination of the 5-year study with periphyton sampling completed using static and dynamic arrays. Sampling in 2010 proved effective with all sample dates completed.

Overall, the 2010 and preceding seasons have been successful in providing periphyton accrual data in Clowhom Lake. It is expected that the data will provide suitable input and facilitate validation of the ELZ model for reservoir management.

The final samples from Clowhom Lake were collected in November of 2010. At that time all arrays were taken out of the lake and the project shutdown.

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1.0 Introduction

In 2006, the shíshálh First Nation and BC Hydro began the first year of a 5 year monitoring program documenting littoral productivity in the Clowhom Lake reservoir. The study and data collected would be used to validate an effective littoral zone (ELZ) model developed by BC Hydro and adapt the model for Clowhom Lake.

The littoral monitoring program was implemented from recommendations made during the water use planning (WUP) process, and was designed to test the validity of the assumption that a reduction in reservoir productivity may be related to reservoir operations and management. In 2010, the final samples were collected and the project deactivated.

The purpose of this report is to summarize the information data collected over the sample period. This report does not analyze the data in detail nor does it attempt to modify or validate the current ELZ model. Validation of the model for Clowhom will be addressed in a future document to be developed with BC Hydro.

2.0 Study Area

Clowhom Lake, a BC Hydro reservoir, is located at the head of Salmon Inlet near Sechelt BC (**Figure 1**). The lake measures approximately 11-km in length and covers an area of about 745-ha and is described as having an upper and lower lake basin relating to the configuration prior to impoundment in the 1950's

Sample locations used for the littoral study were initially selected in late 2006 (Year-1) and include sites in both the upper and lower lake. Three sites were used for the littoral study with one (Array 2) located in the lower and 2 (Arrays 1 and 3) in the upper lake (**Figure 2**). Sites have fixed sample arrays that were flagged along the shoreline and identified in the lake with orange Scotsman® buoys.

3.0 Methods

3.1 Periphyton Growth Substrata and Sampling

Periphyton sample methodology remained the same throughout the study period (*Bates*, 2007, 2008; *Bates and Staats*, 2009; *Bates et al*., 2011). Periphyton samples were collected from plexiglass substrata attached to sample arrays in the lake. The periphyton was collected from the plate by scraping a predetermined area that measured 100-cm^2.

The sample was removed using a modified putty knife with a 5-cm wide blade that was pulled down the plate face for 10-cm. The collected sample was cleaned from the knife into a dry sample jar and the knife then washed into the jar. This ensured all collected materials were captured. Samples were collected using the same staff member whenever possible to further reduce bias and variability in technique.

