Stave River Project Water Use Plan

Pelagic Monitor and Littoral Productivity Assessment (Year 4)

Reference: SFLMON#1 Pelagic Monitor
Reference: SFLMON#2 Littoral Productivity Assessment

Stave River Project Water Use Plan: Pelagic Monitor and Littoral Productivity Assessment

Study Period: 2008

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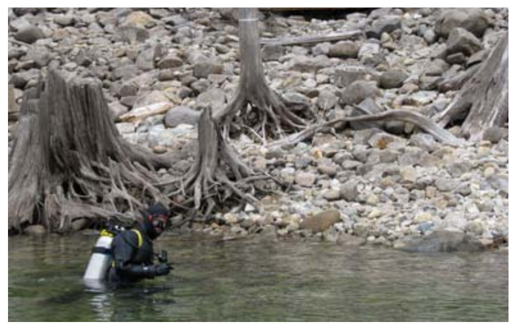
Ness Environmental

May 2009

STAVE RIVER WATER USE PLANNING

Report on the 2008 Pelagic Monitor and Littoral Primary Production Monitor

[StaveLimnoNess2006–2008]



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Date: May 2009

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1. Introduction

This report summarizes all components of a fresh water productivity monitoring and data collection program undertaken in 2008 on Stave and Hayward reservoirs as part of the Stave WUP Monitor. The 2008 monitoring program was the fourth year of the second phase of a comprehensive pelagic and littoral monitoring program resulting from BC Hydro's Stave River Water Use Planning process. Phase 2 monitoring is defined by BC Hydro as a ten-year base level sampling program (to 2014) or until the next Water Use Plan review process. The more intensive Phase 1 monitoring was conducted from 2000 to 2003 (Stockner and Beer, 2004; Beer 2004).

The objectives for both the littoral and pelagic components of the monitoring program are to collect the data necessary to test the impacts of reservoir operations on the productivity of Stave Reservoir (fluctuating water level) and Hayward Reservoir (comparatively stable water level). BC Hydro has identified several management questions and hypotheses to be tested against the collected data. This report discusses both the littoral and the pelagic components of the Phase 2 data collection program, as defined by BC Hydro, and specifically addresses the activities conducted in 2008, including details of field sampling and laboratory programs, and summaries of both the littoral and pelagic components of the 2008 sampling season. Some relatively simple multiple-year summaries are also provided. While pelagic and littoral components of the monitoring program are considered separately in the terms of reference provided by BC Hydro, both components are presented together in this report.

Ness Environmental Sciences (Ness) is the project manager for Phase 2 of the monitoring and data collection program (BC Hydro contract StaveLimnoNess2006-2008). Ness has experience in the practical application of both littoral and pelagic research components of the study, including study design, sampling, and laboratory and data analysis and reporting. Ness conducted all field components of Phase 1 with BC Hydro and contributed significantly to the preliminary data analysis as part of a Master's thesis at UBC (Beer, 2004). Ness has seven years of site-specific expertise conducting littoral productivity assessments and nutrient sampling on Stave and Hayward reservoirs, as well as experience conducting ^{14}C incubations and estimates of pelagic productivity.

Ness has collaborated with Eco-logic Ltd. to act as senior scientific advisor on the monitoring program by providing the limnological expertise of Dr. John Stockner who has over 30 years of research experience. Eco-logic has extensive expertise in nutrient poor ecosystems and in the methods of ^{14}C analysis. Dr. Stockner has acted as an advisor throughout the 2008 sampling season, conducted phytoplankton analyses and aided in the preparation of this report.

The project also relied upon the diving expertise of Pelagic Technologies. Pelagic Technologies provided a 2-person dive team for all field sampling components. In 2008 Kwantlen First Nation and Pelagic Technologies shared responsibility for providing a boat, operator and dive tender.

2. Background

The Phase 2 pelagic and littoral monitoring programs commenced in 2005. As the Phase 1 monitoring program was completed in 2003, there was a need to re-establish the fixed monitoring locations for the littoral transects on both Stave and Hayward reservoirs. In July 2005 the same four littoral sampling transects from Phase 1 were re-established (three sites on Stave and one site on Hayward) using the concrete blocks that were left in place following the completion of the Phase 1 monitoring. Figure 2.1 indicates these transect locations along with their coordinates (Table 2.2).

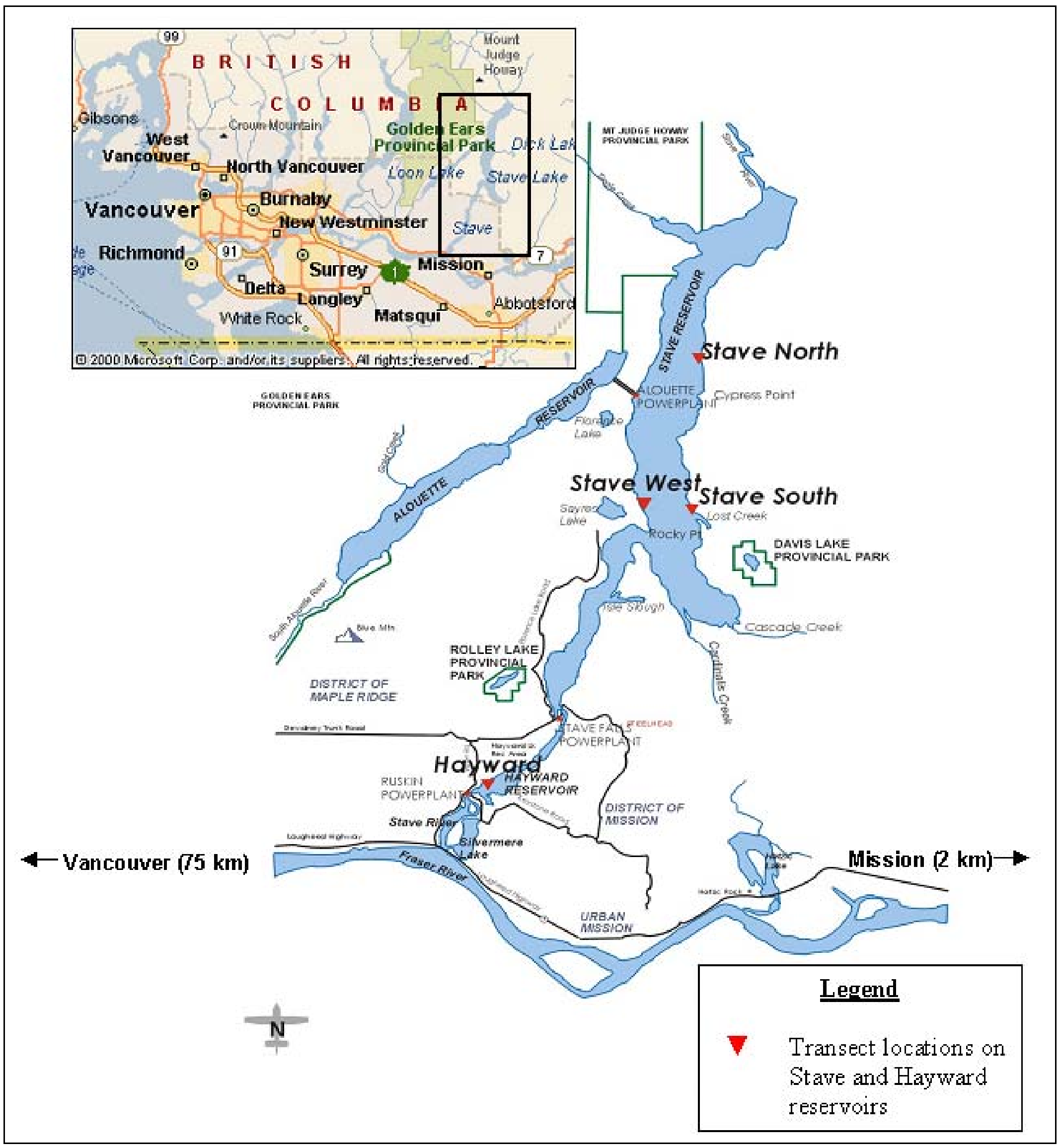


Figure 2.1: Transect Locations on Stave and Hayward Reservoirs (Beer 2004)

Table 2.1: GPS Coordinates of Transect Locations

Site	UTM Easting	UTM Northing
Stave North	552870	5469570
Stave West	549957	5464097
Stave South	552255	5465284
Hayward	544767	5450607

Each of the three sampling transects on Stave (Stave North, Stave West and Stave South) are comprised of 10 sampling stations, with approximately 2 metres elevation separating each station. Hayward is comprised of 8 sampling stations. Each station includes a large concrete block (Figure 2.2) to act as an anchor for the sampling plate. The deepest 4 stations at each site have sampling plates suspended approximately 1 metre above the concrete block by buoyant sampling trays (Figure 2.3). This approach avoids having the sampling plates impacted by loose sediment at these depths. The upper stations at each site have the sampling plates attached directly to the concrete blocks by stainless steel studs (Figure 2.4).

Two additional (spare) concrete blocks were located at Zajac Ranch on the west side of Stave Reservoir (site of the former Stave Lake Correctional Facility where the sampling blocks were constructed prior to Phase 1 in 2000) and are available in the future as needed.

Figure 2.2: Concrete Littoral Sampling Blocks

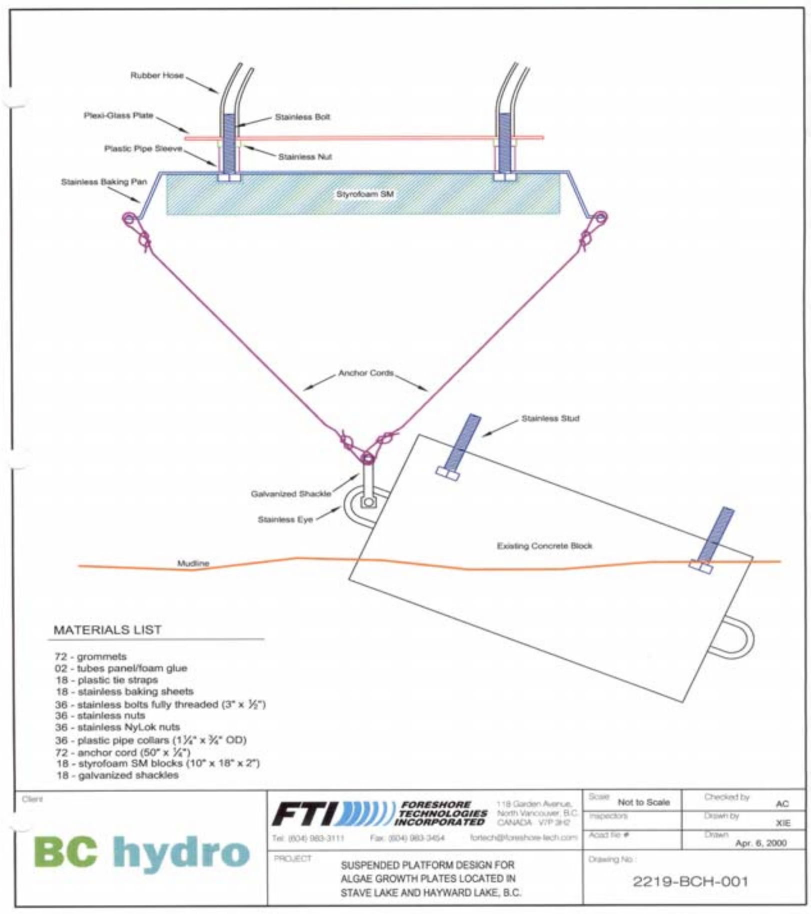


Figure 2.3: Littoral Sampling Apparatus (Cement Block and Buoyant Tray)

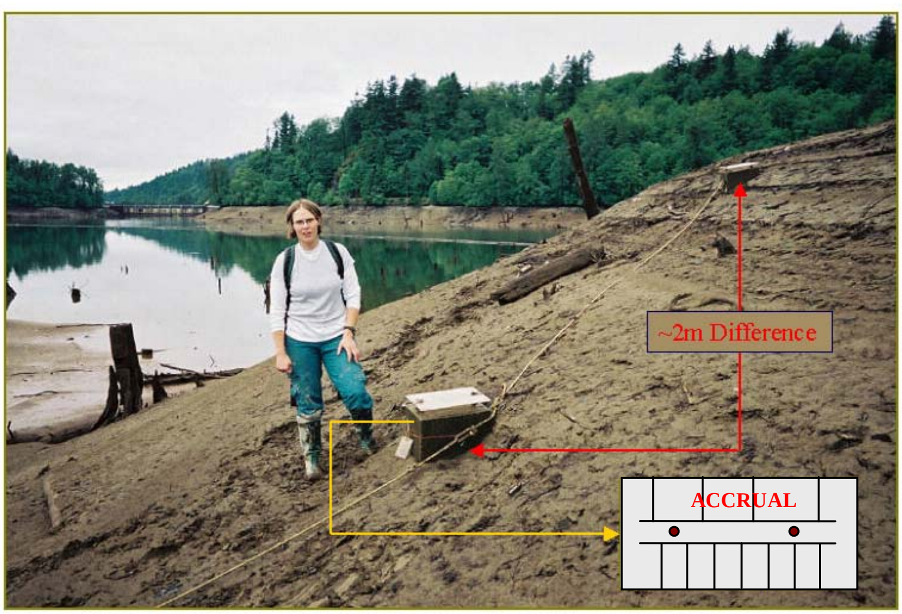


Figure 2.4: Littoral Sampling Design

3. Pelagic and Littoral Monitoring Programs for 2008

The littoral monitoring program measures periphyton as a surrogate from which to estimate primary productivity in the near-shore environment. As part of Phase 2, direct measures of littoral primary productivity using ^{14}C inoculation and incubation were also conducted. These direct estimates were taken from one sampling station in each reservoir to provide a calibration for the estimates of littoral primary production from Phase 1, and will continue to be collected as part of Phase 2 of the monitoring program. As part of the pelagic monitoring program, nutrient and phytoplankton analyses are conducted in each year. As an indicator of overall productivity, pelagic primary productivity analyses (^{14}C analyses) will be conducted every three years. The first year of these analyses took place in 2008. A summary of the monitoring programs is provided in Table 3.1.

