Water Licence Requirements

Stave
Water Licence Requirement Reporting

Ref Study:SFLMON#1 & 2

Stave Reservoir Pelagic Monitor and Littoral Productivity Assessment

Study Period: 2005 Assessment Year
Report Date: April 06

Ness Environmental Sciences

STAVE RIVER WATER USE PLANNING

Report on the 2005 Pelagic Monitor and Littoral Primary Production Monitor

[Stave – Ness 05/06]

Report to: **BC Hydro**
6911 Southpoint Drive
Burnaby, BC
Attention: Dave Hunter and James Bruce

Date: April 2006

Submitted by: **Ness Environmental Sciences**
201-125 East 15th Avenue
Vancouver, BC V5T 2P6

Contact: **Julie Beer**, M.Sc., P.Geo.
Phone: 604.874.8095 or 604.729.0925
Email: nessenvironmental@shaw.ca

GST No. 837242676 RT0001

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1. Introduction

This report summarizes all components of a fresh water productivity monitoring and data collection program undertaken in 2005 on Stave and Hayward reservoirs as part of the Stave WUP Monitor. The 2005 monitoring program was the first 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 base level sampling program intended to continue for ten years 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 re-establishment of the littoral sampling transects from Phase 1; field sampling and laboratory program/protocols; and summary results of both the littoral and pelagic components of the 2005 sampling season. While pelagic and littoral components of the monitoring program are considered separately in the draft terms of reference provided by BC Hydro, both components are presented concurrently in this report. A budgetary summary and recommendations for monitoring in future years is also provided.

Ness Environmental Sciences (Ness) is the project manager for Phase 2 of the monitoring and data collection program (BC Hydro contract Stave-Ness 05/06). 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 four 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 2005 sampling season, conducted phytoplankton analyses and aided in the preparation of this report.

The project relies upon the diving expertise of Pelagic Technologies Inc. Pelagic Technologies Inc. provides a 2-person dive team and tender for the field sampling components. Finally, the project also depends upon the partnership between Kwantlen First Nation and BC Hydro, with Kwantlen First Nation providing a boat and operator for the field sampling.

2. Commencement of 2005 Pelagic and Littoral Monitoring

The start of the Phase 2 monitoring program was delayed somewhat in 2005 while BC Hydro sought approvals to commence this work. As a result, the 2005 field-sampling season was shortened and only four sampling trips were completed. To build efficiencies into the monitoring program, pelagic and littoral field sampling trips were combined and completed on the same day. The littoral sampling transects were re-established in late July 2005 and the first field sampling commenced in September 2005 for both the littoral and the pelagic monitoring programs. Sampling continued through December 2005 on a 4-5 week interval (Table 2.1).

Table 2.1: 2005 Field Schedule

Date	Activity
July 29, 2005	Re-establishment of littoral sampling blocks and plates
September 7, 2005	1st sampling day
October 4, 2005	2nd sampling day
November 7, 2005	3rd sampling day
December 5, 2005	4th sampling day

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 preparation:

- additional Plexiglas sampling plates were cut and etched with three 100 cm^2 sampling areas and six 40 cm^2 areas, in order to provide for a full complement of sampling plates and to ensure sufficient spares were available;
- buoyant sampling trays, which comprise part of the sampling apparatus at the deepest sampling stations on each transect, were re-rigged with fresh rope and stainless steel eyes, shackles, rubber grommets and foam.

On July 29, 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 the transect locations. The installation involved establishment of plates and buoyant sampling trays along each transect, deploying rope between consecutive concrete blocks, marking transect locations with shoreline flagging tape, and obtaining GPS coordinates for each transect location (Table 2.2).

Table 2.2: 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

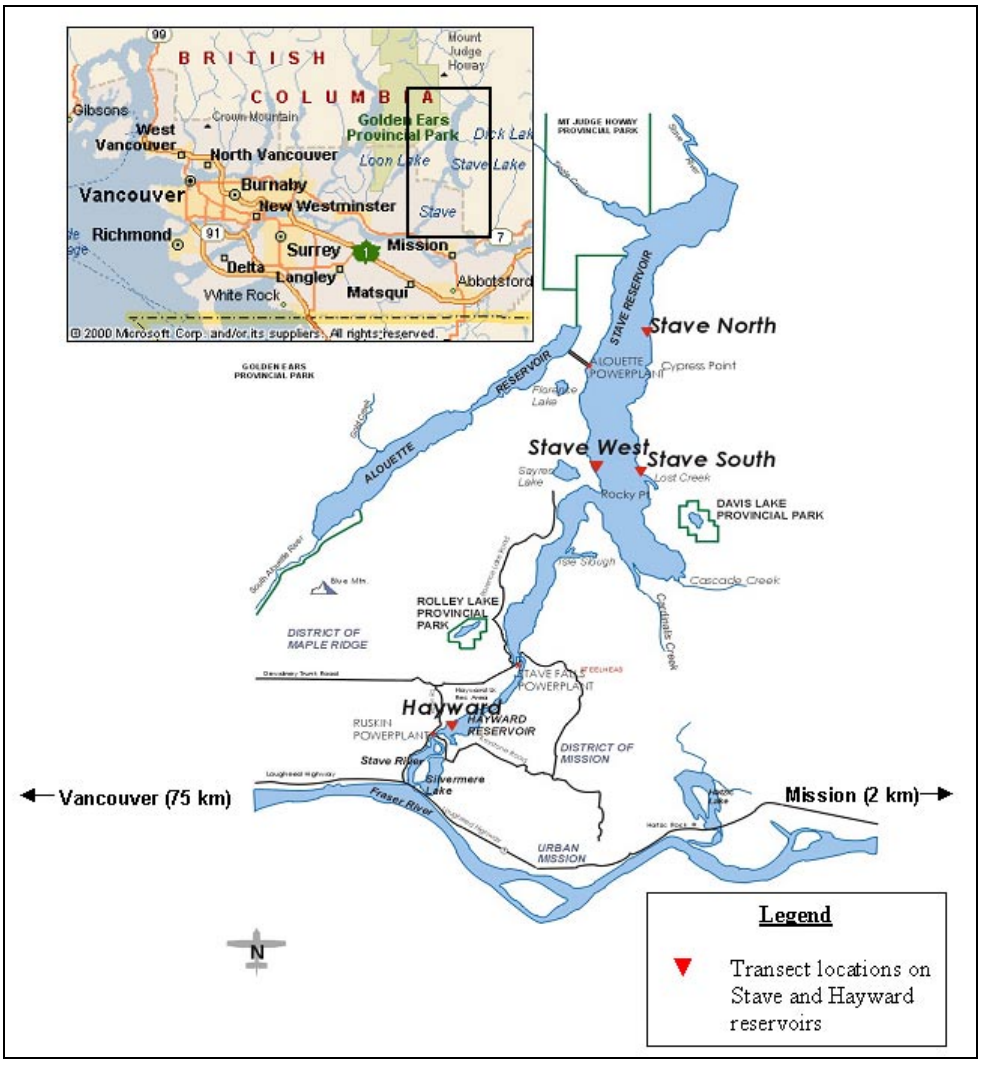


Figure 2.1: Transect Locations on Stave and Hayward reservoirs
(from Beer, 2004)

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 the buoyant sampling trays (Figure 2.3). This approach avoids having the sampling plates impacted by loose sediment at these depths. The upper 6 stations at each site have the sampling plates attached directly to the concrete blocks by the stainless studs (Figure 2.4).

