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3.0 WATER QUALITY

3.1 WATER QUALITY MONITORING AND ASSESSMENT STUDY (WAQ 1)

3.1.1 Study Objectives

Objectives of the Water Quality Monitoring and Assessment Study are described in Section 4.3 of the Study Plan Document (PacifiCorp and Cowlitz PUD 1999, as amended) and are summarized below.

- Determine the current water quality conditions in the study area.
- Assess effects on water quality or water temperature that are attributable to the projects or to project operations.
- Determine if water quality in project-affected waters meets existing water quality standards of the State of Washington.

Results of water temperature and water quality monitoring are described in this section of the report. The total dissolved gas (TDG) studies conducted in 1999 and 2000 are presented in Section 3.2.

3.1.2 Study Area

The study area for WAQ 1 is shown in Figure 3.1-1. Monitoring sites extend from the inflow to Swift Reservoir to Eagle Island downstream of Merwin Dam. Data were collected at several tributaries to Swift Reservoir; at all 4 project tailraces (Swift No. 1, Swift No. 2, Yale, and Merwin); and at the Speelyai, Lewis, and Merwin hatchery effluents. Sample sites and associated monitoring activities at each are shown below, along with the corresponding WDOE classification (Table 3.1-1). Applicable Washington State Department of Ecology (WDOE) classes were determined through consultation with WDOE. The standards are described in Section 3.1.4, Table 3.1-6.

3.1.3 Methods

3.1.3.1 Laboratory Samples

At stream and hatchery effluent sites, samples for laboratory analysis were collected as grab samples in flowing water near the center of the channel. Tailrace samples were collected with a Van Dorn sampler, which was lowered into the tailrace area to a depth of approximately 1-2 m. A blank sample (deionized water) and a field duplicate sample were collected at one of the sample locations during each monthly visit. The blank sample was used to assess potential contamination due to field and/or laboratory methods. The field duplicate was a second sample used to assess natural variability and laboratory precision. These quality assurance / quality control (QA/QC) samples were over and above the routine QA program maintained by the analytical laboratory.

Table 3.1-1. Monitoring sites for Water Quality Study WAQ 1.

Site Code	Site Description	Water Body	WDOE Class	Stream	RM	RM to Columbia	Elev.	Temp., DO, pH, Cond.	TDG	Secchi	Chlor-*a*	Turbidity, Alkalinity	Nutrients	Fecal Coliform	Fuel	Hg	Metals, Hardness, Organics, Ions	Thermograph
CANCM	Canyon Creek near mouth	Canyon Cr.	AA	Canyon	1.0	34.2	300	S				S	S					YES
CREBL	Cresap Bay boat launch	Lake Merwin	Lake	Lewis		31.0	240								S			NO
DRICM	Drift Creek near mouth	Drift Cr.	AA	Drift	1.5	55.5	1,020	S				S	S	S				YES
LEWEA	Lewis River near Eagle Island	Lewis R.	A	Lewis		11.0	14	S				S	S					YES
LEWHE	Lewis River Hatchery effluent	Lewis R. Hatchery effluent	NPDES	Hatchery		15.7	40	S				S	S					NO
MERHE	Merwin Hatchery effluent	Merwin Hatchery effluent	NPDES	Hatchery		19.0	80	S				S	S					NO
MERLD	Lake Merwin near the dam	Lake Merwin	Lake	Lewis		20.0	240	VP		S	1	1, I	1, I		S			NO
MERLI	Lake Merwin inflow to Lake Merwin at Hwy 503 crossing	Lake Merwin	Lake	Lewis		31.4	240	S				S	S					YES
MERTR	Lewis River near Merwin powerhouse tailrace	Lewis R.	A	Lewis		19.6	50	S	S			S	S		S	S	S	YES
NWOOD	Northwoods boat and recreation area	Swift Reservoir	Lake	Lewis		58.5	1,000							S				NO
OLECM	Ole Creek near mouth	Ole Cr.	A	Ole	0.5	45.8	520	S				S	S					YES
PINCM	Pine Creek near mouth	Pine Cr.	AA	Pine	0.1	59.6	1,020	S				S	S					YES
SPLBL	Speelyai boat launch	Lake Merwin	Lake	Lewis	1.0	29.6	240								S			NO
SPLYE	Speelyai Hatchery effluent	Speelyai Hatchery Effluent	NPDES	Hatchery	1.7	30.3	245	S				S	S					NO
SPLYL	Speelyai Creek lower site near Speelyai Hatchery	Speelyai Cr.	AA	Speelyai	2.0	30.6	250	S										YES

Table 3.1-1. Monitoring sites for water quality study WAQ 1 (cont.).

Site Code	Site Description	Water Body	DOE Class	Stream	RM	RM to Columbia	Elev	Temp., DO, pH, Cond.	TDG	Secchi	Chlor-*a*	Turbidity, Alkalinity	Nutrients	Fecal Coliform	Fuel	Hg	Metals, Hardness, Organics, Ions	Thermograph
SPLYU	Speelyai Creek upper site	Speelyai Cr.	AA	Speelyai	4.3	32.9	520	S				S	S					YES
SW1TR	Swift No. 1 tailrace at the canal	Swift No. 2 canal	A	Canal		47.6	600	S	S			S	S		S		S	YES
SW2BL	Lewis River bypass reach lower	Lewis R.	A	Lewis		44.7	500	S				S	S					YES
SW2TR	Swift No. 2 tailrace	Lewis R.	A	Lewis		44.2	495	S	S			S	S		S		S	YES
SWIBL	Swift Reservoir boat launch at the upper end of the reservoir	Swift Reservoir	Lake	Lewis		57.0	1,000								S			NO
SWICM	Swift Creek near mouth	Swift Cr.	AA	Swift	2.0	49.9	1,010	S				S	S					YES
SWRED	Swift Reservoir near the dam	Swift Reservoir	Lake	Lewis		48.5	1,000	VP		S	1	1, I	1, I		S			NO
SWREI	Lewis River inflow to Swift Reservoir	Lewis R.	A	Lewis		59.0	1,000	S				S	S			S		YES
WOODP	Lake Merwin at Woodland Park	Lake Merwin	Lake	Lewis		25.8	240							S				NO
YALBL	Yale Lake boat launch	Yale Lake	Lake	Lewis		40.2	490								S			NO
YALTR	Lewis River near Yale powerhouse tailrace	Lewis R.	A	Lewis		34.0	240	S	S			S	S		S	S	S	YES

Key:				
	S	Surface water sample	1	1-meter sample
	VP	Vertical profile	RM	River Mile
	I	Intake level samples		

Samples collected on a monthly basis are considered routine samples for purposes of this report and were analyzed by AmTest Laboratory in Seattle, a Washington State Department of Ecology (WDOE) certified lab. Parameters, methods, and detection limits for these samples are listed in Table 3.1-2. On an approximate quarterly basis (July, September, and December 1999, and March 2000), an additional suite of measurements was made on samples collected at the 4 powerhouse tailraces. These measurements included hardness, metals, fuel (gasoline, diesel, oil), and cations/anions. With the exception of mercury (see below) quarterly samples were also analyzed by AmTest.

Table 3.1-2. Constituents, analytical methodology, and detection limits for routine water quality samples.

Parameter	Detection Limit	Methodology
Turbidity	0.01 NTU	EPA 180.1
Total phosphorus	0.005 mg/l	EPA 365.2
Ortho-phosphorus	0.001mg/l	EPA 365.2
Total persulfate N	0.10 mg/l	EPA 353.2 (mod)
Nitrate+nitrite N	0.001 mg/l	EPA 353.2
Ammonia N	0.005 mg/l	EPA 350.1
Fecal coliform	1 CFU/100 ml	SM 92222D
Alkalinity	0.5 mg/l	EPA 310.1

The need for specialized mercury analysis was based on discussion among the Lewis River Aquatic Resource Group (ARG) in the summer of 1999 concerning elevated mercury in samples collected during Yale relicensing. Three of 8 samples collected between April 1996 and January 1998 had mercury concentrations in excess of the chronic standard; these values ranged from 0.26 µg/l to 0.41 µg/l (PacifiCorp 1999a). Discussion with WDOE as well as Oregon Department of Environmental Quality (DEQ) staff suggested laboratory and/or field contamination of the previous samples as the cause of the elevated mercury results (memo from M. Bonoff, EA, to Lewis River ARG, 6/25/99). The detection limit for the previous analyses was 0.20 µg/l, higher than the chronic standard. Thus, there was a need for reanalysis using methodology that would allow meaningful comparison to the state standard. On recommendation from the ARG and WDOE staff, mercury analyses were conducted by Frontier Geosciences in Seattle, a lab specializing in dilute inorganic analyses. The detection limit used for these analyses was 0.0005 µg/l, well below the 0.012 µg/l chronic standard.

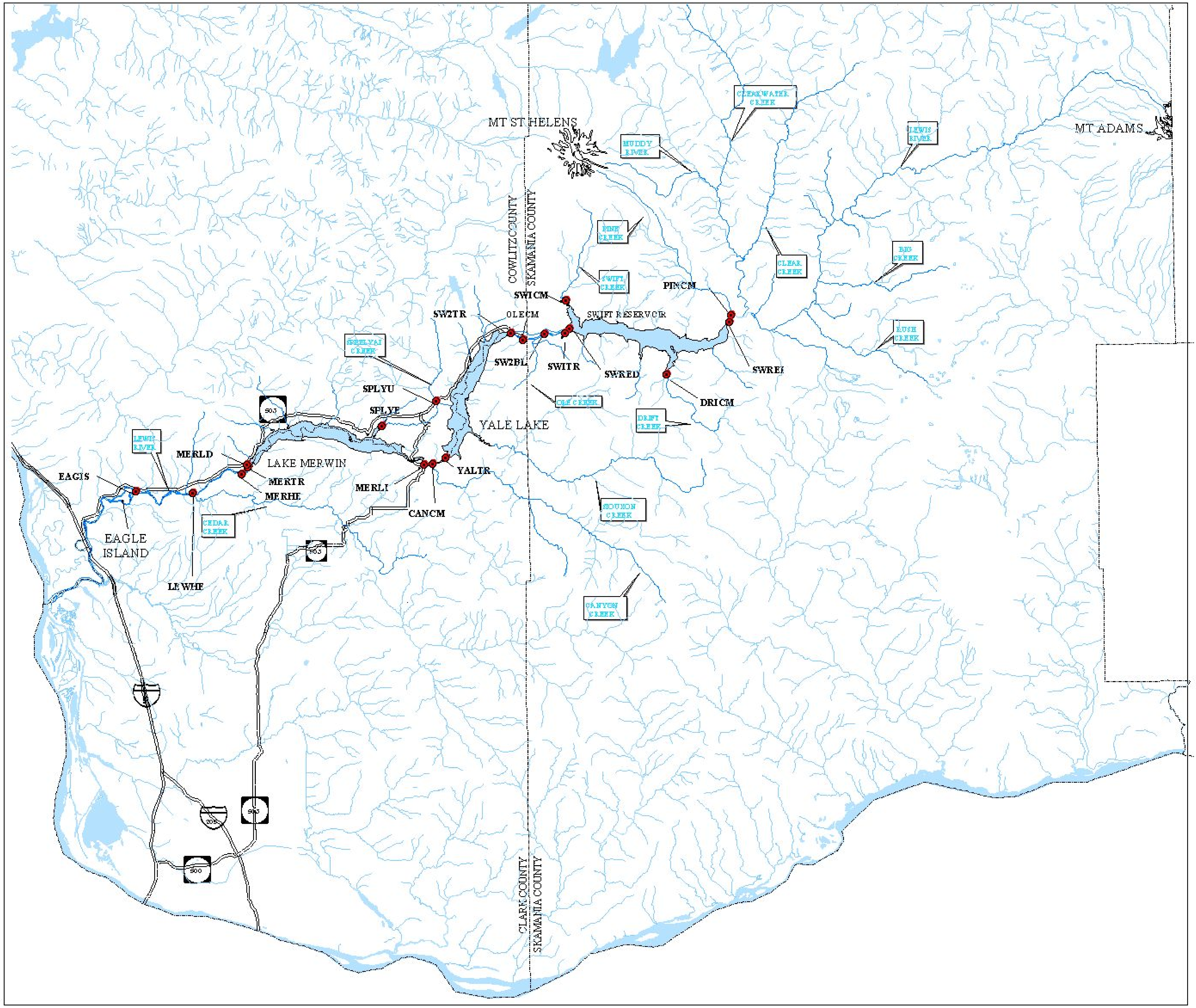
In addition to measurements described above, samples were collected for pesticide analyses from the 4 powerhouse tailraces in July 1999. As mentioned above with respect to mercury sampling, detection limits used previously during Yale relicensing were equal to or greater than the WDOE chronic criteria for several of the pesticides measured; thus, comparisons to state standards were not possible. On recommendation from the ARG, pesticides sampled previously at higher detection limits were measured again in July 1999 at the 4 powerhouse tailraces. With the exception of Heptachlor (see below) these samples were analyzed by Columbia Analytical in Kelso, WA at detection limits that were lower than the freshwater chronic criteria (Table 3.1-3). Although Aroclor (poly-chlorinated biphenyl [PCB]) was one of the parameters sampled previously at detection limits above the chronic standard, it was not measured again in July 1999. Discussion among the ARG indicated a low probability of the presence of PCB in the project area, as both PacifiCorp and Cowlitz County PUD let a contract in 1986 for removal of PCBs in transformers (pers. comm., Frank Shrier, August 18, 1999).

Lewis River
Hydroeletric Projects

Figure 3.1-1

Water Quality Monitoring Sites

LEWIS RIVER REGION

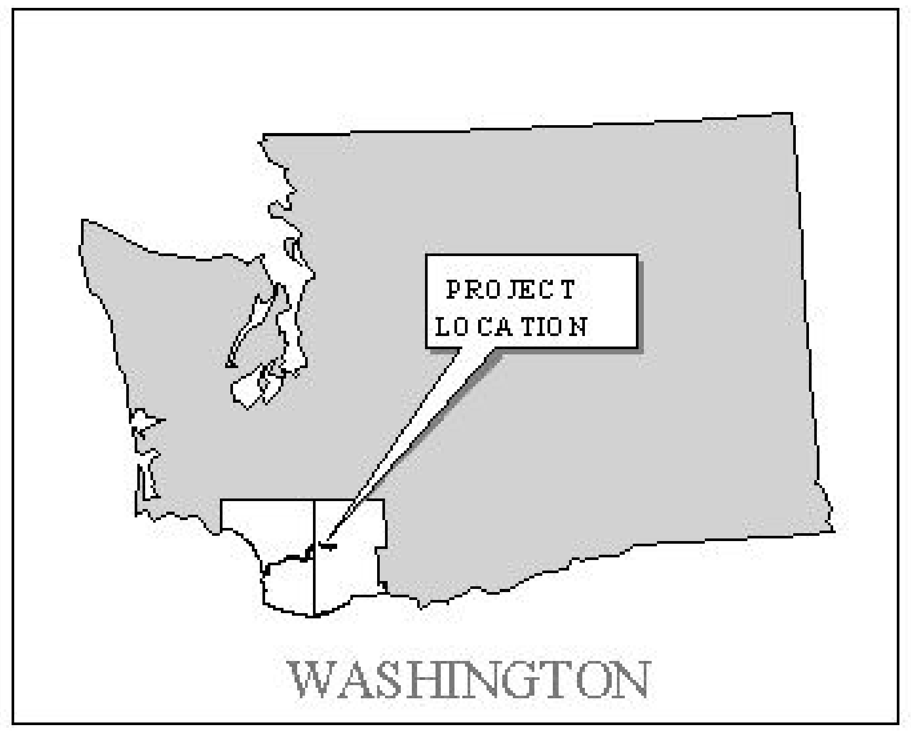


● Monitoring Sites

╱╲ Major Tributary

╱╲ Major Road

╱╲ County



5 0 5 10

Miles

PACIFICORP

Geographic Information System

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March 23, 2001

Table 3.1-3. Pesticides for which previous detection limits were greater than the WDOE Freshwater Chronic Criteria (FCC).

Analyte	Method	Yale IDL	New IDL	WDOE FCC
Aldrin	EPA 8081A	0.003	0.001	0.0019
4,4'-DDT	EPA 8081A	0.003	0.001	0.001
Dieldrin	EPA 8081A	0.003	0.002	0.0019
Endrin	EPA 8081A	0.003	0.002	0.0023
Heptachlor	EPA 608 (mod)	0.003	0.003	0.0038
Toxaphene	EPA 608 (mod)	0.1	0.05	0.0002

IDL= Instrument Detection Limits. All values µg/l.

Fuel Analysis

As an indicator of potential effects of gasoline and fuel oil to the Lewis River from outboard motors, samples collected at the 4 project tailraces and at Swift and Merwin dams (SWRED, MERLD) were analyzed for total petroleum hydrocarbons (TPH). This analysis reports levels of gasoline, diesel fuel, and oil at detection limits of 44, 110, and 220 µg/l, respectively.

3.1.3.2 *In Situ* Measurements

In situ water quality data (with the exception of TDG) were collected with a Hydrolab® Surveyor 2 or 3 multiparameter probe. The Hydrolab was calibrated immediately prior to field data collection, using commercial buffers (pH 7 and 10) and a low ionic strength specific conductance standard (typically 74 µS/cm). Dissolved oxygen (DO) was calibrated in air following the manufacturer's recommendations. Post calibration checks for Hydrolab parameters were conducted as soon as possible following each day in the field. TDG was measured *in situ* with a Common Sensing® TDG meter. The instruments were allowed to stabilize prior to recording data. At stream sites, the Hydrolab and TDG measurements were taken in flowing water near the center of the channel. The instrument's sensor was lowered to a depth of approximately 1-2 m at tailrace sites.

Field and calibration data were recorded on standardized data sheets. The field data sheets included the instrument serial number to allow verification of calibration for a particular day's use.

Reservoir profile and *in situ* data (pH, DO, temperature, and specific conductance) were collected using a Hydrolab® multi-parameter probe. Reservoir samples were collected at near-surface and near-intake depths near Swift and Merwin dams and analyzed for parameters shown in Table 3.1-2, plus chlorophyll-a. Secchi-disk transparency was also measured at reservoir sites. Calibration and post-calibration data, as well as field data, were recorded on standardized field forms.

Water temperatures were recorded on an hourly basis throughout the study using Onset® optical thermographs. Data analysis routines used in Yale relicensing studies were applied to develop running 7-day averages of daily maximum temperatures, percent exceedence analyses, and diel fluctuations at each monitoring station.

3.1.4 Key Questions

WAQ 1 addressed many of the questions relating to water quality arising from the Lewis River Cooperative Watershed Studies meetings; however, many of these questions were not addressed, or were addressed only partially. The following section presents water quality-related key questions, and discusses the degree to which they have been addressed by this study.

- What physical and chemical interactions currently exist between reservoirs (especially the Merwin and Yale reservoirs) and what are the potential effects on aquatic species and habitats?

  This question has been addressed in large part with continuous temperature and *in situ* water quality monitoring at the powerhouse tailraces, the effective links between the reservoirs. Data collected during WAQ-1 as well as during Yale relicensing indicate that summer water temperatures and water quality in the upper-most reaches of Lake Merwin are strongly influenced by generation at the Yale powerhouse. During the night and other periods of reduced generation, surface waters from Lake Merwin extend further upstream, increasing Yale tailrace temperatures. As generation increases, cold hypolimnetic water from Yale Lake displaces the warmer water, dropping temperatures substantially (Figure 3.1-2). Daily fluctuation immediately downstream of the tailrace can be upwards of 10°C.

  An effect similar to that seen for temperature also occurs for pH (Figure 3.1-3). Periods of low generation are characterized by higher pH, reflective of greater primary productivity of Lake Merwin surface waters than colder (light-poor) hypolimnetic waters of Yale Lake.

  Changes in temperature and pH in the Yale tailrace suggest that other physical and chemical interactions (nutrients, phytoplankton, zooplankton) occur in upper Lake Merwin as a result of project operations at Yale. Effects of these interactions on aquatic species and their habitats are unknown. In addition, the longitudinal extent of these interactions is not clearly known. However, available data indicate that the narrow region of Lake Merwin upstream of the mouth of Canyon Creek disrupts thermal gradients and acts to dampen the effects of changes in water quality downstream.

- What water quality problems currently exist in the watershed and what are the current conditions and trends in the basin with regard to water quality (e.g., dissolved oxygen, nitrogen [organic and inorganic], phosphorus [total P, Ortho P], TDGs, pH, turbidity, and thermal gradients)?

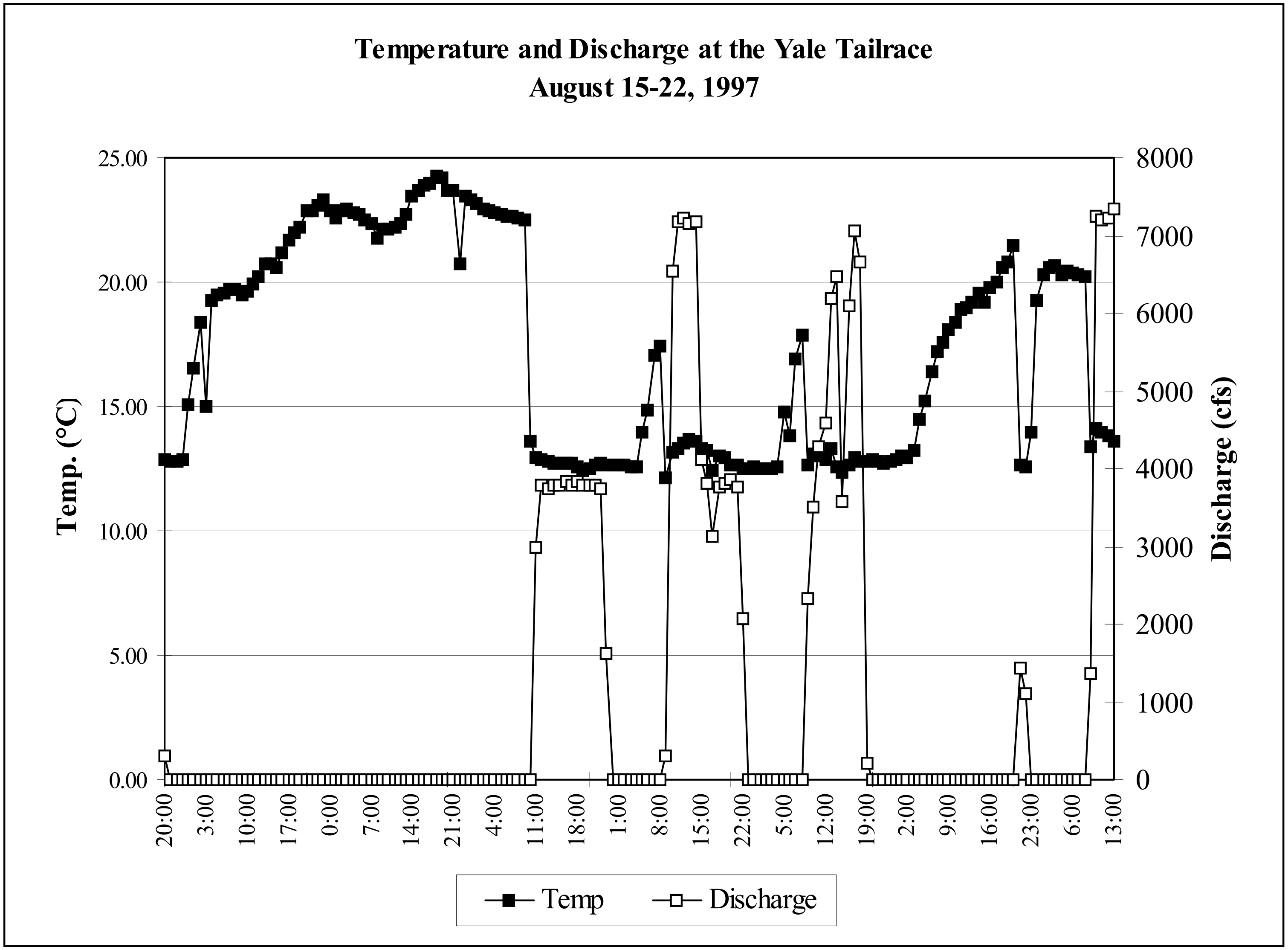

Figure 3.1-2. Hourly monitoring of temperature at Yale Powerhouse tailrace, and average hourly flow; August 15–22, 1997.

