Evaluation of an Experimental Re-introduction of Sockeye Salmon into Skaha Lake; Year 3 of 3

Addendum to the Assessment of Juvenile Oncorhynchus nerka (Sockeye and Kokanee) Rearing Conditions of Skaha and Osoyoos Lakes 2002 Section of the 2002 Technical Report

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Bonneville Power Administration
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Addendum to Assessment of Juvenile Oncorhynchus nerka (Sockeye and Kokanee) Rearing Conditions of Skaha and Osoyoos Lakes in the Report Entitled "Evaluation of an Experimental Introduction of Sockeye into Skaha Lake: Year 3 of 3," May 2003

Authors:
Howie Wright, BSc, R.P. Bio
Shayla Lawrence, BSc
Betty Rebellato, BNRS

Prepared for:
Colville Confederated Tribes

January 2004

Okanagan Nation Alliance
3255 C Shannon Lake Road,
Westbank, BC V4T 1V4
Phone: (250) 707-0095 Fax: (250) 707-0166

FINAL

OBJECTIVE 3 Task D
Final Assessment of Juvenile *Oncorhynchus nerka* (Sockeye and Kokanee) Rearing Conditions of Skaha and Osoyoos Lakes 2002

Presented to: Colville Confederated Tribes

Date: January 31, 2004

Authors: Howie Wright, BSc, R.P. Bio
Shayla Lawrence, BSc
Betty Rebellato, BNRS

Technical Review by: Chris Bull, R.P. Bio

Edited by: Howard Smith

EXECUTIVE SUMMARY

Okanagan Basin sockeye salmon are widely thought to have ranged upstream well above their present limits, and studies now underway are designed to assess the opportunities and risks of reintroducing them higher into the system. As a first step, a planned reintroduction into Skaha Lake is being explored. Based upon two years of intensive monitoring, physical and chemical features of Skaha L. appear to be as good or better for both adult holding and juvenile rearing as those which are currently utilized in Osoyoos L.

This is a final report of results presented by Wright and Lawrence (2003) along with additional exploration and analysis of zooplankton, *Mysis relicta*, *Oncorhynchus nerka* - *M. relicta* interactions, and diet analysis from the 2002 sampling season.

Data collected in 2002were used to examine the relationship between total dissolved phosphorus and total fish biomass, which enabled estimates to be made of the rearing capacity for sockeye salmon (*O. nerka*) smolts both 86 mm and 100 mm in length in two Okanagan Valley lakes .For Skaha L., estimates of smolt production per hectare were 2,781 and 1,977 respectively, and for Osoyoos L., they were 2,981 and 2,119 respectively. Based on the total phosphorus to biomass relationship, the two lakes appear similar in rearing potential. However, there are many other factors, both biotic and abiotic, that affect these estimates.

Secchi disc depths corresponded well with the levels of productivity measured in both lakes, where decreasing depths were found to be associated with increases in phosphorus concentrations. In terms of temperature and dissolved oxygen limitations, Skaha L. had the greatest amount of optimal habitat for juveniles. Osoyoos L. had suitable habitat in the north basin, but it was limited there during the month of September. When Skaha L. conditions were compared to current juvenile Okanagan sockeye rearing conditions in the north basin of Osoyoos L., temperature and oxygen limitations appeared unlikely to be an issue in Skaha. L. In addition, in terms of adult holding habitat prior to spawning, Skaha L. had superior conditions to those in Osoyoos L.

The total nitrogen to total phosphorus (TN:TP) ratio suggests that Skaha production was phosphorus-limited and that the north basin of Osoyoos L. was phosphorus-limited from April to September but may have been either nitrogen or phosphorus-limiting in October and November. Chlorophyll *a* related well to the increase in total phosphorus from Skaha L. to Osoyoos L. Because silica levels did not vary greatly in either Skaha or Osoyoos lakes, it is not believed to be limiting for either lake.

Cyclopoids were most abundant in terms of both mean density and mean biomass in Skaha L. over the April to November sampling period. Rotifers made up the highest density in Osoyoos L., and *Diaptomus* was highest in terms of biomass. Mean sizes of zooplankton were relatively similar in both lakes in terms of individual species, but when all species were combined, there was a larger amount of zooplankton in the 0.5 to 0.9 mm length range in Skaha L.
The mean density of *Mysis relicta* was slightly higher in Osoyoos L. than in Skaha L. However, mean biomass of *Mysis* was considerably higher in Skaha L. than in Osoyoos L.

Diel vertical migration monitoring and diet analysis suggests that *O. nerka* - *M. relicta* interactions are appreciable and that mysids are a food source to *O. mykiss*, which warrants further attention. The *Mysis* – *O. nerka* interactions varied in intensity throughout the year and between lakes.

The kokanee escapement in Skaha L. in 2002 was greater than 86,000 fish - the most observed since the early 1970's. Nevertheless, it is still low compared to numbers in some historical records.

Because the physical and chemical features of Skaha L. appear to offer as good or better holding and rearing conditions than Osoyoos L., optimism for the reintroduction is warranted.

However, only two years of monitoring have been completed and there are still several unanswered questions arising from the second year of lake rearing assessment that may need answering to create a proper design for successful implementation and monitoring of the experimental reintroduction project:

1. Why has the kokanee population in Skaha L. been smaller than historically (except in 2002)?
2. What part, if any, has *M. relicta* played in the decline in Skaha L. kokanee numbers?
3. What is the nature of *O.nerka – M.relicta* – zooplankton interactions in Skaha L.?
4. Would these interactions affect the success of any reintroduction of sockeye into Skaha L.?
5. Would these interactions affect the success of the present kokanee population in Skaha L.?
6. Since preliminary results suggest that *Mysis relicta* has increased in density in Osoyoos L., how might this affect the future survival of the Okanagan sockeye?

It is recommended that the following information be gathered to increase our rearing and limnological knowledge of the north basin of Osoyoos L. and Skaha L.:

1. Compare historical 'predicted versus observed' Skaha L. kokanee spawner numbers and compare results with those obtained from the total phosphorus to fish biomass relationship,
3. Continue monthly water quality sampling regime (physical and chemical) of Skaha L. and the north basin of Osoyoos L.,
4. Conduct biweekly *Mysis relicta* and zooplankton sampling data from March to the Cladoceran bloom (usually in June or July) and then conduct monthly sampling from bloom to November using the 2002 sampling methodology,
5. Continue collection of kokanee information from Skaha L. and sockeye information from Osoyoos L. to include juvenile abundance and growth rates of maturing fish.

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Carol Cooper of Zootec Services Ltd. conducted the zooplankton and diet analysis, and Al Hirst of Jensyd Biotech conducted the *Mysis relicta* analysis. PSC Analytical Services conducted the water chemistry analysis.

Howard Smith provided a thorough and insightful senior review and editing of the report, and Chris Bull provided technical comments on the report.

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1.0 INTRODUCTION

One of the last two significant sockeye salmon populations of the Columbia River system spawns in the Okanagan River in British Columbia (Fig. 1a). However, despite high spawner returns in 2000 and 2001, their population has been declining to levels causing concern (Hyatt & Rankin 1999). Although sockeye were once able to gain access to habitat as far north as Okanagan Lake in the Okanagan Basin, they are presently only able to access lake habitat in Osoyoos L. due to a series of dams along the mainstem Okanagan River, which block access to Okanagan, Skaha, and Vaseux lakes. A long-term restoration goal is to reintroduce sockeye into Okanagan Lake in order to increase lake habitat for adult holding and juvenile rearing. It has been proposed to first reintroduce sockeye into Skaha Lake. With funding from the Columbia Basin Fish and Wildlife Program of the Bonneville Power Administration, the Okanagan Nation Alliance Fisheries Department (ONAFD) and Colville Confederated Tribes (CCT) are currently evaluating the Skaha introduction proposal. One concern is that adult holding and juvenile rearing conditions in Skaha Lake may be limiting factors to the success of the reintroduction. This is a final report containing results from Wright and Lawrence (2003) as well as additional analyses of zooplankton-*Mysis relicta* interactions, *O. nerka*-*M. relicta* interactions, and diet analysis of *O. nerka* collected during the 2002 sampling season.

In addition to this present project, seasonal in-lake abundance estimates of juvenile sockeye and kokanee (*O. nerka*), zooplankton, and *M. relicta*[1] in Osoyoos and Skaha lakes have been completed since May of 1999 by ONAFD and Fisheries and Oceans Canada (Rankin 2002, Research Biologist, personal communication). However, work on seasonal distribution of juvenile *O. nerka* and their potential interactions with *M. relicta* have been limited, and biosampling of Skaha Lake kokanee has also been limited (Wright 2002).

Mysis relicta and *O. nerka* both occupy the pelagic area of the lake system during specific times of their life history. In addition, both undergo diel vertical migrations (Levy 1991). In Okanagan L. (immediately upstream of Skaha L.), *M. relicta* were found to remain at depths of 90-150 m during the day and migrate up to the thermocline during the night (Levy 1991). *O. nerka* were also found to undergo a similar migration, however slightly different by not migrating to depths as deep as *M. relicta* and also varying depending on age class of kokanee. Levy (1991) also found that *O. nerka* and *M. relicta* were segregated spatially during much of their diel vertical migration cycle in Okanagan L.; thus, access to *M. relicta* as a potential food source was limited. However, Okanagan L. has a mean depth of 75.3 m while Skaha and Osoyoos lakes are much shallower: 26.5 m and 20.7 m respectively (Pinsent et al. 1974b). Because *M. relicta* will not be able to migrate to depths as observed in Okanagan L., it is hypothesized that *M. relicta* may offer a greater potential as a food source for *O. nerka* in these lakes. What is not known is how long the two species interact on a daily basis, and when they do interact, whether they are a competitor or a source of prey for *O. nerka*.

[1] For this report *M. relicta* and mysid(s), common name, will be used interchangeably

The objectives of this report are to:

1. Assess adult holding[2] habitat,
2. Calculate the juvenile rearing capacity of Skaha and Osoyoos lakes
3. Describe the pelagic interactions between *O. nerka* and *M. relicta*,
4. Compile historical information on Skaha L.
5. Summarize the physical and chemical limnology, zooplankton abundances, and *Mysis relicta* abundances of Skaha and Osoyoos lakes
6. Analyze the diet of Skaha L. kokanee.

2.0 METHODOLOGY

2.1 Background Data Compilation

Limnological and other pertinent Skaha L. data were reviewed to find information gaps and determine what would be useful when comparing past lake productivity with that measured in a post-introduction period should reintroduction occur. In addition to the ONAFD library archives, information sources included: MoWLAP, Okanagan Basin limnological studies by various authors under the Canada-British Columbia Okanagan Basin Agreement, Summerland Hatchery documents, water quality measurements from a number of separate sources, a collection of documents from Fisheries and Oceans Canada (DFO), and a 1949 thesis by a student at the University of British Columbia (UBC).

2.2 Field Sampling

Selection of sample stations was based on recommendations from Wright (2002) and from the year-end review meeting for the project. A summary of sample areas for Osoyoos L. (Fig. 1b) and Skaha L. (Fig. 1c). Key recommendations for this report from the year-two review meeting are:

- Discontinue assessments of the south and central basins of Osoyoos L. and Vaseux L., because temperature and oxygen extremes suggest they have very little rearing potential,
- Have two sites for each of Skaha and Osoyoos lakes for comparison purposes,
- Increase frequency of zooplankton and *Mysis relicta* sampling to biweekly intervals,
- Increase frequency of temperature and dissolved oxygen sampling to biweekly intervals throughout the field season and to weekly intervals from late August to late October.

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[2] Adult holding is defined as the period of time that adult sockeye spend in a lake or river between migration from the marine life history phase and prior to spawning. In this case, Osoyoos L. is the only available adult holding habitat in Canada with the potential for Skaha L.

Table 1 lists sampling stations. Sample location ID's were kept consistent with sample stations from the previous year for comparability. Physical limnology, water chemistry, phytoplankton (not analyzed), zooplankton, and *Mysis relicta* were sampled at all sites. Physical limnology and water chemistry methodology was based on Okanagan Lake Action Plan methodology for comparability and consistency (Andrusak et al. 2000). Zooplankton and *Mysis relicta* sampling was based on methodology as described in Rankin et al. (2000).

Table 1. Summary of sampling stations

Lake	Site ID	Site No.	Site Name	Depth (m)
Skaha	0500615	2	Skaha opposite Gillies Creek	53
Skaha	0500846	3	Skaha South Basin	37
Osoyoos	0500249	1	Osoyoos North Basin	37
Osoyoos	0500728	2	Osoyoos opposite Monashee Co-op	60

2.3 Rearing Capacity

For comparability and discussion of 2001 and 2002 data, the rearing capacities of Skaha and Osoyoos lakes were calculated using the relationship between total phosphorus and total fish biomass (Downing et al. 1990; Hanson & Leggett 1982; Stockner 1987). This relationship is based on many years of data from northern temperate lakes and has also been used by Hyatt and Rankin (1999) to calculate the rearing capacity of Osoyoos L.. Total phosphorus concentrations and juvenile *O. nerka* biomass were used to develop a regression equation for predicting total fish biomass for lakes where total phosphorus concentrations are measured. It has worked well in other British Columbia lakes, including Osoyoos L., and it also takes into account seasonal variability in environmental factors (Hyatt & Rankin 1999).

2.4 Physical Limnology and Water Chemistry

2.4.1 Physical Limnology

Temperature (^{o}C) and dissolved oxygen profiles (mg/L) were taken at least bimonthly in both lakes from April to August and weekly from September to early October. In addition, profiles were taken opportunistically when the field crew was out in the field.

At each sample site, temperature and dissolved oxygen profiles were taken from the surface down to 20 m in 2 m intervals and every 4 m thereafter to the bottom using a calibrated YSI model 52 dissolved oxygen meter, with measurements taken to the nearest 0.1 mg/L. Secchi disk depth was also measured. A zone of tolerance was delineated for each lake, based upon water temperature (>17 ^{o}C), and dissolved oxygen (<4 mg/L), tolerances of *O. nerka.* The zones of tolerance are approximately the amount of vertical habitat available in the hypolimnion (Rankin 2002, Research Biologist, personal communication).

2.4.2 Water Chemistry

Water chemistry was measured monthly from April to November during daylight with three samples taken from each lake site. The samples from 1-10 m depths were integrated; in addition, discrete samples of a volume equal to one third of a sample bottle were also taken at 1 m, 5 m, and 10 m depths. Additional discrete samples were taken at 20 m, as was a deep sample (32 m and 45 m at Sites 1 and 2 respectively in Osoyoos L. and 36 m and 45 m at Sites 2 and 3 respectively in Skaha L.). Plastic 1 L bottles were rinsed three times prior to inserting samples. Separate bottles for total phosphorus at each depth, site, and lake and were taken to the field lab where H_2SO_4 was added.

Phytoplankton was collected at each site by an additional integrated sample, which was placed in a clear 250 ml glass jar and preserved with Lugol's iodine solution. The phytoplankton samples are in ONAFD storage in case it is later determined that phytoplankton analysis is required.

An additional integrated (0-10 m) sample was taken and put in brown plastic 1 L bottles for chlorophyll *a* analysis. The samples were filtered and preserved with 2 drops of $MgCO_3$, then frozen and shipped on ice in sealed plastic bags with a small amount of silica gel to the PSC Analytical Services laboratory in North Vancouver along with the water samples.

2.5 Macrozooplankton

Macrozooplankton sampling was conducted at biweekly intervals between April and November. Sampling was conducted at night using a plankton net (terminal mesh size of 105 microns). Flow measurements were also taken to determine net efficiency. Samples were put in 250 ml glass jars, preserved in 4 % formalin, and shipped to the Pacific Biological Station (PBS) in Nanaimo, BC where they were picked up by AMC lab for analysis.

Sprules et al. (1981) provide a summary of the methodology used to analyze zooplankton and *Mysis relicta* samples. The samples were initially stained with methylene blue for contrast purposes (visibility) when measuring. The formalin solution was then decanted from the sample jar and poured into a Folsom splitter and split as required. Once the split number was determined, it was poured into a round-bottomed graduated flask, and the water level was raised to 300 ml. Using an automatic pipette, subsamples of 3 ml and its multiples were taken and placed in a plankton wheel for identifying, enumerating, and measuring. Both a regular count and rare scan were conducted.

The samples were processed using an IBM computer-based caliper measuring system and dissecting scope. A program called Zebra2 was used to generate a bench (summary) sheet and save individual measurements and counts to a file. Zooplankton were identified to the genus level whenever possible.

2.6 *Mysis relicta*

Mysis relicta sampling was also conducted biweekly between April and November. Sampling was conducted at night using a *Mysis relicta* net (terminal mesh size of 300 microns). Samples were preserved in 4 % formalin in 250 ml glass jars. Samples were forwarded and processed much as described in the macrozooplankton abundance methodology.

2.7 *O. nerka/M. relicta* Interactions Monitoring

For 2002, the ONAFD conducted monthly diel vertical migration monitoring by acoustic methods (described below) in both lakes, and gill netting in Skaha Lake to increase our knowledge of the interactions between *O. nerka, Mysis relicta* and zooplankton.

2.7.1 Diel Vertical Migration Monitoring

Diel acoustic trawl surveys (ATS) were conducted in both lakes to assess potential interactions between mysids and *O. nerka*. To determine the extent to which mysids and sockeye were interacting in each lake for 2002, monthly diel surveys were conducted over a 24 hour period from April to November, using a Biosonics model 115 portable chart recorder provided by DFO. A DFO survey transect was used from the deepest basin of Skaha L. (noted as Gillies Point transect, Fig. 1b) and the north basin of Osoyoos L. (noted as Monashee Coop transect, Fig. 1c) due to their proximity to mysid and zooplankton sample site designations. Settings were set constant at a:

- Frequency of 420 KHz,
- threshold of 0.06 Volts,
- range of 80 m, gain 12,
- pulse width of 0.4 m, and
- paper speed of 3.

Surveys were conducted near the end of each month with at least 5 transects in each 24 hour period in each lake. There were: a day survey, a before and after sunset survey, a night survey, and a before and after sunrise survey. Survey boat speed was approximately 1 m/s, and at the middle of the survey, the boat was stopped for a stationary survey for 5 minutes. This was used to help distinguish between *O. nerka* and plankton (ie. mysids) as *O. nerka* will be held in the sound beam longer and hit with multiple sound pulses, thereby producing an elongated target signature on the echograms (Hyatt 2003, Research Scientist, personal communication). In addition, the monthly 24-hour surveys were conducted simultaneously when DFO did their ATS surveys in April, August, and October. DFO uses a Simrad recorder (EYM 20069), which uses a frequency that does not 'pick up' the *Mysis relicta* like the Biosonics Model 115 recorder. The DFO surveys were used as a quality check for distinguishing mysids and *O. nerka* in study lakes (Rankin 2002, Research Biologist, personal communication).

Unfortunately, there was difficulty with the Biosonics recorder for October and November, so surveys were not conducted.

2.7.2 *O. nerka* Diet Analysis

In addition to the acoustic surveys, monthly trawl surveys and gillnetting sessions were carried out for juvenile *O. nerka* in Skaha and Osoyoos lakes. Trawls were conducted with a 1x2 m net at varying depths depending on acoustic results and temperature and dissolved oxygen conditions. The sinking gillnets in Skaha L. were set at either 4 m off the bottom of the lake or where the 10-12 ^{o}C water occurred in the vertical lake profile, as identified by temperature-dissolved oxygen readings immediately north and south of the west end of the transect site for Skaha L. (Fig. 1c). Five to six gillnets (8' depth by 50' length) were used for each gang ranging in mesh size from 1 "-5.5 ". For Osoyoos L., gillnets were set either within the vicinity of the inlet of Osoyoos L. or immediately north and/or south of the west end of the Osoyoos L. transect site (Fig. 1b). Gillnets were set prior to dusk and picked the next morning.

Trawled and gillnetted kokanee samples were sent to the Pacific Biological Station in Nanaimo for diet analysis by Zootec Services Ltd. Trawled samples from the DFO February surveys in both lakes for 0+ fish were also analyzed. Due to budget constraints, stomach samples were only sampled for presence/absence of *M. relicta* and identification of major food items by sample date. Stomachs were removed and weighed both with and without stomach contents. In addition, samples were stored for later analysis.

3.0 RESULTS

3.1 Background Data Compilation

The compilation of data available for Skaha L. provided the following information:

1. **Ferguson (1949)** – This UBC graduate thesis outlines fish interrelations and production of Kamloops trout, settled volumes and genera of zooplankton, and fish species and abundance information gathered from various methods including gillnetting, seining, dynamiting, and angling. This thesis also provides information pertaining to the growth of kokanee by age and the age structure of the kokanee population. Copies are stored at the UBC Department of Zoology and at ONAFD.

2. **Canada-British Columbia Okanagan Basin Agreement -** This Okanagan Basin study includes information on both fisheries and limnology of the lakes within the Okanagan Basin. Specifically, the use of fish as indicators of water quality as compared to Ferguson (1949) is applied. In addition, adult kokanee enumerations, zooplankton abundance and composition, and water chemistry parameters are examined in the report. For further information, see Northcote et al. (1972) and Pinsent et al. (1974a; 1974b). Lastly, several published documents related to Skaha L. are available (Fleming & Stockner 1975; Stockner & Northcote 1974).

3. **Summerland Egg Take 1972-1975 –** The information at the Summerland hatchery in the 1970's provides estimates of adult kokanee numbers during this time period. Information can be obtained from the Summerland Hatchery files (contact Mark Siemens) or a copy is at ONAFD.

4. **Canada-British Columbia Okanagan Basin Implementation Agreement –** This agreement consists of several limnological reports to evaluate the success of implementation of the agreement (Jensen 1981; Nordin 1982; Truscott & Kelso 1979). Copies are located at the ONAFD office.

5. **Ministry of Water, Land and Air Protection (WLAP) reports to file (1980-present)-** Lake limnological information (water chemistry and zooplankton) are provided from this large number of sources. Files at MoWLAP Penticton office (contact Vic Jensen).

6. **Eric Parkinson (WLAP – University of British Columbia) –** Information provided by Parkinson includes work in the 1980's with Skaha Hatchery, including trawl survey data, temperature-dissolved oxygen profiles of Skaha L., and acoustic trawl survey estimates. Files are now at ONAFD (contact Howie Wright).

7. **MoWLAP –** Adult kokanee enumerations from 1989 to present were made available to the ONAFD by MoWLAP. Raw data is still with MoWLAP (contact Steve Matthews).

8. **Fisheries and Oceans Canada –** Acoustic trawl survey data from 1999 to present are available from Fisheries and Oceans Canada (Contact Paul Rankin).

9. **Okanagan Nation Alliance Fisheries Department –** Information gathered for the assessment of *O. nerka* juvenile rearing potential in Skaha and Osoyoos lakes was gathered in 2001 and 2002 (contact Howie Wright, ONAFD).

10. **MoWLAP regional library references-** The MoWLAP Penticton library was searched for documents (mostly unpublished literature) relevant to Skaha L. A list of relevant references can be found in Appendix A.

3.2 Juvenile Rearing Capacity

Lake rearing capacities for 2001 and 2002 as determined from the described sampling procedures are given in Table 2. Factors influencing these data are discussed later. Fig. 2 shows the relationship between total phosphorus and fish biomass used to estimate total fish biomass per hectare for each lake. Fig. 3 shows the length-weight regression used to estimate the number of smolts per hectare for each lake. Sockeye smolt lengths of 86 mm and 100 mm were used for the calculations so as to be consistent and comparable with Hyatt and Rankin's (1999) rearing estimate of Osoyoos L. With this relationship, juvenile sockeye smolt lengths of 86 mm and 100 mm would have mean weights of 6.79 g and 9.55 g respectively. The average total phosphorus was measured from April to November 2002. All measurements per site were summed and divided by their totals. For example, Skaha L. had two sites with a total of 48 samples (approximately 24 for each site). The sum of all the total phosphorus readings was 384 µg/L. Therefore, the seasonal average for Skaha L. was about 8 µg/L. Using the Fig. 2 regression equation, a fish biomass of 15.88 kg/ha was determined. This 15.88 kg/ha of total fish biomass was divided by the mean weight of 86 mm and 100 mm sockeye smolts to calculate the number of smolts per hectare. The number of smolts per hectare for 86 mm and 100 mm are 2,339 and 1,663 respectively.

Table 2. Summary of Predicted Juvenile *O. nerka* Rearing Capacities for Skaha Lake and Osoyoos Lake, 2001 and 2002

Year	Lake	Lake Area (ha)	No. of Sites	TP (mg/L)	Fish Biomass (kg/ha)	No. of 86mm smolts /ha (6.79g)	No. of 100mm smolts/ha (9.55g)
2001	Skaha	2,010	3	12.0	18.88	2,781	1,977
2002	Skaha	2,010	2	8.00	15.88	2,339	1,663
2001	Osoyoos**	1,505	3	14.2	20.24	2,981	2,119
2002	Osoyoos**	1,505	2	14.75	20.54	3,025	2,151

**Canadian Portion only for lake area

For Osoyoos Lake calculations, the lower depth measurements were omitted because of the anoxic conditions that cause an irregular increase in total phosphorus in the hypolimnion (Johannes 2002, personal communication). For example, the epilimnion reading (0-10 m) for Osoyoos L. in September was 0.008 mg/L at both sites, yet the deep sample was 0.026 mg/L (Fig. 10d and f). This would have resulted in a larger fish biomass estimate for the lakes than would accurately be represented by environmental conditions.

The Osoyoos L. mean total phosphorus measurement for 2002 is slightly lower than that used by Hyatt and Rankin (1999) for their calculation of a total phosphorus concentration of 22 µg/L. However, there are other abiotic and biotic factors that affect this relationship.

3.3 Physical Limnology and Water Chemistry

3.3.1 Physical Limnology

Skaha Lake

Skaha L. secchi depth measurements at the two sites averaged 4.8 m (Fig. 4a). A maximum depth of 6.6 m at Site 2 in September and a minimum depth of 3.9 m at Site 3 in July were recorded.

A maximum surface temperature of 22.7 ^{o}C occurred at both Skaha L. sites during July (Figs. 5s and u).

Skaha L. began to stratify in early June when the epilimnion boundary was at about 10 m (Figs. 5l and m) and remained stratified until late October. The epilimnion layer at Sites 2 and 3 settled to a maximum depth of 14 m and 18 m respectively (Figs. 5bb and mm).

Dissolved oxygen levels in Skaha L. ranged from 5.6 -16.26 mg/L at Site 2 and from 6.72-16.4 mg/L at Site 3. Summer profiles were slightly clinograde, suggesting waters of moderate productivity (Horne & Goldman 1994). Dissolved oxygen measurements were recorded to the lake bottom and demonstrated little, if any, anoxic conditions in Skaha L.

Osoyoos Lake

Osoyoos L. secchi depth measurements averaged 3.5 m at the two sites (Fig. 4b). The maximum depth recorded was 4.4 m, and the minimum was 2.6 m (Fig. 4b). Maximum surface temperatures occurred in August and were 23.7 ^{o}C for Sites 1 and 2 (Figs. 6uu and 6vv).

The lake began to stratify at both sites in late May (Figs. 6e and f) and remained stratified until early November (Figs. 6yy and 6zz) when isothermal conditions reappeared and the epilimnion layer at Sites 1 and 2 settled to a maximum 18 m.

Dissolved oxygen levels in Osoyoos L. ranged from <4 mg/L (the minimum dissolved oxygen tolerance for survival of *O. nerka*) to 16.56 mg/L at Sites 1 and 2 (Fig. 6a-bbb). Summer profiles were slightly clinograde suggesting waters of moderate productivity (Horne & Goldman 1994).

Zone of Tolerance

Fig. 7a-d show the zone of tolerance for all sites at both lakes, based on maximum temperature (17 °C) and minimum dissolved oxygen (4 mg/L) tolerances for juvenile *O. nerka*. No suitable vertical habitat is predicted if the temperature tolerance line and dissolved oxygen tolerance line meet or cross. The area in the space between the two lines in the figures is hypothesized to be an approximation of the optimal vertical habitat available for juvenile sockeye in the pelagic zone (Rankin 2002, Research Biologist, personal communication). In addition, this zone of tolerance can also be considered to approximate the conditions required for adult sockeye holding in a lake until river spawning temperatures are optimal (about 15 °C).

Skaha L. Sites 2 and 3 had conditions suitable for juvenile *O. nerka* throughout the monitoring period. One observation of dissolved oxygen constraint occurred during the month of September, at Site 2 when a maximum of 30 m of optimal habitat was available over a maximum of 14 days based on sampling frequency (Fig. 7a). The layer posing a vertical temperature constraint of 17 °C lasted at least from June 19 to September 26 and reached a maximum depth of 14 m, again based on sampling frequency. Site 3 in the south basin had no dissolved oxygen constraints during the monitoring period, but a vertical temperature constraint of 17 °C lasted from June 12 to September 30 and reached a maximum depth of 18 m.

In Osoyoos L., September was the most critical month at Site 1 where it is estimated that 20 vertical meters of optimal hypolimnion habitat was available and lasted at most from September 6 to 19 (Fig. 7c). At Site 2, only about two vertical meters of habitat were available from September to the beginning of October. This condition lasted a maximum period of 3 weeks, from September 13 to October 2 (Fig. 7d). This was also seen in 2001, where September was observed to be the most critical month in terms of amount of optimal rearing habitat (Wright 2002). This 'squeeze' of optimal habitat is not new but was poorly documented in previous years, and with the long-term outlook of warmer conditions due to climate change, it could potentially become more severe (Rankin 2002, Research Biologist, personal communication).

During 2002 (as in 2001), Skaha L. had more optimal habitat for sockeye adults holding and juveniles rearing than did Osoyoos L., in terms of temperature and oxygen limits. Based upon previous sampling, Osoyoos L. is assumed to have suitable habitat in the north basin only, and this area becomes vertically constrained for both holding adult and rearing juvenile sockeye. In comparing Skaha L. conditions with those of the north basin of Osoyoos L., it appears that temperature and oxygen are unlikely to be an issue in Skaha L., and this may translate into increased survival for adult sockeye holding in the lake until spawning time.

3.3.2 Water Chemistry

Skaha Lake

Total nitrogen levels averaged 0.20 mg/L from April to November at the two sites and ranged from 0.07 – 0.34 mg/L (Fig. 8a - c). Dissolved nitrogen (nitrate-nitrogen) levels averaged 0.003 mg/L from April to November monthly sampling for the 0-10 m integrated sample (Fig. 9a - c). There were no differences in the nitrate-nitrogen concentrations at the two sample depths at Site 2 of Skaha L. (Fig. 9a - c). However, in Site 3, the dissolved nitrogen levels were greater (average 0.011 mg/L) at the 36 m sample depth (Fig. 9c). The difference may be due to photosynthetic biological uptake with limited mixing between the epilimnion and the hypolimnion, resulting in limited replenishment of nutrients from the hypolimnion into the epilimnion.

Total phosphorus levels averaged 0.008 mg/L for the April to November monthly samples for all three sites and depths (Fig. 10a- c). The 20 m and deep section total phosphorus samples (36 m and 45 m) did not differ greatly from those of the epilimnion (Fig. 10a-c), nor did those for total dissolved phosphorus in the same period and depths (Fig. 11a-c).

Osoyoos Lake

Total nitrogen levels averaged 0.23 mg/L from the April to November monthly samples at the two sites and ranged from 0.13 – 0.38 mg/L (Fig. 8d - f). Dissolved nitrogen (nitrate-nitrogen) levels averaged 0.005 mg/L for the April to November monthly samples in the 0-10 m integrated sample (Fig. 9d). Both sites showed a difference between the 0-10 m integrated sample and those from discrete sample depths (20 m, 32 m-Site 1, and 45 m-Site 2, Fig. 9d - f). In addition, there was a large difference at both sites between the 20 m discrete sample depth and the 32 m-Site 1 and 45 m-Site 2 (Fig. 9e and f). As in the case of Skaha L., the differences may be due to photosynthetic biological uptake with limited mixing between the epilimnion and the hypolimnion thus resulting in limited replenishment of nutrients from the hypolimnion into the epilimnion.

Total phosphorus levels averaged 0.014 mg/L from April to November for all three sites and depths (Fig. 10d- f), and the 20 m and deep sections (32 m-Site 1 and 45 m-Site 2) samples did not differ appreciably from those of the epilimnion. The same was true of total dissolved phosphorous.

Nitrogen:Phosphorus Ratios

In most lakes, there is a direct relationship between concentrations of the limiting nutrient and phytoplankton (Horne & Goldman 1994). Phosphorus is usually the limiting nutrient as most living matter requires a total phosphorus to total nitrogen (TN:TP) ratio of about 16:1 (Horne & Goldman 1994). This can be further refined to: TN:TP>15, phosphorus limiting, TN:TP<10, nitrogen limiting, TN:TP between 10 and 15, can be either, neither or both limiting (Andrusak et al. 2001; Wetzel 1983).

A measure of the nutrients available to phytoplankton in the epilimnion is the amount of dissolved nitrogen and phosphorus in the 0-10 m integrated sample depth (Andrusak et al. 2001). A ratio of 7:1 for nitrates to total dissolved phosphorus (NO_3:TDP) is often used as an indicator of the bio-availability of certain nutrients: if the ratio is <7, then conditions are more favorable for cyanobacteria (blue-green algae) and if >7, then conditions are favorable for other phytoplankton such as diatoms. This is relevant in that blue-green algae are a poor food source for zooplankton (Andrusak et al. 2001).

At all Skaha L. sites, the TN:TP ratios were greater than 15 except for Site 3 in October (TN:TP ratio of 9.6), suggesting that the lake is phosphorus limited (Fig. 12a). Site 3 in the south basin of Skaha L. was close to 10 in October, which may signify either, neither or both nitrogen and phosphorus are limiting. The available dissolved nutrients (NO_3:TDP), ratios were all <7, which suggests an environment favorable to blue-green algae production (Fig. 13a).

In Osoyoos L., average TN:TP ratios were above 15 from April to September and between 10 and 15 for October and November (Fig. 12b). This suggests that the lake was phosphorus limited up to September and then either, neither or both phosphorus and nitrogen limited in October and November. NO_3:TDP ratios, were all less than 7 suggesting conditions favorable for blue-green algae production (Fig. 13b).

