3.0 WATER USE AND QUALITY

Pursuant to requirements of 18 CFR Sections 4.51 and 16.8, PacifiCorp has prepared a report on water use and quality for the Yale Hydroelectric Project. This report contains the following elements:

- A description of existing water quality resources and factors that may affect existing water quality;
- A summary of existing resource management plans and existing measures that relate to water quality;
- PacifiCorp's proposed water quality measures for the term of a new license;
- A discussion of agency and tribal involvement related to water quality;
- A description of continuing effects of the project on water quality; and
- Implementation, cost, and schedule information.

3.1 EXISTING RESOURCES

This section describes existing water quality resources in the project study area, based on studies conducted as part of the relicensing process. Information summarized includes existing and proposed uses of project waters, existing water quality, factors affecting water quality, existing resource management plans, and existing measures. The information presented in this section is a summary of water quality studies described in PacifiCorp's FTR for Aquatic Resources (PacifiCorp 1998a).

3.1.1 Existing and Proposed Uses of Project Waters

Current and continued operation of the Yale Project does not represent a consumptive use of project waters. All flows diverted into the Yale powerhouse are discharged immediately downstream of the dam into the upper portion of Lake Merwin. Project facilities (powerhouse and residences) use wells for drinking water. A very minor consumptive use is for flushing toilets and potential use at eye-wash stations. No change in consumptive use is anticipated under the term of a new license.

3.1.2 Existing Water Quality

Water quality studies for relicensing the Yale Project were initiated in March 1996. Results for both 1996 and 1997 field seasons are presented in the FTR for Aquatic Resources (PacifiCorp 1998a), distributed to resource agencies in January 1998 and in the draft Exhibit E (PacifiCorp 1998e). These water quality studies were outlined in the FSCD (PacifiCorp 1996) and consisted of the following:

- Continuous (hourly) monitoring of water temperature at stream and tailrace sites.

- Monthly monitoring of the following water quality parameters at stream and tailrace sites:

– turbidity
– total phosphorus
– ortho-phosphorus
– total persulfate nitrogen
– nitrate plus nitrite nitrogen
– ammonia nitrogen
– fecal coliform
– alkalinity

- Monthly limnological monitoring at Yale Lake (profiles, phytoplankton, zooplankton, chlorophyll *a*).

- Diel study of key *in situ* water quality parameters (pH, dissolved oxygen, temperature, specific conductance) at selected locations.

- Study of the effects of project operations on total dissolved gas (TDG).

- Benthic invertebrate community assessment.

With the exception of benthic invertebrate studies (discussed in Section 4.0), water quality and water temperature study results are summarized in the following sections.

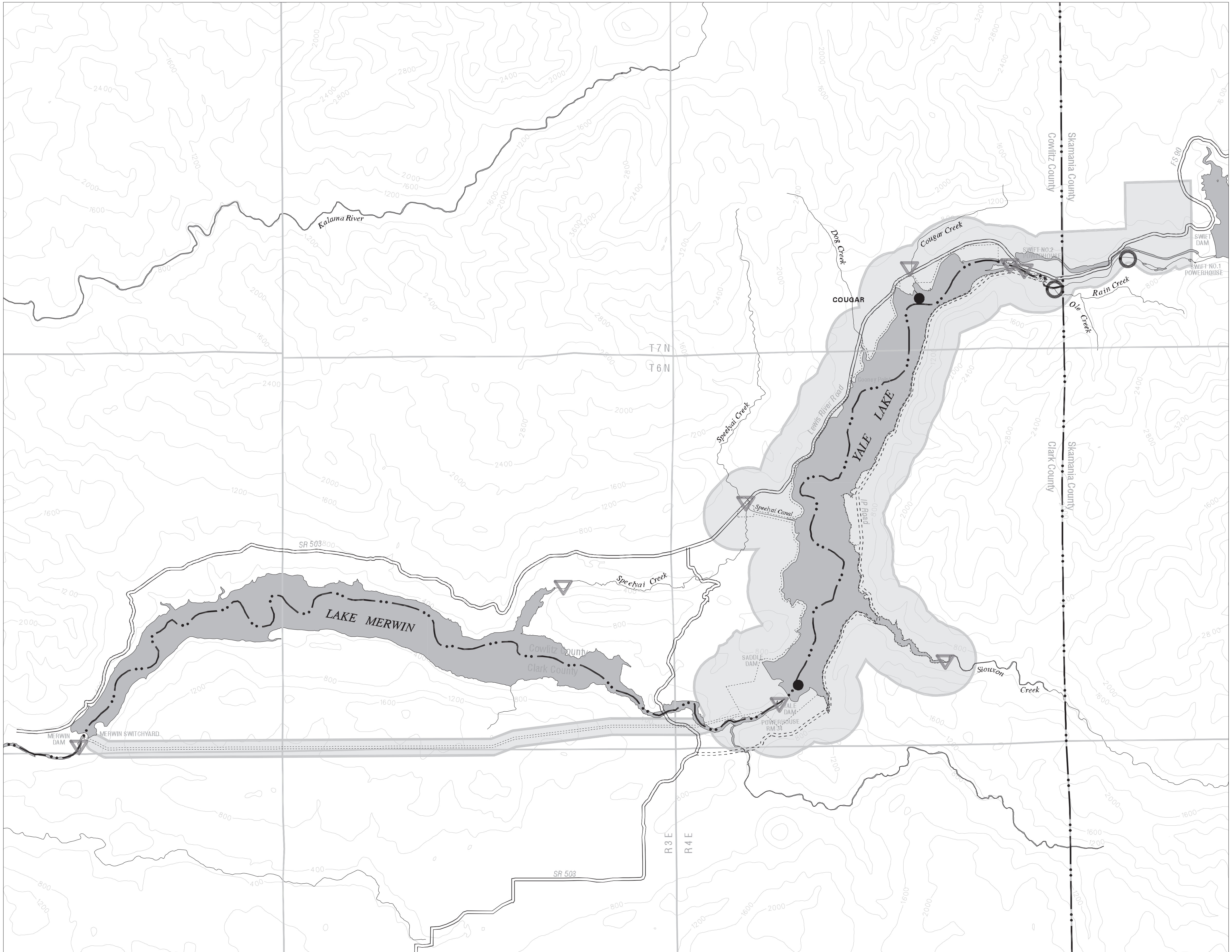
3.1.2.1 Water Temperature

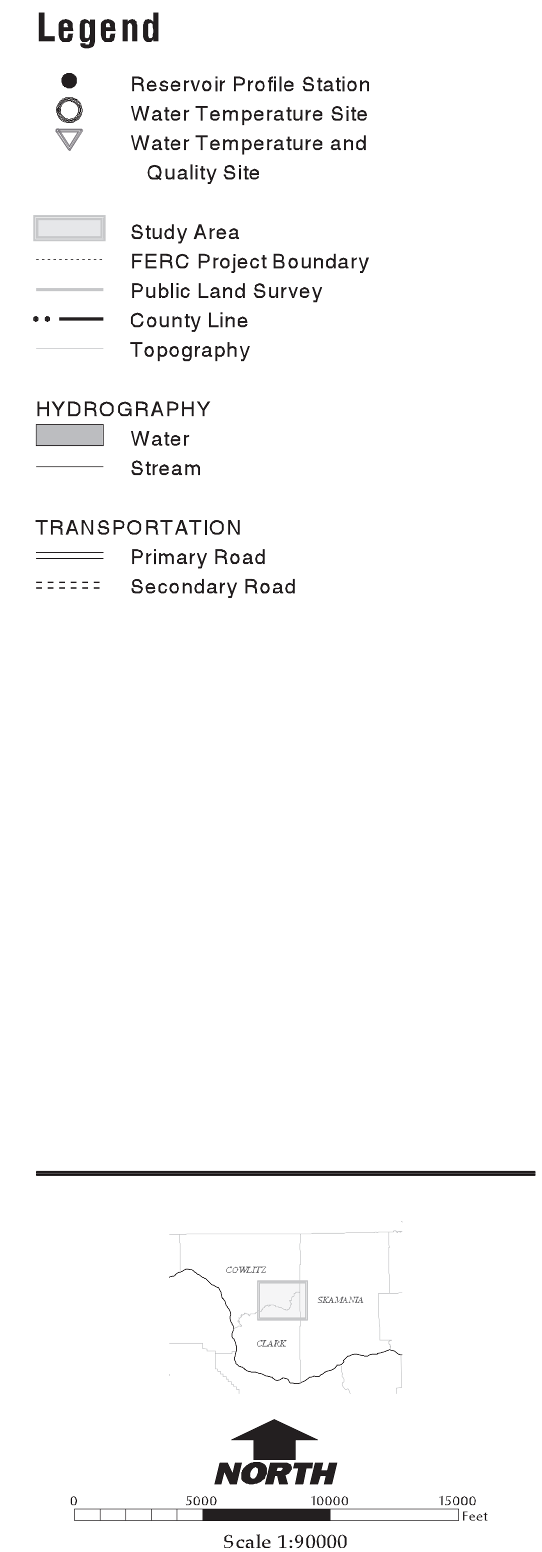
As part of the water quality studies conducted for relicensing of the Yale Project, PacifiCorp initiated water temperature monitoring in April 1996. The objectives of the monitoring program were to: (1) describe the thermal regime in the project vicinity, and (2) assess the effects of the project on water temperature. The project study area and results of temperature studies are summarized in the following sections, and described in detail in the FTR for Aquatic Resources (PacifiCorp 1998a).

<u>Study Area</u>

During 1994, PacifiCorp monitored thermal conditions at 11 sites in the North Fork Lewis River basin, including the North Fork Lewis River and several tributaries. PacifiCorp evaluated data collected in 1994 and, in consultation with the resource agencies, selected the monitoring stations displayed in Figure 3.1-1. Note that this figure shows both temperature and water quality locations, and is referred to later in this section in connection with water quality monitoring.

Two Speelyai Creek monitoring stations were added at the request of the Washington Department of Ecology (WDOE); *in situ* monitoring at these sites began in November 1996 and temperature monitoring began in December 1996. The first site is located upstream of PacifiCorp's diversion headgate on Speelyai Creek, and the second site is just





Yale Hydroelectric Project

Figure 3.1-1
Water Quality Monitoring Sites

Created by VESTRA Resources for PacifiCorp
/p1/proj_map/projects/yale/license/exe/h2o_qual/h2o_qual.map
April 05, 1999

above the Speelyai Hatchery intake. To improve the quality of hatchery intake water, Speelyai Creek is diverted to Yale Lake, leaving colder groundwater inflow as the primary source of intake water. WDOE requested an analysis of the effects of the diversion on water quality and water temperature. Temperature monitoring sites are shown below (Table 3.1-1).

Results and Discussion

Monitoring data collected at sites shown in Table 3.1-1 were summarized using the following analyses, all of which were based on hourly data:

Table 3.1-1. Water temperature monitoring sites.

Site Code	Site Description	Date Monitoring Initiated
SWRES	North Fork Lewis River inflow to Swift Reservoir	April 8, 1996
SW2BU	Upstream end of Swift No. 2 bypass	May 6, 1996
SW2BP	Downstream end of Swift No. 2 bypass	May 6, 1996
SW2TR	Swift No. 2 powerhouse tailrace	April 29, 1996
YALTR	Yale powerhouse tailrace	April 29, 1996
MERTR	Merwin powerhouse tailrace	April 29, 1996
OLECM	Ole Creek near mouth	April 3, 1996
COUGM	Cougar Creek near mouth	April 29, 1996
SIOUX	Siouxon Creek near mouth	April 29, 1996
SPLYU	Speelyai Creek upstream of diversion	December 18, 1996
SPLYL	Speelyai Creek at hatchery intake	December 18, 1996

- Descriptive statistics and tabular summaries;
- Evaluation of relationships between temperature and discharge in powerhouse tailraces;
- Percent exceedance analysis to assess seasonal and site-to-site differences; and
- 7-day moving averages to evaluate warmest temperatures recorded at each of the monitoring sites.

A summary of daily temperature data for the period April 1996 through February 1998 is included in PacifiCorp (1998a). Summary data include the date equipment was deployed; number of hourly observations; the minimum, maximum, and mean temperatures; difference between the maximum and minimum temperatures; and the standard error of hourly temperatures.

Monthly median temperatures at stations on the North Fork Lewis mainstem (Table 3.1-2) and tributaries (Table 3.1-3) were generally lowest during January and February, although the minimum occurred during December 1996 at a few sites. Median temperatures were highest at most stream sites during July and August.

The monthly median temperatures of Cougar Creek (COUGM) varied little (5.3°C to 7.5°C) from May 1996 through February 1998 (Table 3.1-3). Both Cougar and Speelyai creeks receive substantial groundwater inflow. Evidence of this at Speelyai Creek is the relatively stable median temperatures near the mouth, in contrast to temperatures upstream of the diversion (7.8 to 12.1°C at SPLYL versus 4.8 to 15.3°C at SPLYU).

Table 3.1-2. Monthly median temperatures (°C) at North Fork Lewis River sites.

	Site Code[1]					
Month	**SWRES**	**SW2BU**	**SW2BP**	**SW2TR**	**YALTR**	**MERTR**
May-96	7.6	10.3[2]	9.2[2]	7.7	8.3	7.6
Jun-96	10.1[2]	12.7	11.5	9.0	10.3	8.9
Jul-96	12.1	14.7	13.6	9.9	11.9	10.2
Aug-96	11.4	13.8	13.3	11.0	12.5	11.4
Sep-96	9.3	11.7	11.9	12.2	13.9	12.3
Oct-96	7.3	9.9	9.8	11.8	13.1	14.6
Nov-96	5.2	8.0	7.7	9.0	9.5	11.2
Dec-96	3.6	6.0	5.8	5.3	6.1	7.4
Jan-97	3.7	5.5	5.2	3.7	4.7	5.3
Feb-97	3.7	5.8	5.3	3.5	4.1	4.4
Mar-97	4.1	6.6	5.8	4.0	4.7	4.9
Apr-97	5.5	8.6	7.4	5.9	6.4	6.0
May-97	7.2	11.7	10.6	8.4	9.5	7.8
Jun-97	8.9	12.7	11.5	9.3	10.6	10.3
Jul-97	11.0	14.1	13.4	10.2	11.5	11.5
Aug-97	11.5	14.4	14.2	11.4	12.3	12.5
Sep-97	10.1	12.7	12.5	12.5	14.0	13.6
Oct-97	7.5	10.3	9.8	11.8	12.8	14.7[2]
Nov-97	5.9	8.3	8.1	8.7	9.6	11.2
Dec-97	4.1	6.5	6.3	5.7	6.4	7.9
Jan-98	4.1	6.3	5.8	4.3	5.0	5.7
Feb-98	4.7	7.1[2]	6.3	4.6	5.4[2]	5.6[2]

[1] Site codes defined in Table 3.1-1.
[2] More than 5 days not monitored.