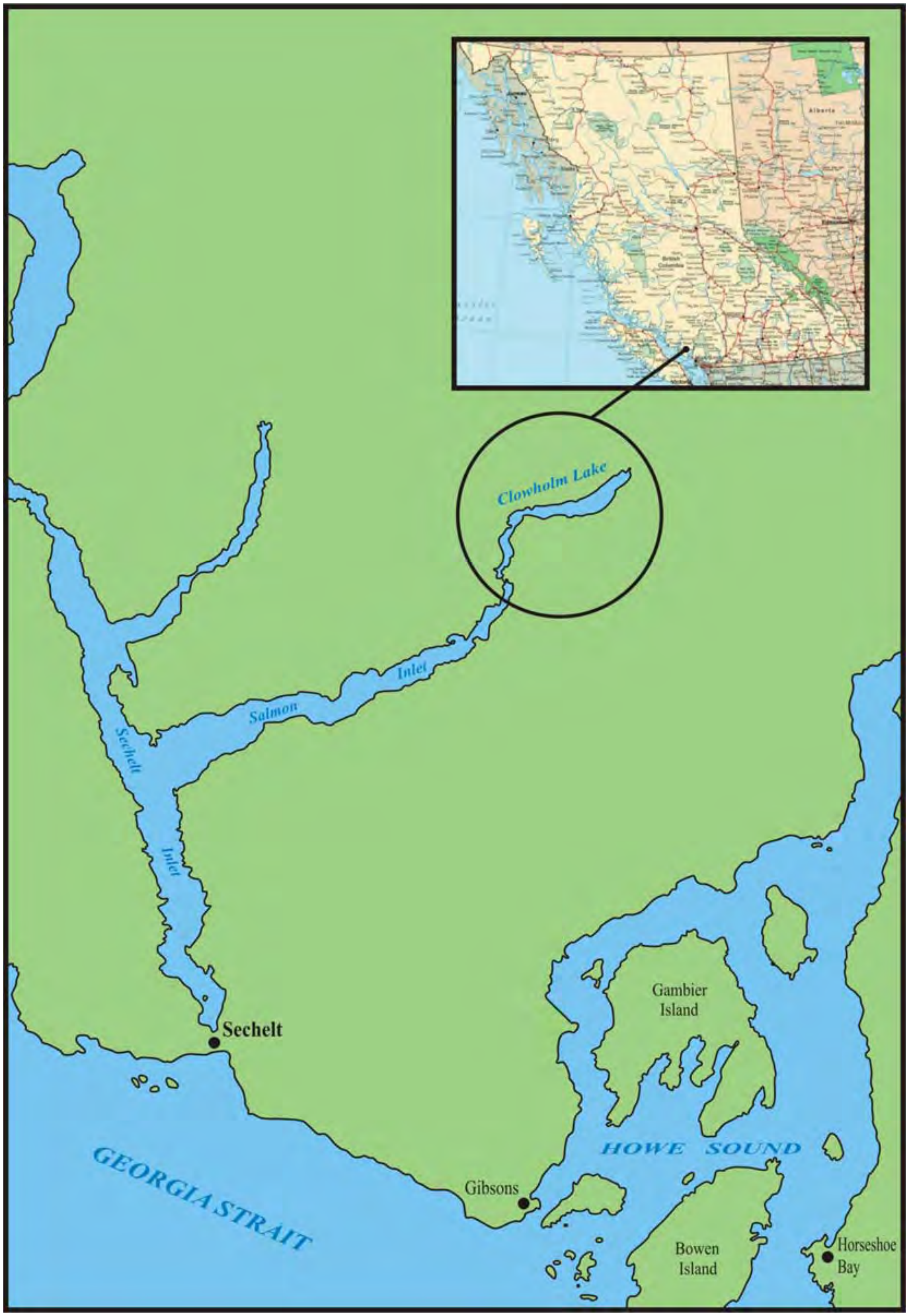

Figure 1: Location of the Clowhom Lake in relation to Sechelt, B.C.