Chlorophyll *a*

Chlorophyll *a* is often used as an indicator of phytoplankton standing crop (Horne & Goldman 1994). The average April-November chlorophyll *a* concentration in Skaha L., was 3.2 µg/L (Fig. 14a); whereas, in Osoyoos L., it was 4.87 ug/L (Fig. 14b). This relates well with the difference in mean total phosphorus levels, which were greater in Osoyoos L. than in Skaha L.

Silica

Diatoms are a preferred food source for zooplankton (Horne & Goldman 1994). Silica is used by diatoms for their rigid cell walls, called frustules, and it accounts for their success. Large variation in silica concentrations, may suggest that silica is potentially limiting (Horne & Goldman 1994). Silica levels in all Skaha and Osoyoos lake sites combined averaged 4.7 mg/L (Fig. 15a - f). Silica does not seem to be limiting diatom production in either of these lakes since concentrations of silica did not fluctuate greatly.

3.4 Macrozooplankton

Both Skaha and Osoyoos lakes contained the following genera of zooplankton: *Diaphanosoma, Bosmina*, Cyclopioda, Calanoida, *Diaptomus, Rotifera, Mysis relicta*, and *Leptodora.* Small numbers *of Alona, Sida*, and *Polyphemus* were also found in Skaha L.

In Skaha L., Cyclopoida made up the largest part of the zooplankton community from April to November in terms of density, with a weighted mean density of 10,347.4 individuals/m^3. Copepod (Cyclopoida, Calanoida) larvae (nauplii) held the second highest weighted mean density of 8035.9 individuals/m^3, followed by *Rotifera* at 6624.0 individuals/m^3 (Fig. 16a). The total April to November weighted mean biomass of zooplankton in Skaha L. was 26,462.8 mg/m^3. In terms of species biomass, Cyclopoida were the largest in Skaha L., with a mean weighted biomass of 210.7 mg/m^3, followed by *Diaptomus* (120.9 mg/m^3) and *Daphnia* (48.8 mg/ m^3, Fig. 17a).

In Osoyoos L., the most abundant species in terms of density was *Rotifera*, with a weighted mean of 15,611.5 individuals/m^3, followed by nauplii with a weighted mean density of 11,572.8 individuals/m^3. The third-most abundant zooplankton were Cyclopoida; although, their mean weighted density was less than ½ that of nauplii at 5078.2 individuals/m^3 (Fig. 16b). Total zooplankton weighted mean density was much higher in Osoyoos L. than in Skaha, totaling 37,903 mg/m^3. *Diaptomus* made up the largest proportion of total biomass in the lake at 152.8 mg/m^3, followed by Cyclopoida (126.9 mg/m^3) and *Daphnia* (45.5 mg/m^3, Fig. 17b).

Weighted mean lengths of individual zooplankton species in Skaha and Osoyoos lakes were similar, with some being slightly larger and some slightly smaller in one lake or the other (Fig. 18).

There was a higher weighted mean density of zooplankton in the 0.5 mm to 0.9 mm range in Skaha L. than in Osoyoos L. The most abundant size class of zooplankton was between 0.1 mm and 0.2 mm for both lakes. However, this size class made up the majority of zooplankton in Osoyoos L.; whereas, there were nearly as many zooplankton in the 0.6 mm to 0.7 mm range in Skaha L. (Fig. 19).

3.5 *Mysis Relicta*

Mean density of *Mysis relicta* in Skaha L. was slightly lower than that of Osoyoos L. during the growing season (April to November 2002). However, mean biomass and mean lengths of mysids were slightly higher in Skaha L. than in Osoyoos L. (Table 3).

Mysid density was highest in October for Skaha L. and highest in July for Osoyoos L.. In both lakes, densities were relatively low in April, became higher over late spring to early fall, and then began to drop again in November (Fig. 20).

The mean length of *M. relicta* increased in both lakes over most of the sampling period (April to November 2002). However, the mean length of mysids was slightly higher in Skaha L. for most of the sampling period, with the exception of April, at which time their mean size was slightly lower than in Osoyoos L. (Fig. 21).

Mean biomass of mysids peaked in September in Osoyoos L. and in October in Skaha L.. Mean mysid biomass remained considerably larger in Skaha L. throughout most of the sampling period. Overall, the mean biomass of mysids in Skaha L. from April to November was 606.7 mg/m^2, compared to only 377.0 mg/m^2 in Osoyoos L. (Fig. 22).

Table 3. Summary of seasonal weighted mean densities, biomass, and length of *Mysis relicta* in Skaha and Osoyoos lakes, April to November 2002.

	Weighted mean density (No./m^2)	**Weighted mean biomass (mg/m^2)**	**Weighted mean length (mm)**
Skaha	83.32	606.68	11.09
Osoyoos	93.82	377.02	9.81

3.6 *O. nerka-M. relicta* Interactions Monitoring

3.6.1 *Oncorhynchus nerka - Mysis relicta:* Diel Vertical Migration

The upper limit of the mysid migration scattering layer was identified for each acoustic survey. Also, where possible, concentrated *O. nerka* layers were identified noting any overlap with mysids. Fig. 23 shows an example of a typical acoustic survey and interpretation. Fisheries and Oceans Canada surveys were also conducted in April, August, and October. The DFO surveys were used to help distinguish between *M.*

relicta and *O. nerka*. Figures 24a-g shows the survey months, times, and sunset/sunrise and is described below.

During April surveys, both Skaha and Osoyoos L. mysids underwent a diel migration (Fig. 24a). They remained on the bottom during the daylight hours, migrating up into the upper parts of the lake during sunset, and migrating back down to the bottom prior to sunrise. The main difference was that mysids occupied the bottom 12 m of Osoyoos L. during the day while Skaha mysids remained right on the bottom. No distinguishable concentration of *O. nerka* was identified for Skaha L., but during both the 23:00 and 02:00 surveys, the distributions of sockeye and mysids in Osoyoos L. were overlapping.

During May surveys, mysids in Skaha L. underwent the typical diel migration (see April description), where *O. nerka* layers overlapped them during the night surveys (21:00 and 02:00, Fig. 24b). Osoyoos L., mysids migrated off the bottom between 14:00 and 18:00 hours and underwent a diel migration prior to sunrise (Fig. 24b). *O. nerka* layers in Osoyoos L. were identifiable in all surveys and they overlapped with mysids in 5 out of the 8 surveys. Interestingly, none overlapped during the night.

During June surveys, Skaha mysids underwent a typical diel migration with an *O. nerka* layer identified during the evening survey (Fig. 24c). As with the May survey, mysids migrated off the bottom sometime during the day but still underwent a diel migration terminating on the bottom before sunrise (Fig. 24c). In one survey an *O. nerka* concentration could be identified, and it overlapped the mysids. In Osoyoos L., the upper extent of mysid migration scattering was 22 m during the late morning and afternoon surveys (Fig. 24c). After sunset, the layer rose slightly to 20 m. A more substantial diel vertical migration was observed after sunrise when the layer moved down to 40 m. A distinguishable *O. nerka* concentration could be found in 6 out of the 7 surveys all within the upper range of mysids.

During July surveys, Skaha L. mysids underwent a typical migration, moving off the bottom during sunset and migrating back down prior to sunrise. A concentrated *O. nerka* layer was identified in 3 of the 7 surveys (all night time), with mysids overlapping in 2 instances (Fig. 24d). The Osoyoos L. mysid scattering layer was at 40 m during the day and moved to 12 m during the night. A distinguishable *O. nerka* concentration was identified in 4 of the 8 surveys, with mysid overlap in 3 of them.

Two surveys were conducted in August (approximately 10 days apart), with one overlapping the Fisheries and Oceans Canada ATS surveys. Both Skaha and Osoyoos L. mysids underwent a diel migration moving off the bottom during evening and migrating back down during the day (Figs. 24e and f). There was a slight difference in the Osoyoos L. surveys where the daytime scattering layers of mysids were at 30 m on August 19, 2002 and 38 m on August 30, 2002.

The last survey in September was quite different from previous ones, in that no distinguishable diel vertical migration was present in either lake (Fig. 24g). However, in Skaha L., there was a definite *O. nerka* concentration in 3 out of the 7 surveys and all within the mysid layer. This was also seen in Osoyoos L., where 3 out of the 6 surveys had a distinguishable *O. nerka* concentration, all overlapping with the upper extent of mysids.

3.6.2 *Oncorhynchus nerka:* Diet Analysis

A total of 145 Osoyoos L. and 112 Skaha L. *O. nerka* stomachs of various age classes were sampled for presence of *M. relicta* (Table 4).

O. nerka, age 0^+ in Skaha L. were as follows: in October 2002, 21% of the fish had mysids in their stomachs, for November 2002, 15 %, and February 2002, 15 % (Fig. 25). However, it is not known at what age they began to utilize mysids prior to October as these were the only months where fish were analyzed.

Osoyoos L. age 0^+ *O. nerka* analysis were from August-November and February. Mysids were present in the August (5 %) and the October 18 (17 %) and 30 (30 %) fish but not present in the September, November, and February (Fig. 25).

All older age classes of *O. nerka* in both lakes ingested *M. relicta* (Fig. 26). Samples from Osoyoos L. were from July and September, and were found present in 13 and 14% of the fish respectively. Skaha L. samples were from August (21 and 30) and November, and in *O. nerka* stomachs, the percent frequency of *M. relicta* increased within the August samples from 13 % (August 21) to 73 % (August 30) and remained high at 65 % in November. This suggests that at some point in August, older age classes of Skaha *O. nerka* were able to utilize *M. relicta* as a food source.

Table 4. Percent Frequency of *O. nerka* stomach fish containing mysids[3]

Osoyoos Lake				
		Season		
Age	**Winter**	**Spring**	**Summer**	**Autumn**
0+	20	-	20	90
1+	-	-	-	-
2+	-	-	8	7
Skaha Lake				
		Season		
Age	**Winter**	**Spring**	**Summer**	**Autumn**
0+	20	4	-	39
1+	-	2	7	21
2+	-	-	19	-

[3] '-' represents no samples analyzed

4.0 DISCUSSION AND CONCLUSIONS

Based on data collected during the 2002 sampling season and on the relationship between total dissolved phosphorus and biomass of limnetic juvenile *O. nerka*, the rearing capacity for 86 mm and 100 mm *O. nerka* smolts in Skaha L. is estimated to be 2,339 smolts/ha and 1,663 smolts/ha respectively. For Osoyoos L., the rearing capacity for 86 mm and 100 mm is estimated to be 3,025 smolts/ha and 2,151 smolts/ha respectively.

As identified in the 2001 report (Wright 2002), the carrying capacity of Osoyoos L. was calculated by Hyatt and Rankin (1999) to be higher than this even though similar concentrations of total phosphorus were used. The main reason for the difference is the range of data used by Hyatt and Rankin (1999). to develop the relationship between total phosphorus and fish biomass They used a broader range of lake trophic conditions (<2 µg/L-300 µg/L of total phosphorus) while the lake trophic conditions used in Fig. 2 of this report ranged only from <2 µg/L-30 µg/L. Another difference is that the lakes represented in Hyatt and Rankin (1999) were not limited to those containing only *O. nerka*. The TP-*O. nerka* biomass relationship we used (Fig. 2) involved lakes whose principal limnetic fish species was *O. nerka*, but some also contained *Mysis relicta*. The impacts of *Mysis relicta* on the rearing habitat of sockeye or kokanee lakes are relatively unknown but have some influence. Nevertheless, the value is in comparing the lakes' rearing capacities even though Skaha has slightly less productive capacity based on its total phosphorus levels for 2002. Osoyoos L. has a demonstrated capacity to sustain a relatively large biomass of juvenile sockeye, so this suggests that nutrient levels do currently not limit the rearing capacity of Skaha L.

In addition, the 2002 kokanee spawning escapement was over 86,000 (Matthews 2002), a population size that has not been seen since the early 1970's when Skaha L. was considered to be in a eutrophic state and prior to tertiary treatment of the Penticton municipal wastewater treatment plant on the Okanagan River Channel (Truscott & Kelso 1979).

Secchi depths related well with the productivity of Skaha L. and Osoyoos L., decreasing in depth as phosphorus concentrations increased. In terms of temperature and oxygen limits, Skaha L. had the greatest amount of suitable habitat for rearing juvenile *O. nerka*. Osoyoos L. habitat remained suitable for most of the year but was limited by temperature and dissolved oxygen constraints for a period of about 14 days. Temperature and dissolved oxygen conditions remained favorable during the entire sampling period in Skaha L. The temperature and oxygen squeeze seen in Osoyoos L. is not a new physical feature but is poorly documented. With the potential for climate change and warmer conditions in the Okanagan Basin, this 'squeeze' may become more extreme in the future (Rankin 2002, Research Biologist, personal communication). Temperature and dissolved oxygen conditions are more suitable in Skaha L. than in Osoyoos L. for adult sockeye holding until spawning conditions are favourable. Therefore, if at some point sockeye are reintroduced into Skaha L. through adult migration, it appears that over-summer survival for adults and juvenile rearing survival could be greater than in Osoyoos L.

The TN:TP ratio suggests that both Skaha L. and the north basin of Osoyoos L. are primarily phosphorus limited. However, for Osoyoos L. in October and November, the TN:TP ratio was between 10 and 15, which suggests that the lake was phosphorus limiting and then in October and November was either, neither or both phosphorus and nitrogen limiting. Both lakes had a dissolved TN:TP ratio less than 7 indicating that conditions are likely favourable for cyanobacteria production. Because Osoyoos L. and Skaha L. are quite similar in these respects, one might again expect that the conditions for sockeye in Skaha L. would not be very different, and might be better than those in the north basin of Osoyoos L.

A simultaneous increase in total phosphorus and chlorophyll *a* can be seen for Skaha and Osoyoos lakes. Silica levels did not vary greatly, which suggests that it is not limiting in either of the lakes.

Cyclopods, daphnids and bosminids can be important components of *O. nerka* diets (Burgner 1991). There were fewer cyclopods in terms of both mean density and mean biomass in Osoyoos L. than in Skaha L. during the 2002 sampling season. This trend was not apparent in 2001; however, the year 2001 was a high spawner year for sockeye in Okanagan River, and fry from this run would have begun to emerge and feed in Osoyoos L. in 2002, which may have accounted for higher grazing pressure by *O. nerka* in Osoyoos L. than in Skaha L.

Mysid density increased considerably from April to June 2002 based on the 2 sampling stations we used for each lake. However, this trend was not apparent in the samples taken by Fisheries and Oceans Canada during their ATS sampling of 10 sites on each lake (Rankin 2002, Research Biologist, personal communication). Therefore, it is difficult to draw conclusions from the data collected from our small sampling area, and an increase in the number of sampling stations for mysid and zooplankton would be useful in future years.

Results of the diel vertical migration monitoring show that mysids undergo a typical migration, migrating up during sunset and migrating back down prior to sunrise. However, the main difference between the two lakes was how the mysid scattering layer moved off the bottom during the day and increased to the fall surveys. This effect was most pronounced in Osoyoos L. and may be due to the gradual anoxic conditions that develop in the lake. In addition, as shown by slightly different secchi depths (less clarity in Osoyoos L.), mysids may not have to go as far to reach preferred light intensities in Osoyoos L. as they do in Skaha L. By the September survey, we were unable to identify a vertical migration of mysids. The reason may be that the large amount of juvenile sockeye in the Osoyoos L. masked a distinguishable mysid layer. Due to technical difficulties with the hydroacoustic equipment, we were unable to collect usable acoustic information in October and November 2002.

Preliminary diet analysis identified that age 0^+ sockeye and kokanee ingested mysids but in variable amounts during the year and between lakes. It is not known when kokanee in Skaha L. were able to begin to utilize mysids as a food source because the samples analyzed all showed mysids to be present. Osoyoos L., age 0^+ sockeye began to utilize mysids by August, but at this time only 5 % of the fish sampled had mysids present in their stomachs, and no mysids were found in the September samples. The data collected suggests that mysids are utilized in greater percentages in Osoyoos L. than in Skaha L. in October, but not in other months sampled where the opposite is true. In the November and February samples, no mysids were present in Osoyoos L. age 0+ fish, but they were present in Skaha L. during these 2 months.

Other age classes of *O. nerka* in Skaha and Osoyoos lakes were also found to utilize mysids. For Skaha L., at some point between the middle and end of August, the frequency of mysids in the stomachs of *O. nerka* increased, but Osoyoos L. samples were relatively constant. It should be noted that while results presented here are preliminary, they do suggests that *M. relicta* is a food source.

The simple sockeye life history model developed and used in the Skaha Reintroduction describes *M. relicta*, juvenile sockeye, juvenile kokanee, and older age class kokanee in *O. nerka* 0^+ equivalents in regards to biomass is the rearing lakes (ie kokanee, sockeye, and mysids have the same food consumption rates relative to their size (Peters & Marmorek 2003). The results from this monitoring and the presence of mysids in *O. nerka* stomachs in both sockeye and kokanee demonstrate that mysids are a source of food and the mysid conversion to 0^+ equivalents may be different from what was assumed in the model. Further work on refining their interactions from a learning perspective should be an integral part of implementing sockeye reintroduction into Skaha L. The additional work will begin to answer some of the unknowns of these interactions for the long-term goal of reintroduction into Okanagan L.

To increase our understanding of these interactions, an analysis similar to the 'Wisconsin' type bio-energetics model reported by Stockwell and Johnson (1997) and currently being adapted by Fisheries and Oceans Canada for another British Columbia L. should be conducted (Hyatt et al. 2004). This further work can be used to refine the sockeye life history model to be used for evaluation of reintroduction of sockeye into Okanagan L.

Physical and chemical features of Skaha L. suggest that it has similar or better conditions for sockeye adult holding and juvenile rearing than those presently being used in Osoyoos L. In addition, the higher density and biomass of cyclopoids in Skaha L. suggest that it has an adequate food supply for rearing sockeye. However, mysid results here show a significant increase in mysid abundance where DFO results did not. Because DFO sampling had 10 sample stations compared to two in this study, this documented increase should not be of great concern. Acoustic monitoring suggests that mysids undergo diel vertical migration but that their migration is lessened toward late fall in both lakes. Diet analysis also suggests that *M. relicta* is utilized as a food source by *O. nerka* in appreciable numbers.

The information collected over the past 2 years suggest that, in terms of rearing conditions, an experimental reintroduction is feasible. However, several unanswered questions remain after the second year of lake rearing assessment, as follows:

1. Other than 2002, why have recent kokanee populations in Skaha L. been smaller than historically?
2. What part, if any has *M. relicta* played in the decline in Skaha L. kokanee numbers?
3. What are the trophic interactions of *O. nerka* and *M. relicta* in Skaha and Osoyoos lakes?
4. How might these interactions affect the success of any re-introduction of sockeye, and the present kokanee population in Skaha L.?
5. Since preliminary results suggest that *Mysis relicta* have increased in density in Osoyoos L., how might this affect the future survival of the Okanagan sockeye?

5.0 RECOMMENDATIONS

To help answer the foregoing questions during implementation of the experimental reintroduction, further physical limnology, water chemistry, zooplankton and *Mysis relicta* abundance sampling and comparison of these features in Skaha L. and the north basin of Osoyoos L. is recommended.

In addition, data suggests that model assumptions as they relate to *O. nerka* and *M. relicta* interactions will need to be refined for long term learning and for evaluating possibilities for reintroduction of sockeye back into Okanagan L.. The following information is recommended to increase our rearing and limnological knowledge on the north basin of Osoyoos L. and Skaha L.:

1. Continue monthly water quality sampling regime (physical and chemical) of Skaha L. (two sites) and the north basin of Osoyoos L. (two sites) as follows:

   - Measure temperature-dissolved oxygen profiles at or near the lake bottom at all sites.

   Increase the frequency of sampling to twice weekly at the sample sites during August to October on Skaha and Osoyoos lakes when temperature and dissolved oxygen conditions for juvenile *O. nerka* habitat are most likely to become critical.

2. Biweekly *Mysis relicta* and zooplankton sampling from March to the bloom of cladoceran (usually June or July) and then monthly to November. Sampling methodology used in 2001 and 2002 is recommended. It is also recommended to increase the number of sites for *M. relicta* to 10 on each lake to improve the confidence limits (Rankin 2002, Research Biologist, personal communication).

3. Continued collection of kokanee information from Skaha L. and sockeye information on Osoyoos L. to include juvenile abundance monitoring and growth rates of maturing fish. This can be accomplished by:

   - Hydroacoustic and trawl surveys to determine juvenile abundance. Fisheries and Oceans Canada is currently conducting this work.
   - Trawl surveys in Skaha L. to determine age structure and species composition of limnetic fish from Hydroacoustic surveys.
   - Seasonal gillnetting of Skaha L. and sampling of Skaha adult spawners to collect biological information (age structure, growth rates, sex, diet analysis, and genetic analysis).

4. An analysis similar to the 'Wisconsin' type bio-energetics model by Stockwell and Johnson (1997) and currently being adapted by Fisheries and Oceans Canada for other British Columbia lakes should be conducted (Hyatt 2003, Research Scientist, personal communication). This can be accomplished by collecting additional data for:

   - Further diet analysis of O. nerka samples.
   - Further analsyis of zooplankton and mysid samples

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APPENDIX B
Figures 1 through 26

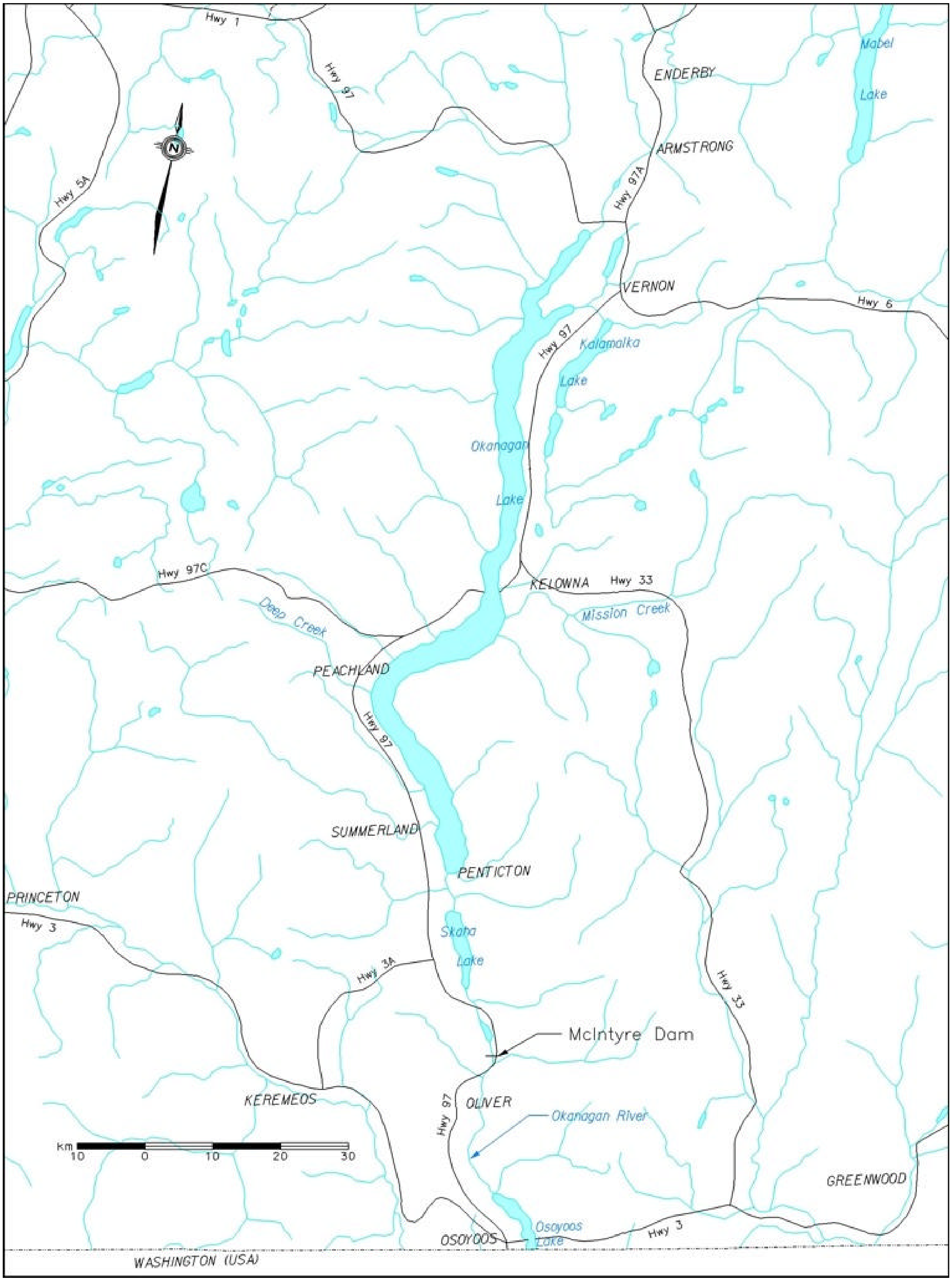


Figure 1a. Okanagan Basin overview map.

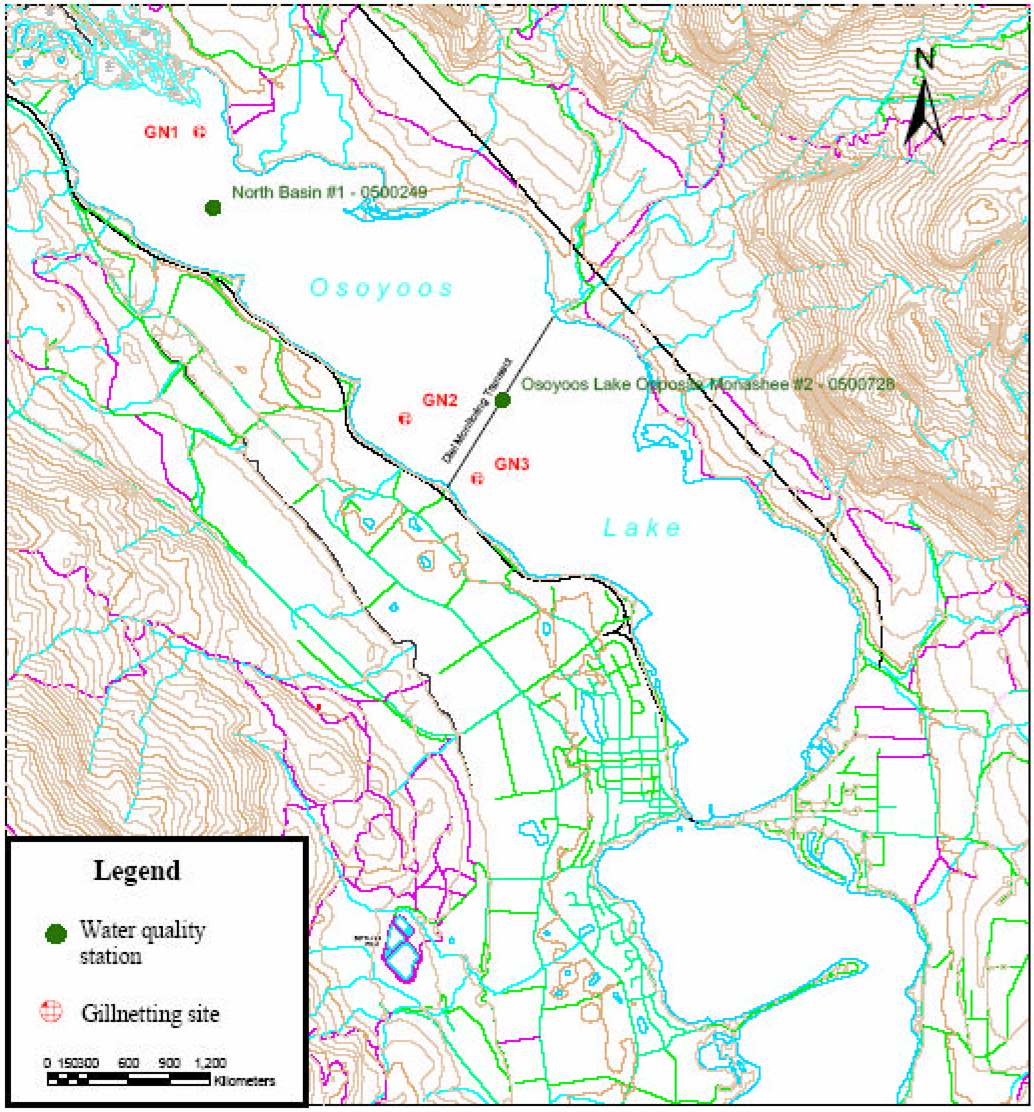


Figure 1b. 2003 water quality, acoustic trawl survey, and gillnetting sampling locations on Osoyoos Lake.

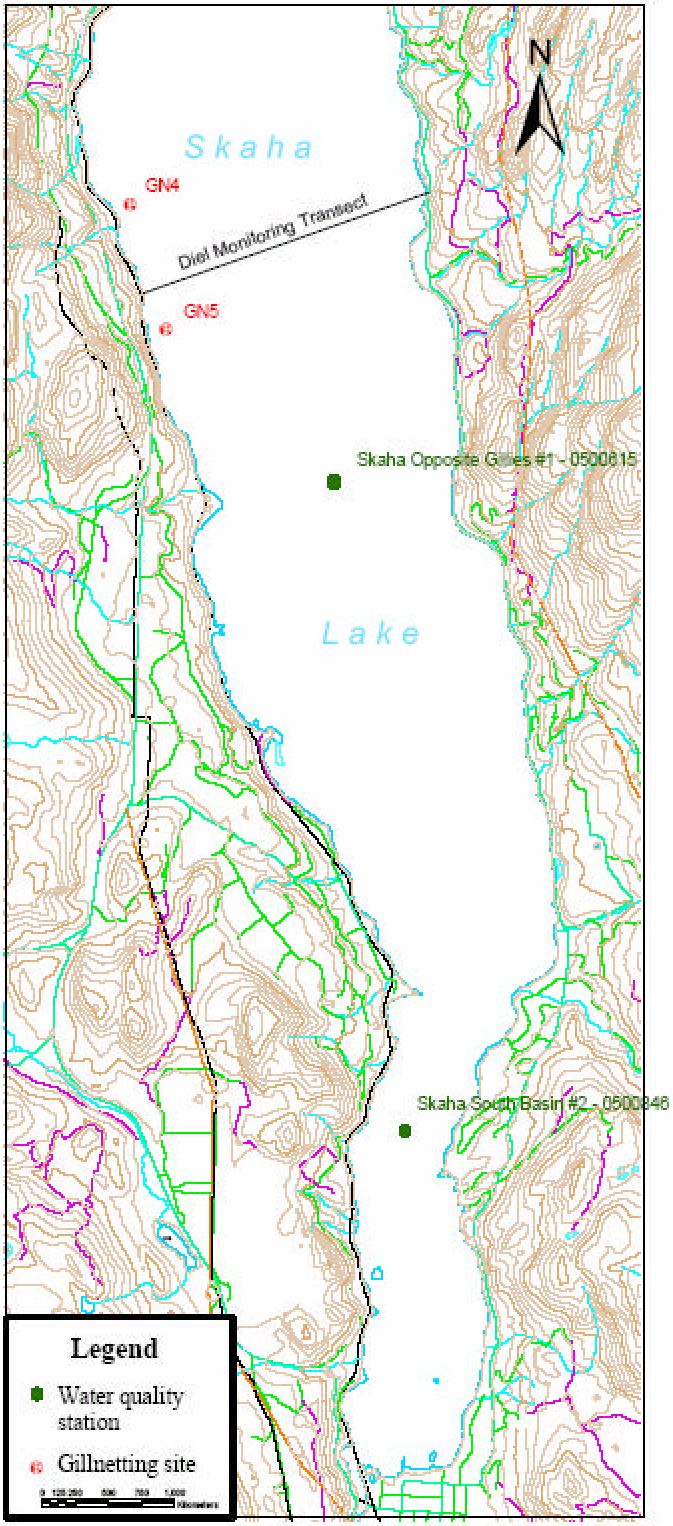


Figure 1c. 2003 water quality, acoustic trawl survey, and gillnetting sampling locations on Skaha Lake.