The highest of the 7-day moving average of maximum temperatures (maximum 7-day average maximum temperatures) for the monitored sites ranged from 8.1°C at Cougar Creek to 19.9°C at Siouxon Creek (Table 3.1-4). These temperatures were very similar (within 0.1°C) for 1996 and 1997 in Cougar Creek, and were considerably lower than values for all of the other sites monitored during both years. As discussed above, Cougar Creek flows are primarily a result of groundwater inflow; thus, temperatures are relatively constant with little diel variation.

Water temperatures at the Swift No. 2 and Yale tailraces are influenced by the amount of water discharged from their respective powerhouses and season. While these plants are generating at or near capacity, temperatures in the tailraces are determined by water temperature at the turbine intake. During periods of reduced generation, tailrace temperatures are warmed by reservoir backwater in summer. In mid- to late-summer, daily temperature fluctuations can be as high as 10°C.

Table 3.1-3. Monthly median temperatures (°C) of North Fork Lewis River tributaries.

	Site Code[1]			
Month	**COUGM**	**SIOUX**	**SPLYU**	**SPLYL**
May-96	6.1	8.2	--[3]	--[3]
Jun-96	6.5	11.6	--[3]	--[3]
Jul-96	6.8	15.6	--[3]	--[3]
Aug-96	6.8	15.3	--[3]	--[3]
Sep-96	6.7	12.0	--[3]	--[3]
Oct-96	6.7	8.2	--[3]	--[3]
Nov-96	6.8	6.6	--[3]	--[3]
Dec-96	6.4	5.4	4.8[2]	7.8[2]
Jan-97	5.6	4.9	4.9	7.8
Feb-97	5.3	4.7	4.9	7.8
Mar-97	5.4	5.0	4.9	7.8[2]
Apr-97	5.4	6.1	6.2	--[3]
May-97	5.7	9.5	10.2	10.9[2]
Jun-97	6.5	11.2	10.7	11.0
Jul-97	7.0	13.7	13.3	11.8
Aug-97	7.0	15.6	15.3	12.1
Sep-97	7.0	12.8	13.0	11.6
Oct-97	7.1	8.3	8.5	10.2
Nov-97	7.5	7.1	7.4	9.5
Dec-97	7.0	4.9	5.2	8.2
Jan-98	6.4	5.5	5.5	7.9
Feb-98	5.9[2]	5.5	5.5	8.5[2]

[1] Site codes defined in Table 3.1-1.
[2] More than 5 days not monitored.
[3] Indicates less than 5 days monitored.
Note: Ole Creek thermograph lost in flood; insufficient data to enable comparison.

The highest 7-day average maximum temperature at the Merwin tailrace occurred in early October in both 1996 and 1997. At the Yale tailrace, the highest 7-day average maximum temperatures occurred in July 1996 and in September 1997. Temperatures at the Yale tailrace (YALTR) during the summer of 1996 were warmer than those in 1997 due to maintenance activities, which reduced flows through the Yale powerhouse. Note that higher temperatures than those reported in the tables were observed at the Yale tailrace during a diel study in August 1997. Diel study results are discussed later in this section.

Table 3.1-4. Maximum 7-day average maximum temperatures (°C) recorded in 1996 and 1997.

	1996		1997	
Site Code	**Temp. (°C)**	**Dates**	**Temp. (°C)**	**Dates**
SWRES	16.2	Jul 21 - Jul 27	14.7	Jul 31 - Aug 05
SW2BU	18.5	Jul 09 - Jul 15	18.4	Aug 01 - Aug 07
SW2BP	17.7	Jul 09 - Jul 15	17.6	Aug 01 - Aug 07
SW2TR	15.8	Jul 11 - Jul 17	16.9	Aug 30 - Sep 05
YALTR	19.3	Jul 14 - Jul 20	15.1	Sep 19 - Sep 25
MERTR	15.2	Oct 09 - Oct 15	15.8[2]	Oct 01 - Oct 07
OLECM	15.2[4]	Aug 28 - Sep 03	--[3]	--[3]
COUGM	8.1	Jul 09 - Jul 15	8.6	Sep 16 - Sep 22
SIOUX	19.9	Jul 23 - Jul 29	18.7	Aug 01 - Aug 07
SPLYU	--[3]	--[3]	18.3	Aug 11 - Aug 17
SPLYL	--[3]	--[3]	14.1[1]	Jul 31 - Aug 05

[1] Theft of thermograph resulted in missing data from March 19 through May 21.
[2] Broken thermograph resulted in partial data recovery during period of August 29 through October 27.
[3] No data collected during July and August of this year.
[4] Data not collected during most of July and August.

3.1.2.2 Water Chemistry

Monitoring was conducted on a monthly basis from March 1996 to February 1998. Data collected at stream and tailrace sites included *in situ* measurement of temperature, dissolved oxygen (DO), pH, specific conductance, and total dissolved gas (TDG). In addition, monthly samples were collected for analysis of the following parameters:

- turbidity
- total phosphorus (TP)
- ortho-phosphorus (OP)
- total persulfate nitrogen
- nitrate + nitrite nitrogen
- ammonia nitrogen
- fecal coliform
- alkalinity

An expanded suite of analytes was measured on a quarterly basis at the Yale tailrace. These included pesticides/polychlorinated biphenyls (PCBs), herbicides, metals, and major cations and anions.

The study area, methods, and results for the water quality monitoring program conducted in stream and tailrace sites are described in the following sections. It is followed by descriptions of reservoir investigations.

<u>Study Area</u>

Water quality monitoring locations, shown previously in Figure 3.1-1, include:

- Inflow to Swift Reservoir (SWRES)
- Swift No. 2 tailrace (SW2TR)
- Swift No. 2 bypass (SW2BP)
- Siouxon Creek mouth (SIOUX)
- Cougar Creek mouth (COUGM)
- Yale tailrace (YALTR)
- Merwin tailrace (MERTR)
- Speelyai Creek - Upper (SPLYU)
- Speelyai Creek - Lower (SPLYL)
- Reservoir profile stations

Methods

Study methods for water quality sampling and *in situ* measurements are described in the FTR for Aquatic Resources (PacifiCorp 1998a). A summary of methods is presented below.

At stream sites, samples for laboratory analysis were collected as grab samples in flowing water, near the center of the channel where possible. Tailrace samples were collected with a Van Dorn sampler, which was lowered into the tailrace area to a depth of approximately 1 meter (m). A blank sample (deionized water) and a field duplicate sample were collected at 1 of the monitoring 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 quality assurance program maintained by the analytical laboratory (Oregon Analytical Laboratory in Beaverton, Oregon).

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 prior to each day's use following 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® Total Dissolved Gas meter. Both instruments were allowed to stabilize prior to recording data. Measurements at stream sites were taken in flowing water near the center of the channel. The instruments were lowered to an approximate 1-m depth at tailrace sites.

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

Results and Discussion

Results of water quality monitoring at stream and tailrace sites are summarized below.

Reservoir monitoring results are presented in Section 3.1.2.6; plots and tabular summaries of all water quality data are included in the FTR for Aquatic Resources (PacifiCorp 1998a).

Alkalinity. Surface waters in the Lewis River drainage are relatively dilute with respect to cation concentrations; alkalinity at tailrace sites was typically between 10 and 25 mg/l as CaCO3. Levels at bypass and tributary sites were slightly higher and more variable than tailrace sites. The inlet to Swift Reservoir (SWRES) was typically higher in alkalinity than other sites; Siouxon and Cougar creeks were typically lower than other sites.

Turbidity. Turbidity at Cougar and Siouxon creeks was consistently low throughout the monitoring period (less than 5 nephelometric turbidity units [NTUs]). Levels at Swift Reservoir inflow were typically higher, increasing to over 30 NTUs in April of both 1996 and 1997 and 76 NTUs in March 1997.

With the exception of high runoff periods during the spring, turbidity at tailrace sites was typically higher than at stream sites. These higher levels occur because turbine inflow is withdrawn from reservoir depths with higher levels of suspended sediments. In addition, agitation in the tailrace causes localized turbidity. Summer turbidity levels were low at all sites, typically 2 to 3 NTUs.

Total Phosphorus. With few exceptions, total phosphorus (TP) levels at the inflow to Swift Reservoir were higher than other sites, possibly a result of the pumice and volcanic ash content of soils in the Swift watershed following the Mount St. Helens eruption. The maximum TP value was 0.26 mg/l at the Swift Reservoir inflow in November 1997 (PacifiCorp 1998a). Values at the Swift No. 2 tailrace were typically higher than other tailrace sites, again reflective of the volcanic influence in the Swift Creek watershed.

Ortho-Phosphorus. Ortho-phosphorus (OP) levels at tributary sites were variable, typically less than 0.05 mg/l. A pattern of lower OP values during the growing season and higher values during the winter months was seen at tailrace sites. During periods of low biological demand (i.e., December 1996 through March 1997), ortho-phosphorus levels were highest at the inflow to Swift Reservoir, intermediate at the Yale tailrace, and lowest at the Merwin tailrace. Ortho-phosphorus levels reached 0.07 mg/l at the Swift No. 2 tailrace in January and February 1997. This pattern reflects deposition of adsorbed phosphorus on fine sediment as suspended material moves through the Lewis River projects during high runoff periods.

Data collected during the summer of 1997 suggest that less phosphorus was available for primary production during the summer of 1997 than in 1996. Chlorophyll *a* and phytoplankton data (see below) support this assertion. These differences may be a result of the high flow event in February 1996, which probably increased the amount of fines and associated phosphorus in runoff throughout the 1996 field season.

Nitrate+Nitrite. Nitrate levels (NO_2+NO_3, mg/l as N) ranged from less than detection (0.01 mg/l) to 0.27 mg/l. However, the nitrate data are suspect in several cases due to measurable nitrogen in field blank samples (PacifiCorp 1998a). In general, higher values were seen in the fall, reflecting allocthonous organic inputs, such as alder leaves. All sites had relatively high nitrate levels in April 1996, possibly due to mobilization of nitrogen from scoured sediments during the February 1996 high flow event.

A pattern of elevated nitrate during high runoff periods and low values during the summer was evident during both 1996 and 1997 field seasons. August levels were less than 0.05 mg/l during both years.

In contrast to the pattern described above for ortho-phosphorus (i.e., decreasing concentrations from Swift to Merwin during the non-growing season), an opposite pattern occurred for NO_2+NO_3. The downstream increases in nitrogen levels are likely due to accumulating allocthonous inputs from the watershed. The pattern breaks down during the growing season as nitrate is utilized by phytoplankton.

Ammonia. Ammonia levels (mg/l as N) ranged from less than detection (0.01 mg/l) to 0.08 mg/l at the Swift No. 2 tailrace in January 1997 (PacifiCorp 1998a, Appendix 2.2-1). In general, higher levels occurred during the summer of both 1996 and 1997. The primary source of ammonia is decomposition of organic material; higher levels in the summer are due to the breakdown of algae, zooplankton, and allocthonous organic material.

Total Persulfate Nitrogen. Total persulfate nitrogen (TPN) is a digestion method which, unlike total Kjeldahl nitrogen (TKN), accounts for inorganic nitrogen as well as organic nitrogen and ammonia. Thus, TPN is a measure of total available nitrogen. TPN values were seldom above the 0.2 mg/l detection limit (PacifiCorp 1998a, Appendix 2.2-1). The 2 highest TPN concentrations, 1.0 mg/l and 0.49 mg/l, were recorded at the Swift Reservoir inlet in March 1997 and April 1996, respectively (PacifiCorp 1998a). Both of these values were much higher than corresponding nitrate (NO_3+NO_2) or ammonia levels. Despite the predominance of less than detectable values, the TPN results suggest that organic nitrogen, probably of allocthonous origin, can be an important component of the nitrogen pool entering the study area during the spring.

Fecal Coliform Bacteria. Fecal coliform levels were less than 2 colonies per 100 ml in most cases (PacifiCorp 1998a, Appendix 2.2-1). The highest fecal coliform count was 170 colonies per 100 ml at the Swift Reservoir inlet in October 1996 (PacifiCorp 1998a).

Quarterly Tailrace Samples. Quarterly sampling at the Yale tailrace showed low levels of all analytes measured except mercury. These include cations and anions, metals, and organics (pesticides, herbicides, and PCBs) (Table 3.1-5).

Table 3.1-5. Results of quarterly analyses at Yale powerhouse tailrace (YALTR), April 1996 through January 1998.

Parameter	Apr-96	Jul-96	Oct-96	Feb-97	May-97	Jul-97	Oct-97	Jan-98
CATIONS/ANIONS	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Chloride	0.9	1	1.3	1	0.9	0.8	1.2	1.1
Sulfate	1.7	1.8	2.1	1.7	1.7	1.6	2	1.4
Calcium	3.41	3.77	3.86	3.35	3.22	3.32	3.99	3.63
Magnesium	0.82	0.942	1.01	0.812	0.818	0.837	1.07	0.85
Potassium	0.41	0.52	0.51	0.57	0.58	0.45	0.55	<0.40
Sodium	2.41	2.79	2.84	2.29	2.35	2.39	3.05	2.31
Silica	13.2	13.8	16	15	16	16	18	16
METALS	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron	<0.010	0.02	<0.010	0.029	0.057	<0.01	0.011	0.063
Lead	<0.025	<0.025	<0.025	<0.025	<0.025	<0.02	<0.025	<0.025
Nickel	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	<0.01
Zinc	<0.005	<0.005	<0.005	0.006	<0.005	0.005	<0.005	<0.010
Mercury	<0.0002	0.00031	<0.0002	<0.0002	<0.0002	0.00041	0.00026	<0.0002
PESTICIDES	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Aldrin	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
alpha-BHC	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
beta-BHC	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
delta-BHC	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
gamma-BHC	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
Chlordane	<0.80	<0.11	<0.097	<0.80	<0.80	<0.80	<0.80	<0.80
4,4'-DDD	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
4,4'-DDE	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
4,4'-DDT	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Dieldrin	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Endosulfan I	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
Endosulfan II	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Endosulfan Sulfate	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Endrin	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Endrin Aldehyde	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Endrin Ketone	<0.16	<0.022	<0.019	<0.16	<0.16	<0.16	<0.16	<0.16
Heptachlor	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
Heptachlor Epoxide	<0.08	<0.011	<0.0097	<0.08	<0.08	<0.08	<0.08	<0.08
Methoxychlor	<0.80	<0.11	<0.097	<0.80	<0.80	<0.80	<0.80	<0.80
Toxaphene	<1	<1.1	<0.97	<1	<1	<1	<1	<1

Table 3.1-5. Results of quarterly analyses at Yale powerhouse tailrace (YALTR), April 1996 through January 1998 (continued).