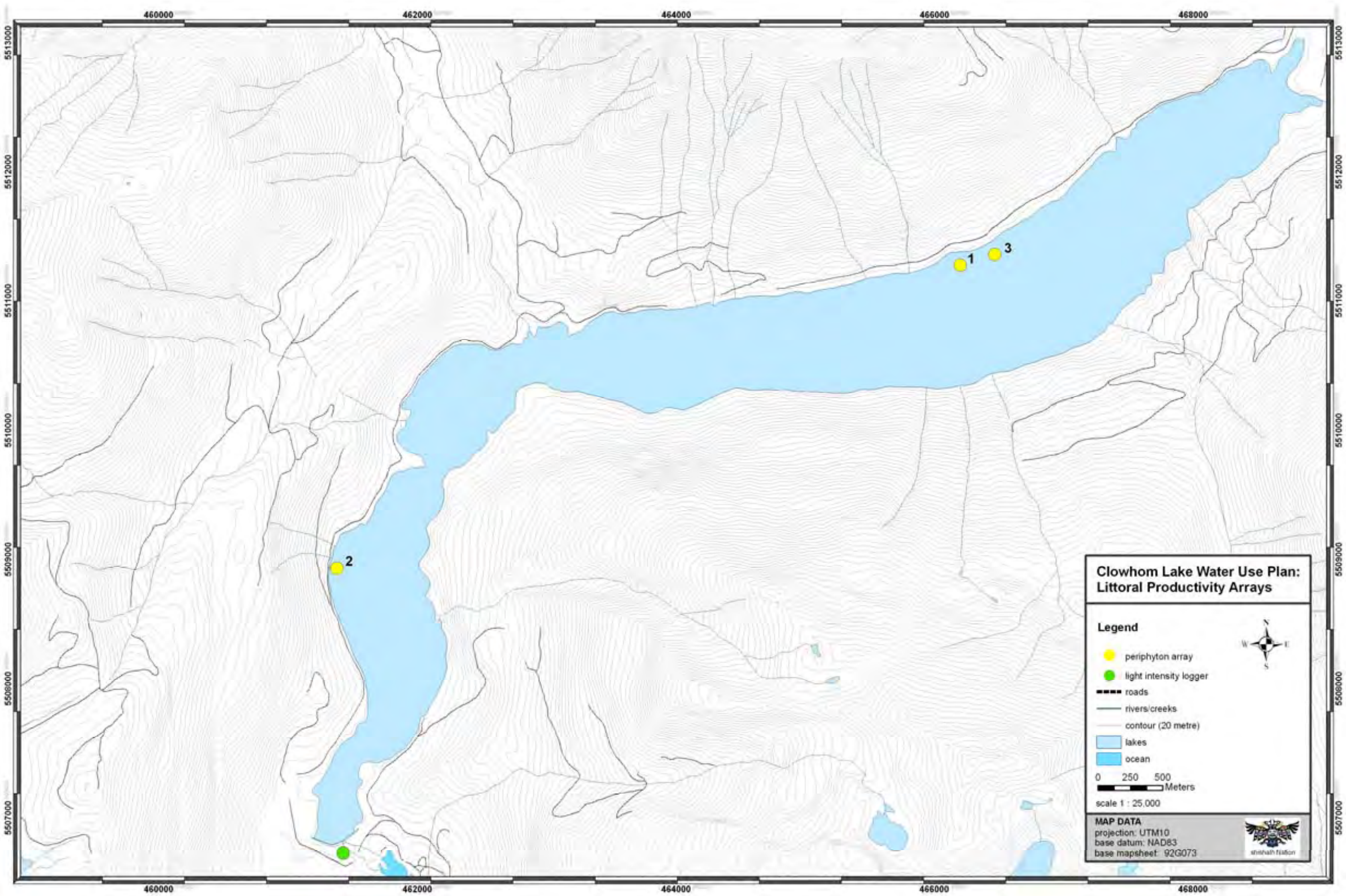

Figure 2: Locations of the periphyton sample arrays in Clowhom Lake, Salmon Inlet, BC. Arrays are located in both the upper and lower reservoir basin and are shown in yellow. The green dot indicates the location of the light intensity logger.

The jars were then sealed in the field, stored in coolers and shipped the following day by courier to Ness Environmental for processing. The lab processed each sample individually and determined ash free dry weight (AFDW) used to estimate periphyton biomass accrual. Results were then provided at the end of each season (*Bates*, 2007, 2008; *Bates and Staats*, 2009; *Bates et al*., 2011).

Sample collection frequency varied was confined to the growing season identified as June to November. Samples were collected approximately every 4-6 weeks and may have varied seasonally if weather hampered safe access to the lake.

Substrata plates were always attached individually and vertical in a series of 11 plates with each plate is spaced 2-m apart. In all years, two types of arrays were deployed, the static (Array 1 and 2), ensuring plates remained in fixed locations in the lake regardless of drawdown range and dynamic (Array 3) that remained at the same depth at all drawdown levels.

3.2 Environmental Data

The collection of environmental data also occurred throughout the five-year period and at each seasonal sample period (June through November). The environmental data included the measurement of light intensity (PAR), water temperature (^{o}C) and dissolved oxygen (mg/L). These parameters were always measured at Arrays 1 and 2 (**Figure 2**).

Light intensity (photosynthetic active radiation (PAR)) was recorded from immediately below the lake surface, then every metre down to a maximum depth of 20-m. The PAR was measured using a Li-Cor® Model LI-1400 light meter. In addition to the PAR through the water column, ambient light intensity was recorded at Clowhom dam using an Onset® data logger tracking daily solar radiation.