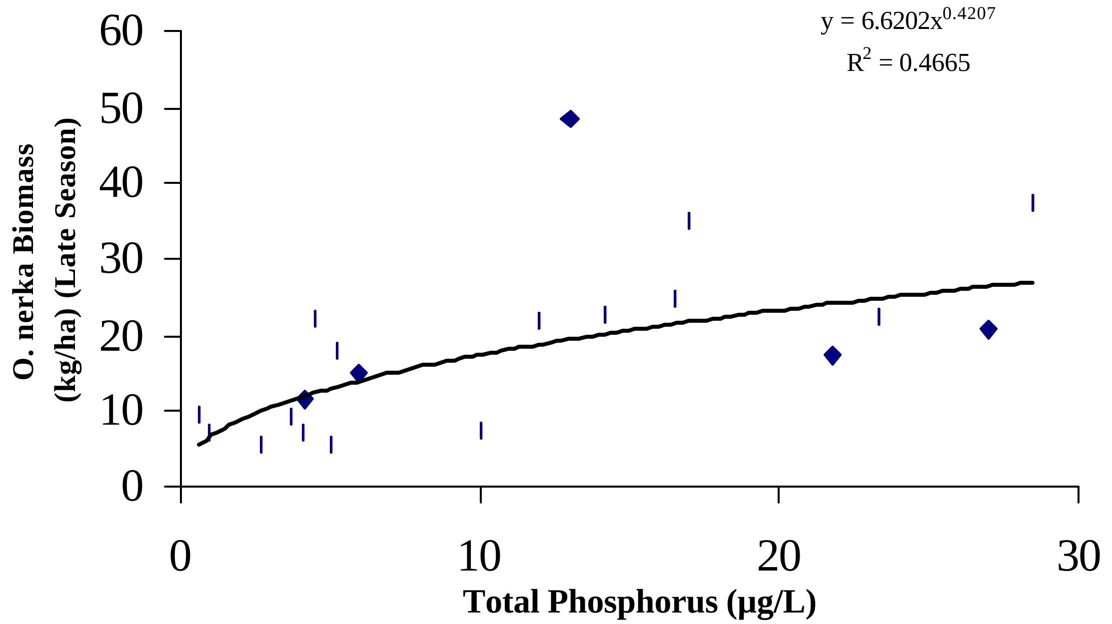


Figure 2: Total phosphorus – O. nerka biomass relationship. Data include biomass and TP estimates from a series of sockeye and kokanee lakes. Methods used to derive nerkid biomass estimates include standard acoustic / trawl surveys. For details see Stockner (1987), Hyatt and Rankin (1999)

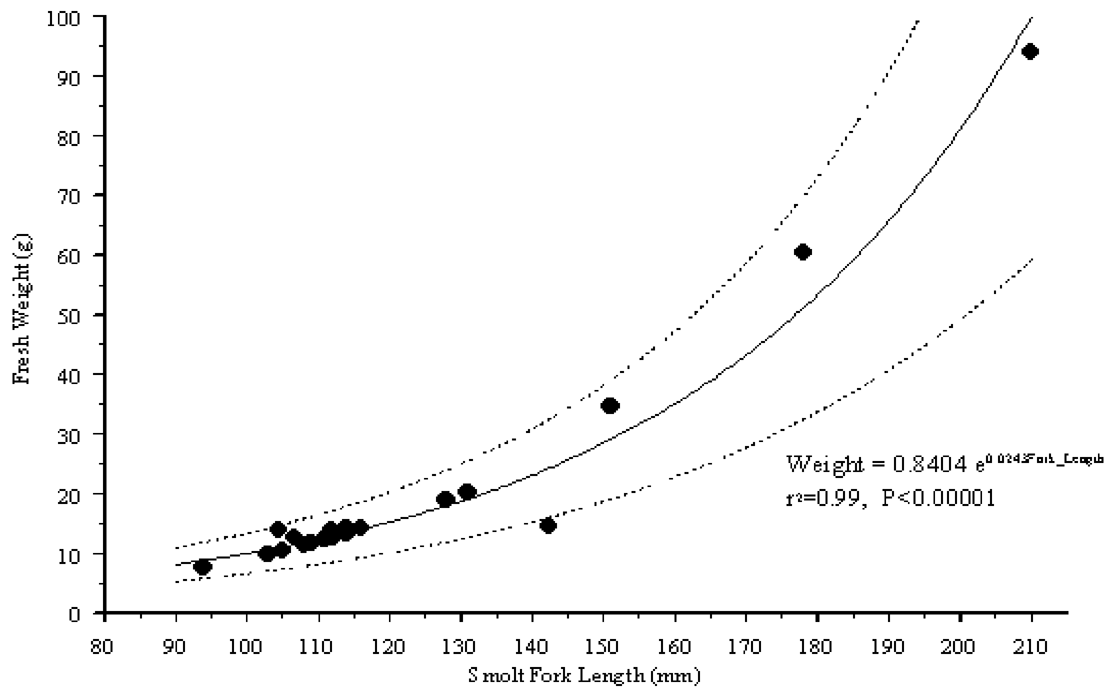


Figure 3: Length – Weight Regression for Osoyoos Lake Sockeye Smolts (1957-2000)
Weight = 0.8404 $e^{0.0243 * \text{Fork Length}}$

Figure 4: Secchi Depth Transparancies 2002

Figure 4a Skaha Lake

2002	Site 2	Site 3
F		
M		
A	4.1	4.1
M	5.0	4.8
J	4.3	4.2
J	4.5	3.9
A	4.6	4.4
S	6.6	6.0
O	5.4	5.4
N		
Average	4.9	4.7

Lake average 4.8

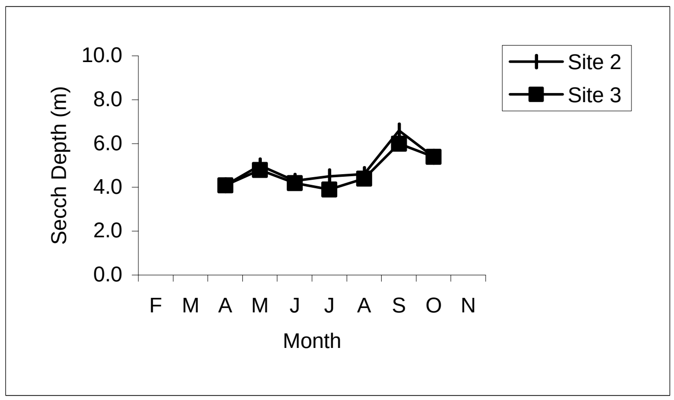


Figure 4b Osoyoos Lake

2002	Site 1	Site 2
F		
M		
A	3.3	3.9
M	3.0	3.1
J	3.0	2.6
J	2.6	3.0
A	4.1	5.0
S	3.6	3.6
O	4.4	4.4
N		
D		
Average	3.4	3.7

Lake Average 3.5

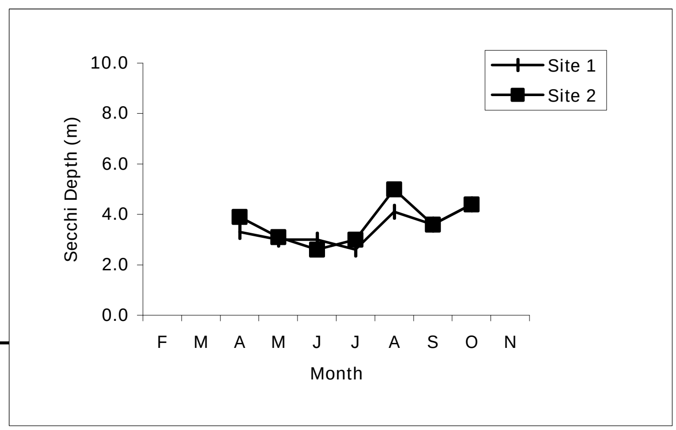


Figure 5: Temperature/Oxygen Profiles for Skaha Lake for 2002

Figure 5a Site 2 April 10

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
4.0	0	13.5	0
3.8	2	13.6	2
3.8	4	13.3	4
3.7	6	13.6	6
3.6	8	14.2	8
3.6	10	13.9	10
3.6	12	13.9	12
3.6	14	14.1	14
3.6	16	13.8	16
3.6	18	13.9	18
3.6	20	13.9	20
3.6	24	13.9	24
3.6	28	13.5	28
	32		32
	36		36
	40		40

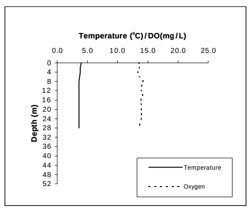


Figure 5b Site 3 April 10

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
4.6	0	14.0	0
4.5	2	14.0	2
4.4	4	14.3	4
4.3	6	14.3	6
4.3	8	14.3	8
4.3	10	14.5	10
4.2	12	14.4	12
4.2	14	14.5	14
4.2	16	14.2	16
4.2	18	14.4	18
4.2	20	14.1	20
4.2	24	14.2	24
4.2	28	14.1	28
	32		32
	36		36
	40		40

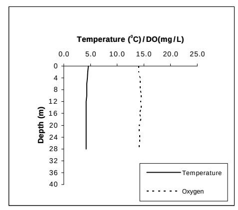


Figure 5c Site 2 April 25

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
7.0	0	14.34	0
7.0	2	16.00	2
7.0	4	16.13	4
6.8	6	16.18	6
6.6	8	16.26	8
6.4	10	15.72	10
6.3	12	15.91	12
6.2	14	15.56	14
6.2	16	15.50	16
6.2	18	15.49	18
6.1	20	15.32	20
6.0	24	15.19	24
5.9	28	15.06	28
	32		32
	36		36
	40		40

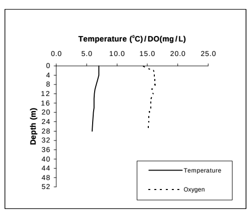


Figure 5d Site 3 April 25

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
6.8	0	13.6	0
6.6	2	15.5	2
6.5	4	15.8	4
6.4	6	16.3	6
6.2	8	16.1	8
6.0	10	16.3	10
5.8	12	16.4	12
7.9	14	15.0	14
7.3	16	15.5	16
7.4	18	14.9	18
7.3	20	14.5	20
7.3	24	13.4	24
7.3	28	13.1	28
	32		32
	36		36
	40		40

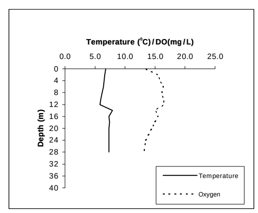


Figure 5e Site 2 May 8

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
11.7	0	14.77	0
10.7	2	12.15	2
10.4	4	10.96	4
10.2	6	10.38	6
9.9	8	10.20	8
9.7	10	9.81	10
9.5	12	9.67	12
9.3	14	9.76	14
9.2	16	9.85	16
8.4	18	9.86	18
8.3	20	9.90	20
8.2	24	9.94	24
7.7	28	10.40	28
7.0	32	9.92	32
6.4	36	9.73	36
	40		40

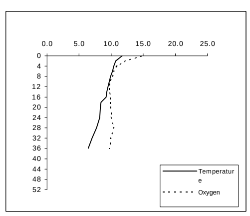


Figure 5f Site 3 May 9

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
10.40	0	8.40	0
10.00	2	8.40	2
9.70	4	8.00	4
9.10	6	8.08	6
9.00	8	8.09	8
9.00	10	8.11	10
9.00	12	7.99	12
8.90	14	8.10	14
8.60	16	8.16	16
7.10	18	8.23	18
7.00	20	8.33	20
6.60	24	8.27	24
6.30	28	8.24	28
6.20	32	8.89	32
6.00	36	6.29	36
6.00	40	5.14	40

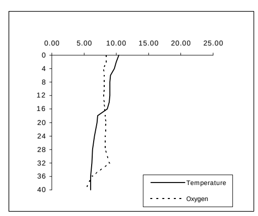


Figure 5g Site 2 May 23

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
12.4	0	11.20	0
12.3	2	10.58	2
12.3	4	9.86	4
12.2	6	9.66	6
12.3	8	9.52	8
12.2	10	9.58	10
12.3	12	9.56	12
12.4	14	9.38	14
12.4	16	9.39	16
12.1	18	9.58	18
11.2	20	9.52	20
9.9	24	9.79	24
8.6	28	10.32	28
7.9	32	10.51	32
7.7	36	10.59	36
7.7	40	10.55	40
7.4	44	10.71	44

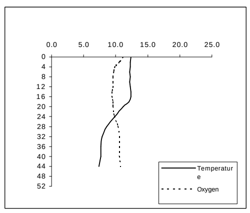


Figure 5h Site 3 May 23

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
13.2	0	9.2	0
13.8	2	9.4	2
13.8	4	9.0	4
13.9	6	9.0	6
13.9	8	8.9	8
13.8	10	9.5	10
13.8	12	9.4	12
13.6	14	9.5	14
13.5	16	9.3	16
13.2	18	9.5	18
13.1	20	9.7	20
12.8	24	9.9	24
12.1	28	10.2	28
10.4	32	10.5	32
9.0	36	10.9	36
	40		40

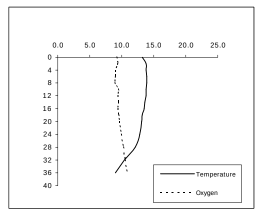


Figure 5i Site 2 May 28

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
15.3	0	10.79	0
15.2	2	12.02	2
15.2	4	11.95	4
14.8	6	13.16	6
13.2	8	13.31	8
12.6	10	13.38	10
12.1	12	13.55	12
11.8	14	13.55	14
11.2	16	13.55	16
10.9	18	13.45	18
10.6	20	13.44	20
9.4	24	13.66	24
7.6	28	14.10	28
7.6	32	13.85	32
7.5	36	13.59	36
6.9	40	13.56	40
	44		44

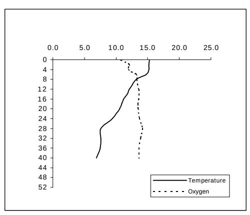


Figure 5j Site 2 June 7

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
10.4	0	11.73	0
12.2	2	11.73	2
13.1	4	10.56	4
13.2	6	10.08	6
13.4	8	10.55	8
13.3	10	10.91	10
13.1	12	10.56	12
12.5	14	11.14	14
12.1	16	11.21	16
11.6	18	11.21	18
11.1	20	11.17	20
10.5	24	11.26	24
9.3	28	12.17	28
8.7	32	11.98	32
8.4	36	11.94	36
7.8	40	11.96	40
7.4	44	12.02	44
7.0	48	12.38	48
6.6	52	12.51	52

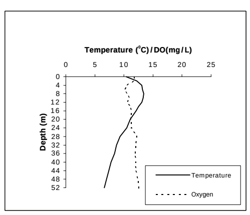


Figure 5k Site 3 June 7

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
9.6	0	12.01	0
11.3	2	10.79	2
12.8	4	12.10	4
13.7	6	11.45	6
14.2	8	10.82	8
14.4	10	10.39	10
14.3	12	10.16	12
14.1	14	10.49	14
13.6	16	10.59	16
12.2	18	10.07	18
11.5	20	10.66	20
10.5	24	10.75	24
9.5	28	10.62	28
9.1	32	10.67	32
8.5	36	11.03	36
7.9	40	11.23	40

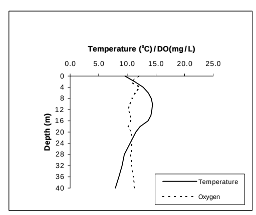


Figure 5l Site 2 June 11

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
15.3	0	10.44	0
14.5	2	13.44	2
14.2	4	13.60	4
14	6	13.60	6
14.2	8	13.60	8
13.8	10	12.70	10
13.7	12	12.14	12
13.6	14	12.11	14
12.8	16	12.07	16
12.3	18	12.18	18
10.8	20	12.11	20
10	24	12.02	24
8.2	28	12.96	28
7.6	32	13.99	32
6.7	36	13.90	36
6.5	40	14.40	40
6.2	44	14.17	44
6.1	48	13.81	48
6.0	52	13.59	52

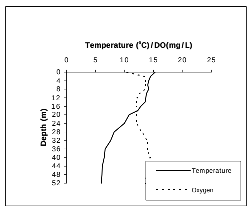


Figure 5m Site 3 June 11

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
15.1	0	8.42	0
14.9	2	8.95	2
14.4	4	9.30	4
12.4	6	9.87	6
11.8	8	9.82	8
10.6	10	10.20	10
8.7	12	10.84	12
8.5	14	11.82	14
8.2	16	11.87	16
8.0	18	11.42	18
7.9	20	11.51	20
7.7	24	11.82	24
7.2	28	12.12	28
6.9	32	12.10	32
6.9	36	12.02	36
	40		40

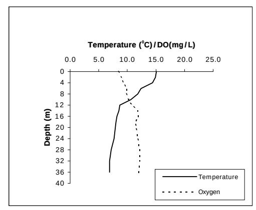


Figure 5n Site 2 June 19

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
17.0	0	7.56	0
17.1	2	9.16	2
16.9	4	10.33	4
14.7	6	10.30	6
13.5	8	9.10	8
12.6	10	9.80	10
11.6	12	9.48	12
10.4	14	9.81	14
9.2	16	10.17	16
7.9	18	10.64	18
7.3	20	10.40	20
6.9	24	10.59	24
6.5	28	10.60	28
6.2	32	10.80	32
6.1	36	10.75	36
6.1	40	10.70	40
5.8	44	10.60	44
5.8	48	10.16	48
6.0	52	9.45	52

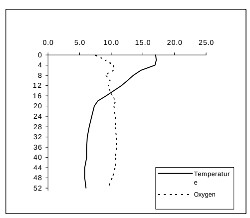


Figure 5o Site 3 June 19

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
17.5	0	6.8	0
17.7	2	7.7	2
17.4	4	8.7	4
17.4	6	9.4	6
15.4	8	9.1	8
12.6	10	10.2	10
9.6	12	10.3	12
7.8	14	11.7	14
7.5	16	11.5	16
7.2	18	11.0	18
7.2	20	11.1	20
7.1	24	11.0	24
7.1	28	10.8	28
6.9	32	10.8	32
7.1	36	10.7	36
7.2	40	4.2	40

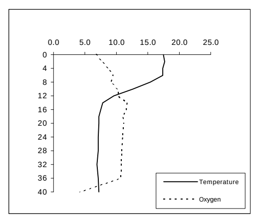


Figure 5p Site 2 June 27

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.8	0	9.66	0
21.9	2	9.98	2
19.0	4	11.29	4
17.9	6	11.75	6
17.3	8	11.55	8
16.6	10	11.39	10
12.3	12	12.00	12
11.2	14	12.04	14
10.2	16	12.30	16
9.2	18	12.76	18
8.6	20	12.87	20
8.1	24	13.04	24
7.3	28	13.59	28
6.6	32	13.08	32
6.4	36	13.92	36
6.1	40	13.70	40
6.2	44	13.34	44
5.6	48	12.20	48
	52		52

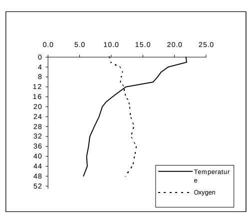


Figure 5q Site 2 July 10

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
19.3	0	9.57	0
19.2	2	9.81	2
18.4	4	10.25	4
18.2	6	10.38	6
17.9	8	10.41	8
16.5	10	10.25	10
12.2	12	10.34	12
10.9	14	10.75	14
10.2	16	10.89	16
9.5	18	11.15	18
8.3	20	11.67	20
7.6	24	12.45	24
7	28	12.84	28
6.7	32	13.34	32
6.3	36	13.37	36
6	40	13.46	40

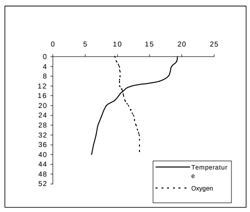


Figure 5r Site 3 July 10

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
20.7	0	9.91	0
20.6	2	9.31	2
20.2	4	9.52	4
19.5	6	9.75	6
18.9	8	9.75	8
16.4	10	9.76	10
14.7	12	9.80	12
11.9	14	9.98	14
10.3	16	10.52	16
8.7	18	10.81	18
8.1	20	11.11	20
7.4	24	11.47	24
7.0	28	11.57	28
6.9	32	11.46	32
6.8	36	11.39	36
6.7	40	10.04	40

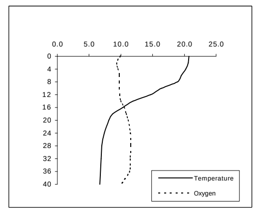


Figure 5s Site 2 July 17

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
22.7	0	9.58	0
22.2	2	10.05	2
21.6	4	10.29	4
21.1	6	10.71	6
18.7	8	10.87	8
16	10	10.73	10
13	12	10.21	12
11.2	14	10.90	14
9.2	16	11.60	16
8.5	18	12.00	18
8	20	12.30	20
7.5	24	12.80	24
7	28	13.12	28
6.6	32	13.47	32
6.4	36	13.47	36
6.2	40	13.24	40
6	44	12.60	44
5.8	48	12.54	48

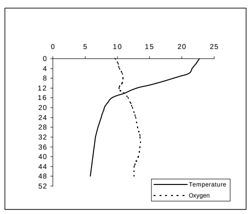


Figure 5t Site 2 July 23

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
22.3	0	8.25	0
22.1	2	8.32	2
22.0	4	8.39	4
21.8	6	8.22	6
19.9	8	8.32	8
17.0	10	8.35	10
13.6	12	8.20	12
11.9	14	8.05	14
10.2	16	8.60	16
9.3	18	8.86	18
8.7	20	9.25	20
7.8	24	9.90	24
7.2	28	10.28	28
6.8	32	10.35	32
6.4	36	10.59	36
6.2	40	10.30	40
6.0	44	10.13	44
5.9	48	9.20	48
5.7	52	7.14	52

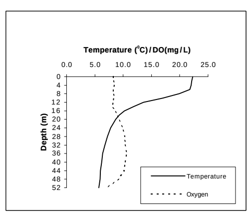


Figure 5u Site 3 July 23

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
22.7	0	8.14	0
22.5	2	7.90	2
22.4	4	7.69	4
22.2	6	7.90	6
16.8	8	8.26	8
14.8	10	8.32	10
12.2	12	8.50	12
10.0	14	9.11	14
9.3	16	9.10	16
8.6	18	9.25	18
8.1	20	9.33	20
7.7	24	9.61	24
7.4	28	9.55	28
7.3	32	9.56	32
7.2	36	8.40	36
7.2	40	2.56	40

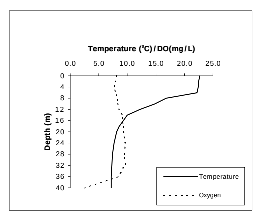


Figure 5v Site 2 August 9

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
20.2	0	9.43	0
20.1	2	9.29	2
19.9	4	9.34	4
19.8	6	9.38	6
19.5	8	9.44	8
19.3	10	9.40	10
17.4	12	8.64	12
11.5	14	8.55	14
10.0	16	8.94	16
8.9	18	9.47	18
8.6	20	9.93	20
7.8	24	10.33	24
7.3	28	10.64	28
6.9	32	10.55	32
6.3	36	10.98	36
6.1	40	10.80	40
5.9	44	9.51	44
5.8	48	8.30	48
5.7	52	7.49	52

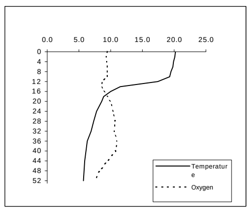


Figure 5w Site 3 August 9

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.6	0	8.77	0
20.6	2	8.98	2
20.3	4	9.11	4
19.8	6	9.24	6
19.7	8	9.20	8
19.5	10	9.16	10
15.3	12	8.81	12
12.7	14	8.98	14
11.0	16	9.16	16
9.4	18	8.47	18
8.4	20	9.69	20
7.8	24	9.74	24
7.4	28	9.74	28
7.3	32	9.64	32
7.3	36	9.46	36
	40		40

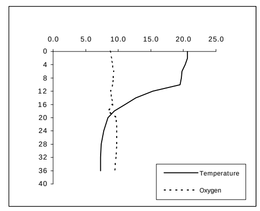


Figure 5x Site 2 August 18

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
20.6	0	8.57	0
20.0	2	8.96	2
19.7	4	9.27	4
19.7	6	9.36	6
19.6	8	9.45	8
19.5	10	9.54	10
18.2	12	9.23	12
11.3	14	9.34	14
10.5	16	9.66	16
10.0	18	9.60	18
9.1	20	9.91	20
8.2	24	10.62	24
7.6	28	11.00	28
7.1	32	11.21	32
6.8	36	11.29	36
6.5	40	11.21	40
6.2	44	11.21	44
5.9	48	9.72	48
5.9	52	9.34	52

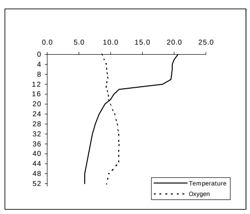


Figure 5y Site 3 August 18

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.8	0	8.31	0
20.7	2	8.39	2
20.5	4	8.77	4
20.4	6	9.08	6
20.3	8	9.17	8
19.7	10	9.41	10
16.3	12	9.27	12
9.5	14	10.34	14
9.4	16	10.39	16
8.3	18	10.45	18
8.1	20	9.83	20
7.9	24	9.98	24
7.7	28	10.14	28
7.5	32	10.21	32
7.4	36	10.18	36
	40		40

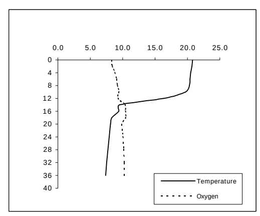


Figure 5z Site 2 August 21

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
19.9	0	8.55	0
19.8	2	8.80	2
19.8	4	9.09	4
19.7	6	9.21	6
19.6	8	9.37	8
19.6	10	9.28	10
16.8	12	8.79	12
11.1	14	9.28	14
9.9	16	9.35	16
8.9	18	9.66	18
8.5	20	9.81	20
7.8	24	10.20	24
7.3	28	10.27	28
6.9	32	10.40	32
6.5	36	10.24	36
6.2	40	9.86	40
6.0	44	8.91	44
6.0	48	7.96	48

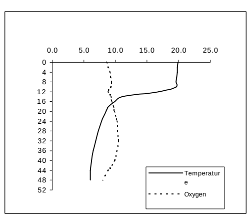


Figure 5aa Site 3 August 21

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.6	0	8.37	0
20.6	2	8.35	2
20.5	4	8.51	4
20.4	6	8.60	6
20.4	8	8.72	8
20.3	10	8.75	10
18.5	12	8.49	12
12.6	14	8.46	14
10.9	16	8.52	16
10.4	18	8.55	18
9.5	20	8.84	20
8.3	24	9.11	24
7.8	28	9.13	28
7.6	32	9.10	32
7.5	36	8.98	36
7.3	40	8.61	40

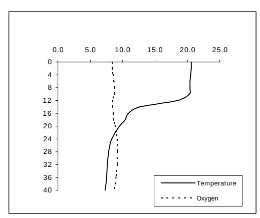


Figure 5bb Site 2 August 30

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
22.5	0	8.19	0
22.6	2	8.22	2
22.6	4	8.35	4
22.3	6	8.48	6
20.9	8	8.51	8
20.0	10	8.38	10
19.4	12	8.12	12
13.4	14	7.56	14
10.0	16	7.92	16
9.2	18	8.12	18
8.6	20	8.21	20
8.1	24	8.26	24
	28		28
	32		32
	36		36
	40		40
	44		44
	48		48

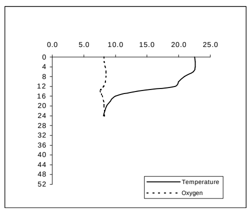


Figure 5cc Site 3 August 30

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.9	0	8.23	0
22.0	2	8.31	2
21.8	4	8.40	4
20.9	6	8.37	6
20.1	8	8.20	8
19.6	10	7.98	10
18.6	12	7.60	12
13.1	14	7.43	14
10.3	16	7.64	16
9.6	18	7.77	18
8.3	20	8.12	20
8.2	24	8.36	24
	28		28
	32		32
	36		36
	40		40

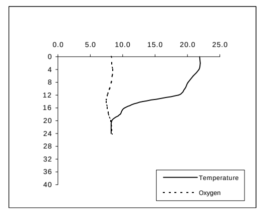


Figure 5dd Site 2 September 3

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.7	0	9.08	0
20.6	2	9.20	2
20.6	4	9.22	4
20.6	6	9.34	6
20.5	8	9.39	8
20.5	10	9.21	10
16.2	12	9.30	12
	14		14
	16		16
	18		18
	20		20
	24		24
	28		28
	32		32
	36		36
	40		40
	44		44
	48		48

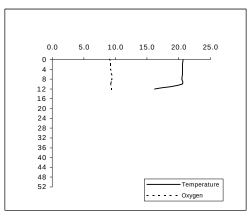


Figure 5ee Site 3 September 3

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.9	0	9.01	0
20.8	2	9.28	2
20.7	4	9.55	4
20.7	6	9.64	6
20.6	8	9.71	8
20.5	10	9.55	10
19.5	12	9.97	12
17.9	14	8.81	14
	16		16
	18		18
	20		20
	24		24
	28		28
	32		32
	36		36
	40		40

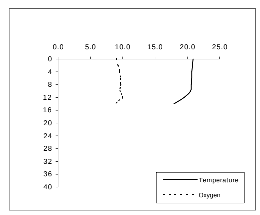


Figure 5ff Site 2 September 5

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
19.7	0	7.56	0
19.7	2	7.68	2
19.7	4	7.93	4
19.7	6	8.11	6
19.7	8	8.28	8
19.6	10	8.11	10
17.9	12	7.69	12
15.2	14	7.34	14
11.6	16	7.44	16
9.9	18	7.63	18
9.1	20	7.91	20
8.1	24	8.45	24
7.5	28	8.98	28
7.1	32	9.25	32
6.6	36	9.24	36
6.3	40	8.94	40
6.0	44	8.05	44

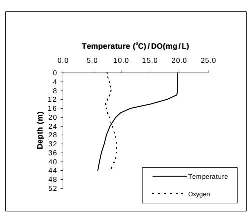


Figure 5gg Site 3 September 5

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
19.6	0	7.88	0
19.7	2	7.56	2
19.8	4	7.68	4
19.8	6	8.00	6
19.8	8	8.07	8
19.8	10	8.01	10
10.8	12	7.87	12
9.3	14	7.85	14
8.5	16	8.06	16
8.2	18	7.95	18
8.0	20	7.97	20
7.7	24	7.95	24
7.5	28	7.87	28
7.5	32	7.81	32
7.3	36	7.72	36
	40		40

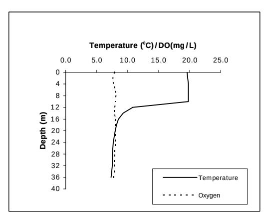


Figure 5hh Site 2 September 12

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
19.6	0	7.45	0
19.3	2	7.98	2
19.3	4	8.05	4
19.2	6	8.01	6
19.1	8	8.07	8
19.0	10	8.19	10
18.9	12	8.06	12
13.3	14	7.87	14
10.5	16	7.54	16
9.5	18	7.58	18
8.8	20	7.81	20
8.0	24	8.22	24
7.6	28	8.40	28
7.1	32	8.88	32
6.7	36	9.18	36
6.1	40	7.83	40
5.9	44	6.90	44
6.1	48	3.89	48

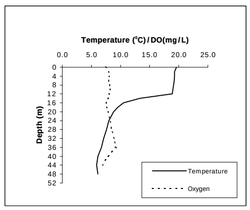


Figure 5ii Site 2 September 22

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
16.7	0	9.41	0
17.5	2	8.61	2
17.5	4	8.98	4
17.5	6	9.25	6
17.5	8	9.43	8
17.5	10	9.31	10
17.3	12	9.31	12
12.4	14	8.96	14
10.5	16	8.51	16
10.6	18	8.07	18
9.9	20	7.83	20
9.1	24	7.69	24
8.3	28	7.88	28
7.8	32	8.09	32
7.3	36	8.42	36
7.0	40	8.40	40
6.8	44	7.73	44
6.7	48	7.53	48
6.4	52	7.42	52

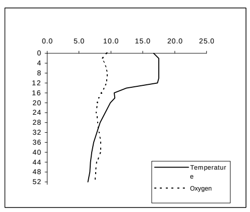


Figure 5jj Site 3 September 22

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
17.7	0	7.84	0
17.7	2	8.10	2
17.7	4	8.59	4
17.7	6	9.04	6
17.6	8	9.42	8
17.6	10	9.16	10
17.5	12	9.07	12
17.5	14	9.08	14
17.4	16	8.81	16
14.2	18	8.53	18
11.1	20	8.12	20
8.6	24	7.86	24
8.1	28	7.68	28
7.8	32	7.40	32
7.6	36	7.21	36
	40		40

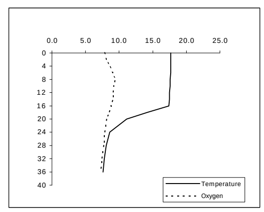


Figure 5kk Site 2 September 27

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
16.7	0	9.25	0
16.7	2	9.31	2
16.7	4	9.43	4
16.7	6	9.50	6
16.7	8	9.52	8
16.7	10	9.28	10
16.7	12	9.38	12
15.1	14	9.16	14
11.9	16	8.92	16
10.2	18	8.35	18
9.5	20	8.32	20
8.0	24	9.14	24
7.4	28	9.69	28
6.9	32	9.96	32
6.5	36	9.68	36
6.3	40	9.66	40
6.2	44	8.92	44
6.1	48	8.25	48
	52		52

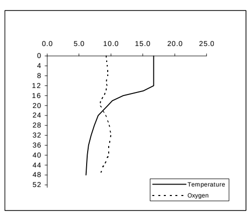


Figure 5ll Site 2 October 1

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
16.2	0	9.21	0
16.1	2	9.45	2
16.0	4	9.72	4
16.0	6	9.92	6
15.9	8	10.09	8
15.9	10	10.00	10
15.9	12	10.00	12
13.7	14	8.83	14
11.1	16	7.81	16
9.5	18	7.81	18
9.0	20	7.99	20
7.6	24	8.72	24
7.1	28	8.93	28
6.7	32	9.13	32
6.4	36	8.74	36
6.2	40	7.80	40
6.1	44	6.83	44
6.1	48	6.17	48
6.1	52	5.74	52

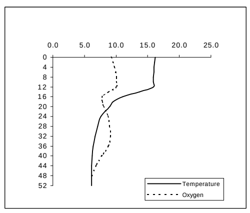


Figure 5mm Site 3 October 1

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
16.3	0	9.83	0
16.3	2	9.33	2
16.2	4	9.43	4
16.1	6	9.48	6
16.1	8	9.45	8
16.1	10	9.47	10
16.0	12	9.43	12
16.0	14	9.43	14
16.0	16	9.37	16
14.8	18	8.85	18
9.9	20	7.98	20
9.2	24	7.61	24
8.3	28	7.64	28
7.8	32	7.64	32
7.6	36	7.46	36
	40		40

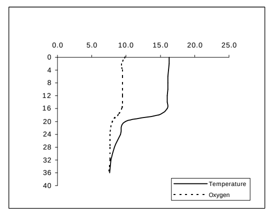


Figure 5nn Site 2 October 3

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
15.7	0	8.96	0
15.7	2	9.02	2
15.7	4	8.96	4
15.7	6	9.05	6
15.6	8	9.22	8
15.6	10	9.33	10
15.5	12	9.42	12
15.5	14	9.39	14
10.2	16	7.65	16
9.3	18	7.73	18
8.6	20	7.92	20
8.1	24	8.17	24
7.5	28	8.26	28
7.2	32	8.31	32
6.8	36	8.43	36
6.6	40	8.05	40
6.4	44	7.63	44
6.1	48	7.16	48

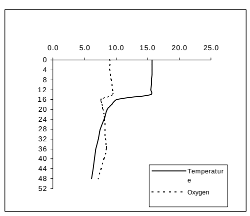


Figure 5oo Site 3 October 3

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
15.7	0	9.13	0
15.7	2	9.23	2
15.8	4	9.22	4
15.7	6	9.05	6
15.7	8	9.14	8
15.7	10	9.16	10
15.6	12	8.95	12
15.2	14	8.72	14
13.1	16	7.74	16
11.8	18	7.16	18
10.1	20	7.05	20
8.4	24	7.12	24
7.9	28	6.93	28
7.6	32	8.86	32
7.5	36	6.72	36
	40		40