Table 3.1: Summary of 2008 Monitoring Programs

Pelagic Monitoring Program	Littoral Monitoring Program
• Sampling takes place on approximately 5-week intervals from April to November	• As in Phase 1, sampling takes place on approximately 5-week intervals from April to November
• 1 sample site on Stave, and 1 on Hayward, plus additional sampling at Allouette outfall when generating.	• 3 sample sites on Stave and 1 on Hayward (4 transects in total)
• Nutrients including: total and dissolved phosphorous, total nitrate, and chlorophyll-a concentrations	• Periphyton sampling from artificial substrata located at all 4 transects, to provide estimates of primary production (ash-free dry mass accrual)
• phytoplankton analyses	• ^{14}C incubation estimates of production are conducted each sampling trip from one plate at both Hayward and Stave North. The plate to be sampled is determined randomly.
• zooplankton analyses	
• ^{14}C incubation estimates of primary production every 3rd year (first in 2008)	
• light intensity and temperature profiles	
• other data: solar irradiance (Metro Vancouver air monitoring network); temperature (BC Hydro, Environment Canada, Metro Vancouver); reservoir levels (BC Hydro)	

Hard copies of all data are kept in field and laboratory notebooks. Excel spreadsheets and an Access database are used to electronically store all data collected, along with some of the other data noted in Table 3.1.

The 2008 monitoring program began in March 2008 and continued in a similar manner and schedule as previous years. To build efficiencies into the monitoring program, pelagic and littoral field sampling trips were combined and completed on the same day, at approximately 5 to 6 week intervals. Field sampling dates and reservoir levels for 2008 are shown in Table 3.2.

Table 3.2: 2008 Field Sampling Schedule and Reservoir Levels

Date	**Hayward Reservoir Level** (at noon, PST)	**Stave Reservoir Level** (at noon, PST)
March 7, 2008	40.85	75.45
April 18, 2008	41.05	72.62
May 23, 2008	41.25	79.17
June 20, 2008	41.31	81.30
July 29, 2008	41.18	80.98
September 8, 2008	41.24	79.94
October 14, 2008	41.32	77.22
November 24, 2008	41.23	77.97

Note that the April 2008 sampling period on Stave could not be completed due to low water levels.

3.1 Littoral Monitoring Program

The littoral monitoring program uses roughened acrylic plates to act as artificial substrata to collect periphyton growth samples. Spare sampling plates are used to replace damaged or missing plates as needed.

The periphyton growth samples are used to estimate the littoral primary productivity at each of the four sampling transects (1 in Hayward and 3 in Stave) that were established as part of the Phase 1 monitoring program. Littoral primary production is being estimated by two methodologies:

- ash-free dry weight (AFDW, or periphyton accrual)
- ^{14}C incubation technique

a) Ash-Free Dry Weight (AFDW) – Periphyton Accrual

Periphyton samples were collected using a glass microscope slide to scrape the periphyton from a 10 cm by 10 cm area off the acrylic plates and conveyed into a labeled plastic jar using a stream of lake water taken from the immediate sampling location. Samples were labeled, stored in a cooler and taken to the laboratory for processing immediately following the sampling session. In theory a total of 38 periphyton samples are collected during each sampling visit. However, depending on the water levels, there may be occasions when there are less than 38 samples when the uppermost plates are above water. Since the implementation of lower operating levels on Hayward reservoir in 2006, the top plate of the Hayward transect has consistently remained above water.

In the laboratory, periphyton growth samples scraped from a known area of the sampling plate are treated similarly as follows:

- filtered at low vacuum pressure onto a pre-weighed, pre-ashed, 0.45 µm, 47 mm glass fibre filter (GFF).
- filter sample is placed in an aluminium weigh boat and dried in an oven at 100ºC for 12-24 hours to ensure all moisture is eliminated from the filter sample.
- oven-dried filter sample weight is recorded as dry-weight (DW_{oven}).
- oven-dried filter samples were ashed at 500ºC in a muffle furnace for a minimum of 5 hours and then re-weighed (DW_{muf}).
- ash free dry weight (AFDW) was calculated as the difference between the DW_{oven} and DW_{muf}.

AFDW (or periphyton accrual) is expressed in mass of organic content per unit area per day (mg/cm^2/day). The carbon (C) component of periphyton accrual is calculated as 45% of the organic content (AFDW) of the sample (Stockner and Armstrong, 1971). The carbon component of periphyton accrual is used as an estimate of littoral primary production.

b) ^{14}C Incubation Technique

Additional littoral primary production estimates were made using a littoral ^{14}C incubation technique. Essentially, littoral primary production can be estimated from the amount of ^{14}C incorporated (during photosynthesis) into periphyton samples during *in-situ* incubations for a known period under known light conditions. The littoral ^{14}C incubation technique is similar to a methodology developed for estimating pelagic primary production.

This method is being further developed as part of the Phase 2 monitoring program. It was determined that in order to test the method it was important to sample at the same locations each time the ^{14}C incubation technique was conducted. From a practical point of view, it made the most sense to select one site on Stave and one on Hayward. In 2007 samples were collected from Stave North and in 2008 samples were collected from Stave South. Periphyton samples were taken from a single plate, determined randomly from amongst the stations on each transect at Hayward and Stave South. For this technique, each of the sampling plates was specially etched with six equivalent 40 cm^2 areas. During sampling, two 40 cm^2 areas were scraped of periphyton and transferred separately to two clear BOD (Biological Oxygen Demand) bottles. Two 40 cm^2 areas were scraped and transferred to a single dark BOD bottle. Each 300 ml BOD bottle was then topped up with deionized water and prepared for incubation with an inoculation of 5 µCu of carbon.

Each of the BOD bottles and samples collected from Stave and Hayward were then attached to acrylic plates designed to hold the bottles in a horizontal plane at right angles to each other and then re-suspended to their original sampling plate depths at Stave North. Samples were incubated *in-situ* for 2-4 hours, generally between 11 AM and 3 PM on the sampling day. Light penetration in the two clear bottles allowed photosynthesis to occur, while the dark bottle excluded light and measured dark uptake or respiration. After incubation, samples were retrieved and placed into light-tight boxes for transport back to the laboratory.

The incubations were terminated in the laboratory on the same day in the following process:

- samples were filtered through a 0.2 µm 47 mm polycarbonate filter using <10 cm Hg vacuum differential (Joint and Pomroy, 1983);
- Prior to filtration the BOD bottles were agitated for 30 seconds and then allowed to settle for 30 seconds before pouring an alloquot of the sample to be filtered. Filtration volumes ranged from 60-100 ml;
- each filter was placed into a 7 ml scintillation vial;
- 200 µL of 0.5 N HCl was added to each vial to eliminate the unincorporated inorganic $NaH^{14}CO_3$ and the vials left uncapped in a darkened fumehood to dry for approximately 48 hours;
- when dry, 5 ml of Ecolite scintillation flour was added to each filter and stored dark for at least 24 hours;
- Replicate samples from randomly selected BOD bottles were also analyzed;
- samples were analyzed by Cantest Labs (Vancouver, BC) in a Beckman LS1801 scintillation counter operated in an external standard mode to correct for quenching (Pieters et al. 2000).

Littoral primary productivity was estimated by the difference of the scintillation counts between filter samples of periphyton incubated in the clear BOD bottles (photosynthetic ^{14}C incorporation) and those incubated in the dark BOD bottles (non-photosynthetic ^{14}C incorporation). Hourly primary production rates were calculated using methodology described by Parsons et al. (1984). Daily primary productivity was obtained by dividing the primary production rate during the incubation by the ratio of the incubation period irradiance to the total daily irradiance.

It is important also to account for the specific activity of the carbon stock used for the inoculation. To control for this variability, a standard assay was performed to determine the total activity (DPM_{total}) added to the samples:

- 100 µL ^{14}C-bicarbonate solution was added to scintillation vials containing 5 ml Ecolite scintillation cocktail;
- scintillation counts were performed using the same scintillation counter used for the filtered periphyton samples.

Figure 3.1: Littoral Carbon Sampling Array

3.2 Pelagic Monitoring Program

Pelagic sampling consisted of a variety of environmental, biological and chemical parameters in both Stave and Hayward reservoirs, including:

- water chemistry
- chlorophyll
- phytoplankton
- zooplankton
- water temperature, and
- light

Pelagic sampling and data collection was conducted mid-reservoir on both Stave and Hayward once per sampling trip. ^{14}C estimates of pelagic primary production were conducted in 2008.

Water chemistry and chlorophyll samples were collected as part of the pelagic monitoring program. A mid-lake composite sample (1, 3, 5 m) was collected from Stave and Hayward using a Van Dorn non-metallic water sampler. Samples were processed in accordance with the appropriate methodology provided by SPA Chemtest (DFO Laboratory, Cultus Lake, BC) for total phosphorus, total dissolved phosphorus, nitrate, and chlorophyll *a*. A copy of this methodology is included as Appendix 1. Additional water quality samples were collected adjacent to the Allouette outfall during the May 23, 2008 sample session, which was the only sampling day that occurred while the Allouette power station was generating. Samples were processed immediately after the water samples were collected, and then stored according to the protocol, either cooled or frozen, until they could be transported to the laboratory for analysis.

Phytoplankton samples were collected from the same composite sample collected for water chemistry analyses and preserved with lugols iodine solution. In the monitoring program Terms of Reference, BC Hydro identified that phytoplankton sampling in the Phase 2 monitoring program would be reduced to one late-summer sample from each reservoir. Senior scientific staff on this project identified concern over the reduction in sampling frequency of phytoplankton, as phytoplankton are the best early indicators of change in oligotrophic pelagic environments. As a result, phytoplankton were collected once each sampling trip. In 2008, all samples were enumerated using the Utermohl (1958) method for micro-phytoplankton (*e.g.* diatoms, dinoflagellates, and blue-green algae) and ultra-phytoplankton (*e.g.* pico-cyanobacteria and nano-flagellates) to the nearest species taxon level. Counts are reported as abundance (cell/ml) and estimates of biovolume (mm^3/L).

Zooplankton were sampled as a vertical tow at 20 metres depth in Stave and at 15 metres in Hayward with a Wisconsin net 80 μm mesh sampler. The Phase 2 monitoring program outlined collection of zooplankton only once per season on each reservoir, to occur in late summer when reservoir levels tend to be held relatively constant to accommodate recreational uses on Stave. However in 2006 a decision was made to sample zooplankton during each sampling trip and assess ability to provide enumeration on an annual basis.

Oxygen levels (O_2, mg/L) were identified in BC Hydro's Terms of References to be measured at 1-metre intervals to a depth just beyond the thermocline and then at 5-metre intervals to the maximum depth possible with the Oxy Guard Handy Beta meter. It was determined through communication with BC Hydro staff that oxygen levels have not been included in the compliment of environmental variables sampled as part of the monitoring program to date. As a result, these data have not been collected as part of the Phase 2 monitoring program. If these data are desired then sampling for oxygen could be undertaken in the future.

Water temperature (ºC) was measured at 1-metre intervals to a depth just below the thermocline (when present) and then at 5-metre intervals to the maximum depth possible of the temperature sensor. The temperature sensor was kept vertical using a light weight and maintaining constant boat position under windy conditions. Temperature profiles were collected at the same locations on the reservoir that other physical variables and water chemistry samples were measured.

Light intensity (photosynthetically active radiation – PAR) was measured at 1-metre intervals to a depth at which PAR is <1% of surface solar radiation. BC Hydro's LiCor Li-250 light meter and Li-192SA submersible quantum sensor were used to maintain consistency with Phase 1 of the sampling program. A light weight was used to keep the sensor vertical while taking measurements, and care was taken to ensure that the boat did not cast a shadow over the sensor. A single light profile was collected mid-reservoir from Stave and Hayward during each sampling trip. Vertical profiles of PAR were log-transformed and plotted against depth to get an estimate of the extinction coefficient (k). Secchi disk readings were also taken on each trip on the shaded side of the boat and will be incorporated into the light analysis conducted as part of the monitoring program.

Although not collected by this monitoring program, there are important data available, including:

- global solar radiation from measurements collected continuously by Metro Vancouver at Port Moody, Coquitlam and Abbotsford using a LI-COR pyranometer (LI-200SA). This data will provide a continuous record of solar radiation at a proximal site that is assumed representative of the solar radiation reaching the surface of both Stave and Hayward Reservoirs.
- air temperature (BC Hydro, Environment Canada, Metro Vancouver)
- reservoir levels (BC Hydro)

Figure 3.2 Diver Retrieving Sampling Plate

4. Results for 2008

Results are presented for data collected in 2008.

4.1 Light

Light profiles for Stave and Hayward on each of the sampling days in 2008 starting with the May 23rd sampling session are presented in figures 4.1 and 4.2. The lower light levels measured at Hayward result from the fact that light measurements on Hayward were typically made about 9 AM, while those on Stave were typically made about 1 or 2 PM.

