Limnological Investigations in John Day Reservoir
Including Selected Upper Reservoir Habitats, April 1994 to September 1995

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EXECUTIVE SUMMARY

The National Marine Fisheries Service conducted limnological sampling of John Day Reservoir from April 1994 to September 1995. The study was initiated to acquire baseline data prior to reservoir drawdown, which was under consideration at that time. Five years of sampling were scheduled, centered on the drawdown year.

The study was designed in anticipation of drawdown to minimum operating pool. Under this scenario, emergent lands would total an estimated 8,400 acres, mostly in the upper reservoir. Accordingly, sampling effort was concentrated at upper-reservoir locations, although we also obtained samples from mid- and lower-reservoir and to a lesser extent at a protected backwater at Crow Butte. Sampling ended in October 1995, following the decision to suspend study of John Day Reservoir drawdown.

We conducted sampling for a wide range of physical, chemical, and biological attributes. Data ranges given in the following summary represent average values for samples collected at lower-, mid-, and upper-reservoir sampling stations. Unless stated otherwise, data do not include results from sampling at the Crow Butte backwater.

Physical variables and corresponding value ranges determined during the study were: 1) temperature, 3.6-21.8°C; 2) Secchi disk visibility, 0.5-3.3 m; 3) turbidity, 2-23 NTU; 4) vertical light absorption coefficients, 0.77-2.85; and 5) sediment volatile solids (0.7-2.7%), median grain size (0.1-0.2 mm), and proportion silt/clay (11.4-31.4%).

Chemical properties and ranges were: 1) dissolved oxygen, 8.4-12.8 mg/L; 2) pH, 7.7-8.6; 3) specific conductance, 112-191 µS/cm; 4) alkalinity, 46-75 mg/L $CaCO_3$; 5) silica, 4.9-17.7 mg/L; 6) ammonia nitrogen, 0.01-0.06 mg/L; 7) nitrite + nitrate nitrogen, 0.01-0.55 mg/L; 8) total nitrogen, 0.20-0.88 mg/L; 9) orthophosphate phosphorus, less than 1-27 µg/L; 10) total phosphorus, 18-83 µg/L; 11) calcium, 9.4-23.0 mg/L; 12) magnesium, 3.4-7.0 mg/L; 13) sodium, 3.5-11.2 mg/L; 14) potassium, 0.8-2.3 mg/L; 15) sulfate, 8.4-18.1 mg/L; and 16) chloride, 1.4-4.0 mg/L.

Biological attributes included chlorophyll *a*, zooplankton, benthic macroinvertebrates, and fish. Chlorophyll *a* content of samples collected in John Day Reservoir ranged from 1.3 to 10.6 mg/m^3. Cladoceran and copepod densities ranged from less than 1 to 25 and from less than 1 to 42 organisms/L, respectively. Densities of benthic macroinvertebrates (by month of sample collection; including Crow Butte samples) varied from 3,100 to 10,700 organisms/m^2. Beach seining at upper reservoir locations resulted in the catch of 5,830 fishes, including 11 common resident taxa and 3

migratory species: American shad, Chinook salmon, and coho salmon. Except for a few adult prickly sculpins, suckers, and common carp, fishes captured were juveniles.

The variation we observed in John Day Reservoir attributes was largely temporal. Spatial variation was negligible between samples collected from the lower-, mid-, and upper-reservoir. Vertical profiles and samples collected from different depths within the water column generally indicated uniformity from surface to bottom.

The homogenous nature of reservoir waters with regard to physical, chemical, and biological attributes is largely a result of low water-retention times within the reservoir. Along the mainstem Columbia and Snake Rivers, thermal and chemical stratification are known to develop only in reservoirs with retention times exceeding those of John Day Reservoir. Biological characteristics of the reservoir are also affected by retention time. In reservoirs with low retention times, as in free-flowing rivers, phytoplankton populations are swept downstream before they can fully develop. Many zooplankton species cannot complete their life cycles during the relatively short time of passage through the reservoir.

In contrast, samples collected at the Crow Butte backwater differed markedly from those collected at near-channel sampling stations. Although sampling at Crow Butte was limited to the final 7 months of the study, results were sufficient to indicate higher phytoplankton and zooplankton abundance than at near-channel stations. The contrast between habitat types was striking.

For the weeks during which we sampled at both habitat types, chlorophyll *a* at Crow Butte averaged 11.2 mg/m^3 compared with 6.8 mg/m^3 at nearby upper-reservoir stations. Cladoceran densities at Crow Butte and at upper-reservoir stations averaged 64 and less than 1 organisms/L, respectively. Copepod densities averaged 32 organisms/L at Crow Butte, but only 2 organisms/L at upper-reservoir stations. Results suggest relatively high productivity of backwater habitats in the present reservoir.

CONTENTS

INTRODUCTION

Drawdown of John Day Reservoir was proposed in 1991, principally as a means of reducing travel times of juvenile migrant salmonids passing through the reservoir. The drawdown under consideration in 1991 was from the normal reservoir elevation of 263.5 to 266.5 ft mean sea level (MSL) to minimum operating pool (MOP) level of 257 ft MSL. Because of the low gradient of the original streambed in the upper reservoir, drawdown to MOP would result in loss of an estimated 8,400 acres of shallow-water habitat, mostly in the Blalock Islands area of the upper reservoir. To evaluate changes in the reservoir environment during and after drawdown to MOP, the National Marine Fisheries Service (NMFS) began collection of baseline physical, chemical, and biological data in April 1994. Data collection continued until September 1995, when funding for the study of reservoir drawdown was withdrawn. Although drawdown to MOP did not occur, NMFS limnological sampling produced an extensive set of baseline data, which is detailed and summarized in this report.

In response to direction provided in the Energy and Water Development Appropriation Bill, 1998, the Corps of Engineers (COE) is again studying drawdown of John Day Reservoir. Options under consideration include operation at spillway crest level (about 220 ft MSL) and restoration to natural river elevation (about 170 ft MSL). During Phase I of the present COE study, existing information, including the NMFS limnological data set, will be used to evaluate potential benefits and costs from the proposed drawdown scenarios.

Study Area

John Day Dam is located at river kilometer (rkm) 347 on the Columbia River (Fig. 1). The pool, Lake Umatilla, filled in 1968, has a surface area of about 20,000 hectares (49,000 acres) and extends 123 km upstream to McNary Dam. The maximum pool elevation is 81.7 m (268 ft) above MSL, and MOP is 78.4 m (257 ft) above MSL. Normal operating levels are usually in the 80.8-81.7 m range for the July to October period and in the 79.3-80.8 m range for the November to June period. Operation below 80.8 m (265 ft) is generally for flood control purposes. Median Columbia River flows are about 7,930 m^3/s in May and June, 5,660 m^3/s in July, and 3,680 m^3/s in August. Water particle travel time through the reservoir has been estimated to range from 3.8 d at flows of 8,495 m^3/second to 11.2 d at river flow of 2,830 m^3/s (COE 1992).

COE data indicate a relatively flat reservoir from John Day Dam upstream to rkm 451. From rkm 451 to McNary Dam, a distance of 19 km, the pool rises more sharply, creating conditions somewhat resembling those of a free-flowing river. In a previous study (Li et al. 1981) velocity data were used to characterize the reservoir into forebay (John Day Dam to rkm 398), transitional (rkm 398 to 454), and tailrace zones (rkm 454 to McNary Dam).

Sampling Stations

A drawdown of John Day reservoir from elevation 80.8 m to elevation 78.4 m (MOP) would result in the loss of approximately 8,400 acres of upper reservoir habitat (COE 1992). Much of this habitat loss would occur in the Blalock Islands area of the upper reservoir, where topography has resulted in broad littoral zones. Accordingly, with the drawdown-to-MOP scenario under consideration at the time of our study, sampling effort was concentrated at five upper-reservoir stations within the Blalock Islands area. These stations were characterized by water depths of 5 to 7 m and were located along the main river channel. Less intensive sampling was conducted at lower- and mid-reservoir stations where water depths ranged from 30 to 40 m. In 1995, the second year of the study, we also collected data from a backwater location at Crow Butte State Park. Sampling areas and stations are shown in Figure 1.

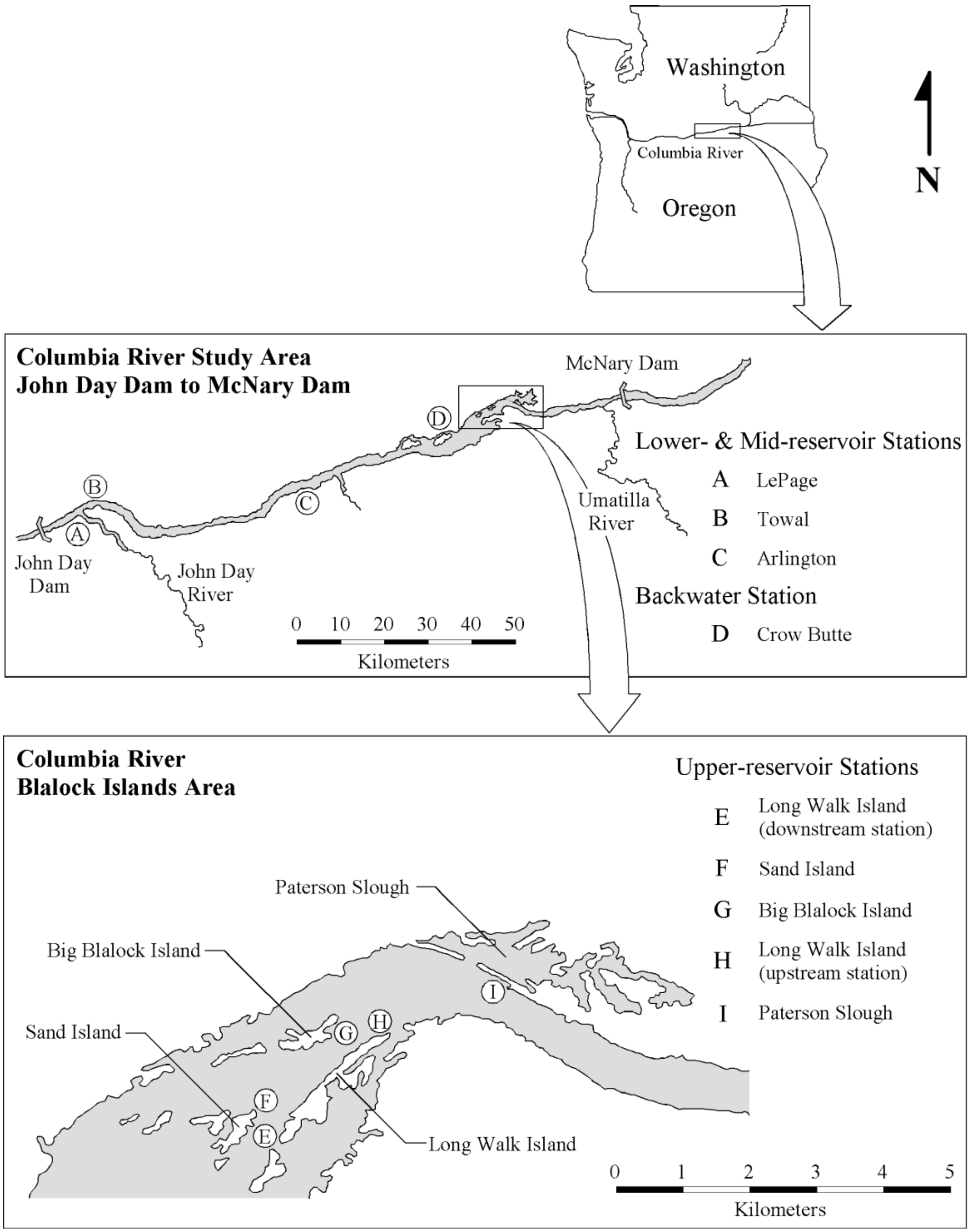

Figure 1. Sampling areas and stations on the Columbia River. John Day Reservoir limnology study, 1994-95. Locations by river kilometer (rkm) were: LePage-352; Towal-355, Arlington-390, Crow Butte-424; Long Walk Island (downstream station)-443a, Sand Island-443b, Big Blalock Island-445, Long Walk Island (upstream station)-446; Paterson Slough-449.

METHODS

At each sampling station, field measurements were made of physical variables including temperature, turbidity, and Secchi disk visibility. Water samples were taken and preserved for laboratory determination of chemical variables including alkalinity, nutrients, and major ions. Other chemical variables such as pH, dissolved oxygen, and specific conductance were monitored directly using a multi-function meter. Biological variables included chlorophyll *a*, zooplankton, benthic invertebrates, and resident and migrant fish, which were collected using a 30-m beach seine.

Sampling Schedule

The sampling schedule followed during the study is provided in Table 1. Upper-reservoir stations were generally sampled biweekly from April through August and monthly from September through March for water quality variables, chlorophyll *a*, and zooplankton. Fish were sampled biweekly from May through August and monthly from September through March. Benthic invertebrates were sampled monthly, and sediment samples were collected quarterly. An exception to the above schedule was December 1994, when data collection was limited to the water quality variables. Sampling at the Crow Butte backwater began in March 1995 and generally followed the schedule for upper-reservoir stations. Lower- and mid-reservoir stations were sampled at monthly intervals, and no sampling of benthic invertebrates, sediment, or fish occurred at these stations.

Table 1. Sampling schedule and reservoir properties for which data were collected during limnological sampling of John Day Reservoir, April 1994 to September 1995. Sampling station details shown in Fig. 1. Sample-type abbreviations: C, chlorophyll *a*; W, water quality; Z, zooplankton; B, benthic invertebrates; S, sediment; F, resident and anadromous fish.

	Stations sampled (rkm)								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	352	355	390	424	443a	443b	445	446	449
4/11/94	CWZ	CWZ	CWZ						
4/12/94					B			B	B
4/13/94					CWZ	BCWZ	BCWZ	CWZ	WZ
4/26/94					CWZ	CWZ	CWZ	CWZ	CWZ
5/10/94	CWZ	CWZ	CWZ						
5/11/94					CWZ	CWZ	CWZ	CWZ	CWZ
5/12/94					BS	BS	BS	BS	BS
5/13/94					F	F	F	F	F
5/24/94					CFWZ	CFWZ	CFWZ	CFWZ	CFWZ
6/7/94	CWZ	CWZ							
6/8/94					BCFWZ	BCFWZ	CFWZ	CFWZ	CFWZ
6/9/94			CWZ				B	B	B
6/21/94					CFWZ	CWZ	CWZ	CWZ	CFWZ
		CWZ			CWZ				
7/7/94					BCFWZ	BCWZ	BCWZ	BCWZ	BCWZ
7/20/94					CFWZ	CWZ	CWZ	CWZ	CFWZ
8/2/94	CWZ	CWZ	CWZ						
8/3/94					BFS	BS	BS	BS	BFS
8/4/94					CWZ	CWZ	CWZ	CWZ	CWZ
8/18/94					CFWZ	CWZ	CWZ	CWZ	CFWZ
9/13/94					BF	B	B	B	BF
9/14/94					CWZ	CWZ	CWZ	CWZ	CWZ
9/15/94	CWZ	CWZ	CWZ						
10/4/94	CWZ	CWZ	CWZ						
10/5/94					BF	B	B	B	BF
10/6/94					CWZ	CWZ	CWZ	CWZ	CWZ
11/15/94	CWZ	CWZ	CWZ						
11/17/94					BCFSWZ	BCSWZ	CWZ	CWZ	CFWZ
11/18/94							BS	BS	BS
12/13/94					W	W	W	W	W
12/14/94	W	W	W						
1/10/95	CWZ	CWZ	CWZ						
1/24/95					BFS	BS	BS	BS	BFS
1/25/95					CWZ	CWZ	CWZ	CWZ	CWZS
2/21/95	W	W	W						
2/22/95					W	W	W	W	W
3/13/95	CWZ	CWZ	CWZ						
3/14/95					B	B	B	B	B
3/15/95				WZ	CWZ	CWZ	CWZ	CWZ	CWZ
4/4/95				CWZ	CWZ	CWZ	CWZ	CWZ	CWZ
4/18/95				BCSWZ					
4/4/95				CWZ	CWZ	CWZ	CWZ	CWZ	CWZ
4/18/95				BCSWZ					
4/19/95					BFS	B	B	B	BFS

Table 1. Continued.

	Sampling stations (rkm)								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	352	355	390	424	443a	443b	445	446	449
4/20/95					CWZ	CWZ	CWZ	CWZ	CWZ
4/21/95	CWZ	CWZ	CWZ						
5/1/95				CWZ					
5/2/95									CFWZ
5/3/95					CWZ	CWZ	CWZ	CWZ	
5/15/95	CWZ	CWZ	CWZ						
5/16/95					B	B	B	B	B
5/17/95				CWZ	CWZ	CWZ	CWZ	CWZ	CWZ
5/30/95				BCWZ					
5/31/95					CFWZ	CWZ	CWZ	CWZ	CFWZ
6/12/95	CWZ	CWZ	CWZ						
6/13/95					B	B	B	B	BF
6/14/95					CWZ	CWZ	CWZ	CWZ	CFWZ
6/15/95				BCWZ					
6/28/95				CWZ					
6/29/95					CWZ	CWZ	CWZ	CWZ	CFWZ
7/10/95	CWZ	CWZ	CWZ						
7/11/95					BFS	BS	BS	BS	BFS
7/12/95					CWZ	CWZ	CWZ	CWZ	CWZ
7/13/95				BCSWZ					
7/24/95				CWZ					
7/25/95					CFWZ	CWZ	CWZ	CWZ	CFWZ
8/8/95				BCWZ	CWZ	CWZ	CWZ	CWZ	CWZ
8/9/95					BF	B	B	B	BF
8/10/95	CWZ	CWZ	CWZ						
8/21/95				CWZ					
8/22/95					CFWZ	CWZ	CWZ	CWZ	CFWZ
9/5/95				BCWZ					
9/6/95					BF	B	B	B	BF
9/7/95					CWZ	CWZ	CWZ	CWZ	CWZ
9/8/95	CWZ	CWZ	CWZ						
9/19/95				CWZ	CFWZ	CWZ	CWZ	CWZ	CFWZ

Physical Variables

Physical attributes measured or recorded at all sites included turbidity, ambient and underwater irradiance, Secchi disk visibility, and surface-to-bottom profiles of water temperature. Physical attributes were logged at the 5-m depth contour at upper-reservoir stations and in depths of 30 to 40 m at lower- and mid-reservoir stations. Sediment samples were taken at the 1-, 3-, and 5-m depth contours of upper-reservoir stations for analyses of organic content, particle size, and soil classification.

Turbidity was measured in Nephelometric Turbidity Units (NTU) using either an HF Instruments Model DRT-15 or Hach Model 2100P portable turbidimeter.[1] Irradiance readings were recorded from a Kahlsico Model 268WD305 digital underwater irradiameter to calculate light extinction coefficients and to delineate the euphotic zone. Secchi disk visibilities were obtained with a standard 20-cm-diameter Sec chi disk. Surface-to-bottom profiles of water temperature were obtained using a Hydrolab Corporation H20 transmitter and Surveyor 3 logging system. At upper-reservoir stations, we recorded data in 1-m increments from surface to bottom (5-7 m). At lower- and mid-reservoir stations we recorded data in 1-m intervals from the surface to 10-m depth, then at 5-m intervals to the bottom (30 to 40-m depth).

Chemical Variables

Surface-to-bottom water profiles of dissolved oxygen, pH, and specific conductance were obtained using a Hydrolab Corporation H20 transmitter and Surveyor 3 logging system. Water samples were analyzed for nitrogen (NH_3-N, NO_2 + NO_3-N, and total), phosphorus (ortho and total), anions (sulfate and chloride), cations (calcium, magnesium, sodium, and potassium), alkalinity, turbidity, and silica. Analyses were conducted by the Water Research Center (WRC) at Washington State University, Pullman, Washington. Alkalinity was also determined at the time of sample collection with a LaMotte alkalinity kit. Water samples for laboratory analyses and for on-board determination of alkalinity were obtained using a 4-L van Dorn bottle lowered to the desired depth. At upper-reservoir stations and at Crow Butte, we collected samples from the surface and just above the bottom. At lower- and mid-reservoir stations we collected samples from just below the surface, at mid-depth, and just above the bottom.

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[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Biological Variables

At all stations, we collected water samples to determine chlorophyll *a* concentrations and sampled zooplankton to determine species composition and abundance. At upper-reservoir stations, benthic macroinvertebrates were sampled, and we also conducted limited beach seining to determine use of these habitats by resident and migrant fish.

Replicate composite samples for chlorophyll *a* analysis were collected from the surface to a depth of 5 m at upper-reservoir stations, from the Crow Butte backwater, and from the surface to a depth of 15 m at lower- and mid-reservoir stations. Composite samples (integrated over depth) were obtained by lowering a weighted 5-cm-diameter hose (both ends open) vertically in the water column. With the lower, weighted end of the hose at the appropriate depth, the upper end was sealed with a rubber stopper. The lower end of the hose was then retrieved by means of an attached rope. The hose was uncapped and the composite water sample collected in a 19-L bucket as the upper end of the hose was retrieved into the boat. A 1-L water sample was taken from the stirred contents of the bucket. The remaining composite sample was filtered through a 25-µm net to obtain the fraction of the composite sample containing phytoplankton less than 25 µm in size. Phytoplankters of this size often constitute a large portion of the overall phytoplankton, and may contain over 90% of the chlorophyll *a* in a unit volume of water. A 1-L sample of the filtrate was obtained from the bucket. Samples were stored on ice in dark polyethylene bottles and transported to the NMFS Point Adams Biological Field Station for filtration and spectrophotometric analysis.

Zooplankton samples were obtained from vertical tows using a Wisconsin-style plankton net with a nonporous truncated upper cone (11.4-cm mouth diameter, 17.8-cm second ring diameter, 87.6 cm long, 80-µm mesh). Three replicate vertical tows were made from 5-m depths to the surface at the 5-m contour of upper-reservoir stations and at the Crow Butte backwater. At lower- and mid-reservoir stations, three replicate tows were made from the 15-m depth to the surface. The plankton net was retrieved at about 0.5 m/second with the vessel either anchored or drifting with the current, as necessary to maintain a vertical tow. Zooplankton were preserved with Lugol's iodine, added at about 5 mL of solution to 100 mL of sample. Samples were stored and shipped in 250-mL polyethylene bottles. Analysis of samples was performed by Beaver Schaberg Associates, Inc. In the contractor's laboratory, at least three 1-mL subsamples were removed from each sample concentrate and placed in Utermohl chambers. A minimum of 200 organisms were identified to species and enumerated using an inverted microscope at 100× magnification. If the species tally was less than 200 organisms, additional subsamples were examined.

Benthic invertebrates were sampled only at upper-reservoir stations and at the Crow Butte backwater. We considered the two to four benthic invertebrate samples collected from each date/station/depth strata as replicates. Replicate sample data were used to calculate mean density (number/m^2) and standard deviation for total benthic invertebrates collected from each strata. Data combined by depth and site were used to summarize monthly densities of dominant benthic invertebrate taxa during the sampling period.

We sampled bottom sediments for benthic invertebrates using a standard 0.052 m^2 Ponar grab. Collected sediments were washed through a U.S. Standard No. 35 sieve bucket. Samples were preserved in 10% buffered formalin solution. Replicate samples were taken at the 1-, 3-, and 5-m contours at each upper-reservoir station.

We sampled resident and migratory fish from the Long Walk Island downstream site and from Patterson Slough using a 30- by 2.4-m beach seine constructed of 6.4-mm (stretch measure) knotless nylon mesh. At the midpoint of the net, a 2.4- by 2.4- by 2.4-m bunt was attached to retain the catch. The net was set parallel to the beach in about 1.2 m of water and the ends retrieved to the shoreline. Fish captured in the net were anesthetized with tricaine methanesulfonate (MS-222) and counted by species. A subsample of each species was measured to the nearest mm (fork length for salmonids, total length for resident species). Following recovery from the anesthetic, all fish were released into the area from which they were captured.

RESULTS

Physical Variables

Temperature

Comparison of water temperatures (overall means for measurements at lower-, mid-, and upper-reservoir sampling stations) during the April to September periods in 1994 and 1995 showed little difference between the two years (Fig. 2). Minimum and maximum temperatures observed at individual sampling stations (lower-, mid-, and upper-reservoir) during the April 1994 to September 1995 study period were 3.4°C in January and February 1995 and 21.8°C in August 1994, respectively (Appendix Table A1). Temperatures at the Crow Butte backwater were typically 1 to 2°C higher than at upper-, mid-, and lower-reservoir stations visited during the same weeks from March through July 1995 (Appendix Fig. B1).

Average surface-to-bottom temperatures were slightly lower (by 0.1 to 0.3°C) at upper-reservoir stations than at lower- and mid-reservoir stations sampled during the same weeks in 1994 (Appendix Table A1). Average surface-to-bottom temperature at lower- and mid-reservoir stations in 1994 varied by as much as 1.4°C between stations sampled on the same date. Similar variations (up to 1.0°C) were observed between upper reservoir sampling stations.

Vertical temperature profiles at lower- and mid-reservoir stations in 1994 show gradually declining temperatures from the surface to depths of 10 to 15 m and then relatively stable temperatures from 15 m to the bottom (Appendix Fig. B2). In contrast, at upper-reservoir stations during 1994, temperature decreases with depth were noted in only the top meter of water (Appendix Fig. B3). Maximum temperature changes with depth in 1994 were observed in May at lower- and mid-reservoir stations (by 3.4°C) and from May to August at upper-reservoir stations (by 1.6°C).

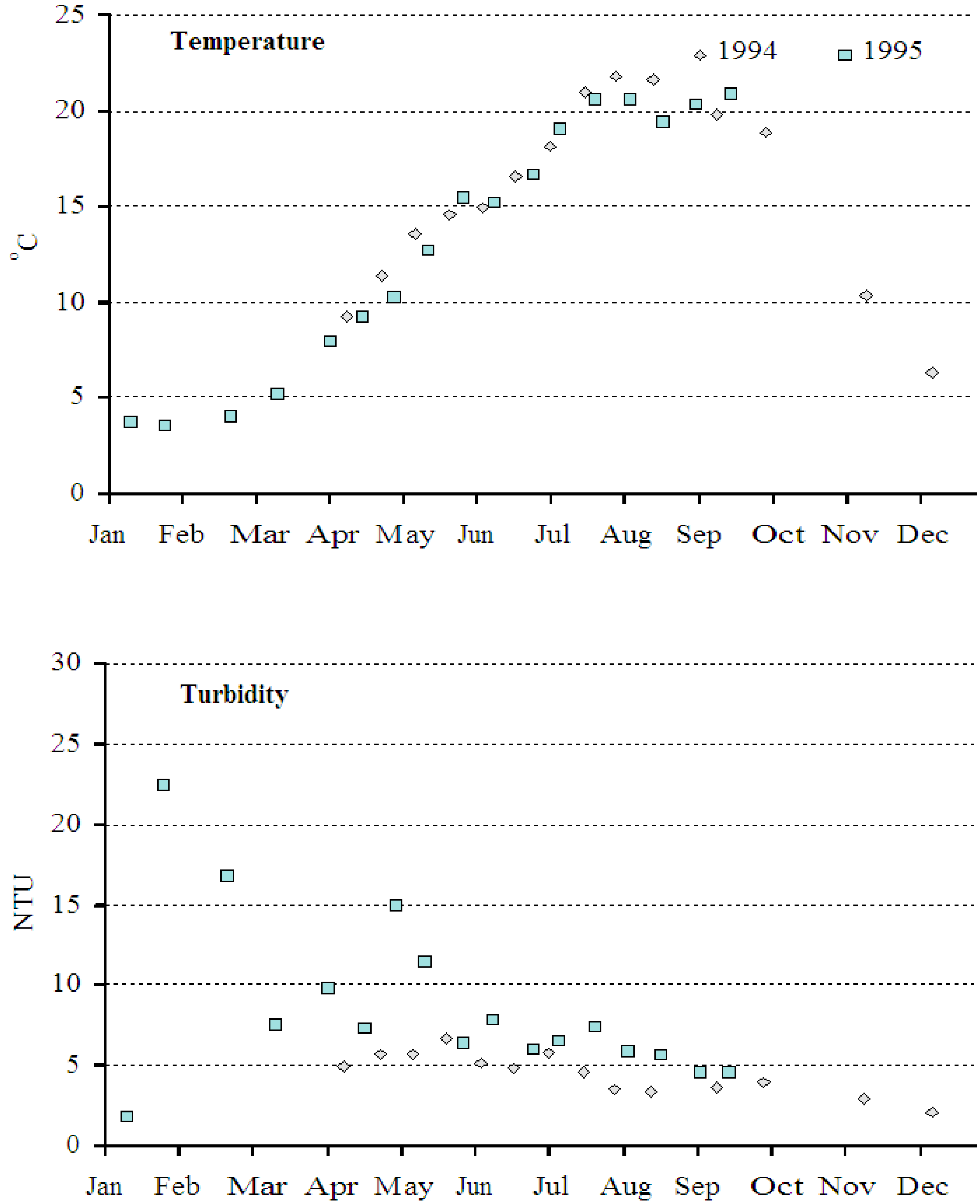


Figure 2. John Day Reservoir water temperature and turbidity in 1994 and 1995. Data points represent overall means for samples collected at lower-, mid-, and upper-reservoir sampling stations.