Water temperature and dissolved oxygen were also measured along the same vertical column as the PAR using a Hanna Model 9147 dissolved oxygen meter that was fitted with a 30-m probe and cable.

4.0 Results/Discussion

4.1 Periphyton Growth Substrata and Sampling

Sampling of the arrays varied over the course of each year and was dictated by problems with the array design preventing retrieval of the plates, poor weather hampering access to the lake and destruction of the arrays during severe storms. **Table I** summarizes the number of sampling dates completed in each year and shows the variation in samples collected.

Table I: The number of periphyton samples collected from sample arrays in Clowhom Lake between 2006 and 2010. The sample in 2006 was a test sample to ensure arrays were working.

Sample Year	Sample Location		
	Array 1	Array 2	Array 3
2006	1	1	1
2007	6	6	6
2008	6	6	6
2009	7	7	7
2010	6	6	6

Sampling occurred as scheduled in 2010, with a total of 6 samples collected and processed. During the sampling in early June, Array 1 tangled and could not be re-launched. A new anchor at the same location was set and the line restrung within 5 days allowing for samples to be taken within the target growth period.

The periphyton samples were processed each sample year and the results presented in *Bates* (2008), *Bates and Staats* (2009), *Bates et al* (2010 and 2011). **Figure 3** shows the accrued periphyton expressed as micrograms of ash free dry weight per unit area and per day over the growing season for each sample year. The greatest periphyton biomass and growth appears to occur at depths around 4-10-metres. When comparing this to the light measurements in **Figure 6** it can be seen that that greatest light penetration on average occurs around surface to 5-m. Assuming that the greatest productivity occurs within this 4-10 metres stage, reservoir operations would likely influence the overall production if excessive drawdown occurs at optimal growing periods.

4.2 Environmental Data

Light, oxygen and temperature data was also collected each year at the same time as the periphyton samples. Data for each year was summarized in earlier reports (*Bates*, 2008; *Bates and Staats*, 2009; *Bates et al.,* 2010 and 2011). The summary for the environmental parameters was graphed for each sample year and is presented in **Figures 4, 5** and **6**.