Figure 4.1: Stave Solar Irradiance

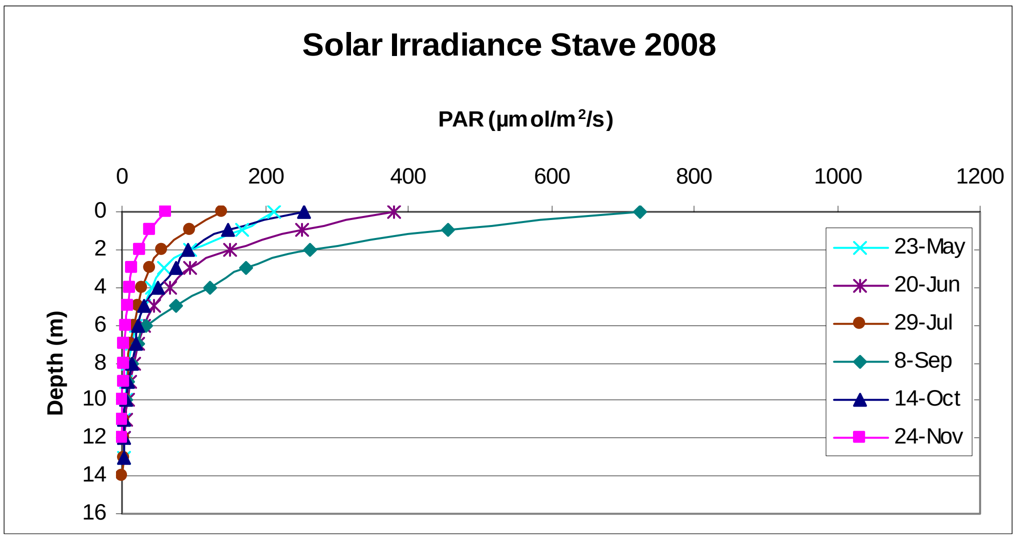
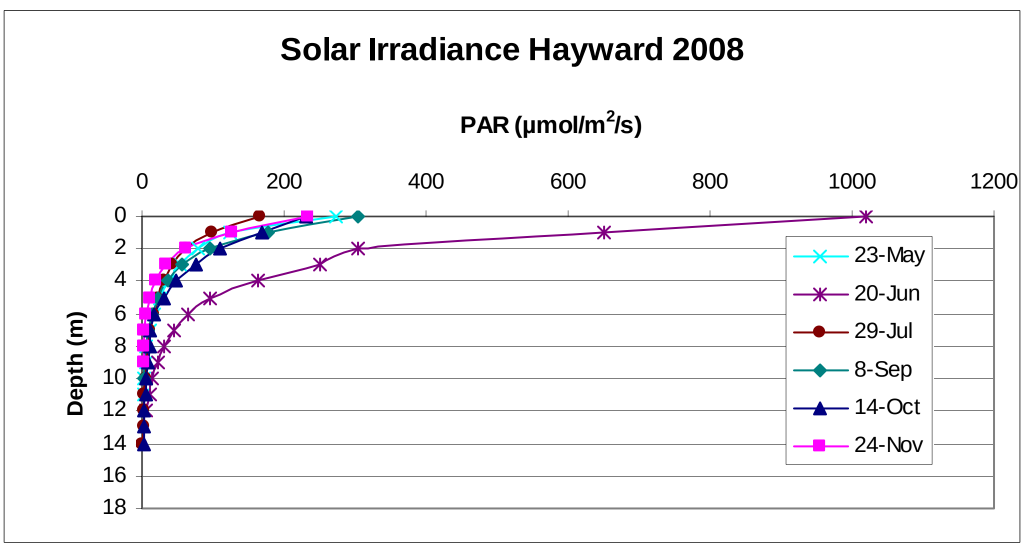


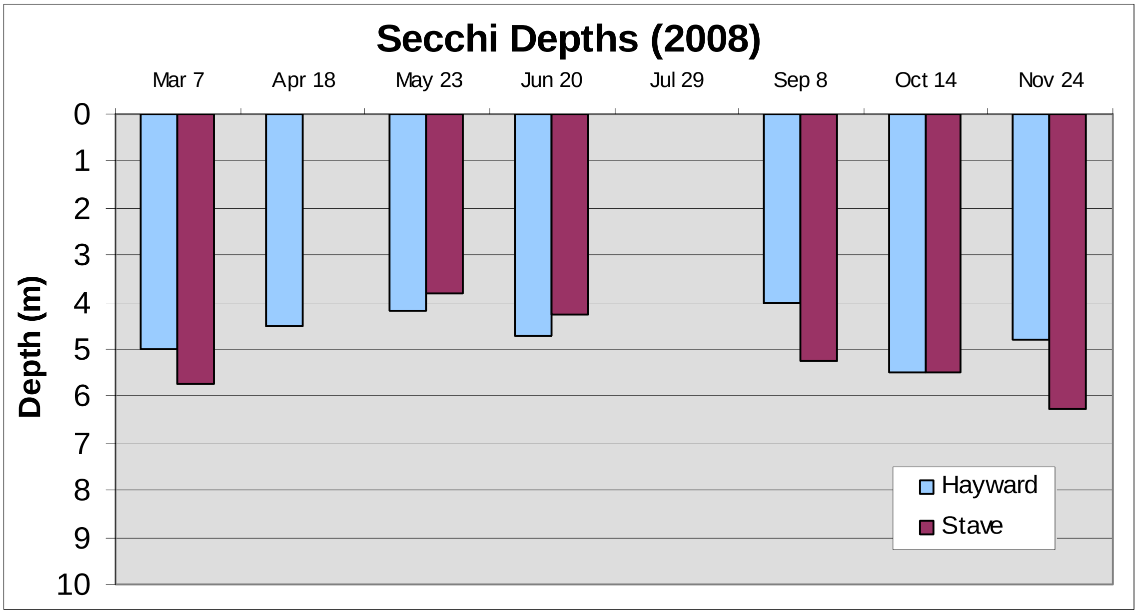
Figure 4.2: Hayward Solar Irradiance



Light measurements were not taken on Hayward or Stave on March 7 or April 18, 2008, as the Licor data sensor was not available.

Secchi depths for each sample day on Stave and Hayward are presented in figure 4.3 below.

Figure 4.3: Secchi Depths for Stave and Hayward



Extinction coefficients calculated from each light sampling profile at Stave and Hayward are presented in Table 4.1.

Table 4.1: Extinction Coefficients (2008)

Date	Hayward	Stave
07-Mar		
18-Apr		
23-May	0.43	0.37
20-Jun	0.41	0.39
29-Jul	0.34	0.33
08-Sep	0.48	0.50
14-Oct	0.35	0.37
24-Nov	0.56	0.39

Surface solar radiation throughout 2008 at Stave and Hayward reservoirs was estimated from hourly measurements of global radiation (sum of direct and diffuse solar radiation) collected by Metro Vancouver at Coquitlam and Abbotsford using a LI-COR pyranometer (LI-200SA). Solar radiation data collected in this manner includes wavelengths from 400 – 1100 nm, a slightly wider range than is typically used in limnological studies (PAR, 400 – 700 nm).

Average daily global radiation estimated for Stave and Hayward are shown in figures 4.4 and 4.5. These data are the average of data collected at Coquitlam and Abbotsford and are expected to be representative of the conditions experienced at Stave and Hayward during the approximate 5-week intervals between sampling.

Figure 4.4: Daily Average Global Solar Radiation (by day)

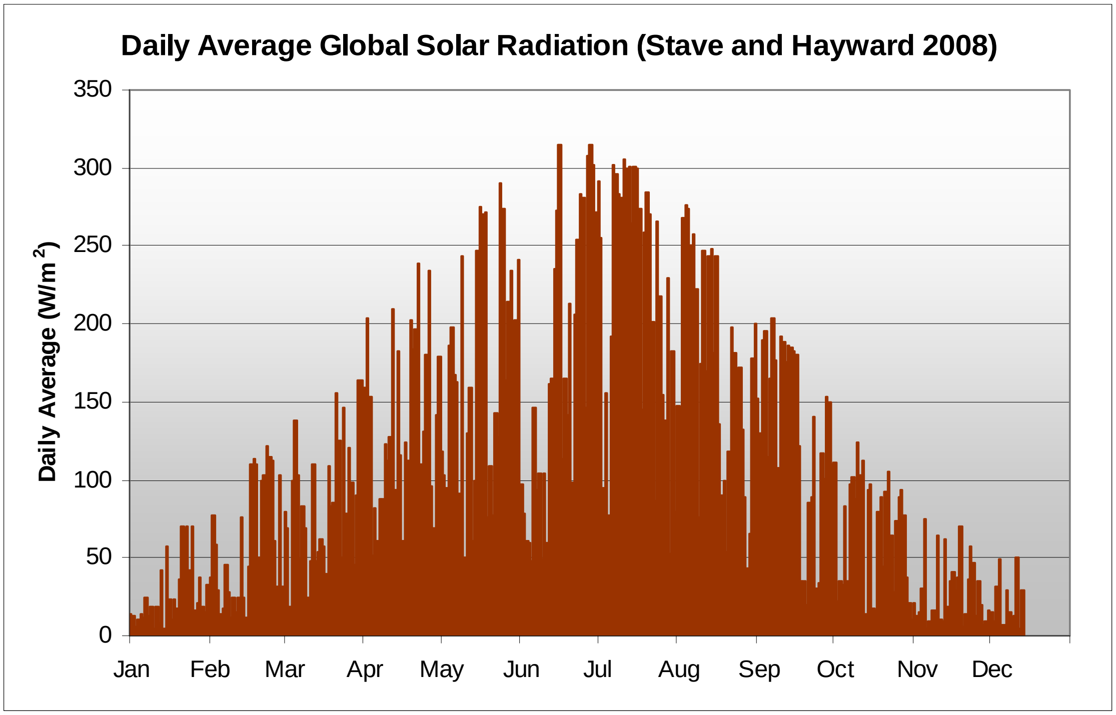
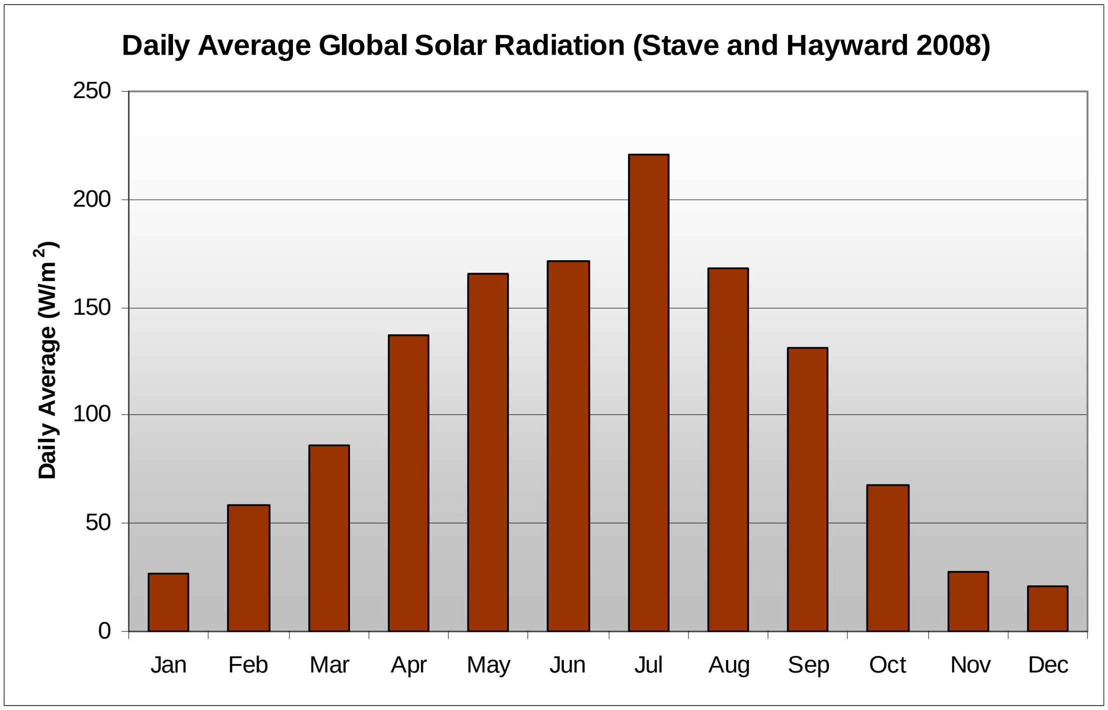


Figure 4.5: Daily Average Global Solar Radiation (by month)



4.2 Water Temperature Profiles

Water temperature profiles for Hayward and Stave on each of the sampling days in 2008 are presented in figures 4.6 and 4.7, respectively.

Temperatures between the two reservoirs were observed to be quite similar, with slightly warmer temperatures in Hayward. Temperature readings at Hayward were typically made about 9 AM, while those on Stave were typically made about 1 or 2 PM, which may account for the slightly higher summertime surface temperatures measured in Stave. Also notable is the summertime development of a warm surface layer and a thermocline in Stave that does not develop in Hayward.