All sampling stations at Hayward, Stave North and Stave South were successfully re-established on July 29, 2005. However, during the July 29, 2005 re-establishment it was discovered that several ropes had become separated between blocks at Stave West, leading to a situation where 3 of the concrete blocks (initially deployed prior to Phase 1)

could not be found. 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 deployed to complete the Stave West transect during the first sampling day (September 7, 2005). Two additional concrete blocks remain at Zajac Ranch and are available in the future as needed.

Figure 2.2: Concrete Littoral Sampling Blocks

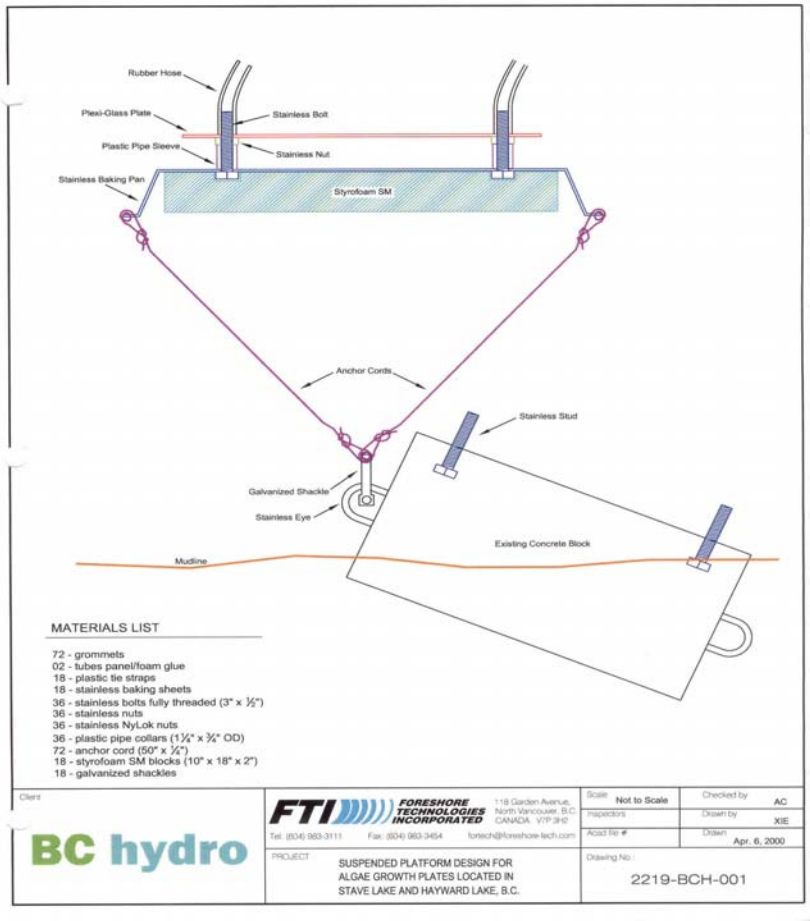


Figure 2.3: Littoral Sampling Apparatus (Cement Block and Buoyant Tray)

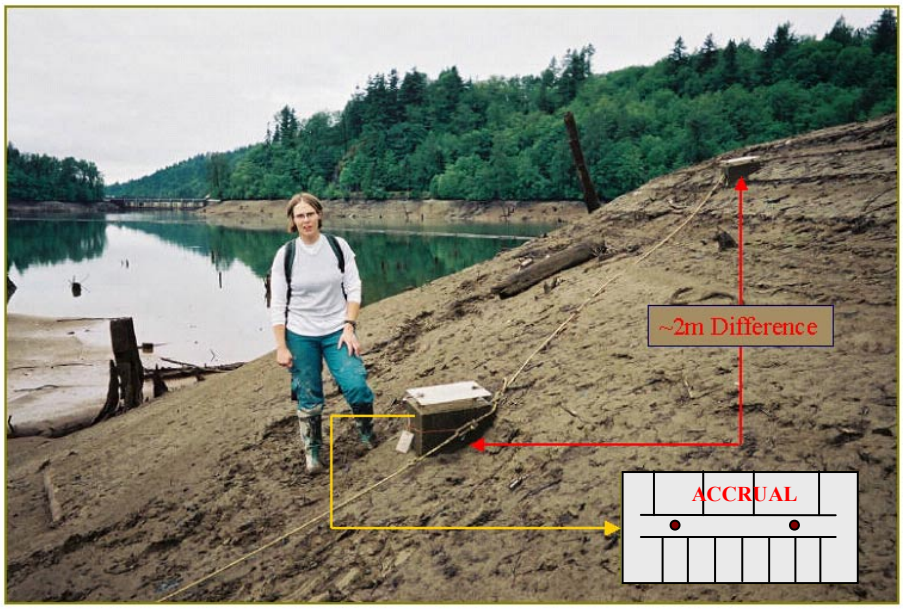


Figure 2.4: Littoral Sampling Design

3. Monitoring Program and Laboratory Protocols

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 are also being 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. The pelagic monitoring program measures primary productivity every three years as an indicator of overall productivity, and nutrient and phytoplankton analyses annually. Pelagic primary production (^{14}C analyses) was not part of the 2005 monitoring program.

Table 3.1: Summary of Monitoring Programs

Pelagic Monitoring Program	Littoral Monitoring Program
• 4 samples per year (May-November)	• As in Phase 1, sampling will take place on approximately 5-week intervals
• 1 sample site on Stave (Stave North), and 1 on Hayward	• 3 sample sites on Stave and 1 on Hayward
• 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 ash-free dry mass
• phytoplankton analyses	• ^{14}C estimates of production will be conducted each sampling trip from 4 metres depth in Hayward Reservoir and from 6 metres depth at Stave North
• zooplankton analyses	
• ^{14}C incubation estimates of primary production every 3rd year (not in 2005)	
• light intensity and temperature profiles	
• other data: daily solar irradiation (from GVRD air monitoring network); temperature (BC Hydro, Environment Canada, GVRD); reservoir levels (BC Hydro)	

Hard copies of all data are kept in field and laboratory notebooks and in Excel spreadsheets. Ness is currently working to create an Access database for all data.

3.1 Littoral Monitoring Program

All sampling blocks at Hayward, Stave North and Stave South were successfully re-established on July 29, 2005, while sampling blocks at Stave West were successfully re-established on September 7, 2005. The littoral monitoring program uses roughened Plexiglas plates to act as artificial substrata to collect periphyton growth samples. These periphyton 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. Sampling commenced in September 2005, approximately five weeks after the transect stations were installed, and continued through December of 2005 (see Table 2.1 for a 2005 sampling schedule). 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 Plexiglas 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 level, there may be occasions when there are less than 38 samples when the uppermost plates are 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 filters were ashed at 500ºC in a muffle furnace for 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

In 2005, 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 14C incorporated (during photosynthesis) into periphyton samples during *in-situ* incubations for a known period under known light conditions. As this method is being developed as part of the Phase 2 monitoring program, incubations from only 2 sampling days were successfully completed as part of the 2005 field season. 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 (Stave North) and one on Hayward. The ^{14}C incubation technique is similar to a methodology developed for estimating pelagic primary production

Periphyton samples were taken from the sampling plates at the transect stations closest to depths of 4 metres and 6 metres below the reservoir elevation (on the day of sampling) for Hayward and Stave North respectively. These depths were selected based on results of the AFDW estimates of primary production from Phase 1 of the monitoring program and typically represent the depths of maximum periphyton growth. 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. One 40 cm^2 area was 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. 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 47mm polycarbonate filter using <10 cm Hg vacuum differential (Joint and Pomroy, 1983);
- 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;
- samples were analyzed by Vizon SciTech 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.