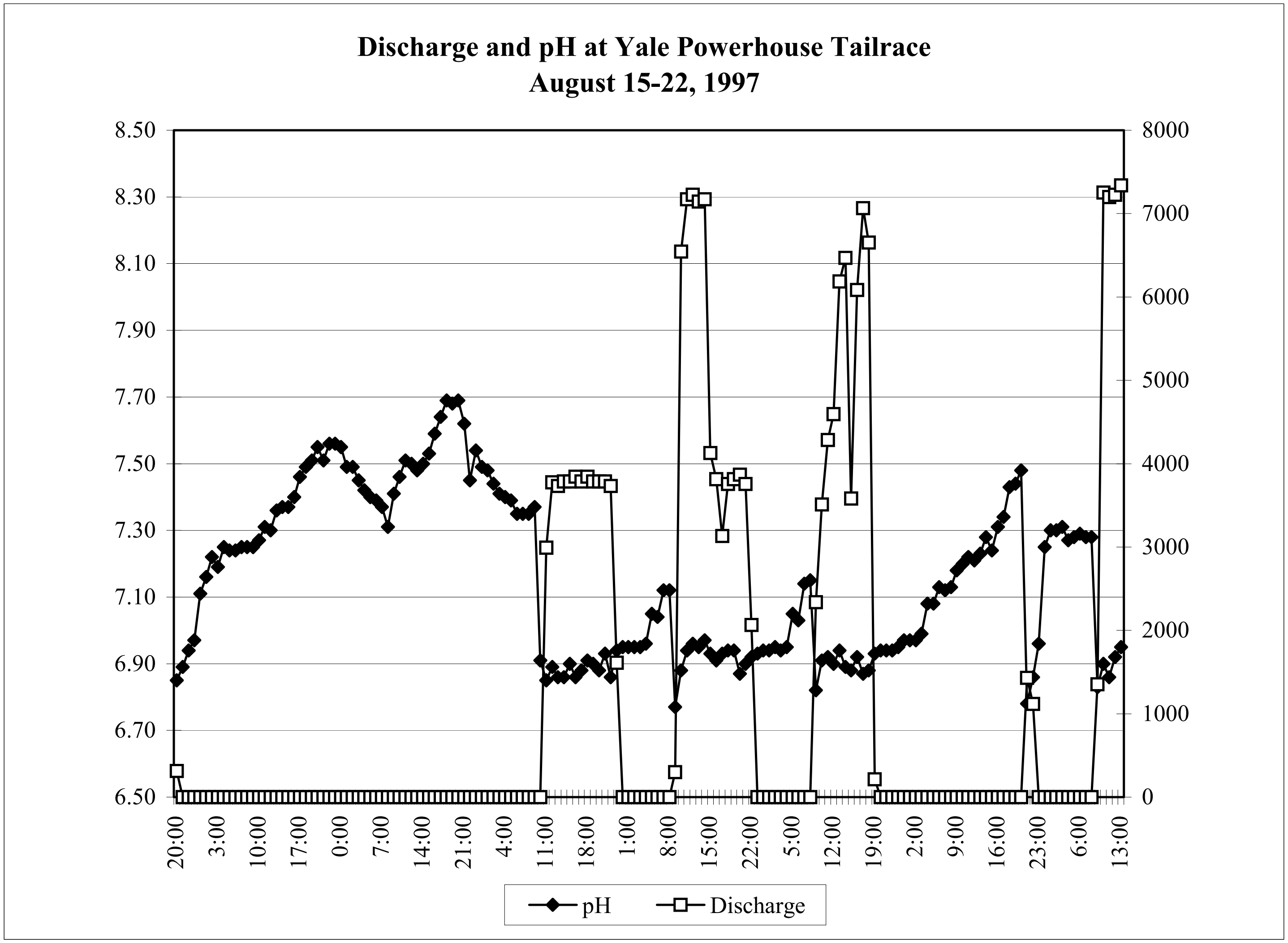

Figure 3.1-3. Hourly monitoring of pH at Yale Powerhouse tailrace, and average hourly flow; August 15–22, 1997.

Study WAQ 1 identified water quality problems and current conditions in project-affected reaches, although long-term trends in water quality cannot be assessed with these data. Additional discussion relative to this question is presented in Section 3.1.6.

- Are state water quality standards being met as required by the federal Clean Water Act?

  Study WAQ 1 addressed this question; some exceedences of State water quality standards were identified (see Section 3.1.6). Most state standards were met, with the exception of TDG in the Yale and Swift No. 1 tailraces and temperature at the lower end of the Swift bypass reach, Canyon Creek, and above the upper diversion of Speelyai Creek.

- How do existing water quality conditions affect existing and potential instream uses (e.g., fish populations, recreational uses, and domestic uses)?

  This question was not directly addressed by this study; however, consistency with state standards, designed to protect instream uses, is an indirect measure of the effects of existing water quality conditions on fish populations, and on recreational and domestic uses.

- What water temperatures and temperature regimes currently exist in reservoirs, downstream areas, and tributaries, and what are the potential effects on aquatic species and food webs?

  Thermal regimes in project reservoirs, tributaries, and downstream of Lake Merwin were characterized during this study; however, potential effects on aquatic species and, in particular, on food webs could not be addressed.

- Where are water temperatures potentially limiting to fish growth, survival, abundance, and/or distribution?

  Reaches where temperatures are potentially limiting to fish growth, survival, abundance, and/or distribution can be inferred from data showing exceedences of WDOE temperature standards (lower end of Swift bypass reach, Canyon Creek, and above the upper diversion of Speelyai Creek). See Section 3.1.6.

- What types of land uses may be acting to increase water temperatures in the basin and what is the potential for reducing water temperatures?

  No assessment of the relationship between land use and water temperature was conducted as a component of this study. In terms of potential for reducing water temperatures, lack of flow in the Swift bypass reach was cited as a key factor in elevated water temperatures.

- What are the potential effects of changes to water quality on aquatic species and ecosystems?

  This question was not addressed by Study WAQ 1; however, inferences can be made about potential effects.

- What is the trophic status of the reservoirs, and how have conditions in these habitats changed?

  Data collected during Yale relicensing studies (1996 and 1997) can be used to address this question. Please see the discussion in Section 3.1.6.

- What nutrient sources might contribute to eutrophication in the basin (e.g., recreational development, grazing, forest fertilization, timber harvest, septic systems)?

  All of these factors are potential contributors; no data have been collected to allow assessment or prioritization of any one of these factors.

- How might water quality characteristics in reservoirs, project-affected stream reaches, and tributaries affect the potential for anadromous fish production upstream of Swift Dam?

  General effects of water quality (i.e., temperature, dissolved oxygen, total dissolved gas) on potential reintroduction have been addressed through WAQ 1.

- What are the short- and long-term effects of the Mount St. Helens eruptions on water quality in the basin (including effects of turbidity on reservoir fish populations [especially kokanee] and reservoir food webs)?

  Effects specific to the eruption of Mount St. Helens are difficult to assess in the absence of pre-eruption water quality data, and cannot be confidently addressed with information collected during WAQ 1. However, nitrogen limitation as a result of volcanic soils in the upper Lewis River watershed is noted is discussed in Section 3.1.6.

- What are the water temperature stratification characteristics of reservoir habitats?

  Stratification characteristics of the reservoirs have been well documented through Study WAQ 1 and in previous studies during Yale relicensing.

- What are the effects of reservoir drawdowns on water temperatures, stratification, and dissolved oxygen?

  Describing the effects of reservoir drawdowns on water quality was not an objective of this study. However, monthly visits to Yale (1996 and 1997) and to Merwin during Study WAQ 1 documented reservoir temperatures and *in situ* water quality over a range of reservoir elevations.

- What water temperatures and dissolved oxygen levels occur in project tailraces and what are the effects of reservoir water temperatures and dissolved oxygen levels on downstream reaches?

  The downstream-most sampling site in this study was the Lewis River at Eagle Island, approximately 11 miles upstream of the mouth of the Columbia River.

- What are the effects of unplanned releases on water quality (e.g., TDG, turbidity)?

WAQ 1 could not address the effects of unplanned releases on water quality.

- What are the effects of flow regulation on water temperatures in stream, and reservoir habitats?

  Effects of flow regulation on water temperature in flowing water can be inferred by comparing the data collected in the Swift bypass reach with an unregulated reach, e.g., the mouth of Pine Creek.

- What are the temperature effects of dam releases and the potential effects on aquatic species?

  Thermal effects of flow releases were assessed using tailrace water temperature data collected during WAQ 1.

- How do flow fluctuations affect water quality downstream?

  Downstream effects of flow fluctuations on water quality, such as ramping below Merwin, were not directly addressed by WAQ 1.

- How do reservoir discharges affect downstream water quality?

  Evaluation of effects of flow releases on downstream temperatures were assessed with data collected during WAQ 1. Effects of discharges on other measured parameters can be inferred but are more difficult to assess given dilution effects, land use impacts, etc.

- Does gas supersaturation occur at any project facilities?

  WAQ 1 characterized monthly TDG levels at the tailraces. Study WAQ 2 and WAQ 4 address this question directly.

- How do water temperatures at the Speelyai Creek hatchery diversion vary when composed of natural surface flow vs. primarily groundwater flow?

  Data collected during the summer months downstream of the diversion reflect groundwater flow, and data collected in the winter months reflect surface flows.

- What would be the effects on the quality of water reaching the hatchery if the water was routed through lower Speelyai Creek?

  Study WAQ 1 includes a comparison of upper and lower Speelyai Creek water temperature and water quality, allowing the assessment of potential changes to water reaching the hatchery.

3.1.5 Results

Data collected to date from May 1999 through April 2000 are described in this report. Time-series plots of many of the *in situ* and laboratory results are included in the body of this report to illustrate site-to-site and seasonal variability; all of the data collected are provided in the various appendices referenced throughout this section.

3.1.5.1. Water Temperature

Hourly temperature data collected during this study are contained in 4 appendices. A summary of the hourly temperature measurements is presented in WAQ 1 Appendix 1. This summary table contains the minimum, maximum, and mean temperatures; difference between maximum and minimum temperature; standard deviation of recorded temperatures; and number of temperature measurements for each day at each of the monitored sites. Data gaps occurring due to lost or stolen thermographs or instrument failure are also indicated in this appendix. Plots of minimum and maximum hourly temperatures recorded at all sites are contained in WAQ 1 Appendix 2. Monthly percent exceedance analyses for both hourly temperature measurements and diel temperature fluctuations for the period May 1999 through April 2000 are displayed in WAQ 1 Appendices 3 and 4, respectively.

Maximum temperatures were recorded at most sites in August. Maximum water temperatures and the maximum 7-day average maximum temperatures at each site are shown in Table 3.1-4. Note that several of the sites do not have complete records for each month. These data gaps were caused by various factors, including the timing of the original deployment, water levels dropping below the location of thermographs, or the inability to retrieve and download thermographs due to high flows.

Table 3.1-4. Maximum of daily maximum and 7-day running mean of daily maximum water temperatures by site.

Site	Max. Temp. (°C)	Number of Days > WDOE Criteria	Max. 7-Day Mean Max (°C)
Class AA (16°C)			
PINCM	14.3	0	13.7
DRICM	**16.3**	**1**	**15.8**
SWICM	10.5	0	10.2
CANCM	**19.5**	**43**	**18.8**
SPLYU	**18.7**	**35**	**18.2**
SPLYL	14.3	0	13.6
SWREI	15.1	0	14.6
Class A (18°C)			
OLECM	16.6	0	16.1
SW1TR	13.9	0	13.3
SW2BL	**18.2**	**1**	**17.5**
SW2TR	15.4	0	13.9
YALTR	17.0	0	15.3
MERTR	15.5	0	15.5
LEWEA	16.3	0	15.7
Lake Class	**No Criteria**		
MERLI	23.4	**	22.8

** Applicable criteria not directly related to a single temperature.

The applicable numeric criteria were exceeded at 3 of the 6 sites with a Class AA designation and 1 of the 8 sites with a Class A designation. Exceedences of the Class AA criteria were recorded at the mouths of Drift Creek (DRICM) and Canyon Creek (CANCM), and at Speelyai Creek above the diversion (SPLYU). A single measurement of 16.3°C recorded on August 4, 1999 was the only value recorded in Drift Creek that was greater than the 16.0°C criterion. In contrast, temperatures greater than 16.0°C persisted during much of July and August 1999 in both Canyon Creek and upper Speelyai Creek. Maximum temperatures of about 19°C were recorded in both creeks, and each creek's maximum 7-day mean maximum temperature was greater than 18.0°C. The only exceedence of the 18.0°C Class A criterion was a value of 18.2°C recorded at the lower end of the Swift bypass reach (SW2BL) on August 4, 1999.

Temperature measurements overall ranged from a low of 0.3°C in upper Speelyai Creek on December 22, 1998 to a high of 23.4°C at the inflow to Lake Merwin (MERLI) on August 28, 1999. Water temperatures of less than 3.0°C were only recorded at 2 of the 15 monitored sites (WAQ 1 Appendix 3): at the inflow to the Swift Reservoir from December 1999 through March 2000, and in Speelyai Creek upstream of the diversion during December 1998. Note that during the winter of 1999/2000, Speelyai Creek's temperature remained above 3.0°C at this site. The temperature of Speelyai Creek remained above 5.0°C near its mouth during the entire period monitored (October 1998–April 2000). This appears to be due to the substantial groundwater inflow between the 2 monitored sites in Speelyai Creek.

As indicated above, the warmest temperatures recorded during this study were at the Highway 503 crossing of Lake Merwin. Temperatures of more than 20.0°C were recorded at this site during the months of July through September 1999. Temperatures at all of the other sites monitored remained below 20°C. Monthly median temperatures at the monitored sites are shown in Table 3.1-5.

In addition to analyses mentioned above, several paired comparisons were made to assess upstream-downstream changes in daily mean temperature between key locations in the project area, including:

- Below and above Swift Reservoir
- Below and above Yale Lake
- Below and above Lake Merwin
- Below Lake Merwin and Eagle Island
- Below Lake Merwin and above Swift Reservoir

Comparison of Lewis River temperatures downstream of Lake Merwin (MERTR) and above Swift Reservoir (SWREI) reveals that the river was generally warmer below Lake Merwin than above Swift Reservoir (Figure 3.1-4). The largest differences in daily mean temperatures occurred in September through December, when Merwin powerhouse tailrace temperatures were generally between 4 and 10°C warmer than the inflow to Swift Reservoir. From January through August, Merwin tailrace temperatures were within 4°C of the inflow to Swift Reservoir. A large fraction of the difference in temperature between MERTR and SWREI is due to differences that occur between the inflow and outflow of Swift Reservoir itself (Figure 3.1-5). Swift outflow temperatures (at SW1TR) exceeded inflow temperatures by approximately 6°C in November. However, SW1TR temperatures are about 2ºC cooler than the inflow during July and August. Summer cooling in Swift is negated by overall warming within Yale Lake. With few exceptions, YALTR was warmer than SW2TR, by nearly 6°C in September (Figure 3.1-6). However, similar to Swift, the Lewis River becomes cooler in Lake Merwin during August and September (Figure 3.1-7). Summer temperatures at Eagle Island downstream of Lake Merwin were within 2°C of those observed at the Merwin tailrace.

Comparison of the daily mean temperatures for upper and lower Speelyai Creek shows that the lower site was cooler than the site upstream of the diversion during mid-summer through early fall, by over 4°C in September (Figure 3.1-8). In contrast, lower Speelyai Creek was warmer during the remainder of the year.

Table 3.1-5. Monthly median water temperatures (°C) for Lewis River and tributary sites, October 1998–May 2000.

Month-Year	SWREI*	SW1TR*	SW2BL*	SW2TR*	YALTR*	MERLI*	MERTR*	LEWEA*
Apr-99	---	---	Nm	Nm	Nm	Nm	---	Nm
May-99	5.9	7.4	9.2^	8.1^	9.0^	Nm	7.5	Nm
Jun-99	7.2	8.8	10.7	9.2	10.4	11.6^	9.6	10.4
Jul-99	9.7	9.1^	13.0	10.0	11.6	17.8	11.9	12.2
Aug-99	11.4	9.8	14.1	11.2	12.9	21.2	12.9	13.5^
Sept-99	9.4	10.7	12.0	11.8	13.8^	18.4^	13.9	Nm
Oct-99	7.7^	12.1	10.7	12.0	12.4^	12.3^	15.0	Nm
Nov-99	5.2^	9.8^	8.9^	9.4	10.4	10.2	12.1	Nm
Dec-99	4.1	5.5^	Nm	6.0	7.0	7.0	8.2	Nm
Jan-00	2.8	4.4	4.6^	4.4	5.2	5.1	5.9	Nm
Feb-00	3.6	4.3	5.2^	4.1	4.7	4.8	5.3	Nm
Mar-00	4.2	4.7	6.2^	4.7	5.2	5.3	5.3	Nm
Apr-00	5.3^	6.9	7.7	6.7^	7.0^	7.9	5.6^	Nm
May-00	Nm	8.0	9.0	Nm	Nm	9.2	Nm	Nm

Month-Year	PINCM	DRICM	SWICM	CANCM	SPLYU	SPLYL	OLECM
Oct –98	Nm	Nm	Nm	Nm	9.3^	10.1^	Nm
Nov-98	Nm	Nm	Nm	Nm	7.7	9.4	Nm
Dec-98	Nm	Nm	Nm	Nm	5.8	8.2	Nm
Jan-99	Nm	Nm	Nm	Nm	Nm	8.1	Nm
Feb-99	Nm	Nm	Nm	Nm	Nm	7.9	Nm
Mar-99	Nm	Nm	Nm	Nm	Nm	8.2	Nm
Apr-99	---	Nm	Nm	Nm	Nm	9.1	---
May-99	6.4	Nm	Nm	Nm	Nm	9.8	6.6
Jun-99	7.9	8.7^	6.5^	10.2^	9.9^	10.9	9.8
Jul-99	8.8	11.8	7.3	14.2	13.1	11.5	11.9
Aug-99	8.8	13.5	7.6	16.3	15.2	11.8	13.6
Sept-99	7.8	11.0	6.8	13.6	13.3	11.0	13.0
Oct-99	7.0	8.5^	6.0	9.0	10.0	9.8	11.0^
Nov-99	6.7^	Nm	5.9^	7.9	7.6	9.4	Nm
Dec-99	Nm	Nm	Nm	6.5	6.0	8.6	Nm
Jan-00	Nm	Nm	Nm	5.3^	4.4	7.8	4.1^
Feb-00	Nm	Nm	Nm	5.6^	4.9	8.2	5.0
Mar-00	5.3^	Nm	Nm	5.9	5.4	8.5	5.4
Apr-00	6.2	Nm	Nm	7.5	6.8	9.9^	7.2
May-00	7.5	Nm	Nm	8.9	8.3	Nm	8.4

* No temperature measurements were made during October 1998 – March 1999.
^ More than 5 days not monitored or less than 5 days monitored.
Nm: Not measured.

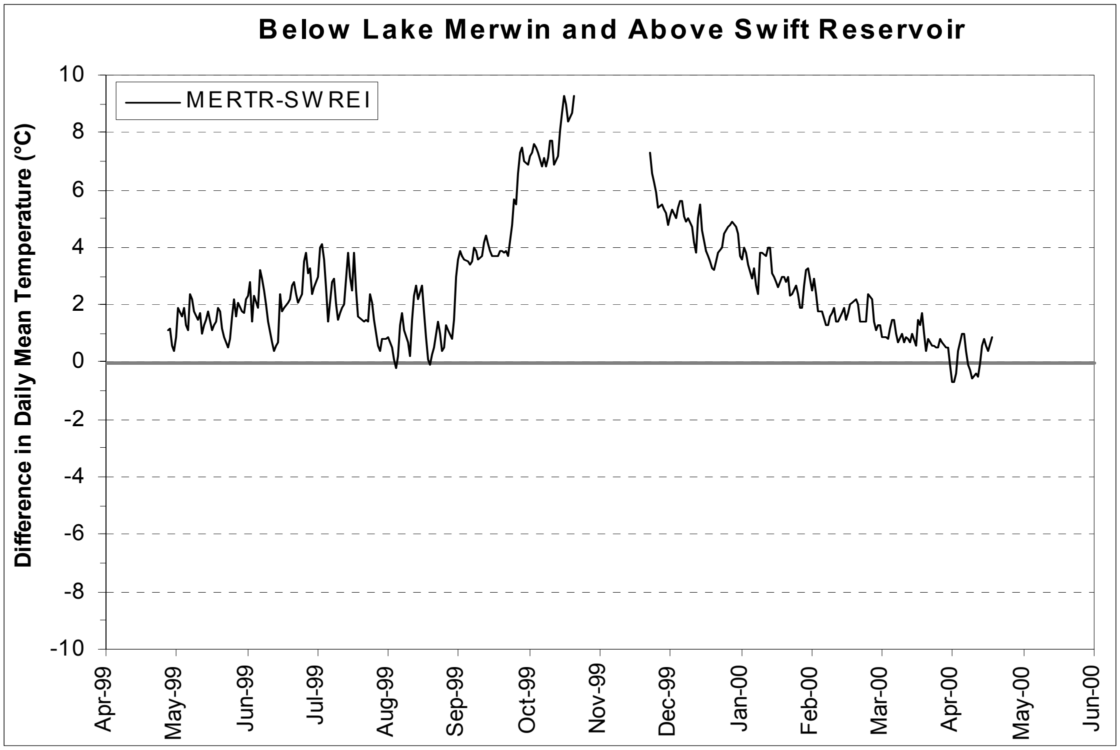

Figure 3.1-4. Comparisons of daily mean temperatures in the Lewis River below Lake Merwin and above Swift Reservoir.