Parameter	Apr-96	Jul-96	Oct-96	Feb-97	May-97	Jul-97	Oct-97	Jan-98
PESTICIDES	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Aroclor-1016	<1	NM	NM	<1	<1	<1	<1	<1
Aroclor-1221	<1	NM	NM	<1	<1	<1	<1	<1
Aroclor-1232	<1	NM	NM	<1	<1	<1	<1	<1
Aroclor-1242	<1	NM	NM	<1	<1	<1	<1	<1
Aroclor-1248	<1	NM	NM	<1	<1	<1	<1	<1
Aroclor-1254	<1	NM	NM	<1	<1	<1	<1	<1
Aroclor-1260	<1	NM	NM	<1	<1	<1	<1	<1
HERBICIDES	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Dalapon	<58	<58	<58	<0.65	<0.061	<0.063	<0.062	<0.5
Dicamba	<3	<3	<3	<0.37	<0.035	<0.036	<0.035	<0.1
MCPA	<2500	<2500	<2500	<0.39	<0.026	<0.027	<0.027	<0.1
MCPP	<2000	<2000	<2000	<0.28	<0.037	<0.038	<0.038	<0.1
Dichloroprop	<7	<7	<7	<0.44	<0.042	<0.043	<0.042	<0.1
2,4-D	<12	<12	<12	<0.27	<0.026	<0.027	<0.026	<0.1
2,4,5-TP	<2	<2	<2	<0.15	<0.014	<0.014	<0.014	<0.1
2,4,5-T	<2	<2	<2	<0.3	<0.029	<0.03	<0.029	<0.1
2,4-DB	<9	<9	<9	<0.25	<0.024	<0.025	<0.024	<0.1
Dinoseb	<1	<1	<1	<0.22	<0.021	<0.022	<0.021	<0.1

No detectable levels of pesticides, herbicides, or PCBs were found in any of the quarterly samples. With the exception of a detectable level of mercury in July 1996 and January 1998, metals were all non-detectable. The mercury level in the July sample was 0.00031 mg/l (0.31 µg/l), and in the January sample 0.41 µg/l. Both values are below the State of Washington acute criteria of 2.4 µg/l (0.0024 mg/l), but above the chronic criteria of 0.012 µg/l (WAC 173-201A-040). Note that the criteria for chronic mercury levels are based on 4-day averages, while the samples in reference are single measurements. Mercury was undetectable in all of the other samples collected.

With the exception of silica, cations and anions measured in the quarterly samples were below average levels in drinking water (National Environmental Testing 1995). Silica levels (approximately 13 to 16 mg/l) were approximately twice the average levels in drinking water.

In Situ Data. Results of *in situ* measurements of DO, pH, specific conductance, and TDG are summarized below for stream and tailrace sites. Results for Speelyai Creek are discussed separately in Section 3.1.2.3.

The minimum DO concentration observed during the monitoring period was 7.3 mg/l at the Swift No. 2 tailrace in August 1997. Values of 8.0 and 8.5 mg/l were recorded at the Merwin tailrace in September 1996 and September 1997, respectively. All other DO values were greater than 9 mg/l (PacifiCorp 1998a). Values were generally higher in the spring and decreased slightly with increasing water temperature throughout the summer.

Overall, monthly pH values ranged from 5.9 to 7.8. The minimum value was observed at the Swift Reservoir inflow in April 1997, and although this was the only measurement less than 6.0, several relatively low values were observed throughout the monitoring program (Table 3.1-6). Decomposition of organic material may be occurring at a relatively high rate in the Lewis River watershed, at times causing slightly lower pH due to high levels of dissolved CO_2.

Table 3.1-6. pH values less than 6.5 recorded during monthly water quality monitoring.

Date	Site	Time	pH	Water Temp. (°C)
22-Jul-96	COUGM	13:30	6.37	8.0
15-Jan-97	SWRES	13:00	6.39	1.9
22-Apr-97	SWRES	10:40	5.92	5.5
22-Apr-97	MERTR	14:50	6.36	6.4
27-Aug-97	MERTR	11:00	6.42	12.6

Specific conductance reached a maximum of 73 µS/cm in August 1997 at the Swift Reservoir inflow. There was less variation in specific conductance at tailrace sites, with values typically between 30 and 50 µS/cm.

TDG levels were close to 100 percent saturation for the majority of sampling events. Higher values were observed at the Swift No. 2 and Yale tailrace sites; measurements in June and July 1997 at these sites exceeded 110 percent saturation. Gas saturation at the Yale tailrace was the subject of separate studies summarized later in Section 3.1.2.5.

3.1.2.3 Speelyai Creek Monitoring

Beginning in November 1996, Speelyai Creek was monitored at 2 locations: upstream of the diversion near the Highway 503 bridge, and downstream at the Speelyai Fish Hatchery intake. Due to the dominance of cold spring inflows in the reach between the hatchery and diversion site, Speelyai Creek (upstream of the springs) was diverted to Yale Lake in the 1950s to route warmer surface flows away from the hatchery intake. *In situ* monitoring by PacifiCorp documented temperature levels at these 2 sites (SPLYU and SPLYL, respectively), as well as DO, pH, and specific conductance. Temperature differences were described earlier in Section 3.1.2.1; results of other *in situ* parameters are discussed below.

Differences in DO at the 2 locations were within a milligram per liter on most visits, and never differed by more than 2.0 mg/l. Minimum DO occurred in May 1997, with readings near 9.0 mg/l at both sites. Values were generally above 10.0 mg/l.

pH values were also similar between the upper and lower Speelyai sites. Values were slightly higher at the lower site during the winter months, and similar or slightly higher at the upper site during the summer months. This weak pattern in the data is probably due to precipitation effects on surface water flows prior to the diversion, which tend to depress pH at the upper site relative to groundwater.

Specific conductance was consistently greater at the lower site, reflecting higher ionic strength of groundwater than the undiverted surface water of Speelyai Creek. Values near the hatchery were from 17 µS/cm to 28 µS/cm greater, or from 50 to nearly 100 percent higher than upstream values (Figure 3.1-2).

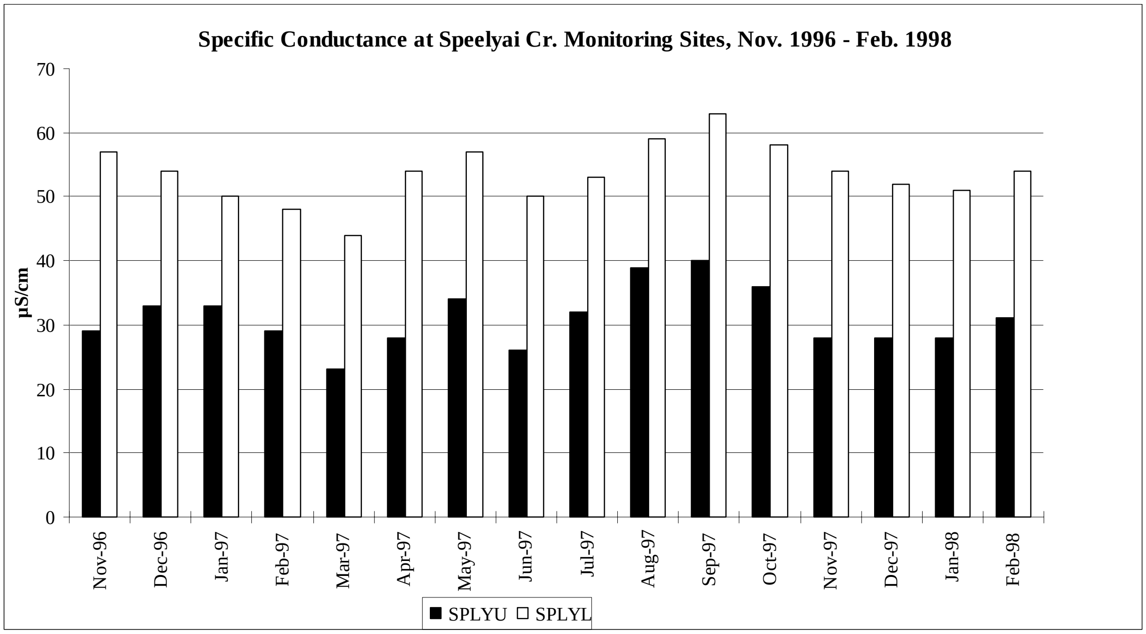


Figure 3.1-2. Specific conductance at Speelyai Creek monitoring sites, November 1996 - February 1998.

3.1.2.4 Diel Studies

In situ data collected by PacifiCorp during monthly water quality visits were primarily used to characterize seasonal trends and differences between sites. However, daily (i.e., diel) changes cannot be inferred from these data. Daily minimum and maximum values of pH and DO are potential stressors to aquatic communities; thus, knowledge of diel fluctuations is important in an overall assessment of aquatic habitat. PacifiCorp conducted diel studies in 1997. These studies involved hourly monitoring of pH, DO, specific conductance, and temperature at 4 locations. The duration of monitoring was slightly less than 7 days at each site (162 hours at Yale tailrace, and 163 hours at the other 3 sites). The study area and results are summarized below. A more detailed presentation of methods and results is contained in the FTR for Aquatic Resources (PacifiCorp 1998a).

<u>Study Area and Methods</u>

Diel studies were conducted in August 1997 at four locations: Cougar Creek, the Swift No. 2 bypass reach, Siouxon Creek, and the Yale tailrace (Figure 3.1-3). Cougar Creek monitoring was conducted approximately 0.5 mile upstream of the Highway 503 Bridge.

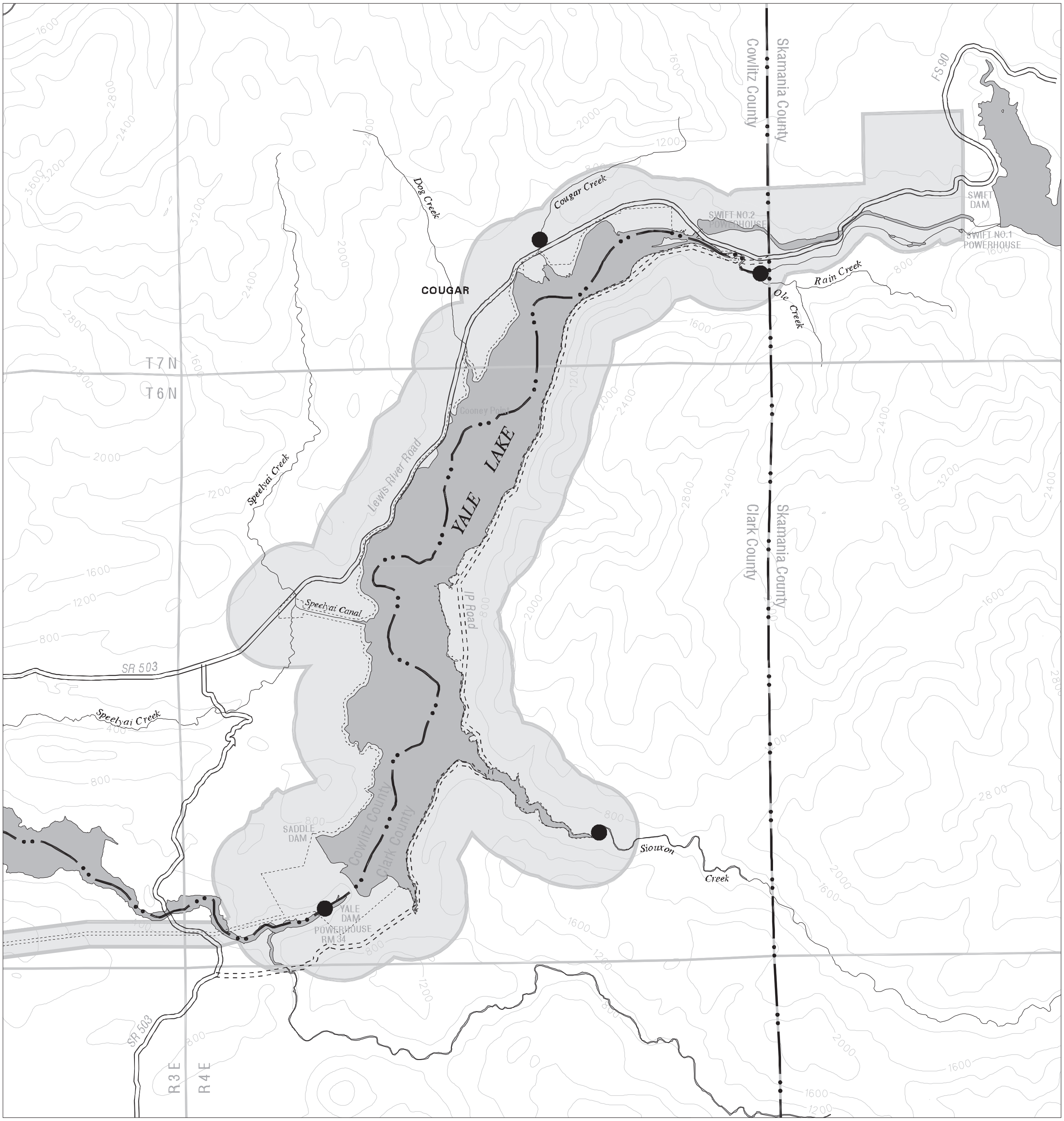
Siouxon Creek was monitored approximately 300 m upstream from the point of full pool (490 feet msl). The site at the Swift No. 2 bypass reach was approximately 50 m upstream of the mouth of Ole Creek. At the Yale tailrace, monitoring was conducted within 5 m of the powerhouse. At each of the sites, Hydrolab® Datasondes recorded pH, DO, specific conductance, and water temperature at hourly intervals. The instruments were deployed on August 15, 1997, and retrieved 1 week later on August 22, 1997.

Results and Discussion

Monitoring results showed a range of diel variation, from relatively constant conditions at Cougar Creek to quite variable conditions at the Yale tailrace and Swift bypass reach. Maximum, minimum, and median values for the monitored parameters are shown below (Table 3.1-7).

Table 3.1-7. Summary of diel study results, August 15-22, 1997.