The methodology for estimating littoral primary production by the ^{14}C incubation technique is still being refined. It is expected that the results of the 2006 sampling season can address several outstanding questions, including the most appropriate depth at which to take the periphyton samples, the area that should be scraped, the recommended filtration volume and the consistency of the method's results. Determination of the size of the sampling plate area to be scraped is a balance of providing a large enough sample, while not so much as to make the filtration unnecessarily difficult or running the risk of utilizing all of the carbon. Ness has created new plates that will allow for a sample area of 40 cm^2 or 80 cm^2. Further experimentation will determine the most efficient sampling area.

Filtration volumes and consistency of results will be assessed by filtering additional subsamples from each BOD bottle over the course of the 2006 season. Finally, the incubations in future years should be conducted using deionized water to top up the 300 ml BOD bottles to ensure the littoral sample is isolated and not incorporating any production from the pelagic components. Finally, the impact on laboratory analyses of samples containing sediment should be investigated.

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

^{14}C estimates of pelagic primary production were not part of the 2005 pelagic monitor, but will be conducted in 2007 in accordance with the Terms of Reference. Pelagic

sampling and data collection was conducted mid-reservoir on both Stave and Hayward once per sampling trip.

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 from Allouette power station during the November 7, 2005 sampling day, the only sampling day that occurred while the 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. Some difficulties transporting samples to SPA Chemtest Laboratory were experienced at the start of the season, resulting in an incomplete water quality data set.

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 temporary resolution to this issue, phytoplankton were collected once each trip so that the option for analyses existed. In 2005, a total of 10 phytoplankton samples were collected from July through December. All ten 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 was sampled as a vertical tow at 20 metres depth in Stave and at 15 metres in Hayward with a Wisconsin net 100 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. In 2005, samples were collected on 3 of the 4 sampling trips, all of which occurred later in the fall, outside of the window identified in the Terms of Reference as the preferred sampling period. Subsequent discussions regarding the best outcomes for the pelagic monitoring program resulted in a decision to put the resources allocated for zooplankton sampling and analysis towards additional phytoplankton sample analysis. As a result, zooplankton samples from 2005 were not analyzed. Samples have been preserved and retained for analysis at a future date if desired.

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. These

data were not collected as part of the 2005 monitor because 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 monitor to date.

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 calibrated by BC Hydro staff at the start of the sampling season. The temperature sensor was kept vertical using a light weight and maintaining 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, or to reservoir bottom. 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:

- solar radiation from measurements collected continuously by the Greater Vancouver Regional District (GVRD) at Port Moody 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. This data is not presented in this report but forms part of the electronic database.
- air temperature (BC Hydro, Environment Canada, GVRD)
- reservoir levels (BC Hydro)

4. Results for 2005

Results are presented for data collected in 2005. Comparisons between 2005 and earlier Phase 1 data were not made due to the short sampling season.

4.1 Light

Light profiles for Stave and Hayward on each of the four sampling days in 2005, and from the day sampling transects were re-established (July 29, 2005), are presented in figures 4.1 and 4.2, respectively.

Figure 4.1: Stave Solar Irradiance

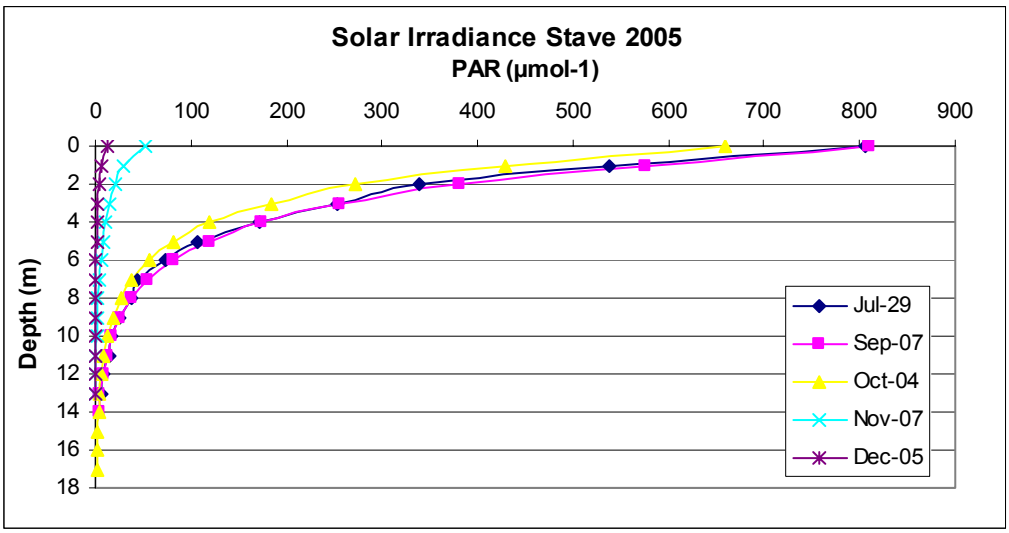
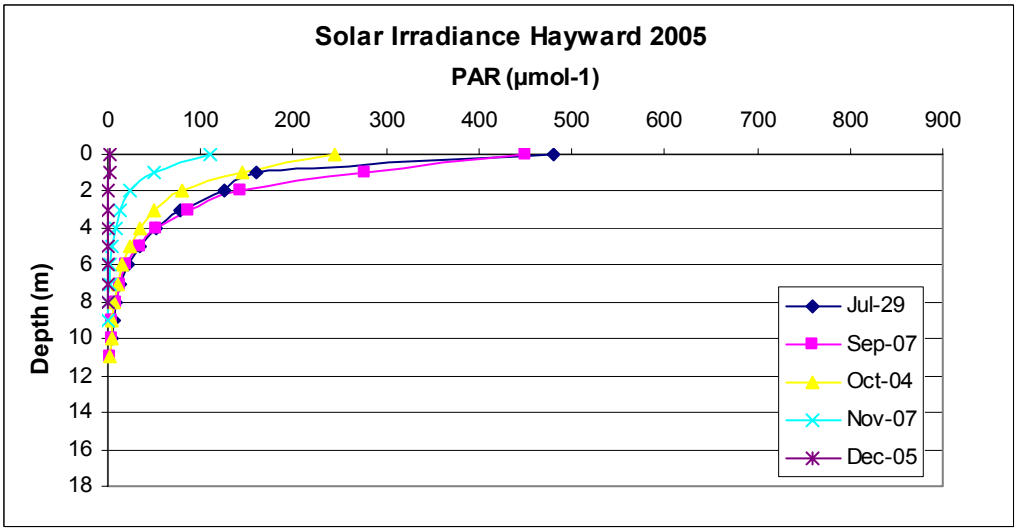


Figure 4.2: Hayward Solar Irradiance



Secchi depths for each sample day on Stave and Hayward are presented in figures 4.3 and 4.4 below.