Water Clarity

Water clarity, as indicated by Secchi disk visibility, generally increased from April to September in both 1994 and 1995 (Fig. 3). Data from individual sampling stations (lower-, mid-, and upper-reservoir) show highest visibility (4.4 m) in December 1994 (Appendix Table A2). Lowest visibility (0.2 m) coincided with a runoff event during February 1995. Secchi disk visibility was usually greater at lower-, mid-, and upper-reservoir stations than at the Crow Butte backwater (Appendix Fig. B4).

Comparisons of turbidity measurements between years show that river conditions were slightly less turbid in 1994 than in 1995 (Fig. 2). Although turbidity measured at lower-, mid-, and upper-reservoir stations during the study period varied from 1 to 42 NTU, readings on most sampling dates were within the range of 2 to 8 NTU (Appendix Table A3). Turbidity readings at lower- and mid-reservoir stations generally increased with depth, whereas surface-to-bottom differences were minimal at upper-reservoir stations (Appendix Table A3). Turbidity readings varied between reservoir locations sampled during the same weeks, with upper-reservoir stations usually showing slightly higher turbidities than lower reservoir stations (Appendix Fig. B1).

Overall mean light absorption coefficients varied from 0.77 to 1.06 in 1994 and from 0.82 to 2.85 in 1995 (Fig. 3). Vertical light absorption coefficients calculated for individual sampling stations are given in Appendix Table A4, and the corresponding light transmittance values are shown in Appendix Table A5. Differences in light absorption coefficients between reservoir locations were minimal in 1994 but more pronounced in 1995 (Appendix Fig. B4). For data collected in 1994, plots of light transmittance vs. depth indicated that euphotic zone depth ranged from about 3.5 to 8 m.

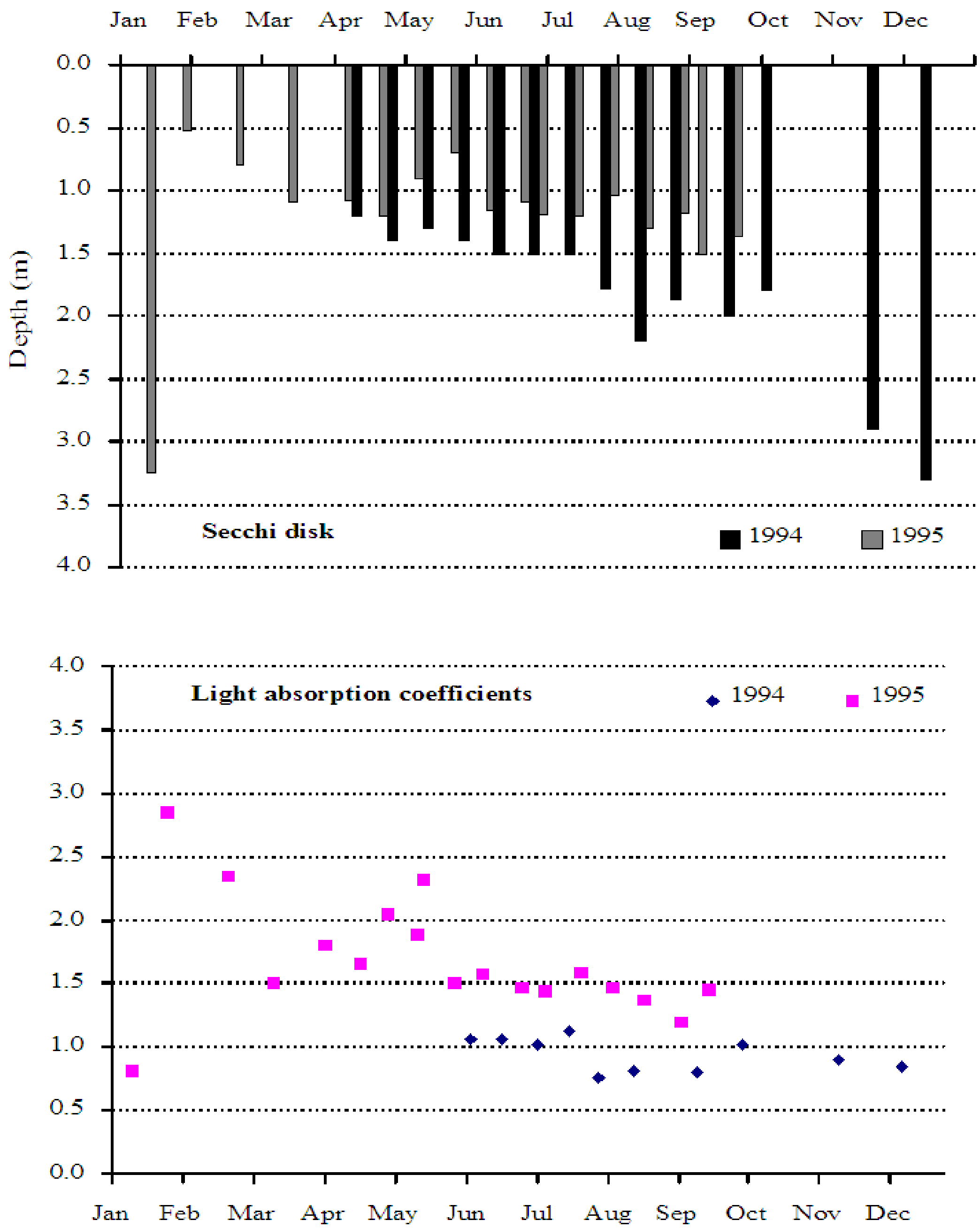


Figure 3. Secchi disk visibility and vertical light absorption coefficients at John Day Reservoir sampling stations in 1994 and 1995.

Sediment Analysis

The majority of sediment samples obtained at upper reservoir sites were classified as silty sand. Median grain size of samples varied from 0.1 to 0.2 mm, volatile solids from 0.7 to 2.7%, and silt/clay from 11.4 to 31.4% (Fig. 4). Consistent differences in sediment parameters related to depth of sample collection (1 m, 3 m, or 5 m) were not evident. Sediment characteristics at individual sampling stations are detailed in Appendix Table A6. Data tend to show higher organic content and smaller grain size at the Oregon shore stations than at the Washington shore sampling stations.

Chemical Variables

Dissolved Oxygen

Dissolved oxygen levels varied from 8.4 to 12.8 mg/L during the 1994-95 sampling period (Fig. 5). On most dates, average surface-to-bottom oxygen levels at upper-reservoir stations were slightly higher than at lower- and mid-reservoir stations (Appendix Fig. B5). Station-to-station differences were typically minimal between stations in the same reservoir location sampled on the same date (Appendix Table A7). Changes in oxygen content with depth are illustrated by the surface-to-bottom oxygen profiles shown for 1994 data in Appendix Figures B6 and B7. In 1994, dissolved oxygen decreased from surface to bottom from April to October, and increased from surface to bottom in November and December. At lower- and mid-reservoir stations, changes in dissolved oxygen were more rapid in the upper 10 m of the water column than in the zone from 10 m to the bottom. Variation in dissolved oxygen with depth at the upper-reservoir stations was comparable to that seen in the upper 5 m at lower- and mid-reservoir stations.

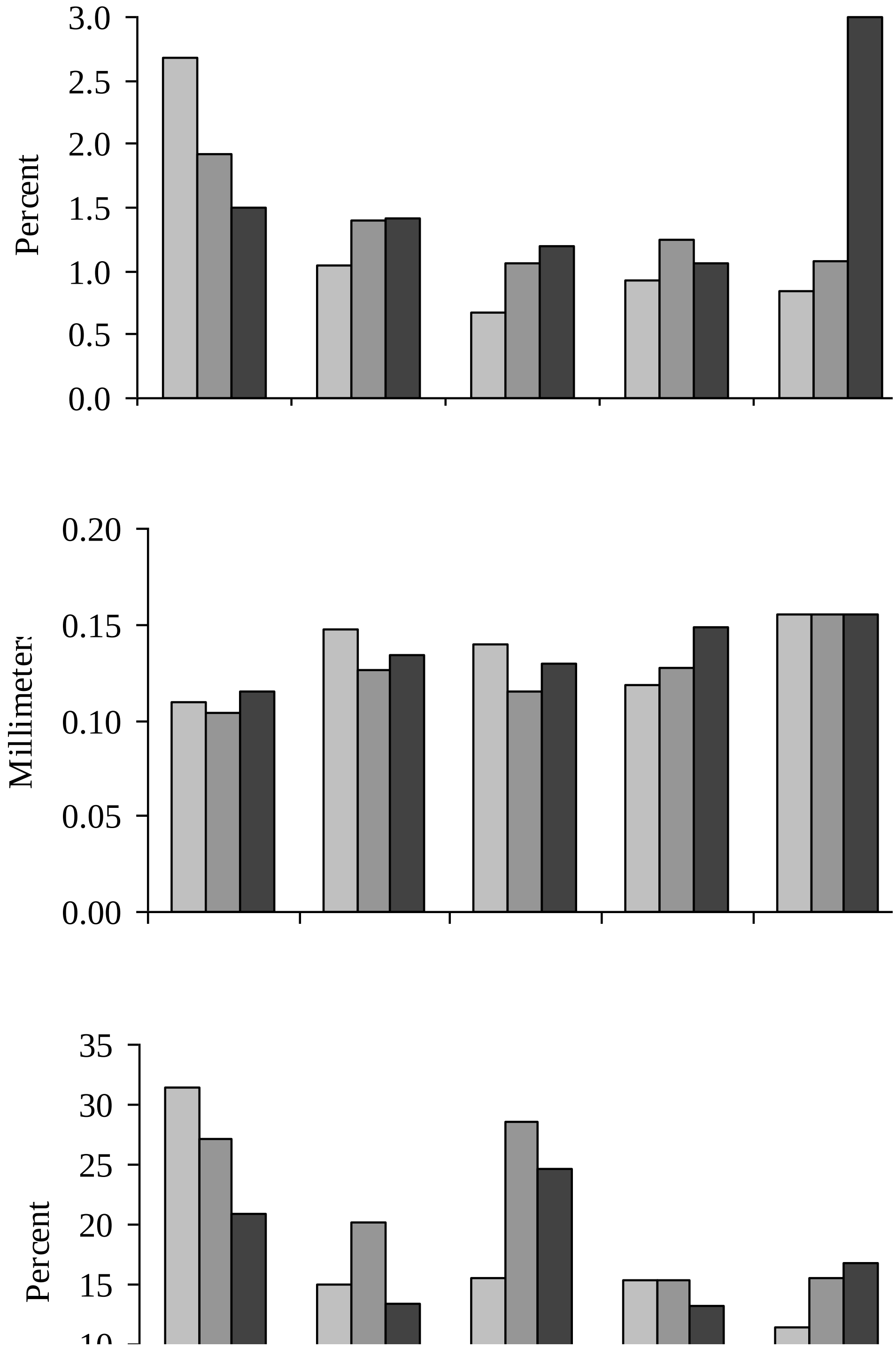


Figure 4. Volatile solids, median grain size, and percent silt/clay in sediment samples collected at upper John Day Reservoir sampling stations (1-, 3-, and 5-m depths), April 1994 to September 1995.

pH

Overall surface-to-bottom pH values (antilog means) at John Day Reservoir sampling stations (exclusive of the Crow Butte backwater) during the 1994-95 sampling period varied from 7.7 to 8.6 pH units (Fig. 6). At lower-, mid-, and upper-reservoir stations, pH values were generally similar, however at the Crow Butte backwater station, pH values were consistently higher (Appendix Fig. B8 and Appendix Table A8). In 1994, variation of pH within the water column was about 0.1 pH units at lower- and mid-reservoir sampling stations on most dates and slightly less than 0.1 pH units at upper-reservoir stations (Appendix Figs. B9 and B10).

Specific Conductance

Overall mean specific conductance measured at John Day Reservoir stations ranged from 112 to 191 μS/cm during the 1994-95 sampling period (Fig. 5). Specific conductance values differed only slightly between lower-, mid-, and upper-reservoir stations sampled during the same week, but higher specific conductance values were generally observed at the Crow Butte backwater than at other reservoir locations (Appendix Fig. B5 and Appendix Table A9). Specific conductance profiles (Appendix Figs. B11 and B12) show minimal variation in specific conductance with depth.

Alkalinity

Total alkalinity (averages of surface, mid-depth, and bottom samples) varied within the range of 46 to 75 mg/L $CaCO_3$ from April 1994 to September 1995 (Fig. 6). Total alkalinity values were similar at lower-, mid-, and upper-reservoir stations (Appendix Fig. B8) and varied little with sample depth (Appendix Table A10).

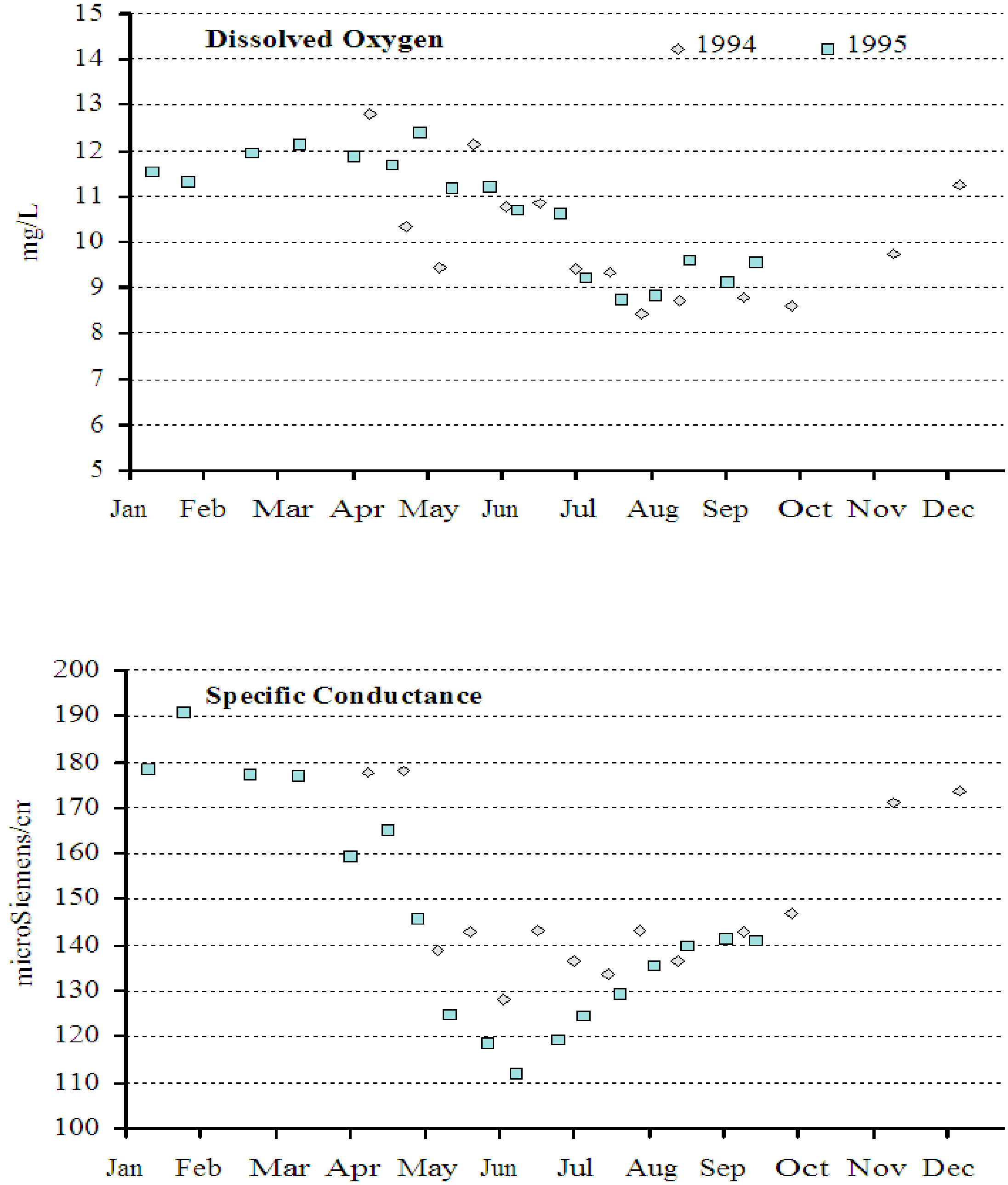
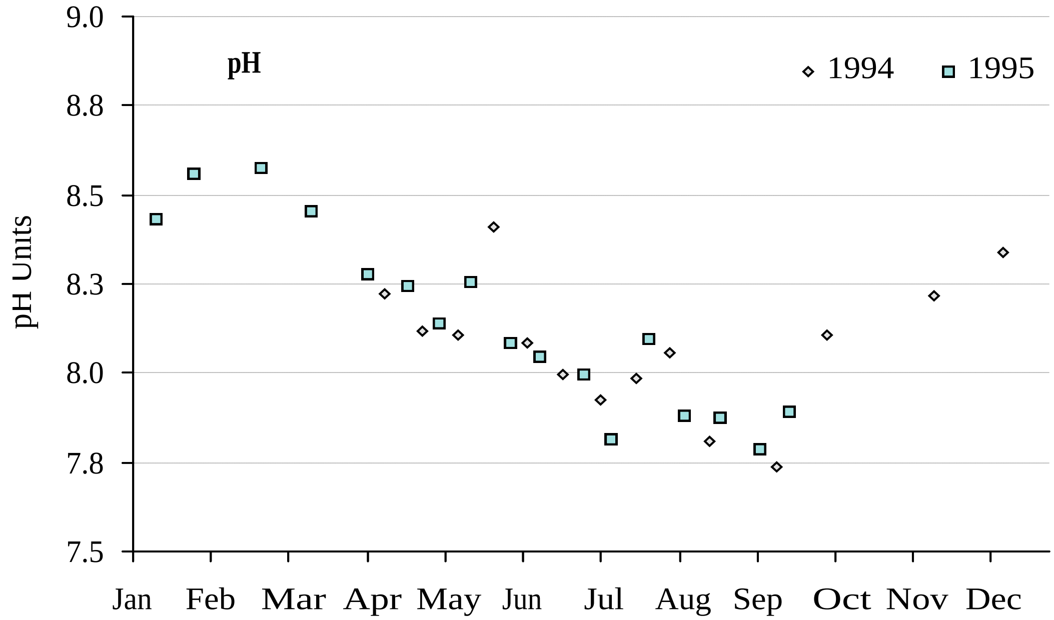


Figure 5. Comparison of 1994 and 1995 John Day Reservoir overall mean dissolved oxygen levels and specific conductance values.



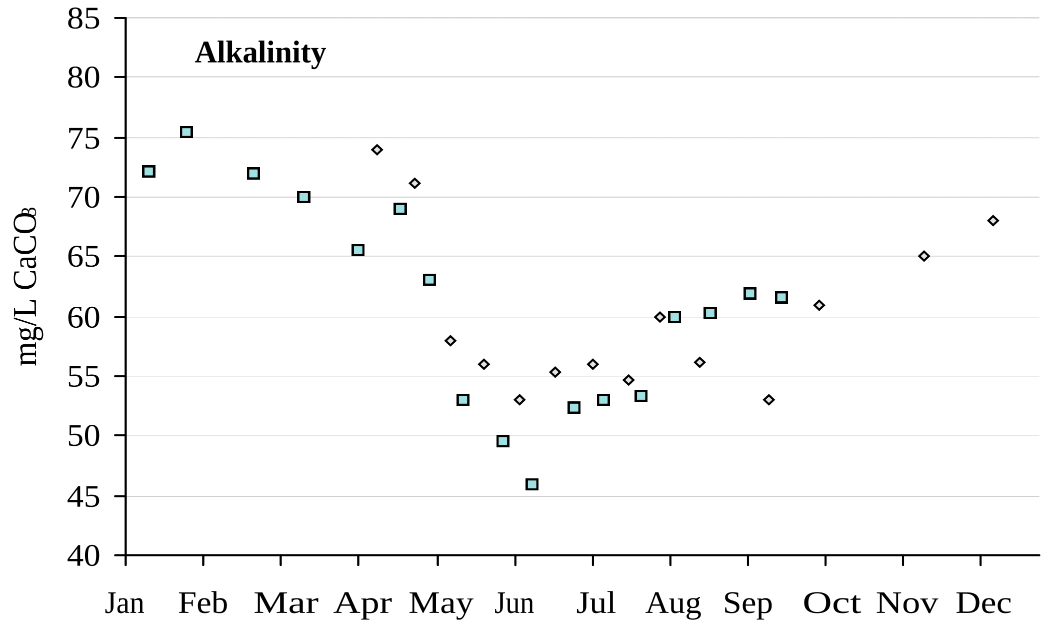


Figure 6. Comparison of 1994 and 1995 John Day Reservoir overall mean pH and alkalinity values.

Silica

Silica concentrations varied from 4.9 to 17.7 mg/L during the 1994-95 sampling period (Fig. 7). Silica content was similar at lower-, mid-, and upper-reservoir locations, but present at lower levels in samples collected during the same weeks at the Crow Butte backwater (Appendix Fig. B13). Silica content was similar in samples collected at different depths (Appendix Table A11).

Major Ions

From April 1994 to September 1995, concentrations of major ions at John Day Reservoir stations varied within the following ranges: sulfate, 8.4 to 18.1 mg/L; chloride, 1.4 to 4.0 mg/L; calcium, 9.4 to 23.0 mg/L; magnesium, 3.4 to 7.0 mg/L; sodium, 3.5 to 11.2 mg/L; and potassium, 0.8 to 2.3 mg/L. Since specific conductance is a measure of ionic concentration, temporal changes in concentrations of major ions closely follow the curve given for specific conductance in Figure 5. Minimal variation was observed in concentrations of major ions between sampling stations or between depths from which samples were obtained (Appendix Tables A12 through A17).

Nitrogen and Phosphorus

Concentrations of ammonia nitrogen (NH_3-N), nitrite + nitrate nitrogen (NO_2+NO_3-N), and total nitrogen (includes organic nitrogen, NH_3-N, and NO_2+NO_3-N) at John Day Reservoir sampling stations are shown in Appendix Tables A18 through A20. Between April 1994 and September 1995, concentrations of these nitrogen forms (averages for lower-, mid-, and upper-reservoir stations) varied within the following ranges: NH_3-N, 0.01 to 0.06 mg/L; NO_2+NO_3-N, 0.01 to 0.55 mg/L; and total nitrogen, 0.20 to 0.88 mg/L. Consistent differences associated with reservoir location or depth of sample collection were not apparent.

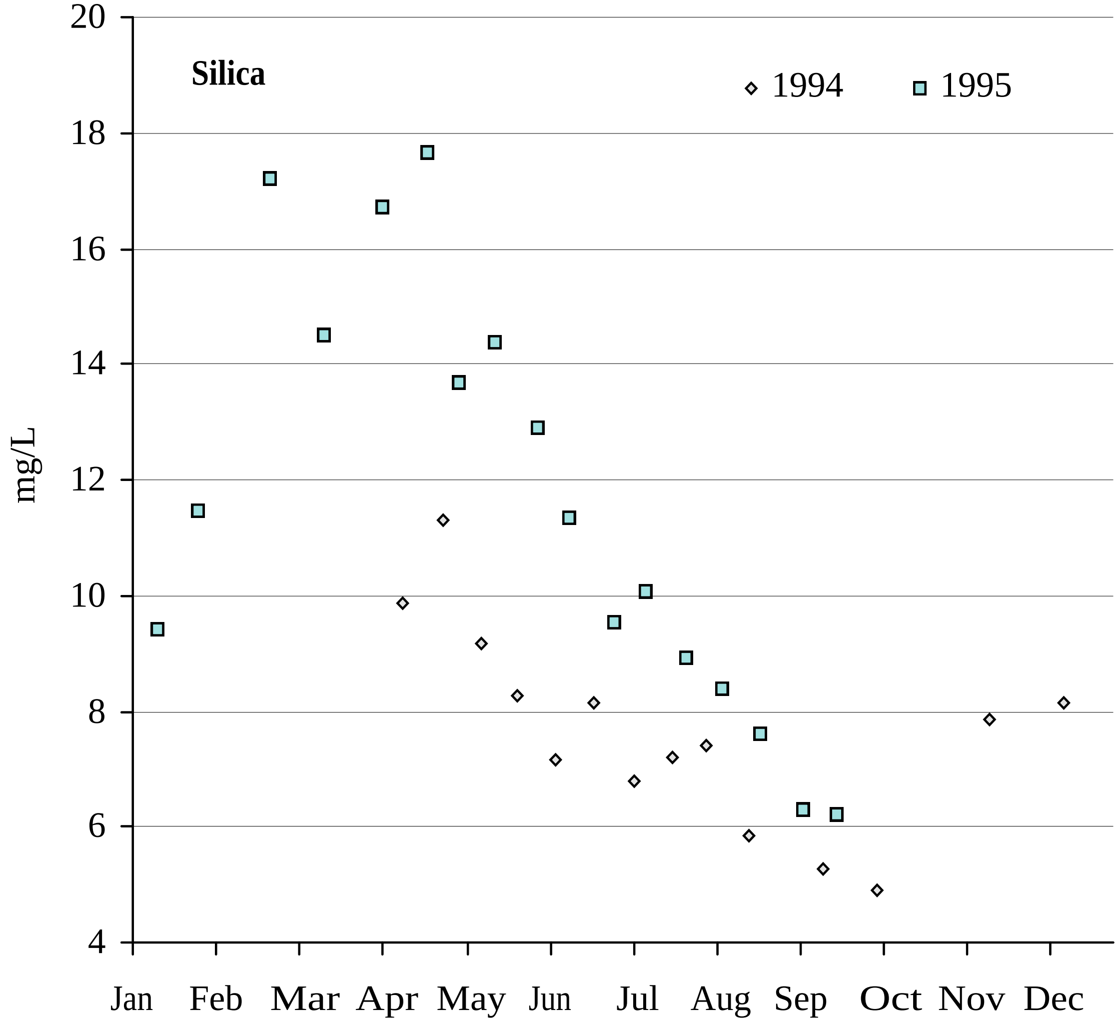


Figure 7. Silica content of John Day Reservoir in 1994 and 1995. Data points represent overall means for samples collected at lower-, mid-, and upper-reservoir sampling stations.