	Temp	**pH**	**SpCond**	**DO Sat**	**DO**
Yale Tailrace					
Max	24.2	7.7	38.0	107.4	11.1
Min	12.2	6.8	35.0	92.4	8.5
Median	17.0	7.1	36.0	100.7	9.4
N (Hrs.)	162	162	162	162	162
Siouxon Creek					
Max	18.8	7.8	47.6	99.0	9.5
Min	13.9	7.3	45.6	86.0	8.2
Median	15.7	7.4	46.5	88.8	8.9
N (Hrs.)	163	163	163	163	163
Cougar Creek					
Max	7.8	7.5	36.4	101.5	12.4
Min	6.5	7.2	35.4	97.6	11.8
Median	6.7	7.3	35.8	99.4	12.2
N (Hrs.)	163	163	163	163	163
Swift No. 2 Bypass					
Max	17.6	7.2	56.3	104.1	10.4
Min	12.0	7.0	54.8	79.3	8.2
Median	13.8	7.0	55.5	86.5	9.0
N (Hrs.)	163	163	163	163	163



Yale Hydroelectric Project

Figure 3.1-3
Diel Study
Site Locations

NORTH

0 1 2 3 Miles

Scale 1:90000

Legend

- Diel Study Site Locations
- Study Area
- FERC Project Boundary
- Public Land Survey
- County Line
- Topography
- Water
- Stream
- Primary Road
- Secondary Road

Maximum temperatures during the 7-day study were recorded on August 17 at all 4 sites, and ranged from 7.8°C at Cougar Creek to 24.2°C at the Yale tailrace. As discussed above, changes in generation at the Yale tailrace can result in changes to temperature, particularly during late summer. Fluctuations at the Yale tailrace reflect the influence of the Merwin pool during periods of reduced power generation at Yale (Figure 3.1-4). Diel changes in temperature (i.e., the difference between daily minimum and maximum temperatures) were less than 1°C at Cougar Creek, 2 to 5°C at Swift No. 2 and Siouxon Creek, and 5 to 12°C at the Yale tailrace.

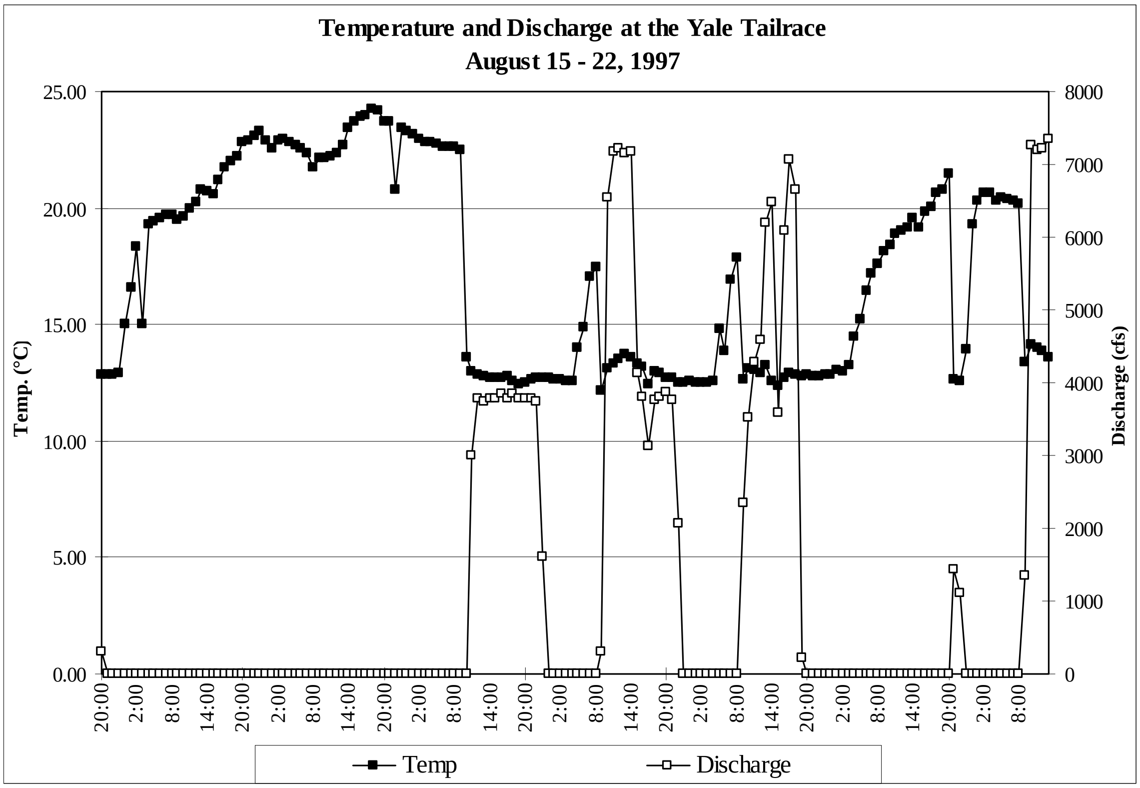


Figure 3.1-4. Hourly monitoring of temperature at Yale powerhouse tailrace, and average hourly flow - August 15-22, 1997.

Maximum pH during the study ranged from 7.2 at the Swift No. 2 bypass reach to 7.8 at Siouxon Creek. With the exception of the Yale tailrace, little diel change in pH was observed among the 4 sites. Variation at the Swift No. 2 bypass, Siouxon, and Cougar Creek was less than 0.5 pH units. Diel changes at the Yale tailrace were similar to the other sites on days when generation was reduced for extended periods. However, on days when normal cycles of generation occurred, greater diel change in pH was observed. This can be attributed to alternating periods of dominance by warmer and more productive Merwin surface waters, with periods in which the tailrace volume was primarily water from the intake depth of Yale Lake (approximately 20 m at full pool).

Maximum DO concentrations ranged from 9.5 mg/l at Siouxon Creek to 12.4 mg/l at Cougar Creek. Minimum values ranged from 8.2 at Siouxon and the Swift No. 2 bypass to 11.8 at Cougar Creek. The 8.2 mg/l value at Siouxon Creek was 87 percent of saturation. Maximum oxygen saturation at the 4 sites ranged from 107 percent at the Yale tailrace to 99 percent at Siouxon Creek. Median percent saturation was less than 90 percent at both Siouxon Creek and the Swift No. 2 bypass reach. Minimum percent saturation ranged from 79 percent at the Swift No. 2 bypass to 97 percent at Cougar Creek. Diel changes in DO were lowest at Cougar Creek (less than 0.5 mg/l), approximately 1.0 mg/l at Siouxon Creek, and between 1.5 mg/l and 2.5 mg/l at the Swift No. 2 bypass and Yale tailrace sites.

Distinct diel changes in oxygen saturation occurred at the Swift No. 2 bypass reach. Values increased in late afternoon to between 100 percent and 104 percent, and fell to near 80 percent between midnight and 06:00. A similar pattern was seen at Siouxon Creek, but with lower maximum and higher minimum values. Diel patterns in oxygen saturation were apparent at the Yale tailrace, although there was greater variability and values remained above 100 percent. At Cougar Creek, oxygen saturation remained at or slightly above 100 percent throughout the study.

Little change in specific conductance was seen on a diel basis at any of the 4 sites. The maximum daily change was 3 µS/cm per day at the Yale tailrace. Median specific conductance was highest at the Swift No. 2 bypass reach (56 µS/cm), and between 36 and 47 µS/cm at the other three sites.

3.1.2.5 Total Dissolved Gas Studies

In situ data collected by PacifiCorp in 1994 indicated that project operations influence TDG levels in the Yale tailrace. At times, TDG levels exceeded WDOE's 110 percent limit. To determine the extent of elevated dissolved gas levels in the tailrace and, if possible, confirm the source of elevated TDG, PacifiCorp initiated the first of several TDG field studies at the Yale tailrace in 1995. Detailed results of these studies are presented in the FTR for Aquatic Resources (PacifiCorp 1998a).

While the source of elevated TDG at the Yale project was not initially known, PacifiCorp suspected that the air admission system was responsible. The Yale turbines incorporate an air admission system that draws air directly into the turbine via an outside vent. When air enters the turbine, it is subject to increased pressure within the turbine, which helps dissolve the entrained air into solution. The air admission system is necessary to equalize pressure within the turbine, which reduces cavitation and improves operating efficiency.

PacifiCorp evaluated the role of the air admission system in field tests conducted in 1996. Results showed that at discharges below approximately 3,000 cubic feet per second (cfs) (~50 MW), TDG may exceed the WDOE limit. Data collected during the study indicated that by closing the air vent at discharges below 3,000 cfs, TDG remained within acceptable state standards (PacifiCorp 1998a).

As a result of these studies, PacifiCorp initiated operational restrictions at the Yale Project to prevent TDG in the tailrace from exceeding state limits. These restrictions involve closing the air intake vent at low discharge levels (at or below 20 MW), and restricting the duration of mid-generation discharge (20-50 MW) to avoid elevated TDG. PacifiCorp evaluated this operational regime in 1996 and found it effective in maintaining TDG within state standards (PacifiCorp 1998a).

3.1.2.6 Reservoir Monitoring

The reservoir monitoring program consisted of monthly visits to Yale Lake for physical, chemical, and biological measurements. The objective of this element of the monitoring program was to characterize the limnology of the reservoir, and to assess the influence of project operations on reservoir water quality.

Study Area

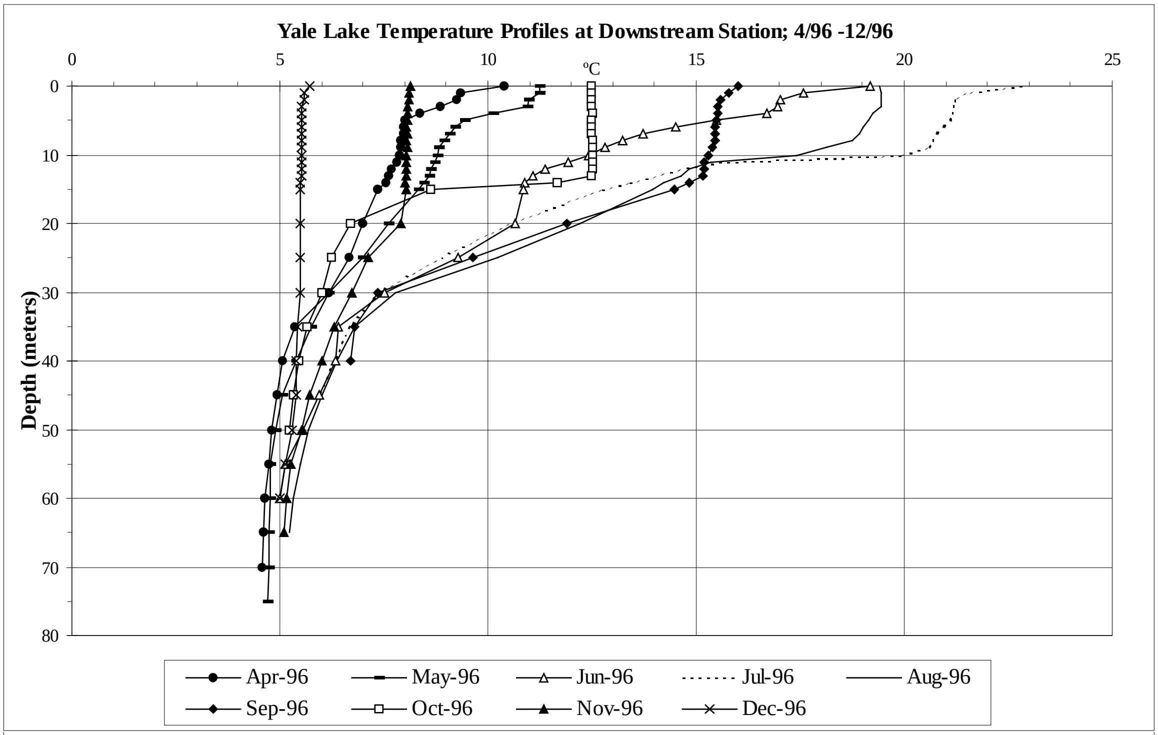
Data were collected at 2 locations in Yale Lake: the upstream end of the reservoir near the Cougar Creek mouth, and near the dam. At each, profiles of *in situ* parameters were conducted, secchi disk transparency was measured, and samples were collected for analysis of water quality and biological constituents. The Hydrolab® Surveyor 2 or 3 previously described for streams and tailraces was used for reservoir monitoring. Data were collected at 1-m intervals from the surface to a depth of 15 m, and at 5-m intervals from 15 m to the reservoir bottom.

The same laboratory analyses for samples collected at stream and tailrace sites were also conducted on the Yale Lake samples. Samples for water chemistry were collected at a depth of 1.5 m at both stations, and near the intake depth at the lower station (approximately 20 m deep at full pool). A Van Dorn sampler was used for reservoir sampling. Chlorophyll *a* and phytoplankton samples were collected as separate aliquots poured from the sampler used for the surface water sample collection (1.5-m depth).

Zooplankton samples were collected monthly at each station with vertical tows (bottom to surface). An 80µ mesh plankton net was used for the plankton tows; samples were preserved in the field using 5 percent buffered formalin. Preserved samples were shipped to the University of Washington Fisheries Research Institute, and analyzed by Mr. Jeff Cordell.

Results and Discussion

Reservoir Profiles. Summaries of profile data for temperature, pH, and DO at the downstream station near Yale Dam are shown in Figures 3.1-5 through 3.1-7. No profile data were collected in March 1996 or August 1997 due to equipment failure. Inclement weather prevented access in January and February 1997. A weak thermocline was evident by April of both years; maximum thermal stratification was seen in July of each year. Surface temperatures were 23°C and 21°C at the upstream and downstream stations, respectively, in July 1996, and 21°C at the downstream site in July 1997. Surface to bottom temperature differences of 10°C at the upstream site, and 17°C at the downstream site were observed in July 1996. The same difference (17°C) between surface and bottom temperatures was also seen in July 1997. During mid-summer, the thermocline resided between 10 and 15 m at both locations.