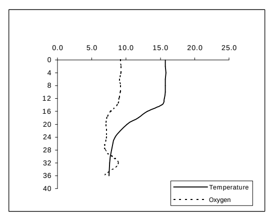


Figure 5pp Site 2 October 17

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
13.5	0	9.40	0
13.5	2	9.70	2
13.4	4	9.76	4
13.4	6	10.22	6
13.3	8	10.25	8
13.3	10	10.39	10
13.3	12	10.37	12
13.2	14	10.50	14
12.2	16	8.35	16
11.3	18	8.02	18
9.8	20	7.85	20
8.8	24	8.17	24
8.1	28	8.28	28
7.5	32	8.61	32
6.9	36	8.87	36
6.7	40	8.32	40
6.4	44	7.72	44
6.2	48	6.76	48
6.1	52	5.60	52

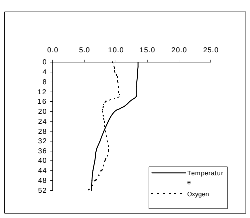


Figure 5qq Site 3 October 17

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
13.0	0	11.75	0
13.5	2	10.44	2
13.5	4	10.21	4
13.5	6	10.52	6
13.5	8	10.60	8
13.5	10	10.46	10
13.5	12	10.54	12
13.5	14	10.61	14
13.4	16	10.59	16
10.2	18	8.52	18
9.2	20	7.84	20
8.3	24	7.80	24
8.1	28	7.58	28
7.9	32	7.43	32
	36		36

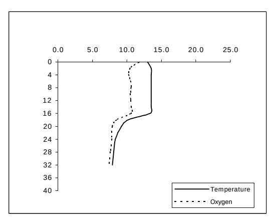


Figure 5rr Site 2 October 31

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
10.5	0	18.16	0
10.5	2	18.24	2
10.5	4	18.39	4
10.5	6	18.14	6
10.5	8	18.07	8
10.5	10	17.92	10
10.5	12	17.84	12
10.5	14	17.85	14
10.5	17	17.81	17
10.5	19	17.73	19
9.8	21	16.02	21
8.7	25	13.84	25
8.1	29	13.33	29

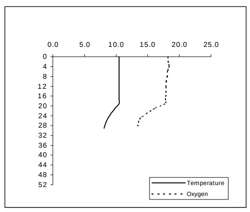


Figure 5ss Site 3 October 31

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
10.6	0	18.55	0
10.6	2	18.77	2
10.6	4	18.95	4
10.6	6	18.74	6
10.6	8	18.57	8
10.6	10	18.57	10
10.6	12	18.54	12
10.6	14	18.49	14
13.4	17	18.34	17
10.2	19	18.29	19
9.2	21	18.23	21
8.3	25	16.34	25
8.1	29	13.69	29

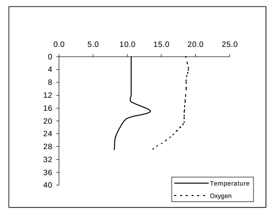


Figure 5tt Site 2 November 12

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
8.8	0	10.56	0
8.8	2	9.99	2
8.8	4	9.52	4
8.8	6	9.45	6
8.8	8	9.38	8
8.8	10	9.29	10
8.8	12	9.27	12
8.9	14	9.22	14
8.8	16	9.12	16
8.8	18	9.13	18
8.8	20	9.14	20
8.8	24	9.11	24
8.8	28	9.12	28
	32		32
	36		36
	40		40

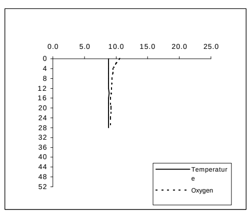


Figure 5uu Site 3 November 12

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
8.6	0	10.29	0
8.6	2	8.79	2
8.6	4	8.65	4
8.6	6	8.60	6
8.6	8	8.49	8
8.5	10	8.47	10
8.5	12	8.43	12
8.5	14	8.34	14
8.5	16	7.92	16
8.5	18	7.94	18
8.4	20	7.97	20
7.9	24	6.91	24
7.7	28	5.84	28
7.5	32	5.36	32
7.4	36	5.15	36
7.3	40	4.44	40

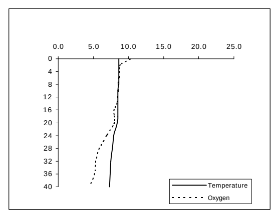


Figure 5vv Site 2 November 27

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
7.4	0	15.33	0
7.5	2	15.08	2
7.5	4	14.93	4
7.5	6	14.86	6
7.6	8	14.85	8
7.6	10	14.76	10
7.6	12	14.70	12
7.6	14	14.69	14
7.6	16	14.68	16
7.6	18	14.66	18
7.6	20	14.59	20
7.6	24	14.57	24
7.6	28	14.45	28
	32		32
	36		36
	40		40

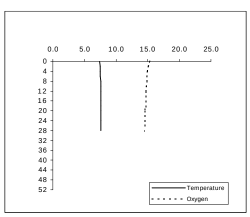


Figure 5ww Site 3 November 27

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
7.6	0	14.65	0
7.6	2	14.67	2
7.6	4	14.65	4
7.6	6	14.60	6
7.6	8	14.63	8
7.6	10	14.62	10
7.6	12	14.64	12
7.6	14	14.51	14
7.6	16	14.64	16
7.6	18	14.60	18
7.6	20	14.53	20
7.6	24	14.50	24
7.6	28	14.43	28
	32		32
	36		36
	40		40

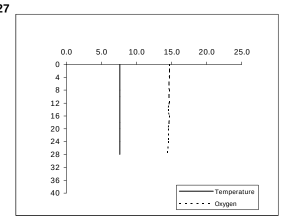


Figure 6: Temperature/Oxygen Profiles for Osoyoos Lake for 2002

Figure 6a Site 1 April 10

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
7.1	0	11.70	0
6.5	2	11.80	2
5.8	4	12.20	4
5.5	6	12.60	6
5.3	8	13.10	8
5.2	10	13.50	10
5.1	12	13.40	12
5.1	14	13.20	14
4.9	16	13.50	16
4.8	18	13.50	18
4.8	20	13.50	20
4.7	24	13.50	24
4.6	28	13.50	28
	32		32
	36		36
	40		40

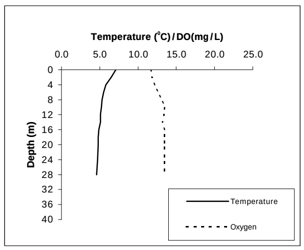


Figure 6b Site 2 April 10

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
5.7	0	13.50	0
5.4	2	12.70	2
5.2	4	13.70	4
5.1	6	14.00	6
4.9	8	13.80	8
4.8	10	13.90	10
4.6	12	14.10	12
4.5	14	13.90	14
4.4	16	14.10	16
4.4	18	14.00	18
4.4	20	14.00	20
4.3	24	13.70	24
4.2	28	13.90	28
	32		32
	36		36
	40		40

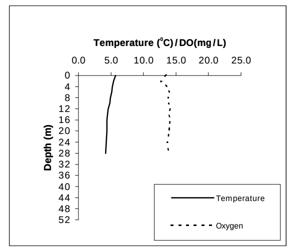


Figure 6c Site 1 April 24

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
8.0	0	11.25	0
7.9	2	12.28	2
7.9	4	12.84	4
7.9	6	13.01	6
7.9	8	13.08	8
7.8	10	13.35	10
7.7	12	13.15	12
7.4	14	13.44	14
7.4	16	12.87	16
7.3	18	12.64	18
7.0	20	12.99	20
6.5	24	12.99	24
6.4	28	12.97	28
	32		32
	36		36
	40		40

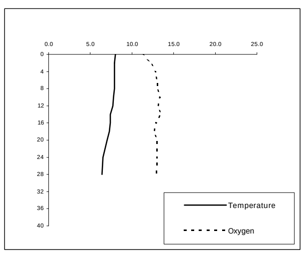


Figure 6d Site 2 April 24

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
8.2	0	10.78	0
8.0	2	11.36	2
7.9	4	11.69	4
7.9	6	11.97	6
7.9	8	12.20	8
7.9	10	12.21	10
8.1	12	11.98	12
7.7	14	12.23	14
7.4	16	12.11	16
7.3	18	12.21	18
7.3	20	12.13	20
7.3	24	12.16	24
7.3	28	11.97	28
	32		32
	36		36
	40		40

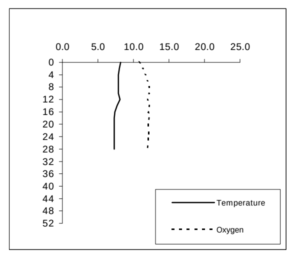


Figure 6e Site 1 May 8

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
9.8	0	7.99	0
9.3	2	6.82	2
9.2	4	7.40	4
9.1	6	8.66	6
9.1	8	8.89	8
9.1	10	9.40	10
9.0	12	10.07	12
8.5	14	9.95	14
7.6	16	9.85	16
6.8	18	10.07	18
6.6	20	10.00	20
6.2	24	8.22	24
6.4	28	2.72	28
6.4	32	2.61	32
	36		36
	40		40

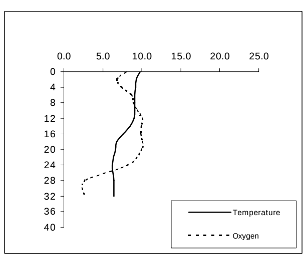


Figure 6f Site 2 May 8

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
10.8	0	12.7	0
9.9	2	12.7	2
9.7	4	12.8	4
9.6	6	12.2	6
9.6	8	12.0	8
9.5	10	11.7	10
9.1	12	11.8	12
8.1	14	11.8	14
7.0	16	11.9	16
6.7	18	11.7	18
6.5	20	11.3	20
6.4	24	10.4	24
6.3	28	10.7	28
6.3	32	10.2	32
6.2	36	10.1	36
6.1	40	9.6	40

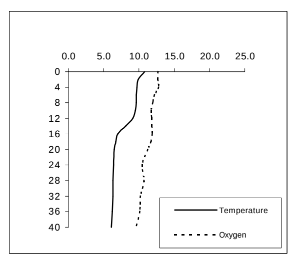


Figure 6g Site 1 May 22

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
13.4	0	9.60	0
13.0	2	11.32	2
12.6	4	12.15	4
12.5	6	12.34	6
12.1	8	12.50	8
11.8	10	12.39	10
11.5	12	12.33	12
10.9	14	13.57	14
10.5	16	13.80	16
10.0	18	12.88	18
9.2	20	13.91	20
8.2	24	14.82	24
7.6	28	14.97	28
7.4	32	14.78	32
7.3	36	14.45	36
7.2	40	11.63	40

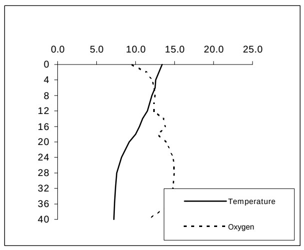


Figure 6h Site 2 May 22

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
13.4	0	14.05	0
13.4	2	12.00	2
13.4	4	13.17	4
13.3	6	12.89	6
13.3	8	12.90	8
13.2	10	12.84	10
13.2	12	12.76	12
13.0	14	12.70	14
12.6	16	12.71	16
12.5	18	12.65	18
12.3	20	12.65	20
11.5	24	12.76	24
9.5	28	13.21	28
9.0	32	13.32	32
8.7	36	13.25	36
8.3	40	13.23	40
8.2	44	13.10	44
8.2	48	12.87	48
7.9	52	12.69	52

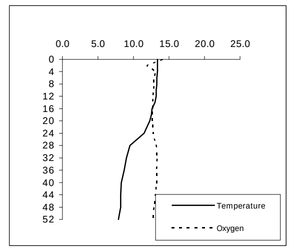


Figure 6i Site 1 June 6

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
12.6	0	10.40	0
12.7	2	12.80	2
13.2	4	13.40	4
13.9	6	12.10	6
14.4	8	11.80	8
14.5	10	11.37	10
14.3	12	11.96	12
13.8	14	11.31	14
13.4	16	11.52	16
12.9	18	12.21	18
12.0	20	11.80	20
11.3	24	12.05	24
10.4	28	12.46	28
9.7	32	12.98	32
9.0	36	13.39	36
9.1	40	17.38	40
	44		44

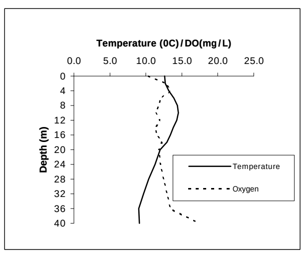


Figure 6j Site 2 June 6

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
12.1	0	11.81	0
13.1	2	14.80	2
13.6	4	15.30	4
14.0	6	14.51	6
14.6	8	15.18	8
14.9	10	14.39	10
15.1	12	14.89	12
15.2	14	14.95	14
15.2	16	14.74	16
15.3	18	14.94	18
15.2	20	13.53	20
14.7	24	14.53	24
13.1	28	13.59	28
12.4	32	13.63	32
11.3	36	14.69	36
10.4	40	14.27	40
9.4	44	16.56	44
8.7	48	15.93	48
8.3	52	15.67	52

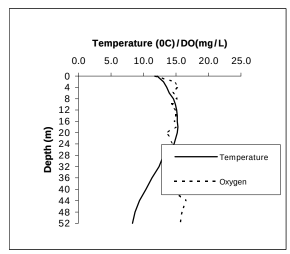


Figure 6k Site 1 June 10

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
15.8	0	10.93	0
14.7	2	9.99	2
14.3	4	10.25	4
14.4	6	10.57	6
14.4	8	10.34	8
14.3	10	10.42	10
14.3	12	10.32	12
14.2	14	10.71	14
13.9	16	10.61	16
13.5	18	10.41	18
12.4	20	10.44	20
8.6	24	11.25	24
8.0	28	11.48	28
7.6	32	11.64	32
7.7	36	11.56	36
7.6	40	11.35	40
7.5	44	10.34	44

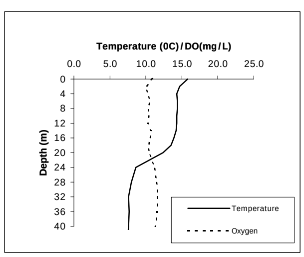


Figure 6l Site 2 June 10

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
16.3	0	10.43	0
14.9	2	10.56	2
14.6	4	11.04	4
14.4	6	11.10	6
14.3	8	11.08	8
14.2	10	10.96	10
14.1	12	10.96	12
14.0	14	10.96	14
13.9	16	10.87	16
13.9	18	10.81	18
13.8	20	10.62	20
13.6	24	10.48	24
13.6	28	10.42	28
12.3	32	10.58	32
9.3	36	10.84	36
8.0	40	11.10	40
7.8	44	11.29	44
7.6	48	11.77	48
7.4	52	11.87	52

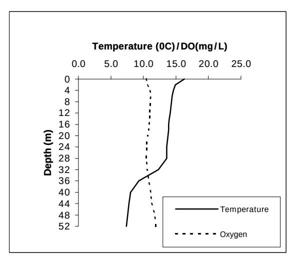


Figure 6m Site 1 June 18

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
17.2	0	9.16	0
16.9	2	9.04	2
16.6	4	9.43	4
16.4	6	9.50	6
15.0	8	9.51	8
14.9	10	9.41	10
13.3	12	9.49	12
12.1	14	9.61	14
9.7	16	9.98	16
10.7	18	9.55	18
9.3	20	9.98	20
8.3	24	10.34	24
7.9	28	10.38	28
7.7	32	10.42	32
7.7	36	10.35	36
7.5	40	10.56	40
7.4	44	10.53	44

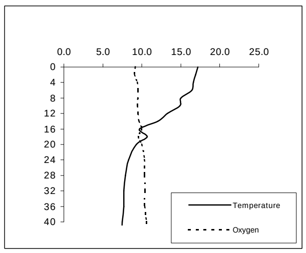


Figure 6n Site 2 June 18

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
17.5	0	9.77	0
17.5	2	9.93	2
17.5	4	10.24	4
17.5	6	10.61	6
17.4	8	10.30	8
13.2	10	10.30	10
13.1	12	10.27	12
17.7	14	10.41	14
11.6	16	10.61	16
10.4	18	10.99	18
8.2	20	11.20	20
7.8	24	11.72	24
7.7	28	11.20	28
7.5	32	11.18	32
7.4	36	11.39	36
7.4	40	11.08	40
7.4	44	11.17	44
7.3	48	10.66	48
7.3	52	10.72	52

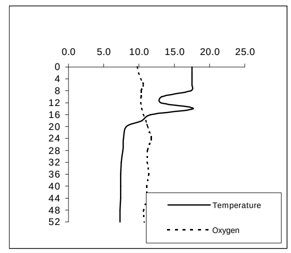


Figure 6o Site 2 June 25

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
22.7	0	6.51	0
20.3	2	7.14	2
19.8	4	8.31	4
19.4	6	8.23	6
17.6	8	8.19	8
15.9	10	8.28	10
14.6	12	7.77	12
12.2	14	8.39	14
11.1	16	8.10	16
9.7	18	8.25	18
8.5	20	8.70	20
7.9	24	8.96	24
7.7	28	8.90	28
7.5	32	8.73	32
7.5	36	8.53	36
7.5	40	8.42	40
7.4	44	8.18	44
7.4	48	8.01	48
7.4	52	7.86	52

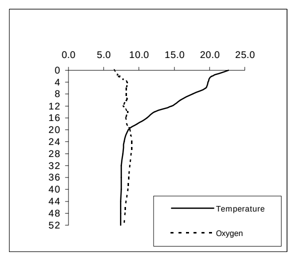


Figure 6p Site 1 July 9

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.9	0	8.76	0
21.3	2	9.41	2
19.6	4	9.89	4
18.9	6	10.21	6
18.4	8	10.13	8
18.0	10	9.71	10
14.8	12	9.32	12
12.2	14	9.01	14
9.7	16	9.28	16
8.5	18	9.49	18
8.1	20	9.68	20
7.8	24	9.73	24
7.7	28	9.45	28
7.7	32	9.04	32
7.6	36	8.05	36
7.5	40	6.04	40
7.5	44	1.47	44

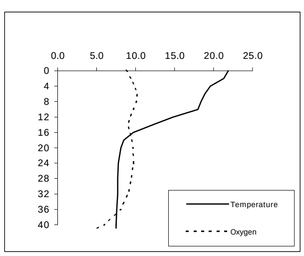


Figure 6q Site 2 July 9

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.0	0	8.56	0
20.3	2	8.55	2
19.3	4	9.07	4
18.8	6	9.23	6
18.4	8	9.20	8
17.8	10	9.07	10
14.8	12	9.06	12
13.1	14	8.25	14
9.8	16	9.13	16
8.9	18	9.43	18
8.5	20	9.70	20
8.0	24	9.83	24
7.8	28	9.95	28
7.8	32	9.81	32
7.7	36	9.66	36
7.7	40	9.45	40

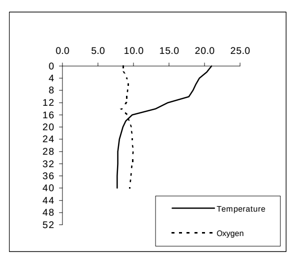


Figure 6r Site 2 July 15

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
22.0	0	8.95	0
21.3	2	9.08	2
21.1	4	9.11	4
20.9	6	9.16	6
20.5	8	9.19	8
19.3	10	9.25	10
16.8	12	7.78	12
14.7	14	7.44	14
12.9	16	7.62	16
10.9	18	8.04	18
9.7	20	8.41	20
8.2	24	8.68	24
7.9	28	8.83	28
7.8	32	8.73	32
7.7	36	8.66	36
7.7	40	8.61	40
7.7	44	8.91	44
7.7	48	8.88	48

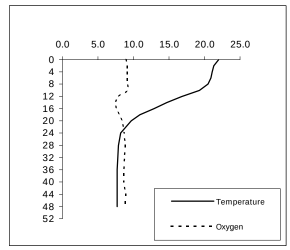


Figure 6s Site 1 July 22

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
23.2	0	8.34	0
22.2	2	8.44	2
21.6	4	8.60	4
21.4	6	8.65	6
20.8	8	8.35	8
19.4	10	7.91	10
14.7	12	6.66	12
12.1	14	6.73	14
10.0	16	7.39	16
8.7	18	7.75	18
8.5	20	7.72	20
8.2	24	7.63	24
8.0	28	7.61	28
7.8	32	7.23	32
7.8	36	6.20	36
7.9	40	5.08	40

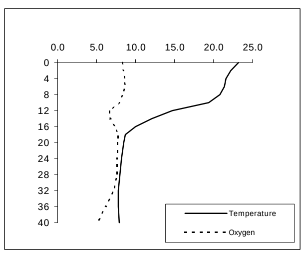


Figure 6t Site 2 July 22

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
23.5	0	8.34	0
21.8	2	8.24	2
21.7	4	8.45	4
21.7	6	8.45	6
21.3	8	8.47	8
19.1	10	7.75	10
15.4	12	7.03	12
12.8	14	7.01	14
10.0	16	7.67	16
9.2	18	7.79	18
8.6	20	7.86	20
8.2	24	7.91	24
8.0	28	7.75	28
8.0	32	7.54	32
7.9	36	7.55	36
7.9	40	7.48	40
7.9	44	7.31	44
7.8	48	7.34	48
7.8	52	7.29	52

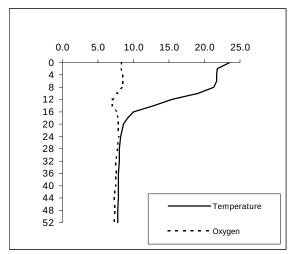


Figure 6u Site 1 August 7

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
19.7	0	8.35	0
19.6	2	8.11	2
19.6	4	8.13	4
19.6	6	8.10	6
19.2	8	7.77	8
18.8	10	7.14	10
17.4	12	6.12	12
10.9	14	5.71	14
9.5	16	6.18	16
8.6	18	6.41	18
8.5	20	6.54	20
8.2	24	6.53	24
8.1	28	6.41	28
8.0	32	6.18	32
7.9	36	4.60	36
	40		40

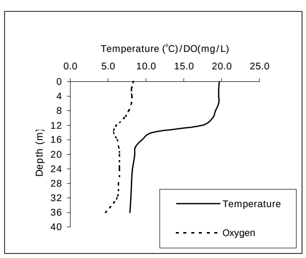


Figure 6v Site 2 August 7

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
19.8	0	8.52	0
19.6	2	8.32	2
19.6	4	8.36	4
19.5	6	8.30	6
19.5	8	8.35	8
19.4	10	8.31	10
15.8	12	5.84	12
13.0	14	5.78	14
10.0	16	6.31	16
9.0	18	6.51	18
8.8	20	6.49	20
8.5	24	6.26	24
8.3	28	6.23	28
8.2	32	6.22	32
8.1	36	6.30	36
8.1	40	6.14	40
8.0	44	6.08	44
8.0	48	6.07	48
8.0	52	6.04	52

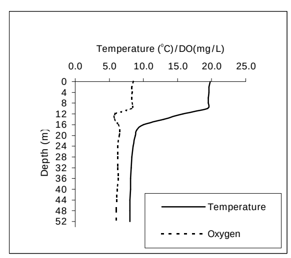


Figure 6w Site 1 August 8

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.4	0	9.29	0
21.2	2	9.31	2
20.1	4	9.41	4
19.7	6	9.63	6
19.5	8	9.30	8
19.2	10	8.57	10
18.4	12	7.87	12
11.5	14	6.82	14
9.6	16	6.82	16
9.0	18	7.11	18
8.6	20	7.15	20
8.3	24	7.27	24
8.1	28	7.24	28
8.0	32	6.94	32
7.9	36	2.34	36
7.9	40	1.45	40

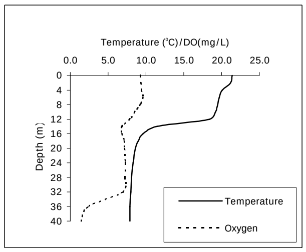


Figure 6x Site 2 August 8

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.4	0	9.44	0
20.4	2	9.32	2
20.0	4	9.57	4
19.8	6	9.65	6
19.6	8	9.37	8
19.5	10	8.95	10
18.8	12	8.35	12
14.1	14	6.01	14
11.0	16	6.57	16
9.7	18	6.74	18
9.1	20	6.85	20
8.4	24	6.84	24
8.2	28	6.69	28
8.2	32	6.61	32
8.1	36	6.51	36
8.1	40	6.47	40
8.1	44	6.43	44
8.0	48	6.40	48
8.0	52	6.22	52

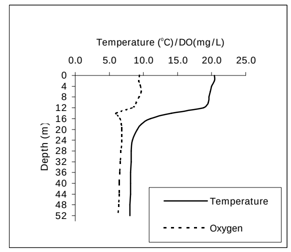


Figure 6y Site 1 August 17

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
19.8	0	9.00	0
19.5	2	9.08	2
19.3	4	9.03	4
19.3	6	8.98	6
19.3	8	8.60	8
19.2	10	8.69	10
19.0	12	8.35	12
17.0	14	7.68	14
12.5	16	6.58	16
9.0	18	6.18	18
9.0	20	6.42	20
8.6	24	6.45	24
8.5	28	6.49	28
8.3	32	7.02	32
8.1	36	3.39	36
	40		40

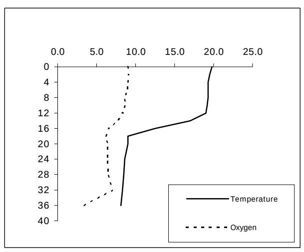


Figure 6z Site 2 August 17

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
20.9	0	9.31	0
20.3	2	9.50	2
19.8	4	9.47	4
19.6	6	9.57	6
19.5	8	9.47	8
19.5	10	9.65	10
19.3	12	9.52	12
17.8	14	9.05	14
12.3	16	8.29	16
9.0	18	9.30	18
9.0	20	7.18	20
8.7	24	7.08	24
8.5	28	6.92	28
8.4	32	6.83	32
8.4	36	6.80	36
8.3	40	6.71	40
8.3	44	6.61	44
8.3	48	6.50	48
8.2	52	6.37	52

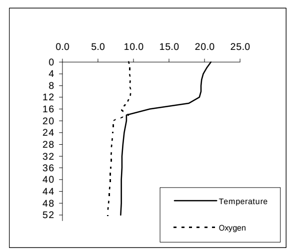


Figure 6aa Site 2 August 19

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.5	0	8.73	0
20.5	2	9.09	2
20.2	4	9.31	4
19.8	6	9.48	6
19.5	8	9.23	8
19.1	10	8.80	10
18.7	12	8.55	12
15.1	14	7.47	14
10.7	16	7.06	16
9.9	18	6.88	18
9.0	20	6.95	20
8.6	24	6.85	24
8.5	28	6.83	28
8.4	32	6.76	32
8.4	36	6.75	36
8.3	40	6.67	40
8.3	44	6.42	44
8.2	48	6.30	48
	52		52

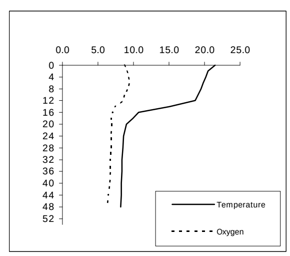


Figure 6bb Site 1 August 27

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
23.7	0	8.67	0
22.5	2	9.49	2
22.0	4	9.51	4
21.6	6	9.34	6
20.6	8	9.02	8
19.5	10	8.29	10
18.0	12	7.16	12
17.0	14	6.60	14
11.3	16	5.36	16
9.6	18	5.46	18
9.1	20	5.54	20
8.6	24	5.16	24
	28		28
	32		32
	36		36
	40		40

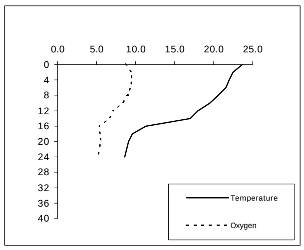


Figure 6cc Site 2 August 27

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
23.7	0	8.84	0
23.1	2	9.22	2
21.9	4	9.44	4
21.1	6	9.18	6
19.9	8	8.98	8
19.4	10	8.46	10
18.7	12	7.90	12
16.5	14	7.01	14
13.0	16	5.73	16
9.8	18	5.60	18
9.1	20	5.63	20
8.6	24	5.69	24
	28		28
	32		32
	36		36
	40		40
	44		44
	48		48
	52		52

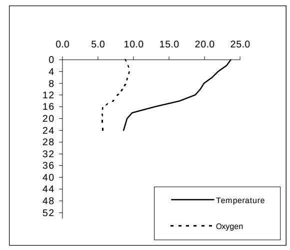


Figure 6dd Site 1 September 3

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
20.3	0	8.31	0
20.3	2	8.32	2
20.3	4	8.40	4
20.2	6	8.50	6
18.8	8	7.21	8
18.3	10	7.52	10
17.8	12	7.21	12
	14		14
	16		16
	18		18
	20		20
	24		24
	28		28
	32		32
	36		36
	40		40

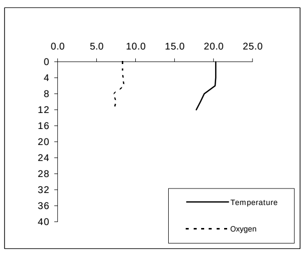


Figure 6ee Site 2 September 3

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
20.8	0	8.82	0
20.8	2	8.88	2
20.8	4	8.95	4
20.7	6	9.07	6
20.7	8	8.83	8
20.6	10	8.77	10
19.1	12	7.85	12
16.1	14	6.49	14
14.0	16	6.15	16
11.3	18	6.10	18
10.7	20	6.11	20
	24		24
	28		28
	32		32
	36		36
	40		40
	44		44
	48		48
	52		52

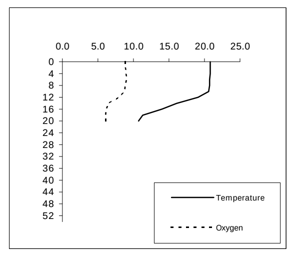


Figure 6ff Site 1 September 5

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
19.4	0	7.51	0
19.4	2	7.54	2
19.4	4	7.85	4
19.4	6	7.87	6
19.1	8	7.34	8
18.7	10	6.51	10
17.3	12	5.75	12
14.1	14	5.84	14
10.6	16	5.41	16
9.1	18	6.43	18
8.8	20	5.94	20
8.6	24	5.21	24
8.5	28	4.84	28
8.4	32	4.63	32
	36		36
	40		40

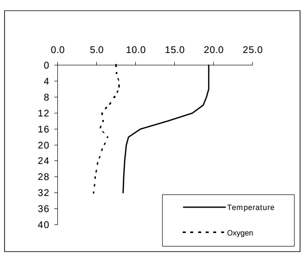


Figure 6gg Site 2 September 5

Temperature		Oxygen	
Temp	Depth	Oxyger	Depth
19.5	0	8.10	0
19.6	2	8.66	2
19.6	4	7.98	4
19.6	6	8.13	6
19.6	8	8.45	8
19.6	10	8.41	10
18.2	12	7.43	12
16.8	14	5.96	14
13.6	16	4.98	16
10.4	18	4.91	18
9.1	20	4.91	20
8.9	24	4.45	24
8.6	28	4.51	28
8.5	32	4.34	32
8.4	36	4.20	36
8.4	40	3.99	40
8.4	44	3.92	44
8.3	48	3.99	48
8.3	52	3.96	52

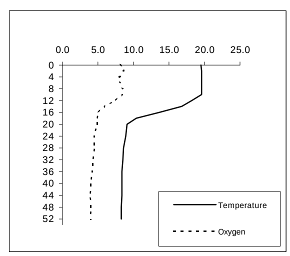


Figure 6hh Site 1 September 12

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.1	0	8.61	0
20.1	2	9.11	2
19.5	4	9.84	4
19.1	6	9.94	6
18.8	8	9.62	8
18.6	10	9.31	10
18.4	12	8.85	12
18.1	14	9.49	14
14.7	16	7.99	16
10.6	18	7.35	18
9.5	20	6.01	20
8.9	24	5.75	24
8.6	28	5.63	28
8.5	32	5.23	32
8.4	36	4.65	36
8.4	40	2.48	40
8.5	44	1.46	44

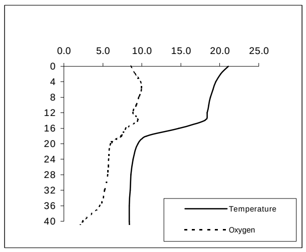


Figure 6ii Site 2 September 12

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
21.2	0	8.35	0
20.5	2	8.22	2
19.4	4	8.81	4
19.3	6	8.91	6
19.0	8	8.77	8
18.9	10	8.74	10
18.5	12	8.30	12
17.5	14	7.48	14
15.1	16	6.45	16
10.0	18	5.90	18
9.3	20	4.95	20
8.8	24	4.94	24
8.6	28	4.82	28
8.5	32	4.52	32
8.5	36	4.36	36
8.4	40	4.21	40
8.4	44	4.19	44
8.3	48	4.09	48
8.3	52	3.93	52

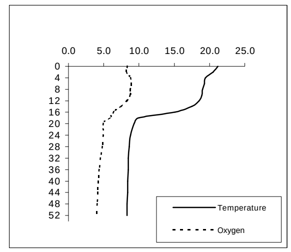


Figure 6jj Site 1 September 20

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
17.7	0	8.86	0
17.9	2	8.26	2
18.0	4	8.37	4
17.9	6	8.31	6
17.9	8	8.22	8
17.1	10	7.81	10
17.3	12	7.48	12
16.8	14	7.50	14
14.6	16	6.89	16
11.9	18	5.61	18
9.9	20	5.16	20
9.2	24	4.91	24
8.9	28	4.71	28
8.7	32	4.65	32
8.5	36	4.34	36
	40		40

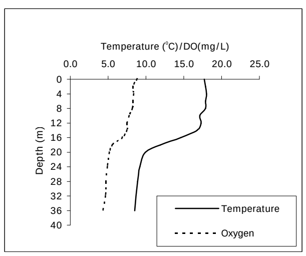


Figure 6kk Site 2 September 20

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
18.1	0	8.24	0
18.1	2	8.44	2
18.1	4	8.31	4
17.9	6	8.28	6
17.8	8	8.25	8
17.7	10	8.24	10
17.9	12	7.85	12
17.5	14	7.86	14
17.4	16	7.06	16
14.1	18	6.75	18
10.9	20	4.73	20
9.3	24	3.76	24
8.9	28	3.29	28
8.8	32	3.20	32
8.7	36	3.01	36
8.8	40	2.61	40
9.0	44	2.29	44
9.1	48	2.20	48
9.0	52	2.33	52