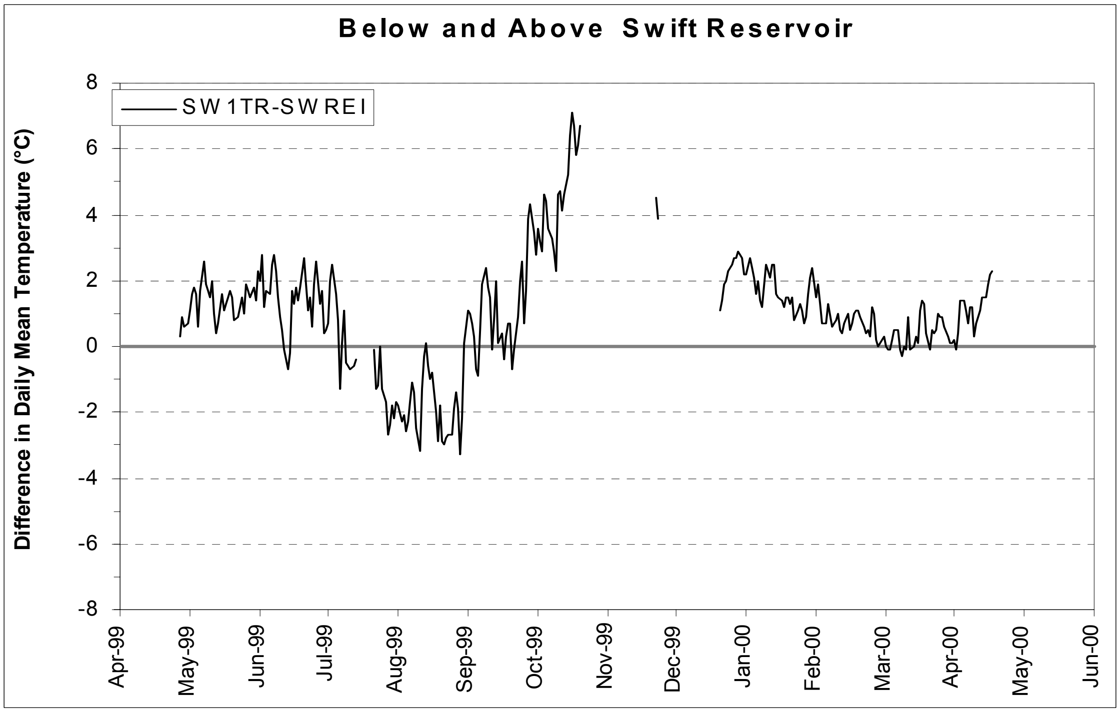

Figure 3.1-5. Comparisons of daily mean temperatures in the Lewis River below and above Swift Reservoir.

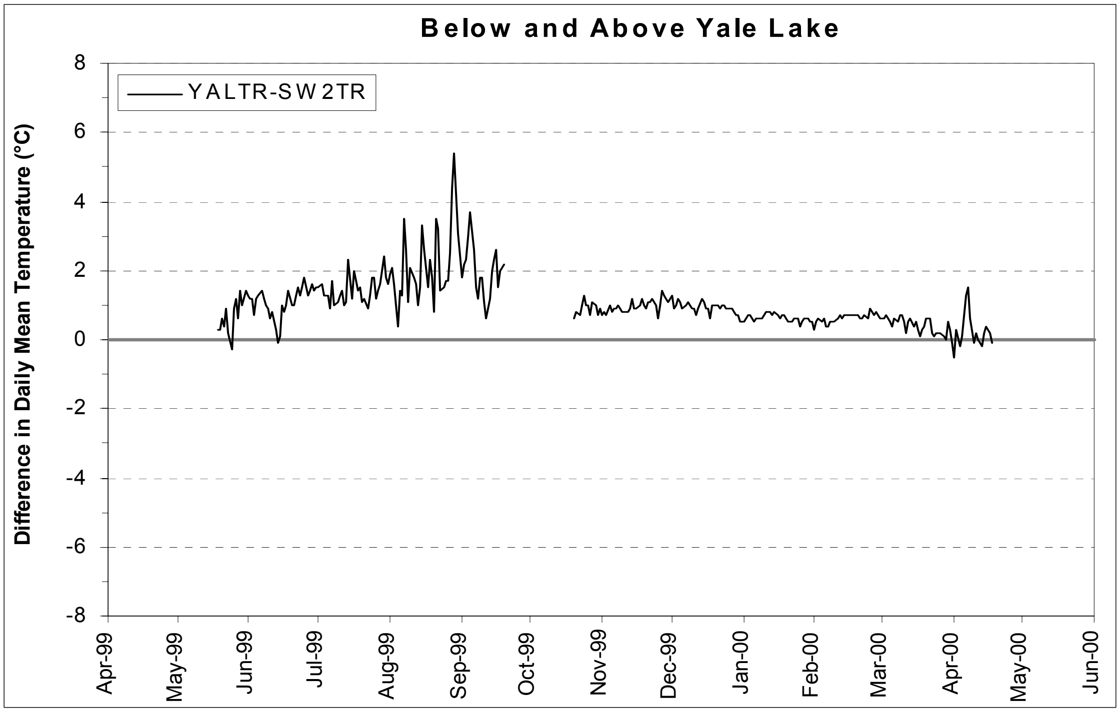

Figure 3.1-6. Comparisons of daily mean temperatures in the Lewis River below and above Yale Lake.

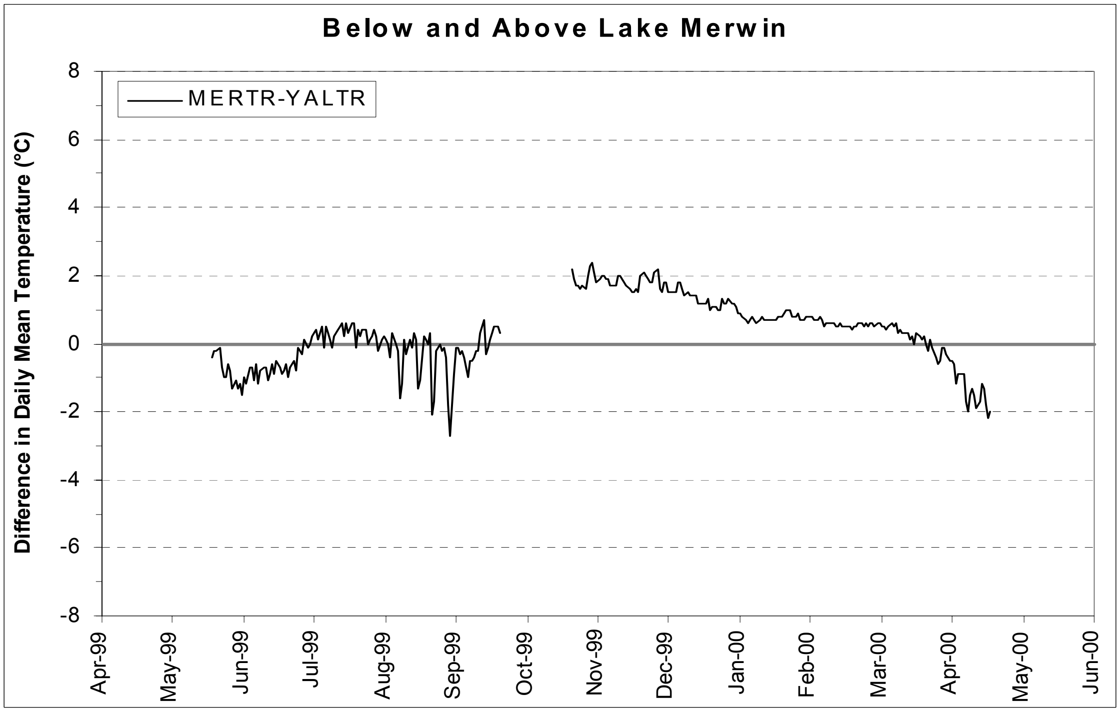

Figure 3.1-7. Comparisons of daily mean temperatures in the Lewis River below and above Lake Merwin.

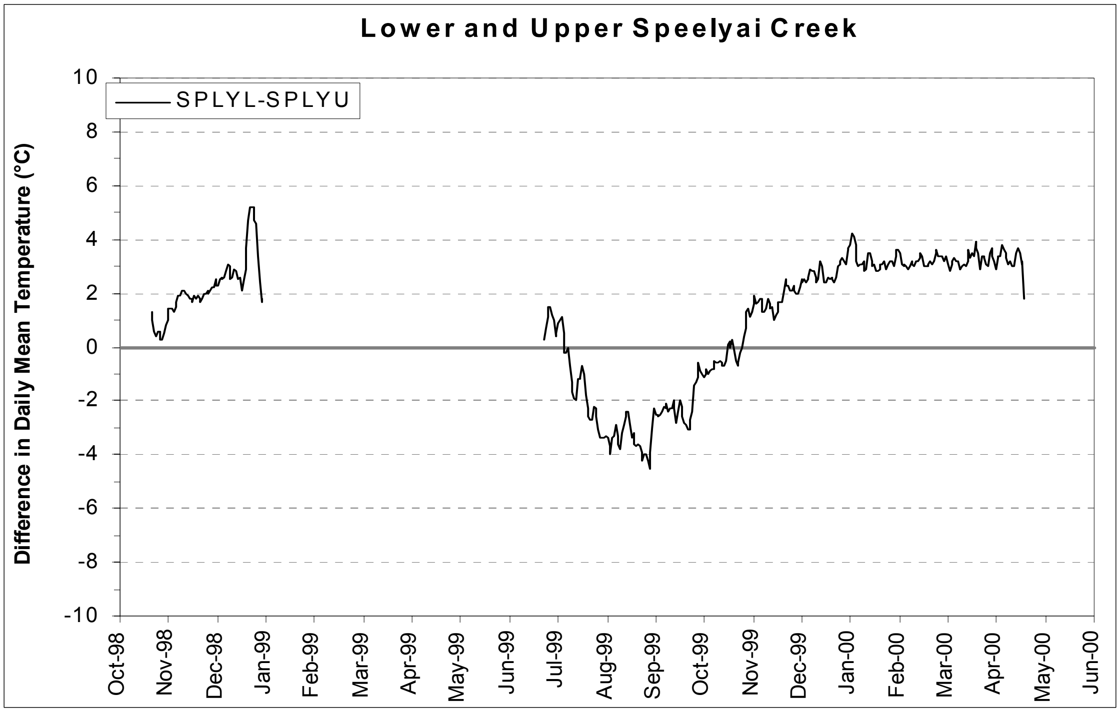

Figure 3.1-8. Comparisons of daily mean temperatures between Lower and Upper Speelyai Creek.

3.1.5.2 Laboratory Results

Results of laboratory analyses (in contrast to *in situ* measurements) are described in this section. Tabular summaries of these data are contained in WAQ 1 Appendix 5.

As described above, documentation of compliance with and/or exceedences of water quality standards for surface waters in the State of Washington has been an important objective of studies completed to date. Washington water quality standards are contained in Chapter 173-201A of the Washington Administrative Code (WAC). WDOE has defined classes of water quality, ranging from Class AA (extraordinary) to Class C (fair). In addition, a separate Lake Class exists. Numeric water quality standards have been developed for each of these classes. As described in Chapter 173-201A(120) WAC, Lake Class consists of all lakes, reservoirs with a mean detention time of 15 days or more, and reservoirs established on pre-existing lakes. With a retention time of greater than 15 days, all 3 reservoirs on the North Fork of the Lewis River are classified as Lake Class. All other mainstem Lewis River reaches within the project area (downstream of the boundary of the Gifford Pinchot National Forest) are designated Class A. However, feeder streams to the project reservoirs are designated Class AA. Thus, streams and impoundments within the study area are subject to water quality standards in each of 3 classifications (Table 3.1-6).

Table 3.1-6. Summary of WDOE surface water quality standards for Class A, Class AA, and Lake Class water bodies.

Parameter	Class A Standard	Class AA Standard	Lake Class Standard
Fecal Coliform	Not to exceed geometric mean of 100 col./100 mL, less than 10% of all samples exceeding 200 col./100 mL.	Not to exceed geometric mean of 50 col./100 mL, less than 10% of all samples exceeding 100 col./100 mL.	Not to exceed geometric mean of 50 col./100 mL, less than 10% of all samples exceeding 100 col./100 mL.
Dissolved Oxygen	Must exceed 8.0 mg/L.	Must exceed 9.5 mg/L.	No measurable decrease from natural conditions.
Total Dissolved Gas	Not to exceed 110% of saturation.	Not to exceed 110% of saturation.	Not to exceed 110% of saturation.
Temperature	Must not exceed 18°C[1].	Must not exceed 16°C.	No measurable change from natural conditions.
pH	Within 6.5 to 8.5[2].	Within 6.5 to 8.5[2].	No measurable change from natural conditions.
Turbidity	Not to exceed 5 NTU over background, or 10% over background of 50 NTU or more.	Not to exceed 5 NTU over background, or 10% over background of 50 NTU or more.	Not to exceed 5 NTU over background conditions.

[1] When natural conditions exceed 18°C, no temperature increase will be allowed which raises receiving water temperature by more than 0.3°C. Incremental increases from point source activities may not exceed t=23/(T+7), where t = maximum possible increase at the mixing zone boundary, and T is background, unaffected upstream temperature. Incremental increases from nonpoint sources may not exceed 2.8°C.

[2] Human-caused variation must be within a range of 0.2 pH units.

WDOE standards for several metals and pesticides also exist and will be referenced as appropriate within the following sections.

Metals

As discussed in meetings of the ARG during the summer of 1999, levels of mercury were well below the chronic standard (0.012 µg/L) at all sampling locations (Lewis River inflow to Swift, Yale tailrace, and Merwin tailrace). Samples were collected in June, September, and December 1999; and in March 2000. Analytical detection limits were low (0.0005 µg/L), and field methods were as prescribed for low level mercury analyses by Frontier Geosciences.

For other metals analyzed during this study (with the exception of manganese), Freshwater Chronic Criteria (FCC) presented in WAC 173-201A-040(3) assume a hardness of 100 mg/l. Given the much lower hardness values measured at tailrace sites during this study (typically 10-11 mg/l), hardness specific criteria were calculated based on formulae provided in the standards referenced above. To provide the most conservative (i.e., lowest FCC, hardness values used for these calculations were the lowest) values measured at each of the tailrace sites.

Results of metals analyses show no exceedences of the FCC for any of the metals analyzed (Table 3.1-7). However, concentrations of copper were equal to the FCC on 4 occasions, and concentrations of lead were equal to the FCC on 2 occasions. Five of these 6 values were from samples collected in March 2000. Lead concentrations at SW2TR and YALTR were also elevated in March 2000 relative to other results at these sites, suggesting laboratory or field contamination of these samples. WDOE has no FCC for iron.

Pesticides

Results of pesticide analyses for parameters listed previously in Table 3.1-3 were less than instrument detection limits.

Fuels

Results of TPH analyses were less than instrument detection limits for all 3 components (gasoline 44 μg/l, diesel 110 μg/l, and oil 220 μg/l) for all sampling dates. It should be noted that recreational impact on water quality is currently an active topic of discussion among the Lewis River ARG. This discussion focuses on unspent fuels released from jet skis and potential polycyclic aromatic hydrocarbon (PAH) toxicity. The TPH data collected during this study do not meet the rigorous analytical requirements needed for assessment of PAH; thus, no inference should be drawn relative to that issue.

Cations/Anions

Levels of cations and anions were low; average alkalinity ranged from 18.3 mg/l at Yale to 23.5 mg/l at the Swift No. 1 tailrace (Table 3.1-8). Lewis River waters are dilute and similar to the Cowlitz River to the north (for which recent data are available). On an equivalent basis, the sum of cations ranged between 0.3 and 0.6 meq/l. Two sites on the Cowlitz River, Mossyrock powerhouse tailrace and downstream of the Mayfield Dam, each had cation sums of about 0.5 meq/l for data collected at 3-month intervals, May 1997 through February 1999 (Tacoma Power 2000). For comparison, the Little River at Peale, OR and Wolf Creek, 2 streams in the North Umpqua River watershed, have cation sums of 1 meq/l based on data recently collected by the USGS (pers. comm., C. Anderson, January 12, 2001). A cation anion balance was not conducted on the Lewis River data due to the absence of bicarbonate measurements, which may comprise 90 percent of the total anions on an equivalent basis.

Turbidity

Turbidity at the mainstem upper watershed sites was generally low during the summer months (1-2 NTUs), and comparatively high with the onset of fall rains from November through January (Figure 3.1-9 [a & b]). Values at the Swift Reservoir inflow were 18 and 33 NTUs in November and December, respectively. Turbidity at Swift No. 1 and No. 2 tailraces was nearly identical; thus, one can serve as a surrogate for the other on days when Swift No. 1 could not be accessed. Turbidity near the intake at Swift No. 1 was slightly higher than near surface samples on all occasions, but not by more than 2 NTUs. Turbidity at the downstream end of the Swift bypass reach was consistently less than 2 NTUs throughout the monitoring period.

Table 3.1-7. Results of metals analyses at Lewis River project monitoring sites. Note: FCC values differ based on measured hardness.

Site	Date Time	Hardness (mg/l)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Fe (µg/l)[1]	Hg (µg/l)	Mn (µg/l)	Ni (µg/l)	Pb (µg/l)	Zn (µg/l)
MERTR	**WDOE Criteria (FCC)**		**0.19**	**27**	**2**	**NA**	**0.01200**	**NA**	**22**	**0.19**	**15**
	06/23/99 18:30						0.00084				
	07/21/99 15:20	11	<0.02		<1	69		8.7	<5	<0.05	6
	09/23/99 14:20	11	0.03	<1	<1	28	0.00042		<5	<0.05	<1
	12/20/99 08:10	10	0.11	2	<1	130	0.00090		<5	0.08	12
	03/22/00 09:15	11	<0.02	<1	<1	58	0.00071		<5	0.19	<1
SW1TR	**WDOE Criteria (FCC)**		**0.20**	**29**	**2**	**1000**	**0.01200**	**NA**	**24**	**0.21**	**16**
	07/21/99 09:00	20	<0.02		<1	900		230	<5	<0.05	<1
	09/22/99 10:45	11	<0.02	<1	<1	16			<5	<0.05	<1
	12/20/99 11:15	11	0.07	2	2	180			<5	0.09	6
	03/21/00 15:00	13	<0.02	<1	2	140			<5	0.21	<1
SW2TR	**WDOE Criteria (FCC)**		**0.20**	**29**	**2**	**1000**	**0.01200**	**NA**	**24**	**0.21**	**16**
	07/21/99 11:10	11	<0.02		<1	62		4.3	<5	<0.05	<1
	09/22/99 12:30	11	<0.02	<1	<1	19			<5	<0.05	<1
	12/20/99 12:30	11	0.20	<1	<1	170			<5	<0.05	11
	03/21/00 15:50	13	<0.02	<1	2	150			<5	0.19	1
SWREI	**WDOE Criteria (FCC)**						**0.01200**				
	06/22/99 16:45						0.00052				
	09/22/99 09:40						0.00036				
	12/19/99 14:20						0.00385				
	03/21/00 11:05						0.00045				
YALTR	**WDOE Criteria (FCC)**		**0.19**	**27**	**2**	**1000**	**0.01200**	**NA**	**22**	**0.19**	**15**
	06/23/99 13:30						0.00052				
	07/21/99 12:40	11	<0.02		<1	41		1.7	<5	<0.05	1
	09/22/99 17:40	11	<0.02	<1	<1	7	0.00050		<5	<0.05	<1
	12/20/99 13:15	10	0.08	1	<1	190	0.00118		<5	<0.05	4
	03/21/00 16:50	11	<0.02	<1	2	59	0.00058		<5	0.14	3

Note: WDOE freshwater chronic criteria shown were calculated based on lowest hardness value at each site.

Table 3.1-8. Results of cation and anion measurements at Lewis River tailrace sites.

	Alkalinity		Chloride		Sulfate		Calcium		Magnesium		Potassium		Sodium		Silicon
Date	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l
MERTR															
Jul-99	30	2.50	1.10	0.03	1.5	0.03	3.1	0.15	0.8	0.07	0.57	0.01	2.60	0.11	4.8
Sep-99	16	1.33	1.10	0.03	1.9	0.04	3.0	0.15	0.8	0.07	0.61	0.02	2.90	0.13	6.4
Dec-99	18	1.50	1.10	0.03	2.3	0.05	2.8	0.14	0.7	0.06	0.49	0.01	2.40	0.10	3.8
Mar-00	16	1.33	2.80	0.08	4	0.08	3.0	0.15	0.9	0.07	0.39	0.01	2.30	0.10	6.6
SW1TR															
Jul-99	32	2.67	0.97	0.03	1.7	0.04	5.6	0.28	1.5	0.12	0.80	0.02	3.20	0.14	5.9
Sep-99	18	1.50	1.10	0.03	2.2	0.05	3.0	0.15	0.9	0.08	0.70	0.02	3.40	0.15	7.7
Dec-99	24	2.00	1.00	0.03	2.3	0.05	3.1	0.15	0.9	0.07	0.63	0.02	2.80	0.12	4.6
Mar-00	20	1.67	2.40	0.07	4	0.08	3.3	0.16	1.2	0.10	0.60	0.02	2.80	0.12	7.8
SW2TR															
Jul-99	22	1.83	0.93	0.03	1.9	0.04	2.9	0.15	0.8	0.07	0.63	0.02	2.70	0.12	5.2
Sep-99	18	1.50	1.10	0.03	2.3	0.05	3.0	0.15	0.9	0.08	0.62	0.02	3.20	0.14	7.5
Dec-99	19	1.58	1.00	0.03	2.4	0.05	3.2	0.16	0.9	0.07	0.62	0.02	2.70	0.12	4.6
Mar-00	20	1.67	2.00	0.06	4	0.08	3.3	0.16	1.2	0.10	0.57	0.01	2.80	0.12	7.8
YALTR															
Jul-99	22	1.83	0.96	0.03	1.5	0.03	3.0	0.15	0.8	0.07	0.60	0.02	2.60	0.11	5.0
Sep-99	17	1.42	1.10	0.03	2.2	0.05	3.0	0.15	0.9	0.07	0.61	0.02	3.20	0.14	7.0
Dec-99	17	1.42	1.00	0.03	2.1	0.04	2.9	0.15	0.8	0.06	0.50	0.01	2.40	0.10	4.0
Mar-00	17	1.42	1.60	0.05	4	0.08	3.0	0.15	0.9	0.08	0.44	0.01	2.40	0.10	6.9

In general, turbidity at lower watershed sites (Merwin inflow, near dam, tailrace, and Eagle Island) was similar to the upper watershed during the summer months, with values less than 2 NTUs. Winter and spring months were higher but reached a maximum of about 4 NTUs, a smaller percentage increase than seen at sites in the upper basin.