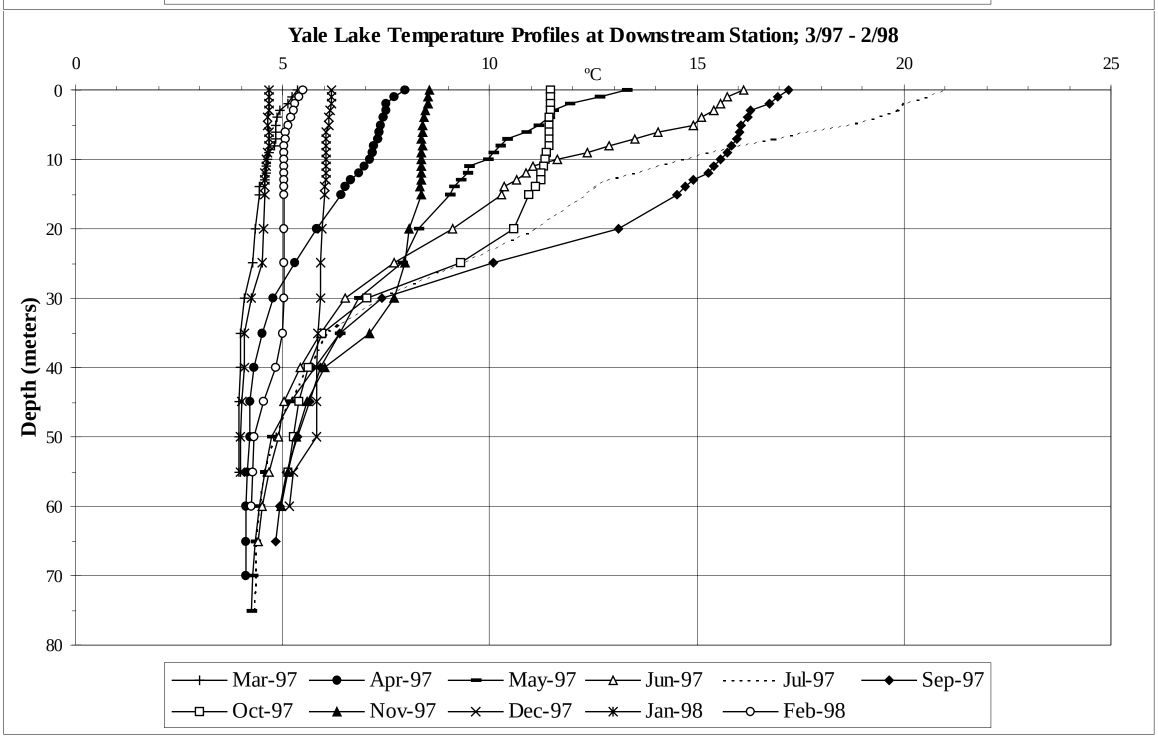
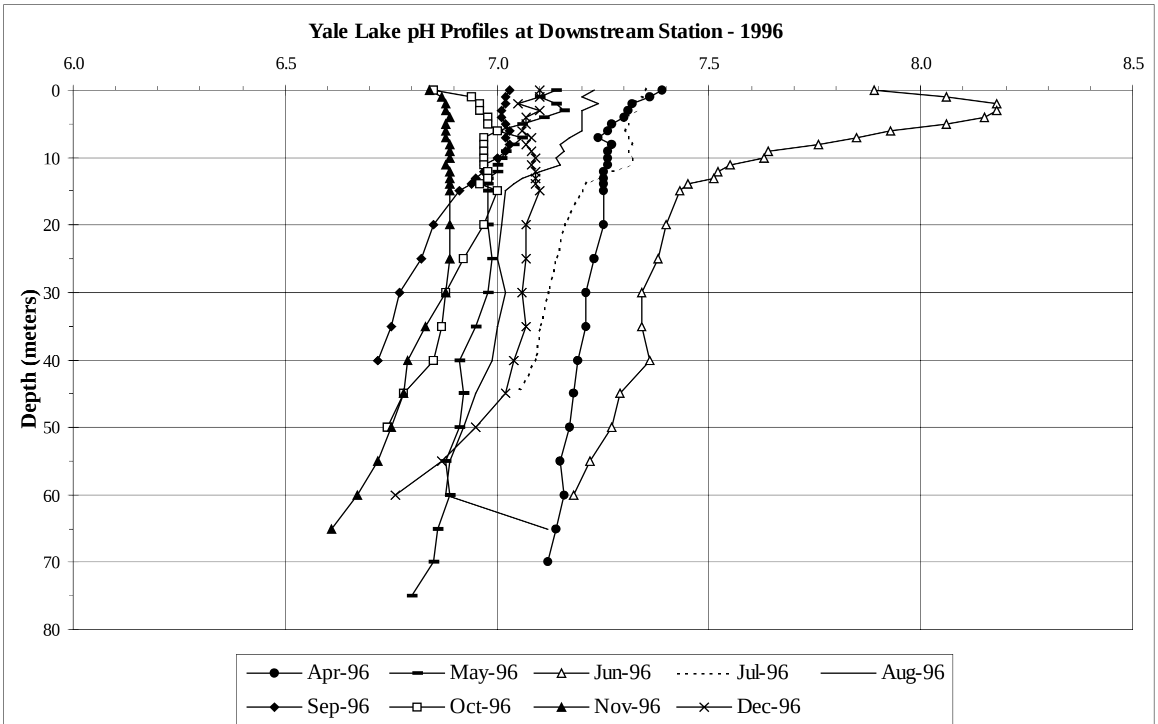


Figure 3.1-5. Yale Lake temperature profiles - April through December 1996 (top) and March 1997 through February 1998 (bottom).



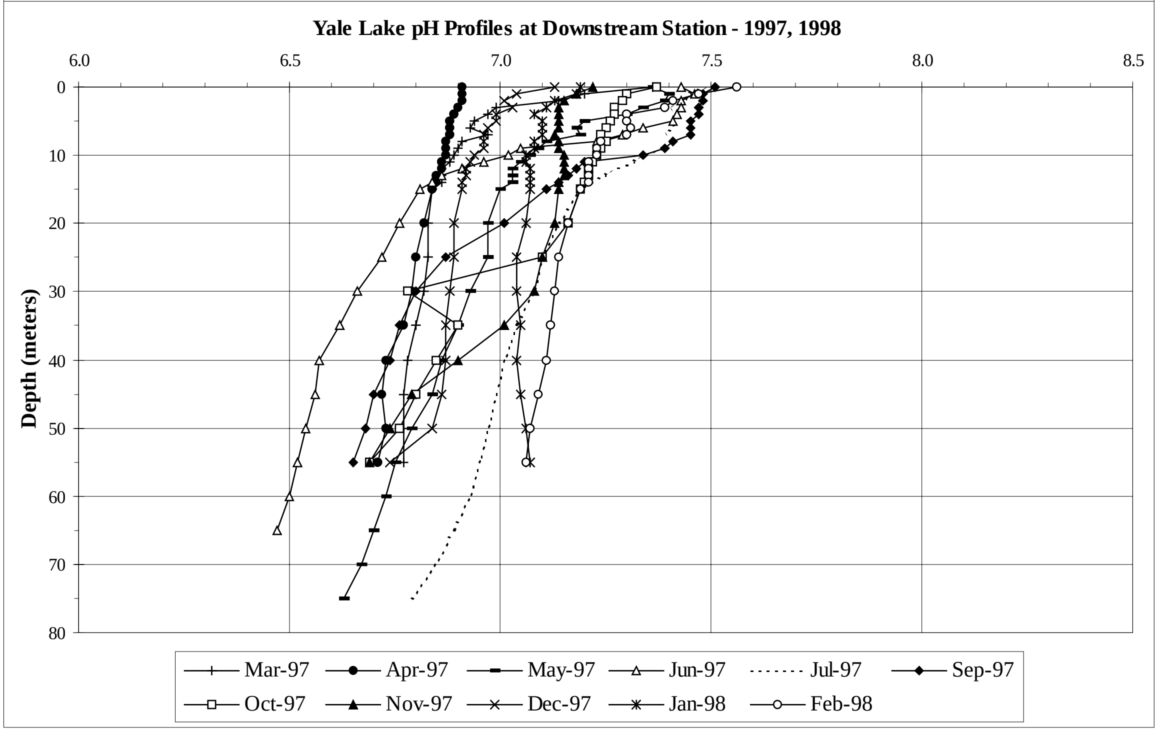


Figure 3.1-6. Yale Lake pH profiles - April through December 1996 (top) and March 1997 through February 1998 (bottom).

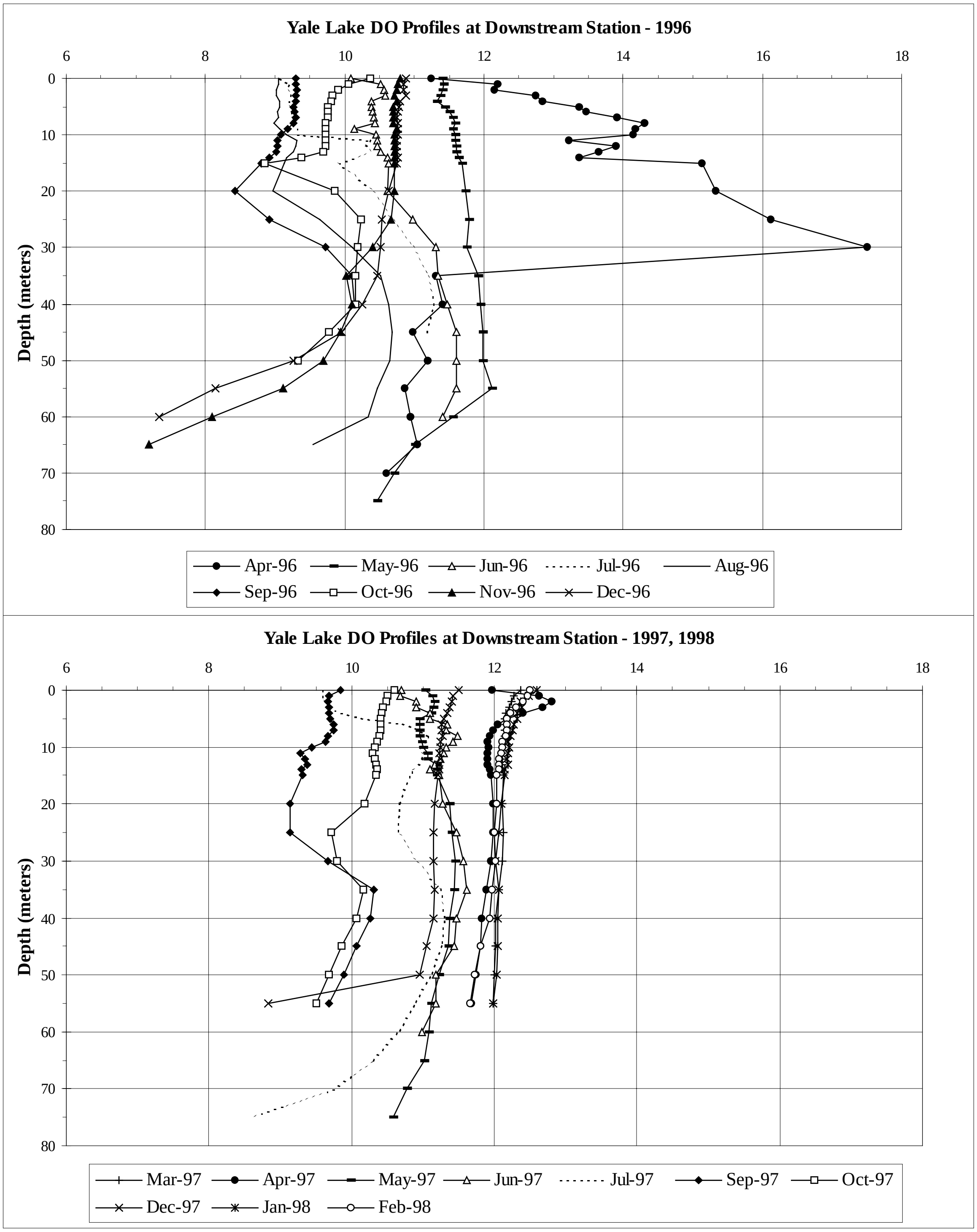


Figure 3.1-7. Yale Lake dissolved oxygen profiles - April through December 1996 (top) and March 1997 through February 1998 (bottom).

Effects of algal photosynthesis were most evident in the June 1996 pH profiles. Epilimnetic pH was above 8.0 at both stations, with a maximum of 8.4 at the downstream station at 2 m (Figure 3.1-6). These results correspond with chlorophyll *a* and phytoplankton data; maximum chlorophyll *a* values and phytoplankton biovolumes were recorded at this time (see below). In 1997, sampling either missed the maximum bloom conditions, or there was reduced effect of phytoplankton on pH. Epilimnetic pH was consistently less than 8.0 at both stations in 1997.

The reservoir bottom did not approach anoxic conditions during either field season (1996 or 1997/1998). Minimum DO was observed in November and December 1996, when values were near 7.0 mg/l at a depth of 60 to 65 m. DO near the reservoir bottom was 8.1 mg/l in August 1996 at the upstream station and 8.4 mg/l in September 1996 at the downstream station. The minimum DO observed in 1997 was 8.6 mg/l at a depth of 78 meters in July (Figure 3.1-7).

A spring algae bloom is evident from the DO profile at the downstream station in April 1996. Gradually increasing DO levels were seen from the surface to a depth of 30 m, where DO reached 17.5 mg/l. A much smaller bloom occurred in April 1997, causing slight increases in DO within the upper 5 m at the downstream station. The dominant algae during both of these periods were diatoms - *Cryptomonas erosa* in April of 1996, and *Rhodomonas minuta* in 1997. Diatom blooms are common during early spring when light levels and water temperatures are still relatively low (Wetzel 1975).

Specific conductance was typically between 30 µS/cm and 50 µS/cm at both stations. Values were somewhat higher and more variable later in the summer, with slightly higher readings at the downstream station.

Secchi depth, a measure of water transparency, was less than 2 m in April and May of both years at upper and lower stations (Figure 3.1-8). Values steadily increased during the summer, reaching 8 m in August 1996 and over 10 m in July 1997 at the downstream station. Greater transparency at the downstream station is likely due to loss of suspended sediment as water traveled down-lake.

3.1.2.7 Yale Lake Water Chemistry

Alkalinity at Yale Lake stations averaged 16 mg/l CaCO3 over the monitoring period (March 1996 through February 1998). Alkalinity at the intake depth was near surface values during most months. However, surface levels were higher at both stations in October and November of 1996.

Total phosphorus (TP) was typically less than 0.03 mg/l, with values ranging from less than detection (0.01 mg/l) to 0.09 mg/l in March 1997. A similarly high value (0.08 mg/l) occurred in March 1996. With the exception of higher TP concentrations in March of both years, there were no apparent patterns in the data with respect to upper and lower station differences, or between surface and intake depth measurements.