Figure 4.3: Stave Secchi Depth

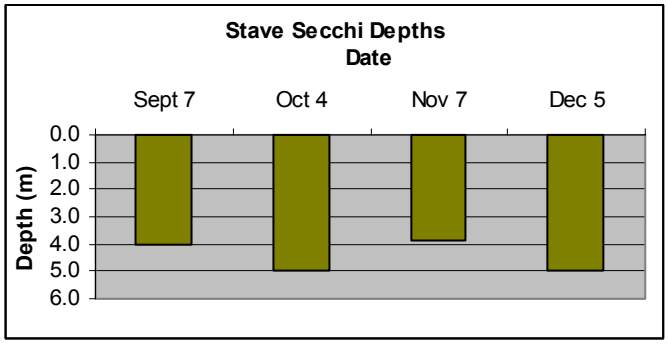
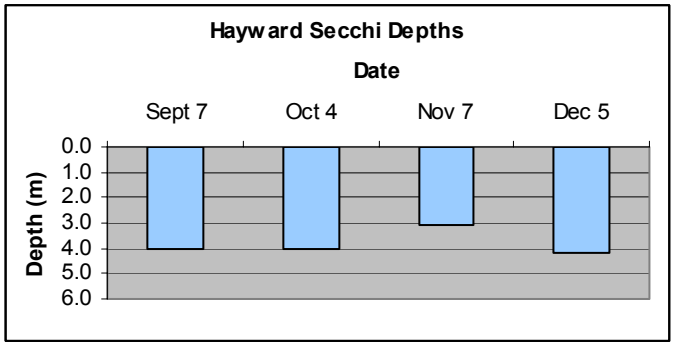


Figure 4.4: Hayward Secchi Depth



Extinction coefficients calculated for each sampling period for Stave and Hayward are presented in Table 4.1.

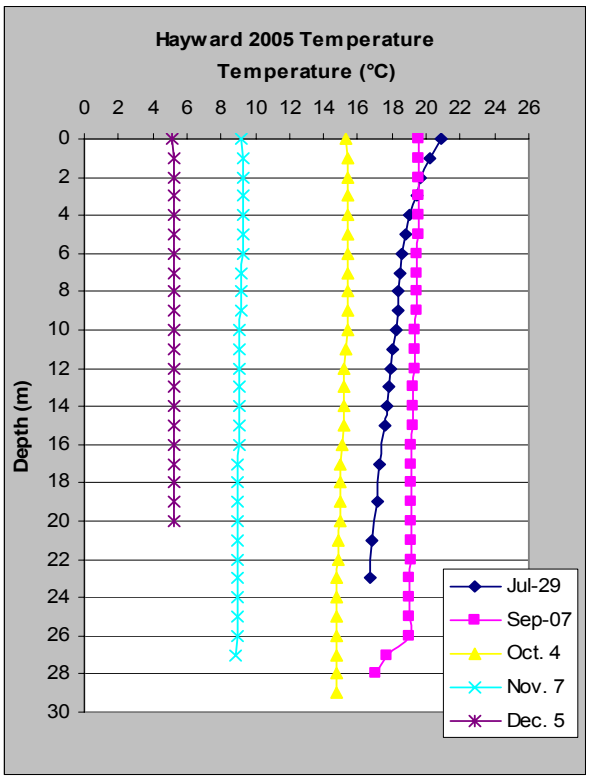
Table 4.1: Sample period extinction coefficients

Date	Stave	Hayward
Jul-29	0.36	0.46
Sep-07	0.40	0.48
Oct-04	0.36	0.42
Nov-07	0.35	0.57
Dec-05	0.34	0.44

4.2 Water Temperature Profiles

Water temperature profiles for Stave and Hayward on each of the four sampling days in 2005, and from the day sampling transects were re-established (July 29, 2005), are presented in figures 4.5 and 4.6, respectively.

Figure 4.5: Hayward Temperature Profile



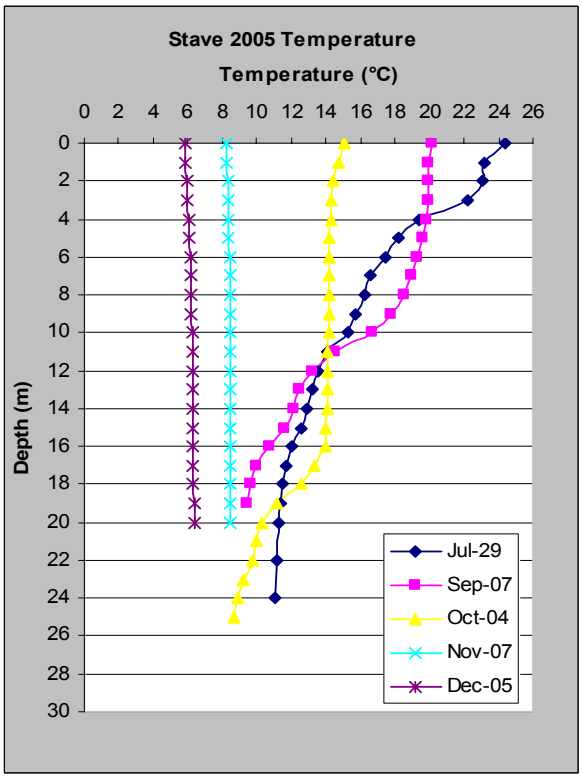


Figure 4.6: Stave Temperature Profile

4.3 Water Chemistry

Water chemistry samples are analyzed at SPAChemtest (DFO Laboratory in Cultus Lake, BC) in order to maintain consistency with analyses from Phase 1.Water chemistry results were not plotted due to the short record from 2005, but over the course of the pelagic monitoring program these data will provide an essential record of the nutrient profile in Stave and Hayward Reservoirs. Tabular results are presented in Table 4.2.

Table 4.2: Water Chemistry Results

Site	Station	Date (y/m/d)	Depth (m)	NO3 µg/L	TP µg/L	TP Turb µg/L	TDP µg/L	Chl.45 µg/L	Phaeo 0.45 µg/L	Corr. Chl.45 µg/L
Stave Lake	Stave	05/10/04	Comp (1, 3, 5)	66.4	2.5	<0.1	0.4	.	.	.
Stave Lake	Hayward	05/10/04	Comp (1, 3, 5)	52.8	2.9	<0.1	0.6	.	.	.
Stave River	Alouette Discharge	05/11/07	Comp (1, 3, 5)	118.1	2.6	<0.1	1.7	0.287	0.247	0.167
Stave Lake	Stave	05/11/07	Comp (1, 3, 5)	113.8	2.7	<0.1	1.9	0.249	0.229	0.138
Stave Lake	Hayward*	05/11/07	Comp (1, 3, 5)	125.6	4.0	<0.1	1.8	0.576	0.316	0.422
Stave Lake	Hayward	05/11/07	Comp (1, 3, 5)	.	.	.	.	0.573	0.399	0.379
Stave Lake	Stave	05/12/05	Comp (1, 3, 5)	124.7	ns	.	1.7	0.193	0.168	0.112
Stave Lake	Hayward	05/12/05	Comp (1, 3, 5)	127.7	2.8	<0.1	1.7	0.306	0.202	0.208

Notes: * Hayward Lake sample for chlorophyll seemed to be processed on a GFF filter.
ns =not sampled

4.4 Phytoplankton

Phytoplankton enumeration results are presented in Appendix 2.