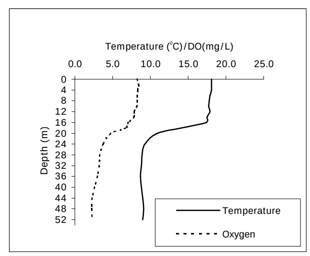


Figure 6ll Site 2 September 26

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
17.4	0	8.98	0
17.4	2	9.17	2
17.4	4	9.33	4
17.3	6	9.17	6
17.3	8	9.09	8
17.3	10	9.23	10
17.3	12	9.29	12
17.2	14	9.16	14
14.8	16	9.03	16
10.2	18	4.47	18
9.5	20	3.86	20
8.9	24	3.79	24
8.7	28	3.74	28
8.7	32	3.33	32
8.6	36	3.41	36
8.6	40	3.11	40
8.6	44	3.01	44
8.7	48	3.12	48
8.6	52		52

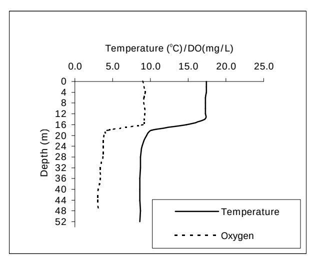


Figure 6mm Site 1 October 1

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
15.9	0	8.58	0
15.8	2	8.55	2
15.8	4	8.45	4
15.8	6	8.43	6
15.8	8	8.39	8
15.8	10	8.39	10
15.8	12	8.37	12
15.8	14	8.32	14
15.7	16	8.23	16
13.1	18	5.95	18
10.0	20	4.15	20
9.1	24	3.23	24
8.9	28	2.79	28
8.7	32	2.58	32
	36		36
	40		40

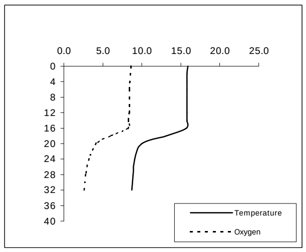


Figure 6nn Site 2 October 1

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
16.1	0	8.58	0
16.0	2	8.59	2
16.0	4	8.79	4
15.9	6	8.93	6
15.9	8	9.13	8
15.9	10	9.19	10
15.9	12	9.26	12
15.9	14	9.07	14
15.3	16	8.36	16
11.8	18	5.36	18
9.9	20	4.21	20
9.2	24	3.78	24
8.9	28	3.45	28
8.7	32	3.25	32
8.7	36	3.12	36
8.6	40	2.86	40
8.6	44	2.76	44
8.6	48	2.73	48
8.5	52	2.65	52

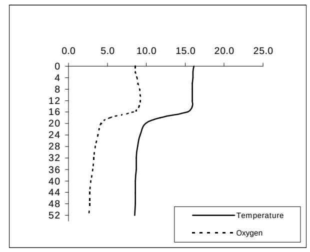


Figure 6oo Site 1 October 3

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
16.0	0	8.56	0
16.1	2	8.94	2
16.0	4	9.10	4
15.7	6	9.23	6
15.7	8	9.12	8
15.6	10	9.11	10
15.6	12	8.97	12
15.5	14	9.06	14
15.3	16	9.17	16
10.5	18	5.11	18
9.4	20	3.87	20
9.1	24	3.26	24
8.8	28	3.17	28
8.7	32	2.84	32
8.4	36	1.26	36
	40		40

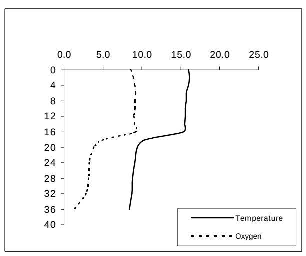


Figure 6pp Site 2 October 3

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
15.6	0	8.6	0
15.7	2	8.7	2
15.7	4	8.9	4
15.7	6	8.9	6
15.7	8	8.6	8
15.6	10	8.6	10
15.6	12	8.6	12
15.4	14	8.7	14
14.9	16	8.6	16
10.4	18	4.3	18
9.5	20	3.3	20
9.0	24	2.9	24
8.8	28	2.5	28
8.7	32	2.3	32
8.7	36	2.2	36
8.6	40	2.1	40
8.6	44	1.99	44
8.6	48	1.95	48
8.5	52	1.93	52

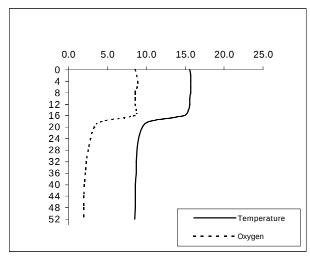


Figure 6qq Site 1 October 12

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
14.7	0	9.08	0
14.6	2	10.30	2
14.6	4	11.02	4
14.4	6	11.29	6
14.3	8	11.37	8
14.3	10	11.08	10
14.3	12	10.86	12
14.2	14	10.88	14
14.1	16	10.56	16
13.8	18	10.06	18
11.8	20	6.23	20
9.2	24	3.73	24
8.8	28	2.64	28
8.7	32	2.46	32
	36		36
	40		40

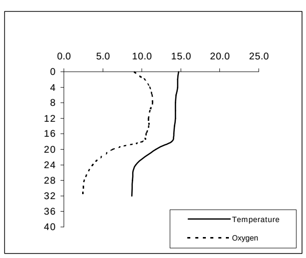


Figure 6rr Site 2 October 12

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
14.7	0	8.65	0
14.7	2	9.17	2
14.7	4	9.60	4
14.6	6	9.68	6
14.5	8	9.68	8
14.5	10	9.41	10
14.5	12	9.43	12
14.5	14	9.49	14
13.8	16	8.16	16
12.5	18	5.45	18
9.8	20	2.91	20
9.3	24	2.63	24
8.9	28	2.28	28
8.8	32	2.19	32
8.7	36	2.15	36
8.6	40	2.02	40
8.6	44	1.99	44
8.6	48	1.88	48
8.6	52	1.76	52

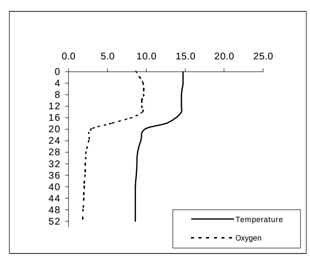


Figure 6ss Site 1 October 17

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
13.5	0	9.90	0
13.6	2	10.14	2
13.6	4	10.24	4
13.6	6	10.32	6
13.5	8	9.95	8
13.5	10	9.98	10
13.4	12	10.34	12
13.4	14	10.26	14
13.3	16	10.34	16
13.1	18	10.63	18
10.2	20	2.82	20
9.0	24	2.23	24
8.8	28	2.18	28
8.7	32	2.07	32
	36		36
	40		40

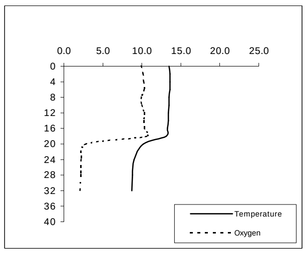


Figure 6tt Site 2 October 17

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
13.5	0	9.98	0
13.7	2	10.26	2
13.7	4	10.49	4
13.7	6	10.64	6
13.7	8	10.67	8
13.7	10	10.62	10
13.7	12	10.61	12
13.6	14	10.11	14
13.5	16	10.10	16
13.1	18	9.19	18
12.1	20	6.66	20
9.4	24	3.17	24
9.0	28	2.18	28
8.9	32	1.98	32
8.8	36	1.82	36
8.7	40	1.69	40
8.7	44	1.51	44
8.6	48	1.39	48
8.6	52	1.39	52

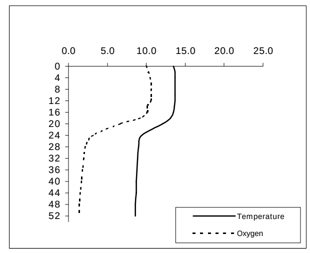


Figure 6uu Site 1 October 23

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
12.6	0	8.64	0
12.9	2	8.68	2
12.9	4	8.69	4
12.9	6	8.71	6
12.9	8	8.64	8
12.9	10	9.63	10
12.8	12	8.63	12
12.8	14	8.62	14
12.7	16	8.67	16
12.6	18	8.49	18
12.5	20	8.42	20
9.4	24	2.66	24
9.0	28	1.81	28
8.8	32	1.42	32
8.7	36	1.24	36
8.5	40	0.71	40
8.4	44	0.63	44

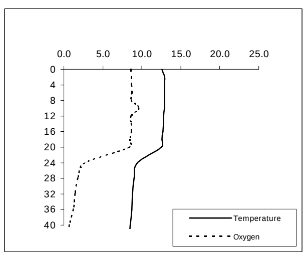


Figure 6vv Site 2 October 23

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
12.7	0	8.91	0
13.0	2	8.77	2
13.0	4	8.77	4
13.0	6	8.81	6
13.0	8	8.73	8
13.0	10	8.68	10
12.9	12	8.57	12
12.7	14	8.55	14
12.9	16	8.30	16
12.6	18	8.38	18
10.0	20	8.46	20
9.1	24	2.44	24
9.0	28	1.87	28
8.9	32	1.60	32
8.8	36	1.43	36
8.7	40	1.26	40
8.7	44	1.17	44
8.7	48	1.10	48
8.7	52	1.04	52

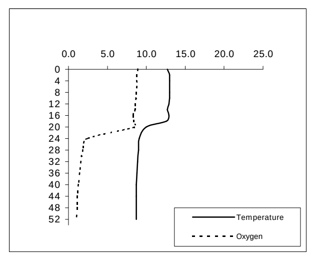


Figure 6ww Site 1 October 29

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
10.7	0	14.93	0
11.0	2	14.74	2
11.1	4	14.73	4
11.1	6	14.72	6
11.2	8	14.73	8
11.2	10	14.72	10
11.2	12	14.60	12
10.3	14	8.34	14
10.0	17	6.32	17
9.3	19	4.03	19
8.9	21	2.87	21
8.8	23	2.47	23
8.8	25	2.34	25
8.7	27	2.27	27
8.7	29	2.25	29

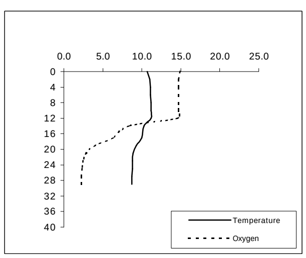


Figure 6xx Site 2 October 29

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
11.3	0	15.20	0
11.3	2	15.19	2
11.3	4	15.22	4
11.3	6	15.23	6
11.3	8	15.13	8
11.3	10	15.46	10
11.3	12	15.22	12
11.3	14	14.01	14
10.2	17	7.10	17
9.2	19	4.63	19
9.2	21	3.35	21
9.0	23	3.05	23
9.0	25	2.56	25
8.8	27	2.45	27
8.8	29	2.32	29

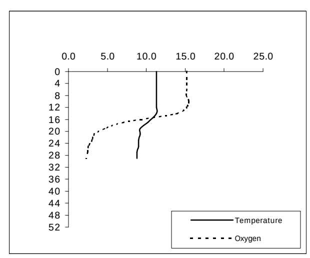


Figure 6yy Site 1 November 12

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
9.2	0	10.11	0
9.2	2	9.41	2
9.2	4	9.21	4
9.2	6	9.22	6
9.2	8	9.24	8
9.2	10	9.22	10
9.3	12	9.32	12
9.3	14	9.31	14
9.3	16	9.29	16
9.3	18	9.28	18
9.3	20	9.26	20
9.3	24	9.31	24
9.2	28	9.43	28
9.3	32	9.54	32
9.2	36	9.54	36
9.2	40	9.59	40

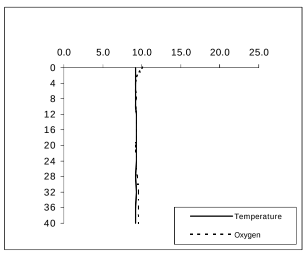


Figure 6zz Site 2 November 12

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
9.3	0	9.72	0
9.3	2	9.14	2
9.3	4	9.01	4
9.3	6	9.01	6
9.3	8	8.79	8
9.3	10	8.81	10
9.3	12	8.90	12
9.3	14	8.87	14
9.3	16	8.84	16
9.3	18	8.84	18
9.3	20	8.82	20
9.3	24	8.74	24
9.3	28	8.61	28
9.2	32	8.15	32
9.1	36	5.01	36
9.0	40	3.27	40
8.9	44	1.46	44
8.8	48	0.71	48
8.8	52	0.57	52

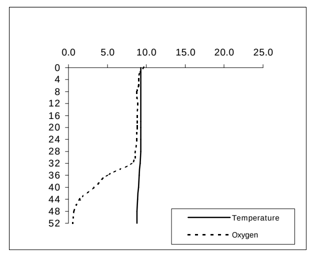


Figure 6aaa Site 1 November 25

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
7.9	0	10.69	0
8.1	2	9.78	2
8.1	4	9.76	4
8.1	6	9.62	6
8.1	8	9.60	8
8.1	10	9.56	10
8.1	12	9.53	12
8.1	14	9.49	14
8.1	16	9.49	16
8.1	18	9.49	18
8.1	20	9.47	20
8.1	24	9.46	24
8.1	28	9.54	28
8.0	32	9.61	32
7.8	36	9.62	36
	40		40

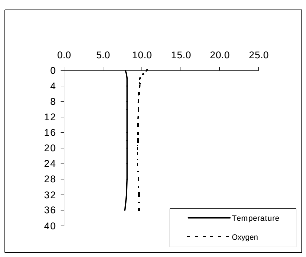


Figure 6bbb Site 2 November 25

Temperature		Oxygen	
Temp	Depth	Oxygen	Depth
7.4	0	7.53	0
8.1	2	7.16	2
8.2	4	7.09	4
8.3	6	6.99	6
8.3	8	6.95	8
8.3	10	6.92	10
8.3	12	6.89	12
8.3	14	6.91	14
8.3	16	6.90	16
8.3	18	6.90	18
8.3	20	6.88	20
8.3	24	6.87	24
8.3	28	6.70	28
8.3	32	6.70	32
8.3	36	6.78	36
8.3	40	6.82	40
8.3	44	6.81	44
8.3	48	6.81	48
8.3	52	6.81	52

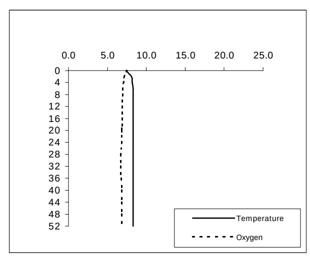


Figure 7: Zones of Tolerance for *Oncorhynchus nerka* in Skaha and Osoyoos Lakes

Figure 7a Skaha Lake Site 2 Gillies

Temp (17 °C) Month	Depth	DO (4 mg/L) Month	Depth
J		J	
F		F	
M		M	
A 10	0	A 10	53
A 25	0	A 25	53
M 8	0	M 8	53
M 23	0	M 23	53
M 28	0	M 28	53
Jn 7	0	Jn 7	53
Jn 11	0	Jn 11	53
Jn 19	0	Jn 19	53
Jn 27	10	Jn 27	53
Jl 10	10	Jl 10	53
Jl 17	10	Jl 17	53
Jl 23	10	Jl 23	53
A 9	14	A 9	53
A18	14	A 18	53
A 21	12	A 21	53
A 30	14	A 30	53
S 3	12	S 3	53
S 5	14	S 5	53
S 12	14	S12	44
S 22	14	S 22	53
S 27	0	S 27	53
O 1	0	O 1	53
O 3	0	O 3	53
O 17	0	O 17	53
O 31	0	O 31	53
N 12	0	N 12	53
N 27	0	N 27	53
D		D	

*max depth, assume ≥ 4mg/L

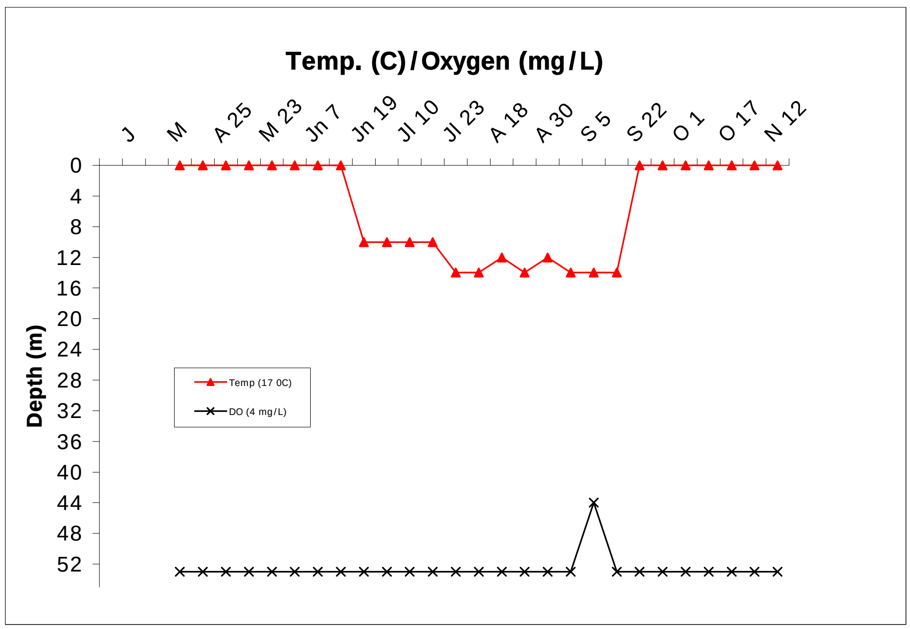


Figure 7b Skaha Lake Site 3 South Basin

Temp (17 °C) Month	Depth	DO (4 mg/L) Month	Depth
J		J	
F		F	
M		M	
A 10	0	A 10	37
A 25	0	A 25	37
M 9	0	M 9	37
M 23	0	M 23	37
Jn 7	0	Jn 7	37
Jn 11	0	Jn 11	37
Jn 19	8	Jn 19	37
Jl 10	10	Jl 10	37
Jl 23	8	Jl 23	37
A 9	12	A 9	37
A 18	12	A 18	37
A 21	14	A 21	37
A 30	14	A 30	37
S 5	12	S 5	37
S 22	18	S 22	37
O 1	0	O 1	37
O 3	0	O 3	37
O 17	0	O 17	37
O 31	0	O 31	37
N 12	0	N 12	37
N 27	0	N 27	37
D		D	

*max depth, assume ≥ 4mg/L

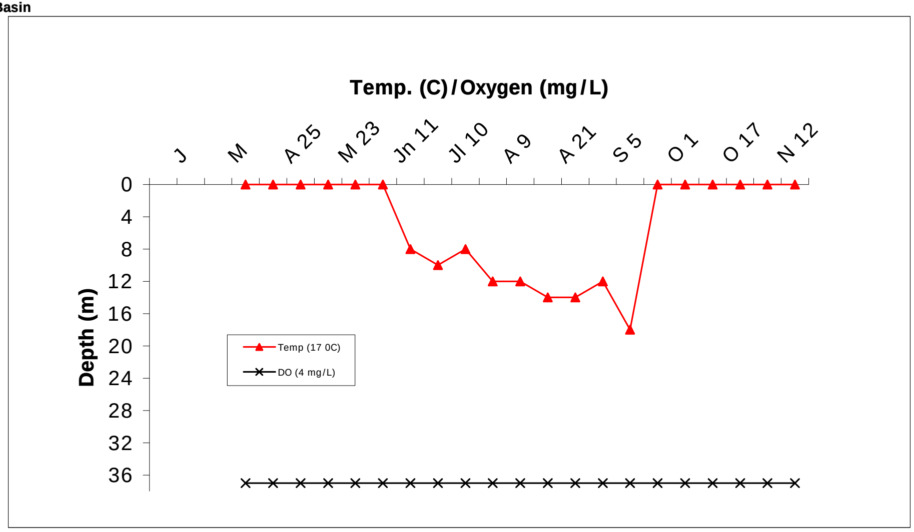
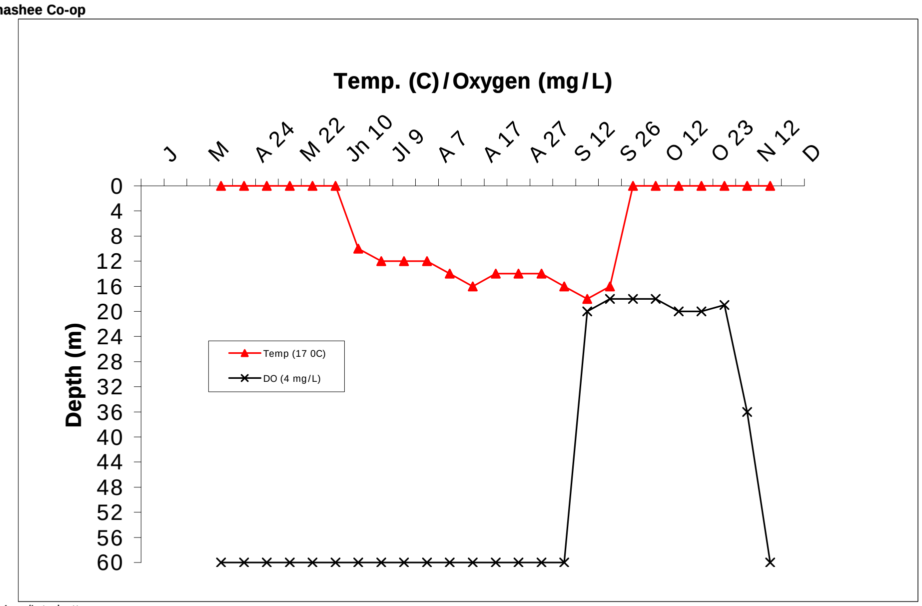


Figure 7c Osoyoos Lake Site 2 Monashee Co-op

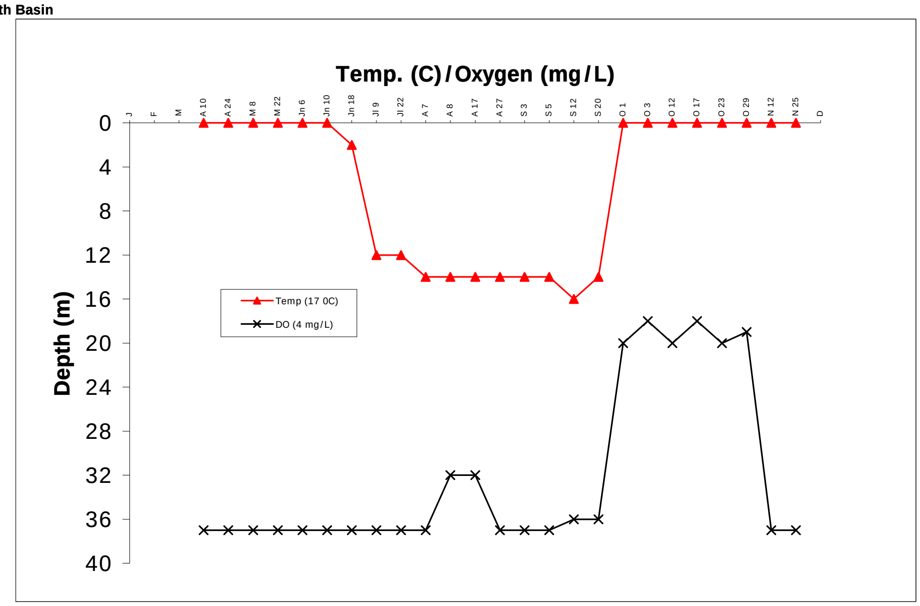
Temp (17 ^{0}C)		DO (4 mg/L)		
Month	Depth	Month	Depth	
J		J		
F		F		
M		M		
A 10	0	A 10	60	
A 24	0	A 24	60	
M 8	0	M 8	60	
M 22	0	M 22	60	
Jn 6	0	Jn 6	60	
Jn 10	0	Jn 10	60	
Jn 18	10	Jn 18	60	
Jl 9	12	Jl 9	60	
Jl 22	12	Jl 22	60	
A 7	12	A 7	60	
A 8	14	A 8	60	
A 17	16	A 17	60	
A 19	14	A 19	60	
A 27	14	A 27	60	*
S 5	14	S 5	60	
S 12	16	S 12	60	
S 20	18	S 20	20	
S 26	16	S 26	18	
O 3	0	O 3	18	
O 12	0	O 12	18	
O 17	0	O 17	20	
O 23	0	O 23	20	
O 29	0	O 29	19	
N 12	0	N 12	36	
N 25	0	N 25	60	
D		D		



*measured only to 24m assume above 4mg/L to bottom

Figure 7d Osoyoos Lake Site 1 North Basin

Temp (17 ^{0}C)		DO (4 mg/L)		
Month	Depth	Month	Depth	
J		J		
F		F		
M		M		
A 10	0	A 10	37	
A 24	0	A 24	37	
M 8	0	M 8	37	*
M 22	0	M 22	37	
Jn 6	0	Jn 6	37	
Jn 10	0	Jn 10	37	
Jn 18	2	Jn 18	37	
Jl 9	12	Jl 9	37	
Jl 22	12	Jl 22	37	
A 7	14	A 7	37	
A 8	14	A 8	32	
A 17	14	A 17	32	
A 27	14	A 27	37	
S 3	14	S 3	37	
S 5	14	S 5	37	
S 12	16	S 12	36	
S 20	14	S 20	36	
O 1	0	O 1	20	
O 3	0	O 3	18	
O 12	0	O 12	20	
O 17	0	O 17	18	
O 23	0	O 23	20	
O 29	0	O 29	19	
N 12	0	N 12	37	
N 25	0	N 25	37	
D		D		



*assumed

Figure 8a: Total Nitrogen Levels at 0 to 10m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.18	0.19
	M	0.20	0.19
	J	0.21	0.20
	J	0.28	0.25
	A	0.21	0.21
	S	0.19	0.20
	O	0.34	0.07
	N	0.19	0.20
	D		
	Average	0.23	0.19

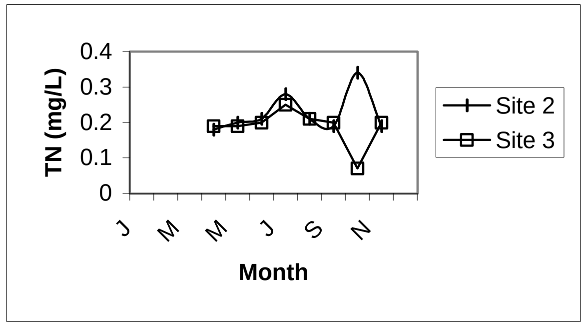


Figure 8b: Total Nitrogen Levels at 20m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.19	0.19
	M	0.20	0.19
	J	0.24	0.18
	J	0.20	0.19
	A	0.20	0.19
	S	0.19	0.19
	O	0.15	0.07
	N	0.19	0.21
	D		
	Average	0.20	0.18

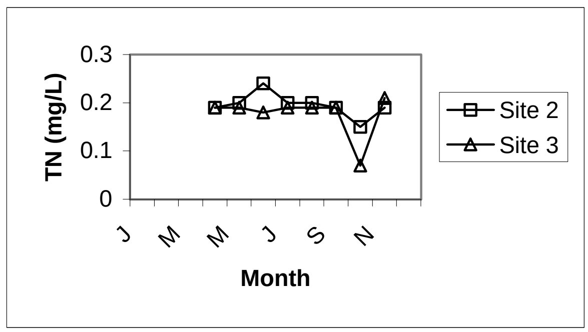


Figure 8c: Total Nitrogen Levels at Deep Sections for Skaha Lake

	Depth	45m	36m
Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.18	0.18
	M	0.18	0.22
	J	0.17	0.18
	J	0.26	0.17
	A	0.17	0.19
	S	0.17	0.20
	O	0.08	0.12
	N	0.20	0.25
	D		
	Average	0.18	0.19

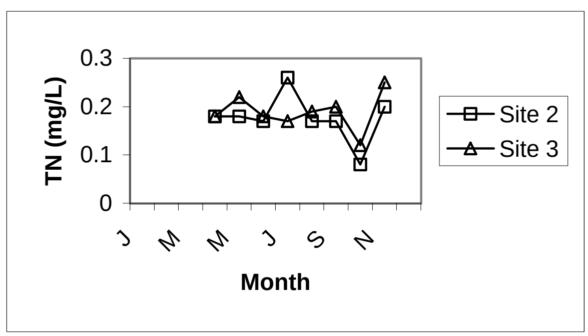


Figure 8d: Total Nitrogen Levels at 0 - 10 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.22	0.22
	M	0.24	0.24
	J	0.24	0.23
	J	0.38	0.21
	A	0.22	0.23
	S	0.25	0.28
	O	0.36	0.13
	N	0.25	0.24
	D		
	Average	0.27	0.22

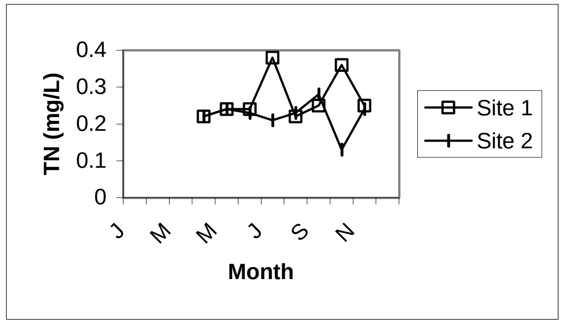


Figure 8e: Total Nitrogen Levels at 20 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.21	0.21
	M	0.21	0.20
	J	0.22	0.22
	J	0.19	0.28
	A	0.22	0.20
	S	0.20	0.19
	O	0.20	0.18
	N	0.25	0.25
	D		
	Average	0.21	0.22

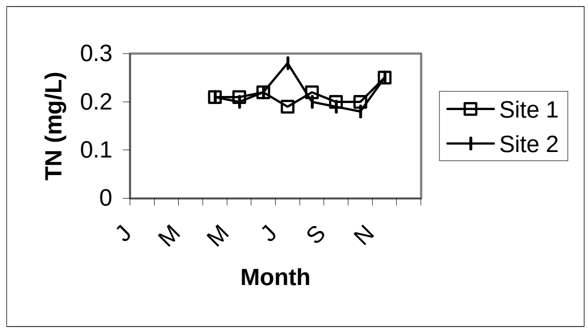


Figure 8f: Total Nitrogen Levels at Deep Sections for Osoyoos Lake

	Depth	32m	45m
Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.19	0.21
24m	M	0.21	0.20
	J	0.21	0.21
	J	0.20	0.21
	A	0.22	0.25
	S	0.25	0.30
	O	0.26	0.30
	N	0.24	0.31
	D		
	Average	0.22	0.25

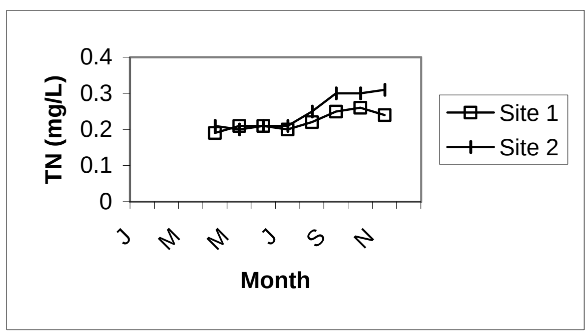


Figure 9a: Nitrate-Nitrogen levels at 0-10m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.002	0.002
	M	0.002	0.002
	J	0.005	0.005
	J	0.002	0.002
	A	0.005	0.004
	S	0.002	0.002
	O	0.002	0.002
	N	0.002	0.002
	D		
	Average	0.003	0.003

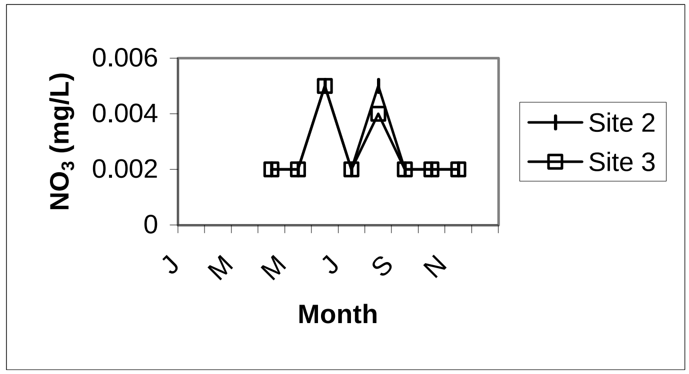


Figure 9b: Nitrate-Nitrogen Levels at 20m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.002	0.002
	M	0.002	0.002
	J	0.005	0.004
	J	0.002	0.002
	A	0.005	0.006
	S	0.002	0.008
	O	0.002	0.002
	N	0.003	0.004
	D		
	Average	0.003	0.004

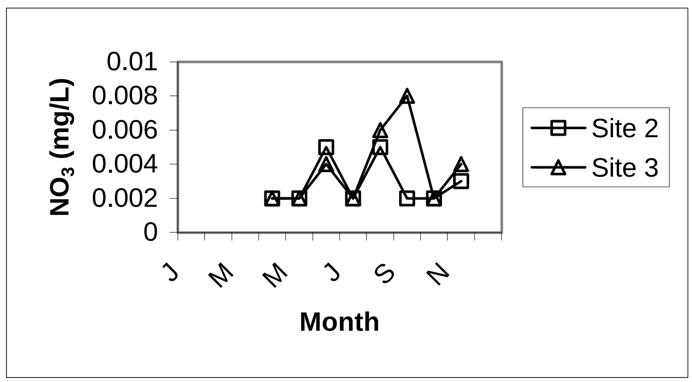


Figure 9c: Nitrate-Nitrogen Levels at Deep Sections for Skaha Lake

	Depth	45m	36m
Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.002	0.002
	M	0.002	0.002
	J	0.007	0.013
	J	0.002	0.002
	A	0.005	0.005
	S	0.004	0.024
	O	0.002	0.034
	N	0.003	0.003
	D		
	Average	0.003	0.011