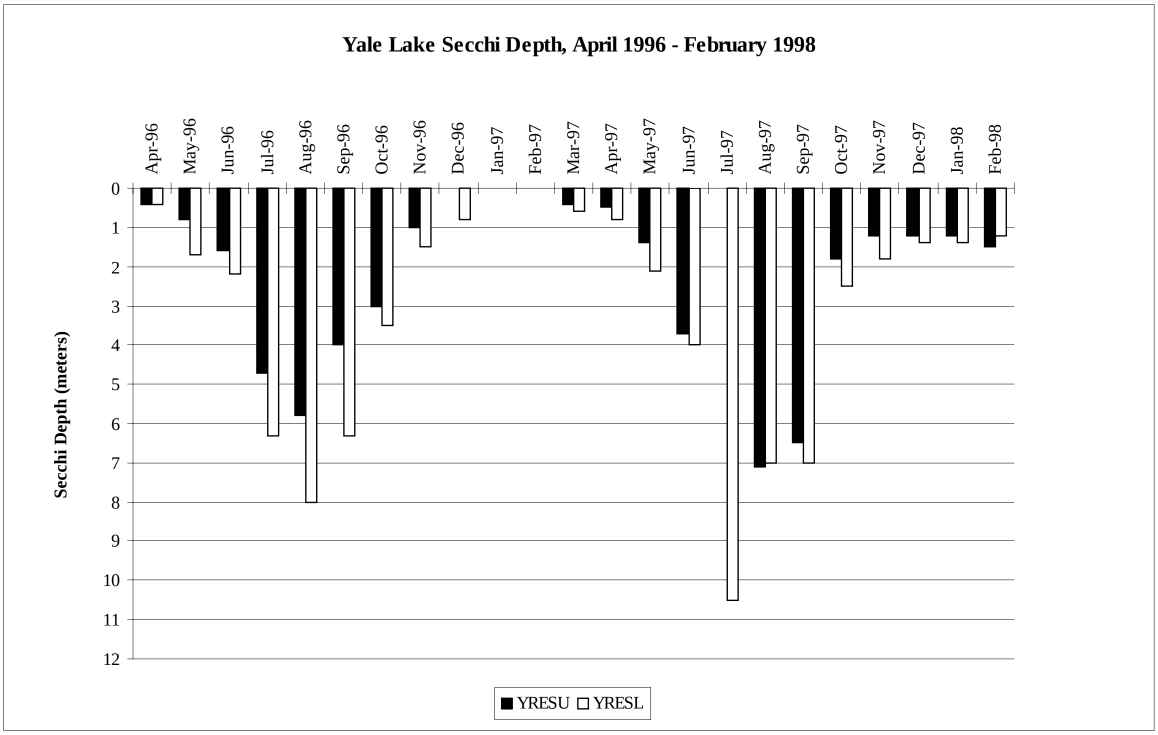


Figure 3.1-8. Secchi depth (meters) at upper and lower Yale Lake stations, April 1996 through February 1998.

Ortho-phosphorus (OP), which is biologically available, declined to non-detectable levels in May 1996 at all 3 locations, and at the 2 surface sites from June through August 1996. Values near the intake (approximately 20 m) remained above detection during this period. OP levels in 1997 were generally higher, suggesting reduced phytoplankton activity over that seen in 1996. OP concentrations were a large fraction of total phosphorus during both years.

Maximum nitrogen (nitrate + nitrite) levels occurred in April 1996 in Yale Lake, as was seen at tributary sites. Levels at this time were 0.14 mg/l at the upstream site, 0.19 mg/l at the lower surface site, and 0.15 mg/l at the intake depth. Nitrogen values during other months were typically half or less of the April 1996 concentrations. N levels from May through October 1996 were at or near detection at all 3 stations (0.01 mg/l). Levels increased again during fall turnover (November and December). A similar but reduced pattern of N concentration was seen in 1997. Values at the 2 surface stations declined from 0.04 mg/l in March to less than detection from May through August. In contrast to 1996, values near the intake depth were above detection from March through June 1997.

Turbidity at Yale Lake stations was markedly higher in the spring of 1996 than at any other time. Maximum turbidity was 30 NTUs at the upper surface station. Spring turbidity levels were several times lower in 1997. Summer levels were less than 5 NTUs in both years.

3.1.2.8 Chlorophyll *a* and Phytoplankton

Chlorophyll *a* is an indicator of algal biomass, and values mirrored those of phytoplankton biovolume throughout the monitoring period (Figure 3.1-9). Chlorophyll *a* levels were less than 5 mg/m^3 in most months, but substantially higher in June 1996 than all other months (34 mg/m^3 and 12 mg/m^3 at the upstream and downstream stations, respectively).

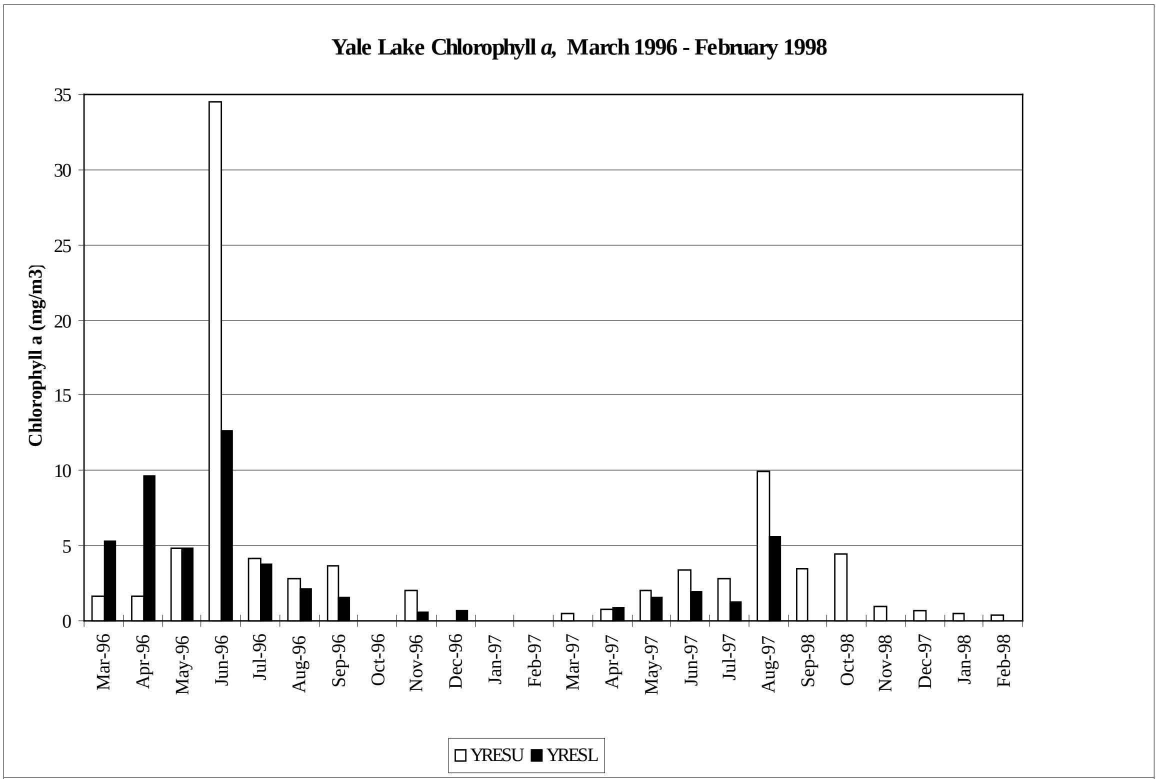
The number of phytoplankton species identified in the monthly samples ranged from 6 in March 1996 near Yale Dam, to 20 species in May and November 1996 at the upstream station. The spring samples (March through May) of both years were dominated by diatoms, primarily *Diatoma hiemale mesodon, Melosira italica, Cryptomonas erosa, Pinnularia microstauron,* and *Stephanodiscus astraea minutula.* Blue-green algae, which are often used as indicators of eutrophic conditions, were dominant each year at Yale Lake during early summer. The shift from diatoms to blue-greens was most dramatic in June 1996, when the blue-green alga *Anabaena flos-aquae* was dominant at both stations (85 percent of the biovolume at the upstream station, and 94 percent at the lower station). Algal biovolume during most months was less than 100,000 cubic µM/ml; however, 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 during both field seasons. In August 1996, the blue green alga *Aphanizomenon flos-aquae*, a species often associated with eutrophic conditions, was present at both stations (37 percent of biovolume at the upstream station, and 8 percent at the downstream station). *Aphanizomenon flos-aquae* was also seen in July 1997 at both stations, and in August 1997 at the lower station. Species observed during each of the monthly sampling periods are listed in the FTR for Aquatic Resources (PacifiCorp 1998a).

Zooplankton

Zooplankton samples were collected as vertical tows at the upper and lower Yale Lake stations. Results of zooplankton sample analyses are presented below; sampling and analytical techniques used in zooplankton identification are contained in the FTR for Aquatic Resources (PacifiCorp 1998a).

On most sampling dates, species of *Daphnia,* a large-bodied cladoceran, were the most abundant zooplankter collected (Figure 3.1-10). In 1996, *D. galeata* experienced a brief but intense increase (>1,400 individuals per m^3) in July and August, whereas, *D. rosea* had 2 relatively lower peaks, in July and October. *D. pulicaria/schodleri* occurred at much lower densities than the other 2 species, except in September and October at the upper site. The trend was similar in 1997; however, the highest *Daphnia* densities occurred in September, about a month later than in 1996.



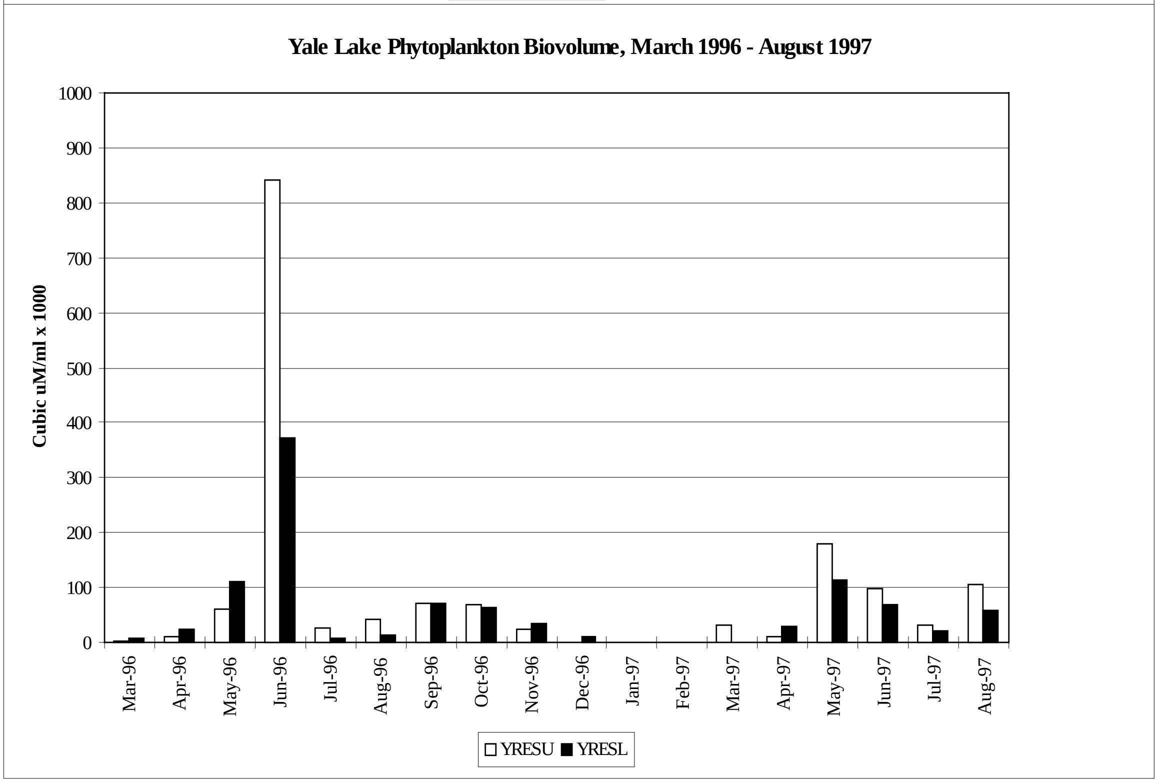


Figure 3.1-9. Yale Lake chlorophyll *a* data from March 1996 – February 1998 (top) and phytoplankton biovolume (bottom), March 1996 through August 1997.

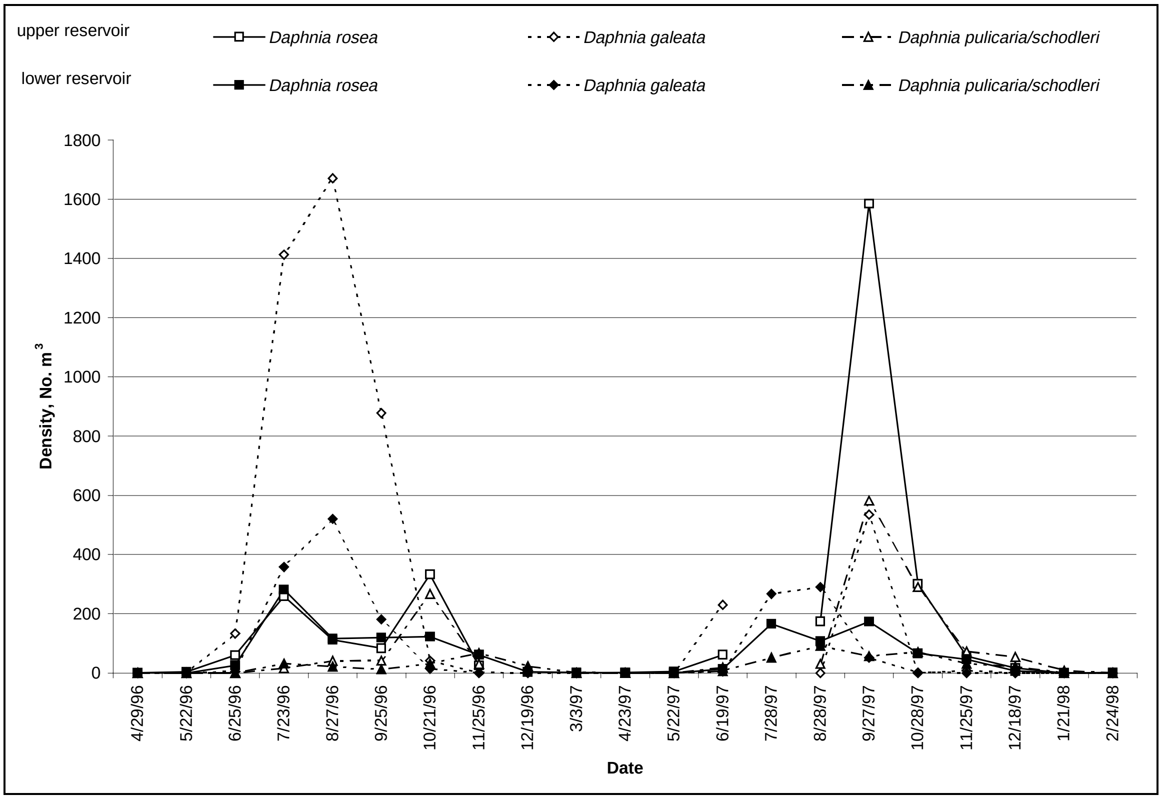


Figure 3.1-10. Density of *Daphnia* sp. at upper and lower Yale Lake sampling sites, April 1996 - February 1998.