Orthophosphate phosphorus and total phosphorus concentrations (averages for lower-, mid-, and upper-reservoir stations) during the 1994-95 sampling period ranged from less than 1 to 27 µg/L and from 18 to 83 µg/L, respectively (Appendix Tables A21 and A22). Orthophosphate phosphorus content of samples collected from different depths shows occasional wide variation, but no consistent increasing or decreasing trends with depth. In contrast, total phosphorus concentrations frequently increased with depth of sample collection.

Biological Variables

Chlorophyll *a*

Chlorophyll *a* content of samples (averages for lower-, mid-, and upper-reservoir stations) during the 1994-95 sampling period ranged from 1.3 to 10.6 mg/m^3. Chlorophyll *a* levels peaked in April and May, declined during June, July, and August, and then increased during the fall months (Fig. 8). Chlorophyll *a* content of samples was highly variable between sampling stations visited on the same date, and between lower-, mid-, and upper-reservoir locations sampled during the same week (Appendix Fig. B14). A greater level of primary production is suggested, however, at the Crow Butte backwater than at other reservoir locations. Appendix Tables A23 and A24 quantify the amounts chlorophyll *a* contributed by phytoplankton larger than 25 µm and smaller than 25 µm at each station throughout the study period.

Zooplankton

Average monthly densities of cladocerans, copepods, and rotifers at John Day Reservoir locations (exclusive of the Crow Butte backwater) during the 1994-95 sampling period are shown in Figure 9. Cladoceran densities ranged from 0.08 to 25 organisms/L, copepod densities from 0.4 to 42 organisms/L, and rotifer densities from 3 to 354 organisms/L. Appendix Tables A25-A27 present monthly density data for zooplankters identified at lower- and mid-reservoir stations, upper-reservoir stations, and the Crow Butte backwater, respectively. Appendix Figures B15 and B16 compare densities of cladocerans and copepods between sampling locations in the open reservoir and the protected Crow Butte backwater. Appendix Table A28 shows mean densities and standard deviations for individual sample locations and dates.

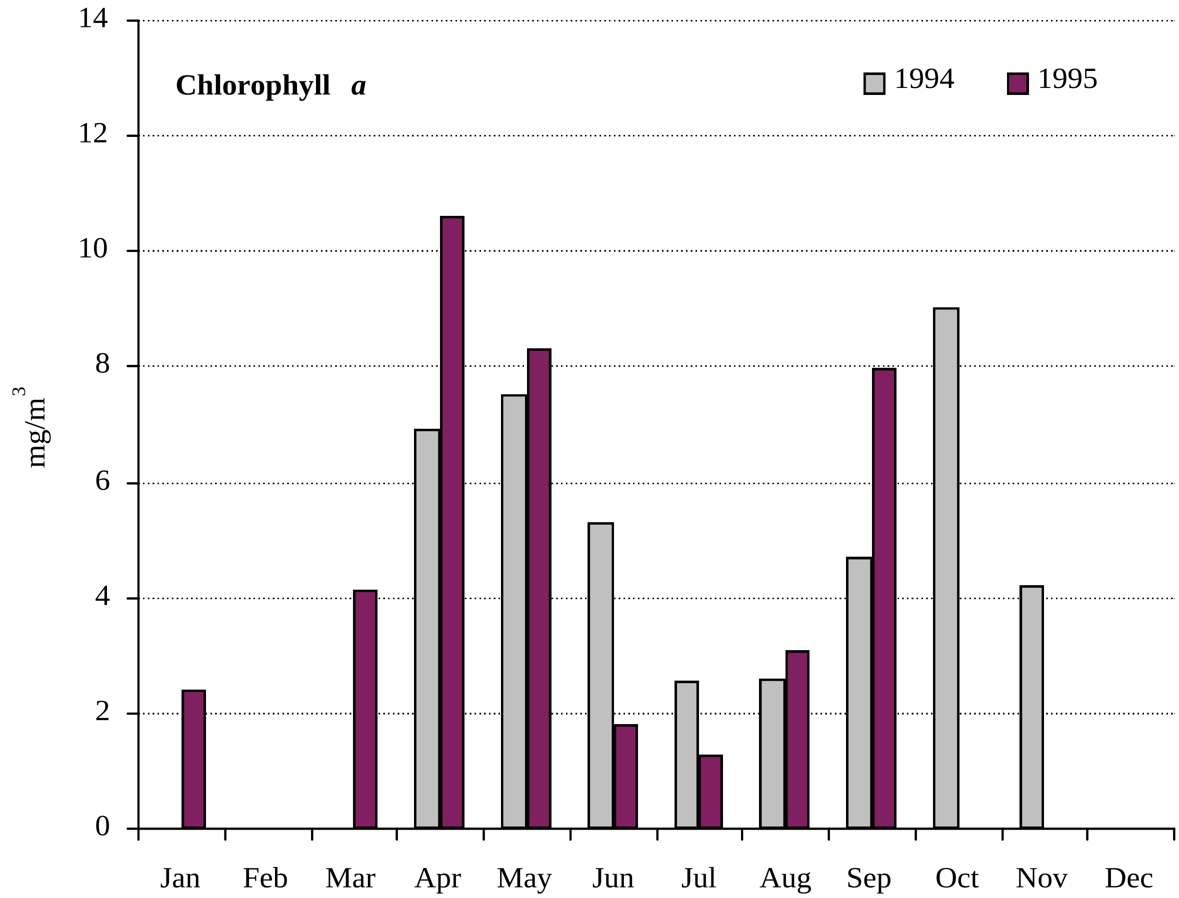


Figure 8. Chlorophyll *a* content of depth-integrated samples collected from John Day Reservoir during 1994 and 1995. Values shown are averages for samples collected from lower-, mid-, and upper-reservoir locations.

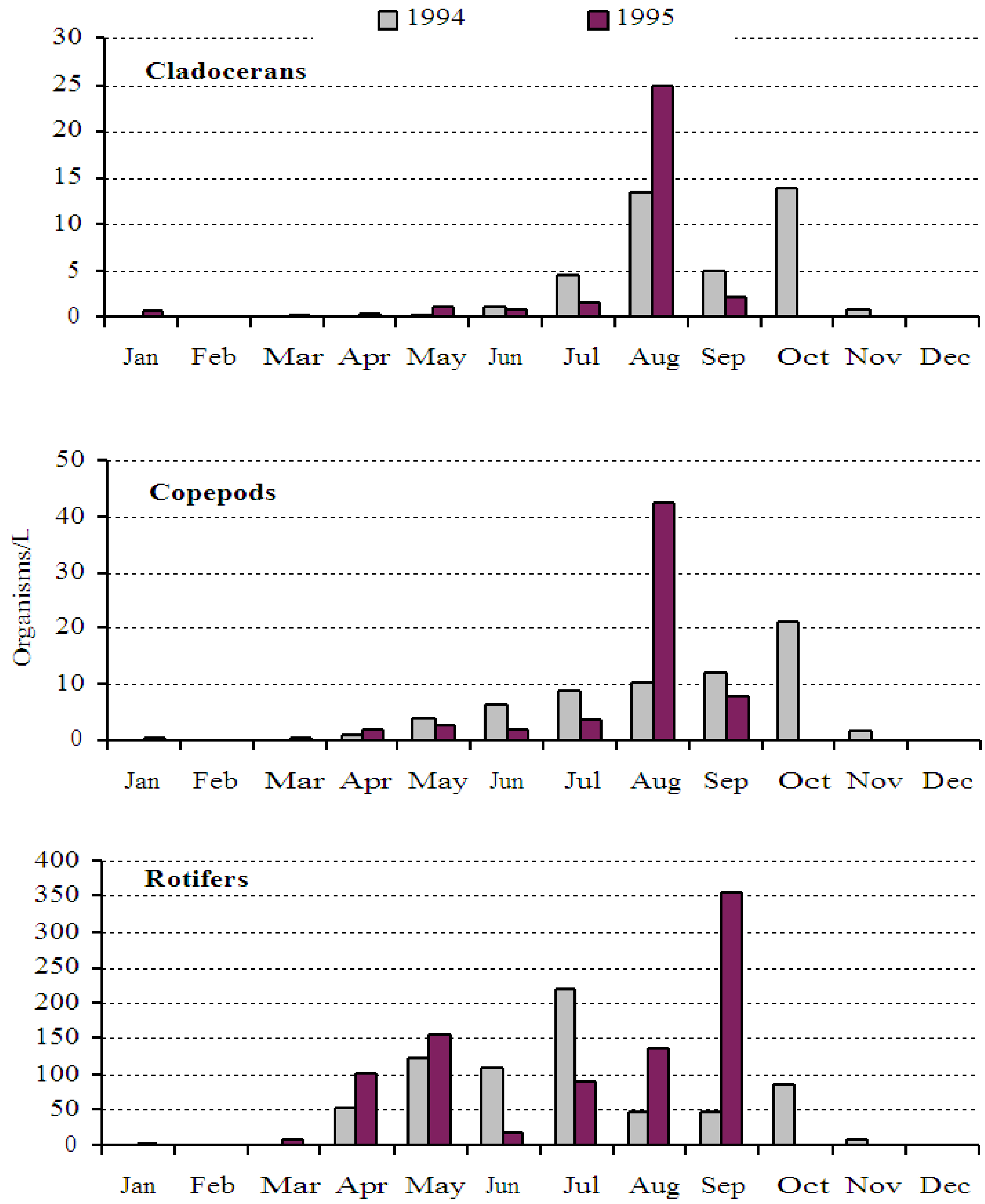


Figure 9. Zooplankton densities in John Day Reservoir during 1994 and 1995 (data from the Crow Butte backwater not included). No sampling occurred during February or December of either year.

Cladocerans—Of ten cladoceran species identified in zooplankton samples collected at lower- and mid-reservoir stations, only *Bosmina longirostris* and *Daphnia thorata* were present at densities exceeding 1 organism/L in any month. Seventeen cladoceran species were identified from samples collected at upper-reservoir stations, including all 10 species identified at lower- and mid-reservoir stations. At upper-reservoir stations, as at lower- and mid-reservoir stations, *Bosmina longirostris* and *Daphnia thorata* were dominant. Other species typically occurred infrequently, at relatively low densities. In 1995, March-to-September cladoceran densities in the Crow Butte backwater peaked at 151 organisms/L, compared with maximum densities of 45 organisms/L at lower- and mid-reservoir stations, and 19 organisms/L at upper-reservoir stations during the same period (Appendix Fig. B15).

Copepods—Collections contained predominantly immature life stages, including nauplii and copepodids. Calanoid copepodids were presumably developmental stages of *Leptodiaptomus ashlandi*, whereas cyclopoid copepodids were probably early life stages of *Diacyclops thomasi* or *Eucyclops agilis*, since these were the only mature copepod species identified in sample collections. *D. thomasi* was numerically dominant on most sample dates. Comparison of copepod densities between lower- and mid-reservoir, upper reservoir, and Crow Butte backwater locations from March to September 1995 shows slightly higher densities at lower- and mid-reservoir locations than at upper-reservoir stations. In general however, copepod densities at the Crow Butte backwater far exceeded those observed on the open river (Appendix Fig. B16).

Rotifers—Twenty-seven rotifer taxa were identified from samples collected at lower- and mid-reservoir stations. Most taxa were rare, appearing infrequently and at very low densities. The dominant taxa, including *Keratella cochlearis, Polyarthra vulgaris,* and *Synchaeta pectinata,* were present at lower- and mid-reservoir stations on all sample dates.

A total of 38 rotifer taxa were identified in samples collected at upper-reservoir stations. Taxa found only at upper reservoir sites were typically present at very low densities and on only a few sample dates. *Keratella cochlearis*, *Polyarthra vulgaris*, and *Synchaeta pectinata*, the three most abundant rotifers at lower- and mid-reservoir stations, were also the dominant species at upper-reservoir stations. As with the cladocerans and copepods, rotifer densities at the Crow Butte backwater were greater than at open river locations from March to September 1995.

Benthic Invertebrates

Whereas monthly average benthic invertebrate densities varied from 3,200 to 10,700 organisms/m^2 (Table 2), average benthic invertebrate densities in samples from individual station/depth/date stratum varied from 130 to 32,480 organisms/m^2 (Appendix Table A29). Data for individual benthic invertebrate samples are omitted from this report but are available in electronic format from NMFS, Point Adams Biological Field Station, P.O. Box 155, Hammond, OR 97121. A list of all benthic invertebrates identified in samples is given in Appendix Table A30.

Table 2 summarizes densities of dominant benthic invertebrate taxa at John Day Reservoir sampling stations from April 1994 to September 1995. Sample collections were numerically dominated by oligochaetes, the amphipod *Corophium*, ostracods (seed shrimp), chironomids (non-biting midge larvae), nematodes, pelecypods (bivalve molluscs), Hydracarina (water mites), and nemerteans (proboscis worms). Samples collected in most months also contained relatively low densities of Ephemeroptera (mayflies), Trichoptera (caddisflies), Ceratopogonidae (biting midges), mysids (opossum shrimp), gastropods, turbellarians, and various other taxa. Density fluctuations were lower for numerically dominant taxa such as oligochaetes, chironomids, nematodes, and *Corophium* than for the less common benthic invertebrates.

Benthic invertebrate densities varied by depth of sample collection in 1994. The overall mean density of samples collected at 3-m depths (8,100 organisms/m^2) was greater than the mean densities of samples collected at 1- and 5-m depths (5,400 and 5,900 organisms/m^2, respectively). Densities of *Corophium* varied with both survey date and depth in 1994. *Corophium* densities were lower in October and November than from June to August, and were less at 1-m depth than at 3- or 5-m depths. Temporal variation was not observed for chironomids or oligochaetes in 1994. However, these taxa did show density differences with depth, appearing at higher densities in samples collected at the 5-m depth contour than in samples from 1-m or 3-m depths.

Resident and Anadromous Fishes

We completed 116 beach seine hauls, catching a total of 5,830 fishes at upper-reservoir stations from May 1994 to September 1995 (Table 3). Eleven common resident taxa were represented in the catch, along with three migratory species, American shad (*Alosa sapidissima)*, Chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). Except for a few adult prickly sculpins (*Cottus asper)*, suckers (*Catostomus* spp.), and common carp (*Cyprinus carpio*), catches consisted almost entirely of juvenile fishes.

American shad were the most numerous species in the catch (4,301 fish), followed by Chinook salmon (584 fish), northern pikeminnow (*Ptychocheilus oregonensis*) (404 fish), smallmouth bass (*Micropterus dolomieui*) (152 fish), and sunfishes (*Lepomis spp*.) (89 fish). Juvenile shad attained a size large enough (about 35 mm) to be retained in the net in early August and were present in the catch from August to October in 1994 and from August to September in 1995. Chinook salmon subsampled from the catch in 1994 (n = 25) had a mean fork length of 74 mm (range 42 to 98 mm). Also in 1994, about 91% of the Chinook salmon were captured during May, 8% during June, and less than 1% during early July. Chinook salmon were not present in the catch from late July through November. Both the size data and time of occurrence at upper-reservoir stations suggest that the chinook salmon we observed were 0-age upriver bright stock fall chinook. Prevalent resident species (northern pikeminnow, smallmouth bass, and sunfishes) were captured in greatest numbers during August, September, or October.

Table 2. Dominant invertebrate taxa in benthic samples collected at John Day Reservoir sampling stations, Apr 1994-Sep 1995. * = Grand means of samples collected at 1-, 3-, and 5-m depths at upper reservoir stations and at Crow Butte backwater.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep
	Mean number/m^2*															
Annelida																
Oligochaeta	4,032	3,672	3,878	2,426	3,583	8,069	4,025	3,784	4,322	2,820	2,791	2,181	5,905	3,569	3,249	4,054
Other Annelida (3 taxa)	0	0	7	14	2	0	0	1	0	0	2	1	96	5	9	2
Crustacea																
Corophium spp.	804	311	1,511	884	1,158	292	184	331	303	206	132	134	690	626	737	612
Ostracoda	214	233	121	34	26	102	43	146	101	45	55	104	58	21	14	30
Mysidacea	2	10	13	15	30	1	0	0	1	0	1	1	1	2	5	1
Other Crustacea (4 taxa)	3	1	3	0	1	1	1	0	0	0	2	2	20	36	36	0
Insecta																
Chironomidae	287	522	980	511	648	560	657	561	602	233	319	187	1,181	1,123	1,101	443
Ephemeroptera	17	16	3	4	7	37	59	26	25	13	11	15	42	18	17	13
Diptera	60	5	3	5	0	1	5	0	0	0	0	1	1	0	0	1
Trichoptera	1	0	2	1	57	4	4	0	15	1	1	1	2	8	1	2
Ceratopogonidae	3	2	3	1	0	2	1	0	0	0	0	1	0	0	0	0
Zygoptera	1	1	0	0	0	2	5	0	1	0	16	0	4	16	27	0
Other Insecta (13 taxa)	2	0	2	4	1	2	2	1	0	0	1	1	1	3	2	3
Nematoda	283	434	322	145	210	735	360	528	401	256	317	235	310	170	245	268
Mollusca																
Pelecypoda	145	113	84	61	41	473	207	507	342	189	151	160	102	133	103	1,345
Gastropoda	5	3	3	2	2	8	7	23	5	6	2	2	2	2	17	5
Arachnida																
Prostigmata	155	94	62	126	414	70	81	118	190	98	67	100	219	114	49	10
Other Arachnida (2 taxa)	0	0	1	2	0	0	0	0	0	0	0	1	0	1	1	0
Nemertea 63	36	24	23	64	340	131	195	51	31	29	28	7	7	7	11	
Cnidaria																
Hydra spp.	0	0	0	0	0	25	0	9	0	0	0	0	0	0	0	0
Platyhelminthes																
Turbellaria	11	8	2	2	0	2	0	3	7	0	12	3	0	0	2	7
Tardigrada	2	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0
Nematomorpha	0	2	0	7	1	1	1	0	1	0	3	0	0	0	0	0
Unidentified	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Total	6,091	5,463	7,025	4,267	6,256	10,727	5,773	6,233	6,368	3,898	3,912	3,158	8,641	5,854	5,623	6,807

Table 3. Observed beach seine catch at upper John Day Reservoir stations, May 1994 to September 1995.

	Month and (number of beach seine sets)[a]													
	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Apr	May	Jun	Jul	Aug	Sept
Taxon	(12)	(11)	(8)	(12)	(5)	(5)	(6)	(6)	(6)	(7)	(2)	(12)	(12)	(12)
American shad	0	0	0	349	167	143	0	0	0	0	0	0	822	2,820
Common carp	4	1	2	3	0	3	1	0	2	0	0	8	1	7
Chinook salmon	255	24	2	0	0	0	0	0	16	178	103	6	0	0
Coho salmon	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Crappies	0	0	0	1	5	0	11	0	0	0	0	0	0	0
Largemouth bass	0	0	1	0	0	0	1	0	0	0	0	1	0	114
Peamouth	0	0	0	2	3	3	0	0	0	0	0	0	0	0
Prickley sculpin	2	1	4	3	2	0	0	1	4	4	1	8	2	2
Smallmouth bass	0	0	0	89	39	10	3	0	0	0	2	0	7	2
Northern pikeminnow	1	0	3	13	29	137	2	1	0	0	0	0	22	196
Sunfishes[b]	0	0	0	0	0	77	0	0	0	0	0	0	0	12
Suckers	0	0	8	9	0	1	0	0	0	0	0	1	11	9
Whitefish	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	10	1	2	0	2	0	4	1	1	3	4	4	1
Unidentified	0	0	4	1	0	0	0	0	0	0	0	3	0	0

a After 8 June 1994 all beach seine sets were made at the Long Walk Island (downstream) and Paterson Slough stations.

b Bluegill and pumpkinseed.

DISCUSSION

Physical Variables

Typical direct thermal stratification is characterized by a uniformly warmer upper layer, a middle layer in which temperature decreases at least 1°C for every 1-m increase in depth, and a lower layer of uniformly cooler water (Cole 1983). Within the Columbia River Basin, thermal stratification has been documented in Franklin D. Roosevelt Lake, the storage reservoir for the Grand Coulee Project (Stober et al. 1977), and in Brownlee Reservoir on the Snake River (Ebel and Koski 1968). In John Day Reservoir and in main-stem run-of-the-river reservoirs thermal stratification does not develop due to low water-retention times (Stober et al. 1979).

Vertical temperature profiles at John Day Reservoir sampling stations did not show thermal stratification, although there was a pronounced (about 2°C) warming from a depth of 15 m to the surface in spring. Temperature differences within the water column diminished through spring and summer. By winter, temperature profiles showed isothermal conditions.

In comparison with results of Funk et al. (1979) who noted less than a 1°C increase in temperature for passage of Snake River water through four reservoirs at time of maximal heat content, we noted differences of 0.3°C and 1.8°C between upper and lower John Day Reservoir locations in August 1994 and July 1995, respectively.

The extent to which light penetrates into waters is a function of turbidity and true color of the water. Available measures of water transparency include Secchi disk visibility, coefficients of absorption computed from readings taken with a subsurface photometer, and turbidity. General relationships exist between Secchi disk visibility, coefficients of absorption, and depth of the euphotic zone (Cole 1983). For example, the constant 1.7 divided by Secchi depth in meters often gives a result approximating the value of the vertical light absorption coefficient calculated from photometer readings. Depth of the euphotic zone may be estimated by multiplying Secchi depth by the factor 3.0.

Secchi disk visibility measured in John Day Reservoir varied from 0.5 to 3 m during the study. Variation was largely seasonal, reflecting higher turbidity during system-wide runoff in winter and spring and maximum clarity during winter periods when runoff and abundance of algae were at minimum levels. Station-to-station differences in Secchi depth were observed, but were usually due to local influences, such as turbid water entering from nearby tributaries such as the Umatilla or John Day Rivers or from wind-generated waves causing re-suspension of fine sediments at some nearshore stations. An exception was noted, in that Secchi depth was usually less at the Crow Butte backwater than at nearby upper-reservoir stations, probably because of the greater abundance of phytoplankton at Crow Butte.

Vertical light extinction coefficients less than 1.0 indicate relatively clear waters. In comparison, average monthly vertical light extinction coefficients in John Day Reservoir from June 1994 to September 1995 varied from 0.77 to 2.85. Water clarity during the June to September period was greater in 1994 than in 1995 as shown by lower extinction coefficients.

Turbidity measurements reflected the station-to-station differences due to tributary inflow as well as differences in water clarity between 1994 and 1995. Turbidity decreased slightly from upstream to downstream within the reservoir and increased from surface to bottom at the deeper sampling stations. These trends were likely due to settling of suspended materials.

Sediment samples were obtained at upper-reservoir stations selected for collection of soft-substrate benthic invertebrate samples. Although these locations were typical of much reservoir habitat, particularly the extensive shallow-water areas of the upper reservoir, other habitat types such as gravel and other hard substrates were not sampled. Li et al. (1981) conducted shoreline surveys of habitat along both the Washington and Oregon shores as part of a study of resident fish species in John Day Reservoir. Results of their study quantify shoreline habitat types and illustrate the increasing amount of hard substrate from upper to lower reservoir. Sediment analysis indicated differences in organic content and grain size between sampling stations used in our study. These differences are discussed in relation to benthic invertebrate collections described in a following section.

Chemical Variables

Other reservoir attributes for which surface-to-bottom profiles were taken at mid- and lower-reservoir stations included dissolved oxygen, pH, and specific conductance. Oxygen content of lakes typically decreases with depth during the growing season. Near-surface oxygen values often exceed saturation levels due to photosynthesis within the euphotic zone, whereas oxygen content at greater depths may be depleted due to respiration and decomposition of organic matter. The extent of oxygen decline with depth at John Day Reservoir sampling stations from spring to fall was slight, amounting to only about 0.5 mg/L in profiles covering 20- to 30-m depths. Expressed in terms of percent saturation, minimum and maximum oxygen concentrations observed in 1994 ranged from 86 to 116%. Funk et al. (1979) reported a much wider range of saturations (27 to 144%) from lower Snake River reservoirs during periods of pronounced oxygen stratification in 1977. Two differences were noted between upper and lower reservoir sampling stations: 1) oxygen content was slightly higher at upper-reservoir stations, and 2) oxygen saturation at upper-reservoir stations varied over a wider range than at lower reservoir stations.

Differences in vertical distribution of pH and alkalinity within the water column occur in some lakes as a result of photosynthetic utilization of CO_2 in the trophogenic zone and respiratory generation of CO_2 throughout the water column (Wetzel 1983). Where such differences exist, they tend to be marked more by pH differences than alkalinity changes within the water column. Changes observed for pH within the water column at lower- and mid-reservoir sampling stations were usually less than 0.3 pH units. These variations may reflect biological processes within the water column or may have resulted from the sampling technique (accuracy of the meter was ± 0.2 pH units; pH is difficult to measure accurately in waters of less than 200 µS/cm specific conductance).

Seasonal pH variation was characterized by highest values (8.6 pH units) in January and February and lowest values (7.7 pH units) in mid-September. There were no clear differences in pH between upper-, mid-, or lower-reservoir sampling stations located near the main river channel. At the Crow Butte backwater, however, pH values differed from those at near-channel stations by 0.1 to 1.0 pH units (average 0.6 pH units) for samples collected in the same weeks. Since pH increases with the level of primary production, the higher pH values observed at Crow Butte suggest a higher level of productivity at that location than at other reservoir stations.

Specific conductance is a measure of the conductivity of water. Since conductivity depends on ion concentration, specific conductance is proportional to major ions concentration and, as such, is often used as a substitute for determination of total dissolved solids (Wetzel 1983). Specific conductance values measured in John Day Reservoir ranged from 112 to 191 µS/cm during the study period. Lowest specific conductance coincided with periods of high runoff and highest values were observed during low runoff periods in winter. Specific conductance was among the most stable water quality parameters relative to spatial variability. No discernable spatial differences were observed, either between stations or with depth of sample collection. Within the Columbia River system, specific conductance values reflect the qualities of individual drainage basins. Funk et al. (1979) reported ranges of 100 to 300 µS/cm and 50 to 70 µS/cm from the Snake and Columbia Rivers, respectively, at locations above their confluence. Values of specific conductance observed in John Day Reservoir reflect the composite nature of waters arriving from upstream.

The alkalinity of the Columbia River is essentially bicarbonate, derived from the weathering of sedimentary carbonate rocks within the drainage basin (Park et al. 1969). Some tributaries such as the Snake and Yakima Rivers are relatively rich in alkalinity, while others, such as the Clearwater River, are less alkaline. Park et al. (1969) found that alkalinity at the mouth of the Columbia River was relatively consistent, averaging about 1 meq/L regardless of river flow. Our sampling of John Day Reservoir showed similar average monthly alkalinity values (range 46 to 75 mg/L $CaCO_3$ or 0.9 to 1.5 meq/L). We did not observe biologically mediated decreases in alkalinity values from upstream to downstream locations as noted by Funk et al. (1979) from rkm 248 downstream to rkm 190 in the lower Snake River reservoir series, probably because of the comparatively short retention time of water in John Day Reservoir. Seasonal variation of alkalinity in John Day Reservoir was characterized by highest values during low river flow in winter and lowest values during high river flow.

Concentrations of the major cations (calcium, magnesium, sodium, and potassium), and the major anions (sulfate and chloride) in John Day Reservoir waters were similar to mean values calculated for North American rivers by Livingstone (1963). Also, the dominance relationships of cations and anions in John Day Reservoir waters were typical of those observed in many rivers and temperate zone open lake systems (i.e., calcium > magnesium ≥ sodium > potassium and sulfate > chloride). Similarities in ionic concentration and dominance are common, particularly for rivers and open lakes with large drainage basins. Since ionic composition is derived primarily from weathering of soil and rock within drainage basins and because large basins tend to include a range of soil and rock types, many large rivers tend toward similar ionic content.

Concentrations of magnesium, sodium, potassium, and chloride undergo relatively minor changes from biotic utilization in the environment. Calcium and sulfate can exhibit marked seasonal and spatial dynamics as a result of microbial metabolism (Wetzel 1983). The major ions are usually considered to be in superabundance relative to biological needs (Funk et al. 1979). Stober et al. (1979), in a review of available Columbia River data, noted that sodium, chloride, and sulfate generally increased from the Canadian border to The Dalles, Oregon.