Turbidity measured at depth in Lake Merwin (near the Merwin intake, MERLD-D) was higher than all other sites from July through October 1999. Values increased sharply from June through August to over 6 NTUs, declining to under 2 NTUs in November. This is a unique pattern among the data and appears specific to Lake Merwin (i.e., upstream data at Yale or Swift tailraces do not explain this pattern, nor do data collected at the Merwin tailrace).

In addition to monthly turbidity measurements, WDOE requested that PacifiCorp collect samples for turbidity analysis prior to and following a drawdown of Lake Merwin in October 2000. A 4-foot (1.2 m) drawdown, from 233 to 229 feet (71 to 70 m), occurred between October 6 and October 10, 2000. Samples were collected on both dates at 3 locations: upper, mid-reservoir, and near dam (forebay) locations, and at depths of 2 meters and 7.5 meters at each site. Samples were also collected at the Merwin tailrace. Heavy rains (0.26 inch [0.6 cm]) were recorded at Merwin dam on October 9, and rain continued during sampling on October 10 (0.03 inch [0.07 cm]). Turbidity was low (less than 2 NTUs, Table 3.1-9) on both dates.

Total Phosphorus (TP)

TP was generally less than 0.05 mg/L at all sites. A discernable pattern observed among the mainstem sites was increasing TP concentration at the inflow to Swift Reservoir (SWREI) from July through October 1999, possibly due to increasing snowmelt in runoff from Mount St. Helens (Figure 3.1-10 [a & b]). TP at SWREI in December (approximately 0.09 mg/l) was unusually high and is likely a result of adsorbed phosphorus in highly turbid water at that time (note: SWREI turbidity in December 1999 was 33 NTUs, highest of all monitoring events). TP in samples collected in July 1999 near Eagle Island (LEWEA) was the highest measured during the study period (0.13 mg/l). TP at the Merwin tailrace was also relatively high at this time, in contrast to other mainstem sites (0.04 mg/l).

TP values at tributary sites in the upper watershed (Pine Creek, Drift Creek, and Swift Creek) were 2-3 times higher than concentrations at the mouths of Ole and Canyon Creek, and above the diversion on Speelyai Creek (SPLYU). However, Drift Creek, which flows north into Swift Reservoir and is not a Mount St. Helens tributary, had consistently lower TP values than the 2 streams on the north side of the reservoir.

TP was also comparatively high in the hatchery effluents, particularly in comparison to Ole Creek, Canyon Creek, and upper Speelyai Creek. TP in the Speelyai Hatchery effluent was over 10 times higher than in upper Speelyai Creek in October and November 1999 (at approximately 0.07 mg/l), and was typically more than 3 times as high as samples collected above the diversion. Whether this can be attributed to the hatchery is questionable, because the high water table in this reach may be influenced by septic systems or by naturally higher background phosphorus levels.

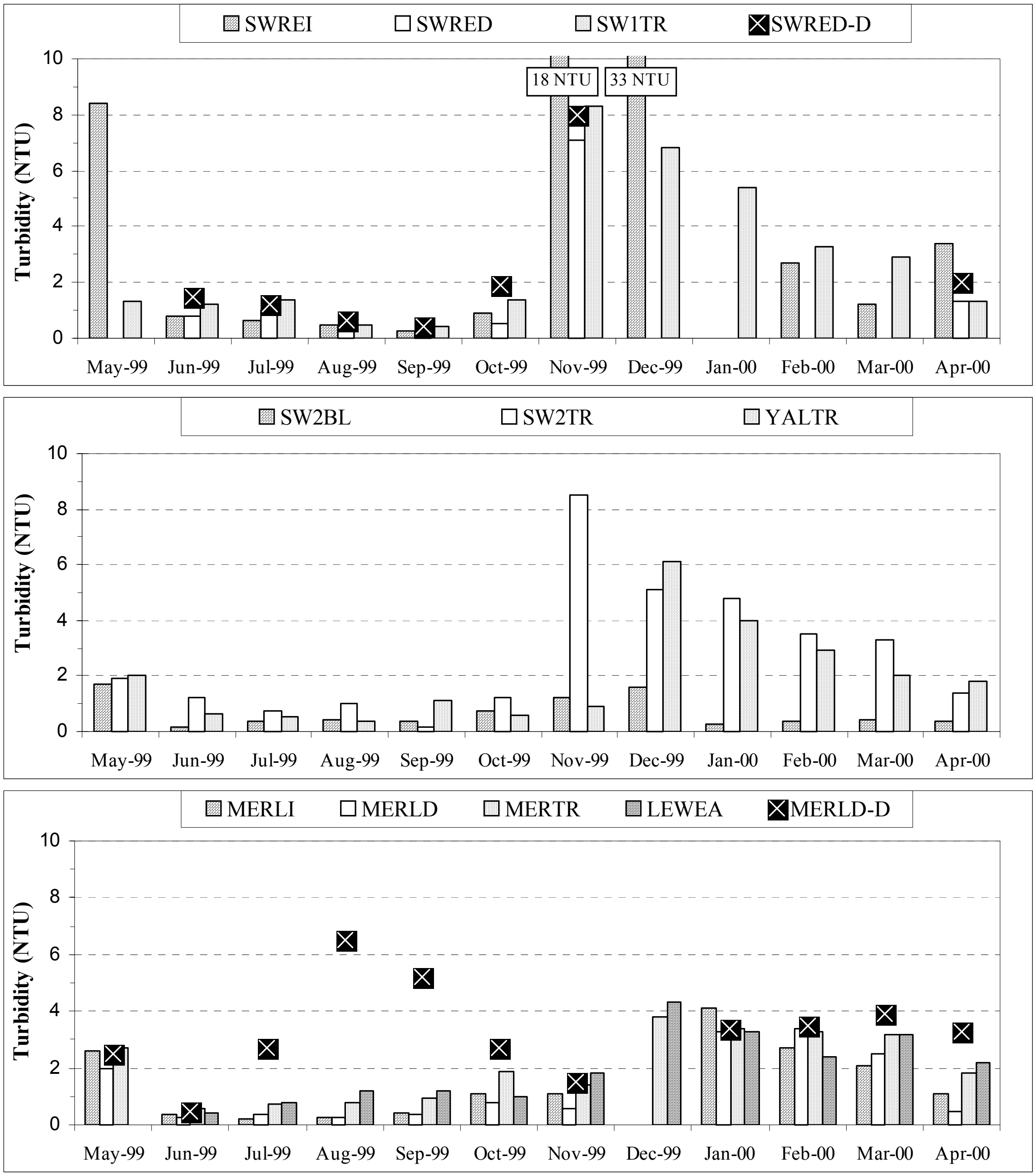

Figure 3.1-9(a). Turbidity at Lewis River mainstem monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that no data were collected. Some sites were not accessible during May and December through March.

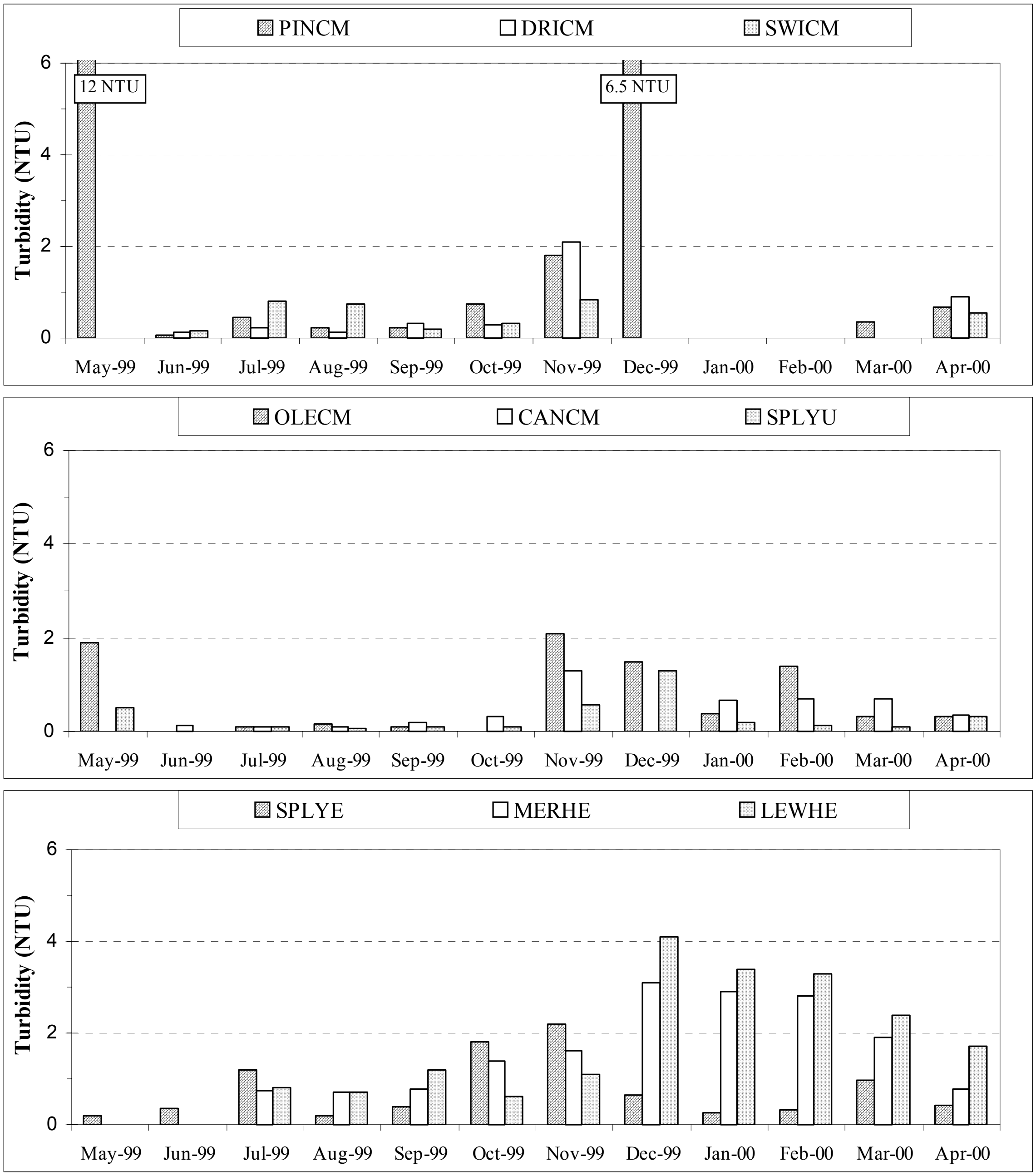

Figure 3.1-9(b). Turbidity at Lewis River tributary and hatchery effluent monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that no data were collected. Sampling of MERHE and LEWHE was added in July, OLECM was dry in October, and some sites were not accessible during May and December through March.

Table 3.1-9. Results of turbidity analyses prior to and following Merwin drawdown, October 2000.

Site	Turbidity (NTUs)	
	10/6/00	10/10/00
Upper - 2 m	0.35	0.30
Upper- 7.5 m	0.30	0.30
Mid. Res. 2 m	0.25	0.30
Mid. Res. 7.5 m	0.25	0.25
Forebay - 2 m	0.35	0.25
Forebay 7.5 m	0.35	0.20
MERTR	0.70	1.15

With the exception of July 1999, TP at the sites near Swift and Merwin dams was less than 0.02 mg/l at both surface and near intake depths. A concentration of 0.046 mg/l was measured near the surface of Swift Reservoir in July 1999.

The total phosphorus values recorded at Swift and Merwin during this monitoring program were consistent with WDOE criteria for ultra-oligotrophic lakes in the Puget Lowlands and Cascades Ecoregions (WAC 173-201A-030, Table 1). Values of 0-4 µg/l (0.004 mg/l) define this trophic classification, with an action value of 20 µg/l (0.020 mg/l) in the Puget Lowlands ecoregion and 10 µg/1 (0.010 mg/l) in the Cascades ecoregion. Measurements greater than the action value trigger various management responses, including studies to assess phosphorus sources and control strategies.

Ortho-phosphorus (OP)

Concentrations of OP, the biologically available form of phosphorus, increased steadily at the inflow to Swift Reservoir (SWREI) during the growing season, while nitrogen (see below) remained at or below detection. OP at upper watershed sites, particularly the 3 tributaries to Swift Reservoir, was much higher than in lower tributary sites, and represented almost all of the available phosphorus at these sites (Figures 3.1-11 [a & b]). Similarly, OP made up a large fraction of TP at hatchery effluent sites, particularly the Speelyai Hatchery (SPLYE). OP at depth in both the Swift and Merwin reservoirs was slightly higher than surface values from July through September.

Ammonia

Ammonia was generally low at all sites, but comparatively high in hatchery effluents (Figures 3.1-12 [a & b]). Values ranged from less than detection (0.01 mg/l) to 0.19 mg/l at the Lewis River Hatchery effluent in October 1999. Ammonia at the site upstream of the Speelyai diversion (SPLYU) was consistently lower than at the site below the Speelyai Hatchery (SPLYE).

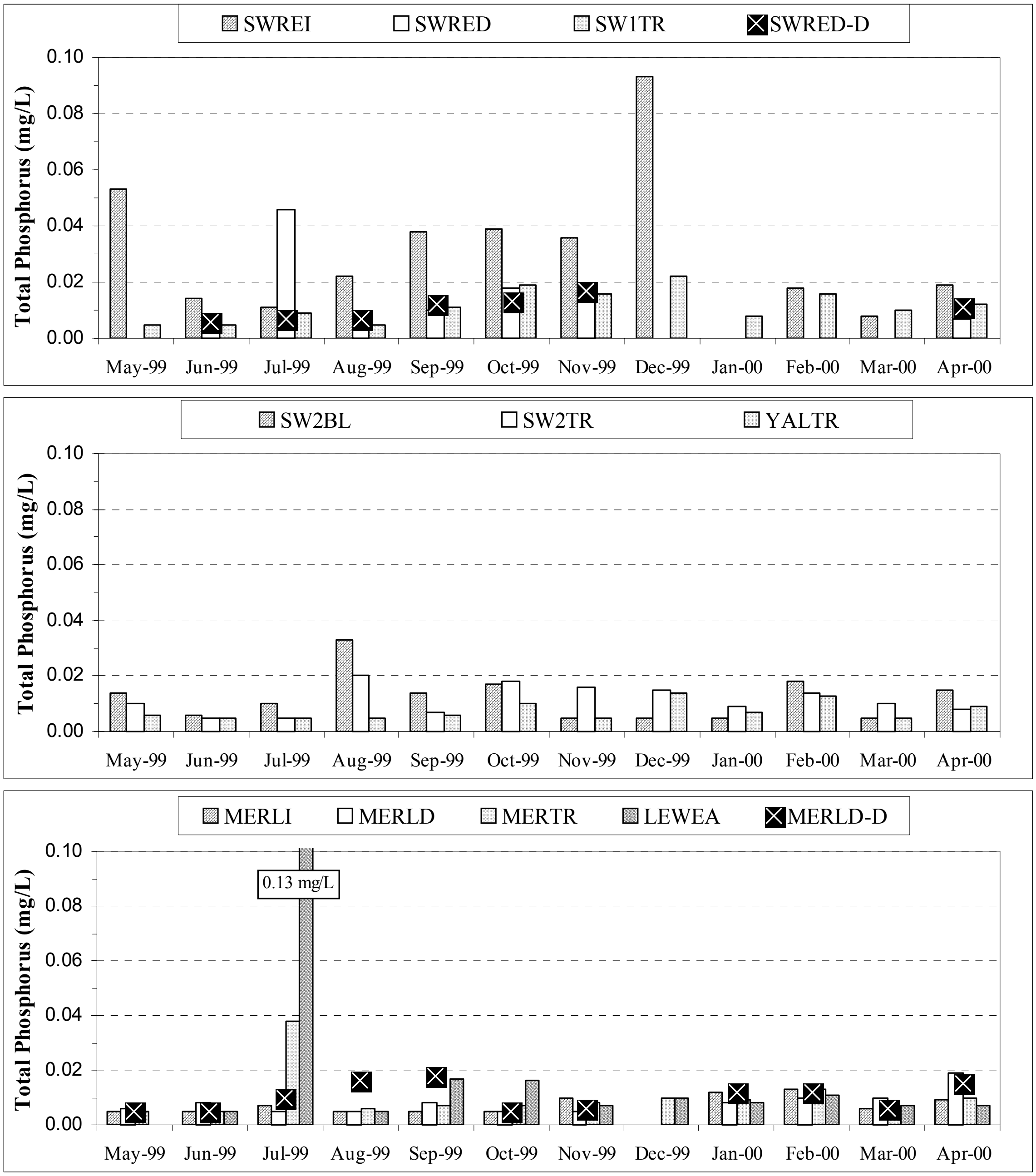

Figure 3.1-10(a). Total phosphorus at Lewis River mainstem monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that no data were collected. Some sites were not accessible during May and December through March.

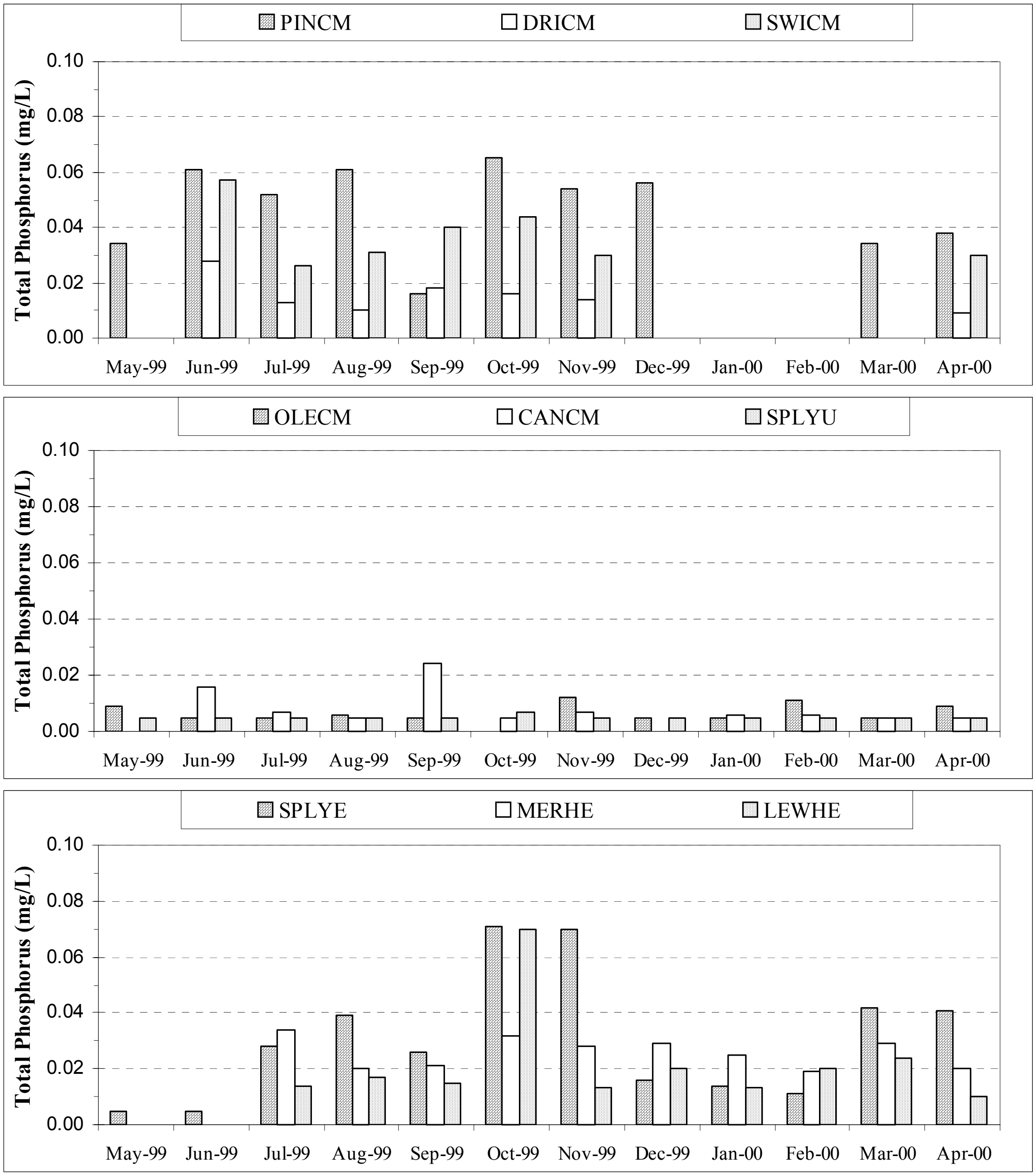

Figure 3.1-10(b). Total phosphorus at Lewis River tributary and hatchery effluent monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit; missing columns indicate that no data were collected. Sampling of MERHE and LEWHE was added in July, OLECM was dry in October, and some sites were not accessible during May and December through March.