Densities of other cladoceran species (*Bosmina longirostris*, *Holopedium gibberum*, and *Leptodora kindtii)* were an order of magnitude lower than those of *Daphnia* species, reaching peak densities of <300 individuals per m^3. These species were also more abundant at the upper reservoir site, with the exception of July, when *Holopedium gibberum* was more abundant at the lower reservoir site in both years. They tended to have relatively brief peaks in late spring/early summer. In 1997, *L. kindtii* and *B. longirostris* had low abundances relative to those in 1996.

The copepod fauna was completely dominated by 2 calanoid species, *Hesperodiaptomus franciscanus* and *Epischura nevadensis*. Cyclopoid copepods, represented by *Diacyclops thomasi* and *Macrocyclops albidus*, occurred only rarely and in very low numbers in winter samples. *E. nevadensis* was the dominant copepod at both sites from April-June in 1996 and at the upper reservoir site in 1997, but decreased greatly thereafter, becoming rare or absent from the samples in August (upper reservoir) and September (lower reservoir). *H. franciscanus* was the most abundant copepod from July-September, and occurred at peak densities in August at both sites and in both years. Both of the dominant copepod species were usually more abundant at the upper reservoir site. As with the adult calanoid copepods, calanoid nauplii peaked in the summer and were usually more abundant at the upper reservoir site.

Total rotifer densities were higher at the upper reservoir site on 13 of the 19 sampling dates on which both stations were sampled. In 1996, rotifer densities peaked in June at the upper reservoir site and in August at the lower site. In 1997, there were both early (May) and later (September) peaks of rotifers.

The zooplankton assemblage in Yale Lake is similar to assemblages in many other lakes in western north America (e.g., see Rankin et al. 1983a and b) and in the Columbia River and its reservoirs (Prahl et al. in press). However, one notable difference between the zooplankton assemblages in this study and those from other sites in this region was the lack of cyclopoid copepods in Yale Lake, which are common elsewhere. For example, the cyclopoids *Diacyclops thomasi* and *Acanthocyclops vernalis* were prominent and abundant members of the zooplankton assemblage in a recent study of the Columbia River and its lower reservoirs (Prahl et al. in press). These and other cyclopoids are also common in a variety of lakes and reservoirs in British Columbia (Carl 1940; Rankin et al. 1983 a and b). The reduction of cyclopoids in Yale Lake is probably not due to preferential feeding on them by kokanee salmon, because kokanee almost always preferentially feed on larger bodied cladocerans such as *Daphnia* sp. and *Bosmina* (Northcote and Lorz 1966; Doble and Eggers 1978; Goldman et al. 1979; Rieman and Bowler 1980; Schneidervin and Hubert 1987; Beauchamp et al. 1993), which were abundant in this study. However, other resident planktivores, including juvenile fish, the predatory copepod *Epischura nevadensis*, or the cladoceran *Leptodora kindtii*, may preferentially feed on cyclopoids, or they may be affected by competitive interactions with other zooplankton species.

The consistently higher abundance of most of the zooplankton taxa at the upper reservoir site is likely a sampling artifact, not a reflection of higher plankton production at the upper site (pers. comm., J. Cordell, University of Washington Fisheries Res. Inst., April 10, 1998). If zooplankton in the reservoir are stratified into a relatively narrow band in the water column at both sites, which is probable, densities at the shallower upper site would appear higher because the volume filtered (towed) is less than at the lower station. Tow length was typically 3 times greater at the lower station.

3.1.2.9 1998 Yale Tailrace Temperature Study

To further evaluate thermal impacts of project operations at the Yale Project, PacifiCorp conducted an additional study during the summer of 1998. As discussed earlier in this section, temperatures at the Yale tailrace are largely determined by release temperatures from Yale Dam. Thus, when the project is at full generation, tailrace temperatures are near hypolimnetic temperatures of Yale Lake, and Lake Merwin surface waters are displaced. Despite the understanding of this general trend, the longitudinal extent of operational effects was unknown. To further address this issue and to look more closely at potential biological impacts of Yale operations on water temperature, an additional study was conducted from August 7-13, 1998.

Study Area and Methods

The Yale tailrace temperature study was conducted at the following 3 locations:

- Yale tailrace;
- Buoy line downstream of the tailrace, approximately 150 m from Yale Dam; and
- Upper Lake Merwin at U.S. Geological Survey (USGS) monitoring cable, approximately 350 m downstream of Yale Dam.

PacifiCorp used the same instrumentation for temperature data collection during this study as was described earlier for routine temperature monitoring. At the Yale tailrace, thermographs were deployed near the surface (3 m) and near the bottom (20 m). Surface and bottom data were also collected at the buoy line, at a bottom depth of 6.4 m, and at the USGS location. At the latter site, temperature data were collected at the surface and at 6.2 m. All temperature data were collected at 15-minute intervals and converted to hourly averages for analysis. During the study, PacifiCorp modified the normal generation schedule to provide a range of test flows separated by off-line periods. Flows ranged from 0 to 7,600 cfs.

<u>Results and Discussion</u>

In contrast to the pattern observed at the Yale tailrace, temperatures at both depths (3 and 20 m) remained relatively cool during off-line periods (approximately 10°C) and, surprisingly, increased slightly with increasing discharge (Figure 3.1-11). This pattern has not been previously observed during PacifiCorp’s monitoring program. The same instrument that had been used in previous tailrace monitoring was active during the study. Results from that unit compared closely to those obtained with the 2 thermographs deployed specifically for this study. Groundwater seepage and spring activity are a likely explanation for these data. Subsurface temperatures are likely to be cooler than temperatures at the intake depth at Yale Lake, and it is possible that groundwater flow near the dam was an important determinant of tailrace temperatures during off-line periods.

At downstream locations, the pattern historically seen at the tailrace was observed at both the buoy and USGS locations (Figure 3.1-12). Temperatures were substantially higher during off-line periods at both sites, most notably at the surface buoy site. Flows as low as approximately 300 cfs caused marked drops in temperature near the bottom at both downstream locations. Substantially higher flows (approximately 3,000 cfs) were necessary to reduce surface temperatures at the buoy site by about 2º C (24 to 22º C). However, flows of approximately 2,000 cfs reduced surface temperatures at the USGS site by 10º C. These results suggest that, although a thermal gradient is obvious from surface to bottom at the USGS site, the stability of thermal stratification is more easily disrupted here than at the buoy location. The channel is narrower in this area and flow is more confined; thus, colder flows occupy a greater percentage of the water column and surface temperatures respond more quickly.

Maximum temperatures during the study ranged from 24.2°C at the buoy surface site to 11.9° C at the USGS bottom site. Off-line temperatures were near 24°C at the surface locations, and between 12°C and 14°C at all 4 downstream sites during full generation (approximately 7,000 cfs).

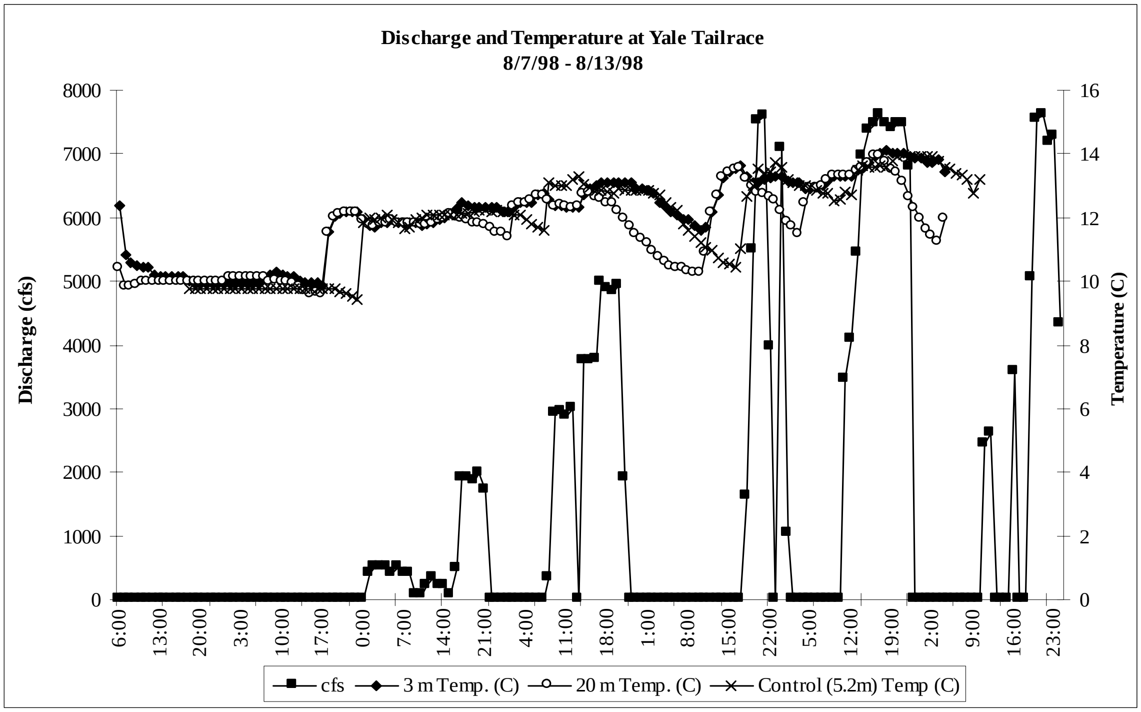


Figure 3.1-11. Discharge and temperature at Yale tailrace, August 7-13, 1998.

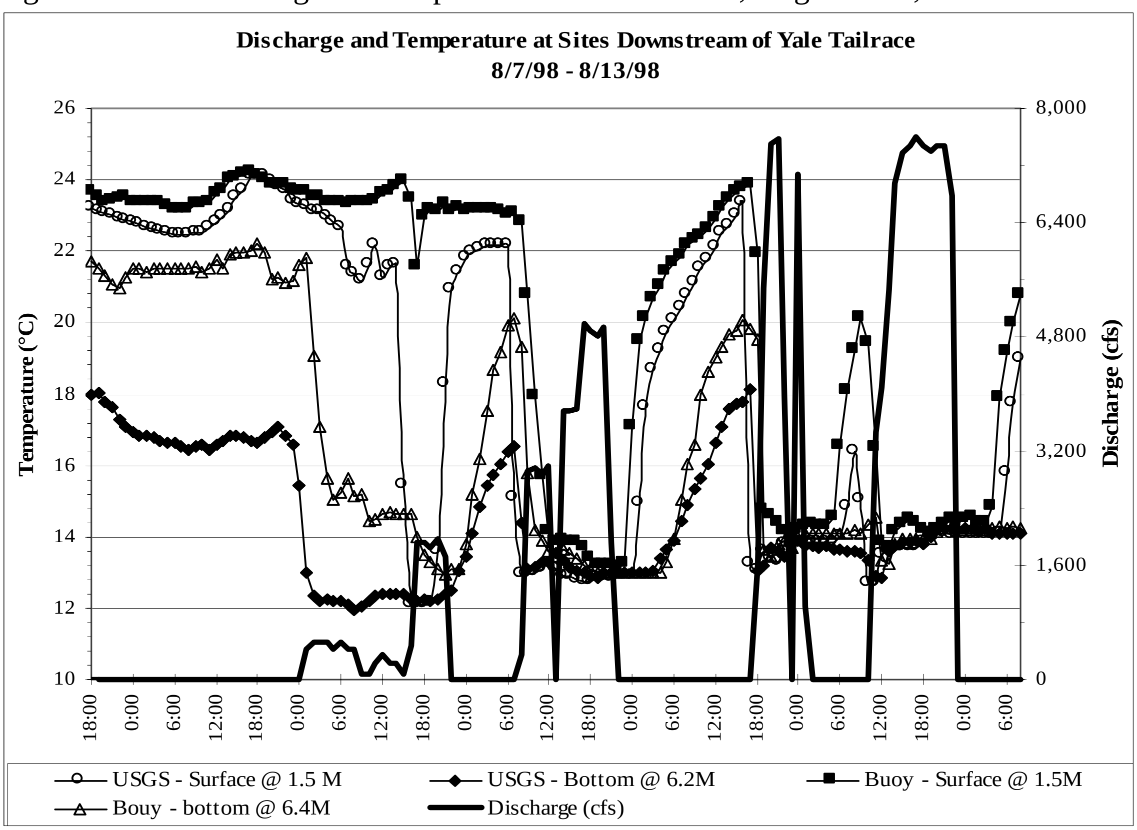


Figure 3.1-12. Discharge and temperature at sites downstream of Yale tailrace, August 7-13, 1998.

The results of this study indicate that project operations have a direct influence on temperatures in the upper portion of Lake Merwin. This effect is measurable but less pronounced near the USGS site, where the channel is more constricted and thermal layering is easily disrupted at flows of approximately 3,000 cfs. Surface temperatures during off-line periods were warm (approximately 20º C), typical of surface waters in Yale Lake and Lake Merwin during mid-summer. In contrast, temperatures during full generation were between 12°C and 14°C.

3.1.2.10 Compliance With State of Washington Water Quality Standards

As described in Section 3.1.4 below, the State of Washington has established standards for several water quality parameters, including fecal coliform, DO, TDG, temperature, pH, and turbidity. Class AA standards are applicable to tributaries to Yale Lake in the project area; Lake Class standards apply to Yale Lake itself, and Class A applies to the Lewis River below the U.S. Forest Service (USFS) boundary. With the exception of TDG and temperature (discussed below), no pattern of parameter exceedance has emerged from the monthly data collected by PacifiCorp. Diel studies (Section 3.1.2.4) indicate that during mid- to late-summer, DO may approach the 8.0 mg/l Class A standard at the Swift No. 2 bypass reach and at Siouxon Creek; however, no exceedances of the state standard were observed.

Exceedances of the water temperature and TDG standards at the Yale tailrace were discussed earlier in this section, and in Section 3.1.3. For both parameters, exceedances are a result of project operations. In addition to the Yale tailrace, 7-day average maximum temperatures exceeded the Class A standard at Siouxon Creek (SIOUX) and at the upper Speelyai Creek site (SPLYU). Temperature at these sites is not influenced by project operations. The station at the upper end of the Swift No. 2 Bypass Reach (SW2BU) exceeded the Class A standard; however, temperatures at the site located near the downstream end of the bypass reach (SW2BP) did not exceed the Class A standard. Both of these sites are located in flowing water, although the downstream site is below the Ole Creek confluence and has slightly greater discharge than the upper site.