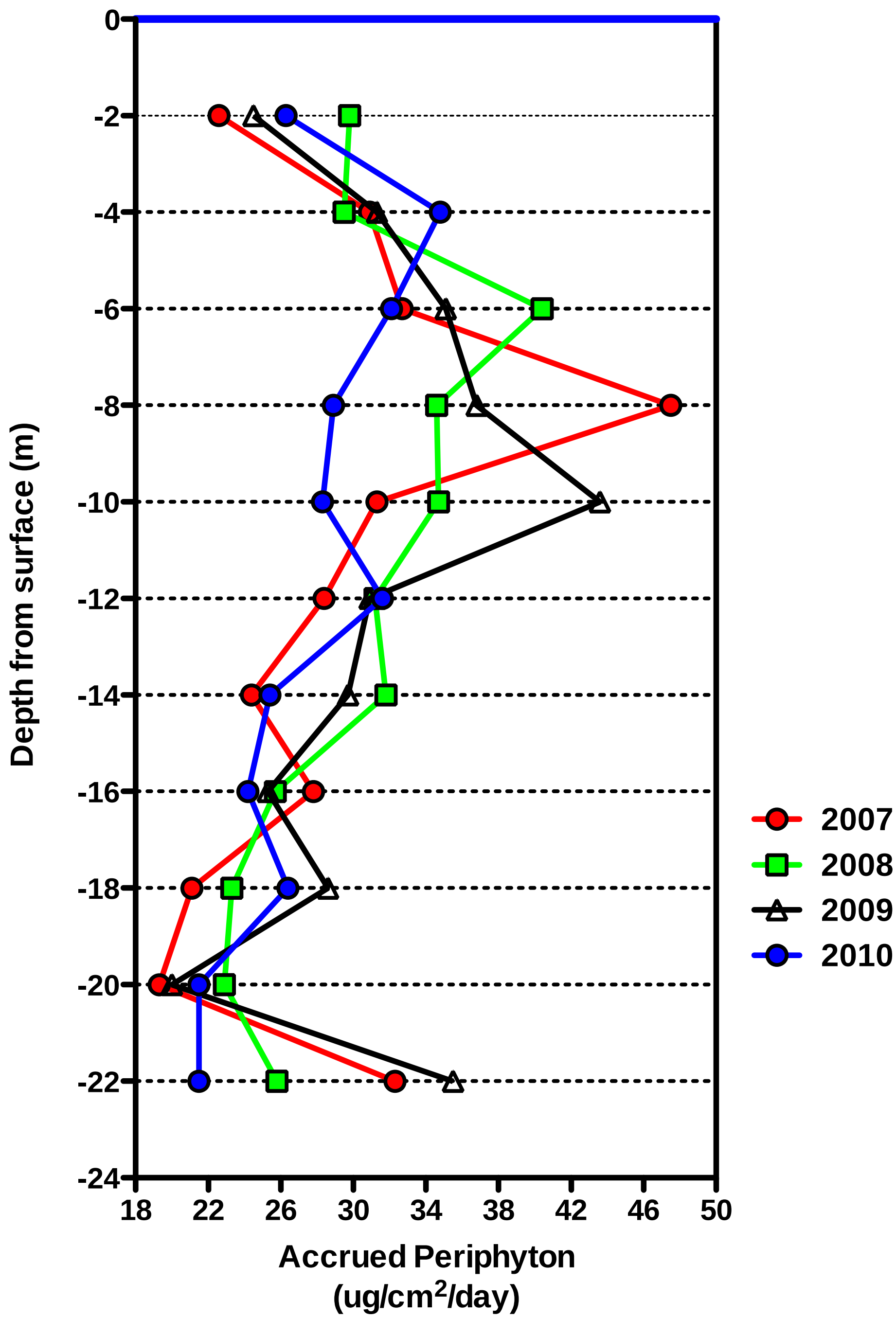

Figure 3: The periphyton accrued on the sample plates in each year sampled. The values are expressed as the micrograms of periphyton per area and day. The accrued weight is based on the ash free dry weight with the averages determined and plotted.