Figure 4.6: Hayward Temperature Profile

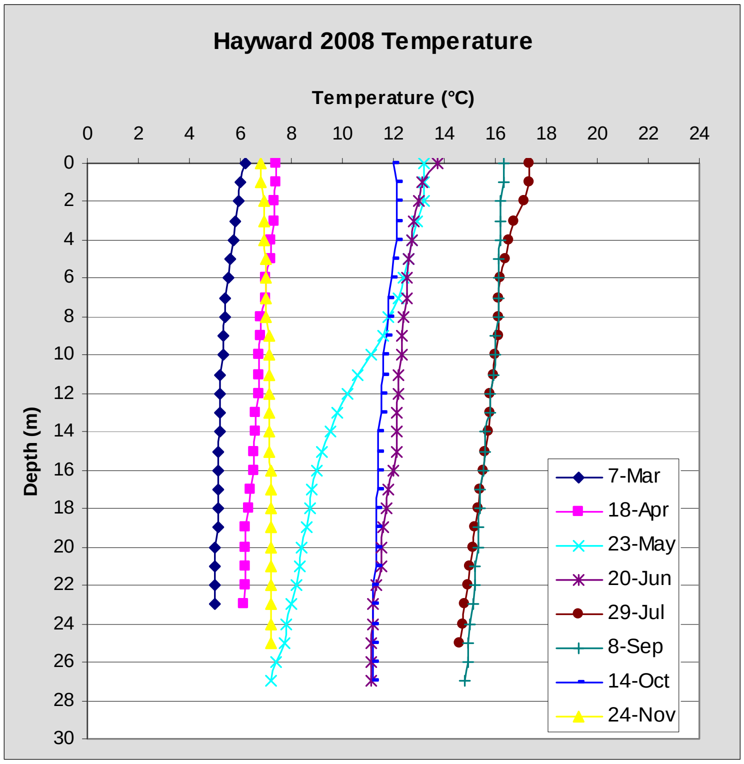
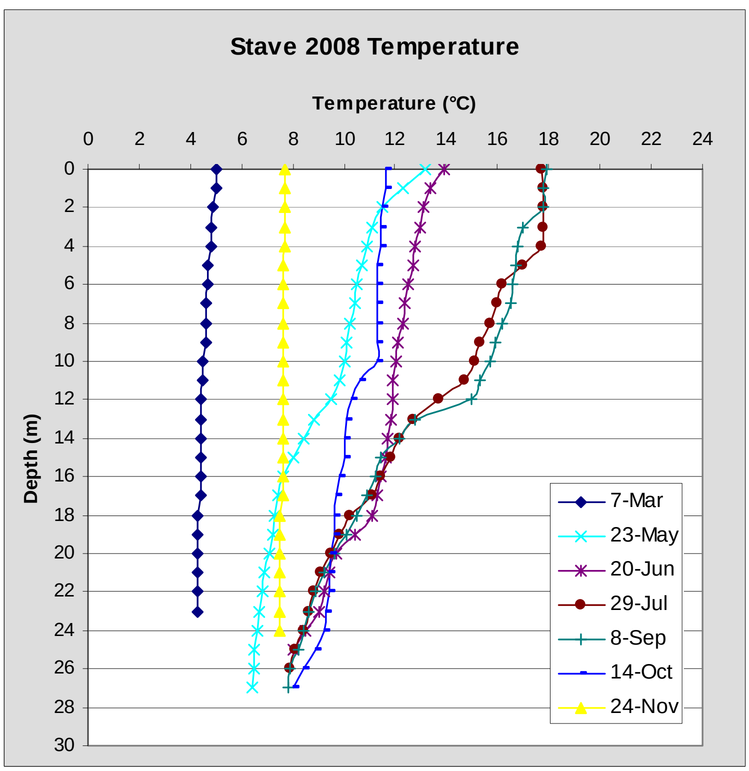


Figure 4.7: Stave Temperature Profile



4.3 Water Chemistry

Water chemistry samples were analyzed at SPAChemtest (DFO Laboratory in Cultus Lake, BC) in order to maintain consistency with analyses from Phase 1. Figures 4.8-4.11 show graphically the results of total phosphorus (TP), total dissolved phosphorus (TDP), nitrates and chlorophyll-*a* values from 2005 through 2008 providing a record of the nutrient profile in Stave and Hayward reservoirs. Tabular results from 2008 are presented in Appendix 2.

In 2008, nitrate concentrations in Stave and Hayward ranged from a high value of approximately 130 μg/L in spring to low values of approximately 70 μg/L in late summer to early fall. Nitrate concentrations exhibit a seasonal trend with peak values occurring in the winter and early spring periods when the reservoirs are isothermal (mixing) and low values in stratified periods in summer and early fall. Stave and Hayward both exhibited low concentrations of phosphorus with TP ranging from 1.3-4.5 μg/L and TDP concentrations from <1.0-6.1 μg/L. TDP values, which are the best approximation of bioavailable phosphorus, are 25- 40% lower than TP values which is a typical pattern observed in reservoir systems (Stockner, 2003, pers. comm.). Chlorophyll-*a* estimates of biomass production from Hayward reservoir were generally higher than those from Stave. Both reservoirs exhibited peaks in biomass production during the summer months, as expected.

Figure 4.8: Nitrate Concentrations

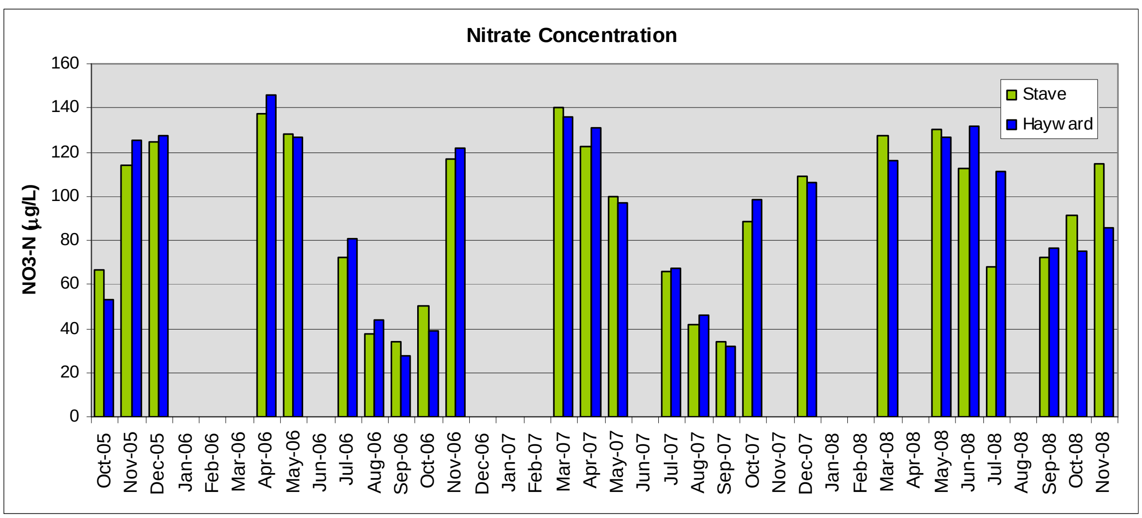


Figure 4.9: Total Phosphorus Concentrations

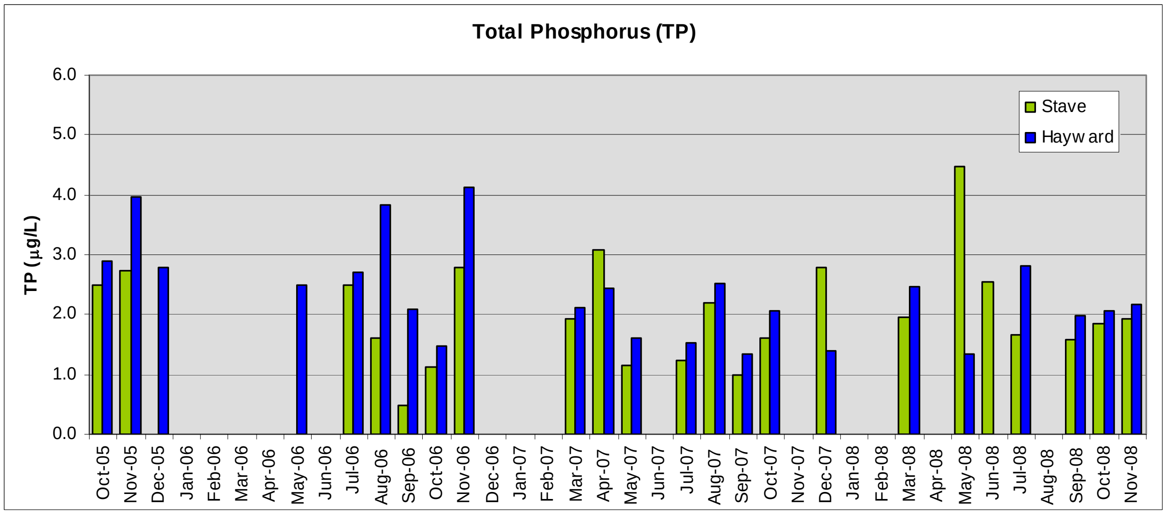


Figure 4.10: Total Dissolved Phosphorus Concentrations

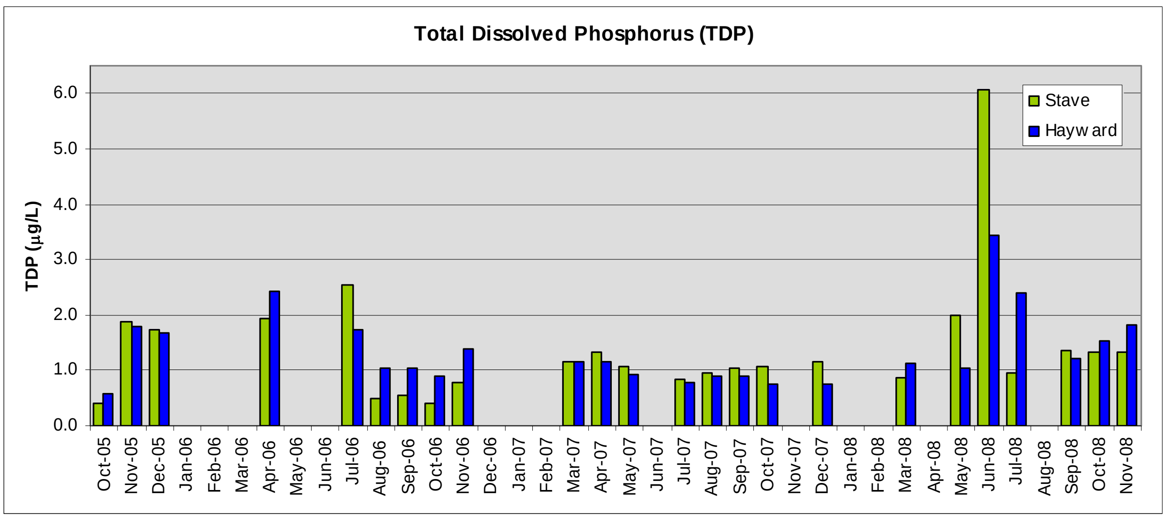
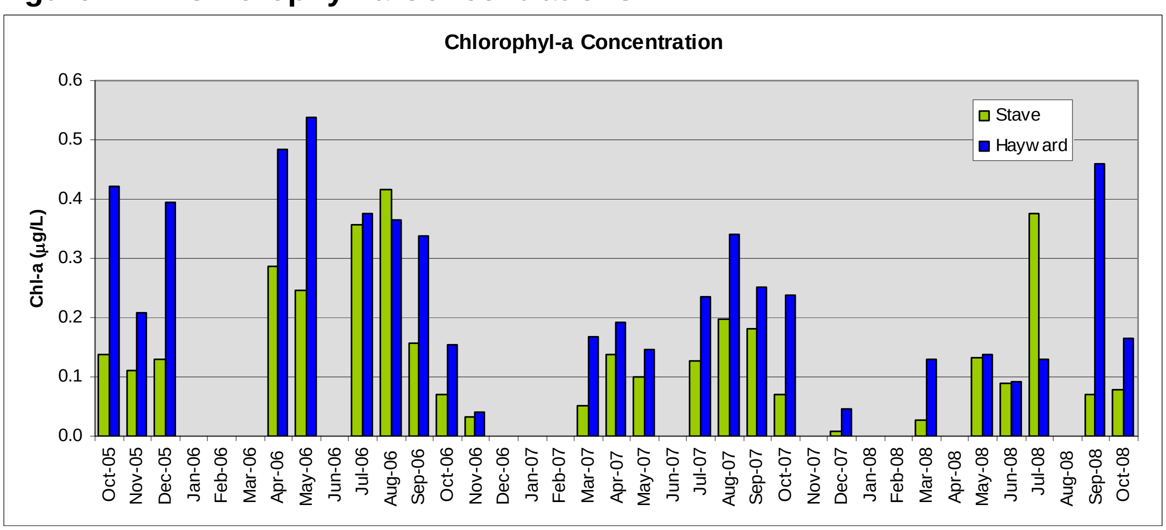


Figure 4.11: Chlorophyll-a Concentrations

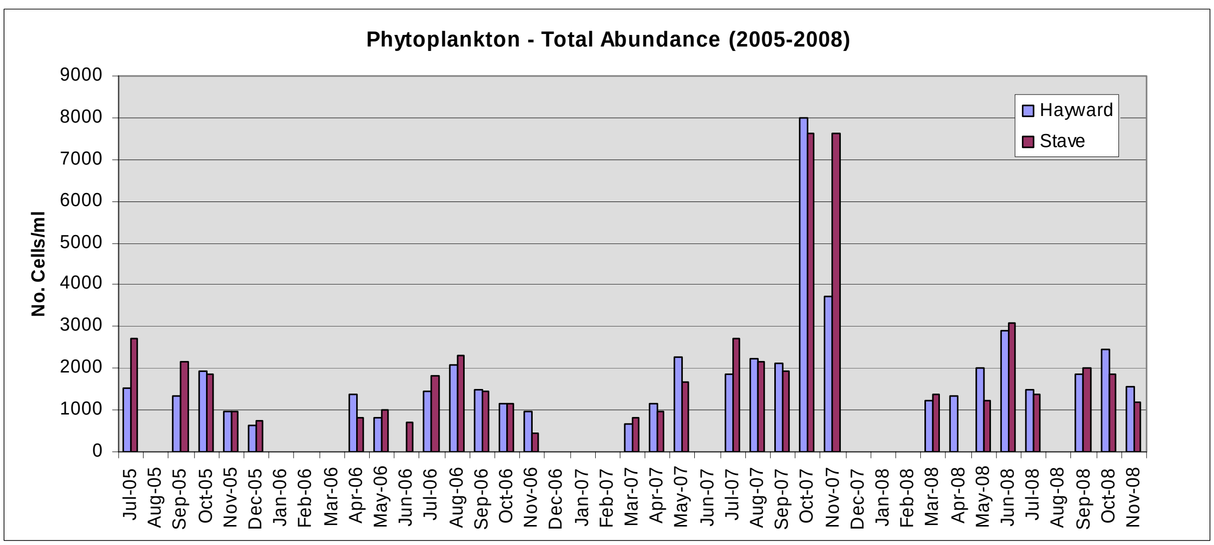


4.4 Phytoplankton

Owing to the ultra-oligotrophic status of Stave and Hayward reservoirs, changes in phytoplankton density are important ‘sentinels’ and are the first responders to abrupt changes in nutrient flux or N/P imbalance (Stockner 1991). Small picoplankton and nano-flagellates dominate the phytoplankton assemblages in both reservoirs, and monitoring their population fluxes through the limnological seasons provides an essential record of key microbial/nutrient imbalances that often occur in highly variable reservoir ecosystems.