Ammonia levels increased from June through August at the Swift Reservoir sites (SWREI, SWRED, SWRED-D), while nitrate concentrations remained near or below detection. A pattern of increasing ammonia levels at depth in Lake Merwin was seen from June to August (0.01 to 0.06 mg/l), and September remained at the August level. This increase followed a relatively high value at the Lake Merwin inflow (MERLI) in July (0.07 mg/l). Ammonia levels near the surface (MERLD) and at the Merwin tailrace (MERTR) were also relatively high in July and August, in contrast to other months. This period coincided with the lowest dissolved oxygen observed in the hypolimnion of Lake Merwin (see below, 4 mg/l). Oxygen consumption and associated decomposition of organic material apparently occurs to a larger extent in Lake Merwin than in Swift Reservoir, leading to higher ammonia concentrations.

Ammonia toxicity can occur at high pH, when the dominant form of ammonia is NH_4OH (Wetzel 1975). A formula for a chronic ammonia standard is contained in WAC 173-201A-040. Using this formula, criteria specific to each ammonia value were calculated based on the associated pH and temperature. For the 199 ammonia observations, the median ammonia criterion was 15 mg/l, with an average of 22 mg/l and a minimum of 4 mg/l. None of the data collected during this study approached the WDOE criteria.

Nitrate plus Nitrite

Nitrate plus nitrite (N) values were near or below detection (0.01 mg/l) at upper watershed sites (tributaries to Swift Reservoir, Lewis River inflow, Swift tailrace), and higher at mid-elevation sites (Ole Creek, Upper Speelyai, Canyon Creek). Values at these sites were typically between 0.1 and 0.2 mg/l. In contrast, nitrate concentrations at the Speelyai Hatchery effluent (SPLYE) were much higher, typically between 0.2 and 0.4 mg/l, and between 0.4 and 0.62 mg/l from November through January 2000 (Figures 3.1-13 [a & b]).

As seen in ammonia levels, near bottom nitrate values in Lake Merwin were considerably higher than surface values during August and September. However, in contrast to ortho-phosphorus results at the Merwin sites, which remained at constant low levels from month to month, nitrate values increased sharply at the end of the growing season (December and January). Nitrate at Swift No. 2 and Yale tailraces showed a similar pattern. While the data are limited, this suggests potential nitrogen limitation, or greater demand for nitrogen than phosphorus at the Lewis River mainstem sites.

Total Persulfate Nitrogen (TPN)

In addition to the other nitrogen forms, Lewis River samples were analyzed for total persulfate nitrogen, a method yielding the total biologically available nitrogen, including organic nitrogen, ammonia, and nitrate+nitrite. Though not a direct measurement of organic nitrogen, large differences observed between TPN and the sum of nitrate and ammonia is an indication that organic N is an important component of the nitrogen pool.

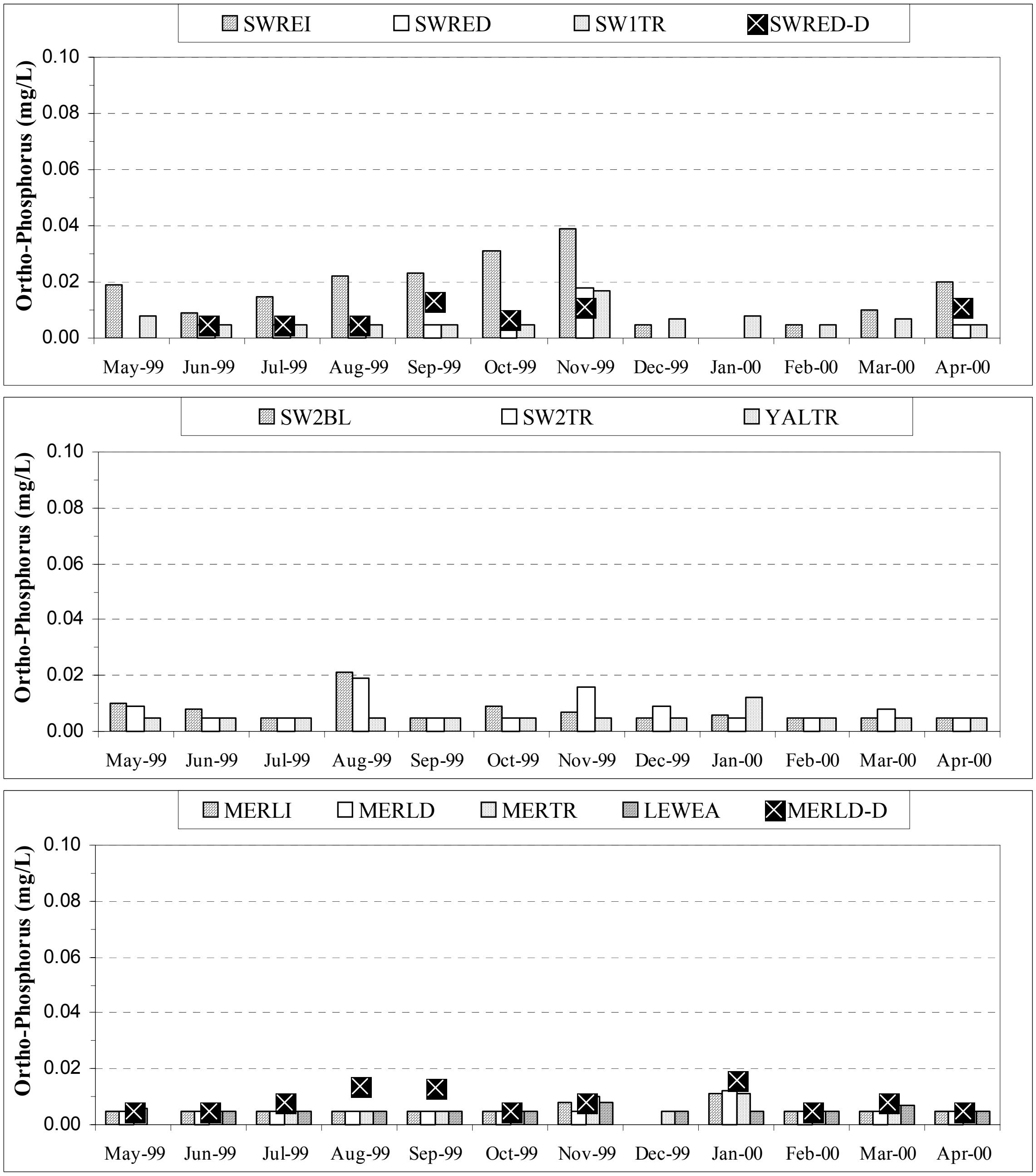

Figure 3.1-11(a). Ortho-phosphorus at Lewis River mainstem monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that no data were collected. Some sites were not accessible during May and December through March.

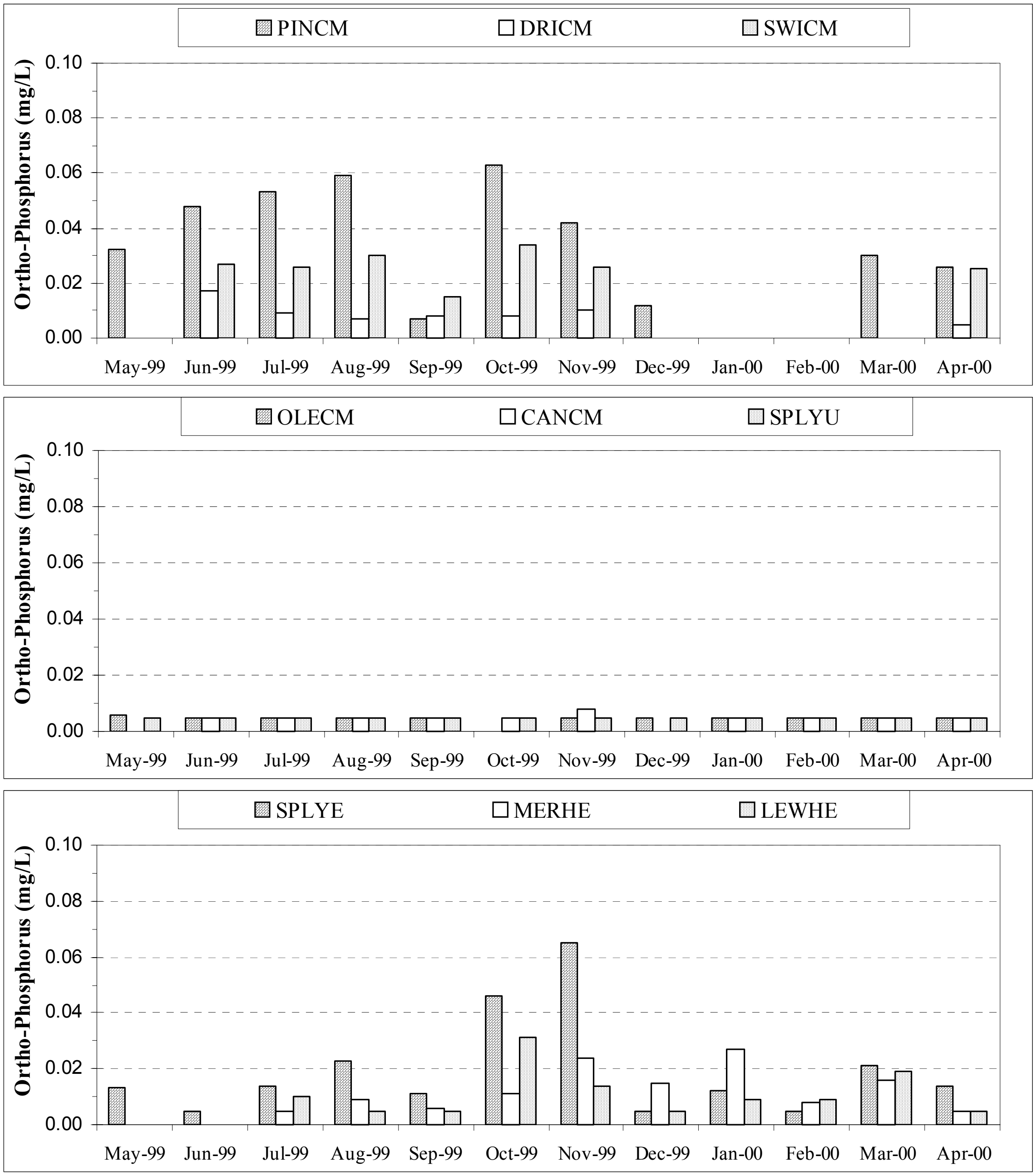

Figure 3.1-11(b). Ortho-phosphorus at Lewis River tributary and hatchery effluent monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Sampling of MERHE and LEWHE was added in July, OLECM was dry in October, and some sites were not accessible during May and December through March.

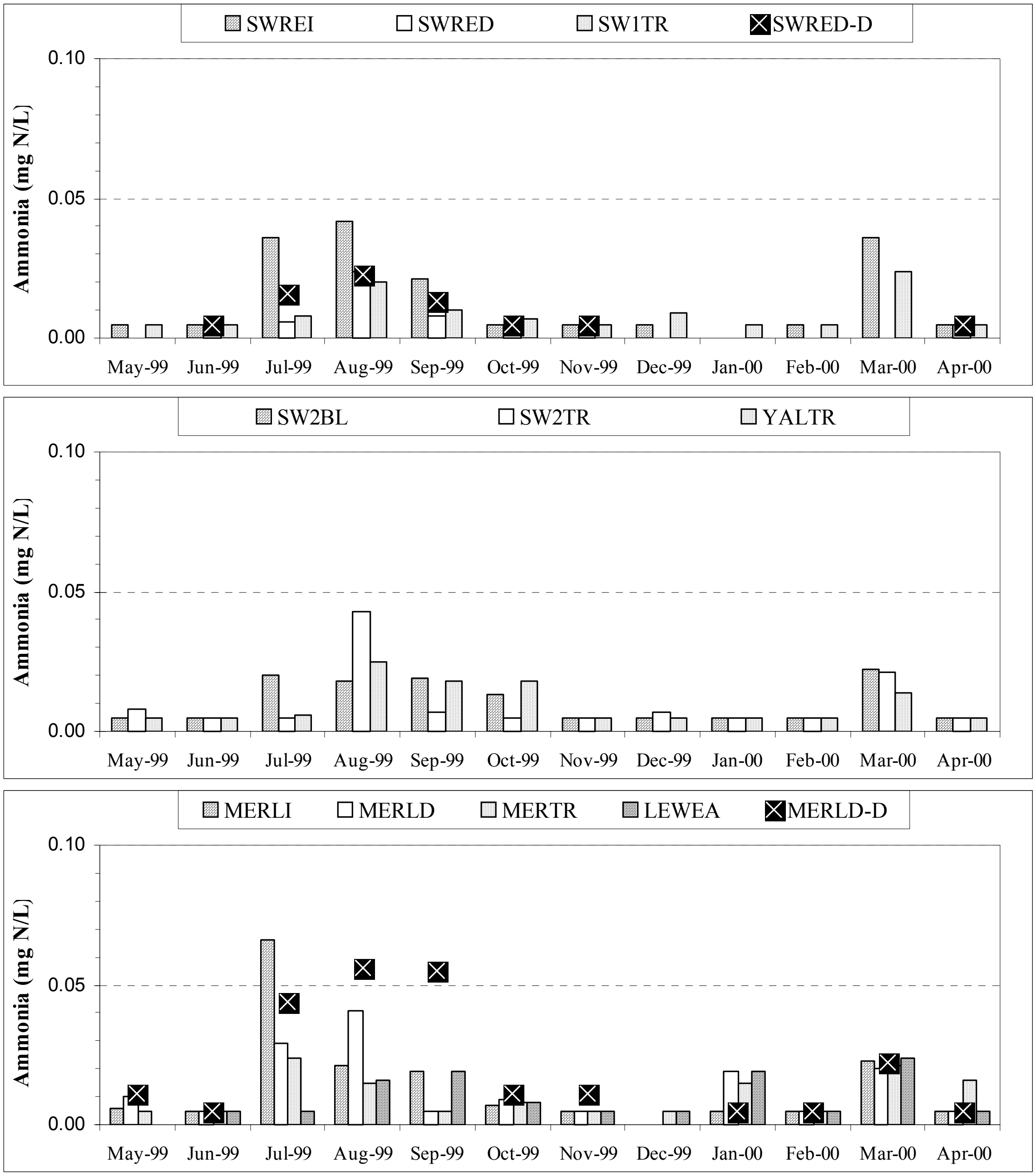

Figure 3.1-12(a). Ammonia at Lewis River mainstem monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Some sites were not accessible during May and December through March.

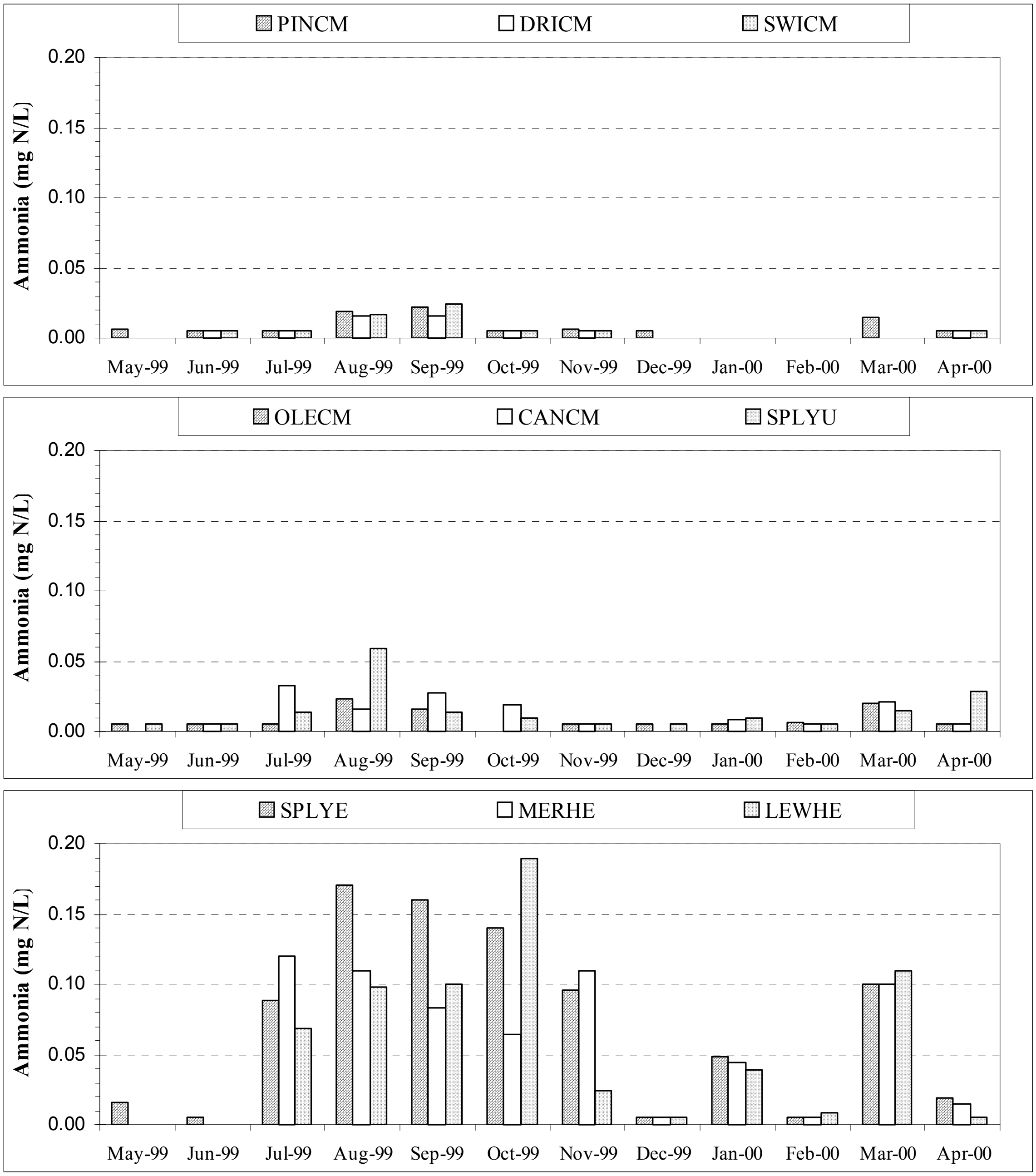

Figure 3.1-12(b). Ammonia at Lewis River tributary and hatchery effluent monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Sampling of MERHE and LEWHE was added in July, OLECM was dry in October, and some sites were not accessible during May and December through March.

Patterns of TPN were similar to those observed for nitrate+nitrite, with values ranging from less than detection (0.1 mg/l) to 0.81 mg/l at SPLYE (Figures 3.1-14 [a & b]). At Lake Merwin, TPN near the intake depth in September was similar to values at the surface (MERLD) and tailrace sites (MERTR). In contrast, the nitrate concentration was relatively high in September at depth in Lake Merwin, but less than detection at the surface and tailrace. The difference, accounting for ammonia, may be due to a relatively large contribution of organic nitrogen at surface and tailrace sites in September.

Alkalinity

Alkalinity was relatively low at all sites (8 to 44 mg/L $CaCO_3$). Values at depth in Swift and Merwin were generally similar (approximately 20 mg/l). Alkalinity at tributaries to Swift Reservoir was higher than at Ole Creek, Canyon Creek, and Upper Speelyai Creek. Higher variability was seen in the summer and fall at all sites.

Bacteria

Results of fecal coliform samples were all less than the WDOE standard of 100 colonies per 100 ml, or 50 colonies per 100 ml at Lake Class sites. In addition to the data below (Table 3.1-10), samples for fecal coliform analysis were collected in the vicinity of dispersed camping locations near the mouth of Drift Creek on August 31, 2000. Twelve samples were collected at 11 locations, including 2 samples in flowing water and 10 within Drift Creek Bay. The maximum coliform count among all samples was 2 colonies per 100 ml. These samples were collected at the request of the U.S. Forest Service (USFS).

Table 3.1-10. Fecal coliform results at Lewis River monitoring sites.

Location	Monitoring Period	N	Min	Max
CANCM	Jun-99	1	8	8
DRICM	Jul-99 to Sep-99	3	<1	<2
MERLD	May-99 to Jun-99	2	<1	2
MERLI	May-99 to Jun-99	2	1	2
MERTR	May-99 to Jun-99	2	<1	<1
NWOOD	Jul-99 to Sep-99	3	<1	3
OLECM	May-99 to Jun-99	2	1	1
PINCM	May-99	1	8	8
SPLYE	May-99 to Jun-99	2	2	13
SPLYU	May-99 to Jun-99	2	1	3
SW1TR	May-99 to Jun-99	2	<1	1
SW2BL	May-99 to Jun-99	2	<1	2
SW2TR	May-99 to Jun-99	2	<1	<1
SWREI	May-99	1	14	14
WOODP	May-99 to Sep-99	5	<1	10
YALTR	May-99 to Jun-99	2	<1	<1

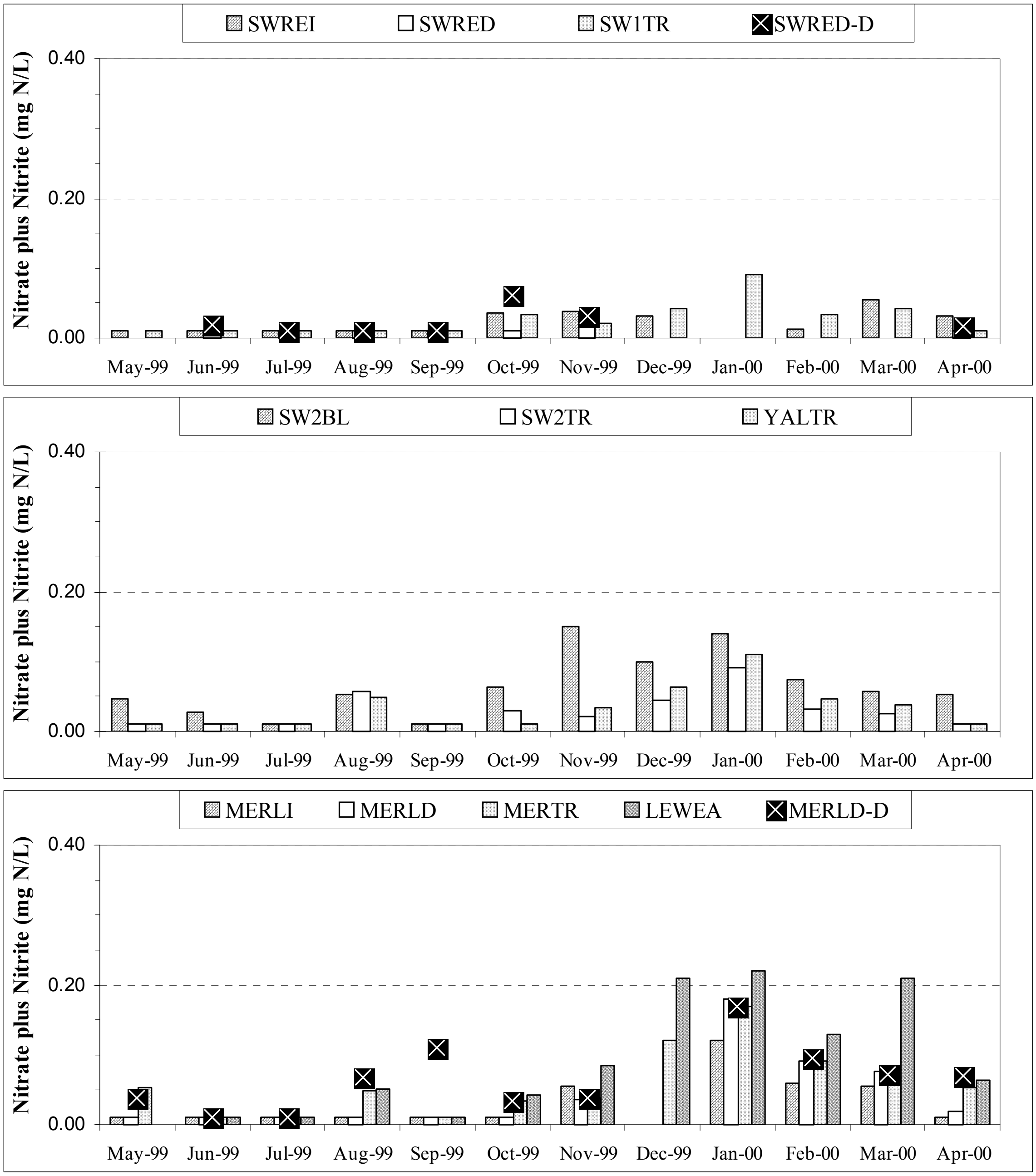

Figure 3.1-13(a). Nitrate plus nitrite at Lewis River mainstem monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Some sites were not accessible during May and December through March.