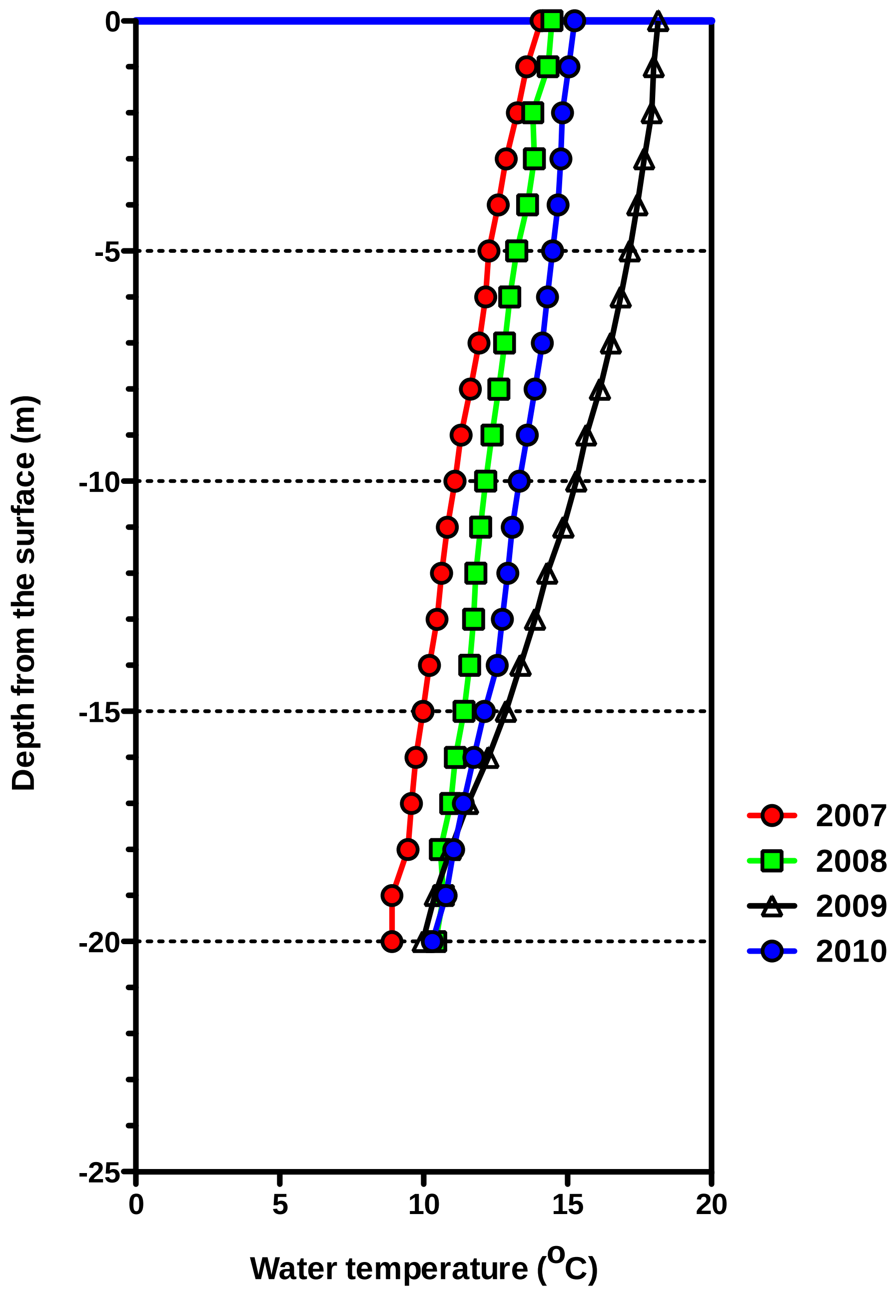

Figure 4: Average water temperature versus depth profile in each of sample. Data was collected along with periphyton samples.