The results of the phytoplankton counts have not been assessed in any detail to date, but a simple plot of total abundance (Figure 4.12) provides a general picture of the number of species occurring and how they seasonally. The high abundance exhibited in fall 2007 is not uncommon in other reservoir systems and likely occurred in response to warm weather in September/October and early fall overturn of the thermocline. Complete phytoplankton enumeration results from Hayward and Stave are presented in Appendix 3. Ness will produce a supplementary report for the fall of 2009 that will more fully assess dominant species and species abundance with respect to other variables such as sample year, transect and season.

Figure 4.12: Total Abundance of Phytoplankton (2005-2008)



4.5 Littoral Primary Production – Periphyton Accrual (AFDW)

Periphyton accrual was measured by assessing AFDW for samples collected at each plate along individual transects. The results of the analyses are graphed below for each sampling day at each transect. Figures 4.13 to 4.16 indicate accrual that occurred over an approximate 5-week sample interval and the reported depths refer to the depth below full pool for each reservoir. For each curve, it can be assumed that the first data point represents the first plate that is under water, unless otherwise noted.

It is notable on the plot of Hayward accrual that growth starts at 4 m below full pool, approximately 2 m lower than in the past. This is a function of the new operating levels at Hayward. The first sampling block at Hayward is situated at approximately 2 m below full pool and is always above water under the new water management regime. Overall Hayward continues to show the typical pattern of a more stable system with peaks in periphytic accrual occurring approximately 2-4 m below the surface and peak growth occurring in late summer. May 2008 experienced considerably higher solar radiation values than in 2006 and 2007, which may provided a possible explanation for the May growth in Hayward.

All three Stave transects (north, south and west) exhibit similar growth curves with peak accrual occurring in late summer (August and September) but with more variability in the depth at which the peak occurs than in Hayward reservoir. Generally the hottest months have steeper growth profiles with peaks that occur closer to the surface, while the cooler months have less steep profiles that are stretched out over a broader depth range. Maximum accrual values are comparable between Stave and Hayward with both exhibiting values of approximately 100 $mgC/m^2/day$. It is noted that Stave West is missing a sample from July that was caused by a broken plate.