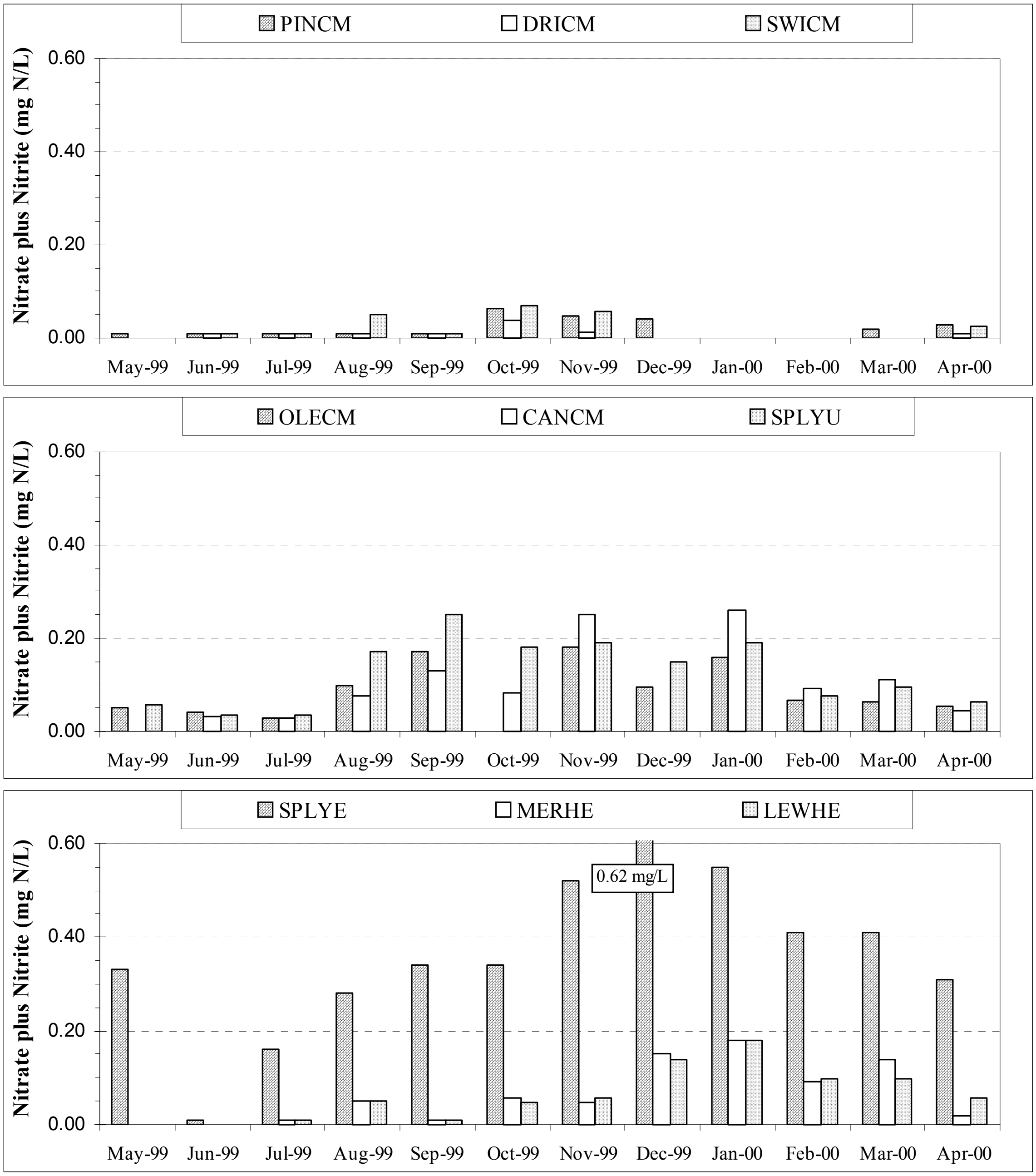

Figure 3.1-13(b). Nitrate plus nitrite at Lewis River tributary and hatchery effluent monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Sampling of MERHE and LEWHE was added in July, OLECM was dry in October, and some sites were not accessible during May and December through March.

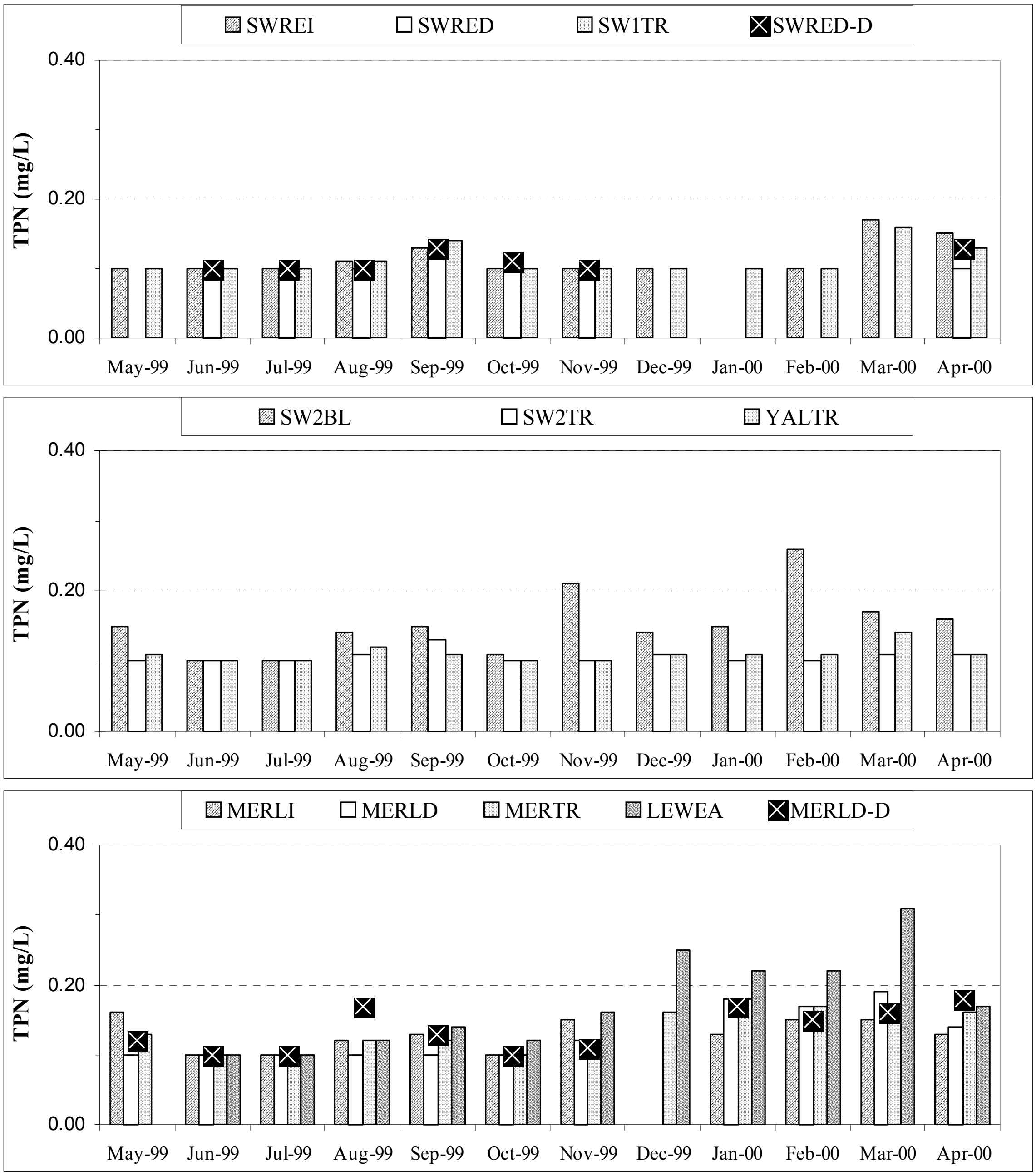

Figure 3.1-14(a). Total persulfate nitrogen at Lewis River mainstem monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Some sites were not accessible during May and December through March.

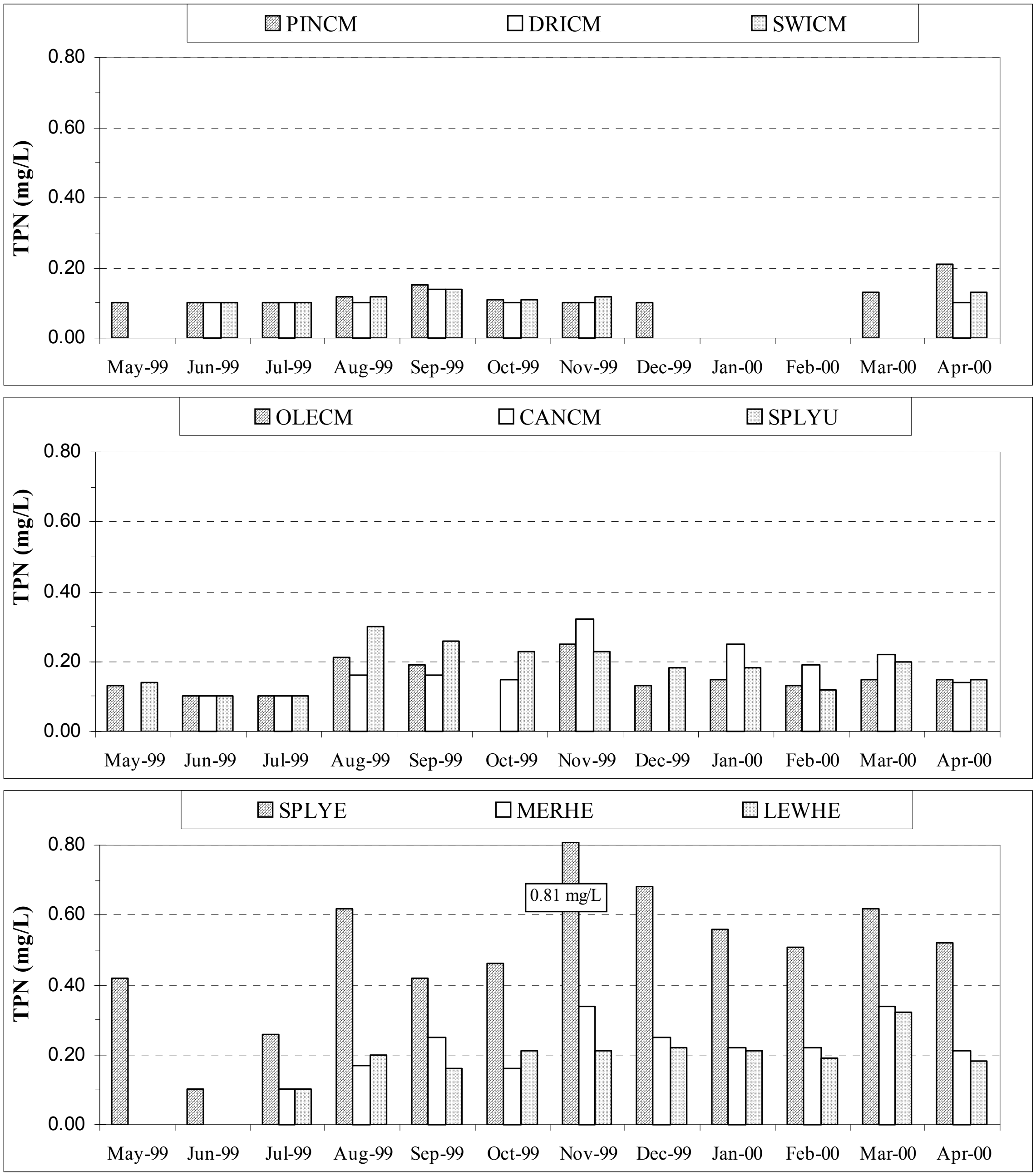

Figure 3.1-14(b). Total persulfate nitrogen at Lewis River tributary and hatchery effluent monitoring stations, May 1999 through April 2000.

Note: Non-detectable values are plotted at the detection limit. Missing columns indicate that data were not collected. Sampling of MERHE and LEWHE was added in July, OLECM was dry in October, and some sites were not accessible during May and December through March.

3.1.5.3 In Situ Results

Results of measurements taken in the field for pH, dissolved oxygen, and specific conductance are summarized in this section. Tabular summaries of these data are included in the WAQ 1 Appendix 6.

pH

pH measurements were within the WDOE standard (6.5-8.5 for Class AA and A streams), with 2 exceptions: values lower than 6.5 were recorded at Swift Creek (6.1) and at the Speelyai Hatchery effluent (6.3) in July 1999. These data must be qualified, however, as the Hydrolab malfunctioned and the results are reported from the laboratory. Trends in pH were not apparent from the data collected.

Dissolved Oxygen

Sites designated Class AA (mouths of Pine Creek, Drift Creek, Swift Creek, Canyon Creek, and upper Speelyai Creek) met the DO standard of 9.5 mg/l, with few exceptions. DO at Canyon Creek was 9.3 mg/l (91 percent saturation) in September 1999. Drift Creek also had a DO concentration of 9.3 mg/l, or 96 percent saturation, in August 1999. Speelyai Creek upstream of the diversion had DO values of 8.4 and 9.0 mg/l in August and September 1999, with saturations of 90 percent and 92 percent, respectively.

Three values (of 183 DO observations) were recorded under the Class A standard of 8 mg/l. Two of these were at Ole Creek during very low flow conditions in August and September 1999 (7.3 and 4.4 mg/l, respectively), and the other at the inflow to Lake Merwin (site MERLI) in August 1999 (7.4 mg/l). The latter is a reservoir site, however, and is designated Lake Class.

Dissolved oxygen at the 3 reservoir tailrace sites (SW1TR, YALTR, and MERTR) averaged between 10.9 and 11.7 mg/l. SW2TR closely mirrored SW1TR in DO, with an average concentration of 11.8 mg/l.

Specific Conductance

Specific conductance at tributaries to Swift Reservoir, particularly Pine Creek, was higher than at other sites in this study (Figure 3.1-15 [a & b]). Values at Pine Creek averaged 72 µS/cm, vs. an average of 32 µS/cm for all sites monitored. At Pine Creek, and to a lesser extent at other sites, conductance increased throughout the summer months to November, and decreased in the winter and early spring.

3.1.5.4 Reservoir Profiles/Secchi Disk/Chlorophyll *a*

Results of monthly vertical profile measurements are summarized in this section, including measurements of secchi disk transparency and chlorophyll *a*. Time series plots of temperature, and DO are included below for selected depths. pH data are deemed unreliable for the period July–September due to equipment failure and are not included in the time series plots. Graphs of all of the profile data are included in WAQ 1 Appendix 7.

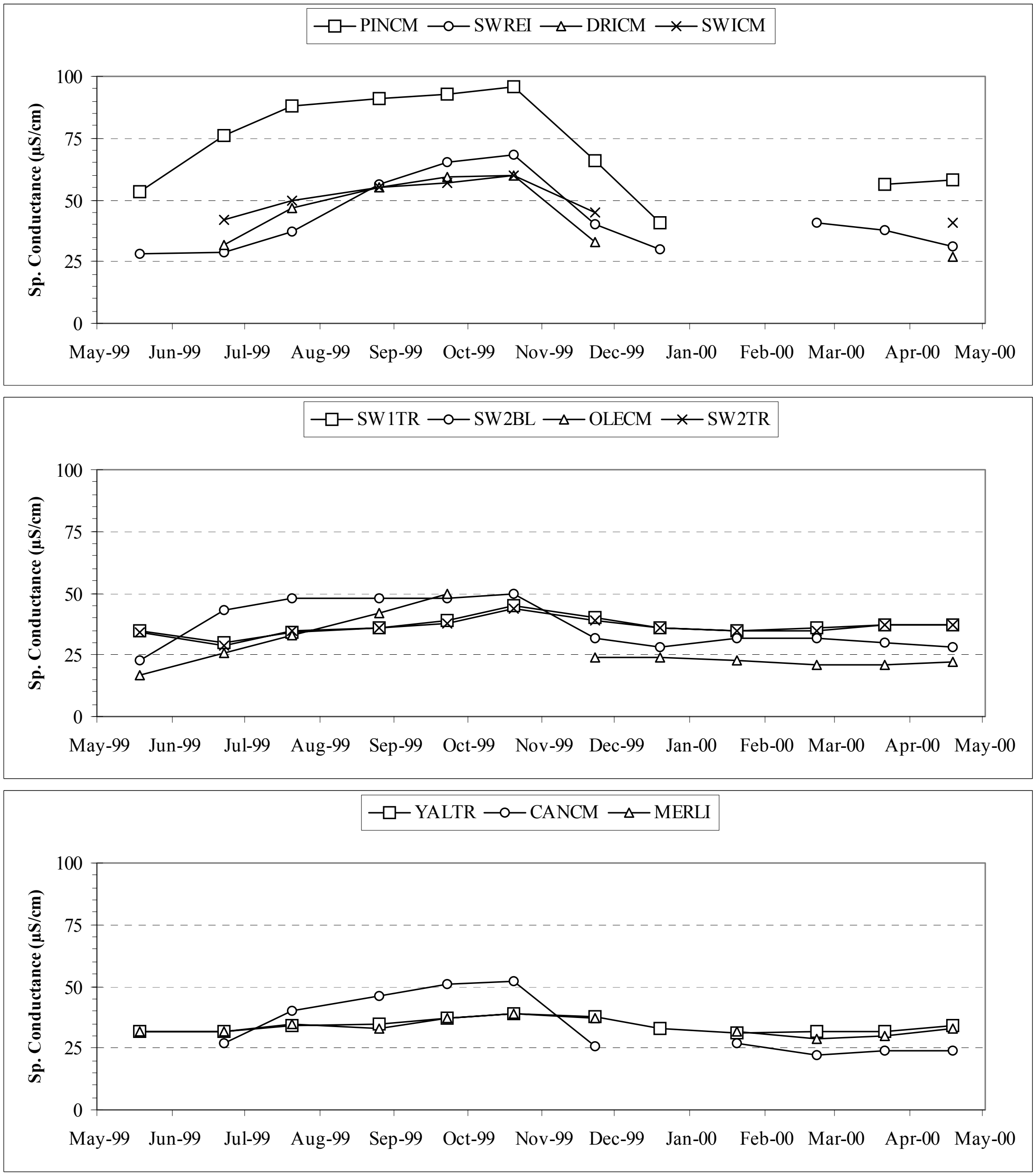

Figure 3.1-15(a). Time series of periodic specific conductance measurements at stream sites, May 1999 through April 2000.

Note: Missing columns indicate that data were not collected. Some sites were not accessible during May and December through March, and OLECM was dry in October.

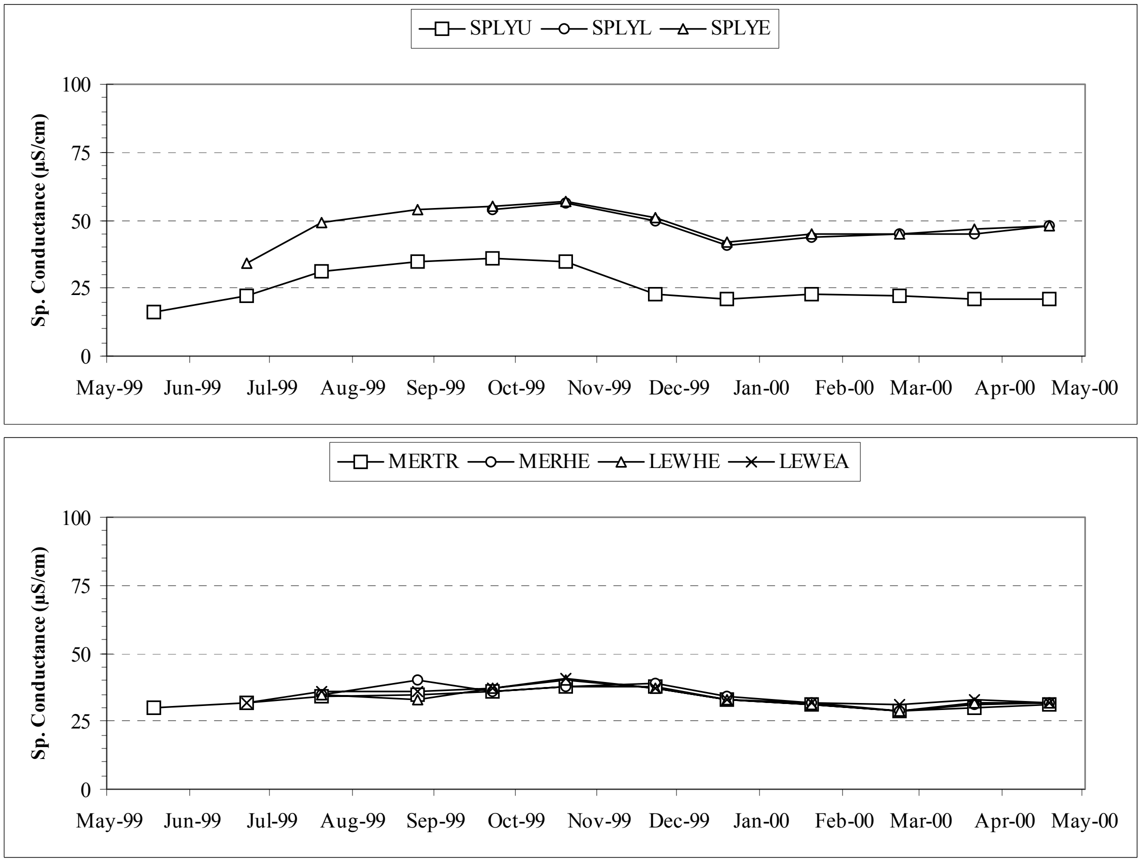

Figure 3.1-15(b). Time series of periodic specific conductance measurements at stream sites, May 1999 through April 2000.