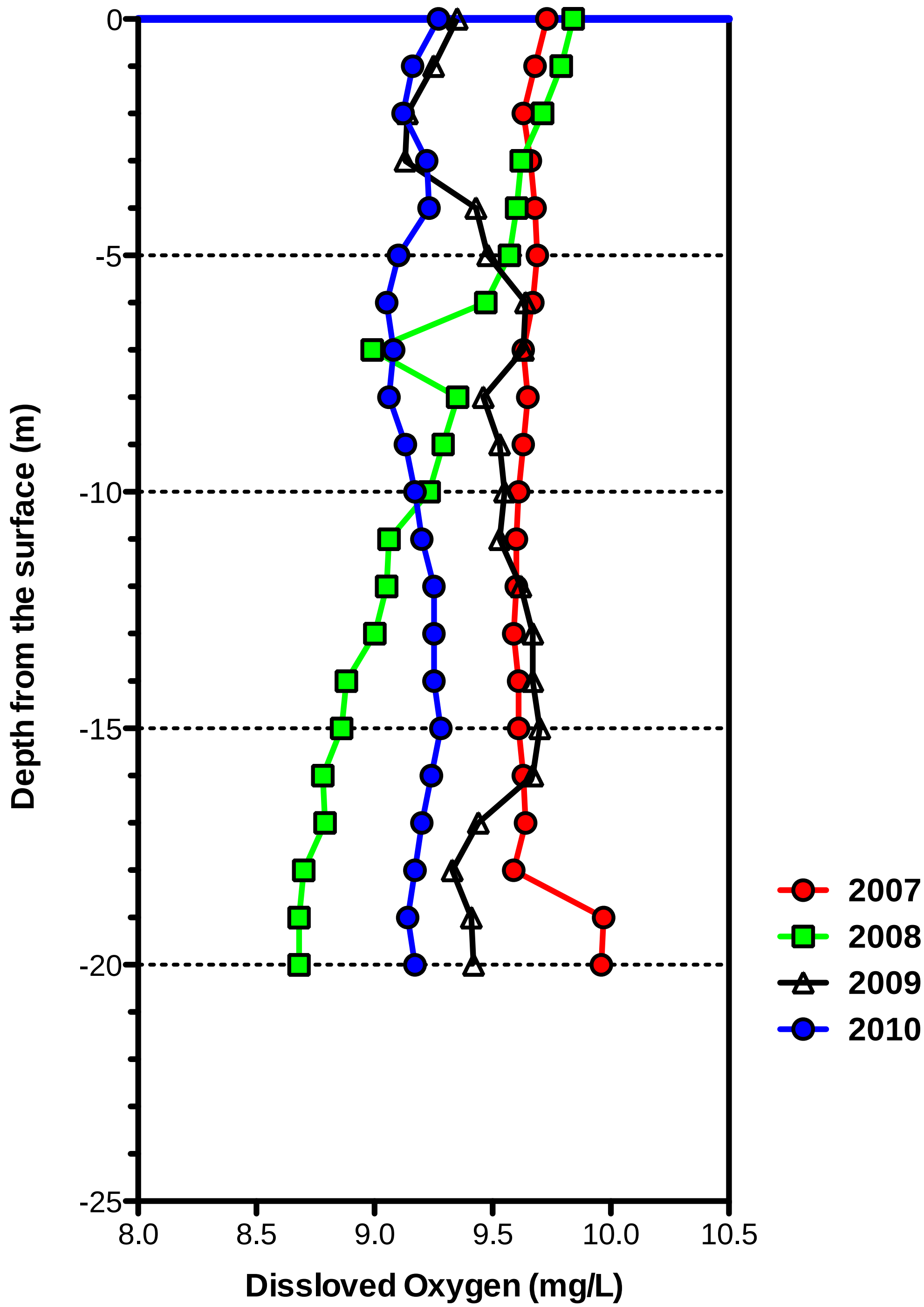

Figure 5: Average dissolved oxygen versus depth profiles for each of the sample years. Data was collected along with periphyton samples.