Figure 4.13: Stave North Periphyton Accrual

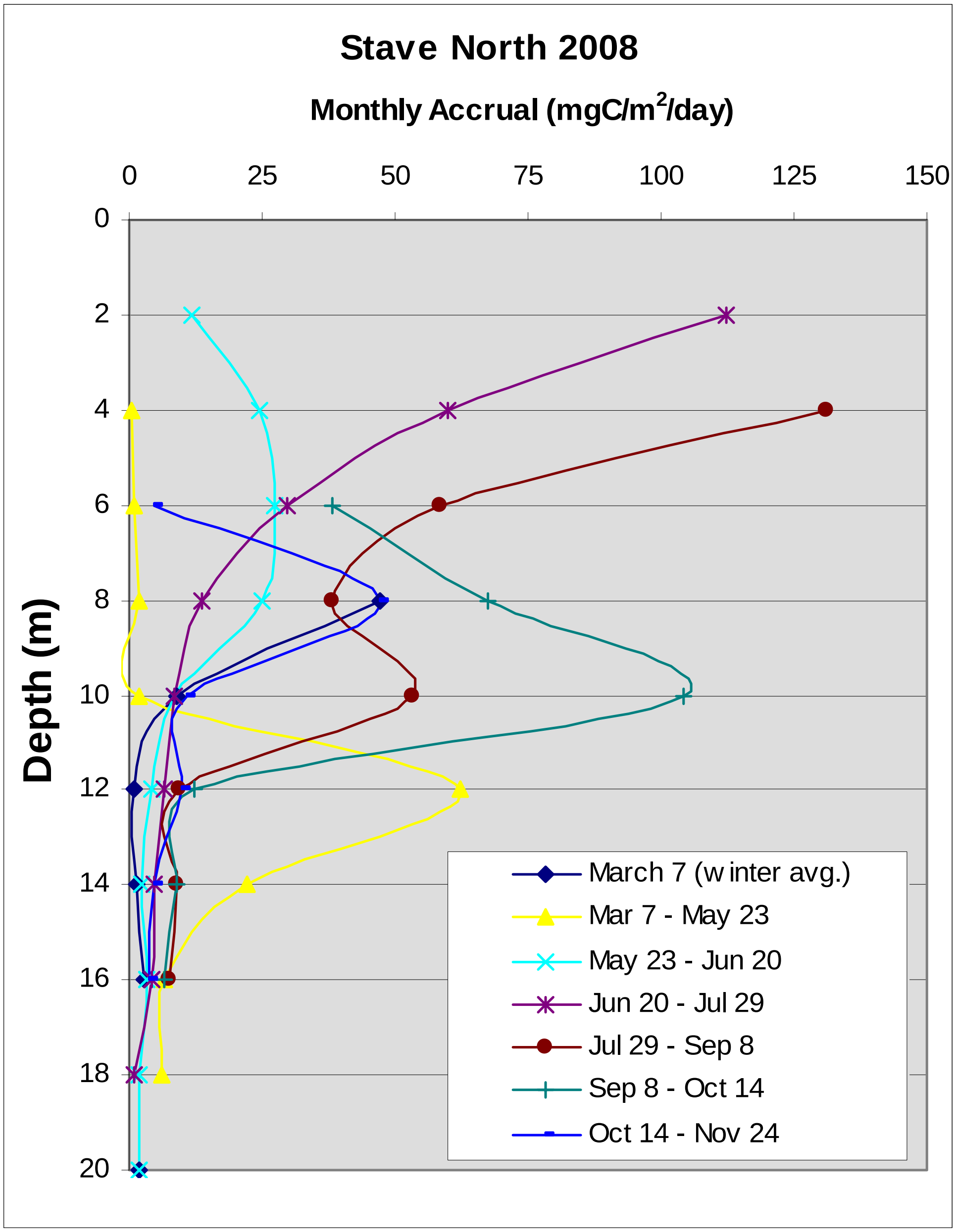


Figure 4.14: Stave South Periphyton Accrual

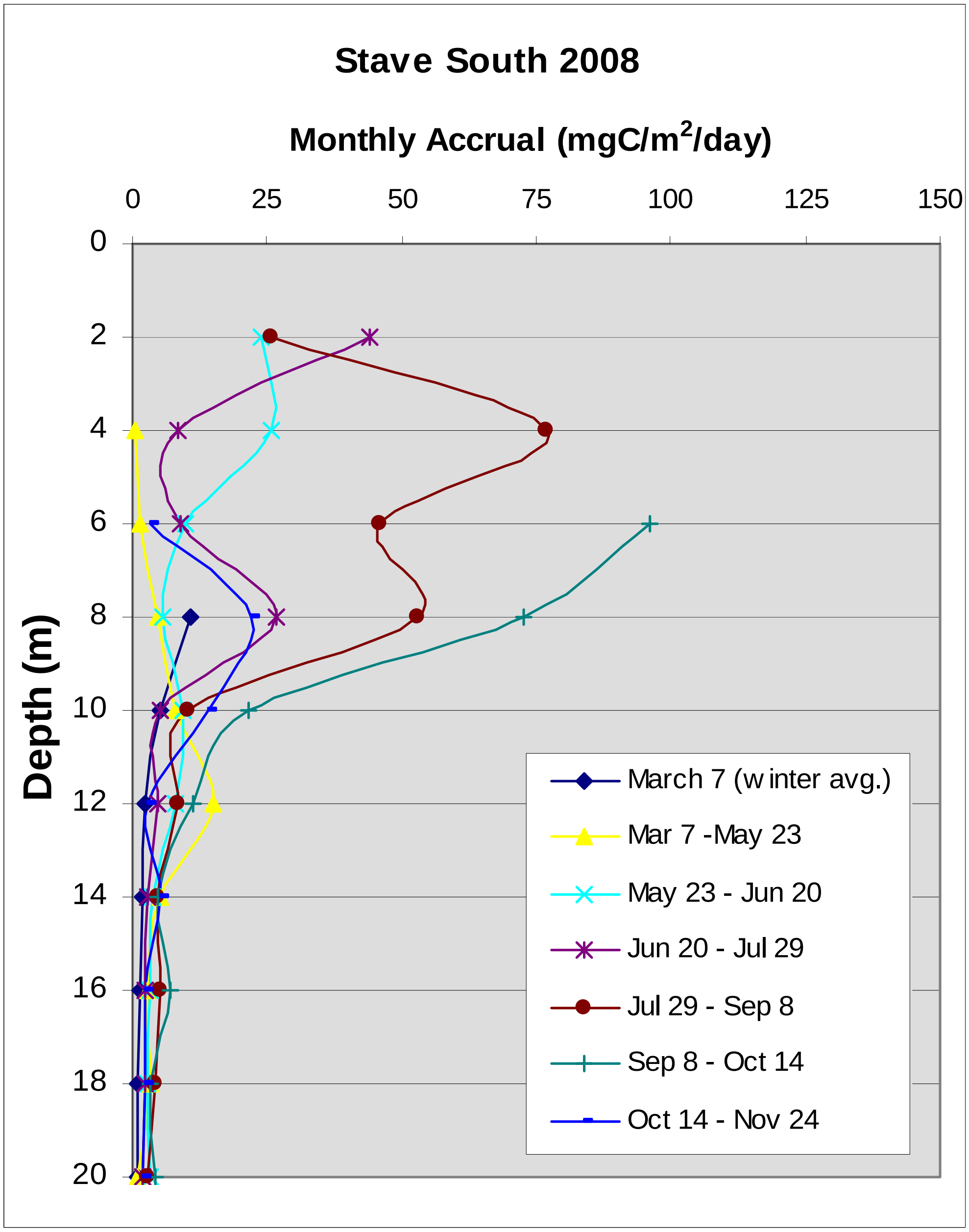


Figure 4.15: Stave West Periphyton Accrual

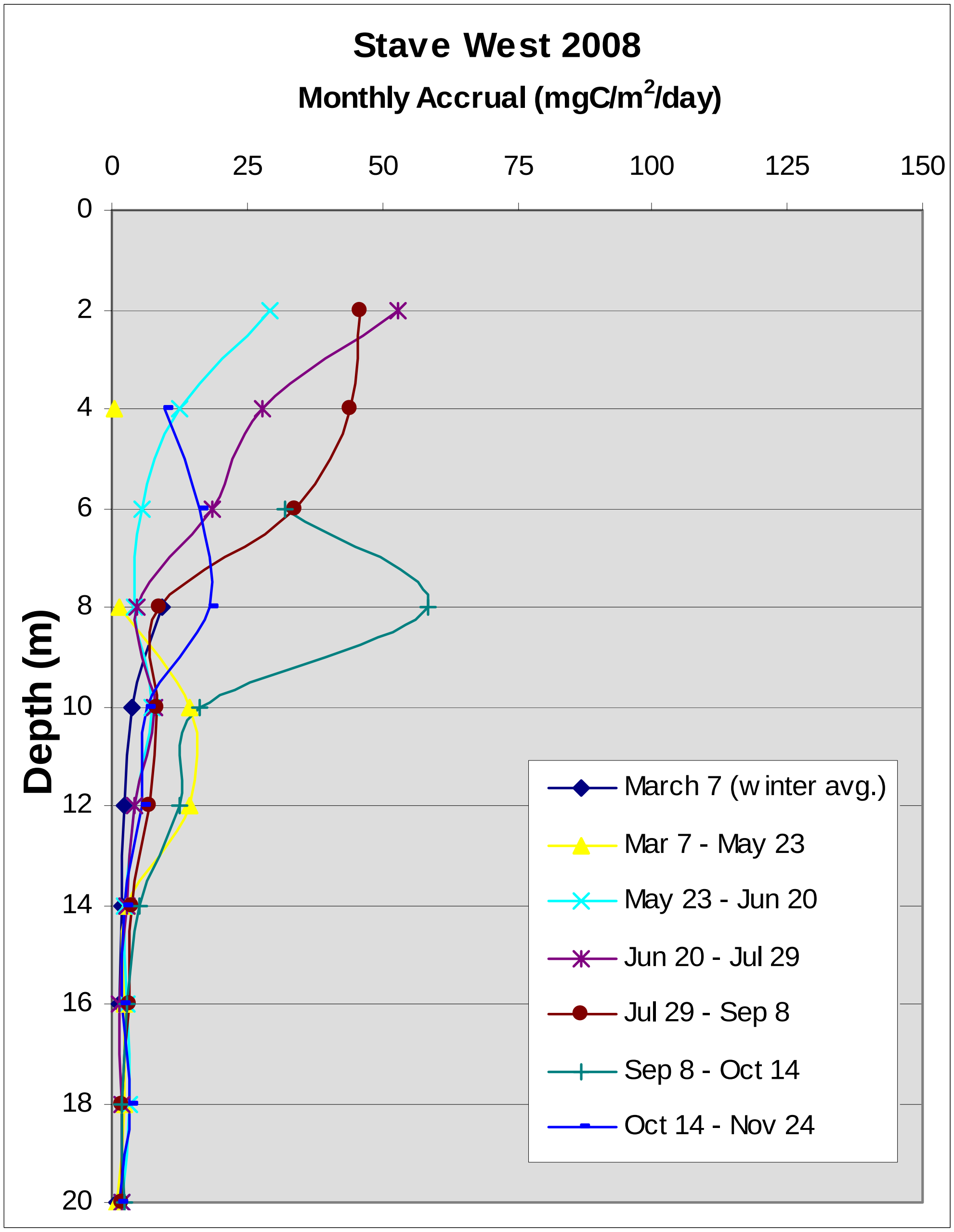
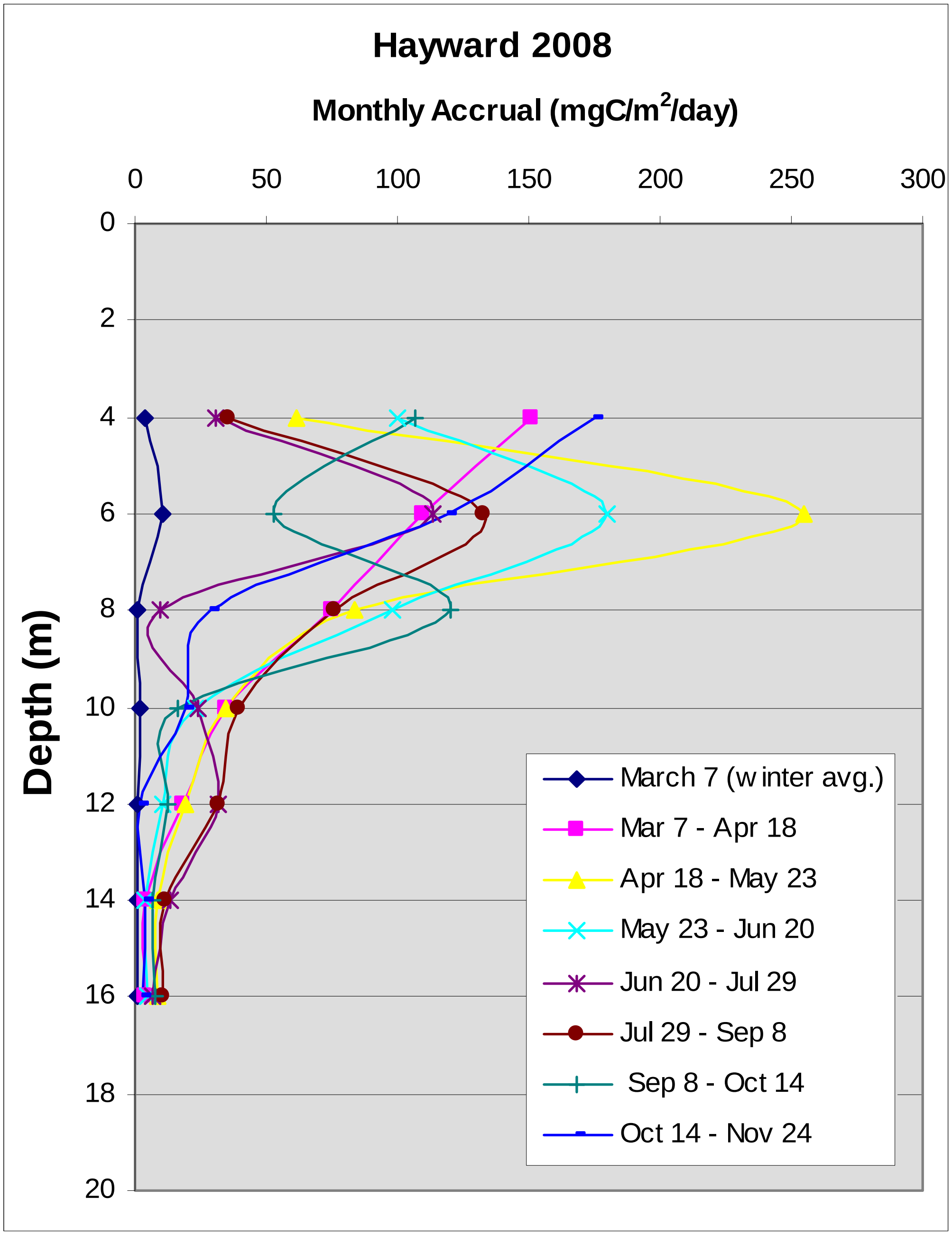


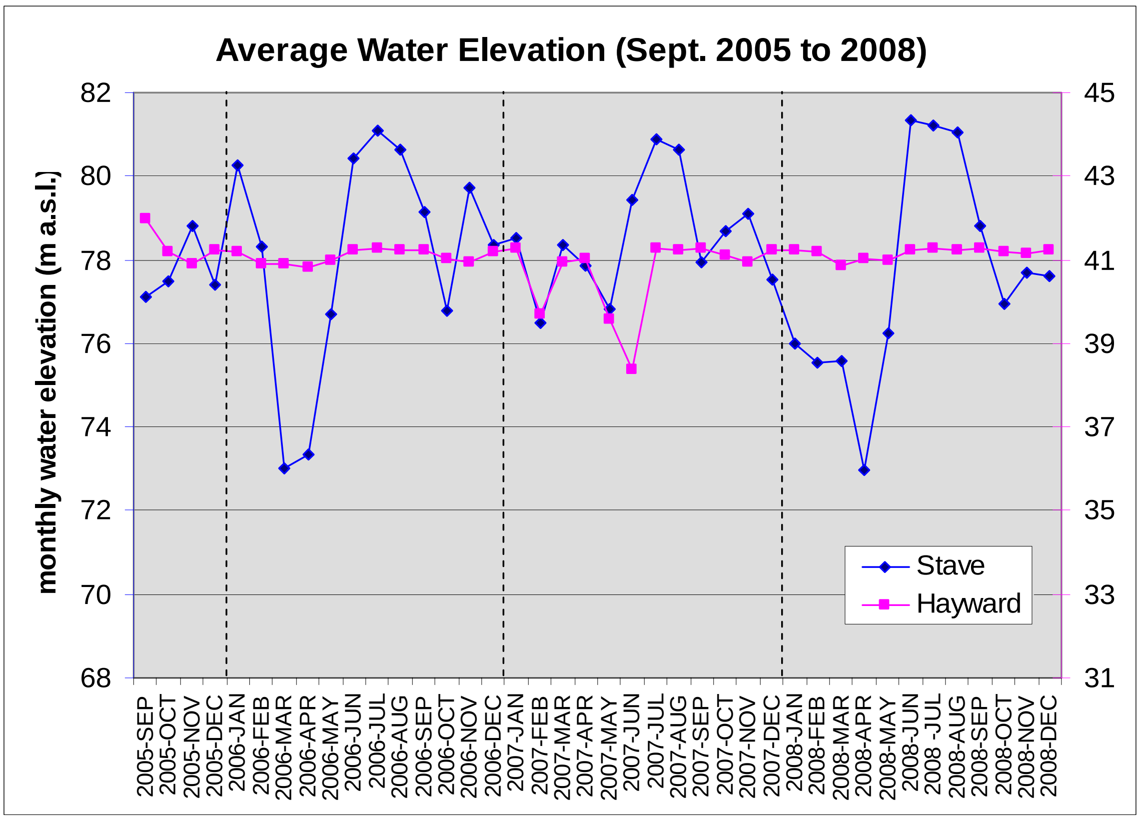
Figure 4.16: Hayward Periphyton Accrual



4.6 Three Year Water Level and Accrual Summary

Figure 4.17 shows monthly averaged water levels in Hayward (pink, right axis) and Stave (blue, left axis) from September 2005 to the end of 2008. Water levels in Hayward reservoir remained relatively constant to the end of 2006, after which there is a period of variation that is attributed to BC Hydro managing Hayward for potential seismic hazard. Following this period of variability, Hayward was maintained at a relatively constant but slightly lower level. Stave reservoir water levels are typically lowered through the fall, reaching a winter and early spring low to accommodate spring melting and recharging to maximum elevations during the summer months. Late winter 2006 and 2008 saw levels drawn down significantly to 73 m a.s.l. The 2008 Stave drawdown prevented sampling from occurring in April, as the Stave boat launches do not allow for boat launch at such low water levels. It will be of interest to compare biomass accrual patterns between 2006 and 2008 to those of 2007 to see if there are notable differences.

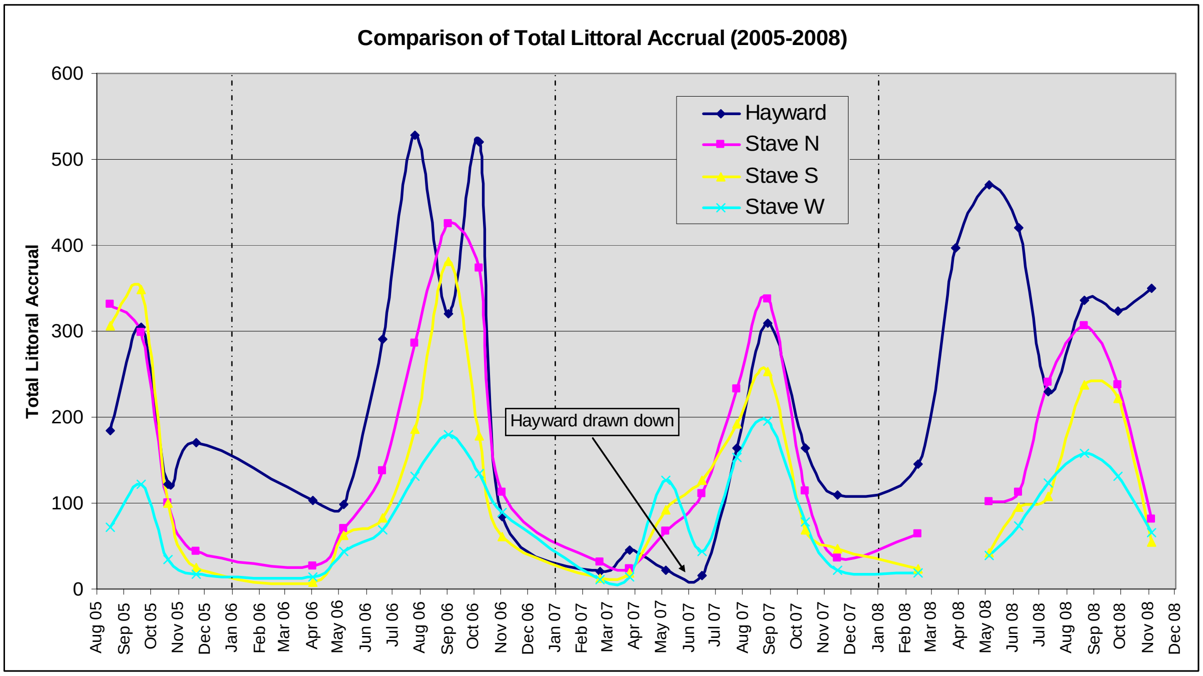
Figure 4.17: Average Water Elevation (Sept. 2005 to 2008)



Total littoral accrual (Figure 4.18) shows that production in both Stave and Hayward varies seasonally with low production during winter months and generally high production in late summer/early fall. The three transects in Stave all follow a similar pattern of production, while it is notable that Stave west is less productive than all other sites. Located on the west side of the lake, it is possible that this transect is shaded earlier in the afternoon than the other two transects which are located on the east side of the lake. The substrata at Stave west transect is also more rocky and steep than the eastern transects which are longer and siltier, which may also account for some of the variability between the Stave sites. Overall production in 2007 was lower in both Stave and Hayward than in 2006 and 2008. This pattern may be indicative of two factors:

- Hayward reservoir was likely less productive than what is typical due to water level variability and drawdown, and
- Stave reservoir was likely more productive due to less impact from less drawdown (i.e. 2007 did not experience extreme low).