4.5 Periphyton Accrual

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. It is notable that peak periphyton growth occurs at the 8-metre depth on Stave. This result differs from results noted in Phase 1 of the monitoring program and reflects the lower water levels under which Stave reservoir has been operating in 2005. Similarly, peak accrual on Hayward occurred at lower elevations, which reflect the lower operating levels experienced at Hayward during 2005. Note in Figures 4.7 to 4.10 that the reported depths refer to the depth below full pool for each reservoir.

Figure 4.7: Stave North Periphyton Accrual

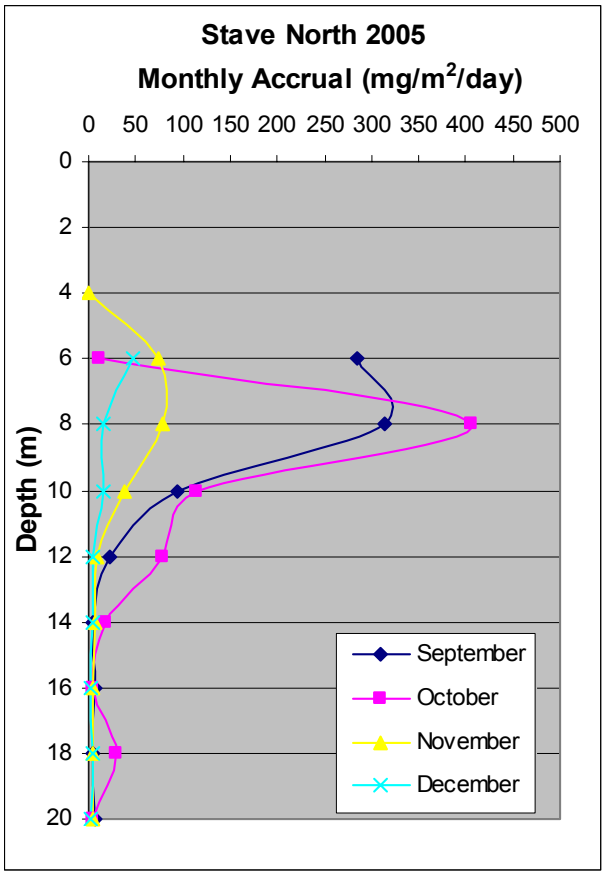


Figure 4.8: Stave South Periphyton Accrual

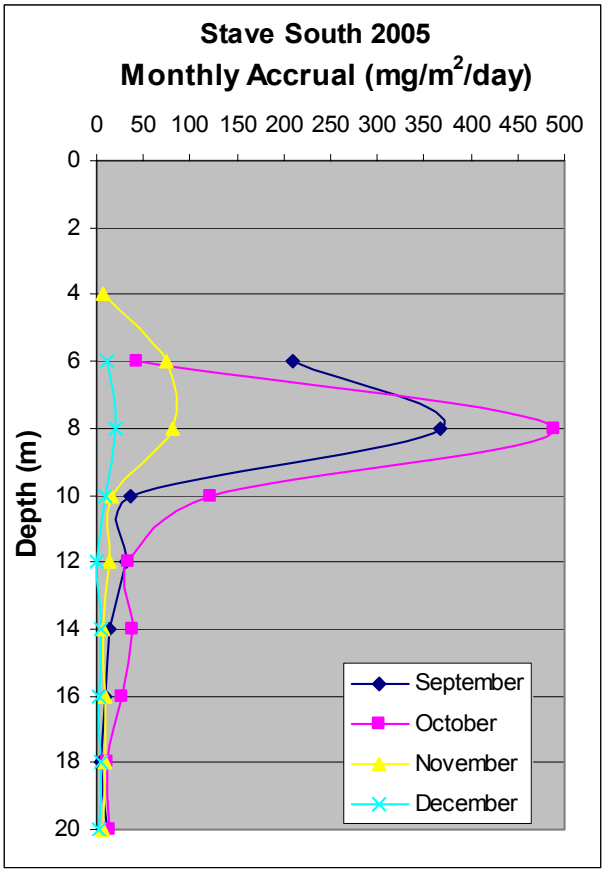


Figure 4.9: Stave West Periphyton Accrual

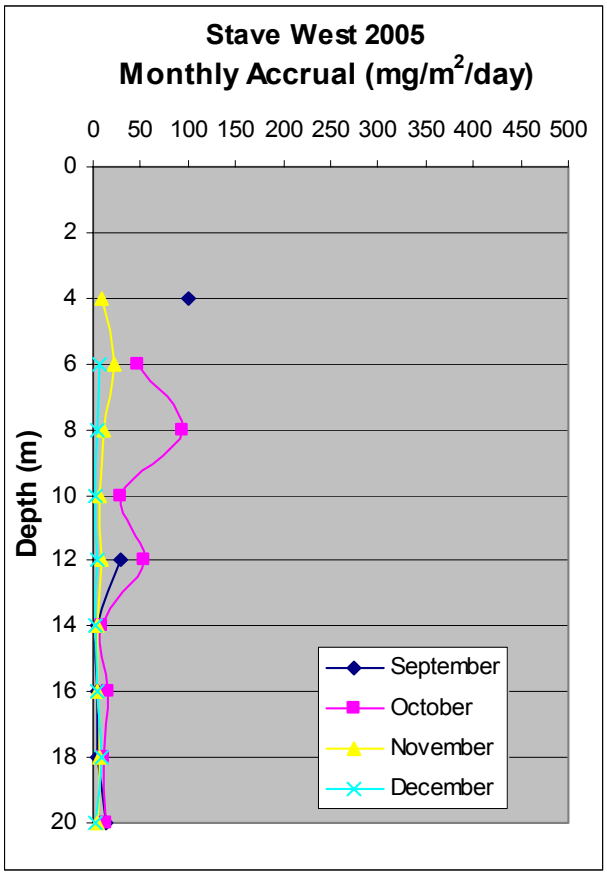
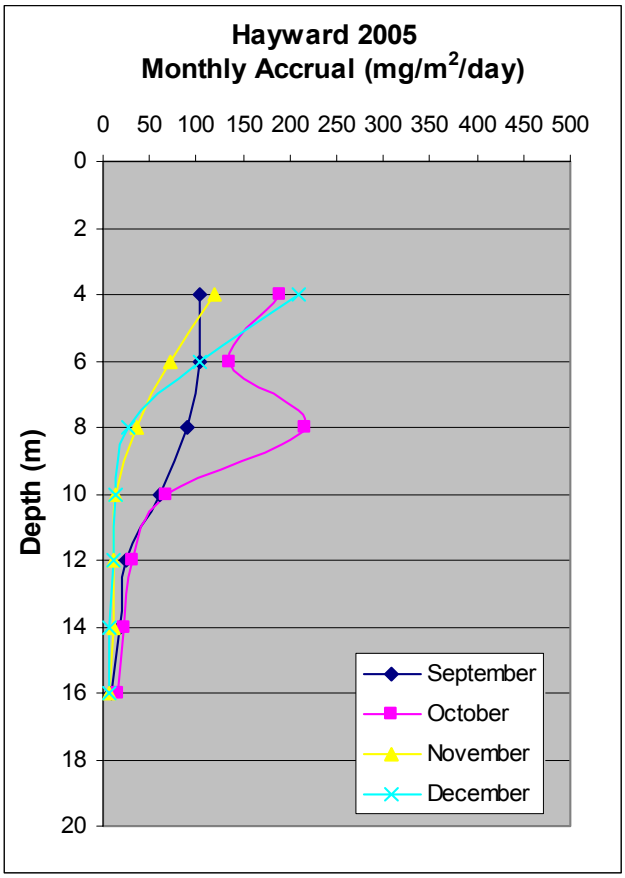