In John Day Reservoir, lowest concentrations of major ions coincided with periods of high runoff and highest concentrations were observed during low runoff periods in winter. There were no discernable differences between stations or within the water column.

In contrast to the common inverse relationship between discharge rate and concentration of some constituents of river waters, silica content is often relatively stable regardless of flow (Wetzel 1983). In John Day Reservoir, however, silica concentrations varied fourfold during the sampling season with minima noted in fall and maxima in spring. Although temporal changes in silica concentrations were roughly similar to those of the major ions, the decline in silica concentrations continued until early October, whereas ion concentrations tended to start increasing by July. Because the decline in silica continued throughout the growing season, it may have been more closely related to uptake of silica by diatom algae than to changes in river flow. Within John Day Reservoir there was little indication of spatial differences in silica concentrations between samples collected at near-channel stations or obtained from different depths within the water column. The silica content of samples collected at the Crow Butte backwater, however, averaged about 21% less than at nearby upper-reservoir stations, suggesting a higher degree of silica uptake by diatoms at Crow Butte that at other reservoir locations .

Nitrate and phosphate are the principal nutrients that support, and in some cases, limit primary production along the main stream Columbia River. Silica, an essential component in the cell walls of diatoms, is also considered a nutrient, but is seldom limiting to phytoplankton production. Temporal variation of phosphate, nitrate, and silica concentrations in the Columbia River system is characterized by maxima in winter and minima during summer months (Park et al. 1970). Summer nutrient levels reported by Park et al. (1970) showed a fourfold decrease in phosphate and a sevenfold decrease in nitrate between Pasco, Washington and Clatskanie, Oregon; this nutrient reduction was attributed to in-stream primary productivity.

Ammonia nitrogen results from bacterial decomposition of organic matter and, to a lesser extent, is introduced into water as an excretory product of aquatic animals. Ammonia is the nitrogen form most readily assimilated by algae and, as a consequence, ammonia levels often fluctuate rapidly. Probably because of the rapid uptake by algae, ammonia levels in John Day Reservoir varied widely among lower-, mid-, and upper-reservoir stations sampled during the same week. Spatial trends in ammonia levels, if present, were not readily apparent. Seasonal ammonia variation was characterized by highest levels from late April through October and lowest ammonia levels from November through early April.

Total oxidized nitrogen was determined as the sum of nitrite and nitrate nitrogen. Nitrite nitrogen is an intermediate stage in the nitrification of ammonia or the denitrification of nitrate. Because nitrite is readily oxidized, it is usually present in low concentrations. Nitrate nitrogen is present in surface runoff, groundwater, and precipitation and, in concentrations exceeding 0.3 mg/L, may result in algal blooms (Stober and Nakatani 1992). Seasonal variation in nitrite + nitrate nitrogen in John Day Reservoir was similar to that observed by Park et al. (1970). Nitrite + nitrate levels were at seasonal highs (0.5 to 0.6 mg/L) during winter, declined rapidly with the onset of the growing season in April, and eventually were reduced to low levels (<0.1 mg/L) at times during the growing season. Nitrite + nitrate values were consistently lower at the backwater habitat at Crow Butte than at near-channel sampling stations, most likely because of greater abundance of phytoplankton and lower turnover rate of water at the Crow Butte station.

Water samples collected from John Day Reservoir were also analyzed for total nitrogen content, defined as the combined concentrations of ammonia, nitrite + nitrate nitrogen, and organic nitrogen compounds including proteins, peptides, nucleic acids, and urea. Seasonal variation in total nitrogen concentration was similar to that of nitrite + nitrate nitrogen. Total nitrogen values were similar at the near-channel sampling stations of the upper-, mid-, and lower-reservoir. In comparison, total nitrogen values at the Crow Butte backwater were usually greater than at the near-channel stations.

Wetzel (1983) states that the dissolved organic nitrogen of fresh waters often contributes over one-half of total soluble nitrogen. In comparison, the organic nitrogen component in reservoir waters was between 50 and 90% from April to September, then declined to 16% in January, February and March. This temporal variation of organic nitrogen was, as expected, essentially the opposite of nitrite + nitrate nitrogen which is at lowest levels during periods of high biotic activity late spring, summer, and fall.

Phosphorus is relatively less abundant than other requirements of biota, such as carbon, nitrogen, and oxygen. Because of this scarcity, phosphorus is commonly the first element to limit biological productivity (Wetzel 1983). Natural sources of phosphorus are via leaching from rocks and decomposition of organic matter; manmade sources include fertilizers, sewage, and detergents (Lind 1979). Phosphorus is lost through chemical precipitation to sediments and adsorption.

Laboratory analyses of John Day Reservoir samples included determinations of orthophosphate phosphorus and total phosphorus content. Orthophosphate phosphorus is directly utilizable by algae. Values observed in John Day Reservoir varied inversely to phytoplankton abundance, declining from maximum levels in winter and early spring (20 to 30 µg/L) to minimum values (<5 µg/L) from late spring through early fall. In comparison, Funk et al. (1979) observed mean orthophosphate phosphorus content ranging from 6 to 38 µg/L in lower Snake River reservoirs. Orthophosphate phosphorus values varied considerably between John Day Reservoir locations with no increasing or decreasing trends evident from upper to lower reservoir. Orthophosphate phosphorus levels at the Crow Butte backwater were typically lower than at other reservoir locations sampled during the same week.

Total phosphorus includes orthophosphate phosphorus as well as various organic forms bound in living organisms, especially algae (Wetzel 1983). Total phosphorus values observed in John Day Reservoir ranged from 18 to 83 µg/L at upper-, mid-, and lower-reservoir stations. This range of values compares with the range of 6 to 38 µg/L reported by Funk et al. (1979) in the Lower Snake River and seasonal mean concentrations of 5.9 to 8.3 µg/L reported by Teuscher et al. (1994) for oligotrophic lakes in the Sawtooth Valley of Idaho. Seasonal variation was similar to orthophosphate phosphorus, although somewhat less variation was observed between sampling stations. No increasing or decreasing trends were evident from upper to lower reservoir.

Biological Variables

Conversion of a free flowing river into a reservoir causes a fundamental change in sources of biotic energy. In the river environment, organic material originating elsewhere is metabolized by heterotrophic organisms, a process which may provide a high percentage of the energy input (Baxter 1977). This process is augmented by primary production in the periphyton (algae attached to river substrates) and by aquatic macrophytes.

Phytoplankton populations in rivers are typically low, due to continual removal by current. Following impoundment of the river, however, phytoplankton populations develop and contribute significantly to aquatic productivity, whereas periphyton populations and aquatic macrophytes are restricted to littoral zones and shallow-water areas of the newly formed reservoir.

Measurement of the chlorophyll *a* content of reservoir waters provides an index of phytoplankton abundance, which is in turn determined by factors including water clarity, nutrient levels, temperature, flow, and utilization by zooplankton. Chlorophyll *a* levels (monthly averages for lower-, mid-, and upper-reservoir stations) during the 1994-95 sampling period peaked in spring (April and May) and again in fall (September and October) a periodicity characteristic of Columbia River reservoirs (Stober and Nakatani 1992).

The maximum average chlorophyll *a* value observed during this study (10.6 mg/m3 in April 1995) appears to be typical for a Columbia River system location. Peak chlorophyll *a* levels documented at other locations include 11.1 mg/m^3 in the forebay of Roosevelt Lake (Stober et al. 1977), 10.35 mg/m^3 in Rufus Woods Reservoir (Erickson et al. 1977), and 8.25 mg/m^3 at the Hanford Reach (Wolf et al. 1976). Funk et al. (1979) combined sampling data to obtain 2-year mean values of 4.9 and 2.5 mg/m^3 for Lower Granite Reservoir stations in 1976 and 1977, respectively.

Short water-retention times in run-of-the-river reservoirs are not conducive to buildup of phytoplankton populations (Erickson et al. 1977). Although John Day Reservoir is classified as a storage reservoir, retention times are short, ranging from 3.8 days at flows of 8,495 m^3/second to 11.2 days at river flow of 2,830 m^3/second (COE 1992). Based on chlorophyll *a* levels measured during study of John Day Reservoir in 1994 and 1995, phytoplankton populations are, as at other Columbia River locations, limited by water retention time. This contention is supported by comparison of average chlorophyll *a* levels between samples collected at upper-reservoir stations located near the main river channel and samples collected at the protected Crow Butte backwater during 1995. Peak chlorophyll *a* level observed at Crow Butte was 34.9 mg/m^3 during April 1995; an average of 12.3 mg/m^3 chlorophyll *a* was observed at upper-reservoir stations during the same week. In all other comparisons between samples collected during the same week at upper-reservoir stations and at Crow Butte, chlorophyll *a* values at Crow Butte were higher.

Factors commonly affecting rotifer abundance include temperature, food availability, and interactions with other zooplankters, particularly the cladocerans. In 1994, as water temperature at lower- and mid-reservoir stations increased from spring to summer, rotifer abundance also increased. In August and September 1994, although water temperature at lower- and mid-reservoir stations remained elevated (19 to 20°C), rotifer abundance declined to only 13% of the level observed during July 1994. This abrupt drop in rotifer abundance from July to September at mid- and lower-reservoir stations could not be explained by food availability, since chlorophyll *a* analysis indicated essentially constant levels of small plankton (<25 µm) throughout the April to November 1994 sampling period. Cladoceran abundance, however, increased from about 1 organism/L in June 1994 to 4.5 organisms/L in July 1994 and peaked at 23 organisms/L in August 1994. Rotifer abundance at lower- and mid-reservoir stations may have been reduced by feeding competition from the increasing cladoceran population, or through predation by insect larvae, copepods, or larval fish.

Mean cladoceran densities at John Day Reservoir stations from August to October and from May to September ranged from 2 to 25 organisms/L and from less than 1 to 25 organisms/L, respectively. Funk et al. (1979) reported low cladoceran concentrations (<1 to 46 organisms/L) in samples collected from lower Snake River reservoirs from August to October 1977. Samples collected at a John Day Reservoir backwater from May to September 1980 contained higher densities of cladocerans (<1 to 85 organisms/L)(Parente and Smith 1981).

The cladoceran densities we observed in John Day Reservoir were higher than densities typically observed in free-flowing rivers, but lower than expected for a non-oligotrophic lacustrine environment. Cladoceran population size and species composition are frequently regulated by predation. Selection by fish tends to remove larger forms such as *Daphnia* spp. from the population, resulting in dominance of small cladocerans such as *Bosmina* spp. When predation is not a factor, larger cladocerans tend to dominate smaller species. These interactions may explain two trends observed in our data: 1) in 1994 and 1995, *Daphnia* abundance declined and *Bosmina* became more abundant from August through the fall months, and 2) in 1994, the peak abundance of *Daphnia* at upper-reservoir stations was only about 10% of the peak observed at lower- and mid-reservoir stations. Increased predation in September and mid-October by young-of-the-year fish would be expected, as would relatively higher predation rates in the nearshore habitats adjacent to upper-reservoir stations. Alternatively, variations in *Daphnia* and *Bosmina* populations may have been due to food availability or normal seasonal fluctuations.

Mean copepod densities at John Day Reservoir stations in 1994 varied from less than 1 to 42 organisms/L during the sampling period and were generally greater than copepod densities reported from Snake River reservoirs in 1977 (<1 to 12 organisms/L)(Funk et al. 1979) or from a John Day Reservoir backwater in 1980 (<1 to 8 organisms/L)(Parente and Smith 1981).

Copepod populations are commonly dominated by one species of cyclopoid copepod and one species of calanoid copepod (Thorp and Covich 1991). Aside from the occurrence of *Eucyclops agilis* on a single date at upper-reservoir stations, John Day Reservoir zooplankton samples obtained in 1994 contained only the cyclopoid copepod *Diacyclops thomasi*, the calanoid copepod *Leptodiaptomus ashlandi*, and copepodids presumed to be immature life stages of these species. Copepod densities were typically higher at lower- and mid- than at upper-reservoir stations, possibly due to differential predation rates. Although copepods are better able to evade capture than the cladocerans, copepods are prey for other copepods, as well as for larval, juvenile, and adult fish. Life cycles of copepods are variable, although developmental time is greater than in rotifers or cladocerans due to the progression through immature life stages. Copepod abundance generally increased from April to October at lower-, mid- and upper-reservoir sampling stations.

Benthic invertebrate data were highly variable, a consequence of differing substrate types within sampling areas and of the difficulties inherent in collecting representative benthic samples (Wetzel and Likens 1979). Mean total benthic invertebrate densities for samples collected at monthly intervals from April 1994 to November 1995 (no samples were collected in December 1994 or February 1995) ranged from 3,200 to 10,700 organisms/m^2. In comparison, benthic samples collected from a John Day Reservoir backwater in November 1979 and in June and August 1980 contained relatively low mean densities of 140 to 1,540 organisms/m^2 (Parente and Smith 1981).

Benthic invertebrate populations were characterized by numerical dominance and relatively stable densities of oligochaetes, chironomids, and nematodes. Reproduction in oligochaetes and nematodes is usually considered to be approximately continuous, while chironomid species may exhibit one or more annual life cycles. Seasonal periodicity was not evident for chironomids in 1994 but definite peak abundances were noted in June, July, and August 1995. For most major taxa, densities were relatively high in spring, declined to seasonal lows during summer, then increased to relatively high levels in the fall. Taxa present at lower densities during the summer months included nemerteans, which are frequently most abundant in autumn, pelecypods, and ostracods. *Corophium* differed most notably from this seasonal trend in that higher *Corophium* densities were observed during the summer months than during fall.

Total benthic invertebrate densities varied by depth of sample collection in 1994. Overall mean densities at the 1- and 5-m depths (5,400 and 5,900 organisms/m^2) were less than overall mean density at the 3-m depth (8,100 organisms/m^2). These results, however, tend to obscure density vs. depth trends shown by individual taxa. Although most amphipods prefer waters less than 1 m deep (Pennak 1989), we noted higher *Corophium* densities at 5 m than at 1 m or 3 m. Nemerteans, or proboscis worms, were also present at higher densities at 5 m than at 1 m or 3 m. Densities of other taxa tended to decrease with depth. Oligochaetes, chironomids, and water mites were more abundant at 1- and 3-m depths than at the 5-m depth. Organic content at sample depths was similar, thus differences in oligochaete densities could not be explained based on organic content. Similarly, we were unable to account for the greater densities of chironomids at shallower depths. Water mites, however, are typically most abundant in 1 to 2 m of water and are predaceous on worms and small insects (Pennak 1989), likely reasons for our observations of higher water-mite densities at the shallower depths.

Although station-to-station differences in benthic invertebrate densities were not considered in the study design, such differences were apparent during sampling, and later, during examination of the data. Stations differed noticeably with respect to bottom contour, current velocity, exposure to wave action, and substrate composition. The Sand Island and Big Blalock Island stations were characterized by steep bottom contours, high current velocities relative to other stations, and minimal wave action. The Long Walk Island stations, in comparison, were characterized by gentler bottom contours, relatively low current velocities, and moderate wave action. Concerning these characteristics, the Paterson Slough station was intermediate between groupings. The results of sediment analysis indicated that organic content at the Long Walk Island stations was about twice that of the Sand Island, Big Blalock Island, and Paterson Slough stations. Median grain size, on the other hand, was about 50% larger at the Big Blalock Island and Sand Island stations than at other stations.

With the exception of pelecypods, individual benthic invertebrate taxa tended to exhibit preference for either the Long Walk Island or Sand Island/Big Blalock Island habitat types. Oligochaetes were about twice as abundant at the Long Walk Island stations as at other stations, probably because of the higher organic content at Long Walk Island. Chironomids, nematodes, ostracods, Ephemeroptera larvae, and water mites were also more abundant at the Long Walk Island stations. Nemerteans and *Corophium*, however, were present at higher densities at Sand Island and at Big Blalock Island than at the Long Walk Island stations. *Corophium* densities appeared more dependent on suitable current velocity than on grain size, since high *Corophium* densities were also present at the Paterson Slough station, despite the small grain size at this location.

Various studies have documented the importance of invertebrates in the diet of resident and anadromous fish in the Columbia River system. Griffith et al. (1995) found that while cladocerans (*Daphnia schødleri*) were the principal prey of Lake Roosevelt kokanee salmon during all seasons, chironomid larvae were important during summer. Parente and Smith (1981) found that from March to June, juvenile chinook salmon (mean length 75 mm) in a John Day Reservoir backwater were feeding on Cladocera (47% of stomach contents by volume), Ephemeroptera (35%), and Diptera (18%). Cladocerans and insects were the principal dietary components for subyearling chinook salmon captured at Jones Beach (rkm 75) in the upper Columbia River estuary (Kirn et al. 1986; Ledgerwood et al. 1990, 1991, 1994). For Columbia River estuary locations farther downstream, McCabe et al. (1983, 1986) concluded that *Corophium salmonis* was a primary prey for juvenile chinook salmon, coho salmon, and steelhead.

Previous research has documented use of littoral areas of John Day Reservoir by resident and anadromous species (Li et al. 1981). Although beach seines have often been used in littoral areas, catches may not be representative of true abundance or species composition (Parsley et al. 1989). Further, the selection of fishing site probably results in a degree of bias since few shoreline locations are suitable for seining due to substrate, current, or bottom contour. An indication that our seine catches may not be representative is the scarcity of adult fishes in the catch, particularly northern pikeminnow and smallmouth bass. Our results do serve to document use of littoral areas by juvenile salmon from April through July and by young-of-the-year of various resident species from summer through fall.

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APPENDIX A

Appendix Table A1. Water temperatures (surface to bottom averages;°C) at John Day Reservoir sampling stations, April 1994 to September 1995. Sample location details are shown in Figure 1.

	Water temperature (°C) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
4/11/94	9.5	9.0	9.4						
4/13/94					9.0	8.8	8.7	9.1	9.2
4/26/94					11.3	11.3	11.4	11.3	11.6
5/10/94	14.7	13.4	13.3						
5/11/94					13.0	12.9	13.2	13.0	14.0
5/24/94					15.1	14.3	14.3	14.2	14.9
6/7/94	15.2	14.9							
6/8/94					15.2	14.7	14.7	14.5	14.7
6/9/94			14.9						
6/21/94					16.5	16.3	16.3	16.3	17.3
7/6/94	18.0	17.9	18.4						
7/7/94					18.2	18.0	17.9	18.1	18.7
7/20/94					20.9	21.0	20.9	20.9	21.2
8/2/94	22.0	22.0	21.8						
8/4/94					21.7	21.7	21.6	21.6	21.7
8/18/94					21.5	21.6	21.6	21.6	21.8
9/14/94					19.7	19.8	19.8	19.8	19.9
9/15/94	19.9	19.9	19.7						
10/4/94	19.4	19.3	18.9						
10/6/94					18.1	18.3	18.3	18.3	18.3
11/15/94	10.6	10.6	10.4						
11/17/94					10.1	10.2	10.2	10.1	9.8
12/13/94					6.3	6.4	6.4	6.3	6.2
12/14/94	6.6	6.5	6.0						
1/10/95	4.2	3.9	3.4						
1/25/95					3.6	3.6	3.6	3.6	3.5
2/21/95	4.8	3.4	3.4						
2/22/95					4.8	4.3	4.2	5.0	4.2
3/13/95	5.5	4.7	4.8						
3/15/95				7.8	6.0	5.5	5.6	6.1	5.9
4/4/95				10.6	7.9	7.8	8.0	7.8	8.3
4/18/95				10.5					
4/20/95					9.2	9.1	9.2	9.2	9.3
4/21/95	9.4	9.3	9.1						
5/1/95				12.2					
5/2/95									10.2
5/3/95					10.3	10.3	10.3	10.3	
5/15/95	12.9	12.6	12.8						
5/17/95				15.9	12.4	12.4	12.6	12.5	13.0
5/30/95				17.6					
5/31/95					15.2	15.4	15.5	15.3	16.2

Appendix Table A1. Continued.

	Water temperature (°C) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
6/12/95	15.6	15.6	15.4						
6/14/95					14.7	14.7	14.7	14.6	14.7
6/15/95				15.8					
6/28/95				18.0					
6/29/95					16.6	16.7	16.7	16.6	16.8
7/10/95	18.8	18.7	19.3						
7/12/95					19.1	19.0	18.9	19.1	19.0
7/13/95				20.5					
7/24/95				21.8					
7/25/95					20.7	20.5	20.5	20.7	20.7
8/8/95				20.4	20.3	20.4	20.4	20.3	20.2
8/10/95	21.1	21.1	20.4						
8/21/95				20.0					
8/22/95					19.3	19.6	19.1	19.3	19.6
9/5/95				20.9					
9/7/95					20.6	20.5	20.2	20.2	20.5
9/8/95	20.3	20.3	20.4						
9/19/95				21.0	21.1	20.9	20.7	20.7	20.8

Appendix Table A2. Secchi disk readings (m) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Dashes indicate data not available.

	Turbidity (m) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
4/11/94	0.6	1.5	1.4						
4/12/94									
4/13/94					0.9	1.5	1.5	0.9	1.3
4/26/94					1.3	1.5	1.4	1.3	1.5
5/10/94	1.2	1.5	1.4						
5/11/94					1.4	1.4	1.4	1.4	1.4
5/12/94									
5/13/94									
5/24/94					1.2	1.5	1.5	1.4	1.4
6/7/94	1.5	1.5	--b						
6/8/94					1.2	1.5	1.5	1.4	1.8
6/9/94			1.5						
6/21/94					1.5	1.5	1.5	1.5	1.5
7/6/94	1.5	1.7	1.8						
7/7/94					1.4	1.4	1.4	1.4	1.4
7/20/94					1.7	1.8	2.0	1.7	1.7
8/2/94	2.7	3.4	2.1						
8/3/94									
8/4/94					1.4	2.3	2.0	2.0	1.5
8/18/94					1.7	2.1	2.1	1.7	1.8
9/13/94									
9/14/94					1.7	--	1.8	1.8	2.1
9/15/94	2.3	2.4	2.0						
10/4/94	2.1	2.3	1.5						
10/5/94									
10/6/94					1.8	1.7	1.7	1.7	1.8
11/15/94	3.0	3.3	3.0						
11/17/94					2.7	2.8	2.8	2.4	3.0
11/18/94									
12/13/94					3.2	4.2	3.5	2.9	4.4
12/14/94	--	2.7	3.2						
1/10/95	3.2	3.4	3.2						
1/24/95									
1/25/95					0.7	0.5	0.5	0.4	0.5
2/21/95	0.2	0.6	0.9						
2/22/95					0.5	1.1	1.1	0.5	1.1
3/13/95	0.9	1.2	1.4						
3/14/95									
3/15/95				0.9	0.8	0.9	0.9	0.8	1.2
4/4/95				0.9	1.1	1.2	1.1	1.1	0.9
4/18/95				0.9					
4/19/95									
4/20/95					1.2	--	1.4	1.2	1.2
4/21/95	0.8	1.3	1.4						
5/1/95				0.9					
5/2/95									1.1

Appendix Table A2. Continued.

	Turbidity (m) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
5/3/95					0.5	0.9	1.0	0.5	
5/15/95	0.6	0.9	0.8						
5/16/95									
5/17/95				0.5	0.5	0.8	0.6	0.5	0.6
5/30/95				1.4					
5/31/95					0.9	1.2	1.2	1.1	1.4
6/12/95	1.1	1.4	1.2						
6/13/95									
6/14/95					1.1	1.1	1.1	0.9	1.1
6/15/95				1.5					
6/28/95				1.2					
6/29/95					1.1	1.2	1.2	1.1	1.4
7/10/95	1.4	1.4	1.2						
7/11/95									
7/12/95					0.9	1.4	1.2	1.1	1.4
7/13/95				0.9					
7/24/95				1.1					
7/25/95					0.8	1.1	1.2	1.1	1.1
8/8/95				0.9	1.2	1.4	1.4	1.2	1.2
8/9/95									
8/10/95	1.5	1.4	1.2						
8/21/95				1.7					
8/22/95					--	1.2	1.2	1.2	1.1
9/5/95				0.9					
9/6/95									
9/7/95					1.1	1.5	1.5	1.3	1.1
9/8/95	1.8	1.8	1.7						
9/19/95				1.1	1.4	1.5	1.5	1.2	1.2

Appendix Table A3. Turbidity measurements (NTU) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Turbidity (NTU) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	--	5	5	4	5	--	4	5	5												
4/13/94												6	6	4	4	4	5	8	8	4	4
4/26/94												6	8	6	--	4	4	6	6	5	5
5/10/94	5	5	7	4	5	5	4	7	--												
5/11/94												6	10	6	5	5	5	--	6	5	5
5/24/94												7	8	6	6	7	7	8	8	6	6
6/7/94	5	5	2	5	6	--															
6/8/94												6	8	4	4	4	5	6	6	5	5
6/9/94							5	4	6												
6/21/94												4	5	5	5	5	5	5	5	4	4
7/6/94																					
7/7/94												6	8	5	6	5	5	5	7	5	6
7/20/94												5	6	4	4	4	4	5	5	4	5
8/2/94	2	2	5	1	2	4	2	3	8												
8/4/94												4	6	2	3	3	3	3	4	3	3
8/18/94												3	4	3	3	3	3	4	4	3	4
9/14/94												2	3	2	2	3	3	3	5	2	3
9/15/94	2	4	5	2	4	4	4	4	5												
10/4/94	3	3	4	3	3	6	4	5	6												
10/6/94												3	3	3	3	3	3	3	5	2	3
11/15/94	2	2	7	2	2	7	2	2	3												
11/17/94												2	5	2	3	2	3	2	3	2	2
12/13/94												2	2	1	1	2	2	2	2	1	1
12/14/94	2	2	2	2	2	2	2	2	3												
1/10/95	2	2	2	2	2	2	2	2	2												
1/25/95												24	24	21	21	22	22	25	26	21	20
2/21/95	42	39	37	11	11	11	8	9	8												
2/22/95												24	42	9	8	8	8	26	32	8	8

Appendix Table A3. Continued.

	Turbidity (NTU) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/13/95	9	8	7	6	6	6	6	6	6												
3/15/95										7	8	13	13	8	8	7	7	12	12	7	6
4/4/95										8	8	11	11	9	9	9	9	10	10	10	10
4/18/95										10	11										
4/20/95												9	9	6	6	6	6	8	8	6	7
4/21/95	10	9	10	6	7	7	7	7	7												
5/1/95										8	9										
5/2/95																				8	7
5/3/95												27	26	8	8	7	7	25	26		
5/15/95	10	10	13	7	8	9	9	10	13												
5/17/95										10	11	16	17	13	12	12	12	19	18	11	12
5/30/95										4	4										
5/31/95												7	9	6	5	6	5	7	7	6	5
6/12/95	7	7	15	5	6	8	5	6	12												
6/14/95												10	11	7	6	7	7	8	8	7	7
6/15/95										5	7										
6/28/95										4	5										
6/29/95												8	7	6	5	6	5	7	7	4	5
7/10/95	4	5	8	7	6	7	6	5	7												
7/12/95												9	13	8	6	9	5	7	6	5	6
7/13/95										10	8										
7/24/95										7	12										
7/25/95												8	13	7	6	6	7	7	8	6	6
8/8/95										7	8	7	8	7	7	6	7	6	6	6	6
8/10/95	4	5	6	4	4	6	6	6	7												
8/21/95										2	7										
8/22/95												7	8	5	6	5	5	5	6	5	6
9/5/95										6	6										
9/7/95												4	6	3	5	4	5	--	--	4	5
9/8/95	3	5	8	3	5	7	3	4	5												
9/19/95										4	6	4	7	4	4	4	4	5	5	4	4

Appendix Table A4. Vertical light absorption coefficients (k) at John Day Reservoir sampling stations, April 1994 to September 1995. Absorption coefficient per meter was expressed as $k \approx (\ln I_0 - \ln I_Z)/Z$, where I_0 = light intensity at zero depth, I_Z = light intensity at depth Z, and Z = depth of reading. Sampling station details are shown in Figure 1.