Figure 4.18: Total Littoral Accrual (2005-2008)



4.7 Littoral Primary Production – ^{14}C Incubation

Samples were collected each sampling trip and processed in the laboratory, including replicates at the completion of each sample session. Primary production was calculated as an average of the sample replicates. There was noted variability among samples collected in 2006 that was thought to be caused by sediment that accumulates on the horizontal plates. Strategies for overcoming issues caused by sedimentation were addressed in subsequent sampling years by reducing the sample volume, agitating and allowing the sample to settle for known lengths of time before taking each sample and sample replicated and by increasing the volume of scintillation cocktail in samples that showed notable colouration due to sedimentation. More consistent results between sample replicates indicate that these methods may have helped in creating a more homogenous sample, but there is still a high degree of variability between sampling sessions.

Ness will conduct a more in depth analyses of these data and present the results and proposals for how to address potential issues with this work in a supplementary report in the fall of 2009.

4.8 Pelagic Primary Production – ^{14}C Incubation

Estimates of pelagic primary production from the 14C incubations in 2008 are not presented at this time, as the scintillation analyses are currently being completed by an external laboratory. Results will be presented in a supplementary report in the fall of 2009.

4.9 Zooplankton Analyses

Zooplankton counts from samples collected in 2008 are shown below. A more in depth analyses of the zooplankton count results will be included in a supplementary that Ness proposes to produce for the fall of 2009.

Hayward Lake

					Cladocerns Count								Copepods			
Date	Depth (m)	Dilution (ml)	Sub sample (ml)	# of Subs	Daphnia	Bosmina	Holopedium	Chydorid	Diaphanosoma	Scapholeberis	Leptodora	Others	Cyclopoid	Ergasilus	Calanoid	Total Individuals
20-Jun-08	15	80	4	2	1	63	0	0	0	0	0	0	65	7	59	195
29-Jul-08	15	100	4	2	20	112	28	0	0	0	0	0	94	10	230	494
8-Sep-08	15	100	4	3	27	23	2	0	0	0	0	0	47	13	101	213
14-Oct-08	15	60	4	3	29	115	21	1	0	0	0	0	111	3	35	315

Stave Lake

					Cladocerns								Copepods			
Date	Depth (m)	Dilution (ml)	Sub sample (ml)	# of Subs	Daphnia	Bosmina	Holopedium	Chydorid	Diaphanosoma	Scapholeberis	Leptodora	Others	Cyclopoid	Ergasilus	Calanoid	Total Individuals
20-Jun-08	20	100	4	3	10	140	2	0	0	0	0	0	74	11	137	374
29-Jul-08	20	100	2	3	29	165	2	0	0	0	0	0	52	9	148	405
8-Sep-08	20	100	6	3	24	30	2	0	0	0	1	0	26	14	167	264

5. References

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Appendix 1: Water Chemistry Methodology

SPA Chemtest - DFO Laboratory, Cultus Lake, BC

Nutrient Samples Collection Procedure

Make sure that nutrient samples are kept frozen and test tubes cool during transport to Cultus Lake Lab. This is critically important so use as much **cubed ice in plastic bags** as necessary. Also, prepare a field sample submission sheet and submit it along with the samples.

Be sure not to touch the test tube mouth or inside of the cap as the Total Phosphorus and Total Dissolved Phosphorus analysis are extremely sensitive.

For TP samples, at each depth, fill labeled test tube with unfiltered sample water, cap, shake tube to rinse and discard sample water. Refill test tube with unfiltered sample water. **Make sure that the bottom of the meniscus rests on the top of the shoulder of the test tube**. Put lids on tightly and make sure all labels are legible and state the lake, station, date, depth and test. Once per field trip, prepare 2 labeled test tubes with unfiltered DDW for TP blanks**. Do not freeze test tubes, but keep them cool**.

Avoid finger contact with filters, use only clean blunt-nosed forceps to handle filters. For the plastic bottles and TDP tubes, use a 47-mm Swinnex holder with an ashed GFF filter and a clean 60-cc syringe. Prepare GFF filter by placing it in the Swinnex holder and rinsing it with 3 full syringes of DDW. If the water runs through with little or no resistance, the filter is either torn or not seated properly in holder. Readjust filter or replace it if readjustment does not rectify the problem. Use one ashed GFF filter for each station unless filtering efficiency becomes hampered (*i.e.* filter becomes plugged).

For nitrate or ammonia/srp samples, at each depth, filter one full syringe of sample water into the appropriate labeled plastic bottle. Put cap on bottle, shake, and discard sample water. Refill bottle to the shoulder with filtered sample water. Put lids on tightly and make sure all labels are legible and state the lake, station, date, depth, test (Ammonia/SRP or NO3) and **freeze bottles immediately** after filtration. Once per field trip, prepare 2 filtered DDW blanks for Ammonia/SRP and Nitrate tests.

For TDP samples, at each depth, filter one full syringe of sample into the appropriate labeled test tube. Put cap on test tube, shake and discard sample water. Refill test tube with filtered sample water. **Make sure that the bottom of the meniscus rests on the top of the shoulder of the test tube**. Put lids on tightly and make sure all labels are legible and state the lake, station, date, depth and test. Once per field trip, prepare 2 labeled test tubes with filtered DDW for TDP blanks. **Do not freeze test tubes, but keep them cool**.

Chlorophyll

For chlorophyll samples, use only clean blunt-nosed forceps designated to handle only chlorophyll filters and a 47 mm filter holder that has been taped with black electrical tape to limit light exposure. Open the filter holder and insert the chlorophyll filter, making sure that the o-ring is seated properly in the filter holder. Place the filter holder into the top of the vacuum flask and attach to a pump that is regulated to 7 inches Hg. Rinse graduate cylinder with sample water and then filter a suitable sized aliquot of lake water, usually between 250 - 500 mls is sufficient. Preserve the filtered sample by placing the filter, folded in half in an aluminum weighing dish. Make sure that the dish has been labelled with the lake, station, date, depth and **filtered amount** on the bottom of the dish with a nail or dry pen (**do not use a pen with ink**). Aluminum dishes may be stacked (make sure that the top filter is covered with an empty dish) and tape together using masking tape. Make sure that the tape is labelled for easy identification in the lab. Place stack in a whirlpac bag or ziploc and **freeze immediately. Chlorophyll samples must be kept in the dark and frozen at all times.**

Appendix 2: Water Chemistry Results (2008)

				TP			Phaeo	Corr.
Station	**Date**	**NO3**	**TP**	**Turb**	**TDP**	**Chl.45**	**0.45**	**Chl.45**
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Stave	2008-03-07	127.4	2.0	0.6	0.9	0.033	0.051	0.009
Hayward	2008-03-07	116.0	2.5	0.4	1.1	0.108	0.129	0.045
Hayward	2008-04-18	127.0	1.3	0.6	1.0	0.286	0.321	0.130
Stave	2008-05-23	130.4	4.5	0.5	2.0	0.284	0.527	0.027
Hayward	2008-05-23	131.4		0.8	3.4	0.442	0.623	0.139
Stave	2008-06-20	112.7	2.6	0.5	6.1	0.397	0.542	0.133
Hayward	2008-06-20	111.4	2.8	0.6	2.4	0.481	0.800	0.092
Stave	2008-07-29	68.2	1.7	<0.1	0.9	0.192	0.208	0.090
Hayward	2008-07-29	76.8	2.0	<0.1	1.2	0.337	0.419	0.131
Stave	2008-09-08	72.1	1.6	<0.1	1.3	0.604	0.462	0.376
Hayward	2008-09-08	74.9	2.1	<0.1	1.5	0.758	0.603	0.460
Stave	2008-10-14	91.5	1.8	<0.1	1.3	0.369	0.609	0.069
Hayward	2008-10-14	85.5	2.2	<0.1	1.8	0.550	0.781	0.164
Stave	2008-11-24	114.5	1.9	<0.1	1.3	0.124	0.094	0.078
Hayward	2008-11-24	117.3	1.9	<0.1	1.3	0.404	0.296	0.258

Appendix 3:

2008 Hayward Phytoplankton Results

Lake: Hayward **Station:** 1 **Depth:** 1,3,5m
Date: Mar. 7, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Tabellaria fenestrata		10.14	0.0051
Navicula sp.		20.27	0.0101
	Group total	30.41	0.0152
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		10.14	0.0002
Chrysochromulina sp.		30.41	0.0023
Chryptomonas spp.		50.68	0.0253
Boda spp.		20.27	0.0020
Ochromonas sp.		40.55	0.0101
Kephyrion sp.		20.27	0.0010
Mallomonas sp.		10.14	0.0071
Small microflagellates		476.43	0.0071
	Group total	658.90	0.0552
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		20.27	0.0101
	Group total	40.55	0.0289
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Chlorella sp.		20.27	0.0004
Leptocinclis stiata		20.27	0.0015
	Group total	50.68	0.0027
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		273.70	0.0014
Synechococcus sp (rod)		111.51	0.0022
Synechocystis sp.		50.68	0.0005
	Group total	435.89	0.0041
	GRAND TOTAL	1216.42	0.1062

Lake: Hayward **Station:** 1 **Depth:** 1,3,5m
Date: Apr. 18, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Cyclotella stelligera		10.14	0.0015
Cyclotella glomerata		10.14	0.0005
	Group total	20.27	0.0020
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		40.55	0.0008
Chrysochromulina sp.		40.55	0.0030
Chryptomonas spp.		10.14	0.0051
Boda spp.		40.55	0.0041
Ochromonas sp.		10.14	0.0025
Dinobryon sp.		101.37	0.0203
Small microflagellates		334.52	0.0050
	Group total	577.80	0.0408
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (small)		30.41	0.0152
	Group total	40.55	0.0188
Chlorophyceae (coccoid greens, desmids, etc.)			
Chlorella sp.		30.41	0.0006
	Group total	30.41	0.0006
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		273.70	0.0014
Synechococcus sp (rod)		364.93	0.0073
Synechocystis sp.		40.55	0.0004
	Group total	679.17	0.0091
	GRAND TOTAL	1348.20	0.0713

Lake: Hayward	**Station:** 1	**Depth:** 1,3,5m	
Date: May. 23, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria acus		10.14	0.0010
Cyclotella glomerata		20.27	0.0010
	Group total	30.41	0.0020
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		50.68	0.0010
Chrysochromulina sp.		101.37	0.0076
Chryptomonas spp.		30.41	0.0152
Boda spp.		70.96	0.0071
Ochromonas sp.		91.23	0.0228
Pseudokephrion sp.		20.27	0.0020
Kephyrion sp.		40.55	0.0020
Dinobryon sp.		30.41	0.0061
Small microflagellates		739.99	0.0111
	Group total	1175.88	0.0750
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		40.55	0.0203
	Group total	60.82	0.0390
Chlorophyceae (coccoid greens, desmids, etc.)			
Chlorella sp.		30.41	0.0006
Clamydocapsa sp.		10.14	0.0056
	Group total	40.55	0.0062
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		324.38	0.0016
Synechococcus sp (rod)		354.79	0.0071
Synechocystis sp.		30.41	0.0003
	Group total	709.58	0.0090
	GRAND TOTAL	2017.24	0.1312

Lake: Hayward	**Station:** 1	**Depth:** 1,3,5m	
Date: Jun. 20, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria capucina		20.27	0.0020
Fragilaria angustissima		10.14	0.0015
Cyclotella glomerata		40.55	0.0020
Rhizosolenia sp.		30.41	0.0015
	Group total	101.37	0.0071
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		70.96	0.0014
Chrysochromulina sp.		141.92	0.0106
Chryptomonas spp.		50.68	0.0253
Boda spp.		50.68	0.0051
Ochromonas sp.		60.82	0.0152
Pseudokephrion sp.		30.41	0.0030
Kephyrion sp.		20.27	0.0010
Dinobryon sp.		60.82	0.0122
Small microflagellates		760.27	0.0114
	Group total	1246.84	0.0853
Dinophyceae (dinoflagellates)			
Peridinium spp.		20.27	0.0071
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		233.15	0.1166
	Group total	263.56	0.1389
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		20.27	0.0016
Elakatothrix sp.		20.27	0.0051
Chlorella sp.		50.68	0.0010
Clamydocapsa sp.		30.41	0.0167
Nephroselmis sp.		20.27	0.0014
	Group total	141.92	0.0258
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		385.20	0.0019
Synechococcus sp (rod)		658.90	0.0132
Synechocystis sp.		101.37	0.0010
	Group total	1145.47	0.0161
	GRAND TOTAL	2899.15	0.2732

Lake: Hayward	**Station:** 1	**Depth:** 1,3,5m	
Date: Jul. 29, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria capucina		10.14	0.0010
Cyclotella glomerata		60.82	0.0030
Navicula sp.		10.14	0.0051
	Group total	81.09	0.0091
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		70.96	0.0014
Chrysochromulina sp.		91.23	0.0068
Chryptomonas spp.		20.27	0.0101
Boda spp.		30.41	0.0030
Ochromonas sp.		30.41	0.0076
Kephyrion sp.		20.27	0.0010
Small microflagellates		375.06	0.0056
	Group total	638.62	0.0357
Dinophyceae (dinoflagellates)			
Peridinium spp.		30.41	0.0106
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		91.23	0.0456
	Group total	131.78	0.0715
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Chlorella sp.		30.41	0.0006
Clamydocapsa sp.		10.14	0.0056
	Group total	50.68	0.0070
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		253.42	0.0013
Synechococcus sp (rod)		253.42	0.0051
Synechocystis sp.		70.96	0.0007
	Group total	577.80	0.0070
	GRAND TOTAL	1479.98	0.1303