Figure 4.10: Hayward Periphyton Accrual



5. Recommendations

Based on the outcomes of the 2005 sampling season, the following modifications to the sampling program are recommended:

1. Water Chemistry: Omit samples from Allouette power station outfall and increase the frequency of other water chemistry sampling on Stave and Hayward. The current Terms of Reference provide for four water chemistry sampling periods at three locations (Hayward, Stave and Allouette outfall) for a total of 12 samples. Based on experience from 2005 and previous years of sampling, Allouette power station is often not generating on the sampling day, therefore a sample is not collected. In addition, samples from Allouette are often very similar to those from Stave. It is recommended that the water chemistry samples at Allouette not be collected and instead an additional sample be collected on each of Stave and Hayward (*e.g.* 6 water chemistry samples). Increased frequency of water chemistry sampling on Stave and Hayward provides for a more complete sampling record. As well, it is important for the littoral monitoring program because the measurements of chlorophyll *a* are used in the calculation of littoral primary production (by the ^{14}C inoculation technique), which is collected on all sampling trips.
2. For consistency with the littoral primary production measurements being conducted on Stave, it is recommended that temperature and light profiles on Stave always be collected near to Stave North.
3. It is recommended that littoral primary production measures on Hayward be taken at the plate closest to 4 metres depth and at the plate closest to 6 metres depth on Stave on the day of sampling. This will ensure estimates of primary production at the plate depth that best approximates maximum periphyton growth levels.
4. In order to determine the consistency of the sampling technique, littoral primary production measures using the ^{14}C inoculation technique should be analyzed in the laboratory as replicates of three from each sample location.
5. It is recommended that the phytoplankton sampling frequency increase to six samples per year (conducted at the same time as the water chemistry samples).
6. As only three zooplankton samples per year were budgeted, and the Wisconsin net sampler from UBC is no longer available, it is recommended that the zooplankton sampling program be terminated. Furthermore, the zooplankton budget could be used to offset the cost of the additional phyto/pico plankton sampling.
7. Ness was of the opinion that there was a need to provide for greater consistency amongst the artificial substrata (plates), both in terms of their material and the etched sampling areas. In 2005 some existing plates (from Phase 1) were Plexiglas and others were Lexan, introducing the possibility of different periphyton growth rates due to differences in the surface properties. In addition, there were some inaccuracies in the etched sampling areas amongst the plates. In March 2006, all sampling plates were replaced with Plexiglas plates, all of which had been cut, etched, numbered and roughened by Ness. Specific areas were also etched to mark the area from which the littoral carbon samples (^{14}C incubation technique) will be collected.

8. The methodology for estimating primary production by the ^{14}C incubation technique is still being refined. It is expected that the results of the 2006 sampling season can address several outstanding questions, including the most appropriate depth at which to take the periphyton samples, the area that should be scraped, the recommended filtration volume and the consistency of the method's results. Determination of the size of the sampling plate area to be scraped is a balance of providing a large enough sample, while not so much as to make the filtration unnecessarily difficult or running the risk of utilizing all of the carbon. Ness has created new plates that will allow for a sample area of 40 cm^2 or 80 cm^2. Further experimentation will determine the most efficient sampling area. Filtration volumes and consistency of results will be assessed by filtering additional subsamples from each BOD bottle over the course of the 2006 season. Finally, the incubations in future years should be conducted using deionized water to top up the 300 ml BOD bottles to ensure the littoral sample is isolated and not incorporating any production from the pelagic components. Finally, the impact on laboratory analyses from samples containing sediment should be investigated.

6. Budget summary

Table 6.1 below summarizes expenditures up to March 2006 for the littoral and pelagic components of the Phase 2 monitoring program.

Table 6.1: 2005 Budget Summary

	Littoral Program Cost ($)	Pelagic Program Cost ($)
Ness/Ecologic	28,127.63	10,459.25
Pelagic (Dive Team)	14,257.80	n/a
Kwantlen (Boat & Operator)	1,945.64	1,945.64
Expenses	2,111.54	296.70
Vizon SciTech Labs (^{14}C Analyses)	107.00	n/a
Analyses (Ecologic & Spa Chemtest)	n/a	1,425.86
Travel	429.75	231.75
Total	46,979.36	14,359.20

7. Summary

The Phase 2 littoral and pelagic monitoring programs on Stave and Hayward Reservoirs commenced in July of 2005. While the relatively late start shortened the overall sampling season for 2005 resulting in only four data collection periods, the season provided essential time to establish the sampling regime and to prepare for subsequent sampling years.

As a result of the short sampling season and given that this is the first year of the Phase 2 monitoring program, this document focused on reporting the data collected and less on analysis and specific outcomes. The report also provided several key recommendations that can be incorporated into the 2006 monitor. It is noted in this report that determination of the best method for the littoral ^{14}C estimates of primary production are still being developed and should be determined by the completion of the 2006 season.

This report also provides a brief summary of the program budget broken down into broad costs for labour, equipment, analyses and travel. The methods for the water chemistry analyses provided by SPA Chemtest Laboratory (DFO Cultus Lake Lab) are provided in Appendix 1. The detailed results of the Phytoplankton analyses are provided in Appendix 2.

8. 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**.

<u>Chlorophyll</u>
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:

2005 Phytoplankton Results

Hayward Phytoplankton Results (2005)