	Light absorption coefficient (k) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
6/7/94	1.045	0.984							
6/8/94					1.334	0.978	0.940	1.102	1.058
6/9/94			1.093						
6/21/94					1.124	1.002	1.038	1.128	1.007
7/6/94	0.979	1.079	0.914						
7/7/94					1.178	1.036	1.016	1.039	0.986
7/20/94					1.227	0.980	0.982	1.351	1.087
8/2/94	0.666	0.679	0.678						
8/4/94					1.042	0.732	0.774	0.899	0.836
8/18/94					0.814	0.732	0.744	1.044	0.717
9/14/94					0.883	0.834	0.848	0.873	0.791
9/15/94	0.652	0.627	0.844						
10/4/94	0.984	0.845	1.014						
10/6/94					1.110	1.050	1.050	1.194	0.999
11/15/94	0.841	0.813	0.854						
11/17/94					1.009	0.953	0.902	0.976	0.890
12/13/94					0.941	0.869	0.878	0.947	0.845
12/14/94	0.822	0.854	0.741						
1/10/95	0.891	0.832	0.777						
1/25/95					2.986	2.626	2.810	3.070	2.734
2/21/95	5.707	1.765	1.569						
2/22/95					2.843	1.438	1.495	2.951	1.535
3/13/95	1.440	1.283	1.213						
3/15/95					2.075	1.517	1.515	2.019	1.535
4/4/95				1.856	1.825	1.846	1.681	1.938	1.741
4/18/95				1.826					
4/20/95					1.902	1.606	1.594	1.868	1.513
4/21/95	1.785	1.470	1.602						
5/1/95				1.764					
5/2/95									1.749
5/3/95					2.961	1.718	1.684	2.994	
5/15/95	2.004	1.658	1.943						
5/17/95				2.290	2.773	2.239	2.010	2.724	1.842
5/30/95				1.257					
5/31/95					1.653	1.474	1.411	1.656	1.345

Appendix Table A4. Continued.

	Light absorption coefficient (*k*) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
6/12/95	1.490	1.180	1.348						
6/14/95					2.125	1.717	1.494	1.970	1.651
6/15/95				1.846					
6/28/95				1.276					
6/29/95					1.666	1.391	1.304	1.665	1.318
7/10/95	1.161	1.195	1.450						
7/12/95					1.894	1.358	1.435	1.638	1.535
7/13/95				1.990					
7/24/95				1.571					
7/25/95					1.749	1.523	1.511	1.674	1.461
8/8/95				1.735	1.635	1.396	1.483	1.501	1.424
8/10/95	1.429	1.220	1.575						
8/21/95				1.058					
8/22/95					1.595	1.279	1.255	1.299	1.392
9/5/95				1.393					
9/7/95					1.347	1.286	1.377	1.368	1.280
9/8/95	1.093	1.033	1.039						
9/19/95				1.319	1.470	1.358	1.471	1.387	1.572

Appendix Table A5. Light transmittance at John Day Reservoir sampling stations, April 1994 to September 1995. Transmittance was expressed as $T = 100\ e^{-k}$. Sampling station details are shown in Figure 1.

	Light transmittance (*T*) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
6/7/94	35.60	38.26							
6/8/94					26.51	38.56	39.48	33.64	35.06
6/9/94			34.39						
6/21/94					32.71	37.19	35.92	32.79	36.85
7/6/94	38.30	34.79	40.28						
7/7/94					33.08	35.61	36.31	35.50	37.39
7/20/94					29.37	37.94	37.67	26.33	34.18
8/2/94	51.42	51.40	50.89						
8/4/94					35.31	48.16	46.24	40.70	43.46
8/18/94					44.50	48.10	47.58	37.92	48.87
9/14/94					41.39	43.71	43.14	41.93	45.53
9/15/94	52.18	53.39	43.01						
10/4/94	38.28	43.26	36.60						
10/6/94					33.26	35.28	35.48	30.61	37.21
11/15/94	44.44	45.71	43.10						
11/17/94					37.97	40.21	41.71	38.49	42.45
12/13/94					40.51	43.39	43.08	40.24	44.51
12/14/94	46.10	44.17	49.46						
1/10/95	43.18	45.32	46.79						
1/25/95					6.86	8.94	7.67	6.51	8.31
2/21/95	0.38	17.54	21.42						
2/22/95					6.43	24.97	23.00	5.95	22.14
3/13/95	24.66	28.46	31.26						
3/15/95					12.99	22.61	22.97	13.68	22.30
4/4/95				16.68	16.38	17.10	20.30	15.01	19.44
4/18/95				18.03					
4/20/95					15.88	21.49	21.36	16.23	24.43
4/21/95	18.19	23.72	20.66						
5/1/95				18.95					
5/2/95									18.04
5/3/95					6.47	18.44	19.31	5.77	
5/15/95	14.05	19.74	15.36						
5/17/95				12.00	7.06	11.57	14.44	7.21	16.12
5/30/95				29.22					
5/31/95					19.77	23.87	25.09	19.66	26.66
6/12/95	23.29	31.84	26.96						
6/14/95					12.70	19.21	22.95	15.09	20.38
6/15/95				17.28					

Appendix Table A5. Continued.

	Light transmittance (T) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
6/28/95				28.96					
6/29/95					19.70	25.58	27.92	19.70	27.90
7/10/95	32.28	31.47	24.52						
7/12/95					15.55	26.46	24.61	20.03	22.98
7/13/95				14.07					
7/24/95				21.46					
7/25/95					17.85	22.52	22.66	19.22	23.68
8/8/95				19.75	20.05	25.27	23.62	23.02	24.52
8/10/95	26.40	36.09	22.13						
8/21/95				35.10					
8/22/95					20.81	28.67	29.34	27.93	25.89
9/5/95				25.05					
9/7/95					27.03	28.68	27.22	27.01	30.15
9/8/95	35.21	38.09	37.26						
9/19/95				27.23	23.68	26.85	23.97	28.52	22.33

Appendix Table A6. Sediment characteristics of samples collected at upper John Day Reservoir sampling stations during 1994 and 1995.

Date	Station	Depth (m)	Volatile solids (%)	Median grain size (mm)	Silt/Clay (%)
5/12/94	Long Walk Island (downstream site)	1	7.2	0.16	5.8
5/12/94	Big Blalock Island	1	0.8	0.12	12.4
5/12/94	Long Walk Island (upstream site)	1	1.9	0.12	16.6
5/12/94	Paterson Slough	1	0.8	0.04	90.8
5/12/94	Long Walk Island (downstream site)	3	2.9	0.07	46.0
5/12/94	Big Blalock Island	3	1.2	0.17	11.1
5/12/94	Long Walk Island (upstream site)	3	2.7	0.07	43.0
5/12/94	Paterson Slough	3	0.9	0.11	8.5
5/12/94	Long Walk Island (downstream site)	5	2.8	0.08	36.0
5/12/94	Big Blalock Island	5	1.2	0.13	25.7
5/12/94	Long Walk Island (upstream site)	5	1.1	0.16	6.2
5/12/94	Paterson Slough	5	0.9	0.09	16.0
8/3/94	Long Walk Island (downstream site)	1	0.6	0.17	4.3
8/3/94	Sand Island	1	0.5	0.22	7.2
8/3/94	Big Blalock Island	1	0.8	0.15	9.9
8/3/94	Long Walk Island (upstream site)	1	2.6	0.08	38.5
8/3/94	Paterson Slough	1	0.7	0.12	15.4
8/3/94	Long Walk Island (downstream site)	3	2.3	0.07	41.0
8/3/94	Sand Island	3	1.1	0.17	7.8
8/3/94	Big Blalock Island	3	1.0	0.14	24.7
8/3/94	Long Walk Island (upstream site)	3	1.6	0.10	13.4
8/3/94	Paterson Slough	3	1.0	0.15	14.4
8/3/94	Long Walk Island (downstream site)	5	2.9	0.08	32.9
8/3/94	Sand Island	5	1.0	0.17	5.9
8/3/94	Big Blalock Island	5	0.8	0.17	3.8
8/3/94	Long Walk Island (upstream site)	5	1.3	0.15	13.6
8/3/94	Paterson Slough	5	1.1	0.10	10.4
11/18/94	Long Walk Island (downstream site)	1	0.5	0.16	6.1
11/18/94	Sand Island	1	0.7	0.16	10.1
11/18/94	Big Blalock Island	1	0.6	0.17	8.6
11/18/94	Long Walk Island (upstream site)	1	0.9	0.07	45.6
11/18/94	Paterson Slough	1	0.7	0.14	7.5
11/18/94	Long Walk Island (downstream site)	3	1.6	0.12	28.3
11/18/94	Sand Island	3	0.5	0.15	16.3
11/18/94	Big Blalock Island	3	0.7	0.14	21.8
11/18/94	Long Walk Island (upstream site)	3	1.7	0.06	48.5
11/18/94	Paterson Slough	3	0.8	0.10	27.7
11/18/94	Long Walk Island (downstream site)	5	1.8	0.08	27.2
11/18/94	Sand Island	5	0.7	0.19	12.2

Appendix Table A6.   Continued.

Date	Station	Depth (m)	Volatile solids (%)	Median grain size (mm)	Silt/Clay (%)
11/18/94	Big Blalock Island	5	0.8	0.12	26.1
11/18/94	Long Walk Island (upstream site)	5	1.5	0.18	16.5
11/18/94	Paterson Slough	5	1.2	0.07	41.6
1/24/95	Long Walk Island (downstream site)	1	0.5	0.17	6.4
1/24/95	Sand Island	1	0.9	0.15	7.3
1/24/95	Big Blalock Island	1	0.9	0.10	16.9
1/24/95	Long Walk Island (upstream site)	1	1.4	0.08	28.3
1/24/95	Paterson Slough	1	0.9	0.09	17.5
1/24/95	Long Walk Island (downstream site)	3	1.9	0.08	28.1
1/24/95	Sand Island	3	0.8	0.17	5.4
1/24/95	Big Blalock Island	3	0.7	0.17	6.5
1/24/95	Long Walk Island (upstream site)	3	2.1	0.08	29.2
1/24/95	Long Walk Island (downstream site)	5	1.8	0.08	27.5
1/24/95	Sand Island	5	0.4	0.25	2.7
1/24/95	Big Blalock Island	5	0.6	0.21	1.6
1/24/95	Long Walk Island (upstream site)	5	1.6	0.09	27.3
1/25/95	Paterson Slough	3	0.7	0.13	8.0
1/25/95	Paterson Slough	5	0.9	0.11	7.2
4/18/95	Crow Butte	1	2.6	0.05	84.0
4/18/95	Crow Butte	3	1.6	0.06	60.6
4/18/95	Crow Butte	5	3.0	0.05	71.6
4/19/95	Long Walk Island (downstream site)	1	0.7	0.17	8.2
4/19/95	Sand Island	1	0.3	0.23	5.6
4/19/95	Big Blalock Island	1	0.9	0.14	9.3
4/19/95	Long Walk Island (upstream site)	1	1.7	0.09	29.3
4/19/95	Paterson Slough	1	0.6	0.15	4.7
4/19/95	Long Walk Island (downstream site)	3	1.7	0.09	29.2
4/19/95	Sand Island	3	0.5	0.27	4.4
4/19/95	Big Blalock Island	3	0.6	0.19	6.1
4/19/95	Long Walk Island (upstream site)	3	1.8	0.09	28.5
4/19/95	Paterson Slough	3	0.8	0.14	9.7
4/19/95	Long Walk Island (downstream site)	5	2.2	0.08	33.7
4/19/95	Sand Island	5	9.6	0.27	6.3
4/19/95	Big Blalock Island	5	0.7	0.17	10.7
4/19/95	Long Walk Island (upstream site)	5	1.7	0.14	26.1
4/19/95	Paterson Slough	5	0.8	0.12	7.0
7/11/95	Long Walk Island (downstream site)	1	0.8	0.16	7.1
7/11/95	Sand Island	1	0.7	0.19	6.7
7/11/95	Big Blalock Island	1	0.9	0.34	7.0
7/11/95	Long Walk Island (upstream site)	1	1.5	0.13	21.8
7/11/95	Paterson Slough	1	0.5	0.16	24.2

Appendix Table A6. Continued.

Date	Station	Depth (m)	Volatile solids (%)	Median grain size (mm)	Silt/Clay (%)
7/11/95	Long Walk Island (downstream site)	3	2.1	0.08	35.1
7/11/95	Sand Island	3	0.5	0.26	2.9
7/11/95	Big Blalock Island	3	1.0	0.16	32.0
7/11/95	Long Walk Island (upstream site)	3	2.6	0.09	28.9
7/11/95	Paterson Slough	3	0.7	0.15	6.0
7/11/95	Long Walk Island (downstream site)	5	2.2	0.08	32.2
7/11/95	Sand Island	5	0.4	0.27	1.9
7/11/95	Big Blalock Island	5	0.4	0.24	13.3
7/11/95	Long Walk Island (upstream site)	5	0.9	0.17	7.7
7/11/95	Paterson Slough	5	0.9	0.12	36.2
7/13/95	Crow Butte	1	1.8	0.08	35.3
7/13/95	Crow Butte	3	1.6	0.14	20.1
7/13/95	Crow Butte	5	3.0	0.06	55.3

Appendix Table A7. Dissolved oxygen levels (surface to bottom averages; mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Details of sampling stations are shown in Figure 1.

	Dissolved oxygen (mg/L) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
4/11/94	12.4	12.8	13.0						
4/13/94					12.5	13.1	12.9	12.3	13.0
4/26/94					10.1	10.4	10.5	10.1	10.5
5/10/94	10.9	11.5	9.1						
5/11/94					8.1	8.2	8.1	8.0	8.2
5/24/94					12.1	12.2	12.3	11.8	12.3
6/7/94	10.4	10.8							
6/8/94					11.0	11.3	11.4	10.7	11.2
6/9/94			10.6						
6/21/94					10.8	10.8	10.8	10.6	11.2
7/6/94	9.0	9.1	9.5						
7/7/94					9.7	9.7	9.8	9.5	10.2
7/20/94					9.2	9.4	9.4	9.2	9.5
8/2/94	8.0	8.1	8.4						
8/4/94					8.5	8.9	8.8	8.8	8.8
8/18/94					8.7	8.7	8.6	8.5	9.0
9/14/94					9.3	9.3	9.3	9.6	9.8
9/15/94	8.1	8.3	8.7						
10/4/94	8.3	8.4	8.9						
10/6/94					9.5	9.4	9.7	10.0	10.2
11/15/94	9.5	9.8	9.9						
11/17/94					9.3	9.6	9.7	9.7	10.5
12/13/94					10.7	10.5	10.3	10.8	10.3
12/14/94	11.4	11.6	11.7						
1/10/95	11.3	11.7	11.6						
1/25/95					11.4	11.5	11.2	11.4	11.1
2/21/95	11.6	12.1	12.1						
2/22/95					11.8	12.1	11.9	11.8	11.8
3/13/95	11.9	12.4	12.4						
3/15/95				12.1	11.6	11.8	12.1	11.7	12.3
4/4/95				13.1	11.7	11.9	11.8	11.9	11.9
4/18/95				12.1					
4/20/95					11.8	11.9	11.9	11.7	12.1
4/21/95	11.4	11.6	11.7						
5/1/95				11.8					
5/2/95									12.3
5/3/95					12.1	12.5	12.7	12.2	
5/15/95	10.5	11.1	11.5						

Appendix Table A7. Continued.

	Dissolved oxygen (mg/L) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
5/17/95				10.1	10.8	11.3	11.4	10.9	11.4
5/30/95				12.1					
5/31/95					10.9	11.2	11.3	11.1	11.6
6/12/95	10.3	10.6	10.7						
6/14/95					10.4	11.1	11.2	10.6	11.3
6/15/95				10.1					
6/28/95				10.3					
6/29/95					10.2	10.7	10.9	10.3	11.1
7/10/95	9.0	9.1	9.4						
7/12/95					9.2	9.2	9.1	9.2	9.2
7/13/95				9.3					
7/24/95				9.0					
7/25/95					8.8	8.7	8.7	8.7	8.8
8/8/95				9.5	9.0	9.0	8.9	9.0	8.9
8/10/95	8.6	8.6	8.9						
8/21/95				10.3					
8/22/95					9.6	9.5	9.5	9.7	9.7
9/5/95				8.4					
9/7/95					9.4	9.3	9.1	9.3	9.6
9/8/95	8.6	8.8	9.2						
9/19/95				8.3	9.8	9.5	9.3	9.5	9.6

Appendix Table A8. pH values (antilog means) at John Day Reservoir sampling stations, April 1994 to September 1995. Details of sampling stations are shown in Figure 1.

	Mean pH (antilog) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
4/11/94	8.4	8.5	8.5						
4/13/94					8.3	8.3	8.3	8.3	8.4
4/26/94					8.5	8.6	8.6	8.5	8.7
5/10/94	8.6	8.6	8.6						
5/11/94					8.4	8.5	8.6	8.4	8.8
5/24/94					8.5	8.5	8.4	8.3	8.6
6/7/94	8.3	8.4							
6/8/94					8.3	8.1	8.2	8.2	8.3
6/9/94			8.2						
6/21/94					8.2	8.2	8.2	8.2	8.4
7/6/94	8.2	8.2	8.3						
7/7/94					8.2	8.1	8.1	8.1	8.4
7/20/94					8.0	8.1	8.1	8.1	8.2
8/2/94	8.0	8.1	8.1						
8/4/94					8.1	8.2	8.2	8.2	8.3
8/18/94					8.1	8.1	8.0	8.0	8.2
9/14/94					8.4	8.4	8.5	8.5	8.5
9/15/94	8.1	8.1	8.2						
10/4/94	8.3	8.3	8.4						
10/6/94					8.5	8.5	8.6	8.6	8.7
11/15/94	8.1	8.1	8.1						
11/17/94					8.0	8.1	8.1	8.1	8.1
12/13/94					8.1	8.2	8.2	8.1	8.2
12/14/94	8.1	8.1	8.0						
1/10/95	8.0	8.0	8.1						
1/25/95					8.0	8.0	8.0	8.0	8.0
2/21/95	8.0	8.0	8.0						
2/22/95					8.0	8.0	8.0	8.0	8.0
3/13/95	7.9	7.9	8.0						
3/15/95				8.3	7.9	7.9	7.9	7.9	8.0
4/4/95				8.8	7.8	7.8	7.8	7.8	7.9
4/18/95				8.6					
4/20/95					8.0	8.0	8.0	8.0	8.1
4/21/95	7.9	8.0	8.0						
5/1/95				8.6					
5/2/95									8.1
5/3/95					8.0	8.1	8.2	8.1	
5/15/95	8.0	8.1	8.1						

Appendix Table A8. Continued.

	Mean pH (antilog) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
5/17/95				8.8	7.9	8.0	8.1	7.9	8.2
5/30/95				8.7					
5/31/95					7.8	7.9	7.9	7.8	8.0
6/12/95	7.8	7.9	7.8						
6/14/95					7.7	7.8	7.8	7.7	7.8
6/15/95				8.0					
6/28/95				8.1					
6/29/95					7.8	7.9	7.9	7.8	8.0
7/10/95	7.8	7.7	7.9						
7/12/95					7.8	7.8	7.7	7.8	7.7
7/13/95				8.6					
7/24/95				8.6					
7/25/95					7.8	7.7	7.7	7.7	7.7
8/8/95				8.5	7.9	7.9	7.8	7.8	7.8
8/10/95	7.9	7.9	8.0						
8/21/95				8.8					
8/22/95					8.1	8.0	8.0	8.2	8.2
9/5/95				8.7					
9/7/95					8.2	8.1	8.0	8.1	8.2
9/8/95	8.1	8.2	8.3						
9/19/95				8.4	8.4	8.3	8.3	8.3	8.4

Appendix Table A9. Specific conductance (temperature compensated to 25°C; surface to bottom averages; µS/cm) at John Day Reservoir sampling stations, April 1994 to September 1995. Details of sampling stations are shown in Figure 1.

	Specific conductance (µS/cm) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
4/11/94	171	179	178						
4/13/94					181	181	177	182	181
4/26/94					179	178	176	179	177
5/10/94	142	139	134						
5/11/94					140	140	141	141	142
5/24/94					144	142	142	144	143
6/7/94	129	128							
6/8/94					130	128	129	129	128
6/9/94			128						
6/21/94					168	136	137	139	137
7/6/94	136	136	135						
7/7/94					138	137	137	139	138
7/20/94					133	134	134	134	134
8/2/94	144	144	144						
8/4/94					142	141	141	142	140
8/18/94					137	136	136	137	136
9/14/94					144	143	142	143	142
9/15/94	144	144	143						
10/4/94	146	147	145						
10/6/94					149	148	148	150	148
11/15/94	172	171	169						
11/17/94					177	175	173	173	168
12/13/94					171	166	164	170	165
12/14/94	178	179	176						
1/10/95	184	178	175						
1/25/95					196	188	188	195	187
2/21/95	170	191	183						
2/22/95					171	169	167	165	167
3/13/95	175	181	187						
3/15/95				189	174	162	158	176	155
4/4/95				170	154	159	161	163	160
4/18/95				162					
4/20/95					173	172	172	173	172
4/21/95	150	160	168						
5/1/95				159					
5/2/95									149
5/3/95					143	147	147	143	

Appendix Table A9. Continued.

	Specific conductance (µS/cm) by sampling station								
	Lower/Mid reservoir			Backwater	Upper reservoir				
Date	rkm 352	rkm 355	rkm 390	rkm 424	rkm 443a	rkm 443b	rkm 445	rkm 446	rkm 449
5/15/95	126	133	128						
5/17/95				147	121	103	123	119	124
5/30/95				126					
5/31/95					119	118	119	118	119
6/12/95	120	117	112						
6/14/95					104	106	106	106	107
6/15/95				112					
6/28/95				121					
6/29/95					120	118	119	120	119
7/10/95	125	125	127						
7/12/95					121	121	121	123	122
7/13/95				107					
7/24/95				132					
7/25/95					129	129	129	130	129
8/8/95				137	135	135	135	136	134
8/10/95	138	135	135						
8/21/95				138					
8/22/95					140	139	140	141	140
9/5/95				144					
9/7/95					141	141	140	143	140
9/8/95	142	141	142						
9/19/95				148	142	140	140	142	140

Appendix Table A10. Alkalinity measurements ($mg/L\ CaCO_3$) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Alkalinity ($mg/L\ CaCO_3$) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	71	75	75	76	76	76	75	74	73												
4/13/94												75	75	75	75	74	74	73	75	73	73
4/26/94												72	72	68	71	71	72	72	71	72	70
5/10/94	59	58	59	57	56	57	57	57	55												
5/11/94												57	58	62	58	59	--	57	61	58	59
5/24/94												56	56	56	57	55	55	56	56	56	57
6/7/94	56	56	53	54	54	53															
6/8/94												54	55	53	53	53	52	54	53	53	53
6/9/94							52	52	53												
6/21/94												55	55	55	56	55	55	56	56	56	55
7/6/94	55	56	56	56	56	56	56	55	56												
7/7/94												56	56	56	55	56	56	56	56	56	56
7/20/94												55	55	55	55	55	55	54	54	54	55
8/2/94	62	63	62	62	61	61	61	60	60												
8/4/94												60	59	59	58	59	58	59	59	58	58
8/18/94												56	57	56	56	56	56	56	56	56	56
9/14/94												54	54	53	53	53	53	54	54	53	53
9/15/94	53	53	53	53	53	54	54	53	54												
10/4/94	60	60	60	61	61	60	60	60	61												
10/6/94												61	61	61	61	60	61	61	61	60	61
11/15/94	64	65	69	65	65	66	63	64	63												
11/17/94												67	66	66	66	65	65	66	66	65	64
12/13/94												69	68	68	67	67	67	67	67	67	67
12/14/94	70	71	70	70	70	70	69	69	69												
1/10/95	74	74	74	72	71	72	71	72	71												
1/25/95												76	80	70	75	75	75	76	76	75	76
2/21/95	76	75	76	77	76	75	77	77	76												
2/22/95												67	68	69	68	68	68	66	65	68	70

Appendix Table A10. Continued.

	Alkalinity (mg/L $CaCO_3$) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/13/95	76	77	77	69	70	71	76	74	75												
3/15/95										73	72	67	67	66	66	65	65	67	67	66	65
4/4/95										71	72	66	66	65	65	65	66	66	66	65	66
4/18/95										70	70										
4/20/95												71	70	70	71	71	70	71	71	71	71
4/21/95	66	67	66	66	66	67	69	69	69												
5/1/95										68	68										
5/2/95																				64	64
5/3/95												61	62	63	64	64	64	62	62		
5/15/95	57	56	56	55	55	55	53	54	54												
5/17/95										66	66	51	52	53	53	53	53	51	50	52	53
5/30/95										54	53										
5/31/95												50	49	49	50	50	50	49	49	50	50
6/12/95	51	48	48	48	48	48	46	46	46												
6/14/95												43	43	45	45	45	45	45	45	46	45
6/15/95										49	46										
6/28/95										53	52										
6/29/95												52	52	52	52	53	53	52	52	53	53
7/10/95	55	53	53	53	53	53	54	54	54												
7/12/95												52	52	52	52	52	52	52	52	52	52
7/13/95										55	55										
7/24/95										53	53										
7/25/95												54	53	53	53	53	53	54	54	53	53
8/8/95										60	61	60	60	60	59	59	59	60	60	59	59
8/10/95	62	60	60	60	60	60	60	60	60												
8/21/95										60	61										
8/22/95												60	60	60	60	60	60	61	61	61	60
9/5/95										63	63										
9/7/95												62	61	61	61	61	61	62	62	61	61
9/8/95	62	63	62	62	62	62	63	63	62												
9/19/95										64	65	62	62	61	61	61	61	62	62	62	62

Appendix Table A11. Silica concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Silica concentration (mg/L) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	16.5	8.8	8.2	9.1	8.7	8.0	8.6	9.6	9.5												
4/13/94												10.2	10.3	10.3	10.4	10.2	10.1	10.8	11.1	10.8	10.3
4/26/94												10.9	11.7	11.4	11.5	11.2	11.5	11.4	11.9	10.8	10.6
5/10/94	18.0	9.2	9.3	8.5	8.7	8.7	7.7	8.2	8.5												
5/11/94												9.4	9.7	8.6	8.6	8.6	--c	9.4	9.5	8.3	8.6
5/24/94												8.6	8.8	7.9	8.1	8.1	7.9	9.0	9.0	7.4	7.9
6/7/94	11.2	11.6	7.7	2.1	2.5	7.3															
6/8/94												6.2	5.2	7.1	7.8	5.8	7.8	5.4	8.3	7.9	7.9
6/9/94							7.5	7.5	7.5												
6/21/94												8.1	8.2	8.1	8.0	8.3	8.2	8.3	8.3	7.8	8.0
7/6/94	6.7	6.9	7.2	6.8	6.9	6.9	6.3	6.4	6.5												
7/7/94												7.0	7.1	7.2	7.1	7.1	7.2	7.2	7.2	6.7	6.7
7/20/94												7.3	7.3	7.3	7.3	7.3	7.0	7.3	7.0	7.0	7.0
8/2/94	7.5	7.5	8.0	7.5	7.5	7.8	7.3	7.3	7.5												
8/4/94												7.5	7.5	7.3	7.3	7.0	7.0	7.3	7.3	6.8	7.0
8/18/94												6.0	6.0	5.8	5.8	5.8	5.8	5.8	6.0	5.5	5.8
9/14/94												5.3	5.5	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
9/15/94	5.0	5.3	5.3	5.3	5.3	5.3	5.0	5.3	5.3												
10/4/94	5.3	5.3	5.3	5.3	5.3	5.3	4.6	4.6	4.6												
10/6/94												5.0	5.0	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
11/15/94	7.4	7.4	8.7	7.6	7.6	7.6	7.8	7.8	7.8												
11/17/94												8.2	8.2	8.2	8.2	8.0	8.0	8.5	8.2	7.6	7.8
12/13/94												8.2	8.2	7.5	7.5	7.5	7.5	8.4	8.2	7.5	7.5
12/14/94	8.4	8.2	8.8	8.4	8.6	8.6	8.2	7.9	8.4												
1/10/95	10.0	10.7	10.7	9.3	9.8	9.3	8.9	8.9	8.9												
1/25/95												13.0	12.6	10.7	10.7	10.7	10.5	12.6	12.8	10.5	10.5
2/21/95	19.0	18.1	17.6	27.5	26.5	26.5	13.0	13.0	13.3												
2/22/95												15.6	15.8	12.1	11.9	11.9	11.9	16.7	16.5	23.5	24.0

Appendix Table A11. Continued.