Note: Missing columns indicate that data were not collected. Monitoring of MERHE and LEWHE was added in July, and some sites were not accessible during May.

Reservoir Profiles

Time series plots of temperature, DO, and specific conductance for selected depths at Swift Reservoir and Lake Merwin are shown below (Figure 3.1-16 [a, b, & c]). Thermal stratification was strongest in August 1999 at both Merwin and Swift reservoirs, but more evident at Swift (Figure 3.1-17). Swift Reservoir surface temperatures were similar at a depth of 10 m in August; both depths were between 18 and 20ºC. Swift's thermocline began at about 10 m, and temperatures dropped sharply to form a broad metalimnion between 10 and 40 m, below which temperatures stabilized at approximately 4ºC. In contrast, thermal stratification of Merwin was less pronounced, with a gradual drop from 23ºC at the surface to near bottom temperatures of 12ºC, much warmer than the hypolimnion of Swift.

Dissolved oxygen at Swift increased slightly at mid-depths and remained greater than 8 mg/l to the reservoir bottom (100 m) during August, the period of maximum thermal stratification. DO at Lake Merwin was also high at this time (between 8 and 10 mg/l) from the surface to approximately 40 m, but dropped substantially near the reservoir bottom at 56 m. Lake Merwin DO at 50 m was 7.8 mg/l, or 74 percent saturation in August. At 56 m, DO dropped to 4 mg/l, or 37 percent saturation. September showed less thermal stratification at both reservoirs, but bottom DO at Lake Merwin was 3 mg/l, the lowest recorded during the monitoring program (Figure 3.1-16b).

Specific conductance at both Swift and Merwin was between 30 and 40 μS/cm during most visits, with bottom reservoir values at Merwin slightly higher. The August profile at Swift showed a decrease in conductance between 20 and 30 m, possibly a result of utilization of dissolved nutrients by algae and zooplankton within the thermocline.

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Increasing water clarity at Swift Reservoir during the summer months is evident from Secchi disk data recorded near the dam (Figure 3.1-18). Secchi depth at Swift increased from approximately 2.5 m in June to over 8 m in August. In contrast, Merwin water clarity, which was highest in June (8 m), decreased slightly during the summer, presumably due to influx of sediment from the upper watershed. Secchi depth at both reservoirs converged in September at over 8 m. Water clarity at Swift remained high in October and decreased sharply to under 1 m in November. Swift could not be accessed during the winter months, and Secchi depth in April 2000 was similar to June 1999.

3.1.6 Discussion

Study WAQ-1 was designed to gather baseline information to assess current water quality conditions in the study area, and to assess of potential impacts to water quality attributable to project operations. A key goal of WAQ 1 was also to determine whether WDOE standards are being met in project-affected waters.

A general discussion of the data collected under this study is provided below, framed by 2 of the overarching "key questions":

1) What water quality problems currently exist in the watershed and what are the current conditions and trends in the basin with regard to water quality (e.g., dissolved oxygen, nitrogen [organic and inorganic], phosphorus [total P, Ortho P], TDGs, pH, turbidity, and thermal gradients)?

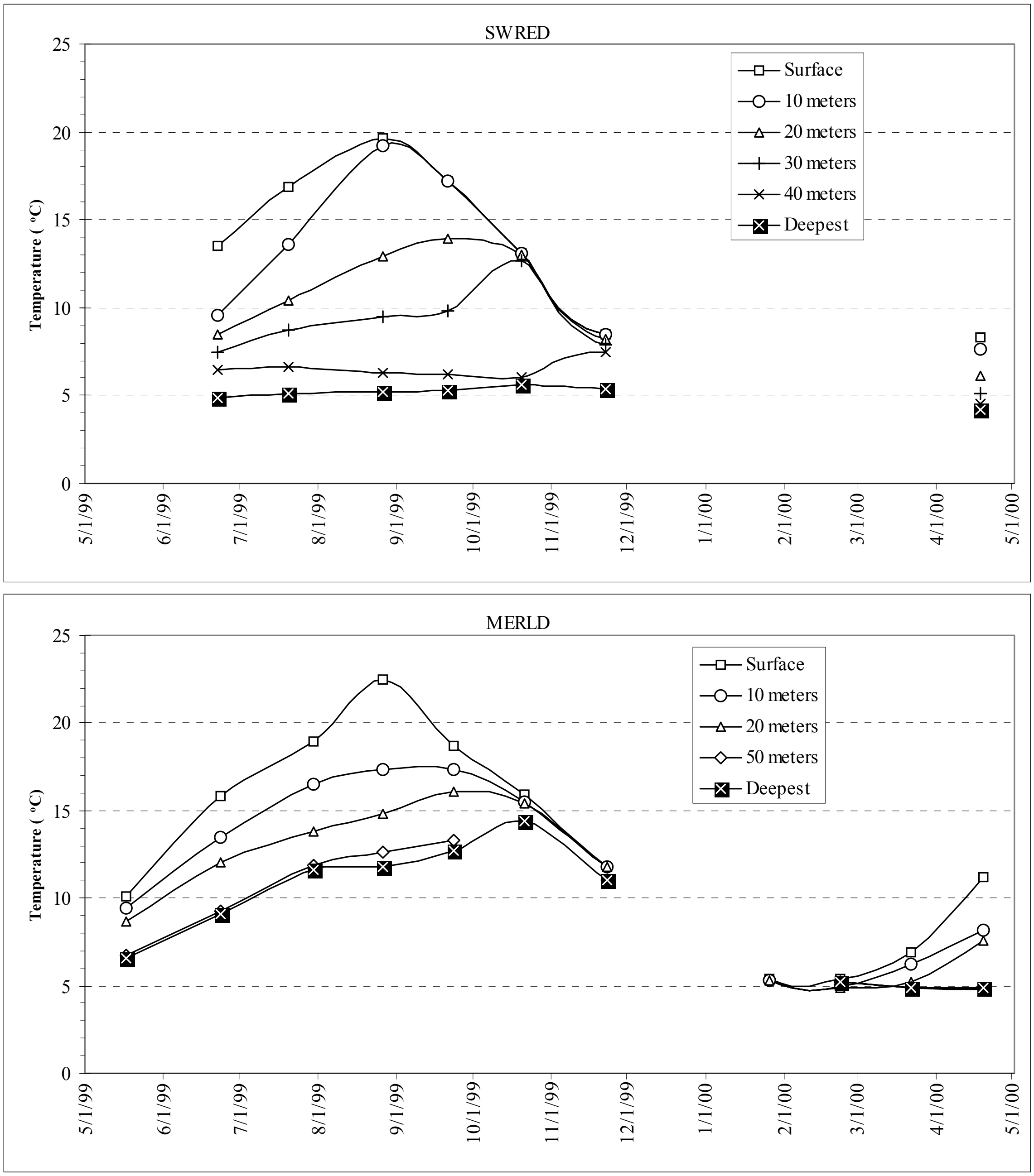


Figure 3.1-16(a). Time series of periodic temperature measurements at Swift Reservoir and Lake Merwin from May 1999 through December 1999.

Note: Could not sample SWRED and SWRED-D in May and December through March; or MERLD in December.

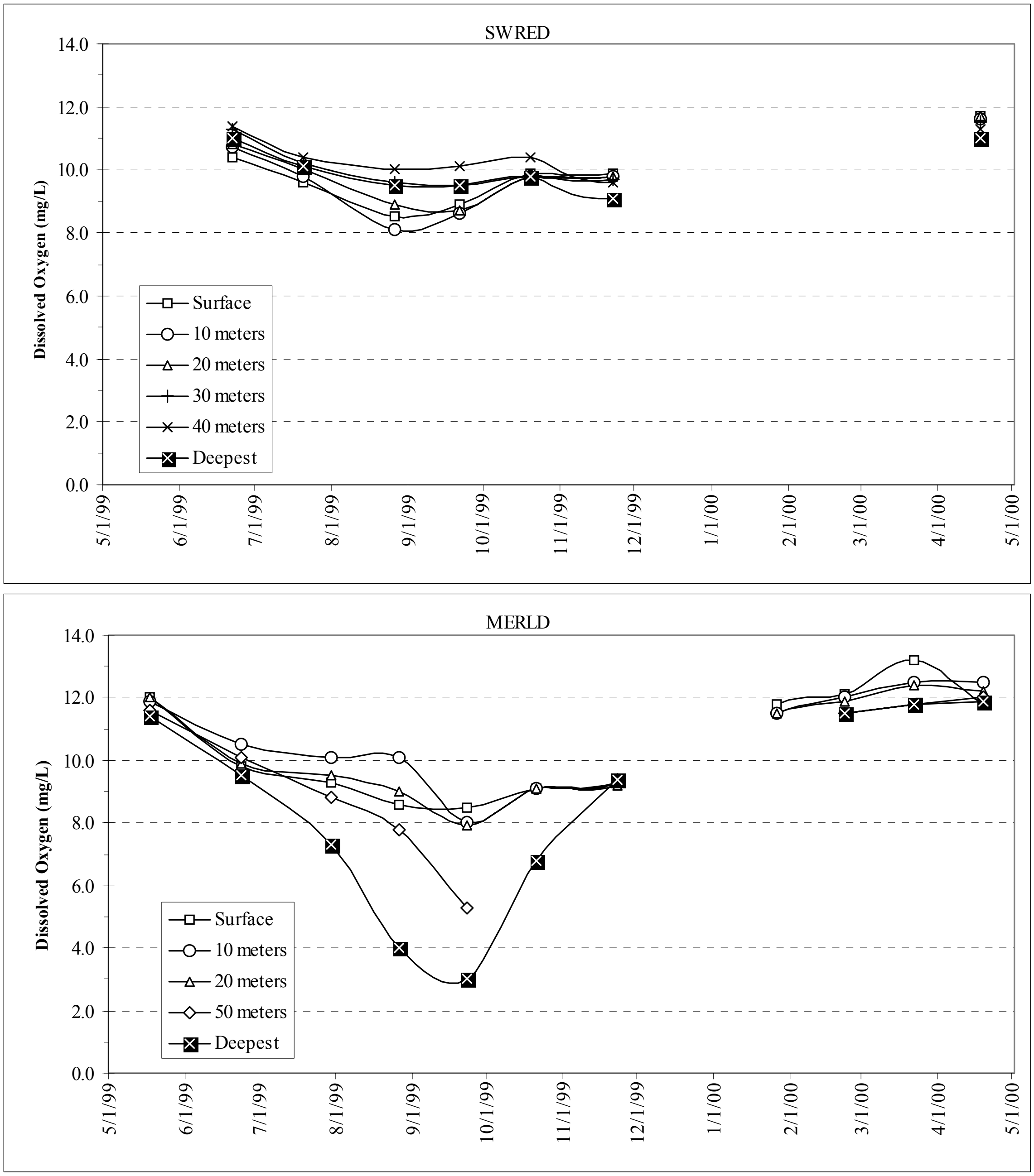


Figure 3.1-16(b). Time series of periodic dissolved oxygen measurements at Swift Reservoir and Lake Merwin from May 1999 through April 2000.

Note: Could not sample SWRED and SWRED-D in May and December through March; or MERLD in December.

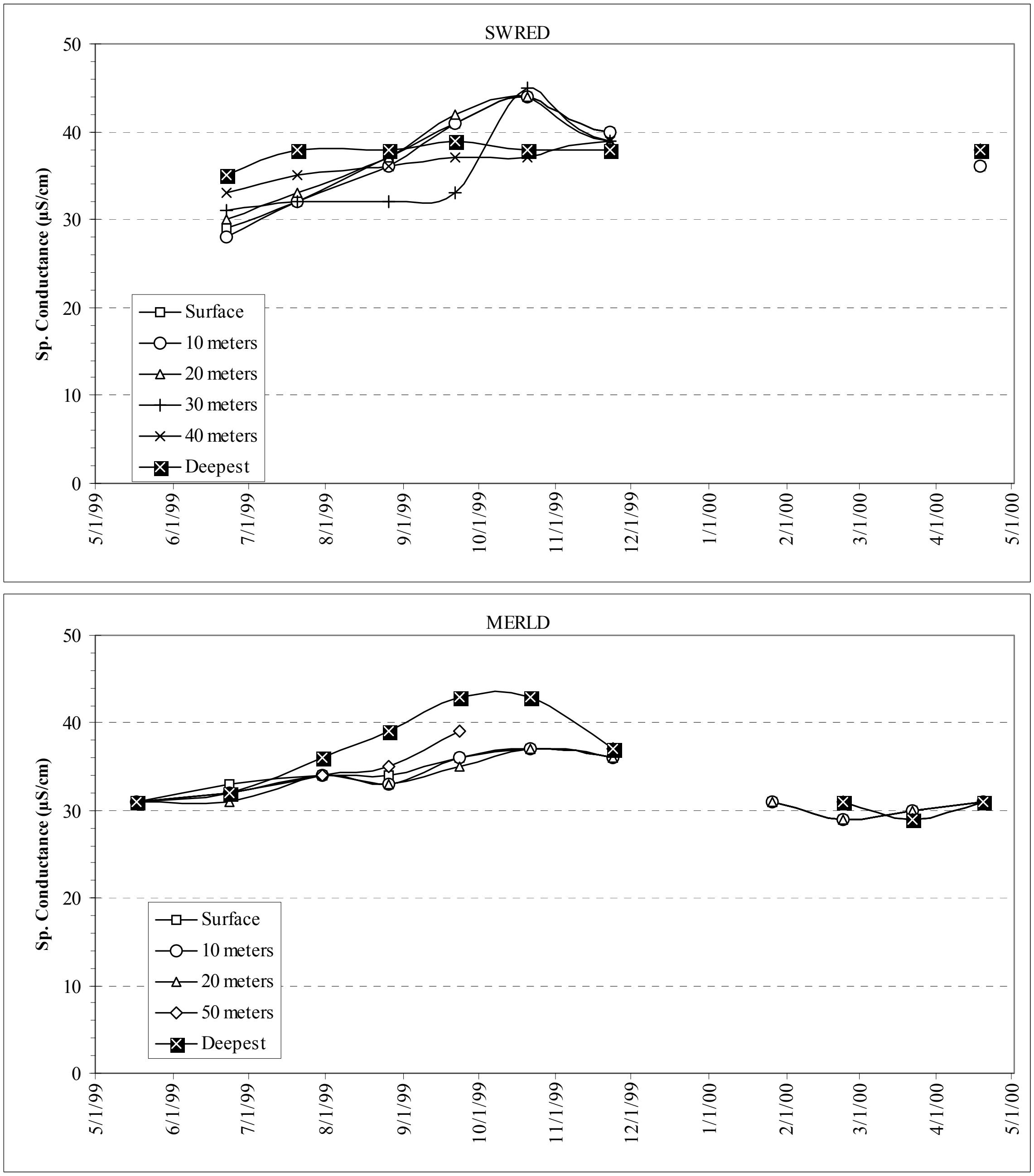
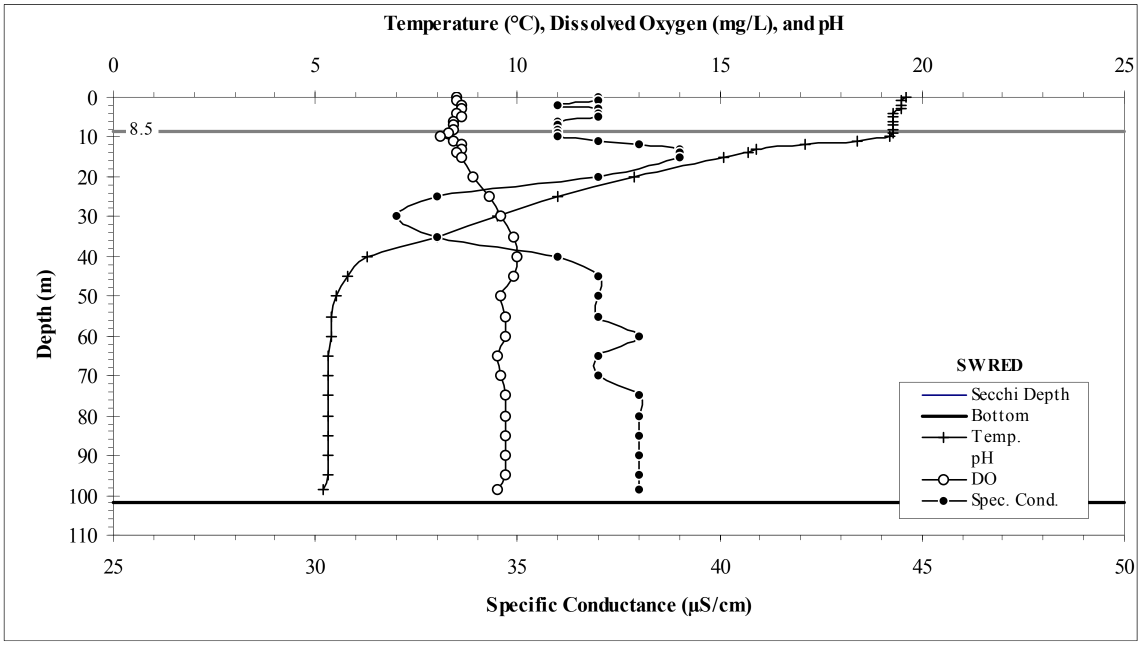


Figure 3.1-16(c). Time series of periodic specific conductance measurements at Swift Reservoir and Lake Merwin from May 1999 through April 2000.

Note: Could not sample SWRED and SWRED-D in May and December through March; or MERLD in December.



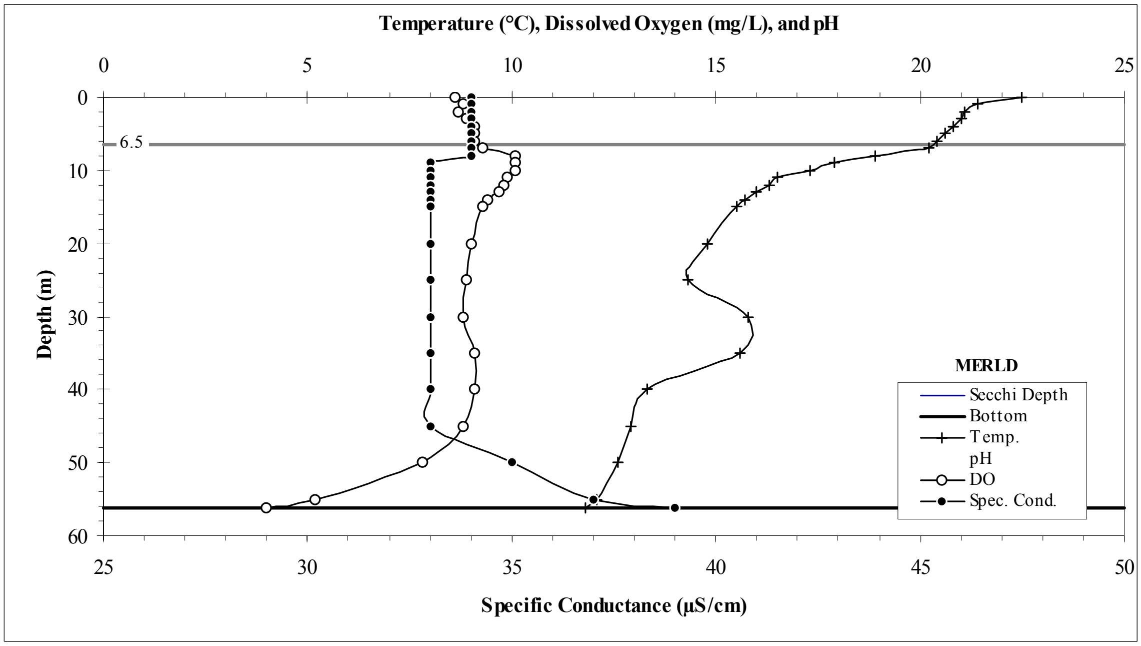


Figure 3.1-17. Vertical profile of periodic measurements at Swift Reservoir near the dam (SWRED) and Lake Merwin near the dam (MERLD) in August 1999.

Note: (1) pH results were unreliable and have not been incorporated; (2) temperatures at Merwin for 30 and 35 meters appear incorrect; suspect 13.8 and 13.6°C instead of 15.8 and 15.6°C, respectively.