Hayward Jul. 29, 2005	Station: 1 Magnif: 1560	Depth: epilimnion		Lake: Hayward Date: Sept. 7, 2005	Station: 1 Magnif: 1560	Depth: epilimnion		Lake: Hayward Date: Oct. 4, 2005	Station: 1 Magnif: 1560	Depth: epilimnion	
Class	Species	No. Cells/mL	BioV. mm3/L	Class	Species	No. Cells/mL	BioV. mm3/L	Class	Species	No. Cells/mL	BioV. mm3/L
ceae (diatoms)				**Bacillariophyceae (diatoms)**				**Bacillariophyceae (diatoms)**			
	Fragilaria acus	10.14	0.0010		*Cyclotella glomerata*	10.14	0.0005		*Fragilaria acus*	20.27	0.0020
	Aulacoseira italica	20.27	0.0041		*Navicula sp.*	20.27	0.0101		*Cyclotella glomerata*	40.55	0.0020
	Navicula sp.	20.27	0.0101						*Navicula sp.*	20.27	0.0101
	Frustrulia	20.27	0.0071								
	Group total	70.96	0.0223		***Group total***	30.41	0.0106		***Group total***	81.09	0.0142
yptophyceae (flagellates)				**Chryso- & Cryptophyceae (flagellates)**				**Chryso- & Cryptophyceae (flagellates)**			
	Chromulina sp1	40.55	0.0008		*Chromulina sp1*	60.82	0.0012		*Chromulina sp1*	81.09	0.0016
	Chrysochromulina sp.	70.96	0.0053		*Chrysochromulina sp.*	91.23	0.0068		*Chrysochromulina sp.*	162.19	0.0122
	Chryptomonas sp.	20.27	0.0101		*Chryptomonas sp.*	10.14	0.0051		*Chryptomonas sp.*	20.27	0.0101
	Rhodomonas sp.	91.23	0.0091		*Rhodomonas sp.*	111.51	0.0112		*Rhodomonas sp.*	141.92	0.0142
	Chroomonas acuta	20.27	0.0030		*Chroomonas acuta*	30.41	0.0046		*Chroomonas acuta*	70.96	0.0106
	Kephyrion sp.	10.14	0.0005		*Small microflagellates*	172.33	0.0026		*Small microflagellates*	273.70	0.0041
	Mallomonas sp2	10.14	0.0071		***Group total***	476.43	0.0314		***Group total***	750.13	0.0529
	Small microflagellates	202.74	0.0030								
	Group total	466.30	0.0391								
(dinoflagellates)				**Dinophyceae (dinoflagellates)**				**Dinophyceae (dinoflagellates)**			
	Peridinium sp1	141.92	0.0497		*Peridinium sp1*	70.96	0.0248		*Peridinium sp1*	111.51	0.0390
	Gymnodinium sp2	40.55	0.0608		*Gymnodinium sp2*	30.41	0.0456		*Gymnodinium sp2*	40.55	0.0608
	Gymnodinium sp1	10.14	0.0051		*Gymnodinium sp1*	10.14	0.0051		*Gymnodinium sp1*	10.14	0.0051
	Group total	192.60	0.1156		***Group total***	111.51	0.0755		***Group total***	162.19	0.1049
ae (coccoid greens, desmids, etc.)				**Chlorophyceae (coccoid greens, desmids, etc.)**				**Chlorophyceae (coccoid greens, desmids, etc.)**			
	Ankistrodesmus sp.	20.27	0.0016		*Ankistrodesmus sp.*	10.14	0.0008		*Ankistrodesmus sp.*	10.14	0.0008
	Ulothrix	10.14	0.0071		*Elakatothrix sp3*	10.14	0.0025		*Elakatothrix sp3*	30.41	0.0076
	Golenkinia sp.	10.14	0.0025		*Planctosphaeria*	10.14	0.0101		*Oocystis sp.*	10.14	0.0051
	Oocystis sp.	10.14	0.0051		*Dichtyosphaerium*	10.14	0.0091		*Monoraphidium*	10.14	0.0020
	Chlorella	40.55	0.0008		*Chlorella*	40.55	0.0008		*Chlorella*	40.55	0.0008
	Group total	91.23	0.0171		***Group total***	81.09	0.0234		***Group total***	101.37	0.0163
ae (blue-greens)				**Cyanophyceae (blue-greens)**				**Cyanophyceae (blue-greens)**			
	Synechococcus sp. (<2 um)	354.79	0.0018		*Synechococcus sp. (<2 um)*	243.28	0.0012		*Synechococcus sp. (<2 um)*	506.84	0.0025
	Oscillatoria sp2	293.97	0.0059		*Oscillatoria sp2*	162.19	0.0032		*Oscillatoria sp2*	152.05	0.0030
	Aphanothecae sp.	20.27	0.0020		*Aphanothecae sp.*	81.09	0.0081		*Aphanothecae sp.*	91.23	0.0091
	Oscillatoria limnetica	30.41	0.0106		*Merismopedia sp.*	152.05	0.0030		*Merismopedia sp.*	60.82	0.0012
					Gomphosphaeria sp.	10.14	0.0076		*Gomphosphaeria sp.*	10.14	0.0076
	Group total	699.44	0.0203		***Group total***	648.76	0.0232		***Group total***	821.09	0.0235
	GRAND TOTAL	1520.53	0.2144		***GRAND TOTAL***	1348.20	0.1642		***GRAND TOTAL***	1915.87	0.2118

Hayward Phytoplankton Results (2005)

Lake: Hayward **Station:** 1 **Depth:** epilimnion
Date: Nov. 7, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Achnanthes sp	91.23	0.0073
	Fragilaria construens	30.41	0.0024
	Navicula sp.	60.82	0.0304
	Frustrulia	20.27	0.0071
	Group total	202.74	0.0472
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	40.55	0.0008
	Chrysochromulina sp.	70.96	0.0053
	Chryptomonas sp.	10.14	0.0051
	Rhodomonas sp.	81.09	0.0081
	Chroomonas acuta	70.96	0.0106
	Small microflagellates	172.33	0.0026
	Group total	446.02	0.0325
Dinophyceae (dinoflagellates)			
	Peridinium sp1	40.55	0.0142
	Gymnodinium sp2	20.27	0.0304
	Group total	60.82	0.0446
Chlorophyceae (coccoid greens, desmids, etc.)			
	Pediastrum sp.	10.14	0.0101
	Chlorella	20.27	0.0004
	Group total	30.41	0.0105
Cyanophyceae (blue-greens)			
	Synechococcus sp. (<2 um)	131.78	0.0007
	Oscillatoria sp2	70.96	0.0014
	Aphanothecae sp.	10.14	0.0010
	Oscillatoria limnetica	10.14	0.0035
	Merismopedia sp.	20.27	0.0004
	Group total	243.28	0.0070
	GRAND TOTAL	983.28	0.1420

Lake: Hayward **Station:** 1 **Depth:** epilimnion
Date: Dec. 5, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Achnanthes sp	10.14	0.0008
	Fragilaria acus	10.14	0.0010
	Cyclotella glomerata	20.27	0.0010
	Navicula sp.	10.14	0.0051
	Group total	50.68	0.0079
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	40.55	0.0008
	Chrysochromulina sp.	10.14	0.0008
	Rhodomonas sp.	30.41	0.0030
	Chroomonas acuta	20.27	0.0030
	Dinobryon sp	60.82	0.0122
	Small microflagellates	101.37	0.0015
	Group total	263.56	0.0213
Dinophyceae (dinoflagellates)			
	Peridinium sp1	20.27	0.0071
	Gymnodinium sp2	10.14	0.0152
	Gymnodinium sp1	10.14	0.0051
	Group total	40.55	0.0274
Chlorophyceae (coccoid greens, desmids, etc.)			
	Oocystis sp.	10.14	0.0051
	Chlorella	20.27	0.0004
	Group total	30.41	0.0055
Cyanophyceae (blue-greens)			
	Synechococcus sp. (<2 um)	91.23	0.0005
	Oscillatoria sp2	152.05	0.0030
	Oscillatoria limnetica	10.14	0.0035
	Merismopedia sp.	10.14	0.0002
	Group total	263.56	0.0072
	GRAND TOTAL	648.76	0.0693

Stave Phytoplankton Results (2005)