Project studies also identified a pattern of TDG exceedance in the Yale tailrace. As a result, PacifiCorp has disabled the air admission system (the primary reason of elevated TDG levels) at generation levels of 20 MW or less (per turbine). PacifiCorp also operates Yale at levels that limit TDG supersaturation.

3.1.2.11 Water Quality Certification

PacifiCorp has been in consultation with WDOE regarding the Application for Section 401 Water Quality Certification for the Yale Project (see Volume 3, Appendix 1.3-1, pages 223-224). Based on their previous and ongoing involvement in the Lewis River watershed studies and APEA planning, WDOE has stated its preference to defer actions relating to the Yale License Application until it is possible to review all 4 of the projects simultaneously (letter from Jeff Marti, WDOE, Water Resources Program, to David Leonhardt, PacifiCorp, January 6, 1999). This would enable WDOE to provide comprehensive water quality terms and conditions for all 4 projects. This approach was described to FERC, which concurred and agreed to waive Section 16.8(f)(7)(i) of its regulations requiring evidence that a Water Quality Certificate has been sought (letter from Mark Robinson, FERC Director of Licensing and Compliance, to Dave Leonhardt, PacifiCorp, April 2, 1999). This letter is included in Volume 3, Appendix 1.3-1, on page 255.

3.1.3 Factors Affecting Water Quality

A factor affecting water quality in the Yale study area is load-factoring or following at the Yale powerhouse. During periods of low generation, Yale tailrace temperatures approach those of the surface water of Lake Merwin. As generation is increased, tailrace temperatures are reduced with the influx of cooler water from the intake depth of Yale Lake (approximately 60 feet at full pool). Daily changes in generation at the Yale powerhouse can cause diel temperature changes on the order of 10°C during mid-summer in the upper-most reaches of Lake Merwin (see also Section 3.3.2.3).

Diversion of Speelyai Creek is also a factor affecting water quality in the study area, resulting in lower flows and cooler temperatures in Speelyai Creek downstream of the diversion. This diversion is considered essential by the Washington Department of Fish and Wildlife (WDFW) to maintain the required intake water temperatures at the Speelyai Fish Hatchery.

3.1.4 Existing Resource Management Plans

The Federal Clean Water Act (CWA or Act) mandates that hydroelectric projects affecting water quality comply with federal and state water quality standards. Through the Act, the federal government assigns the states the responsibility of reviewing and issuing Section 401 Water Quality Certification permits. In Washington, WDOE has management authority for water quality.

WDOE has taken a watershed approach to water quality management, and is developing a regionalized management framework based on major river basins throughout the state. The Yale Project, as well as Swift and Merwin reservoirs, are within the Columbia Gorge Watershed, one of 5 Water Quality Management Areas in WDOE's Southwest Region. Swift, Yale, and Merwin reservoirs and their tributaries are within Water Resource Inventory Area No. 27. This area contains the North and East Forks of the Lewis River, the Kalama River, and their tributaries. The area is bounded on the north by Mount St. Helens, on the east by Mount Adams, and on the west by the Columbia River. The Lewis River watershed boundary forms the southern limit of this area.

Water quality standards for surface waters in the State of Washington 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 3.1-8).

Table 3.1-8. 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 6.5-8.5[2].	Within 6.5-8.5[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.

3.1.5 Existing Measures

No water quality measures are included in PacifiCorp's existing FERC license, nor have any been implemented subsequent to the issuance of the license.

3.2 PROPOSED ENHANCEMENT MEASURES

As discussed earlier in this section, PacifiCorp has disabled the air admission system to the Yale turbines at generation levels below 20 MW per turbine. PacifiCorp also operates Yale to minimize the potential for TDG supersaturation. Field studies confirmed that these changes are effective in maintaining TDG within state standards (less than 110 percent saturation) (PacifiCorp 1998a).

The effects of project operations at Yale powerhouse on temperature will be addressed during the Lewis River watershed studies. Results of the study discussed in Section 3.1.2.9 will be used to evaluate the significance of temperature fluctuations from a biological and regulatory perspective. Measures to reduce temperature fluctuations will be developed in consultation with participants in the collaborative Lewis River relicensing process.

Exceedances of the Class A temperature standard in the upper Swift No. 2 bypass reach are a result of diversion of the Lewis River to the Swift No. 2 powerhouse. This and other impacts of the Swift No. 2 and Merwin projects, including Speelyai Creek issues, will be addressed during upcoming watershed studies.

3.3 AGENCY AND TRIBAL CONSULTATION

Consultation with aquatic resource agencies has been ongoing throughout the Yale Project relicensing process. The National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), USFS, WDFW, WDOE, American Rivers, and Trout Unlimited were all involved in scoping and developing aquatic resource study plans and reviewing results. Written comments and consultation letters are included in Appendix 1.3-1.

PacifiCorp initiated the first stage of consultation with the agencies and public in the spring of 1996 following submittal of the FSCD (PacifiCorp 1996). The FSCD summarized aquatic resources in the study area, described PacifiCorp's proposed licensing studies, and presented a study schedule. The FSCD also discussed PacifiCorp's proposal to conduct a cumulative effects assessment (watershed studies approach) on the North Fork Lewis River to supplement and facilitate the relicensing process (Section 1.1).

Phone conversations, written correspondence, and a joint agency/public meeting occurred between May and August 1996 to discuss aquatic study plans presented in the FSCD. Aquatic resource studies receiving the greatest attention included the entrainment evaluation, bull trout population study, creel survey, and habitat survey (see Section 4.0). Several comments were also received regarding instream flows in the basin and the reintroduction of anadromous fish to the upper watershed. Based on this consultation, PacifiCorp initiated aquatic studies in late spring 1996.

On December 17, 1996, PacifiCorp held a agency/public meeting to respond to additional agency comments on the FSCD, discuss PacifiCorp's approach to relicensing the Yale Project, and describe the proposed North Fork Lewis River watershed studies approach. Several comments were received regarding reservoir drawdown impacts and project tailrace issues, and questions were raised regarding the methods to be used in PacifiCorp's proposed watershed studies approach. PacifiCorp addressed the reservoir drawdown and tailrace comments during the meeting and scheduled a watershed studies approach workshop in February 1997.

In January 1997, PacifiCorp issued the Yale Project ITR to agencies, tribes, and the public (PacifiCorp 1997). The ITR presented the results of all studies performed during 1996. Comments received on this document were incorporated into the 1997 studies and the FTR for Aquatic Resources (PacifiCorp 1998a).

To address several questions regarding the proposed watershed studies approach, PacifiCorp held a series of agency/public workshops. The first, held on February 21, 1997, explained how PacifiCorp's watershed studies approach would be conducted and specifically how the impacts of the hydroelectric projects would be evaluated. The workshop also addressed how the results of the analysis would be used in the relicensing effort for the Yale, Swift, and Merwin projects.

Since the spring of 1997, an aquatic resources "Science Team," comprised of agency scientists, environmental groups, PacifiCorp scientists, and interested parties, has gone through an extensive watershed studies approach scoping and study plan development process. As an outcome of this process, a series of proposed study plans were developed for the watershed studies approach. It is anticipated that these watershed studies will take place over the next 3 years, culminating in a final synthesis report to be issued in May 2001.

The second agency/public watershed studies approach workshop was held on June 2 and 3, 1997. The purpose of this workshop was to address additional questions regarding the watershed studies approach and to discuss how the process could be used to formulate alternative management strategies. The workshop included a Cougar Creek site visit and a discussion of the role that watershed studies approach plays in creating and maintaining habitat for fish and other aquatic resources.

In January 1998, the results of aquatic resource studies conducted in 1996 and 1997 were combined and presented to the agencies/public in the draft FTR for Aquatic Resources (PacifiCorp 1998a).

Although no comments were received on the FTR for Aquatic Resources (PacifiCorp 1998a) that pertained to water quality, a number of issues addressed had been raised earlier by the resource agencies based on the FSCD (PacifiCorp 1996). Actual comment letters and a matrix summarizing agency consultation are included in Appendix 1.3-1. Major water quality issues raised by the resource agencies are summarized below.

3.3.1 Stage 1 and Stage 2 Consultation Prior to the Draft License Application

3.3.1.1 Issue: Speelyai Creek Diversion

In their comments on the FSCD, WDOE noted several issues that pertain to diversion of Speelyai Creek to Yale Lake including minimum flow in the diverted channel, water rights, Speelyai Creek Hatchery requirements, and water temperature effects of the diversion.

Based on WDOE's comments, PacifiCorp initiated a monitoring program at the upper and lower ends of the Speelyai Creek diversion in late 1996 (see data reported in Section 3.1.2.3). PacifiCorp has asked for a meeting between WDOE and WDFW to discuss the Speelyai Creek data and related issues as a component of the watershed studies for the Lewis River projects.

3.3.1.2 Issue: Limnological Sampling in Yale Lake

The WDFW recommended weekly sampling during the spring in Yale Lake to improve understanding of the timing of peak phytoplankton and zooplankton abundance. PacifiCorp had proposed monthly sampling in the FSCD.

As discussed at the resource issue meeting with agencies in December 1995, PacifiCorp did not alter its proposed monitoring schedule in light of the WDFW comments. While monthly monitoring may not capture the annual peak densities of phytoplankton and zooplankton, it does characterize seasonal trends in these communities. Establishing these "baseline" conditions is a primary objective of the limnological monitoring program at Yale Lake.

3.3.1.3 Issue: Elevated Temperatures in Siouxon Creek

The USFWS requested that PacifiCorp work with the Washington State Department of Natural Resources (DNR) to determine the cause of elevated temperatures in Siouxon Creek. PacifiCorp monitored Siouxon Creek temperatures for a 2-year period from May 1996 through February 1998. These data, summarized in Section 3.1, have been used to characterize the thermal regime in Siouxon Creek. However, causes of elevated temperatures cannot be inferred from these data. Factors influencing temperatures in the basin, including those in the Siouxon Creek watershed, will be identified in the upcoming watershed studies for the Lewis River projects.

3.3.2 <u>Stage 2 Consultation - Comments on the Draft License Application</u>

The draft License Application was submitted to the agencies and stakeholders for comment in August 1998. Comments pertaining to water quantity and quality have been consolidated into issue areas and are addressed below.

3.3.2.1 Issue: Speelyai Creek Water Temperature and Flows

WDOE requested additional analysis of management issues surrounding the Speelyai Creek diversion. These issues include flow information and the benefits of a minimum flow level in the creek; expected effects of the introduction of flow to the creek; WDFW's position on flow levels and their suitability for hatchery purposes; information on other Speelyai Creek water right holders; and measures to address water temperatures.

WDOE raised a number of flow issues related to the diversion of Speelyai Creek and the effects on the downstream hatchery and water rights holders. PacifiCorp will facilitate discussion of these issues related to surface flows and hatchery water quality at a spring 1999 meeting between the 3 parties.

Water temperature data were collected at 2 locations in Speelyai Creek (upstream of the canal diversion and above the hatchery intake) on a daily basis from December 1996 through February 1998. The results are presented in Section 3.1.2.1 of this Exhibit E, and in greater detail in Section 2.1 of the FTR for Aquatic Resources (PacifiCorp 1998a).

The water temperature data collection program for Yale was not designed to address hatchery operational criteria (such as temperatures of natural surface flow vs. primarily groundwater flow). This will be discussed with both WDFW, which operates the hatchery, and with WDOE at a meeting during the spring of 1999.

3.3.2.2 Issue: Speelyai Creek Hatchery

Water supply options for the Speelyai Creek Hatchery and the potential temperature effects of changes in water supply sources will be discussed with WDFW and WDOE during the spring of 1999.

3.3.2.3 Issue: Yale Tailrace Temperature

WDOE comments that elevated temperatures in the Yale tailrace may be affecting fish and other beneficial uses. It was previously noted that tailrace temperatures are largely determined by the temperature of Yale Lake, although the longitudinal extent of these operation effects was not known. PacifiCorp conducted an additional study to evaluate the thermal impacts of project operations on the tailrace, the results of which are presented in Section 3.1.2.9 of this Exhibit E. During the study, tailrace temperatures remained cool (less than 15°C) during both on-line and off-line periods. At downstream locations, distinct thermal stratification occurred during off-line periods, but was disrupted by cold water flows (10-12°C) from Yale Lake during generation periods. Lake Merwin surface waters occupy the zone immediately downstream of the tailrace during off-line periods; surface temperatures at these times are above optimal for salmonids (in excess of 20°C). PacifiCorp will evaluate options to reduce temperature fluctuations below the Yale tailrace during upcoming watershed studies.

3.3.2.4 Issue: Swift No. 2 Bypass Conditions

WDOE noted that state water temperature standards are being exceeded in the Swift No. 2 bypass reach and inquired what measures are being taken to ensure compliance with state criteria. The water quality within this reach of the Lewis River will be addressed as an effect of the Swift No. 2 Project. Enhancement measures will be included in the section of the License Application for 401 certification addressing that project and in the basin-wide PDEA.

3.3.2.5 Issue: Compliance with State Water Quality Criteria

WDOE advised that because of its location, the project area should be analyzed according to a different set of state water quality criteria than were used in the draft License Application. Section 3.1.2.10 of this Exhibit E has been revised to reflect the Class A status of the mainstem and Lewis River tributaries downstream of the USFS boundary. Yale Lake and Lake Merwin have retention times greater than 15 days, so the Lake Class correctly applies. Tributaries to the reservoirs are classified as Class AA.

3.3.2.6 Issue: Compliance with Section 401

Consultation between WDOE and PacifiCorp regarding Section 401 compliance has been ongoing since late 1998. As described in Section 3.1.2.11 of this Exhibit E, WDOE will not request a Water Quality Certification for the Yale Project because WDOE views all of the Lewis River projects as operationally connected. WDOE maintains their preference to require certification based on a watershed approach for all 4 projects. As cited in Section 3.1.2.11, FERC concurs with this approach.

3.3.2.7 Issue: Consumptive Use

Based on retention time, WDOE interprets the storage of water in Yale Lake as a consumptive use. It also cites other consumptive uses in the area that should be described as such in the Exhibit E. PacifiCorp's definition of consumptive use is whether or not waters are returned to the Lewis River (Lake Merwin) immediately below the Yale Project following retention in Yale Lake or diversion to Yale Lake from Speelyai Creek. Project facilities, such as the powerhouse and operators' residences, use wells for drinking water. The only consumptive use, based on the above definition, is for flushing toilets and potential use at eye-wash stations.

3.4 CONTINUING IMPACTS

Summer water temperatures exceeding the WDOE standard of 16°C will likely continue within the Yale tailrace during periods of reduced generation.

3.5 IMPLEMENTATION, COST, AND SCHEDULE

The schedule and cost for implementing additional water quality enhancement measures will be developed as a component of the watershed studies approach for all the North Fork Lewis River projects.