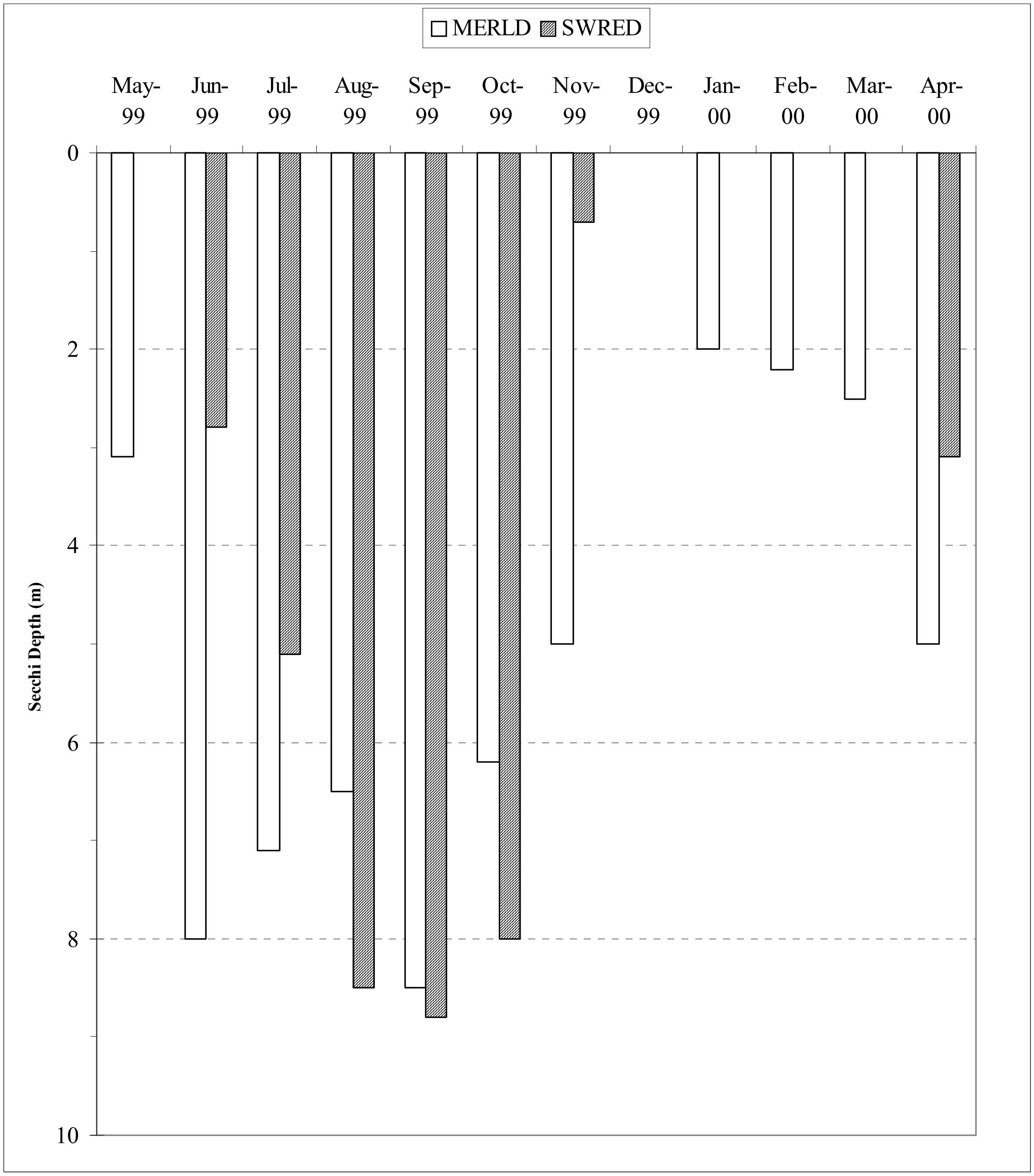


Figure 3.1-18. Time series of periodic secchi depth measurements at Swift Reservoir and Lake Merwin from May 1999 through April 2000.

Note: Could not sample SWRED and SWRED-D in May and December through March, or MERLD in December.

and,

2) Are state water quality standards being met as required by the federal Clean Water Act?

The data collected during WAQ 1 show that only total dissolved gas levels in the Swift and Yale tailraces are a project-related water quality problem. While this is clearly a concern from a regulatory standpoint, biological effects were not investigated, and none have been established or documented. The Licensees have taken steps to implement a solution to this problem and additional studies were undertaken (WAQ 2 and WAQ 4).

Stream temperatures monitored in project-affected reaches of the Lewis River are supportive of salmonids and other beneficial uses and, with one exception, are within WDOE criteria. The exception was the downstream end of the Swift bypass reach, in which a temperature of 18.2°C was recorded on a single day (August 4, 1999). No other project-related temperature exceedance was observed.

The largest number of non-project-related exceedences of the WDOE temperature standard occurred at the mouth of Canyon Creek and above the diversion at Speelyai Creek. Both are subject to the Class AA criterion of 16°C applicable to feeder streams to lakes or reservoirs. This criterion was exceeded on 43 days at Canyon Creek and 35 days at upper Speelyai Creek. Monitoring at the mouth of Canyon Creek, a tributary to Lake Merwin, was in flowing water, uninfluenced by reservoir elevation.

Dissolved oxygen (DO) levels in project-affected sites did not exceed state standards. Exceedences of the WDOE DO standard (9.5 mg/l for Class AA and 8 mg/l for Class A reaches) were discussed in the 2000 Technical Report. Class AA exceedences occurred on 4 occasions; and Class A on 3 occasions. With the exception of low flow conditions at Ole Creek in August and September 1999, exceedences of the DO standard occurred while oxygen saturation was at or above 90 percent.

The DO regimes at Swift and Merwin reservoirs are quite different, reflecting the different temperature regimes of these reservoirs. Temperatures at the bottom of Swift reservoir varied little, and were approximately 5°C throughout the monitoring period. In contrast, temperatures near the bottom of Lake Merwin gradually increased from May (6°C), to nearly 14°C in October. Snowmelt from Mount St. Helens and Mt. Adams, combined with a shallower intake at Swift (approximately 45 meters) creates a more stable and colder hypolimnion. The intake at Lake Merwin is deeper, well below the thermocline (approximately 55 meters). This results in quicker turnover in the fall, and a more pronounced depletion of colder water during the summer months.

Dissolved oxygen at Swift remained above 9 mg/l during late summer, while DO near the bottom of Lake Merwin decreased from approximately 11 mg/l in May to 4 mg/l in August and to 3 mg/l in September. However, DO in the majority of the Lake Merwin water column (above 40-45 meters in August and September) remained at or near 8 mg/l.

Although this study did not directly address reservoir trophic status, phytoplankton data collected during Yale relicensing (1996 and 1997) indicate that short-term algal blooms occur during early summer, temporarily increasing trophic status from generally oligo-trophic to more mesotrophic conditions. Blue green algae, often used as indicators of eutrophic conditions, were dominant at upper and lower Yale Lake during early summers of 1996 and 1997. The shift from diatoms to blue-greens was most dramatic in June 1996, when the blue-green algae *Anabaena flos-aquae* was dominant at both stations (85 percent of the biovolume at the upstream station, and 94 percent near the dam). Algal biovolume during most months was less than 100,000 cubic µM/ml; however, in June 1996 biovolume was approximately 8 times higher than this at the upstream station, and approximately 4 times higher at the downstream station. Blue-green algae were also observed later in the summer at Yale during both field seasons.

Patterns in phytoplankton community composition observed at Yale are likely to be similar at Swift and Merwin. Carlson Trophic State (TSI) (Carlson 1977) values calculated for Swift and Merwin based on 1999 data show similar, short-term changes in trophic status indicative of algal blooms, although no phytoplankton data were collected. Summertime chlorophyll *a* and secchi disk-based TSI values were in the mesotrophic range for both reservoirs; however, total phosphorus-based values increased to near 60 in July, well above the 40-50 level indicative of mesotrophic conditions. As discussed above, nutrient levels among upper watershed sites differed markedly from those in the lower watershed. The pattern observed at the inflow to Swift Reservoir suggested increasing total phosphorus (TP) concentrations correlated with snowmelt from Mount St. Helens, and, in general, higher TP values were recorded for upper watershed sites. These data suggest that soil geochemistry is not uniform throughout the project area. While this region of the Lewis River watershed historically may have had higher soil phosphorus levels, it is likely that the Mount St. Helens eruption continues to exert an influence on water quality. Exposure of previously subsurface ash as a result of the 1996 flood may also have caused higher phosphorus concentrations in Mount St. Helens runoff.

To further assess differences among sites relative to nutrient concentrations, and assess potential nutrient limitation, nitrogen-to-phosphorous (N:P) ratios were calculated for all sites monitored during Study WAQ 1. High ratios (greater than 10:1) suggest that phosphorous is the limiting nutrient, while ratios less than 5:1 are indicative of nitrogen limitation (Rast et al. 1989). Welch (1980) suggests N:P less than 16 is indicative of nitrogen limitation. The nitrogen term in the ratio was total persulfate nitrogen (TPN), the sum of biologically available nitrogen forms (organic N, ammonia, and nitrate+ nitrite). Total phosphorous was used for the phosphorous term of the equation.

Using the definition by Rast et al. (1989) the N:P evaluation strongly suggests nitrogen limitation for streams draining to Swift Reservoir (Figure 3.1-19). Nitrogen limitation is not uncommon in Pacific Northwest streams (Lauer et al. 1979, Salminen and Beschta 1991). Sites designated as Lower Swift Reservoir are also likely nitrogen-limited. Sites designated Lower Watershed are more likely phosphorus limited, although ratios for these sites are also relatively low. In general, nitrogen limitation in lakes and reservoirs creates a competitive advantage for nitrogen-fixing algae, such as the *Anabaena sp.* mentioned above (Levine and Shindler 1999). Hendzel et al. (1994) reported that summer dominance of heterocystous cyanabacteria (nitrogen fixing) occurred as a function of experimental reduction in N:P loading of Lake 227, the subject of whole lake nutrient experiments in northwestern Ontario. However, the magnitude and duration of these blooms was variable, despite known, constant external loading. This variability was attributed to nitrogen regeneration from epilimnetic sediments, which added significant quantities of nitrogen to the lake (approximately 3 times higher than in runoff) (Hendzel et al. 1994).

The proportion of total nitrogen inputs to project-affected reaches of the Lewis River contributed by annual algae blooms and associated nitrogen fixation is unknown. However, in light of the volcanic, nitrogen poor soils that dominate the watershed, and the absence of marine-derived nitrogen (MDN) to reaches upstream of Merwin Dam, the contribution is likely to be significant. Geochemical influences and the role of MDN in freshwater streams are discussed below.

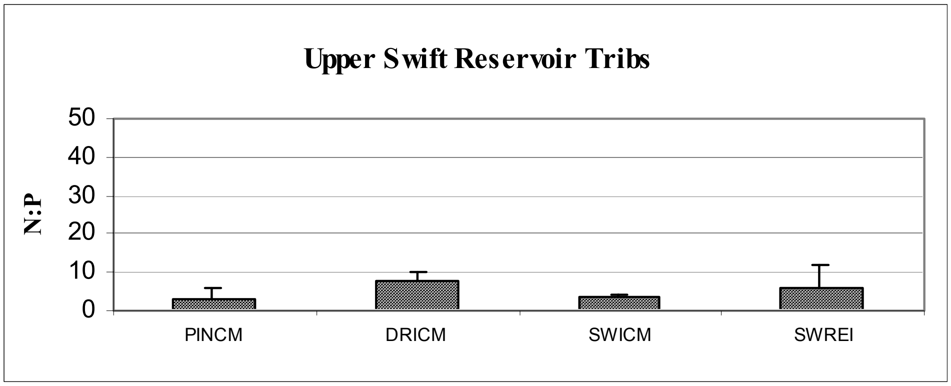
All of the streams in the upper Swift watershed drain volcanic soils. Pine Creek, Swift Creek, and the mainstem Lewis River drain soils of the Cinnamon-Stabler-Chemawa group (USDA 1990). All of these soils formed in pyroclastic flows of volcanic ash, with ash influences extending to 60 inches or more in the Chemawa series. The southeast side of Swift is comprised mainly of Zygore-Aschoff-Swift parent materials. These soils are more diverse, but the soil type in the Drift Creek subbasin is Swift cindery sandy loam, also derived from volcanic ash with a mantle of ash and pumice.

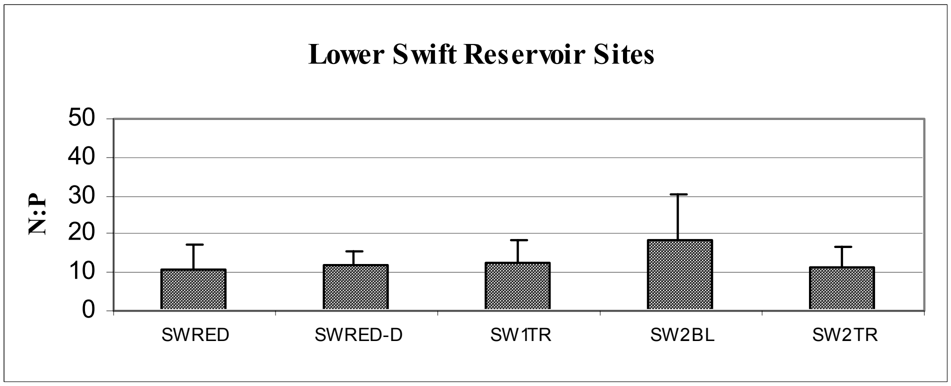
In contrast to phosphorus, fixed nitrogen is nearly absent from most non-sedimentary rocks, so young soils must accumulate it from the atmosphere. Nitrogen limits forest growth on young substrates in Hawaii, for example, whereas phosphorus limits growth on old substrates, and nitrogen and phosphorus are both relatively available in intermediate-aged sites (Vitousek and Farrington 1997). Headwater streams are also comparatively nitrogen poor, in contrast to larger-order streams and rivers (Gregory et al. 1991).

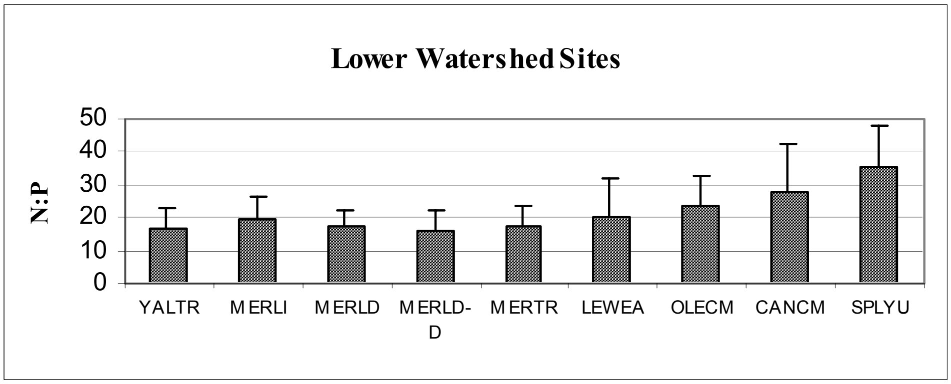
The lack of MDN via salmon carcasses in project-affected streams may contribute significantly to current nitrogen limitation in the Lewis River basin. Nutrients from decaying salmon provide a mechanism for transporting nutrients from the fertile Pacific Ocean to relatively nutrient poor freshwater streams and adjacent terrestrial communities (Kline et al., 1990, 1993; Bilby et al., 1996). Helfield and Naiman (2001) summarize much of the literature on this topic and present data from Alaska that strongly support a positive feedback mechanism whereby MDN create significantly higher growth rates in trees near spawning streams, thus improving spawning and rearing habitat for subsequent generations. Growth of Sitka spruce (mean annual basal area growth) at spawning sites was 3 times higher than at non-spawning sites. Trees at spawning sites reached a dbh of 50 cm at approximately 86 years, versus 307 years at non-spawning sites (Helfield and Naiman 2001). Similar to riparian vegetation, increased productivity has been observed in stream macroinvertebrates and in terrestrial invertebrates in carcass-enriched streams vs. sites upstream of spawning salmon (Wipfli et al., 1998; Hocking and Reimchen 2002). The effect of MDN as a “nutrient subsidy” would be expected to be no less important and likely of greater importance in the Lewis River watershed, where geochemical influences already act to reduce N:P ratios. In the Lewis River, differences observed in N:P ratios between upper and lower watershed sites suggest that upper watershed streams and Swift Reservoir would respond more rapidly to actions that would increase nitrogen concentrations, such as salmon carcass placement, experimental placement of fish, and re-introduction of anadromous fish to the upper Lewis River watershed. As discussed above, this response may be faster growth rates in riparian vegetation, increased primary and secondary production of streams receiving carcasses, and long-term improvement in stream habitat quality. A shift towards phosphorus limitation (increased N:P ratio) in Swift Reservoir would be expected from these actions, possibly reducing the competitive advantage of blue-green, nitrogen fixing algae. Whether this would reduce or potentially exacerbate algae blooms in project reservoirs is unknown. Monitoring of water quality in conjunction with management actions that could change the existing nutrient regime is therefore recommended.

3.1.7 Schedule

This study is complete.







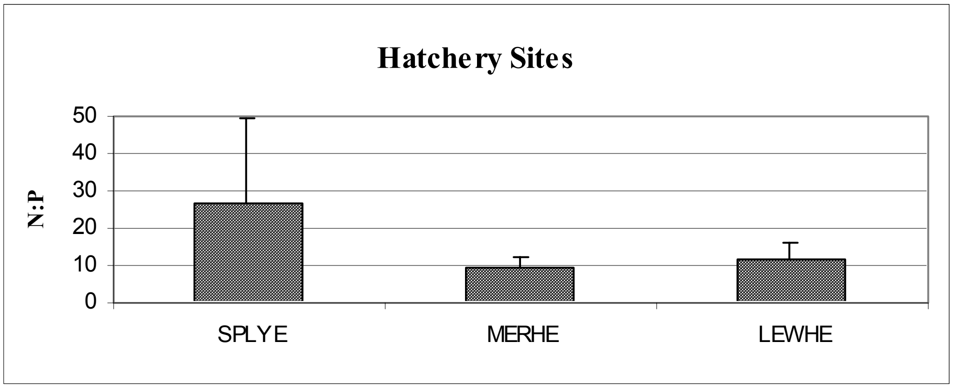


Figure 3.1-19. N:P ratios for sites sampled monthly during May 1999 through April 2000. Error bars are one standard deviation.

3.1.8 References

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3.1.9 Comments and Responses on Draft Report

This section presents stakeholder comments provided on the draft report, followed by the Licensees' responses. The final column presents any follow-up comment offered by the stakeholder and in some cases, in italics, a response from the Licensees.

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
WDFW – CURT LEIGH	1	WAQ 01 Sec 3.1	Water Quality.	Swift and Yale tailrace both exceed TDG standards. Now what is TDG status of Swift Bypass?	TDG data were collected monthly at the downstream end of the Swift bypass reach from March 1996 though July 1997 as part of the Yale relicensing studies. Values ranged from 96 to 105%. TDG in the bypass reach above 100% as a result of spill from Swift No. 1 is unlikely due to turbulent flow and rapid dissipation below the spillway. TDG in the upper bypass reach during the June 1999 flow test (which used spill at Swift No. 1 to determine the feasibility of providing controlled flows to the bypass) was 104%.	
WDFW – JIM BYRNE	1	WAQ 01-11	Key question.	Key question #4 talks about existing conditions effecting existing uses and potential instream use. This was not addressed, and should have been.	Data collected during WAQ 1 identified potential effects of the projects on water quality-dependent instream uses. Using the results of WAQ 1 as well as outside research on potential effects on water quality (TDG,	

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
					PAH), the ARG recommended additional studies that were implemented and completed by the Licensees (studies WAQ 2, WAQ 3, and WAQ 4). In combination with previous data collected during the Yale relicensing, these studies in total allow an assessment of existing and potential effects of the projects on existing and potential instream uses (fish populations, recreation uses, and domestic uses).	
WDFW – JIM BYRNE	1	WAQ 01-12	Key question.	Key question #10 mentions nutrient inputs but no data was collected. There has to be info in literature on effects of agriculture and timber (fertilizers, herbicides, etc.) inputs.	Key question 10 refers to the assessment of inputs which may lead to eutrophication in the Lewis River Basin. A literature-based assessment of nutrient sources (agriculture, timber harvest, nutrient/pesticide runoff) that may contribute to eutrophication was not a component of WAQ1, as approved by the ARG.	Why was question 10 designated? **Licensees' Response:** *The key questions were developed by a broad group of participants prior to the initiation of relicensing studies***.**
WDFW – JIM BYRNE	1	WAQ 01-12 – 13	Key question 16.	Unplanned releases. The answer says that it could not address unplanned releases. These things do occur (Swift Power Canal failure) and there is a need for some worst case scenario planning.	On April 26-27, 2002 following the canal failure, the turbidity of Yale Lake in the vicinity of the Swift No. 2 tailrace ranged from 1 – 14 NTUs. For comparison, turbidity in Yale Lake in	Let's plan ahead and address potential unplanned releases.

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
					April 1996 and 1997 ranged from 8 to 30 NTUs. Swift Reservoir inflow turbidity was over 30 NTUs in April 1996 and April 1997 and as high as 76 NTUs in March 1997 (Yale Technical Report, PacifiCorp 1999).	
WDFW – JIM BYRNE	1	WAQ 01-40 para 2		Are these real values or extrapolations from a malfunctioning Hydrolab? Is this real?	The two pH data points in question were reported from the analytical laboratory because the Hydrolab (normally used for field pH) was malfunctioning. Thus the values are believable.	
J. Sampson, Technical Advisor to the Conservation Groups	1	WAQ 01-50 para 3	"…blue green algae…"	A discussion of the effect of algae blooms on nutrient cycling, and on nutrient delivery to the reach downstream of the projects would be helpful.	A discussion on potential effects of algae blooms on nutrient delivery will be incorporated in a revision to the WAQ 1 discussion (page WAQ 1-49).	
J. Sampson, Technical Advisor to the Conservation Groups	1	WAQ 01-51 para 4	"Headwater streams are also comparatively nutrient poor…"	This discussion ignores the role of the projects in preventing the influx of marine derived nutrients from migrations of spawning salmon to the upper tributaries of the Lewis River. The apparent nitrogen limitation of these tributaries is at least equally the result of the absence of adult salmon as it is of the absence of fixed nitrogen in sedimentary rock, as discussed in this paragraph. Please include a discussion, grounded in peer-reviewed scientific literature, of the role of salmon carcasses in the	Marine-derived nutrients as a potential contributing factor to nitrogen limitation in the upper watershed will be discussed in a revision to the text on page WAQ 1-50 and WAQ 1-51. A key reference that will be cited in this section is Helfield and Naiman (2001): Effects of salmon derived nitrogen on riparian forest growth and implications for stream productivity. Ecology. 82(9)	

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
				nutrient concentrations in streams of the same order as those examined in this study. Please provide specific references to N:P ratios in streams not blocked by dams with those given in paragraph one of this same page.	pp. 2403-2409. The discussion of N:P ratios on p. WAQ-51 included streams not blocked by dams (upper Swift Reservoir tribs) as well as sites downstream below dams.	

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