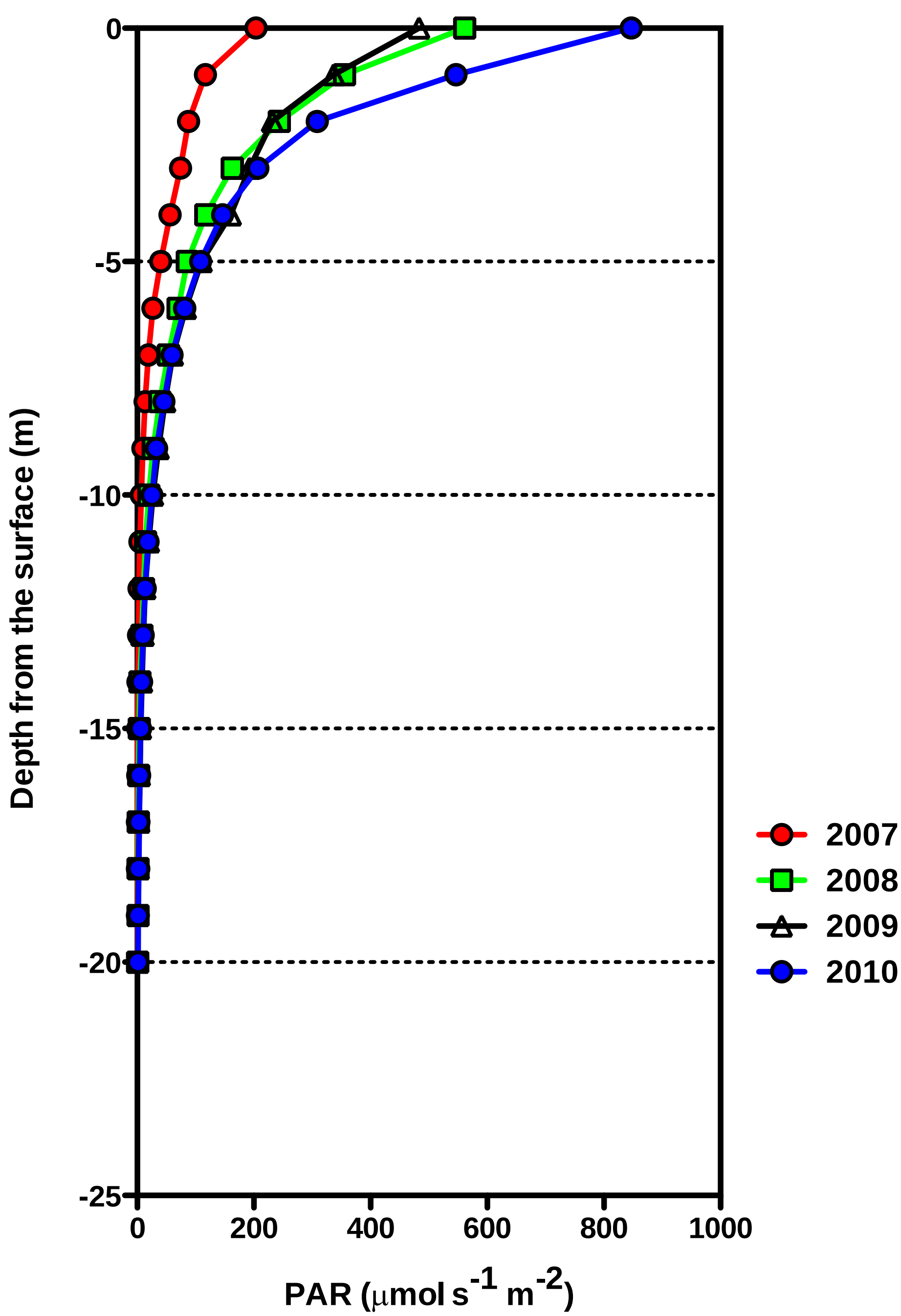

Figure 6: The average PAR versus depth profiles for each complete sample year. Data was collected along with periphyton samples.

6.0 Conclusion(s)

The periphyton or littoral monitoring program proved to be challenging throughout the project from both a planning and logistical perspective. The culmination of the 2010 sample season has provided four years of continuous data following problems and a slow start in 2006. System (Array) failures and weather events throughout the study did result in some data loss but it is argued that the array systems did provide continuous data that should be further analyzed for the modified ELZ model and Clowhom Lake. This analysis will be completed in a future document.

Recognizing that the array design and logistical problems have hampered some sample retrieval, there were also problems outside the control of the project. In 2009 and 2010 BC Hydro implemented deep drawdown's that prevented sample retrieval and in 2010 delayed the start of the sample season. This appears to be unavoidable and a function of the reservoir operations.

The purpose of this project was to provide additional field data on periphyton accrual that could be used to further validate and use of the effective littoral zone (ELZ) performance models developed by *BC Hydro* (2005). The original ELZ model is currently being updated and once complete the data from the Clowhom Lake study will be input and analyzed, examining the applicability of the model to other reservoirs. As a result the project was considered successful and accomplished this goal.

7.0 Future Recommendations

At the completion of the fifth year for the littoral productivity-monitoring program a number of recommendations were presented (*Bates et al*., 2011). These are presented again in the event a similar study or continuation of the Clowhom Lake study is considered in the future. These are:

1. Improved communication and notification of reservoir drawdown where active studies are being conducted. The "last" minute notification of pending drawdown resulted in adaptation and changes to study components like sampling schedules and access to boat. While not directly a threat to the project it creates costly, unexpected alterations to processes and scheduling. There is also concern that this unexpected drawdown during high productivity windows may influence data quality.

2. Future studies that include simpler array concepts must be as simple in design as possible. The original conceptual designs, while suitable in concept proved costly to build and maintain and had an extremely high failure rate. The less hardware in the water the more effective from an operational standpoint.

8.0 Reference

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