	Silica concentration (mg/L) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/13/95	22.1	14.8	13.3	13.0	13.5	13.5	13.9	13.7	13.9												
3/15/95										10.5	10.8	17.1	17.1	13.9	13.9	13.0	13.0	17.4	17.4	11.9	12.1
4/4/95										11.2	11.2	16.7	16.7	16.7	16.8	16.7	16.5	17.0	17.0	16.5	16.5
4/18/95										12.8	11.8										
4/20/95												17.8	17.8	17.0	17.0	17.2	17.2	17.8	17.8	17.2	15.4
4/21/95	23.0	21.7	17.5	16.7	16.5	16.7	17.2	17.0	17.2												
5/1/95										10.8	11.3										
5/2/95																				13.5	12.9
5/3/95												15.1	15.4	12.4	12.4	12.7	12.1	15.1	15.1		
5/15/95	18.6	14.6	14.6	14.3	14.6	14.8	14.0	14.3	15.1												
5/17/95										9.7	9.7	15.9	16.4	12.9	12.9	9.7	10.0	16.2	16.2	11.9	11.9
5/30/95										11.5	12.4										
5/31/95												13.3	13.3	13.0	13.0	12.7	12.4	13.3	13.3	12.4	12.4
6/12/95	14.2	12.4	12.4	11.5	11.5	11.8	11.2	11.2	11.2												
6/14/95												11.2	11.2	10.3	10.3	10.3	10.3	10.9	10.9	10.0	10.0
6/15/95										8.8	10.0										
6/28/95										8.7	9.0										
6/29/95												10.2	10.2	9.6	9.6	9.0	9.0	10.2	10.2	8.7	8.7
7/10/95	10.2	10.2	10.2	11.1	10.5	10.5	10.2	9.9	10.2												
7/12/95												9.3	9.3	10.2	9.9	9.6	9.9	9.6	9.6	9.9	9.9
7/13/95										7.8	8.1										
7/24/95										6.9	6.9										
7/25/95												9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.4	8.7
8/8/95										6.6	6.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
8/10/95	8.6	8.3	8.3	8.1	8.3	8.3	8.1	8.3	8.3												
8/21/95										5.7	6.0										
8/22/95												7.5	7.5	7.8	7.8	7.8	7.8	7.5	7.5	7.2	7.5
9/5/95										4.9	4.9										
9/7/95												6.6	6.9	6.9	6.9	6.9	6.9	6.9	7.2	6.3	6.9
9/8/95	6.0	6.3	6.3	5.7	6.6	6.6	5.7	5.7	6.0												
9/19/95										5.1	5.4	6.0	6.3	6.0	6.3	6.3	6.0	6.3	6.6	6.3	6.0

Appendix Table A12. Sulfate concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Sulfate concentration (mg/L) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	9.9	13.7	13.9	13.6	15.5	14.1	12.9	13.6	13.5												
4/13/94												14.0	14.2	14.7	14.8	14.3	13.3	14.4	17.0	14.2	15.5
4/26/94												13.5	15.6	15.5	13.6	13.7	15.6	13.8	14.3	15.8	15.7
5/10/94	7.8	10.5	10.2	10.2	9.9	--c	9.9	10.2	10.4												
5/11/94												10.4	10.1	10.6	12.0	10.6	--	10.2	11.6	10.5	10.7
5/24/94												10.7	10.6	10.6	10.1	10.4	10.6	10.2	10.4	10.7	10.8
6/7/94	7.8	7.5	8.6	8.9	9.0	8.5															
6/8/94												8.4	8.5	8.6	8.5	8.4	9.2	8.4	8.3	8.3	8.3
6/9/94							8.3	8.4	8.5												
6/21/94												--	--	--	--	--	--	--	--	--	--
7/6/94	8.8	8.8	8.9	8.9	8.9	8.9	8.7	8.8	8.8												
7/7/94												9.1	9.2	9.2	9.1	--	--	--	--	--	--
7/20/94												8.6	8.5	8.8	8.6	8.7	8.8	8.6	8.6	8.7	8.7
8/2/94	9.9	10.0	10.1	9.8	10.1	10.0	10.1	10.1	10.1												
8/4/94												10.1	9.9	9.9	9.8	9.8	10.1	9.9	10.0	9.7	9.7
8/18/94												9.1	9.4	9.1	9.0	9.1	9.1	9.2	9.2	9.1	9.0
9/14/94												9.8	10.0	10.0	9.9	9.8	9.9	9.9	9.9	10.1	9.8
9/15/94	9.8	9.7	9.6	9.7	9.9	9.7	9.4	9.9	9.8												
10/4/94	12.1	14.5	11.7	10.5	10.7	10.7	10.5	10.8	11.8												
10/6/94												11.1	11.1	11.3	11.1	12.1	11.2	11.4	11.3	11.7	11.6
11/15/94	13.5	13.5	12.9	13.6	13.4	12.8	13.4	13.3	13.5												
11/17/94												13.8	14.4	14.3	14.4	13.9	14.0	13.9	13.9	13.0	12.9
12/13/94												12.7	13.0	12.5	12.3	12.2	12.3	12.8	12.8	12.5	12.4
12/14/94	14.2	14.2	14.0	14.3	14.3	14.4	13.8	13.9	14.1												
1/10/95	14.0	13.5	13.6	14.1	14.0	13.7	13.0	13.3	13.2												
1/25/95												15.1	15.3	14.0	14.2	14.4	14.3	15.1	15.0	14.0	13.7
2/21/95	11.5	12.0	12.3	15.0	15.1	14.9	15.2	15.4	15.3												
2/22/95												12.7	12.0	12.3	12.3	12.2	11.8	11.8	11.8	12.0	12.0
3/13/95	11.5	16.7	18.4	17.8	19.0	18.2	19.4	19.2	19.4												
3/15/95										19.6	19.4	17.4	17.4	15.7	15.7	15.1	15.1	17.6	17.8	14.4	14.6

Appendix Table A12. Continued.

	Sulfate concentration (mg/L) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/4/95										14.9	14.9	14.4	14.4	13.6	13.8	13.6	13.8	14.4	14.4	14.4	14.4
4/18/95										18.3	18.1										
4/20/95												19.0	19.0	18.5	18.1	19.0	19.3	19.0	19.1	19.1	19.0
4/21/95	14.1	14.7	17.2	17.6	17.6	17.8	19.1	19.1	18.8												
5/1/95										14.4	14.4										
5/2/95																				13.1	13.1
5/3/95												12.5	12.5	12.7	12.7	12.5	12.5	12.2	12.2		
5/15/95	13.9	15.4	14.9	14.2	13.7	13.7	15.7	15.4	15.4												
5/17/95										13.4	13.7	10.8	10.5	10.8	10.8	10.5	10.8	10.8	10.5	11.6	12.4
5/30/95										13.4	13.4										
5/31/95												12.9	13.2	12.9	13.2	12.7	12.9	13.2	12.9	13.4	13.4
6/12/95	13.7	13.9	9.0	9.0	9.0	9.2	13.2	13.4	13.4												
6/14/95												12.1	12.1	11.9	11.9	11.9	12.1	11.9	12.1	12.1	12.1
6/15/95										13.2	12.4										
6/28/95										12.7	12.7										
6/29/95												12.7	12.5	12.3	12.3	12.1	12.1	12.5	12.5	11.9	11.9
7/10/95	10.6	11.2	10.9	10.9	11.2	11.2	11.2	11.2	11.2												
7/12/95												10.6	10.6	10.6	10.6	10.3	10.6	10.6	10.9	10.9	10.9
7/13/95										11.2	11.5										
7/24/95										10.6	10.6										
7/25/95												10.3	10.6	10.0	10.3	9.7	9.7	10.3	10.3	10.6	10.9
8/8/95										11.4	11.4	11.6	11.6	11.2	11.6	10.9	10.9	11.6	11.6	11.9	11.9
8/10/95	11.4	11.6	11.6	11.9	12.1	11.6	11.9	11.9	11.9												
8/21/95										10.6	10.6										
8/22/95												10.6	10.3	10.6	10.6	10.6	10.3	10.3	10.6	10.6	10.6
9/5/95										11.2	11.2										
9/7/95												11.0	11.0	10.7	10.7	10.7	10.7	11.0	11.0	10.7	11.0
9/8/95	10.7	10.7	11.0	11.0	11.0	11.0	11.0	11.0	11.0												
9/19/95										13.7	14.1	13.5	13.5	13.0	13.0	13.5	13.2	13.5	13.5	13.2	13.0

Appendix Table A13. Chloride concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Chloride concentration (mg/L) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	3.3	3.7	3.7	3.8	3.8	3.8	3.7	3.7	4.3												
4/13/94												4.3	4.3	4.2	4.4	4.2	4.0	4.3	4.9	4.2	4.5
4/26/94												4.6	4.9	5.4	4.7	4.7	5.1	5.3	5.1	4.9	4.7
5/10/94	2.3	2.8	2.7	2.9	2.5	--c	2.5	2.5	2.1												
5/11/94												2.6	3.0	2.9	3.4	2.6	--	2.9	3.2	2.8	2.9
5/24/94												2.7	2.7	2.7	2.9	3.6	2.6	2.8	2.7	2.8	2.6
6/7/94	1.3	1.2	1.4	1.5	1.3	1.3															
6/8/94												3.2	1.3	1.2	1.2	1.2	1.3	1.3	1.2	1.2	1.3
6/9/94							2.1	1.9	1.2												
6/21/94												--	--	--	--	--	--	--	--	--	--
7/6/94	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2												
7/7/94												1.6	1.6	1.6	1.6	--	--	--	--	--	--
7/20/94												2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.0	2.1	2.1
8/2/94	2.9	2.9	2.6	2.9	2.8	3.2	2.7	2.7	3.0												
8/4/94												2.7	3.0	2.6	2.5	2.9	2.6	3.0	2.7	2.4	2.4
8/18/94												1.6	1.6	1.6	1.6	1.7	1.6	1.6	1.7	1.6	1.9
9/14/94												1.9	2.0	2.0	2.0	1.9	2.0	2.0	2.0	1.9	2.0
9/15/94	1.9	2.3	2.0	1.9	1.9	1.9	2.5	1.9	2.0												
10/4/94	3.6	4.5	2.1	2.3	2.4	2.0	1.9	1.9	2.3												
10/6/94												2.1	2.5	2.1	2.8	2.1	2.3	2.2	2.7	2.3	3.1
11/15/94	3.5	3.5	3.2	3.5	3.5	3.5	3.5	3.5	3.5												
11/17/94												3.7	4.0	4.0	4.0	3.7	3.7	3.7	3.7	3.2	3.2
12/13/94												3.1	3.1	2.8	3.0	2.9	3.2	3.0	3.4	3.0	3.1
12/14/94	3.9	3.8	3.8	4.0	3.9	3.9	3.5	3.7	3.8												
1/10/95	3.9	3.8	3.7	3.9	3.9	3.6	3.4	3.3	3.3												
1/25/95												4.5	4.5	4.1	4.1	4.1	4.1	4.6	4.5	4.0	3.8
2/21/95	3.6	3.7	3.6	4.8	4.5	4.4	4.2	4.4	4.7												
2/22/95												3.4	3.3	2.9	3.2	3.0	2.9	3.6	3.3	2.8	3.0
3/13/95	2.4	3.7	4.0	4.0	4.2	4.2	4.7	4.5	4.7												

Appendix Table A13. Continued.

	Chloride concentration (mg/L) by sampling station																				
	Lower/mid reservoir stations									Backwater		Upper reservoir stations									
	rkm 352			rkm 355			rkm 390			rkm 424		rkm 443a		rkm 443b		rkm 445		rkm 446		rkm 449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/15/95										5.0	5.0	4.5	4.5	3.2	3.2	2.9	2.9	4.5	4.7	2.4	2.4
4/4/95										4.0	4.0	3.5	3.5	3.5	3.5	3.5	3.5	3.7	3.7	3.5	3.5
4/18/95										3.7	3.7										
4/20/95												4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
4/21/95	2.4	2.7	3.5	3.5	3.5	3.5	4.0	4.0	4.0												
5/1/95										3.7	3.5										
5/2/95																				2.9	3.2
5/3/95												2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7		
5/15/95	2.2	2.7	2.7	2.4	2.4	2.7	2.2	2.2	2.2												
5/17/95										3.2	3.2	2.4	2.4	1.9	1.9	2.4	1.9	2.4	2.4	1.7	1.7
5/30/95										2.7	2.7										
5/31/95												2.7	2.7	2.4	2.4	2.4	2.4	2.7	2.7	2.4	2.4
6/12/95	3.2	3.0	3.0	3.0	3.0	2.7	2.7	2.7	2.7												
6/14/95												2.4	2.5	2.0	2.0	2.0	2.0	2.2	2.2	2.0	2.0
6/15/95										2.7	2.0										
6/28/95										1.0	0.7										
6/29/95												0.7	1.0	0.4	0.4	0.1	0.1	0.7	0.7	0.1	0.1
7/10/95	1.0	2.3	2.3	2.3	1.0	1.0	1.3	1.3	1.3												
7/12/95												1.0	1.0	1.0	1.0	2.3	1.0	1.0	5.8	1.0	1.0
7/13/95										1.3	1.3										
7/24/95										2.6	2.6										
7/25/95												1.8	1.8	1.8	2.1	2.1	2.1	2.1	2.1	2.1	2.1
8/8/95										2.6	2.6	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
8/10/95	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1												
8/21/95										2.1	2.4										
8/22/95												2.1	2.4	2.1	2.1	2.4	2.4	2.1	2.1	2.1	2.1
9/5/95										2.9	2.9										
9/7/95												2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.1	2.4
9/8/95	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.1	2.1												
9/19/95										2.8	3.8	2.5	2.5	2.5	2.5	2.3	2.3	2.8	2.5	2.3	2.3

Appendix Table A14. Calcium concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Calcium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	19.0	22.0	22.2	21.7	22.2	22.1	21.8	21.5	21.9												
4/13/94												21.6	21.5	21.6	21.8	21.7	21.8	22.0	22.0	21.9	22.0
4/26/94												19.2	19.5	19.4	19.5	19.5	19.5	19.6	19.4	19.6	19.6
5/10/94	16.2	17.0	17.2	16.9	16.8	16.7	16.8	16.8	17.0												
5/11/94												16.5	16.8	17.4	17.2	16.9	--[c]	16.8	16.9	17.3	17.3
5/24/94												16.3	16.1	16.2	16.2	16.2	16.3	16.4	16.4	16.4	16.4
6/7/94	14.3	14.1	14.3	15.5	15.6	14.5															
6/8/94												15.2	15.1	15.0	15.2	15.3	15.6	15.3	15.1	15.1	15.0
6/9/94							14.7	14.8	15.1												
6/21/94												15.7	15.8	15.6	15.5	15.5	15.7	15.4	15.5	15.6	15.2
7/6/94	15.6	16.1	15.8	15.6	15.7	15.7	15.7	16.0	15.9												
7/7/94												15.5	15.8	15.6	15.8	15.8	15.7	15.6	15.9	15.7	15.8
7/20/94												16.1	16.1	16.0	15.8	16.1	16.0	16.1	16.1	15.8	16.0
8/2/94	16.8	16.7	17.0	17.1	18.1	17.2	17.0	17.1	17.1												
8/4/94												16.8	16.7	16.7	16.7	16.7	16.7	16.7	16.6	16.7	16.7
8/18/94												17.4	17.4	18.2	17.4	17.2	17.3	17.3	17.4	17.3	17.3
9/14/94												17.3	17.3	17.3	17.2	17.2	17.0	17.2	17.1	17.2	17.2
9/15/94	17.4	17.4	17.4	17.5	17.5	17.4	17.1	16.4	17.3												
10/4/94	17.3	17.1	17.3	17.2	16.9	17.2	17.3	17.4	17.5												
10/6/94												17.5	17.4	17.4	17.0	17.4	17.2	17.5	17.6	18.5	18.4
11/15/94	19.0	19.0	20.0	20.0	19.0	20.0	19.0	19.0	19.0												
11/17/94												20.0	20.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
12/13/94												20.0	18.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
12/14/94	20.0	21.0	21.0	21.0	20.0	21.0	21.0	20.0	21.0												
1/10/95	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0												
1/25/95												23.0	22.0	22.0	22.0	22.0	22.0	22.0	21.0	22.0	22.0
2/21/95	21.0	21.0	20.0	23.0	23.0	23.0	23.0	23.0	23.0												
2/22/95												20.0	20.0	21.0	21.0	20.0	20.0	20.0	20.0	21.0	22.0

Appendix Table A14. Continued.

	Calcium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/13/95	19.0	19.0	19.0	21.0	21.0	21.0	22.0	22.0	22.0												
3/15/95										22.0	22.0	20.0	19.0	20.0	20.0	20.0	20.0	19.0	19.0	20.0	20.0
4/4/95										21.0	21.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
4/18/95										20.0	20.0										
4/20/95												20.0	20.0	21.0	21.0	21.0	21.0	20.0	20.0	21.0	21.0
4/21/95	19.0	19.0	19.0	21.0	21.0	21.0	20.0	20.0	20.0												
5/1/95										19.1	19.1										
5/2/95																				18.4	18.5
5/3/95												17.3	17.4	18.4	18.4	18.5	18.4	18.0	18.0		
5/15/95	13.6	22.1	16.3	14.8	14.9	14.7	13.9	13.7	13.9												
5/17/95										16.7	16.4	13.6	13.1	13.8	13.8	12.3	11.1	13.2	13.1	14.8	15.5
5/30/95										11.5	11.5										
5/31/95												10.1	10.1	10.0	10.0	10.6	10.4	10.1	10.0	10.6	10.5
6/12/95	10.8	10.3	10.3	10.6	10.3	10.6	10.6	10.5	10.3												
6/14/95												9.4	9.4	10.0	9.8	10.0	10.0	10.3	10.0	10.3	10.3
6/15/95										10.7	10.2										
6/28/95										13.8	14.1										
6/29/95												13.5	13.6	14.2	14.0	14.3	14.1	13.9	13.8	14.5	14.4
7/10/95	13.8	14.0	13.6	13.7	13.7	13.5	14.1	14.0	14.1												
7/12/95												13.7	13.9	14.5	14.4	15.1	14.7	13.9	13.7	15.4	14.4
7/13/95										14.8	14.4										
7/24/95										13.9	13.7										
7/25/95												14.0	14.2	14.1	14.1	14.3	14.1	13.9	14.1	14.0	14.2
8/8/95										16.8	16.8	16.9	16.6	16.4	16.8	17.0	16.8	16.5	16.7	16.7	16.6
8/10/95	16.5	16.3	16.2	16.3	16.1	16.1	16.8	16.6	16.7												
8/21/95										16.7	16.5										
8/22/95												16.8	16.8	16.6	16.7	16.8	16.6	16.5	16.6	16.7	16.7
9/5/95										17.4	17.6										
9/7/95												17.4	17.2	17.0	17.2	17.1	16.9	17.4	17.3	17.2	17.2
9/8/95	17.2	17.4	17.1	17.0	17.1	17.0	17.3	17.4	17.4												
9/19/95										17.5	17.9	17.2	17.1	17.2	17.1	17.3	16.9	17.4	17.4	18.0	17.0

Appendix Table A15. Magnesium concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Magnesium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	6.1	6.7	6.6	6.4	6.2	6.1	6.6	6.5	6.5												
4/13/94												6.0	6.0	6.2	6.1	6.5	6.4	6.8	6.6	6.6	6.5
4/26/94												6.3	6.3	6.1	6.3	6.6	6.6	6.6	6.2	6.3	6.3
5/10/94	5.7	5.0	5.0	4.8	4.8	4.8	4.7	4.9	4.8												
5/11/94												5.0	5.0	5.0	5.0	4.9	--c	5.0	5.0	5.0	5.0
5/24/94												5.0	4.9	4.9	4.9	4.9	4.9	5.0	5.0	5.0	4.9
6/7/94	4.3	4.8	4.7	4.2	4.2	4.5															
6/8/94												4.4	4.5	4.3	4.3	4.3	4.4	4.4	4.4	4.3	4.4
6/9/94							4.3	4.3	4.4												
6/21/94												4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
7/6/94	4.4	4.6	4.5	4.5	4.5	4.4	4.4	4.5	4.5												
7/7/94												4.5	4.7	4.6	4.6	4.7	4.3	4.6	4.6	4.6	4.7
7/20/94												4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.6	4.5	4.5
8/2/94	4.8	4.8	4.8	4.9	5.2	5.0	5.0	4.9	4.9												
8/4/94												4.8	4.8	4.8	4.8	4.8	4.9	4.7	4.8	4.8	4.8
8/18/94												4.8	4.7	4.7	4.8	4.6	4.4	4.8	4.8	4.8	4.9
9/14/94												5.1	5.1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
9/15/94	5.0	5.3	5.0	5.0	5.0	5.0	5.0	5.1	5.0												
10/4/94	5.2	5.2	5.2	5.0	5.2	5.2	5.2	5.1	5.2												
10/6/94												5.3	5.3	5.3	5.3	5.3	5.3	5.4	5.2	5.3	5.3
11/15/94	5.6	5.6	7.0	5.6	5.6	5.6	5.6	5.6	5.6												
11/17/94												5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
12/13/94												5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
12/14/94	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6												
1/10/95	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0												
1/25/95												7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
2/21/95	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5												
2/22/95												5.2	5.2	5.2	5.2	5.2	5.2	6.5	6.5	5.2	5.2

Appendix Table A15. Continued.

	Magnesium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/13/95	6.5	6.5	6.5	5.2	5.2	5.2	6.5	6.5	6.5												
3/15/95										6.5	6.5	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
4/4/95										6.5	6.5	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
4/18/95										6.5	6.5										
4/20/95												5.2	5.2	5.2	5.2	6.5	6.5	5.2	5.2	5.2	5.2
4/21/95	6.5	6.5	6.5	5.2	5.2	5.2	5.2	5.2	5.2												
5/1/95										4.7	4.6										
5/2/95																				4.8	4.8
5/3/95												4.3	4.3	4.5	4.4	4.7	4.5	4.3	4.2		
5/15/95	4.6	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4												
5/17/95										5.1	5.0	4.2	4.1	4.4	4.1	4.2	4.1	4.0	4.0	4.2	4.2
5/30/95										4.3	4.4										
5/31/95												4.0	4.0	4.0	4.0	4.1	4.1	4.0	3.9	4.1	4.1
6/12/95	4.3	4.4	4.3	4.0	4.0	4.0	3.8	3.7	3.8												
6/14/95												3.4	3.4	3.5	3.6	3.5	3.5	3.6	3.6	3.6	3.6
6/15/95										4.0	4.0										
6/28/95										4.0	4.0										
6/29/95												3.9	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.0
7/10/95	4.1	3.9	4.0	4.0	3.9	4.0	4.1	4.0	4.0												
7/12/95												3.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
7/13/95										4.1	4.1										
7/24/95										3.9	3.9										
7/25/95												3.7	3.7	4.0	3.9	3.9	4.0	3.8	3.8	3.8	3.8
8/8/95										4.6	4.7	4.6	4.6	4.6	4.6	4.7	4.6	4.7	4.6	4.6	4.6
8/10/95	4.8	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.6												
8/21/95										4.9	4.9										
8/22/95												4.8	4.8	4.8	4.9	4.8	4.8	4.9	4.9	4.8	4.8
9/5/95										5.1	5.1										
9/7/95												5.0	4.9	5.0	4.9	5.0	5.0	5.1	5.0	5.0	5.0
9/8/95	5.0	5.1	5.0	5.0	5.1	5.0	5.1	5.0	5.0												
9/19/95										5.1	5.3	5.0	5.0	5.0	4.8	4.9	5.0	5.1	5.0	5.0	5.0

Appendix Table A16. Sodium concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Sodium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	6.1	6.1	5.9	6.1	5.8	5.8	6.3	6.2	6.1												
4/13/94												6.8	6.9	6.6	6.7	6.5	6.4	6.9	7.1	6.9	6.9
4/26/94												7.2	7.2	7.1	7.1	7.1	7.0	7.2	7.2	7.0	6.9
5/10/94	6.1	5.3	5.3	5.1	4.9	5.0	4.6	4.6	4.6												
5/11/94												5.3	5.2	5.1	5.1	5.0	--c	5.3	5.3	4.9	5.1
5/24/94												5.7	5.7	5.5	5.5	5.5	5.5	5.6	5.6	5.6	5.5
6/7/94	4.6	4.7	4.0	4.0	3.9	4.0															
6/8/94												4.0	4.0	3.7	3.7	3.8	3.7	4.0	3.9	3.7	3.7
6/9/94							3.6	3.7	3.6												
6/21/94												4.0	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.0	4.2
7/6/94	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.5	3.5												
7/7/94												4.1	4.0	4.1	4.1	4.1	4.2	4.1	4.1	4.0	4.1
7/20/94												4.5	4.5	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.8
8/2/94	5.4	5.4	5.5	5.4	5.5	5.6	5.7	5.7	5.6												
8/4/94												5.6	5.6	5.5	5.5	5.5	5.5	5.6	5.6	5.3	5.3
8/18/94												3.9	3.9	3.9	3.9	3.9	3.9	4.0	3.9	3.9	3.9
9/14/94												4.6	4.6	4.5	4.5	4.5	4.5	4.6	4.6	4.5	4.5
9/15/94	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4												
10/4/94	5.1	5.1	5.1	5.1	5.1	5.1	4.8	4.8	4.8												
10/6/94												5.2	5.2	5.2	5.1	5.2	5.2	5.5	5.4	5.3	5.3
11/15/94	8.6	8.4	8.3	7.4	7.4	7.1	8.0	7.7	7.6												
11/17/94												8.3	8.1	8.1	8.1	8.3	8.1	8.1	8.1	7.4	7.6
12/13/94												6.2	6.0	6.3	5.9	6.0	5.9	5.9	6.2	6.3	5.9
12/14/94	8.1	7.4	7.1	7.3	7.0	7.1	7.0	6.7	7.0												
1/10/95	9.8	9.8	8.4	8.4	8.4	8.4	8.4	8.4	8.4												
1/25/95												9.8	9.8	9.8	8.4	9.8	11.2	11.2	11.2	9.8	9.8
2/21/95	11.2	11.3	11.2	9.0	8.9	8.8	10.7	10.7	10.7												
2/22/95												8.2	8.2	10.0	10.0	7.7	7.8	8.0	8.0	7.2	7.3

Appendix Table A16. Continued.