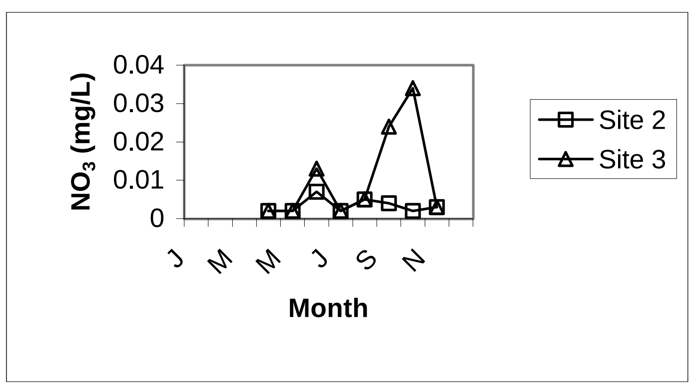


Figure 9d: Nitrate-Nitrogen Levels at 0 - 10 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.002	0.002
	M	0.002	0.002
	J	0.003	0.007
	J	0.002	0.002
	A	0.003	0.003
	S	0.005	0.002
	O	0.002	0.002
	N	0.010	0.016
	D		
	Average	0.004	0.005

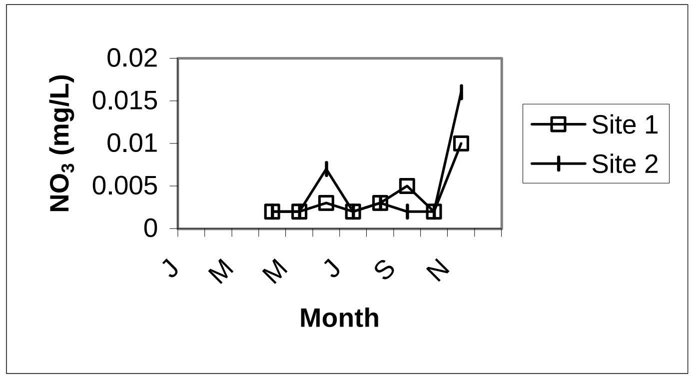


Figure 9e: Nitrate-Nitrogen Levels at 20 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.002	0.002
	M	0.002	0.002
	J	0.002	0.003
	J	0.002	0.002
	A	0.004	0.003
	S	0.002	0.002
	O	0.066	0.065
	N	0.009	0.015
	D		
	Average	0.011	0.012

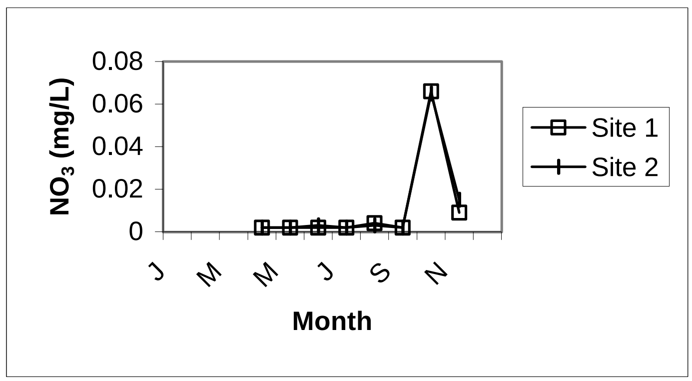


Figure 9f: Nitrate-Nitrogen Levels at Deep Sections for Osoyoos Lake

		Depth	32m	45m
	Year	Month	Site 1	Site 2
	2002	J		
		F		
		M		
		A	0.002	0.002
24m		M	0.002	0.003
		J	0.006	0.002
		J	0.002	0.006
		A	0.002	0.002
		S	0.009	0.044
		O	0.111	0.121
		N	0.002	0.094
		D		
		Average	0.017	0.034

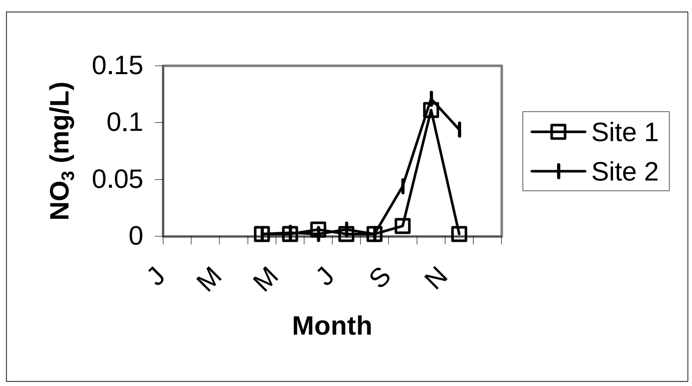


Figure 10a: Total Phosphorous Levels at 0 to 10m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.005	0.011
	M	0.007	0.009
	J	0.010	0.016
	J	0.005	0.005
	A	0.008	0.007
	S	0.010	0.005
	O	0.005	0.007
	N	0.010	0.006
	D		
	Average	0.008	0.008

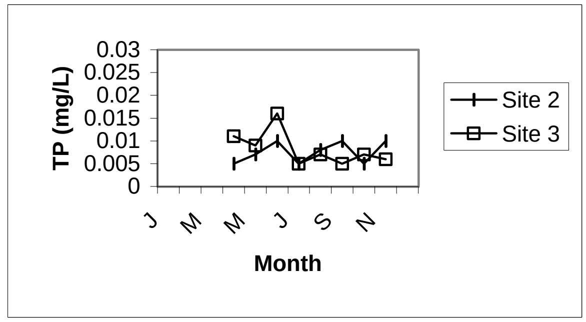


Figure 10b: Total Phosphorous Levels at 20m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.015	0.009
	M	0.005	0.009
	J	0.010	0.009
	J	0.005	0.004
	A	0.014	0.007
	S	0.009	0.008
	O	0.006	0.005
	N	0.008	0.012
	D		
	Average	0.009	0.008

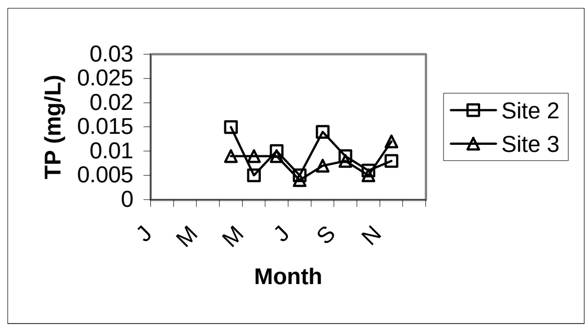


Figure 10c: Total Phosphorous Levels at Deep Sections for Skaha Lake

	Depth	45m	36m
Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.005	0.006
	M	0.005	0.009
	J	0.006	0.009
	J	0.003	0.006
	A	0.007	0.010
	S	0.004	0.012
	O	0.006	0.015
	N	0.008	0.012
	D		
	Average	0.006	0.010

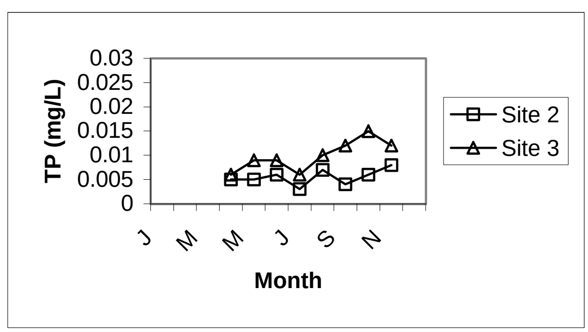


Figure 10d: Total Phosphorous Levels at 0 - 10 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.009	0.008
	M	0.015	0.007
	J	0.018	0.013
	J	0.020	0.017
	A	0.013	0.012
	S	0.010	0.008
	O	0.016	0.006
	N	0.023	0.019
	D		
	Average	0.016	0.011

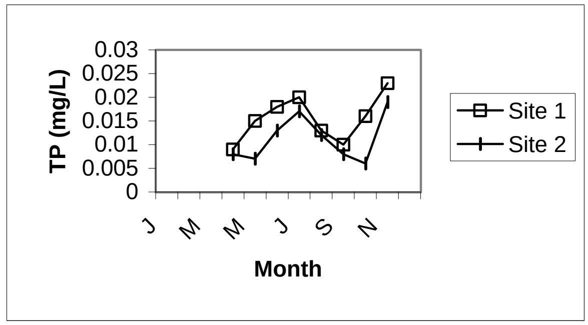


Figure 10e: Total Phosphorous Levels at 20 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.012	0.009
	M	0.008	0.007
	J	0.012	0.010
	J	0.004	0.014
	A	0.010	0.009
	S	0.009	0.005
	O	0.011	0.013
	N	0.022	0.019
	D		
	Average	0.011	0.011

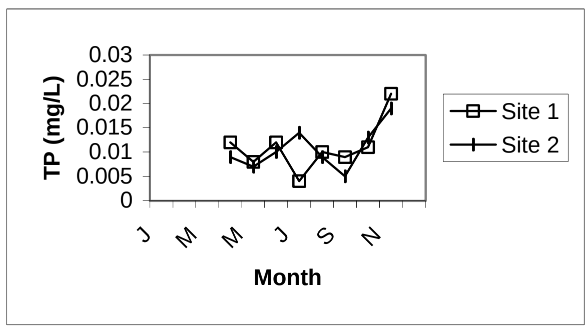


Figure 10f: Total Phosphorous Levels at Deep Sections for Osoyoos Lake

	Depth	32m	45m
Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.007	0.009
24m	M	0.012	0.012
	J	0.009	0.009
	J	0.005	0.019
	A	0.019	0.021
	S	0.012	0.026
	O	0.022	0.032
	N	0.018	0.034
	D		
	Average	0.013	0.020

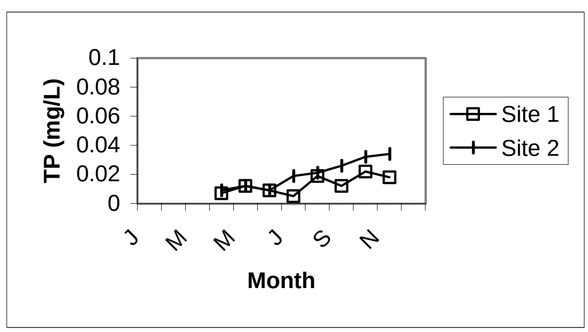


Figure 11a: Total Dissolved Phosphorous Levels at 0 to 10m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.006	0.003
	M	0.006	0.004
	J	0.007	0.009
	J	0.004	0.007
	A	0.010	0.005
	S	0.007	0.004
	O	0.009	0.011
	N	0.004	0.003
	D		
	Average	0.007	0.006

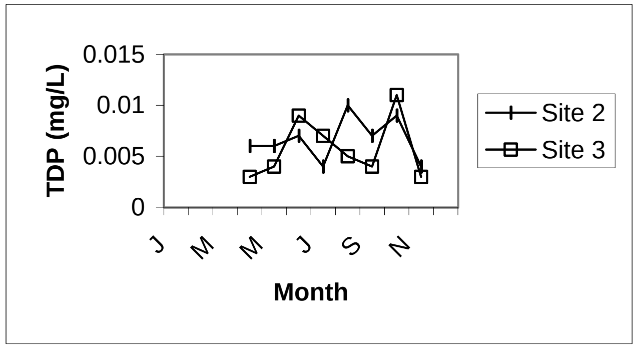


Figure 11b: Total Dissolved Phosphorous Levels at 20m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.002	0.005
	M	0.005	0.004
	J	0.006	0.006
	J	0.005	0.003
	A	0.004	0.007
	S	0.005	0.004
	O	0.007	0.007
	N	0.005	0.007
	D		
	Average	0.005	0.005

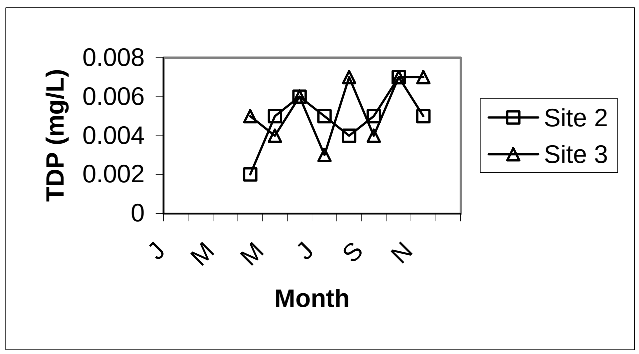


Figure 11c: Total Dissolved Phosphorous Levels at Deep Sections for Skaha Lake

	Depth	45m	36m
Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	0.002	0.004
	M	0.003	0.004
	J	0.006	0.005
	J	0.003	0.003
	A	0.005	0.006
	S	0.003	0.007
	O	0.008	0.005
	N	0.005	0.008
	D		
	Average	0.004	0.005

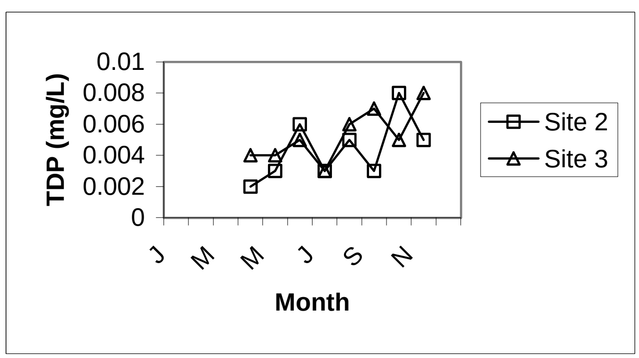


Figure 11d: Total Dissolved Phosphorous Levels at 0 - 10 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.008	0.004
	M	0.008	0.006
	J	0.011	0.005
	J	0.012	0.003
	A	0.007	0.007
	S	0.007	0.004
	O	0.010	0.005
	N	0.012	0.010
	D		
	Average	0.009	0.006

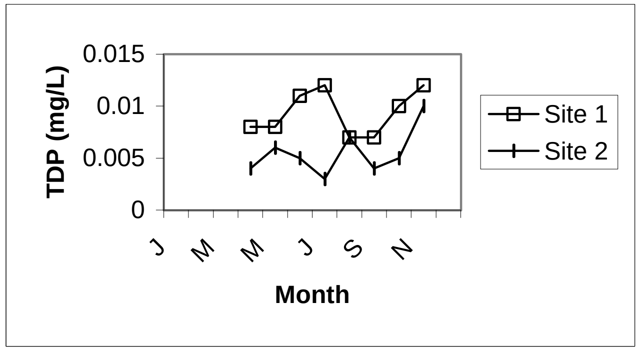


Figure 11e: Total Dissolved Phosphorous Levels at 20 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.003	0.002
	M	0.008	0.005
	J	0.007	0.008
	J	0.003	0.005
	A	0.011	0.005
	S	0.005	0.003
	O	0.005	0.007
	N	0.012	0.010
	D		
	Average	0.007	0.006

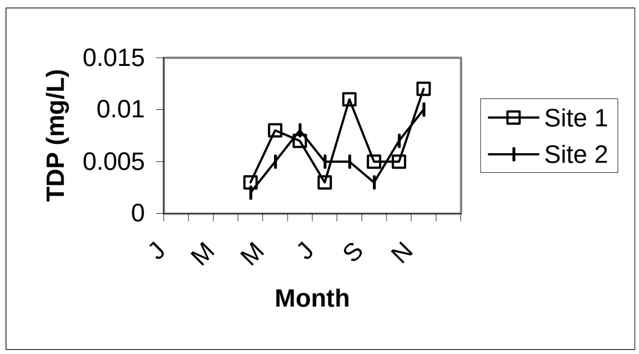


Figure 11f: Total Dissolved Phosphorous Levels at Deep Sections for Osoyoos Lake

	Depth	32m	45m
Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	0.004	0.004
	M	0.007	0.005
	J	0.002	0.004
	J	0.005	0.009
	A	0.005	0.011
	S	0.008	0.022
	O	0.011	0.024
	N	0.013	0.028
	D		
	Average	0.007	0.013

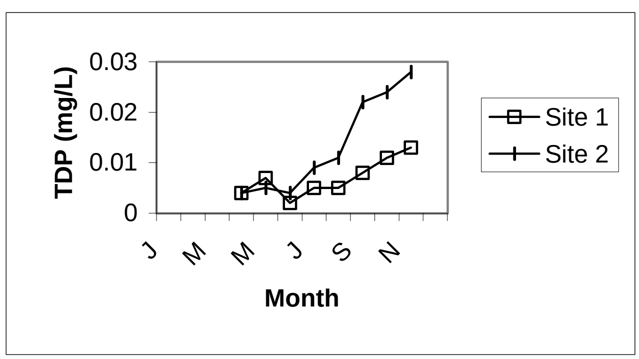
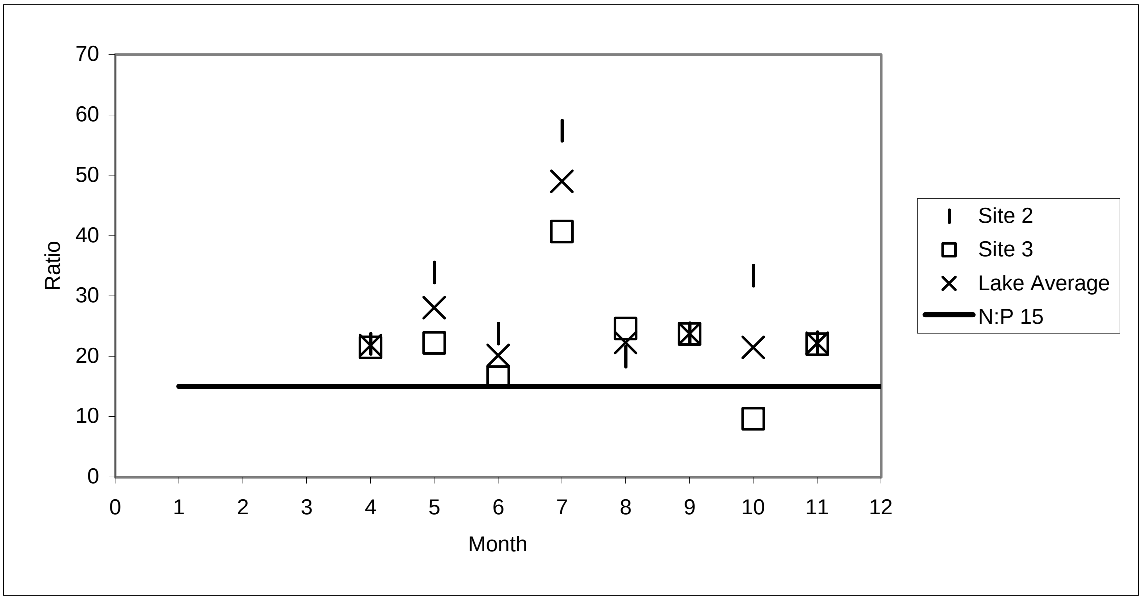
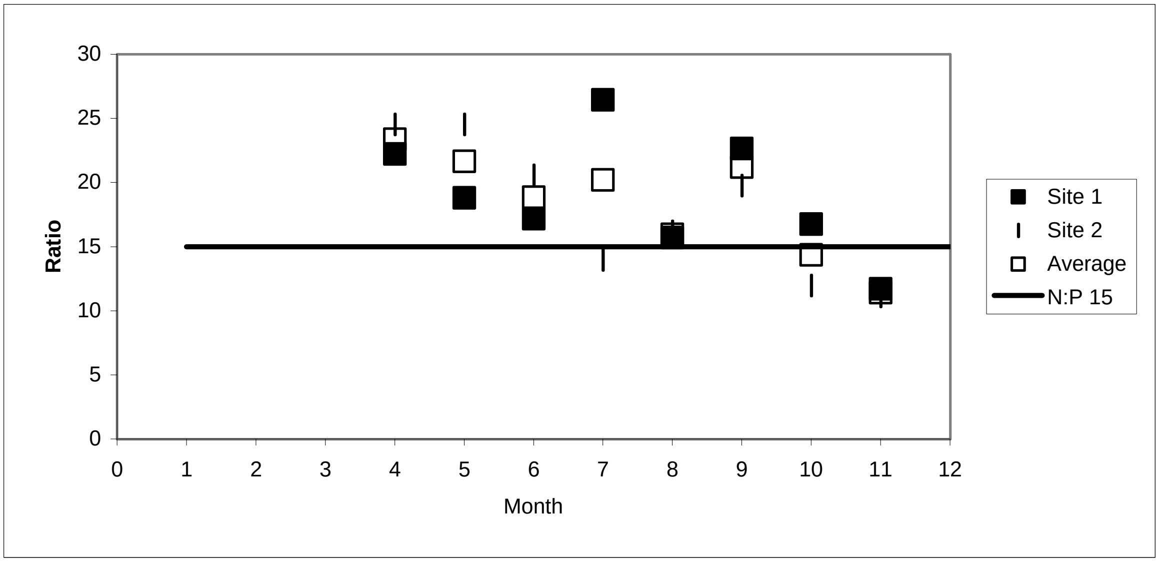


Figure 12a: Total Nitrogen:Total Phosphorous Ratio for Skaha Lake



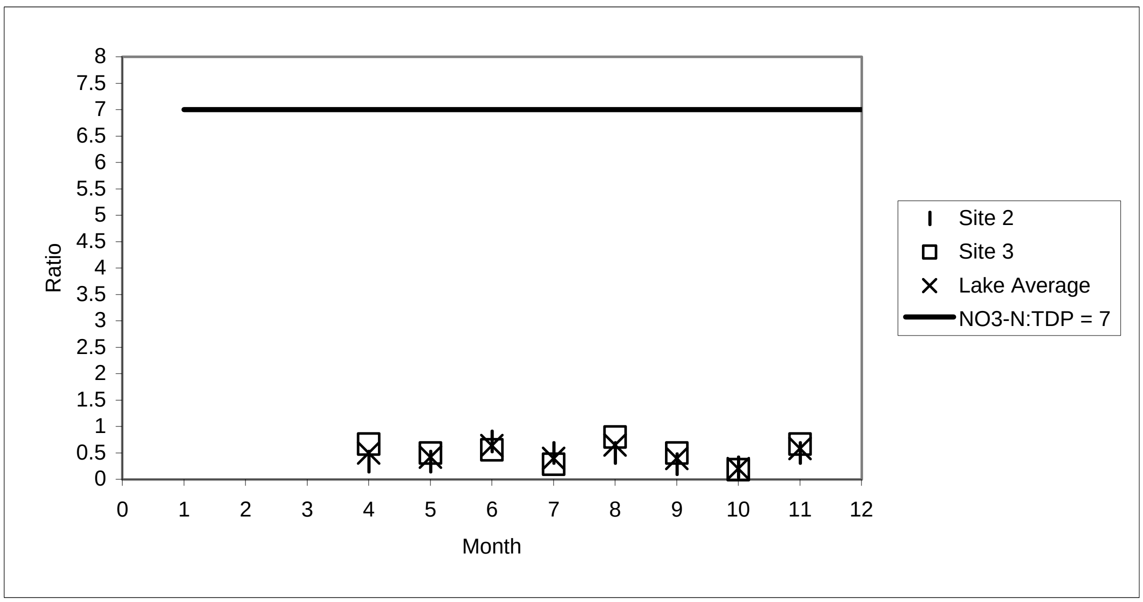
Year 2002	Month	TN:TP Site 2	Site 3	Lake Average
January	1			
February	2			
March	3			
April	4	22.1	21.5	21.8
May	5	33.9	22.2	28.1
June	6	23.8	16.5	20.1
July	7	57.4	40.7	49.0
August	8	19.9	24.6	22.3
September	9	23.8	23.7	23.8
October	10	33.3	9.6	21.5
November	11	22.3	22.0	22.2
December	12			

Figure 12b: Total Nitrogen:Total Phosphorous Ratio for Osoyoos La



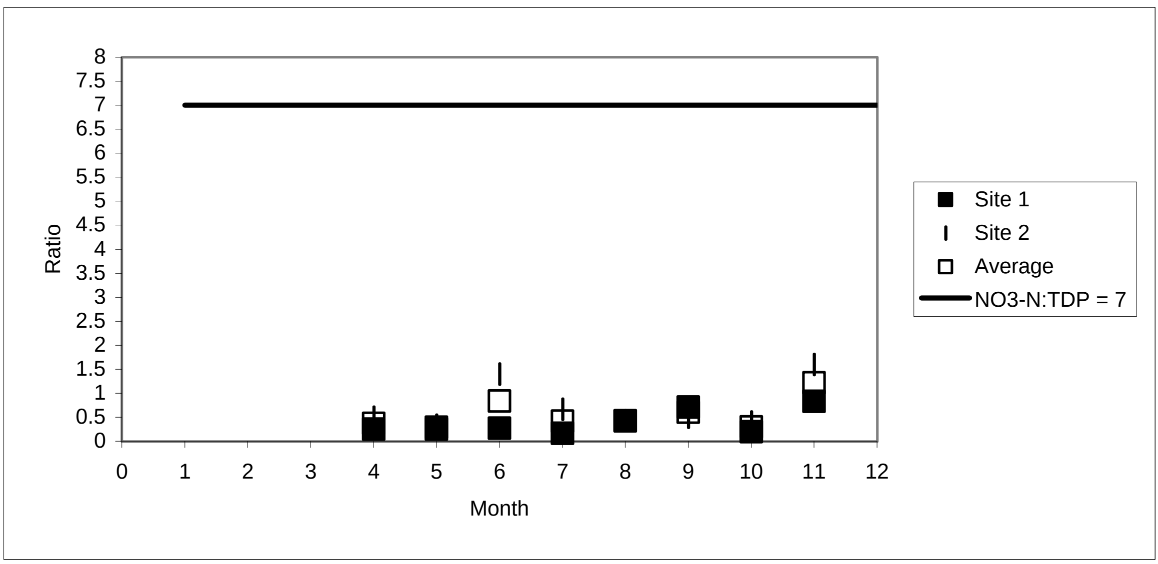
Year 2002	Month	Site 1	Site 2	Average
January	1			
February	2			
March	3			
April	4	22.2	24.5	23.4
May	5	18.8	24.5	21.7
June	6	17.2	20.6	18.9
July	7	26.5	14.0	20.2
August	8	15.7	16.2	16.0
September	9	22.7	19.7	21.2
October	10	16.8	12.0	14.4
November	11	11.7	11.1	11.4
December	12			

Figure 13a: N03/TDP ratio at 0 to 10m for Skaha Lake



Year		N03:TDP		
2002	Month	Site 2	Site 3	Lake Average
January	1			
February	2			
March	3			
April	4	0.33	0.67	0.50
May	5	0.33	0.50	0.42
June	6	0.71	0.56	0.63
July	7	0.50	0.29	0.39
August	8	0.50	0.80	0.65
September	9	0.29	0.50	0.39
October	10	0.22	0.18	0.20
November	11	0.50	0.67	0.58
December	12			

Figure 13b: N03/TDP ratio at 0 to 10m for Osoyoos Lake



Year 2001	Month	Site 1	Site 2	Average
January	1			
February	2			
March	3			
April	4	0.25	0.50	0.38
May	5	0.25	0.33	0.29
June	6	0.27	1.40	0.84
July	7	0.17	0.67	0.42
August	8	0.43	0.43	0.43
September	9	0.71	0.50	0.61
October	10	0.20	0.40	0.30
November	11	0.83	1.60	1.22
December	12			

Figure 14a: Chlorophyll a levels at 0-10m for Skaha Lake

	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	4.50	2.70
	M	2.40	2.10
	J	3.10	3.50
	J	3.40	3.20
	A*		
	S	3.00	2.50
	O	4.30	3.60
	N	3.20	3.30
	D		
	AVERAGE	3.41	2.99

*Samples lost

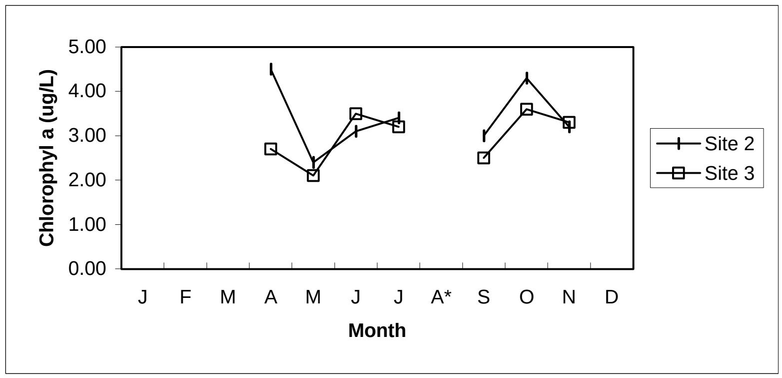


Figure 14b: Chlorophyll a levels at 0-10m for Osoyoos Lake

	Month	Site 1	Site 2
2002	F		
	M		
	A	5.50	5.00
	M	3.20	3.60
	J	2.90	4.00
	J	2.60	3.50
	A*		
	S	4.60	6.80
	O	5.30	6.30
	N	7.50	7.40
	D		
	AVERAGE	4.51	5.23

*samples lost

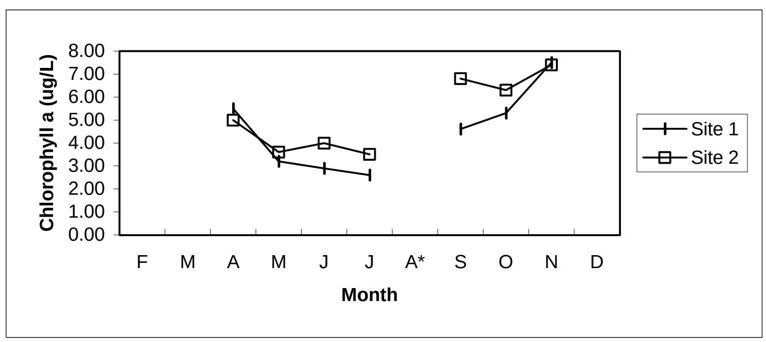


Figure 15a: Silica Levels at 0 to 10m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	3.2	3.1
	M	4.0	3.7
	J	5.5	5.4
	J	5.7	5.6
	A	6.4	6.3
	S	5.9	5.9
	O	5.9	5.8
	N	5.3	5.2
	D		

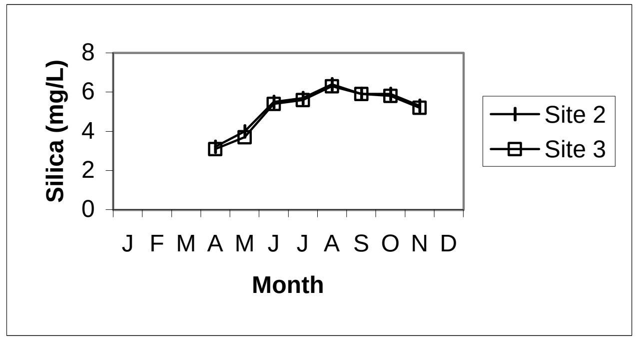


Figure 15b: Silica Levels at 20m for Skaha Lake

Year	Month	Site 2	Site 3
2002	J		
	F		
	M		
	A	3.2	3.0
	M	3.8	3.6
	J	5.2	4.4
	J	5.7	4.8
	A	5.3	5.3
	S	4.9	5.1
	O	4.7	5.1
	N	5.3	5.2
	D		

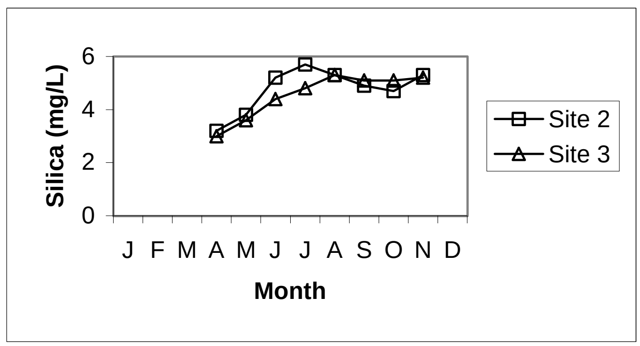


Figure 15c: Silica Levels at Deep Sections for Skaha Lake

	Depth	45m	36m
Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	3.2	3.1
	M	3.6	3.6
	J	3.8	4.2
	J	3.8	4.3
	A	4.6	5.3
	S	4.8	5.2
	O	4.7	5.7
	N	5.2	5.3
	D		

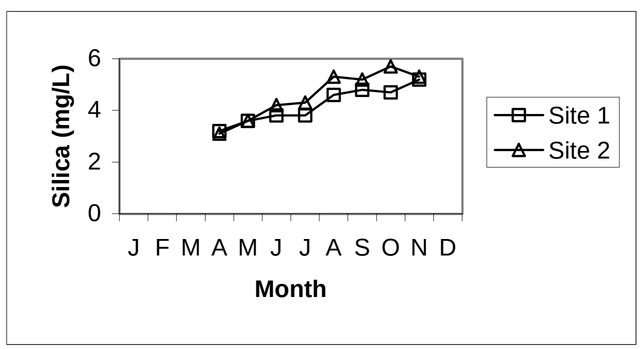


Figure 15d: Silica Levels at 0 - 10 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	2.4	1.5
	M	3.4	3.0
	J	5.4	5.4
	J	5.6	5.4
	A	5.9	5.8
	S	6.1	5.9
	O	6.2	6.1
	N	6.5	6.6
	D		

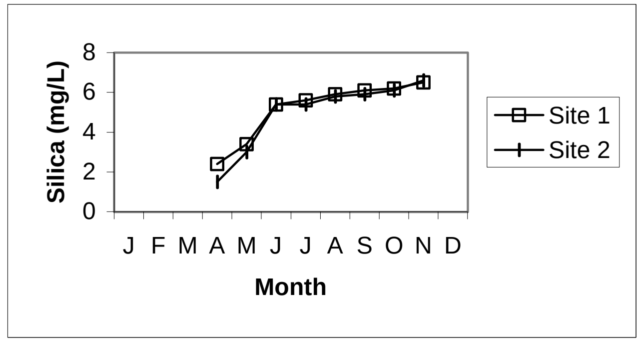


Figure 15e: Silica Levels at 20 m for Osoyoos Lake

Year	Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	1.7	1.5
	M	2.8	2.3
	J	5.1	5.3
	J	4.9	4.6
	A	4.6	5.0
	S	5.5	5.3
	O	5.8	6.4
	N	6.6	6.6
	D		