Lake: Hayward	**Station:** 1	**Depth:** 1,3,5m	
Date: Sept. 8, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Achnanthidium spp.		10.14	0.0008
Navicula sp.		10.14	0.0051
	Group total	20.27	0.0059
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		70.96	0.0014
Chrysochromulina sp.		101.37	0.0076
Chryptomonas spp.		40.55	0.0203
Boda spp.		60.82	0.0061
Ochromonas sp.		60.82	0.0152
Pseudokephrion sp.		20.27	0.0020
Kephyrion sp.		30.41	0.0015
Small microflagellates		506.84	0.0076
	Group total	892.04	0.0617
Dinophyceae (dinoflagellates)			
Peridinium spp.		30.41	0.0106
Gymnodinium sp. (large).		20.27	0.0304
Gymnodinium sp. (small)		121.64	0.0608
	Group total	172.33	0.1019
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		20.27	0.0016
Elakatothrix sp.		10.14	0.0025
Chlorella sp.		30.41	0.0006
Scenedesmus sp.		10.14	0.0006
Cosmarium sp.		10.14	0.0051
Clamydocapsa sp.		30.41	0.0167
	Group total	111.51	0.0272
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		253.42	0.0013
Synechococcus sp (rod)		121.64	0.0024
Synechocystis sp.		70.96	0.0007
Limnothrix redekei		10.14	0.0035
Merismopedia sp.		192.60	0.0039
Microcystis sp.		10.14	0.0051
Gomphosphaeria sp.		10.14	0.0076
	Group total	669.03	0.0245
	GRAND TOTAL	1865.18	0.2211

Lake: Hayward **Station:** 1 **Depth:** 1,3,5m
Date: Oct. 14, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria capucina		20.27	0.0020
	Group total	20.27	0.0020
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		70.96	0.0014
Chrysochromulina sp.		152.05	0.0114
Chryptomonas spp.		40.55	0.0203
Boda spp.		50.68	0.0051
Ochromonas sp.		70.96	0.0177
Pseudokephrion sp.		20.27	0.0020
Dinobryon sp.		10.14	0.0020
Small microflagellates		709.58	0.0106
	Group total	1125.19	0.0706
Dinophyceae (dinoflagellates)			
Peridinium spp.		20.27	0.0071
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		111.51	0.0558
	Group total	141.92	0.0781
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		30.41	0.0024
Elakatothrix sp.		10.14	0.0025
Chlorella sp.		30.41	0.0006
Tetraedron sp.		10.14	0.0005
Oocystis sp.		10.14	0.0051
Scenedesmus sp.		10.14	0.0006
	Group total	101.37	0.0118
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		314.24	0.0016
Synechococcus sp (rod)		344.65	0.0069
Synechocystis sp.		50.68	0.0005
Merismopedia sp.		314.24	0.0063
Microcystis sp.		20.27	0.0101
Gomphosphaeria sp.		30.41	0.0228
	Group total	1074.51	0.0482
	GRAND TOTAL	2463.26	0.2106

Lake: Hayward	**Station:** 1	**Depth:** 1,3,5m	
Date: Nov. 24, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		30.41	0.0006
Chrysochromulina sp.		70.96	0.0053
Chryptomonas spp.		20.27	0.0101
Boda spp.		50.68	0.0051
Ochromonas sp.		30.41	0.0076
Small microflagellates		446.02	0.0067
	Group total	648.76	0.0354
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (small)		30.41	0.0152
	Group total	40.55	0.0188
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		30.41	0.0024
Chlorella sp.		20.27	0.0004
	Group total	50.68	0.0028
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		354.79	0.0018
Synechococcus sp (rod)		293.97	0.0059
Synechocystis sp.		172.33	0.0017
Merismopedia sp.		10.14	0.0002
	Group total	831.22	0.0096
	GRAND TOTAL	1571.22	0.0666

2008 Stave Phytoplankton Results

Lake: Stave	**Station:** 1	**Depth:** 1,3,5m	
Date: Mar. 7, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Achnanthidium spp.		10.14	0.0008
	Group total	10.14	0.0008
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		30.41	0.0006
Chrysochromulina sp.		30.41	0.0023
Chryptomonas spp.		20.27	0.0101
Boda spp.		50.68	0.0051
Ochromonas sp.		20.27	0.0051
Small microflagellates		618.35	0.0093
	Group total	770.40	0.0324
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		20.27	0.0101
	Group total	40.55	0.0289
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Chlorella sp.		30.41	0.0006
	Group total	40.55	0.0014
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		364.93	0.0018
Synechococcus sp (rod)		60.82	0.0012
Synechocystis sp.		70.96	0.0007
	Group total	496.71	0.0038
	GRAND TOTAL	1358.34	0.0673

Lake: Stave **Station:** 1 **Depth:** 1,3,5m
Date: May. 23, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Achnanthidium spp.		10.14	0.0008
Cyclotella stelligera		20.27	0.0030
Tabellaria fenestrata		40.55	0.0203
Navicula sp.		10.14	0.0051
	Group total	81.09	0.0292
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		50.68	0.0010
Chrysochromulina sp.		81.09	0.0061
Chryptomonas spp.		20.27	0.0101
Boda spp.		50.68	0.0051
Ochromonas sp.		30.41	0.0076
Mallomonas sp.		30.41	0.0213
Small microflagellates		263.56	0.0040
	Group total	527.12	0.0551
Dinophyceae (dinoflagellates)			
Peridinium spp.		30.41	0.0106
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		50.68	0.0253
	Group total	91.23	0.0512
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Chlorella sp.		40.55	0.0008
Gleotila sp.		10.14	0.0008
	Group total	60.82	0.0024
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		273.70	0.0014
Synechococcus sp (rod)		131.78	0.0026
Synechocystis sp.		70.96	0.0007
	Group total	476.43	0.0047
	GRAND TOTAL	1236.70	0.1426

Lake: Stave **Station:** 1 **Depth:** 1,3,5m
Date: Jun. 20, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Cyclotella stelligera		10.14	0.0015
Cyclotella glomerata		40.55	0.0020
Rhizosolenia sp.		10.14	0.0005
Eunotia sp.		10.14	0.0025
	Group total	70.96	0.0066
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		81.09	0.0016
Chrysochromulina sp.		111.51	0.0084
Chryptomonas spp.		40.55	0.0203
Boda spp.		60.82	0.0061
Ochromonas sp.		50.68	0.0127
Pseudokephrion sp.		20.27	0.0020
Kephyrion sp.		10.14	0.0005
Dinobryon sp.		10.14	0.0020
Small microflagellates		1165.74	0.0175
	Group total	1550.94	0.0711
Dinophyceae (dinoflagellates)			
Peridinium spp.		20.27	0.0071
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		101.37	0.0507
	Group total	131.78	0.0730
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		20.27	0.0016
Chlorella sp.		60.82	0.0012
Tetraedron sp.		20.27	0.0010
Golenkinia sp.		30.41	0.0076
Scenedesmus sp.		20.27	0.0012
Clamydocapsa sp.		10.14	0.0056
	Group total	162.19	0.0182
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		415.61	0.0021
Synechococcus sp (rod)		658.90	0.0132
Synechocystis sp.		111.51	0.0011
	Group total	1186.01	0.0164
	GRAND TOTAL	3101.88	0.1853

Lake: Stave **Station:** 1 **Depth:** 1,3,5m
Date: Jul. 29, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria capucina		10.14	0.0010
Cyclotella glomerata		131.78	0.0066
	Group total	141.92	0.0076
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		50.68	0.0010
Chrysochromulina sp.		91.23	0.0068
Chryptomonas spp.		20.27	0.0101
Boda spp.		20.27	0.0020
Ochromonas sp.		30.41	0.0076
Kephyrion sp.		20.27	0.0010
Dinobryon sp.		20.27	0.0041
Small microflagellates		324.38	0.0049
	Group total	577.80	0.0376
Dinophyceae (dinoflagellates)			
Peridinium spp.		30.41	0.0106
Gymnodinium sp. (large).		20.27	0.0304
Gymnodinium sp. (small)		121.64	0.0608
	Group total	172.33	0.1019
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Chlorella sp.		30.41	0.0006
Coelastrum sp.		10.14	0.0051
	Group total	50.68	0.0065
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		263.56	0.0013
Synechococcus sp (rod)		101.37	0.0020
Synechocystis sp.		40.55	0.0004
Planktolyngbya sp.		10.14	0.0028
	Group total	415.61	0.0065
	GRAND TOTAL	1358.34	0.1601

Lake: Stave **Station:** 1 **Depth:** 1,3,5m
Date: Sept. 8, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria acus		30.41	0.0030
Cyclotella glomerata		101.37	0.0051
	Group total	131.78	0.0081
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		70.96	0.0014
Chrysochromulina sp.		91.23	0.0068
Chryptomonas spp.		70.96	0.0355
Boda spp.		50.68	0.0051
Ochromonas sp.		50.68	0.0127
Kephyrion sp.		30.41	0.0015
Mallomonas sp.		10.14	0.0071
Dinobryon sp.		20.27	0.0041
Small microflagellates		537.25	0.0081
	Group total	932.59	0.0822
Dinophyceae (dinoflagellates)			
Peridinium spp.		40.55	0.0142
Gymnodinium sp. (large).		20.27	0.0304
Gymnodinium sp. (small)		91.23	0.0456
	Group total	152.05	0.0902
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		20.27	0.0016
Chlorella sp.		30.41	0.0006
Tetraedron sp.		10.14	0.0005
Clamydocapsa sp.		30.41	0.0167
	Group total	91.23	0.0195
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		273.70	0.0014
Synechococcus sp (rod)		131.78	0.0026
Synechocystis sp.		91.23	0.0009
Merismopedia sp.		162.19	0.0032
Microcystis sp.		30.41	0.0152
Gomphosphaeria sp.		20.27	0.0152
	Group total	709.58	0.0386
	GRAND TOTAL	2017.24	0.2386

Lake: Stave **Station:** 1 **Depth:** 1,3,5m
Date: Oct. 14, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Cyclotella glomerata		20.27	0.0010
Navicula sp.		10.14	0.0051
	Group total	30.41	0.0061
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		91.23	0.0018
Chrysochromulina sp.		40.55	0.0030
Chryptomonas spp.		30.41	0.0152
Boda spp.		60.82	0.0061
Ochromonas sp.		40.55	0.0101
Kephyrion sp.		10.14	0.0005
Mallomonas sp.		20.27	0.0142
Small microflagellates		506.84	0.0076
	Group total	800.81	0.0586
Dinophyceae (dinoflagellates)			
Peridinium spp.		30.41	0.0106
Gymnodinium sp. (large).		10.14	0.0152
Gymnodinium sp. (small)		81.09	0.0405
	Group total	121.64	0.0664
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Elakatothrix sp.		30.41	0.0076
Chlorella sp.		30.41	0.0006
Botryococcus sp.		10.14	0.0066
Nephroselmis sp.		10.14	0.0007
	Group total	91.23	0.0163
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		263.56	0.0013
Synechococcus sp (rod)		334.52	0.0067
Synechocystis sp.		81.09	0.0008
Merismopedia sp.		141.92	0.0028
Gomphosphaeria sp.		10.14	0.0076
	Group total	831.22	0.0193
	GRAND TOTAL	1875.32	0.1667

Lake: Stave	**Station:** 1	**Depth:** 1,3,5m	
Date: Nov. 24, 2008	**Magnif:** 1560		
Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria acus		10.14	0.0010
	Group total	10.14	0.0010
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		20.27	0.0004
Chrysochromulina sp.		40.55	0.0030
Chryptomonas spp.		20.27	0.0101
Boda spp.		60.82	0.0061
Ochromonas sp.		30.41	0.0076
Kephyrion sp.		10.14	0.0005
Small microflagellates		283.83	0.0043
	Group total	466.30	0.0320
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (small)		20.27	0.0101
	Group total	30.41	0.0137
Chlorophyceae (coccoid greens, desmids, etc.)			
Ankistrodesmus sp.		10.14	0.0008
Chlorella sp.		20.27	0.0004
	Group total	30.41	0.0012
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		202.74	0.0010
Synechococcus sp (rod)		375.06	0.0075
Synechocystis sp.		20.27	0.0002
Merismopedia sp.		30.41	0.0006
Microcystis sp.		10.14	0.0051
Gomphosphaeria sp.		10.14	0.0076
	Group total	648.76	0.0220
	GRAND TOTAL	1186.01	0.0699

2008 Allouette Phytoplankton Results

Lake: Stave **Station:** 2-alouette **Depth:** 1,3,5m
Date: May. 23, 2008 **Magnif:** 1560

Class Species		No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
Fragilaria acus		10.14	0.0010
Cyclotella glomerata		10.14	0.0005
	Group total	20.27	0.0015
Chryso- & Cryptophyceae (flagellates)			
Chromulina sp.		30.41	0.0006
Chrysochromulina sp.		70.96	0.0053
Chryptomonas spp.		30.41	0.0152
Boda spp.		30.41	0.0030
Ochromonas sp.		50.68	0.0127
Dinobryon sp.		10.14	0.0020
Small microflagellates		506.84	0.0076
	Group total	729.85	0.0465
Dinophyceae (dinoflagellates)			
Peridinium spp.		10.14	0.0035
Gymnodinium sp. (small)		40.55	0.0203
	Group total	50.68	0.0238
Chlorophyceae (coccoid greens, desmids, etc.)			
Chlorella sp.		30.41	0.0006
	Group total	30.41	0.0006
Cyanophyceae (blue-greens)			
Synechococcus sp. (coccoid)		273.70	0.0014
Synechococcus sp (rod)		1621.90	0.0324
Synechocystis sp.		60.82	0.0006
Planktolyngbya sp.		304.11	0.0836
	Group total	2260.52	0.1180
	GRAND TOTAL	3091.75	0.1905