	Sodium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/13/95	8.0	7.9	7.8	7.3	7.9	7.9	8.8	8.5	8.8												
3/15/95										8.0	8.0	8.6	8.6	7.0	7.0	6.4	6.4	9.0	8.9	5.6	5.6
4/4/95										8.0	8.0	8.7	8.8	7.2	7.2	7.0	7.0	9.0	8.9	5.8	5.8
4/18/95										7.9	7.9										
4/20/95												8.8	8.8	7.2	7.2	7.2	7.2	9.0	9.0	5.8	5.8
4/21/95	7.9	7.8	7.8	7.5	7.9	7.9	8.9	8.6	8.8												
5/1/95										7.4	7.6										
5/2/95																				6.4	6.5
5/3/95												6.5	6.6	6.0	6.3	6.0	6.0	6.3	6.4		
5/15/95	6.8	6.9	6.9	6.6	6.5	6.5	6.2	6.2	6.2												
5/17/95										6.8	7.0	6.0	6.1	5.5	5.5	5.5	5.3	6.2	6.2	5.1	5.2
5/30/95										5.1	5.1										
5/31/95												5.6	5.6	5.1	5.1	5.0	4.9	5.6	5.7	4.9	4.8
6/12/95	6.0	5.7	5.7	5.5	5.4	5.4	5.0	5.1	5.0												
6/14/95												4.7	4.6	4.1	4.1	4.1	4.1	4.5	4.4	3.8	3.9
6/15/95										5.0	4.6										
6/28/95										4.7	4.5										
6/29/95												4.7	4.7	4.1	4.1	3.7	3.7	4.7	4.8	3.7	3.6
7/10/95	4.6	4.4	4.4	4.3	4.4	4.3	4.6	4.7	4.7												
7/12/95												4.2	4.3	4.4	4.3	4.4	4.2	4.2	4.3	4.2	4.3
7/13/95										4.8	4.8										
7/24/95										5.5	5.4										
7/25/95												4.6	4.5	4.6	4.5	4.6	4.7	4.8	4.5	4.6	4.7
8/8/95										5.1	5.2	4.7	4.8	4.7	4.8	4.6	4.8	4.7	4.6	4.8	4.7
8/10/95	5.0	4.6	4.7	4.6	4.5	4.6	4.7	4.7	4.7												
8/21/95										4.9	5.1										
8/22/95												4.9	5.0	4.8	4.9	4.9	5.0	5.0	5.0	4.7	4.9
9/5/95										5.5	5.6										
9/7/95												5.0	5.1	5.0	5.0	5.0	5.0	5.1	5.2	4.9	5.0
9/8/95	5.1	5.2	5.2	5.2	5.2	5.3	4.9	5.0	5.1												
9/19/95										5.6	6.0	5.3	5.1	4.9	5.1	5.0	5.0	5.1	5.3	4.9	5.0

Appendix Table A17. Potassium concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Potassium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	1.5	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5												
4/13/94												1.6	1.6	1.6	1.5	1.5	1.5	1.6	1.6	1.6	1.6
4/26/94												1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
5/10/94	1.4	1.2	1.9	1.2	1.2	1.2	1.1	1.1	1.1												
5/11/94												1.2	1.2	1.2	1.2	1.2	--c	1.2	1.2	1.2	1.2
5/24/94												1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1
6/7/94	1.1	1.0	0.9	0.9	1.0	0.9															
6/8/94												0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.8	0.8
6/9/94							0.9	0.8	0.9												
6/21/94												0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7/6/94	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8												
7/7/94												0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7/20/94												0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8/2/94	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9												
8/4/94												0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8/18/94												1.0	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0
9/14/94												1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9/15/94	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0												
10/4/94	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1												
10/6/94												1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.1	1.1
11/15/94	1.4	1.4	1.5	1.4	1.4	1.5	1.4	1.4	1.4												
11/17/94												1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4
12/13/94												1.2	1.2	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.0
12/14/94	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3												
1/10/95	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.3	1.2												
1/25/95												1.7	1.5	1.5	1.6	1.5	1.6	1.6	1.5	1.5	1.5
2/21/95	2.3	2.3	2.2	2.0	2.0	2.0	2.0	2.0	2.0												
2/22/95												2.1	1.9	1.7	1.6	1.6	1.6	1.9	2.0	1.6	1.6
3/13/95	1.7	1.8	1.9	1.8	1.9	1.9	2.0	2.0	2.0												

Appendix Table A17. Continued.

	Potassium concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/15/95										1.8	1.8	2.1	2.1	1.7	1.7	1.6	1.6	2.2	2.2	1.4	1.4
4/4/95										1.7	1.7	2.0	2.0	1.8	1.8	1.6	1.6	2.2	2.2	1.4	1.4
4/18/95										1.7	1.7										
4/20/95												1.9	1.9	1.7	1.7	1.6	1.6	1.8	2.0	1.3	1.3
4/21/95	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0												
5/1/95										1.6	1.6										
5/2/95																				1.5	1.5
5/3/95												1.6	1.6	1.5	1.4	1.4	1.4	1.6	1.6		
5/15/95	1.5	1.5	1.5	1.5	1.5	1.5	1.7	1.4	1.4												
5/17/95										1.4	1.5	1.5	1.5	1.3	1.3	1.2	1.2	1.5	1.5	1.2	1.2
5/30/95										1.3	1.3										
5/31/95												1.3	1.3	1.3	1.3	1.2	1.2	1.3	1.3	1.2	1.2
6/12/95	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2												
6/14/95												1.2	1.2	1.0	1.1	1.0	1.1	1.1	1.1	1.0	1.0
6/15/95										1.2	1.1										
6/28/95										1.0	1.0										
6/29/95												1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0	0.9	0.9
7/10/95	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2												
7/12/95												1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.0
7/13/95										1.2	1.2										
7/24/95										1.2	1.1										
7/25/95												1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0
8/8/95										1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
8/10/95	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1												
8/21/95										1.1	1.1										
8/22/95												1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
9/5/95										1.2	1.2										
9/7/95												1.2	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1
9/8/95	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1												
9/19/95										1.2	1.3	1.2	1.2	1.1	1.1	1.1	1.1	1.2	1.4	1.1	1.1

Appendix Table A18. Ammonia nitrogen (NH3-N) concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Ammonia nitrogen concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01												
4/13/94												0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00
4/26/94												0.02	0.02	0.01	0.02	0.02	0.02	0.00	0.02	0.00	0.01
5/10/94	0.04	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.03												
5/11/94												0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03
5/24/94												0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6/7/94	0.06	0.05	0.01	0.05	0.05	0.01															
6/8/94												0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
6/9/94							0.05	0.05	0.04												
6/21/94												0.03	0.03	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.03
7/6/94	0.04	0.04	0.05	0.04	0.04	0.01	0.04	0.04	0.03												
7/7/94												0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.02	0.02
7/20/94												0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04
8/2/94	0.07	0.05	0.05	0.05	0.06	0.05	0.05	0.04	0.04												
8/4/94												0.03	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.04
8/18/94												0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.02	0.03
9/14/94												0.01	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
9/15/94	0.03	0.04	0.04	0.04	0.01	0.02	0.02	0.02	0.02												
10/4/94	0.07	0.06	0.06	0.06	0.05	0.06	0.05	0.05	0.05												
10/6/94												0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
11/15/94	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.02												
11/17/94												--	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
12/13/94												0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
12/14/94	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01												
1/10/95	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02												
1/25/95												0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.02
2/21/95	0.04	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.02												
2/22/95												0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02
3/13/95	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.01	0.01												
3/15/95										0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.01

Appendix Table A18. Continued.

	Ammonia nitrogen concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/4/95										0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
4/18/95										0.07	0.06										
4/20/95												0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4/21/95	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03												
5/1/95										0.03	0.03										
5/2/95																				0.01	0.00
5/3/95												0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01		
5/15/95	0.02	0.02	0.04	0.01	0.03	0.03	0.02	0.03	0.01												
5/17/95										0.04	0.03	0.02	0.01	0.01	0.03	0.01	0.02	0.01	0.02	0.01	0.01
5/30/95										0.08	0.09										
5/31/95												0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01
6/12/95	0.03	0.02	0.02	0.01	0.04	0.02	0.03	0.02	0.01												
6/14/95												0.02	0.02	0.02	0.03	0.00	0.00	0.02	0.02	0.01	0.02
6/15/95										0.02	0.03										
6/28/95										0.06	0.03										
6/29/95												0.02	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
7/10/95	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04												
7/12/95												0.03	0.03	0.04	0.06	0.05	0.02	0.01	0.01	0.01	0.01
7/13/95										0.01	0.02										
7/24/95										0.00	0.00										
7/25/95												0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.00	0.00
8/8/95										0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.02	0.02	0.01	0.03	0.02
8/10/95	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.01												
8/21/95										0.06	0.06										
8/22/95												0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.03	0.06	0.03
9/5/95										0.07	0.06										
9/7/95												0.04	0.05	0.04	0.04	0.03	0.04	0.05	0.05	0.04	0.03
9/8/95	0.04	0.03	0.02	0.06	0.02	0.00	0.05	0.06	0.05												
9/19/95										0.00	0.00	0.04	0.02	0.00	0.00	0.01	0.02	0.04	0.03	0.00	0.00

Appendix Table A19. Nitrite + nitrate nitrogen (NO2+NO3-N) concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Nitrite + nitrate nitrogen (NO2+NO3-N) concentration (mg/L) by sampling station																				
	Lower/mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	0.10	0.17	0.17	0.17	0.15	0.17	0.19	0.21	0.21												
4/13/94												0.26	0.25	0.26	0.26	0.25	0.25	0.25	0.28	0.25	0.24
4/26/94												0.23	0.23	0.22	0.22	0.22	0.22	0.25	0.25	0.19	0.20
5/10/94	0.03	0.09	0.10	0.07	0.08	0.08	0.55	0.09	0.09												
5/11/94												0.12	0.13	0.10	0.10	0.10	0.10	0.13	0.14	0.07	0.08
5/24/94												0.10	0.11	0.09	0.09	0.09	0.09	0.12	0.13	0.06	0.07
6/7/94	0.02	0.02	0.02	0.02	0.03	0.03															
6/8/94												0.09	0.09	0.07	0.07	0.06	0.06	0.09	0.09	0.06	0.06
6/9/94							0.03	0.04	0.05												
6/21/94												0.07	0.07	0.06	0.06	0.06	0.06	0.08	0.08	0.04	0.04
7/6/94	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01												
7/7/94												0.06	0.05	0.06	0.05	0.04	0.04	0.06	0.06	0.04	0.04
7/20/94												0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
8/2/94	0.03	0.03	0.04	0.03	0.03	0.03	0.02	0.03	0.04												
8/4/94												0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.03	0.04
8/18/94												0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.02	0.03
9/14/94												0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
9/15/94	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01												
10/4/94	0.28	0.29	0.33	0.21	0.23	0.12	0.08	0.10	0.35												
10/6/94												0.33	0.08	0.07	0.08	0.09	0.01	0.07	0.19	0.21	0.22
11/15/94	0.20	0.21	0.16	0.20	0.21	0.21	0.22	0.23	0.23												
11/17/94												--c	0.27	0.24	0.24	0.24	0.24	0.28	0.27	0.23	0.23
12/13/94												0.28	0.28	0.22	0.22	0.22	0.22	0.27	0.27	0.22	0.22
12/14/94	0.27	0.26	0.27	0.28	0.28	0.28	0.26	0.26	0.27												
1/10/95	0.29	0.28	0.28	0.29	0.29	0.29	0.26	0.26	0.27												
1/25/95												0.49	0.53	0.46	0.42	0.38	0.43	0.51	0.54	0.43	0.46
2/21/95	0.46	0.48	0.49	0.52	0.54	0.54	0.54	0.54	0.54												
2/22/95												0.63	0.60	0.50	0.51	0.49	0.49	0.58	0.58	0.47	0.48
3/13/95	0.23	0.47	0.52	0.51	0.53	0.54	0.56	0.55	0.55												

Appendix Table A19. Continued.

	Nitrite + nitrate nitrogen (NO2+NO3-N) concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/15/95										0.49	0.49	0.65	0.62	0.51	0.51	0.47	0.47	0.64	0.67	0.42	0.42
4/4/95										0.29	0.28	0.52	0.52	0.49	0.49	0.52	0.53	0.54	0.54	0.51	0.49
4/18/95										0.19	0.20										
4/20/95												0.35	0.35	0.30	0.30	0.31	0.33	0.34	0.35	0.32	0.31
4/21/95	0.24	0.26	0.35	0.35	0.36	0.37	0.26	0.34	0.34												
5/1/95										0.15	0.15										
5/2/95																				0.29	0.27
5/3/95												0.29	0.25	0.22	0.24	0.19	0.21	0.25	0.24		
5/15/95	0.14	0.21	0.20	0.17	0.19	0.22	0.16	0.16	0.18												
5/17/95										0.06	0.07	0.26	0.22	0.13	0.18	0.14	0.20	0.26	0.24	0.12	0.13
5/30/95										0.04	0.05										
5/31/95												0.16	0.16	0.15	0.15	0.11	0.11	0.15	0.16	0.13	0.14
6/12/95	0.11	0.13	0.13	0.11	0.12	0.12	0.12	0.13	0.11												
6/14/95												0.13	0.13	0.11	0.11	0.11	0.11	0.13	0.12	0.10	0.11
6/15/95										0.07	0.08										
6/28/95										0.06	0.06										
6/29/95												0.11	0.11	0.11	0.11	0.07	0.10	0.12	0.10	0.07	0.08
7/10/95	0.10	0.10	0.10	0.11	0.11	0.12	0.10	0.10	0.12												
7/12/95												0.11	0.11	0.11	0.11	0.12	0.12	0.11	0.11	0.12	0.13
7/13/95										0.01	0.01										
7/24/95										0.02	0.01										
7/25/95												0.10	0.11	0.10	0.12	0.11	0.11	0.09	0.12	0.09	0.01
8/8/95										0.00	0.00	0.08	0.08	0.08	0.08	0.10	0.08	0.08	0.08	0.08	0.07
8/10/95	0.03	0.03	0.03	0.03	0.03	0.03	0.10	0.04	0.04												
8/21/95										0.00	0.00										
8/22/95												0.04	0.05	0.06	0.06	0.08	0.07	0.05	0.05	0.03	0.06
9/5/95										0.00	0.00										
9/7/95												0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09
9/8/95	0.01	0.02	0.03	0.01	0.03	0.03	0.01	0.02	0.02												
9/19/95										0.01	0.01	0.05	0.08	0.07	0.07	0.08	0.07	0.08	0.09	0.07	0.07

Appendix Table A20. Total nitrogen concentrations (mg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Total nitrogen concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	0.41	0.62	0.49	0.50	0.48	0.49	0.49	0.53	0.53												
4/13/94												0.54	0.56	0.54	0.53	0.53	0.54	0.54	0.59	0.53	0.51
4/26/94												0.47	0.47	0.49	0.47	0.47	0.47	0.49	0.50	0.44	0.49
5/10/94	0.31	0.33	0.36	0.28	0.33	0.33	0.35	0.31	0.33												
5/11/94												0.36	0.45	0.33	0.33	0.33	0.34	0.34	0.39	0.31	0.33
5/24/94												0.33	0.38	0.30	0.32	0.30	0.32	0.38	0.40	0.33	0.35
6/7/94	0.28	0.25	0.42	0.25	0.25	0.55															
6/8/94												0.28	0.28	0.27	0.22	0.25	0.27	0.27	0.32	0.27	0.30
6/9/94							0.25	0.25	0.27												
6/21/94												0.23	0.25	0.22	0.22	0.22	0.22	0.23	0.25	0.20	0.22
7/6/94	0.20	0.21	0.36	0.38	0.21	0.26	0.25	0.25	0.25												
7/7/94												0.28	0.30	0.25	0.26	0.25	0.28	0.26	0.35	0.26	0.30
7/20/94												0.23	0.23	0.18	0.18	0.21	0.21	0.21	0.23	0.20	0.28
8/2/94	0.25	0.23	0.18	0.21	0.20	0.23	0.21	0.21	0.27												
8/4/94												0.27	0.27	0.20	0.23	0.37	0.20	0.21	0.21	0.21	0.21
8/18/94												0.28	0.30	0.25	0.22	0.22	0.30	0.23	0.27	0.17	0.18
9/14/94												0.37	0.30	0.28	0.26	0.25	0.19	0.21	0.23	0.25	0.25
9/15/94	0.21	0.21	0.32	0.28	0.28	0.19	0.18	0.23	0.26												
10/4/94	0.28	0.26	0.30	0.25	0.23	0.26	0.25	0.23	0.25												
10/6/94												0.28	0.27	0.26	0.35	0.30	0.28	0.44	0.33	0.30	0.35
11/15/94	0.34	0.36	0.36	0.36	0.37	0.44	0.41	0.41	0.41												
11/17/94												--c	0.46	0.39	0.37	0.41	0.39	0.44	0.44	0.37	0.37
12/13/94												0.40	0.40	0.33	0.37	0.35	0.35	0.42	0.40	0.33	0.35
12/14/94	0.39	0.37	0.39	0.40	0.40	0.39	0.39	0.39	0.40												
1/10/95	0.41	0.42	0.39	0.44	0.42	0.41	0.35	0.41	0.41												
1/25/95												0.42	0.70	0.55	0.53	0.60	0.53	0.63	0.67	0.60	0.53
2/21/95	0.93	0.76	0.68	0.64	0.66	0.64	0.62	0.64	0.62												
2/22/95												0.70	0.87	0.60	0.62	0.58	0.58	0.76	0.76	0.58	0.56
3/13/95	0.60	0.52	0.50	0.60	0.66	0.68	0.60	0.78	0.60												
3/15/95										0.85	0.78	0.78	0.82	0.64	0.62	0.62	0.60	0.80	0.85	0.56	0.60

Appendix Table A20. Continued.

	Total nitrogen concentration (mg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/4/95										0.80	0.91	0.84	1.08	0.84	0.84	0.87	0.85	0.91	0.91	0.84	0.80
4/18/95										0.75	0.67										
4/20/95												0.61	0.61	0.58	0.61	0.58	0.56	0.54	0.59	0.58	0.58
4/21/95	0.38	0.46	0.50	0.58	0.58	0.59	0.59	0.59	0.61												
5/1/95										0.66	0.68										
5/2/95																				0.53	0.51
5/3/95												0.63	0.64	0.50	0.53	0.55	0.55	0.55	0.57		
5/15/95	0.51	0.55	0.55	0.50	0.51	0.48	0.44	0.50	0.46												
5/17/95										0.61	0.59	0.61	0.51	0.44	0.46	0.48	0.44	0.50	0.50	0.42	0.50
5/30/95										0.37	0.35										
5/31/95												0.39	0.37	0.35	0.35	0.33	0.33	0.33	0.35	0.31	0.33
6/12/95	0.43	0.35	0.41	0.34	0.35	0.35	0.35	0.35	0.34												
6/14/95												0.32	0.35	0.30	0.50	0.34	0.32	0.32	0.32	0.28	0.27
6/15/95										0.35	0.35										
6/28/95										0.30	0.27										
6/29/95												0.29	0.45	0.31	0.25	0.22	0.23	0.32	0.40	0.26	0.25
7/10/95	0.30	0.04	0.29	0.30	0.29	0.26	0.35	0.30	0.30												
7/12/95												0.33	0.35	0.32	0.29	0.38	0.35	0.35	0.30	0.32	0.33
7/13/95										0.45	0.33										
7/24/95										0.41	0.39										
7/25/95												0.33	0.35	0.29	0.29	0.29	0.31	0.29	0.37	0.29	0.29
8/8/95										0.30	0.33	0.25	0.26	0.25	0.25	0.23	0.23	0.25	0.26	0.30	0.25
8/10/95	0.22	0.20	0.20	0.18	0.20	0.20	0.23	0.22	0.22												
8/21/95										0.34	0.38										
8/22/95												0.29	0.29	0.29	0.29	0.21	0.23	0.29	0.30	0.34	0.29
9/5/95										0.40	0.35										
9/7/95												0.28	0.31	0.28	0.31	0.32	0.32	0.32	0.35	0.28	0.32
9/8/95	0.23	0.28	0.32	0.28	0.28	0.32	0.28	0.25	0.28												
9/19/95										0.23	0.34	0.26	0.28	0.25	0.26	0.26	0.28	0.29	0.28	0.26	0.26

Appendix Table A21. Orthophosphate concentrations (µg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Orthophosphate concentration (µg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	1.0	1.0	1.0	0.1	1.0	1.0	0.1	1.0	1.0												
4/13/94												3.0	3.0	3.0	3.0	4.0	4.0	2.0	3.0	3.0	2.0
4/26/94												3.0	4.0	5.0	3.0	3.0	--	2.0	4.0	4.0	--
5/10/94	0.1	0.1	0.1	0.1	0.1	1.0	0.1	0.1	0.1												
5/11/94												1.0	1.0	3.0	4.0	1.0	1.0	3.0	2.0	3.0	1.0
5/24/94												1.0	1.0	0.1	0.1	3.0	0.1	1.0	1.0	0.1	0.1
6/7/94	2.0	3.0	5.0	3.0	3.0	5.0															
6/8/94												3.0	4.0	7.0	7.0	3.0	2.0	5.0	5.0	4.0	2.0
6/9/94							3.0	3.0	3.0												
6/21/94												5.0	6.0	5.0	5.0	5.0	5.0	6.0	6.0	4.0	5.0
7/6/94	5.0	6.0	8.0	4.0	5.0	5.0	3.0	2.0	3.0												
7/7/94												4.0	4.0	3.0	3.0	4.0	2.0	3.0	4.0	0.1	2.0
7/20/94												0.1	0.1	1.0	2.0	0.1	0.1	0.1	1.0	0.1	0.1
8/2/94	13.0	11.0	15.0	10.0	10.0	11.0	5.0	6.0	7.0												
8/4/94												6.0	8.0	8.0	5.0	5.0	7.0	7.0	7.0	4.0	5.0
8/18/94												8.0	9.0	10.0	3.0	12.0	10.0	8.0	11.0	0.1	6.0
9/14/94												0.1	0.1	0.1	0.1	0.1	0.1	6.0	4.0	0.1	0.1
9/15/94	9.0	7.0	7.0	5.0	6.0	6.0	3.0	3.0	1.0												
10/4/94	5.0	6.0	6.0	7.0	17.0	6.0	1.0	0.1	2.0												
10/6/94												5.0	1.0	0.1	15.0	0.1	0.1	0.1	0.1	0.1	10.0
11/15/94	14.0	15.0	14.0	15.0	15.0	16.0	16.0	17.0	17.0												
11/17/94												--	20.0	18.0	18.0	18.0	18.0	21.0	20.0	17.0	17.0
12/13/94												12.0	12.0	10.0	11.0	12.0	11.0	13.0	12.0	10.0	9.0
12/14/94	13.0	12.0	13.0	14.0	15.0	16.0	12.0	15.0	13.0												
1/10/95	14.0	14.0	14.0	14.0	14.0	14.0	11.0	12.0	12.0												
1/25/95												28.0	29.0	26.0	27.0	26.0	25.0	29.0	29.0	24.0	24.0
2/21/95	22.0	30.0	30.0	18.0	21.0	20.0	16.0	15.0	17.0												
2/22/95												22.0	26.0	15.0	16.0	15.0	15.0	26.0	24.0	16.0	15.0
3/13/95	17.0	20.0	20.0	19.0	19.0	20.0	20.0	20.0	22.0												

Appendix Table A21. Continued.

	Orthophosphate concentration (µg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
3/15/95										3.0	2.0	31.0	34.0	21.0	23.0	21.0	20.0	33.0	32.0	15.0	16.0
4/4/95										0.1	0.1	22.0	22.0	19.0	20.0	21.0	23.0	22.0	23.0	20.0	20.0
4/18/95										1.0	0.1										
4/20/95												11.0	12.0	11.0	10.0	11.0	10.0	13.0	13.0	8.0	8.0
4/21/95	15.0	14.0	14.0	13.0	13.0	14.0	10.0	9.0	10.0												
5/1/95										1.0	1.0										
5/2/95																				4.0	5.0
5/3/95												24.0	11.0	3.0	2.0	3.0	5.0	10.0	11.0		
5/15/95	7.0	6.0	5.0	2.0	7.0	7.0	4.0	6.0	8.0												
5/17/95										1.0	0.1	14.0	15.0	8.0	7.0	7.0	7.0	15.0	16.0	4.0	4.0
5/30/95										1.0	1.0										
5/31/95												9.0	10.0	7.0	7.0	8.0	7.0	8.0	12.0	2.0	5.0
6/12/95	4.0	4.0	4.0	4.0	5.0	2.0	1.0	4.0	4.0												
6/14/95												5.0	4.0	3.0	3.0	4.0	5.0	5.0	3.0	0.1	1.0
6/15/95										0.1	0.1										
6/28/95										0.1	0.1										
6/29/95												4.0	6.0	4.0	4.0	0.1	7.0	3.0	5.0	0.1	2.0
7/10/95	10.0	12.0	11.0	14.0	10.0	11.0	12.0	11.0	10.0												
7/12/95												15.0	11.0	13.0	15.0	38.0	29.0	13.0	12.0	9.0	9.0
7/13/95										8.0	5.0										
7/24/95										3.0	3.0										
7/25/95												7.0	9.0	8.0	8.0	10.0	9.0	7.0	9.0	6.0	8.0
8/8/95										0.1	0.1	5.0	5.0	6.0	6.0	6.0	6.0	6.0	5.0	3.0	5.0
8/10/95	6.0	6.0	7.0	3.0	4.0	6.0	0.1	0.1	1.0												
8/21/95										0.1	0.1										
8/22/95												0.1	0.1	1.0	0.1	1.0	0.1	0.1	0.1	0.1	0.1
9/5/95										2.0	1.0										
9/7/95												0.1	1.0	1.0	2.0	3.0	2.0	2.0	2.0	2.0	2.0
9/8/95	0.1	3.0	4.0	1.0	2.0	1.0	0.1	0.1	0.1												
9/19/95										0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Appendix Table A22. Total phosphorus concentrations (µg/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Sampling station details are shown in Figure 1. Sample depth abbreviations: S-surface, M-mid-depth, B-just off the bottom. Dashes indicate data not available.

	Total phosphorus concentration (µg/L) by sampling station																			
	Lower/Mid reservoir									Backwater		Upper reservoir								
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/11/94	36.0	46.0	34.0	24.0	26.0	30.0	24.0	34.0	34.0												
4/13/94												34.0	34.0	24.0	30.0	30.0	44.0	34.0	44.0	26.0	26.0
4/26/94												34.0	38.0	34.0	28.0	28.0	34.0	34.0	34.0	32.0	52.0
5/10/94	70.0	28.0	90.0	18.0	22.0	24.0	22.0	70.0	80.0												
5/11/94												32.0	68.0	34.0	32.0	28.0	28.0	32.0	38.0	24.0	28.0
5/24/94												36.0	66.0	26.0	30.0	34.0	30.0	36.0	42.0	20.0	26.0
6/7/94	22.0	22.0	51.0	22.0	26.0	80.0															
6/8/94												22.0	26.0	16.0	16.0	16.0	12.0	18.0	18.0	16.0	18.0
6/9/94							18.0	16.0	22.0												
6/21/94												16.0	18.0	18.0	16.0	18.0	18.0	22.0	22.0	12.0	22.0
7/6/94	22.0	26.0	43.0	22.0	22.0	36.0	18.0	26.0	38.0												
7/7/94												42.0	38.0	22.0	18.0	22.0	26.0	22.0	36.0	22.0	38.0
7/20/94												22.0	28.0	12.0	18.0	18.0	22.0	16.0	28.0	18.0	26.0
8/2/94	20.0	20.0	16.0	20.0	16.0	22.0	16.0	20.0	30.0												
8/4/94												22.0	22.0	20.0	20.0	14.0	16.0	16.0	22.0	16.0	22.0
8/18/94												27.0	38.0	23.0	27.0	25.0	36.0	32.0	46.0	21.0	29.0
9/14/94												44.0	51.0	39.0	41.0	39.0	43.0	43.0	44.0	39.0	39.0
9/15/94	39.0	46.0	46.0	36.0	44.0	41.0	41.0	43.0	48.0												
10/4/94	44.0	53.0	48.0	39.0	41.0	50.0	44.0	46.0	53.0												
10/6/94												43.0	53.0	43.0	48.0	48.0	32.0	50.0	50.0	46.0	48.0
11/15/94	28.0	30.0	39.0	28.0	34.0	64.0	35.0	34.0	44.0												
11/17/94												--[c]	53.0	37.0	34.0	53.0	40.0	41.0	41.0	35.0	35.0
12/13/94												25.0	36.0	21.0	32.0	21.0	25.0	25.0	27.0	25.0	20.0
12/14/94	23.0	23.0	23.0	25.0	29.0	29.0	29.0	27.0	30.0												
1/10/95	23.0	23.0	23.0	26.0	28.0	25.0	23.0	32.0	28.0												
1/25/95												51.0	64.0	45.0	45.0	55.0	40.0	53.0	77.0	72.0	94.0
2/21/95	112.0	130.0	96.0	53.0	49.0	51.0	41.0	43.0	43.0												
2/22/95												94.0	185.0	43.0	43.0	43.0	41.0	110.0	141.0	47.0	43.0
3/13/95	57.0	49.0	47.0	35.0	49.0	49.0	57.0	75.0	57.0												
3/15/95										63.0	57.0	79.0	92.0	47.0	51.0	49.0	47.0	92.0	98.0	41.0	47.0

Appendix Table A22. Continued.