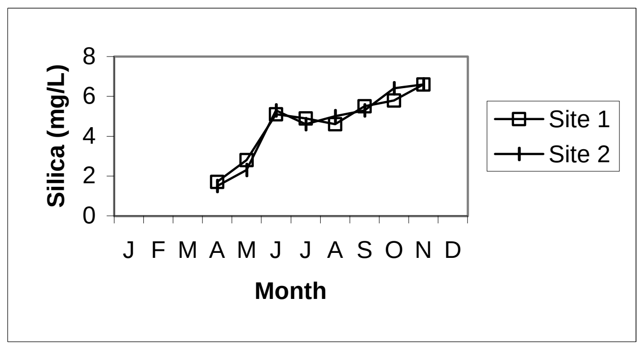
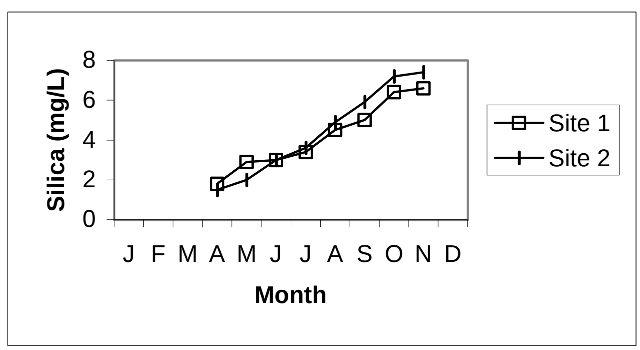


Figure 15f: Silica Levels at Deep Sections for Osoyoos Lake

Year	Depth Month	Site 1	Site 2
2002	J		
	F		
	M		
	A	1.8	1.5
	M	2.9	2.0
	J	3.0	3.0
	J	3.4	3.6
	A	4.5	4.9
	S	5.0	5.9
	O	6.4	7.2
	N	6.6	7.4
	D		



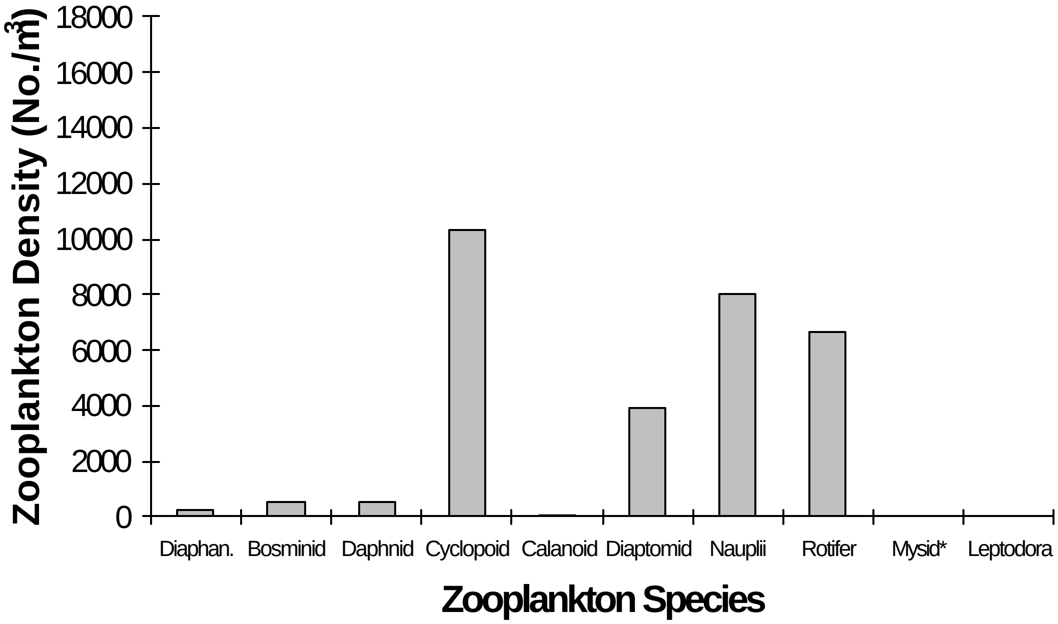
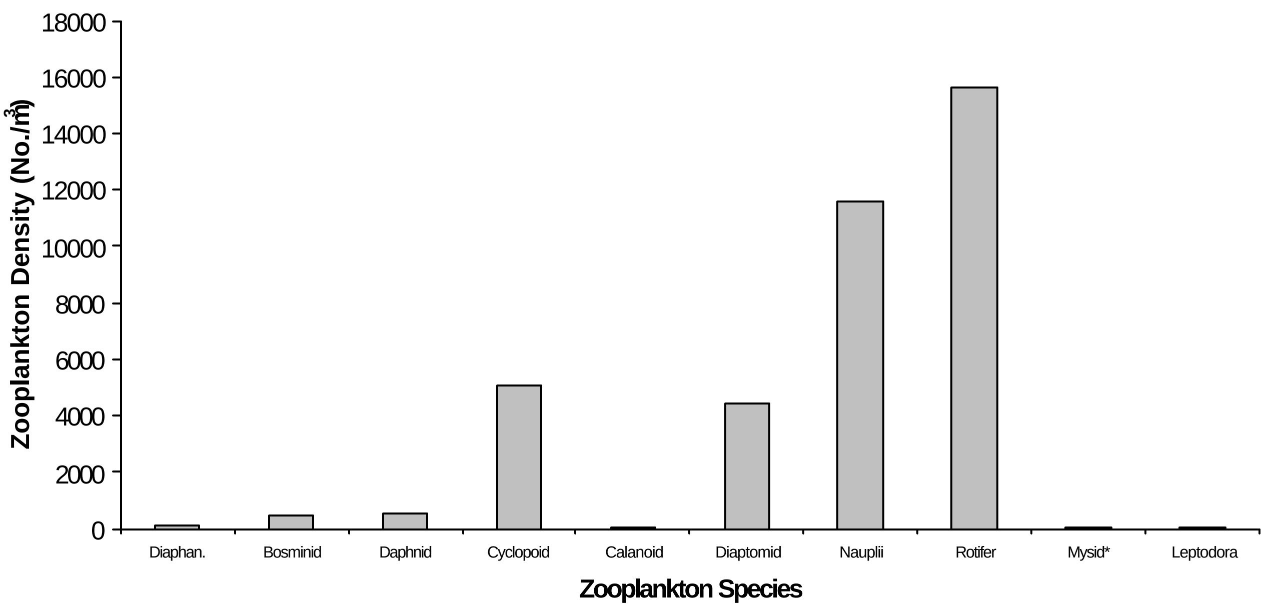


Figure 16a. Community structure of zooplankton by weighted mean density (April-November 2002) in Skaha Lake.



*Mysid vertical haul sampling conducted separately with 300 micron net

Figure 16b. Community structure of zooplankton by weighted mean density (April-November 2002) in the north basin of Osoyoos Lake.

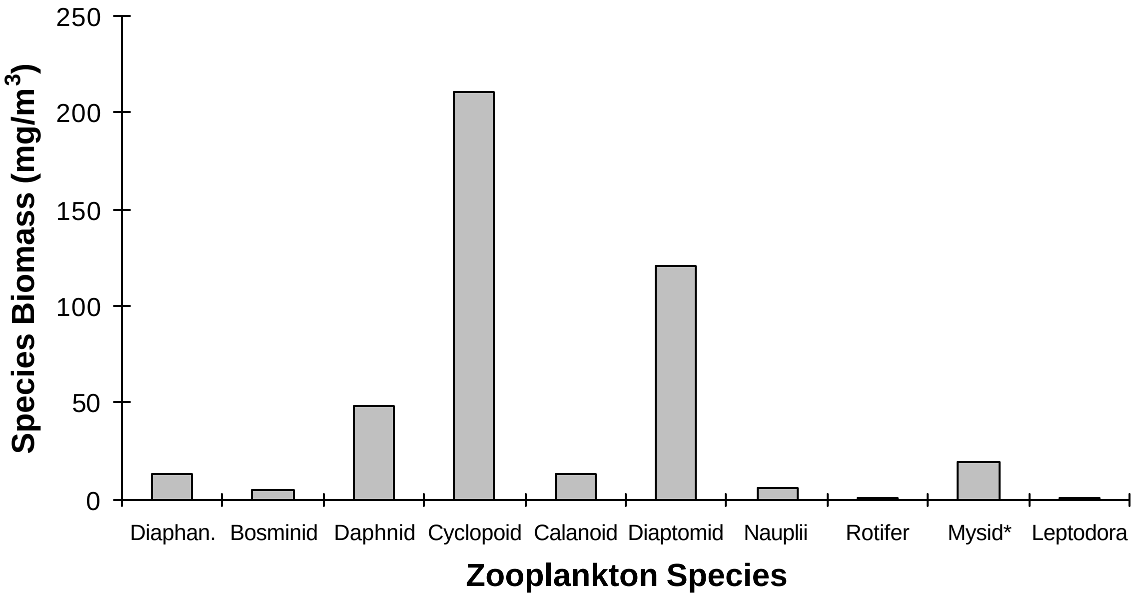
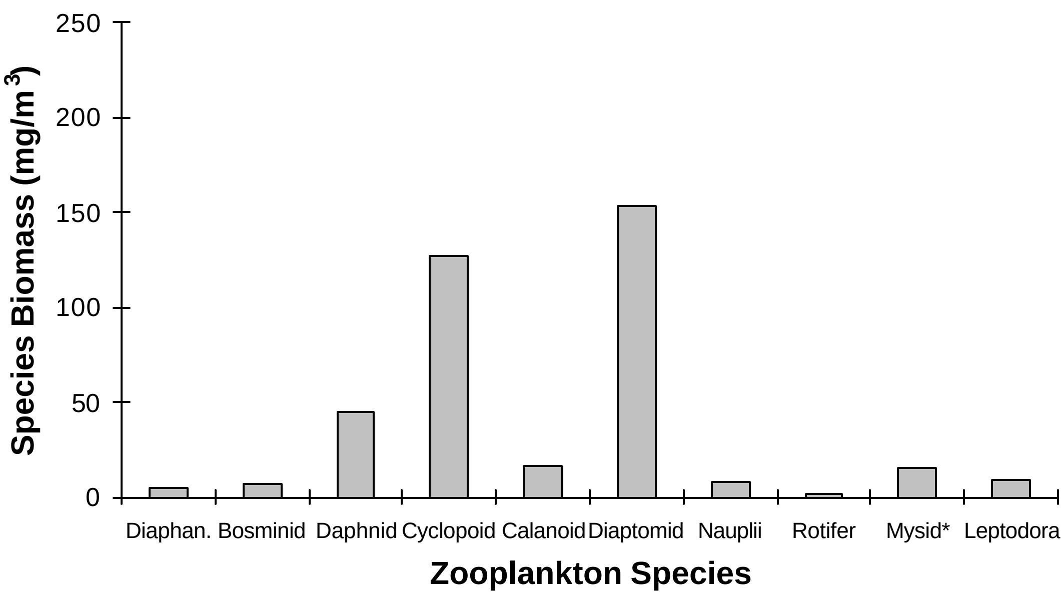
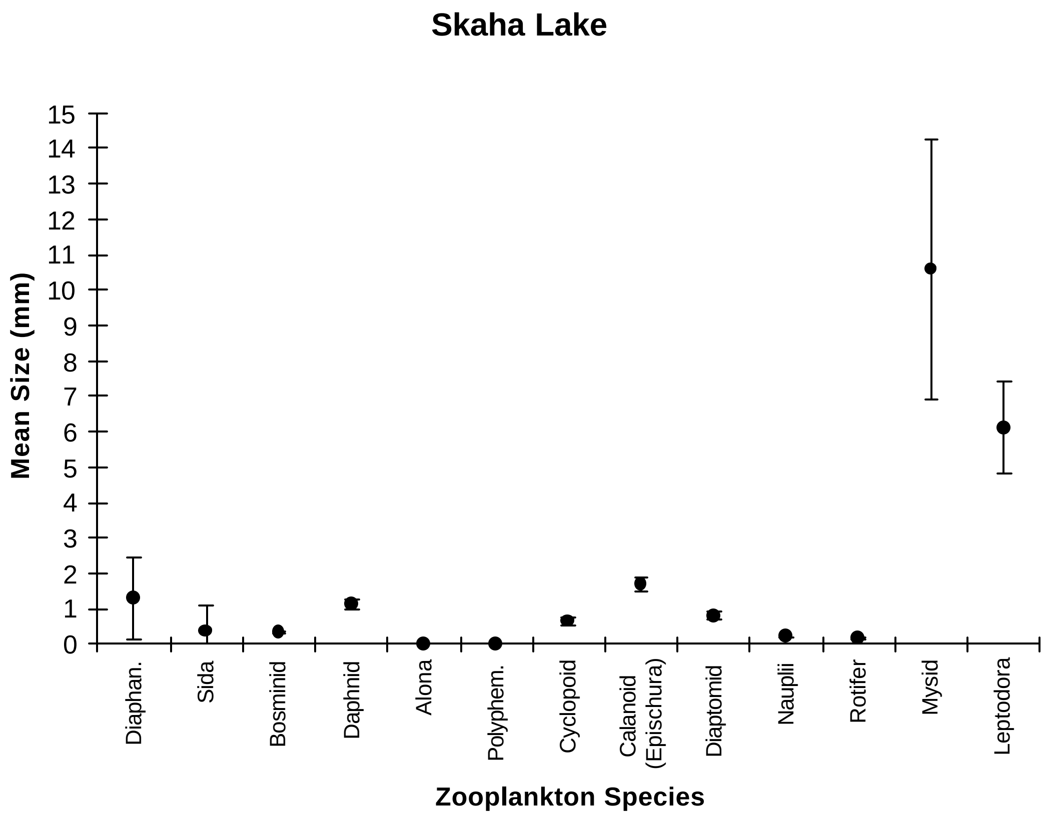


Figure 17a. Community structure of zooplankton by weighted mean species biomass (April-November 2002) in Skaha Lake.



*Mysid vertical haul sampling conducted separately with 300 micron net

Figure 17b. Community structure of zooplankton by weighted mean species biomass (April-November 2002) in the north basin of Osoyoos Lake.



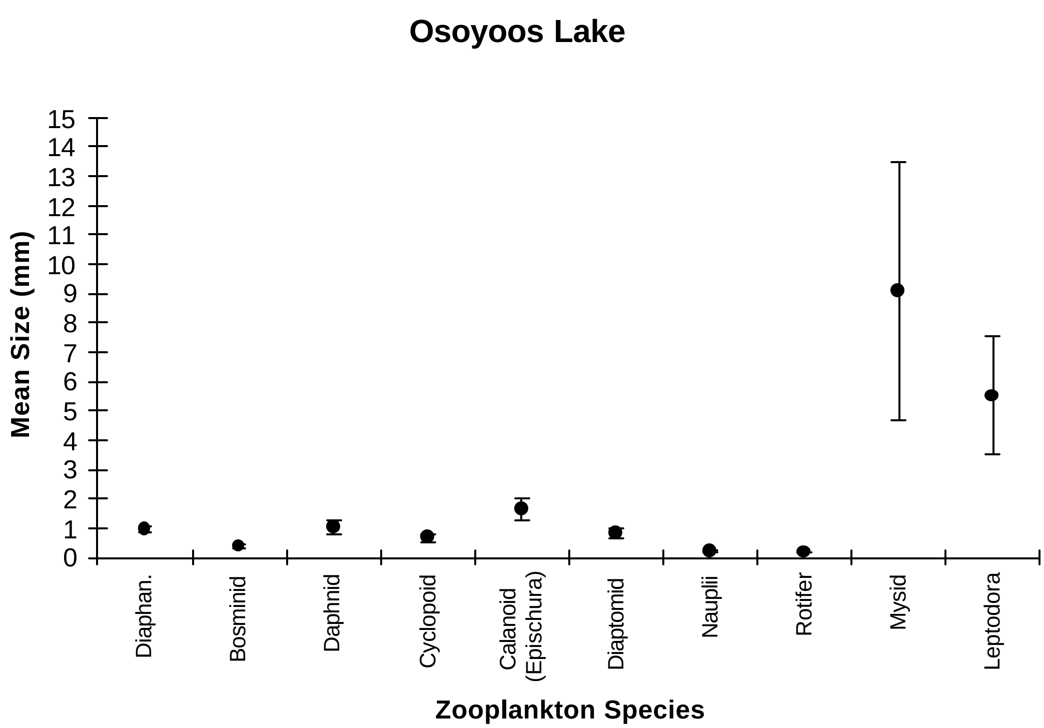
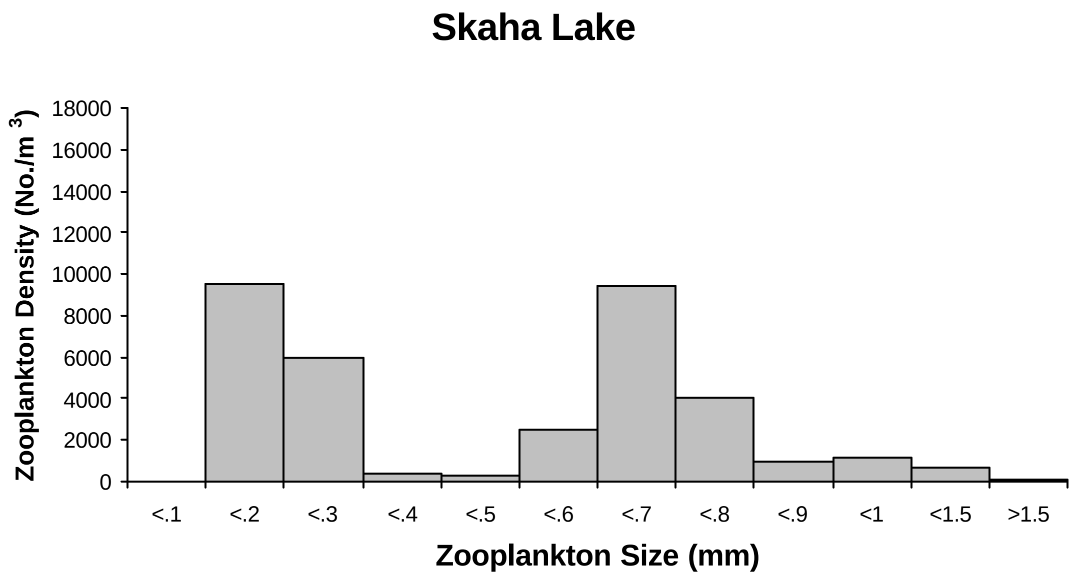


Figure 18. Weighted mean length of zooplankton (+/- 1 standard deviation) in Skaha and Osoyoos Lakes.



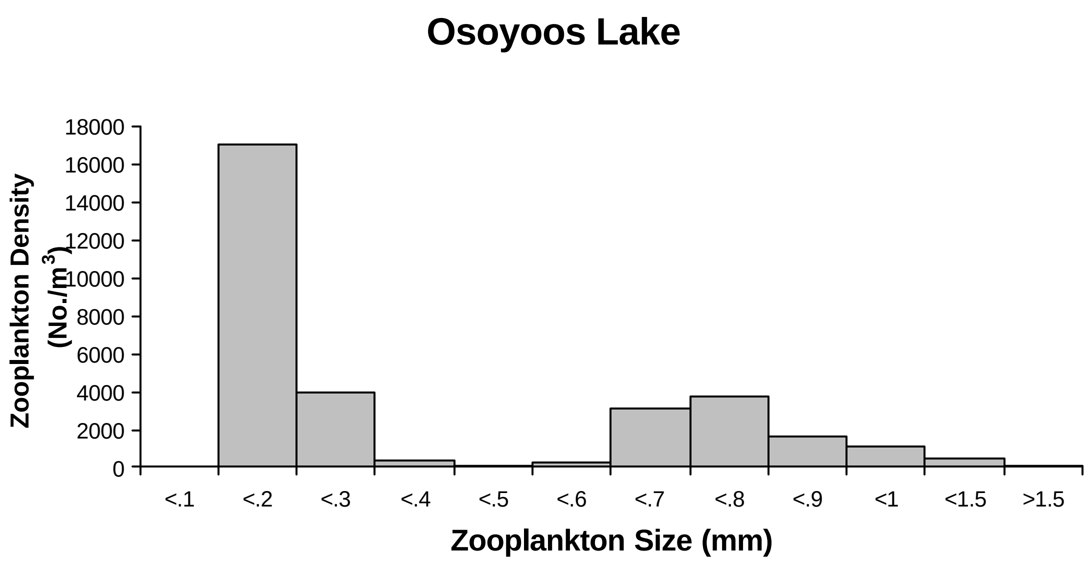


Figure 19. Seasonal (April-November 2002) weighted mean zooplankton density by size frequency in Skaha and Osoyoos Lakes.

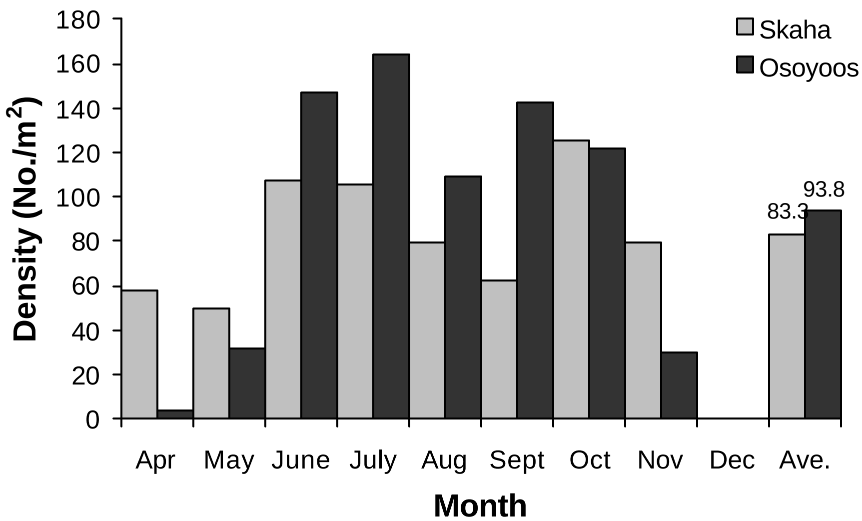


Figure 20. *Mysis relicta* weighted densities from April to November 2002 in Skaha Lake and North Basin of Osoyoos Lake.

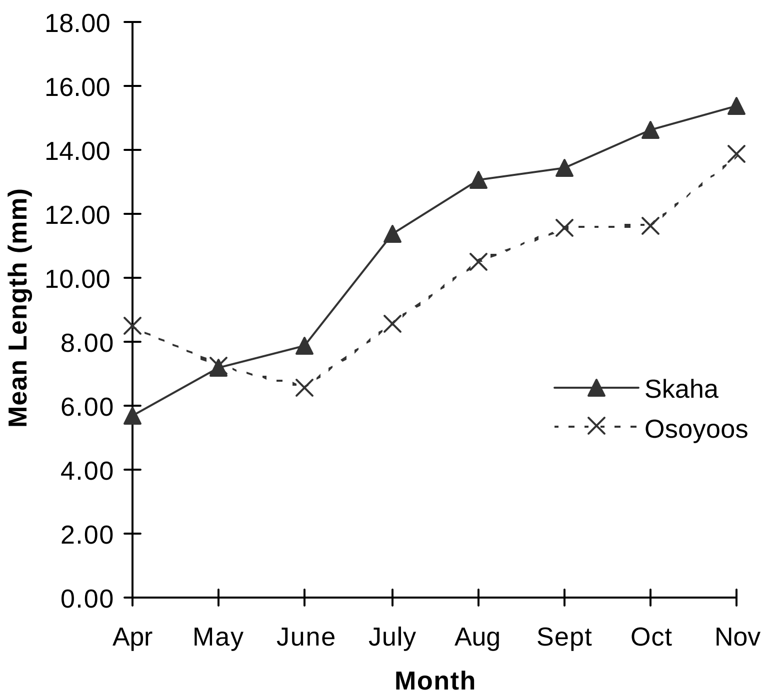


Figure 21. Weighted mean lengths of *Mysis relicta* in Skaha and North Basin of Osoyoos Lake from April to November 2002.

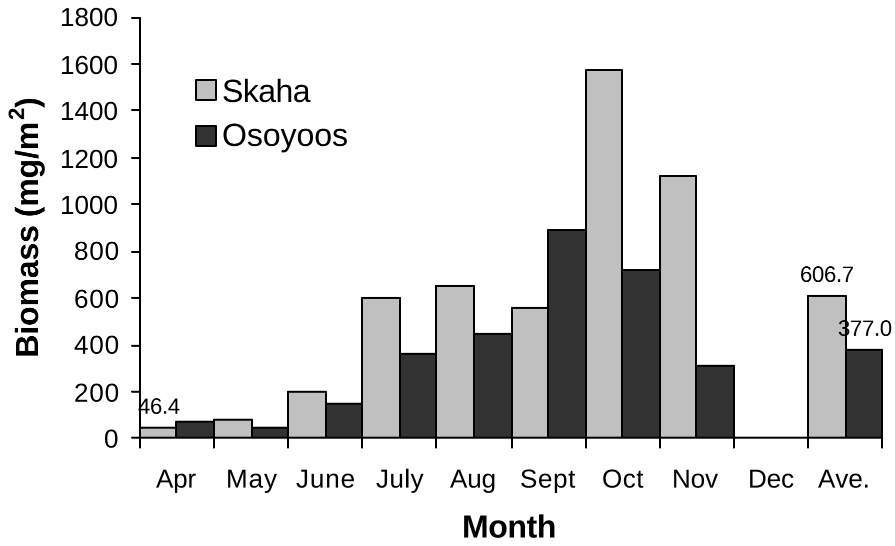


Figure 22. *Mysis relicta* weighted biomass from April-November 2002 in Skaha Lake and North Basin of Osoyoos Lake.

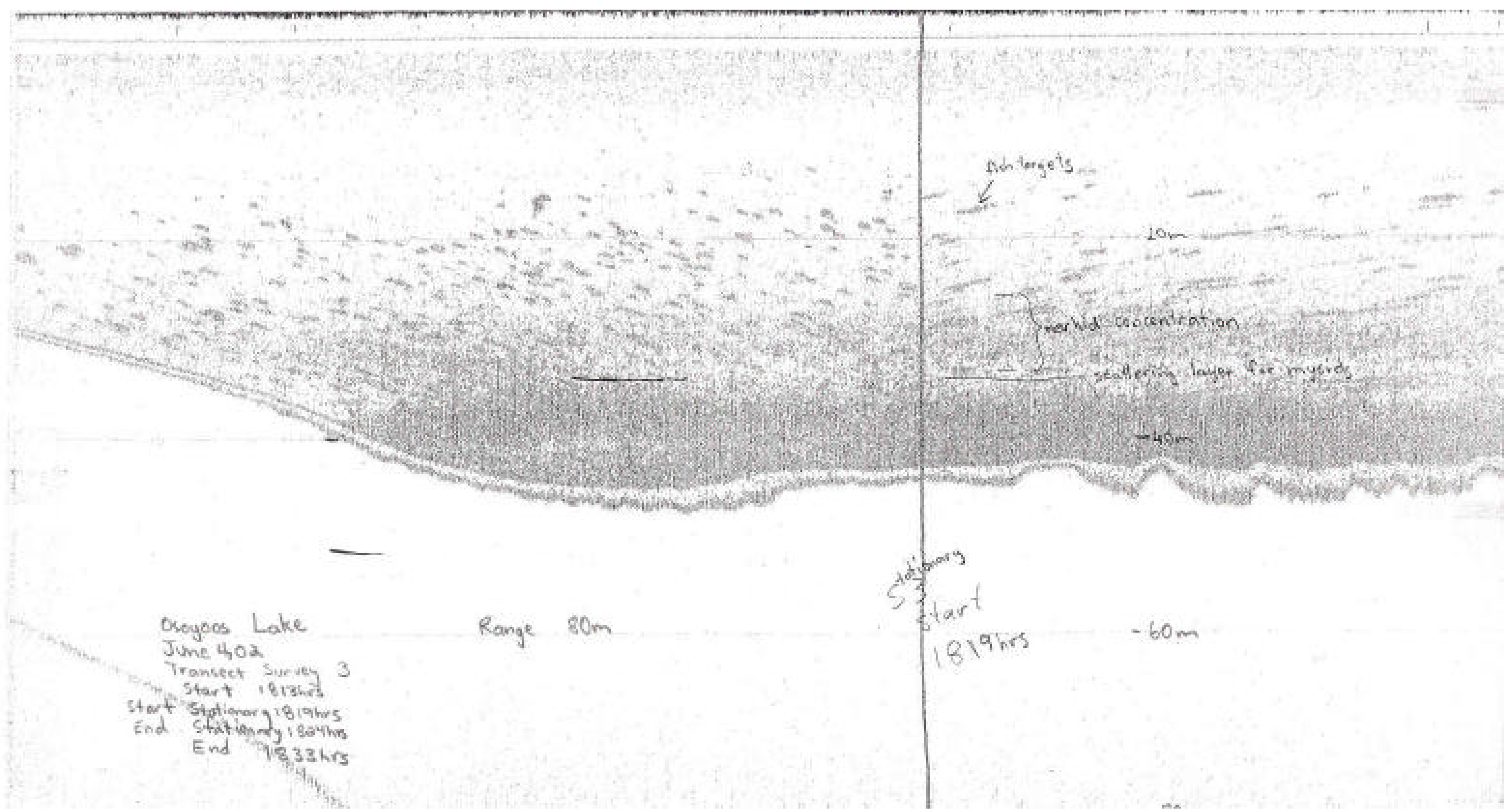
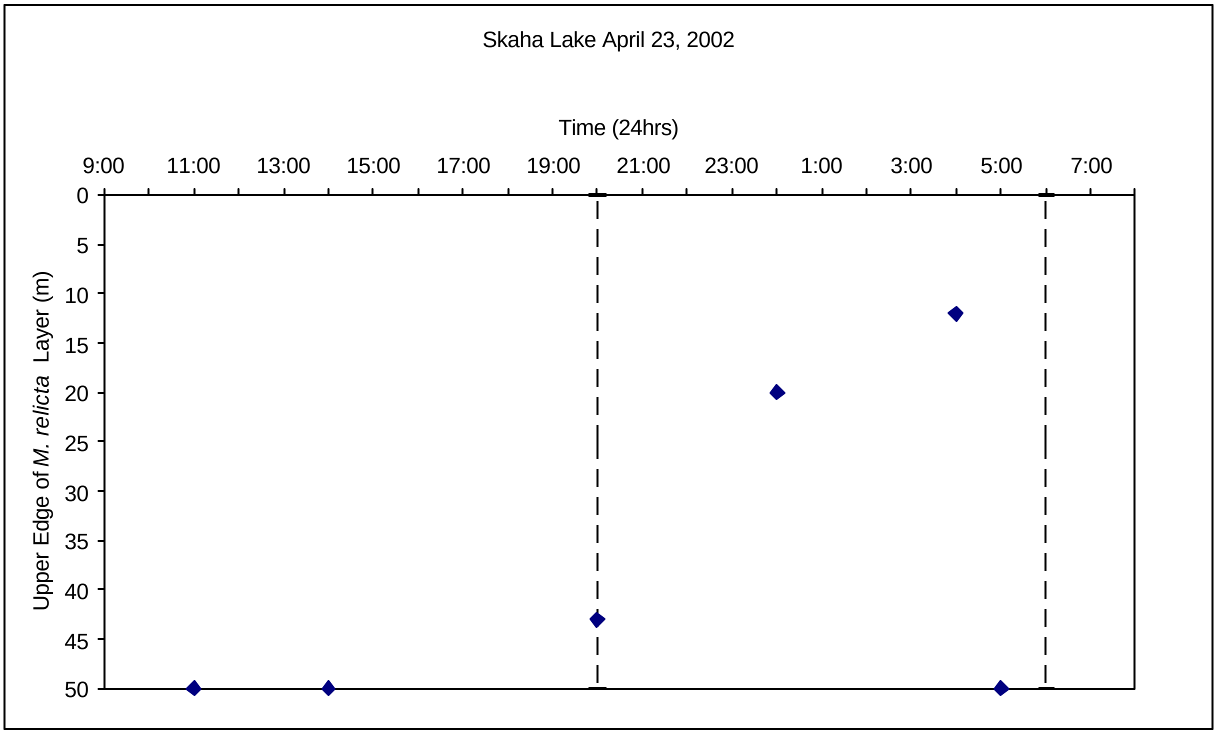


Figure 23. Typical Acoustic Survey with Interpretation



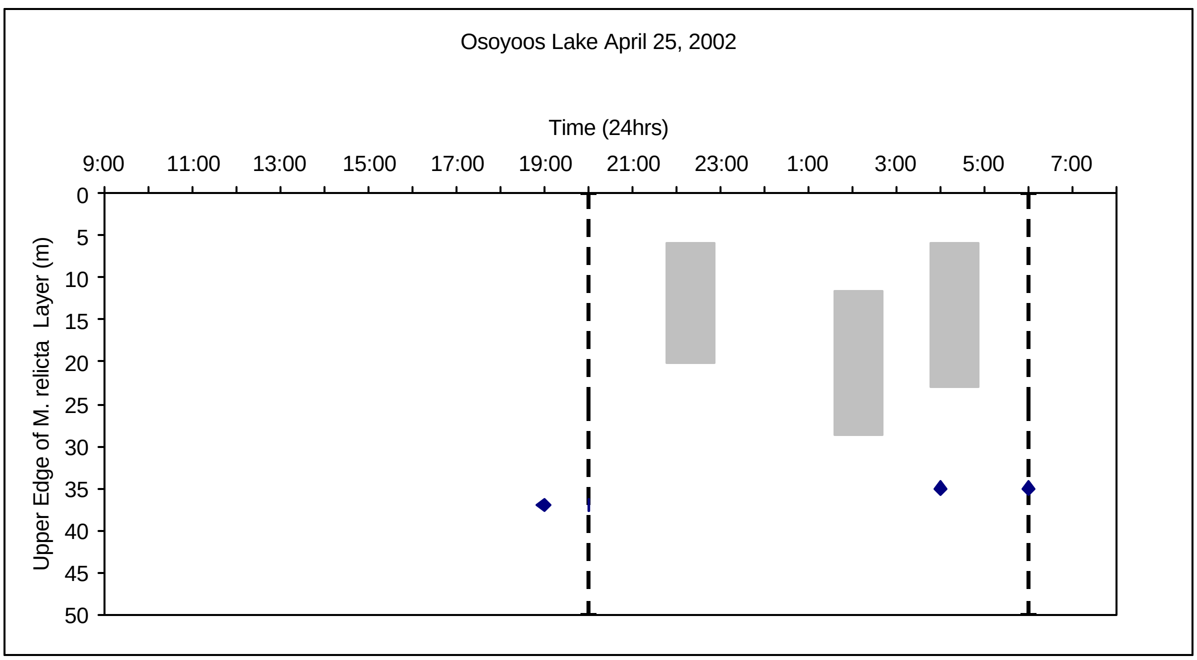


Figure 24a. April diel migration monitoring for Skaha and Osoyoos Lakes[1]