Lake: Stave **Station:** 1 **Depth:** epilimnion
Date: Jul. 29, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Cyclotella glomerata	20.27	0.0010
	Navicula sp.	30.41	0.0152
	Group total	50.68	0.0162
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	152.05	0.0030
	Chrysochromulina sp.	141.92	0.0106
	Chryptomonas sp.	20.27	0.0101
	Rhodomonas sp.	131.78	0.0132
	Chroomonas acuta	30.41	0.0046
	Mallomonas sp2	10.14	0.0071
	Small microflagellates	334.52	0.0050
	Group total	821.09	0.0537
Dinophyceae (dinoflagellates)			
	Peridinium sp1	60.82	0.0213
	Gymnodinium sp2	40.55	0.0608
	Gymnodinium sp1	30.41	0.0152
	Group total	131.78	0.0973
Chlorophyceae (coccoid greens, desmids, etc.)			
	Elakatothrix sp3	10.14	0.0025
	Planctosphaeria	30.41	0.0304
	Cosmarium sp.	10.14	0.0051
	Chlorella	40.55	0.0008
	Group total	91.23	0.0388
Cyanophyceae (blue-greens)			0.0048
	Synechococcus sp. (<2 um)	963.00	0.0057
	Oscillatoria sp2	283.83	0.0071
	Aphanothecae sp.	70.96	0.0355
	Oscillatoria limnetica	101.37	0.0014
	Merismopedia sp.	70.96	0.0507
	Microcystis sp.	101.37	0.1052
	Group total	1591.49	
Bacillariophyceae (diatoms)			
	Cyclotella stelligera	10.14	0.0015
	Group total	10.14	0.0015
	GRAND TOTAL	2696.41	0.3127

Lake: Stave **Station:** 1 **Depth:** epilimnion
Date: Sept. 7, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Fragilaria acus	20.27	0.0020
	Cyclotella glomerata	10.14	0.0005
	Navicula sp.	20.27	0.0101
	Group total	50.68	0.0127
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	111.51	0.0022
	Chrysochromulina sp.	70.96	0.0053
	Chryptomonas sp.	10.14	0.0051
	Rhodomonas sp.	91.23	0.0091
	Chroomonas acuta	20.27	0.0030
	Small microflagellates	263.56	0.0040
	Group total	567.66	0.0287
Dinophyceae (dinoflagellates)			
	Peridinium sp1	40.55	0.0142
	Gymnodinium sp2	10.14	0.0152
	Gymnodinium sp1	10.14	0.0051
	Group total	60.82	0.0345
Chlorophyceae (coccoid greens, desmids, etc.)			
	Ankistrodesmus sp.	20.27	0.0016
	Elakatothrix sp3	10.14	0.0025
	Chlorella	50.68	0.0010
	Group total	81.09	0.0052
Cyanophyceae (blue-greens)			
	Synechococcus sp. (<2 um)	810.95	0.0041
	Oscillatoria sp2	243.28	0.0049
	Aphanothecae sp.	91.23	0.0091
	Oscillatoria limnetica	20.27	0.0071
	Merismopedia sp.	233.15	0.0047
	Gomphosphaeria sp.	10.14	0.0076
	Group total	1409.03	0.0374
	GRAND TOTAL	2169.29	0.1184

Lake: Stave **Station:** 1 **Depth:** epilimnion
Date: Oct. 4, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Fragilaria capucina	10.14	0.0010
	Fragilaria acus	30.41	0.0030
	Cyclotella glomerata	111.51	0.0056
	Navicula sp.	10.14	0.0051
	Group total	162.19	0.0147
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	50.68	0.0010
	Chrysochromulina sp.	91.23	0.0068
	Chryptomonas sp.	10.14	0.0051
	Rhodomonas sp.	60.82	0.0061
	Chroomonas acuta	20.27	0.0030
	Small microflagellates	212.87	0.0032
	Group total	446.02	0.0252
Dinophyceae (dinoflagellates)			
	Peridinium sp1	40.55	0.0142
	Gymnodinium sp2	20.27	0.0304
	Gymnodinium sp1	10.14	0.0051
	Group total	70.96	0.0497
Chlorophyceae (coccoid greens, desmids, etc.)			
	Ankistrodesmus sp.	30.41	0.0024
	Elakatothrix sp3	20.27	0.0051
	Planctosphaeria	20.27	0.0203
	Cosmarium sp.	10.14	0.0051
	Dichtyosphaerium	10.14	0.0091
	Chlorella	40.55	0.0008
	Group total	131.78	0.0428
Cyanophyceae (blue-greens)			
	Synechococcus sp. (<2 um)	456.16	0.0023
	Oscillatoria sp2	141.92	0.0028
	Aphanothecae sp.	223.01	0.0223
	Oscillatoria limnetica	10.14	0.0035
	Merismopedia sp.	172.33	0.0034
	Gomphosphaeria sp.	40.55	0.0304
	Group total	1044.10	0.0648
	GRAND TOTAL	1855.05	0.1972

Stave Phytoplankton Results (2005)

Lake: Stave **Station:** 1 **Depth:** epilimnion
Date: Nov. 7, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Fragilaria construens	111.51	0.0089
	Fragilaria capucina	60.82	0.0061
	Fragilaria acus	10.14	0.0010
	Navicula sp.	40.55	0.0203
	Frustrulia	131.78	0.0461
	Cymbella sp.	10.14	0.0025
	Group total	364.93	0.0849
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	10.14	0.0002
	Chrysochromulina sp.	60.82	0.0046
	Chryptomonas sp.	10.14	0.0051
	Rhodomonas sp.	30.41	0.0030
	Chroomonas acuta	10.14	0.0015
	Small microflagellates	162.19	0.0024
	Group total	283.83	0.0168
Dinophyceae (dinoflagellates)			
	Peridinium sp1	20.27	0.0071
	Gymnodinium sp2	10.14	0.0152
	Group total	30.41	0.0223
Chlorophyceae (coccoid greens, desmids, etc.)			
	Ankistrodesmus sp.	10.14	0.0008
	Chlorella	30.41	0.0006
	Group total	40.55	0.0014
Cyanophyceae (blue-greens)			
	Synechococcus sp. (<2 um)	111.51	0.0006
	Oscillatoria sp2	50.68	0.0010
	Aphanothecae sp.	70.96	0.0071
	Oscillatoria limnetica	10.14	0.0035
	Gomphosphaeria sp.	10.14	0.0076
	Group total	253.42	0.0198
	GRAND TOTAL	973.14	0.1453

Lake: Stave **Station:** 1 **Depth:** epilimnion
Date: Dec. 5, 2005 **Magnif:** 1560

Class	Species	No. Cells/mL	BioV. mm3/L
Bacillariophyceae (diatoms)			
	Navicula sp.	20.27	0.0101
	Frustrulia	10.14	0.0035
	Group total	30.41	0.0137
Chryso- & Cryptophyceae (flagellates)			
	Chromulina sp1	10.14	0.0002
	Chrysochromulina sp.	50.68	0.0038
	Rhodomonas sp.	30.41	0.0030
	Chroomonas acuta	10.14	0.0015
	Group total	101.37	0.0086
Dinophyceae (dinoflagellates)			
	Peridinium sp1	20.27	0.0071
	Gymnodinium sp2	10.14	0.0152
	Group total	30.41	0.0223
Chlorophyceae (coccoid greens, desmids, etc.)			
	Chlorella	20.27	0.0004
	Group total	20.27	0.0004
Cyanophyceae (blue-greens)			
	Synechococcus sp. (<2 um)	91.23	0.0005
	Oscillatoria sp2	405.47	0.0081
	Aphanothecae sp.	30.41	0.0030
	Oscillatoria limnetica	20.27	0.0071
	Group total	547.39	0.0187
	GRAND TOTAL	729.85	0.0637