[1] diamonds are upper *M. relicta* scattering layer at survey time, shaded area is *O. nerka* concentrations, and dashed lines are sunset/sunrise times

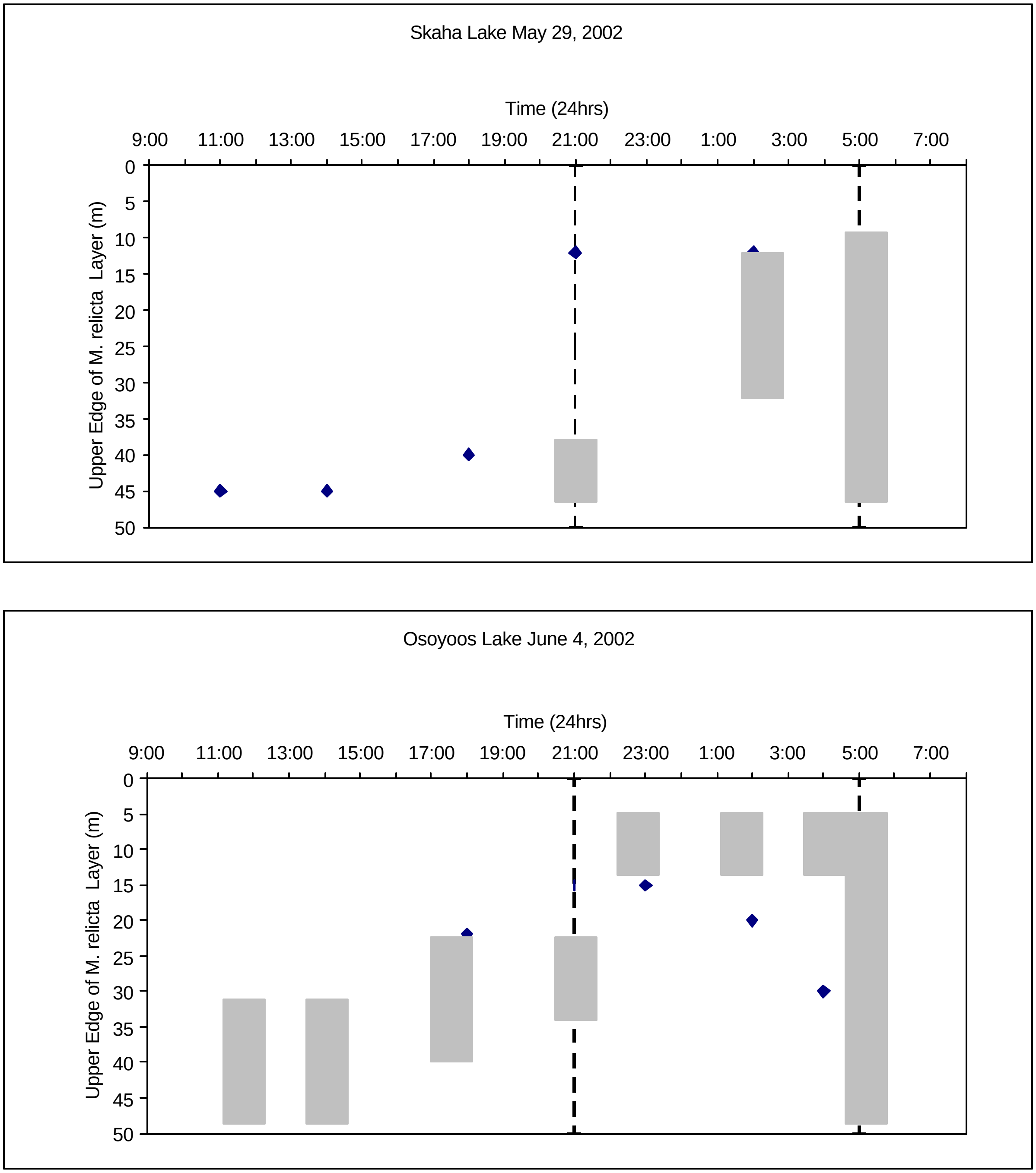
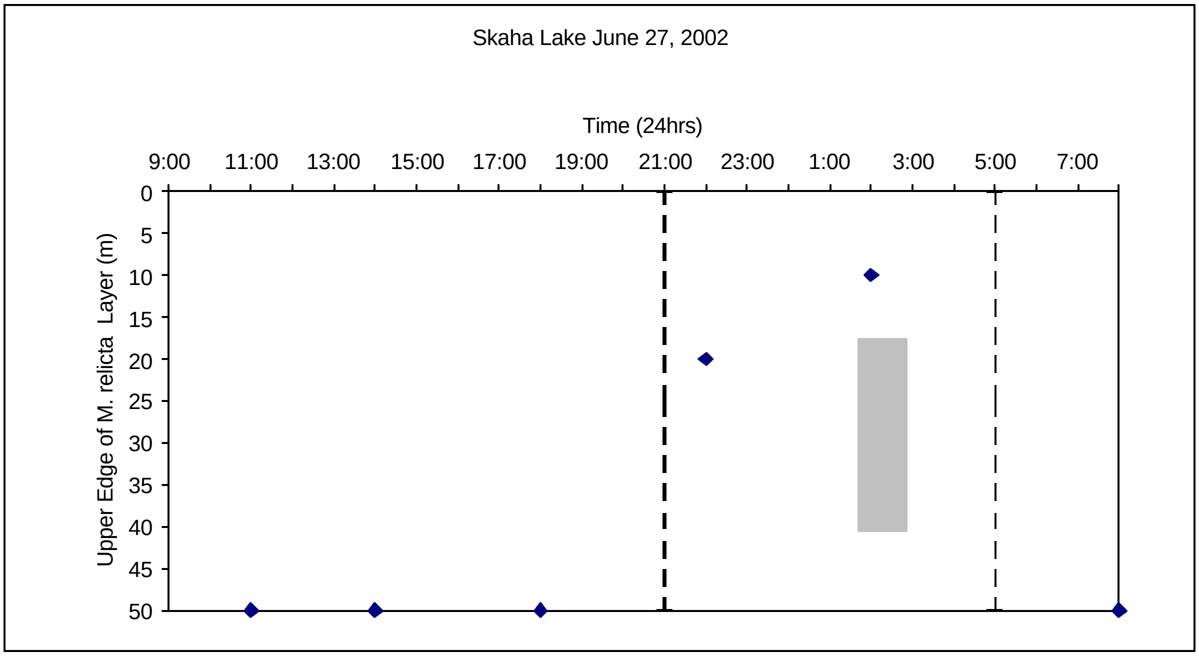


Figure 24b. May diel migration monitoring for Skaha and Osoyoos Lakes



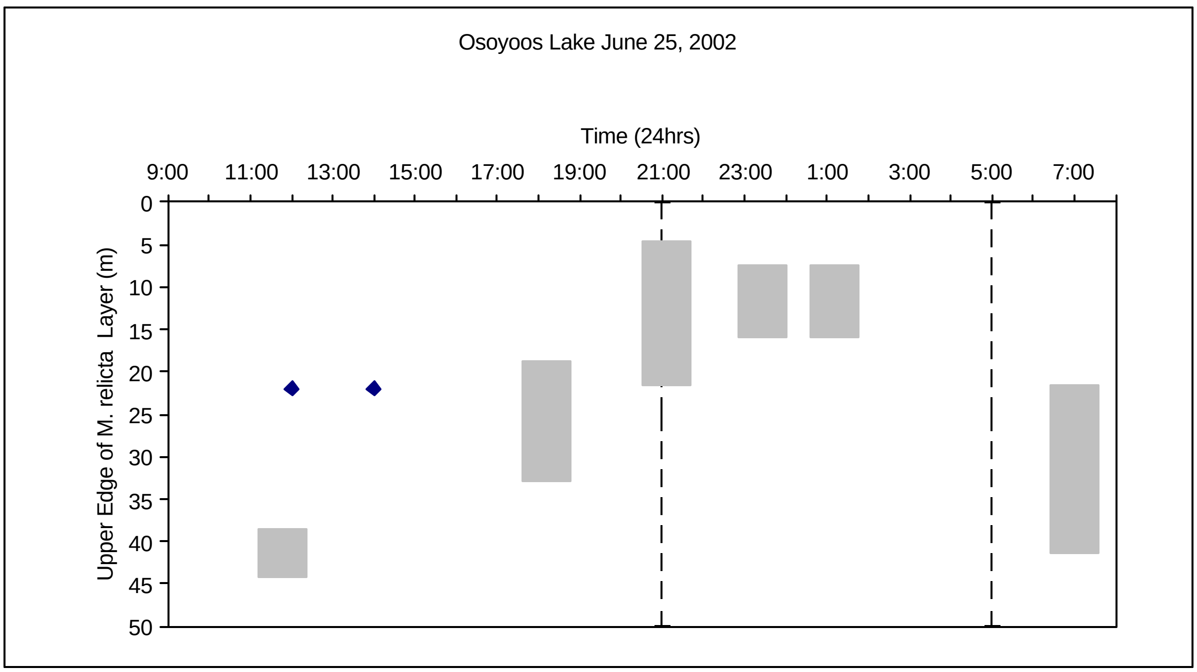
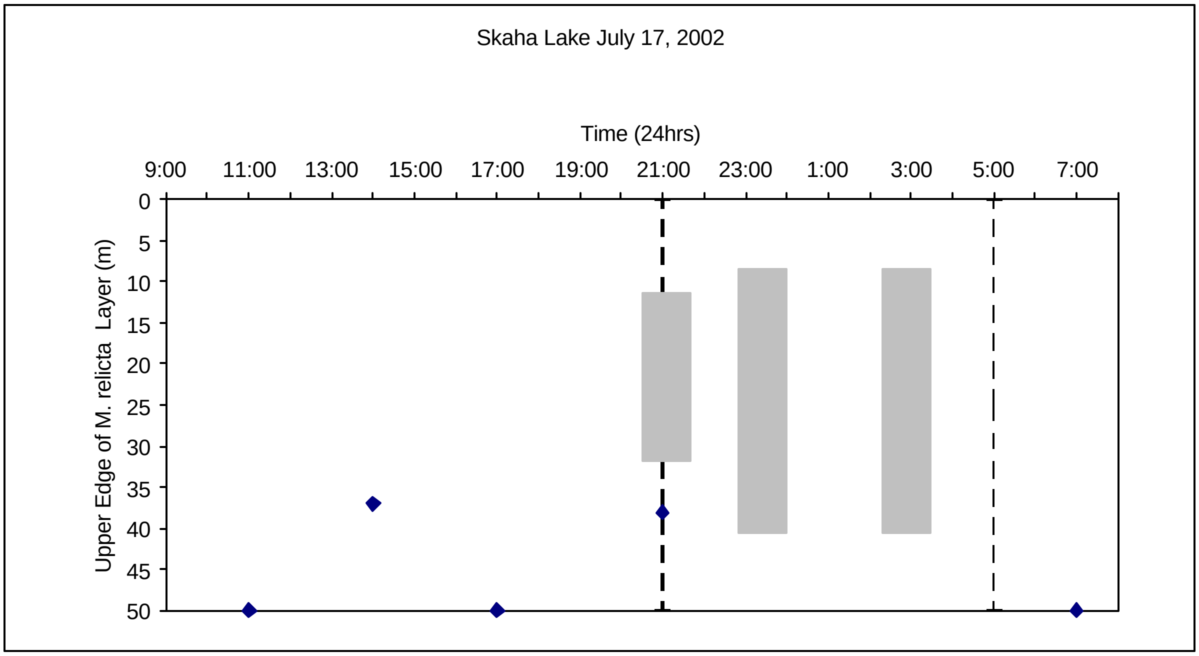


Figure 24c. June diel migration monitoring for Skaha and Osoyoos Lakes



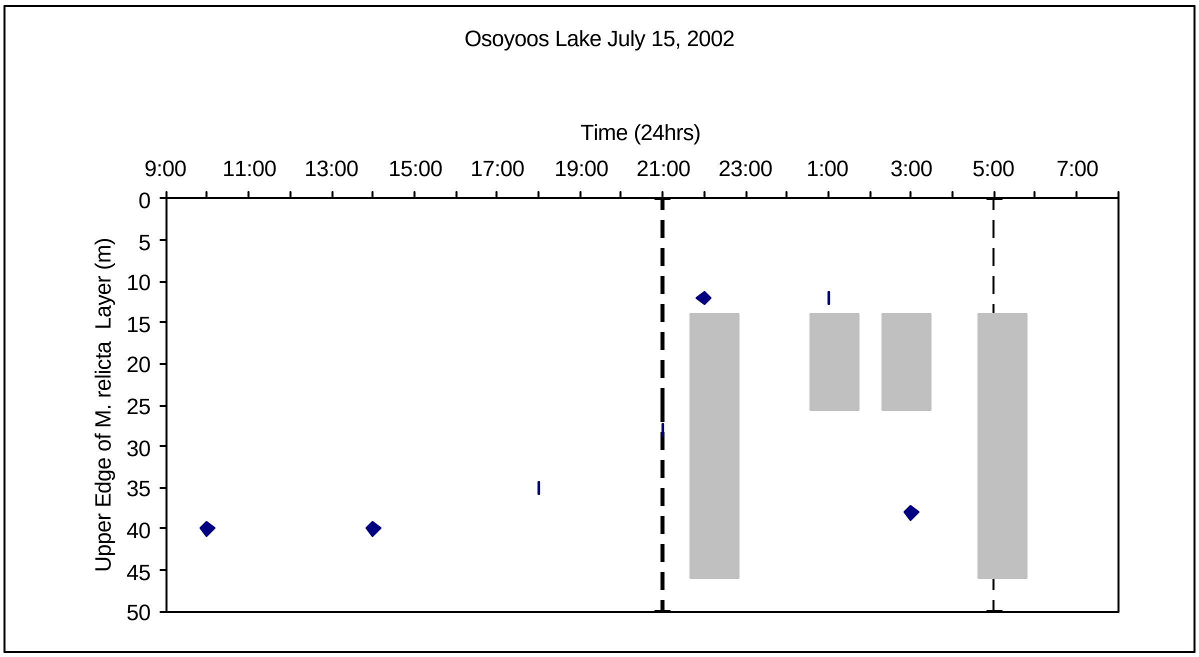
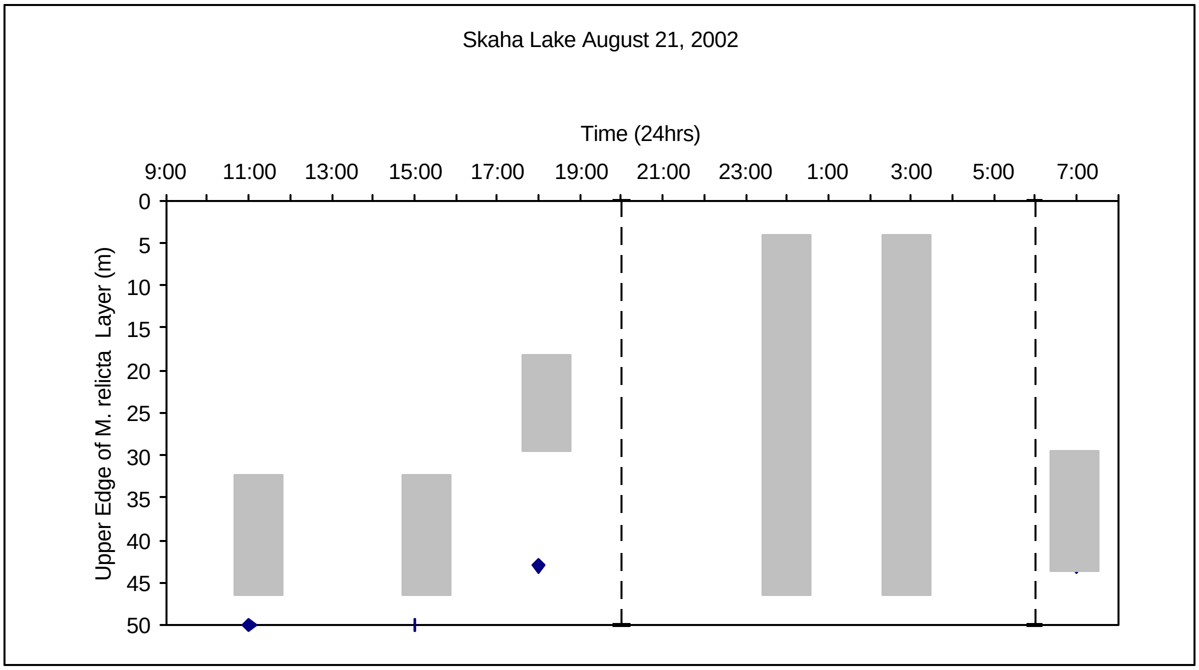


Figure 24d. July diel migration monitoring for Skaha and Osoyoos Lakes



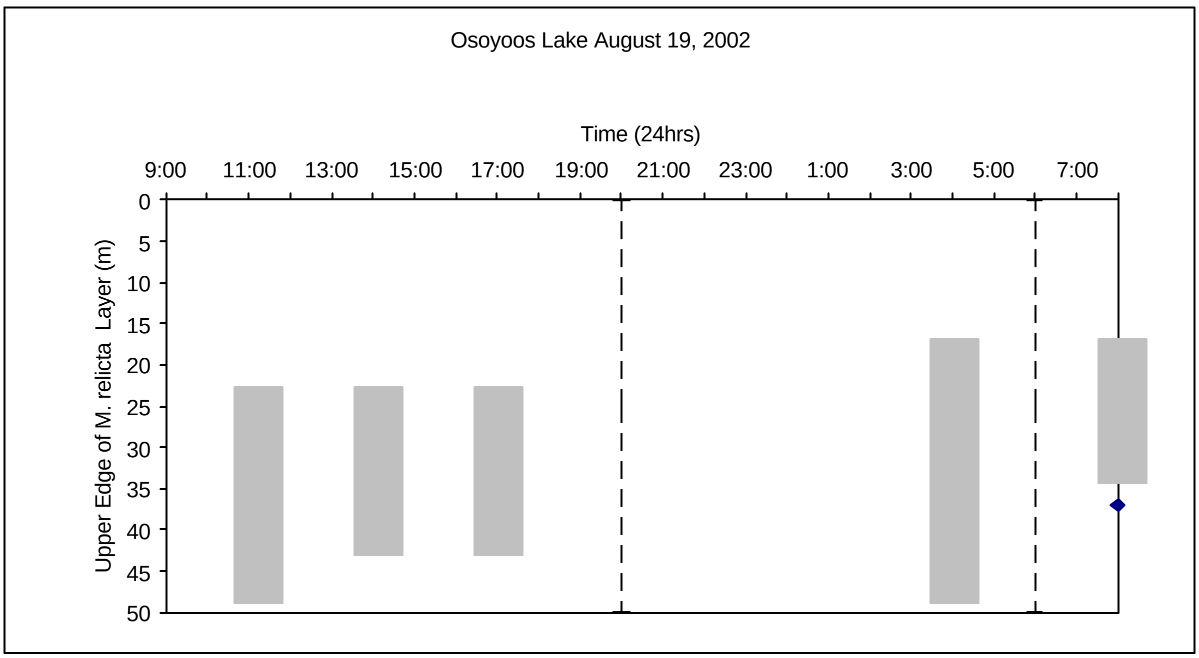


Figure 24e. August (middle) diel migration monitoring for Skaha and Osoyoos Lakes

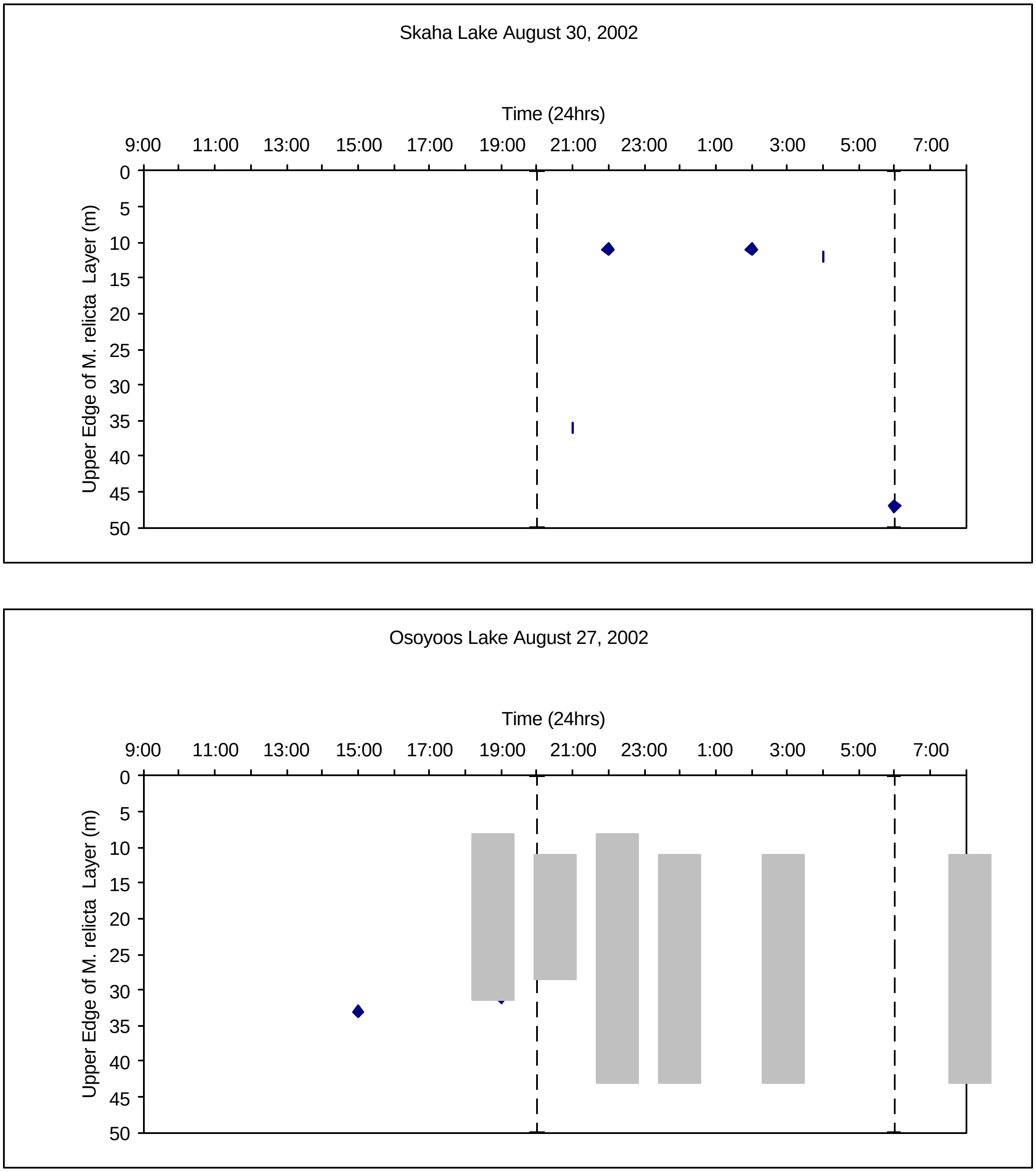
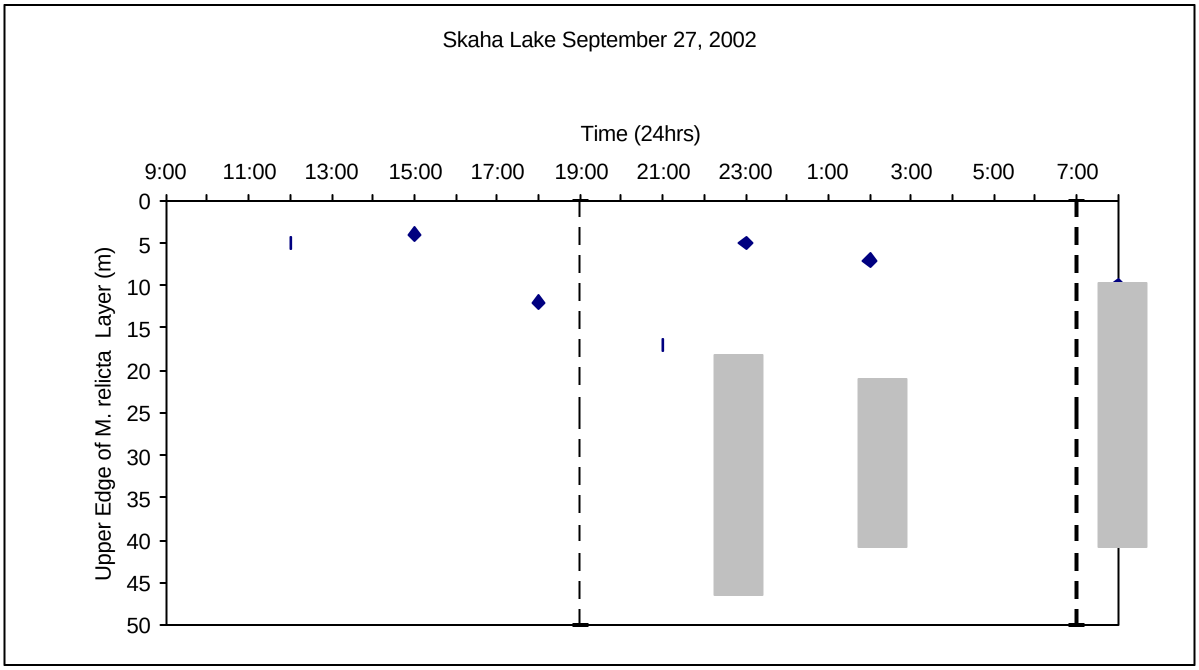


Figure 24f. August (late) diel migration monitoring for Skaha and Osoyoos Lakes



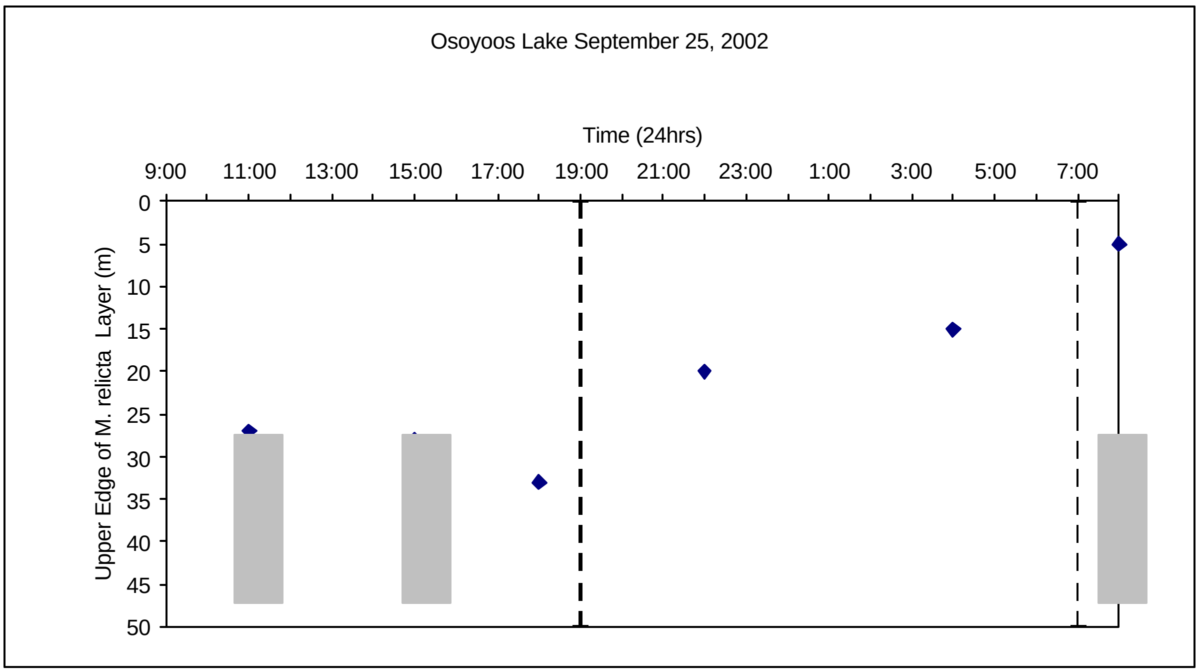


Figure 24g. September diel migration monitoring for Skaha and Osoyoos Lakes

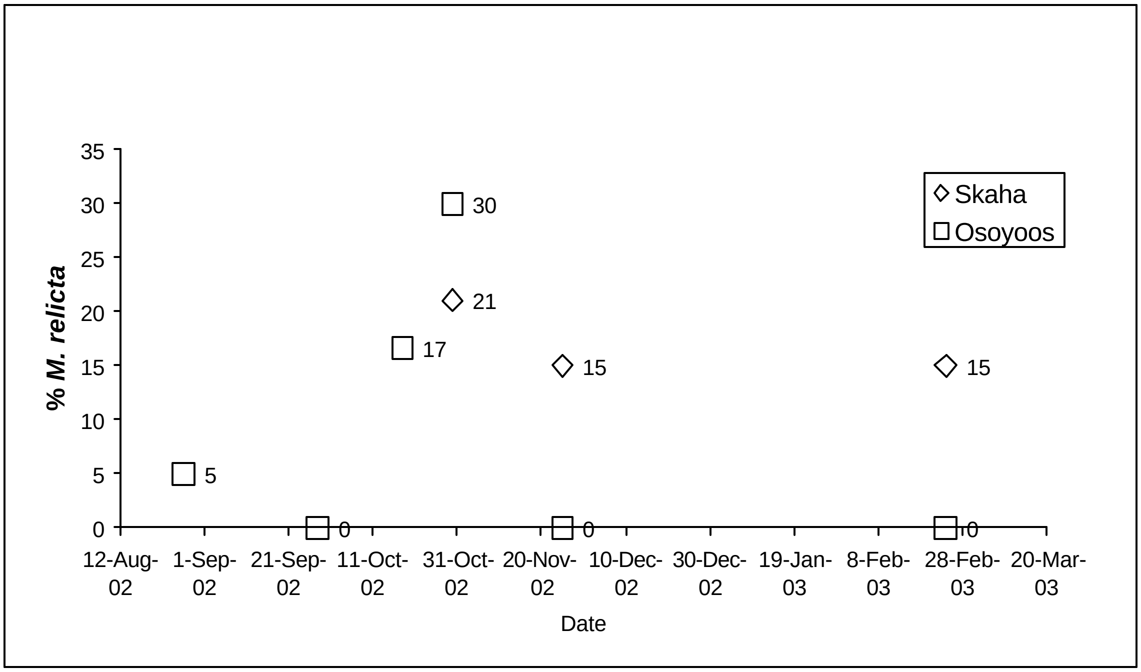


Figure 25. Monthly percent frequency of *M. relicta* presence in *O. nerka* stomach samples (0^+) from August to February for Skaha and Osoyoos Lakes.

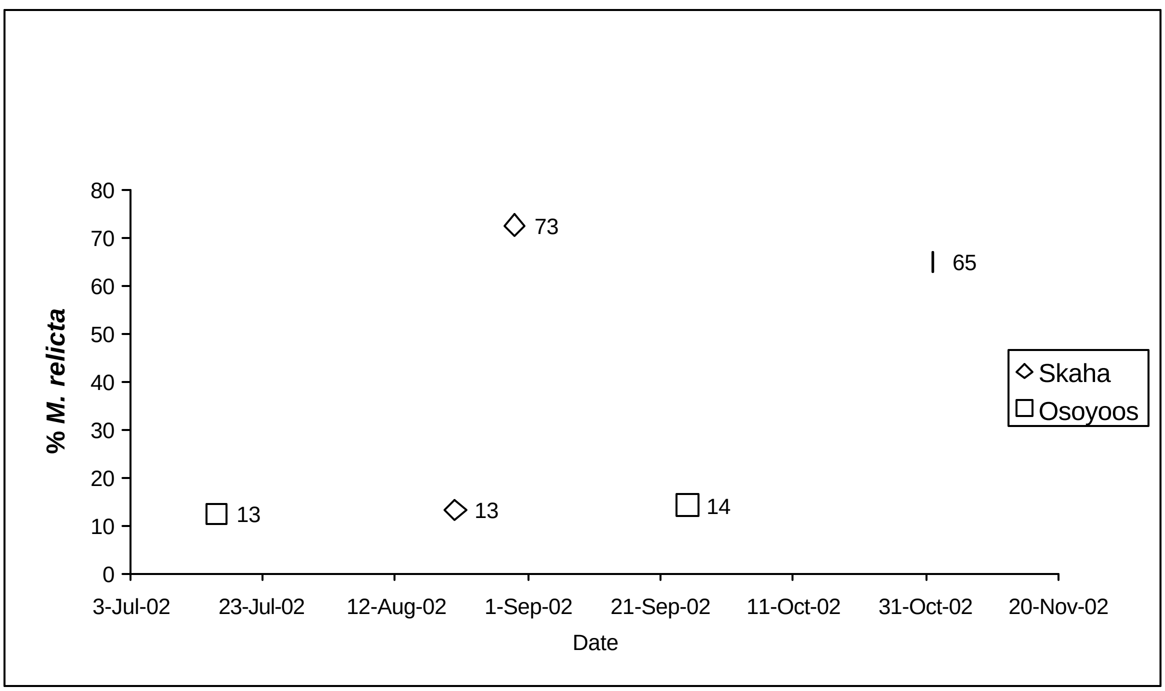


Figure 26. Monthly percent frequency of *M. relicta* presence in *O. nerka* stomach samples (older age classes) from July to November for Skaha and Osoyoos Lakes.