	Total phosphorus concentration (µg/L) by sampling station																				
	Lower/Mid reservoir									Backwater		Upper reservoir									
	352			355			390			424		443a		443b		445		446		449	
Date	S	M	B	S	M	B	S	M	B	S	B	S	B	S	B	S	B	S	B	S	B
4/4/95										25.0	20.0	42.0	47.0	62.0	50.0	74.0	44.0	52.0	90.0	50.0	53.0
4/18/95										108.0	103.0										
4/20/95												85.0	85.0	74.0	85.0	80.0	68.0	63.0	80.0	74.0	74.0
4/21/95	74.0	91.0	91.0	74.0	74.0	74.0	85.0	80.0	85.0												
5/1/95										53.0	55.0										
5/2/95																				46.0	34.0
5/3/95												89.0	93.0	36.0	42.0	40.0	42.0	65.0	72.0		
5/15/95	42.0	55.0	61.0	44.0	51.0	42.0	59.0	57.0	42.0												
5/17/95										57.0	46.0	80.0	53.0	40.0	40.0	46.0	57.0	53.0	51.0	44.0	53.0
5/30/95										21.0	21.0										
5/31/95												23.0	32.0	32.0	27.0	30.0	30.0	30.0	34.0	21.0	25.0
6/12/95	40.0	42.0	59.0	38.0	33.0	52.0	47.0	47.0	47.0												
6/14/95												61.0	66.0	38.0	47.0	52.0	42.0	38.0	38.0	35.0	29.0
6/15/95										33.0	43.0										
6/28/95										23.0	27.0										
6/29/95												40.0	67.0	35.0	35.0	28.0	28.0	45.0	63.0	27.0	32.0
7/10/95	35.0	45.0	35.0	28.0	27.0	30.0	37.0	28.0	37.0												
7/12/95												38.0	42.0	38.0	33.0	55.0	43.0	42.0	37.0	27.0	32.0
7/13/95										65.0	35.0										
7/24/95										48.0	50.0										
7/25/95												34.0	66.0	31.0	31.0	31.0	31.0	34.0	43.0	29.0	36.0
8/8/95										33.0	43.0	23.0	28.0	20.0	22.0	22.0	22.0	25.0	25.0	22.0	22.0
8/10/95	22.0	23.0	25.0	22.0	23.0	25.0	25.0	25.0	23.0												
8/21/95										14.0	25.0										
8/22/95												23.0	34.0	20.0	21.0	21.0	23.0	20.0	25.0	18.0	23.0
9/5/95										43.0	44.0										
9/7/95												23.0	34.0	23.0	34.0	30.0	32.0	28.0	39.0	23.0	34.0
9/8/95	23.0	36.0	46.0	27.0	28.0	41.0	27.0	20.0	28.0												
9/19/95										18.0	39.0	20.0	30.0	18.0	21.0	21.0	23.0	25.0	28.0	23.0	21.0

Appendix Table A23. Monochromatic chlorophyll *a* content (mg/m3) of depth-integrated samples collected at lower-reservoir, mid-reservoir, and backwater locations in John Day Reservoir, April 1994 to September 1995. Sampling station details are shown in Figure 1. P1 is chlorophyll *a* content of phytoplankton passing through a 25-µm net, P2 is estimated chlorophyll *a* content of phytoplankton retained by a 25-m net, Total is chlorophyll *a* content of unfiltered samples.

	rkm 352			rkm 355			rkm 390			rkm 424		
	P1	P2	Total	P1	P2	Total	P1	P2	Total	P1	P2	Total
4/11/94	1.5	7.3	8.8	2.7	13.2	15.9	2.1	2.0	4.1			
5/10/94	2.1	10.2	12.3	1.6	4.4	6.0	4.4	3.1	7.5			
6/7/94	2.5	2.7	5.2	3.5	2.2	5.7						
6/9/94							2.3	5.2	7.5			
7/6/94	0.9	1.3	2.2	1.5	0.8	2.3	1.2	0.4	1.6			
8/2/94	1.3	0.6	1.9				2.9	0.0	2.9			
9/15/94	1.9	0.5	2.4	1.6	0.8	2.4	2.9	2.7	5.6			
10/4/94	2.9	1.6	4.5	4.0	1.1	5.1	3.5	3.7	7.2			
11/15/94	2.0	2.7	4.7	2.3	3.0	5.3	2.4	1.5	3.9			
1/10/95	1.9	0.6	2.5	2.2	0.5	2.7	2.0	1.2	3.2			
3/13/95	2.3	0.6	2.9	3.3	1.0	4.3	4.0	1.5	5.5			
4/4/95										12.1	8.9	21.0
4/18/95										8.2	26.7	34.9
4/21/95	3.1	4.2	7.3	5.2	7.5	12.7	4.8	9.0	13.8			
5/1/95										15.7	7.0	22.7
5/15/95	1.3	1.8	3.1	1.5	9.0	10.5	3.2	0.7	3.9			
5/17/95												
5/30/95										5.1	3.5	8.6
6/12/95	1.2	2.6	3.8	1.0	0.8	1.8	0.4	0.7	1.1			
6/15/95										0.8	1.0	1.8
6/28/95										0.8	2.5	3.3
7/10/95	0.4	0.6	1.0	0.4	0.7	1.1	0.9	0.6	1.5			
7/13/95										1.1	1.4	2.5
7/24/95										1.4	3.8	5.2
8/8/95										1.8	2.8	4.6
8/10/95	0.7	1.1	1.8	0.7	1.2	1.9	1.3	2.2	3.5			
8/21/95										3.3	4.0	7.3
9/5/95										3.9	6.6	10.5
9/8/95	3.3	3.5	6.8	3.4	4.0	7.4	2.8	5.9	8.7			
9/19/95										4.6	6.8	11.4

Appendix Table A24. Monochromatic chlorophyll *a* content (mg/m^3) of depth-integrated samples collected at locations in the upper John Day Reservoir, April 1994 to September 1995. Sampling station details are shown in Figure 1. P1 is chlorophyll *a* content of phytoplankton passing through a 25-µm net, P2 is estimated chlorophyll *a* content of phytoplankton retained by a 25-m net, Total is chlorophyll *a* content of unfiltered samples.

	Chlorophyll *a* (mg/m^3)														
	rkm 443a			rkm 443b			rkm 445			rkm 446			rkm 449		
Date	P1	P2	Total	P1	P2	Total	P1	P2	Total	P1	P2	Total.	P1	P2	Total
4/13/94	2.7	7.8	10.5				1.2	4.3	5.5	3.2	7.6	10.8			
4/26/94	2.0	1.8	3.8	0.6	2.4	3.0	0.2	1.8	2.0	1.3	1.0	2.3	0.7	0.4	1.1
5/11/94	1.6	6.5	8.1	2.0	7.4	9.4	2.0	5.7	7.7	3.1	3.5	6.6	2.7	0.2	2.9
5/24/94	1.1	1.2	2.3	1.7	4.7	6.4	2.3	2.9	5.2	0.8	5.5	6.3	2.8	1.5	4.3
6/8/94	4.3	0.6	4.9	2.1	3.4	5.5	1.5	0.8	2.3	3.3	1.5	4.8	0.9	3.0	3.9
6/21/94	0.3	0.5	0.8	0.8	0.5	1.3				1.1	1.0	2.1	1.1	0.2	1.3
7/7/94	1.6	2.1	3.7	1.6	1.6	3.2	1.6	3.2	4.8	2.1	2.4	4.5	2.1	4.6	6.7
7/20/94	1.6	1.3	2.9	1.8	0.3	2.1	1.9	0.8	2.7	2.4	0.3	2.7	2.7	1.0	3.7
8/4/94	2.1	0.8	2.9				1.9	0.2	2.1	1.9	0.0	1.9	1.3	0.6	1.9
8/18/94	2.1	3.2	5.3	2.1	1.4	3.5	1.6	2.7	4.3	1.9	2.1	4.0	2.1	2.2	4.3
9/14/94	0.8	0.0	0.8				3.2	4.0	7.2	4.5	4.0	8.5	4.0	3.7	7.7
10/6/94	3.7	10.2	13.9	4.3	9.1	13.4	4.3	10.4	14.7	5.6	12.6	18.2	4.5	10.7	15.2
11/17/94	2.3	2.2	4.5	1.6	2.5	4.1	1.7	1.0	2.7	2.1	1.9	4.0	2.7	1.0	3.7
1/25/95	1.2	0.2	1.4	1.1	0.4	1.5									
3/15/95	2.5	0.3	2.8	2.2	0.9	3.1	2.5	1.1	3.6	1.9	0.4	2.3	3.2	1.4	4.6
4/4/95	3.1	0.9	4.0	2.1	2.3	4.4	2.7	1.4	4.1	1.7	0.8	2.5	2.9	1.9	4.8
4/20/95	5.2	7.1	12.3	4.1	7.0	11.1	4.9	7.1	12.0	4.9	7.2	12.1	12.4	1.4	13.8
5/3/95	5.0	9.4	14.4	4.8	11.8	16.6	4.3	10.7	15.0	5.3	7.4	12.7	5.1	10.5	15.6
5/17/95				1.7	3.3	5.0	0.7	4.3	5.0	0.5	0.6	1.1	1.1	6.6	7.7
5/31/95	2.5	2.2	4.7	3.5	2.5	6.0	2.9	2.4	5.3	3.5	0.5	4.0	4.0	1.3	5.3
6/14/95	0.4	0.3	0.7	0.6	0.1	0.7	0.4	0.5	0.9	0.7	0.1	0.8	0.8	0.7	1.5
6/29/95	1.3	1.5	2.8	1.4	1.0	2.4	1.1	1.3	2.4	0.7	0.2	0.9	0.9	0.5	1.4
7/12/95	1.1	0.4	1.5	0.9	0.2	1.1	0.7	0.2	0.9	0.9	0.1	1.0			
7/25/95	0.6	0.8	1.4	0.7	0.5	1.2	0.7	0.4	1.1	0.8	0.5	1.3	0.9	0.5	1.4
8/8/95	0.9	1.1	2.0	0.9	0.9	1.8	1.0	0.9	1.9	1.0	1.0	2.0	1.0	1.0	2.0
8/22/95	2.9	3.8	6.7	2.7	2.7	5.4	2.1	2.3	4.4	3.6	3.3	6.9	3.0	2.6	5.6
9/7/95	2.6	5.6	8.2	2.0	6.4	8.4	2.2	4.3	6.5	2.7	4.8	7.5	2.7	4.1	6.8
9/19/95	1.9	8.2	10.1	2.8	5.8	8.6	3.1	5.0	8.1	3.1	5.7	8.8	2.7	5.7	8.4

Appendix Table A25. Zooplankton densities at lower and middle John Day Reservoir sampling stations, April 1994 to September 1995.

	Zooplankton densities (mean number/L)															
Taxon	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep
Cladocera																
Alona quadrangularis	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00
Alona rectangula	0.00	0.00	0.00	0.00	0.27	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alona rustica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Bosmina longirostris	0.00	0.07	0.82	2.16	0.55	3.32	8.04	0.96	0.12	0.14	0.32	1.13	0.96	1.23	1.54	2.69
Ceriodaphnia quadrangula	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.00	0.00
Chydorus sphaericus	0.02	0.00	0.03	0.04	0.02	0.04	0.06	0.02	0.06	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Daphnia retrocurva	0.00	0.00	0.00	0.00	0.00	0.38	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.14	38.08	0.00
Daphnia thorata	0.00	0.02	0.21	1.73	19.58	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.06	0.28	1.46	0.00
Leptodora kindtii	0.00	0.00	0.03	0.00	0.27	0.11	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00
Leydigia leydigi	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Immature	0.00	0.02	0.06	0.60	2.29	0.03	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.33	4.21	0.00
Totals	0.02	0.11	1.15	4.53	22.98	3.98	8.36	1.00	0.20	0.14	0.32	1.13	1.22	2.06	45.34	2.69
Copepoda																
Calanoid copepodid	0.02	0.00	0.03	0.10	0.19	0.19	0.91	0.01	0.02	0.00	0.00	0.00	0.00	0.08	0.00	0.00
Cyclopoid copepodid	0.05	0.23	2.31	0.74	1.01	1.80	4.12	0.13	0.06	0.09	0.35	0.23	0.50	1.54	1.92	0.46
Diacyclops thomasi	0.01	0.34	0.76	1.19	2.10	0.99	2.95	0.14	0.03	0.00	0.27	0.29	0.06	0.42	10.43	1.12
Harpacticoid	0.00	0.00	0.00	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Leptodiaptomus ashlandi	0.03	0.00	0.12	0.11	0.32	0.07	1.14	0.03	0.00	0.00	0.13	0.00	0.00	0.00	0.26	0.00
Nauplii	0.34	1.76	4.00	8.54	9.97	11.15	18.10	1.81	0.38	0.17	1.08	1.24	1.77	2.19	65.63	10.98
Totals	0.45	2.33	7.22	10.71	13.64	14.20	27.22	2.12	0.49	0.26	1.83	1.76	2.38	4.23	78.24	12.56
Rotifera																
Asplanchna girodi	0.26	0.37	0.36	0.12	0.00	0.04	1.26	0.26	0.24	0.00	0.08	0.21	0.25	0.05	0.00	1.56
Bdelloid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Brachionus angularis	0.00	0.00	0.04	0.09	0.26	0.08	0.00	0.00	0.00	0.04	0.00	0.00	0.08	2.07	1.07	1.39
Brachionus calyciflorus	0.22	0.59	0.03	0.00	0.00	2.45	0.57	1.03	0.15	0.32	0.23	0.90	0.00	0.00	0.00	0.68

Appendix Table A25. Continued.

Taxon	Mean number/L															
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep
Rotifera (continued)																
Brachionus caudatus	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brachionus quadridentatus	0.08	0.03	0.00	0.00	0.05	0.20	0.15	0.00	0.04	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Collotheca libera	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Collotheca spp.	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
Conochiloides dossaurius	0.00	0.00	0.03	6.49	1.97	0.11	0.78	2.47	0.05	0.00	0.00	0.00	0.18	0.05	0.00	5.24
Conochilus unicornis	0.00	0.00	0.03	0.37	0.43	0.12	0.74	0.05	0.00	0.00	0.00	0.20	0.31	0.09	0.15	0.21
Euchlanis calpidia	0.03	0.03	0.07	0.10	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.16	0.17	0.03	0.00	0.00
Euchlanis dialata	8.63	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Filinia longiseta	0.34	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.20	0.03	0.00	0.00	0.00
Gastropus hypotus	0.00	0.00	0.00	0.00	0.00	0.41	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kellicottia bostoniensis	0.00	0.00	6.01	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Kellicottia longispina	0.28	0.83	2.64	9.98	0.00	0.00	0.00	0.01	0.00	0.10	0.10	3.39	2.61	2.94	0.21	0.00
Keratella cochlearis	23.24	62.21	65.65	115.28	3.98	3.51	2.58	0.30	0.13	0.77	21.76	81.36	6.50	11.29	5.19	67.14
Keratella quadrata	5.36	9.65	1.15	1.61	0.00	0.02	0.00	0.01	0.34	0.21	2.64	1.25	0.26	0.00	0.00	0.00
Keratella serrulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Lecane spp.	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.96
Mytlinia mucronatum	0.00	0.02	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Notholca acuminata	5.64	2.10	17.64	0.21	0.00	0.00	0.00	0.00	0.04	0.16	0.91	18.99	1.00	0.00	0.00	0.00
Polyarthra vulgaris	4.27	48.77	29.32	56.25	13.33	21.83	39.79	1.40	0.21	0.73	33.39	22.87	4.14	12.34	114.81	280.82
Pompholyx sulcata	0.00	0.00	0.00	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
Synchaeta pectinata	0.20	1.14	34.96	77.08	1.31	0.41	0.69	3.60	2.48	4.96	22.97	20.46	10.48	85.20	6.35	6.80
Trichocerca spp.	0.01	0.00	0.46	6.17	13.37	1.20	3.65	0.16	0.02	0.00	0.00	0.00	0.12	6.52	24.69	49.58
Trichotria pocillum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.03	0.00	0.00	0.20
Totals	48.60	126.23	159.19	273.78	34.80	30.38	50.63	9.34	3.72	7.42	82.38	150.20	26.16	120.74	152.47	418.04

Appendix Table A26. Zooplankton densities at upper John Day Reservoir sampling stations, April 1994 to September 1995.

	Mean number/L															
Taxon	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep
Cladocera																
Alona afflinis	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alona costata	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Alona guttata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00
Alona quadrangularis	0.00	0.00	0.00	0.05	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00
Alona rectangula	0.00	0.00	0.06	0.05	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alona rustica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Bosmina longirostris	0.13	0.08	0.82	1.43	0.23	5.27	18.45	0.43	1.32	0.18	0.22	1.17	0.09	0.27	0.22	0.34
Camptocercus rectirostris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceriodaphnia quadrangula	0.00	0.00	0.02	0.07	0.02	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Chydorus sphaericus	0.02	0.01	0.04	0.06	0.01	0.27	0.08	0.04	0.00	0.05	0.00	0.10	0.00	0.00	0.00	0.00
Daphnia retrocurva	0.00	0.00	0.00	0.00	1.57	0.06	0.22	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.66	0.22
Daphnia thorata	0.02	0.07	0.09	0.78	1.82	0.12	0.03	0.01	0.00	0.00	0.00	0.09	0.11	0.04	0.00	0.11
Diaphanasoma birgeii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.09
Ilypcryptus spinifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00
Kurzia latissima	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptodora kindtii	0.00	0.02	0.00	0.05	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leydigia leydigi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Immature	0.04	0.00	0.05	0.02	0.54	0.00	0.03	0.01	0.00	0.00	0.00	0.11	0.03	0.01	0.16	0.03
Totals	0.24	0.30	1.08	2.51	4.27	5.76	18.91	0.52	1.35	0.23	0.23	1.58	0.35	0.39	1.10	0.79
Copepoda																
Calanoid copepodid	0.03	0.01	0.06	0.03	0.07	0.90	0.43	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.00	0.03
Cyclopoid copepodid	0.16	0.10	0.55	1.05	1.61	2.70	2.49	0.07	0.00	0.04	0.13	0.13	0.06	0.19	0.61	0.88
Diacyclops thomasi	0.49	0.08	0.16	0.24	0.58	0.71	1.76	0.04	0.00	0.00	0.06	0.08	0.04	0.10	0.30	0.54
Eucyclops agilis	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Harpacticoid	0.02	0.10	0.02	0.02	0.00	0.08	0.08	0.07	0.02	0.15	0.00	0.09	0.02	0.02	0.00	0.00
Leptodiaptomus ashlandi	0.06	0.00	0.00	0.07	0.03	0.25	1.20	0.01	0.00	0.00	0.00	0.00	0.01	0.05	0.06	0.03
Nauplii	2.75	4.66	5.06	3.60	5.62	4.62	7.54	0.35	0.44	0.46	0.86	3.05	1.69	1.53	2.25	1.82
Totals	3.52	4.95	5.85	5.01	7.91	9.26	13.50	0.54	0.46	0.65	1.05	3.38	1.82	1.91	3.22	3.31

Appendix Table A26. Continued.

Taxon	Mean number/L															
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep
Rotifera																
Ascomorpha ovalis	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Asplanchna girodi	0.35	0.28	0.07	0.11	0.00	0.12	1.13	0.00	0.02	0.00	0.02	0.04	0.00	0.00	0.00	1.46
Asplanchna sieboldi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Bdelloid	0.04	0.01	0.35	0.11	0.01	0.00	0.00	0.01	0.00	0.00	0.04	0.29	0.37	0.32	0.32	0.00
Brachionus angularis	0.00	0.00	0.18	0.18	0.31	0.07	0.03	0.00	0.00	0.03	0.00	0.13	0.22	0.39	0.52	0.30
Brachionus calyciflorus	3.76	0.09	0.04	0.05	0.01	2.66	0.20	0.02	0.00	0.08	1.22	0.37	0.00	0.00	0.05	0.08
Brachionus caudatus	0.01	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brachionus patulus	0.00	0.00	0.00	0.00	0.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brachionus quadridentatus	0.42	0.00	0.01	0.02	0.08	0.35	0.18	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00
Brachionus rubens	0.00	0.00	0.01	0.02	0.00	0.00	0.04	0.00	0.00	0.04	0.03	0.00	0.05	0.00	0.00	0.00
Collotheca libera	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Collotheca spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.84
Colurella spp.	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.18
Conochiloides dossaurius	0.01	0.00	0.00	4.65	0.94	0.40	3.46	0.95	0.00	0.00	0.00	0.08	0.06	0.10	3.58	8.53
Conochilus unicornis	0.00	0.00	0.20	0.24	0.55	0.67	1.06	0.04	0.00	0.00	0.00	0.00	0.03	0.00	0.49	0.94
Euchlanis calpidia	0.34	0.19	0.88	0.83	0.04	0.25	1.02	0.21	0.00	0.02	0.03	0.19	0.05	0.13	0.27	0.00
Euchlanis dialata	8.66	0.21	0.30	0.06	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Filinia longiseta	3.04	0.47	0.01	0.00	0.52	0.00	0.00	0.01	0.03	0.02	0.58	1.33	0.03	0.00	0.08	0.10
Gastropus hypotus	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gastropus stylifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Hexarthra mira	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.01	0.00	0.00
Kellicottia bostoniensis	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.01	0.00	0.00
Kellicottia longispina	1.13	1.12	4.89	0.82	0.17	0.00	0.00	0.02	0.00	0.04	0.45	3.21	1.58	0.65	0.04	0.03
Keratella cochlearis	57.45	56.48	15.76	9.80	5.09	4.22	2.99	0.12	0.09	0.39	15.16	68.70	3.36	1.87	3.85	10.17
Keratella quadrata	10.10	4.65	0.46	0.18	0.01	0.00	0.04	0.00	0.16	0.42	2.72	5.16	0.06	0.00	0.00	0.00
Keratella serrulata	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.02	0.00
Lecane spp.	0.01	0.01	0.06	0.12	0.00	0.05	0.32	0.05	0.01	0.00	0.00	0.10	0.01	0.00	0.08	0.20
Lepadella ovalis	0.00	0.04	0.00	0.00	0.01	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table A26. Continued.

Taxon	Mean number/L															
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep
Rotifera (continued)																
Monostyla bulla	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mytlinia mucronatum	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Notholca acuminata	5.99	10.21	2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.59	22.76	0.16	0.02	0.00	0.00
Philodina spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.20
Platyias quadricornis	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polyarthra vulgaris	34.32	19.68	10.90	15.88	10.88	51.47	96.54	0.71	0.04	0.04	17.38	26.63	5.26	5.92	24.60	37.30
Pompholyx sulcata	0.01	0.00	0.02	0.02	0.00	0.08	0.08	0.07	0.02	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Synchaeta pectinata	4.17	0.66	11.37	49.22	32.05	1.09	0.19	0.72	0.47	1.94	15.72	15.29	7.97	25.96	66.72	44.21
Trichocerca spp.	0.00	0.19	0.26	3.62	4.65	4.36	23.14	0.06	0.00	0.00	0.05	0.05	0.22	2.01	2.66	6.82
Trichotria pocillum	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Totals	129.80	94.35	48.36	85.93	55.39	65.94	130.69	2.99	0.84	3.22	54.03	144.55	19.40	37.41	104.20	111.43

Appendix Table A27. Zooplankton densities at John Day Reservoir, Crow Butte backwater, March to September 1995.

Taxon	Mean number/L						
	Mar	Apr	May	Jun	Jul	Aug	Sep
Cladocera							
Alona costata	0.00	0.00	0.00	0.18	0.00	0.00	0.00
Alona quadrangularis	16.02	114.10	115.13	7.38	1.11	0.00	9.20
Bosmina longirostris	0.00	0.00	0.20	0.36	0.20	0.00	0.00
Ceriodaphnia quadrangula	6.01	1.94	0.92	0.42	0.00	0.00	0.46
Chydorus sphaericus	0.00	0.00	0.00	9.95	35.40	1.28	0.00
Daphnia retrocurva	1.00	2.64	26.04	6.79	0.83	0.00	0.00
Daphnia thorata	0.00	0.00	0.00	0.00	4.12	0.00	0.00
Diaphanasoma birgeii	0.00	0.00	2.38	0.00	0.00	0.00	0.00
Kurzia latissima	0.00	0.00	0.07	0.18	0.93	0.00	0.50
Leptodora kindtii	3.00	3.03	6.44	0.71	3.78	0.00	0.00
Immature	26.03	121.71	151.25	25.97	46.73	1.28	10.16
Copepoda							
Cyclopoid copepodid	0.00	0.87	0.39	2.14	1.45	5.42	3.79
Diacyclops thomasi	0.00	6.07	2.44	1.90	3.65	1.32	1.36
Leptodiaptomus ashlandi	0.00	0.00	0.00	0.00	1.11	0.00	0.00
Nauplii	3.00	14.37	17.66	18.80	54.73	55.32	17.90
Totals	3.00	21.31	20.49	22.84	60.94	62.06	23.05
Rotifera							
Asplanchna girodi	2.00	23.17	18.59	2.32	0.00	0.36	43.92
Asplanchna sieboldi	8.01	0.00	0.21	0.00	0.00	0.00	0.00
Bdelloid	1.00	0.18	0.00	0.00	0.20	0.00	0.00
Brachionus angularis	0.00	0.00	0.00	0.54	5.97	17.90	4.90
Brachionus calyciflorus	21.03	9.41	0.55	0.12	0.00	0.00	1.12
Collotheca spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Colurella spp.	0.00	0.00	0.00	0.12	0.00	0.00	0.00
Conochiloides dossaurius	0.00	0.00	0.00	0.00	0.81	9.53	1.05
Conochilus unicornis	0.00	0.00	0.00	5.37	0.00	12.09	12.81
Euchlanis calpidia	0.00	0.27	0.00	0.12	0.15	0.00	0.00
Filinia longiseta	0.00	0.00	0.69	0.00	0.00	0.00	0.00
Gastropus hypotus	0.00	0.00	0.00	0.00	0.00	0.00	0.85
Gastropus stylifer	0.00	0.00	0.00	0.00	0.00	0.00	14.78
Kellicottia longispina	0.00	0.30	2.95	7.20	29.11	0.00	0.00
Keratella cochlearis	18.03	57.78	92.49	28.13	254.67	94.15	163.58
Keratella quadrata	4.01	4.78	2.54	0.00	0.00	0.00	0.00
Lecane spp.	0.00	0.00	0.00	0.12	0.84	1.70	0.96
Lepadella ovalis	0.00	0.00	0.00	0.12	0.00	0.00	0.00
Monostyla bulla	0.00	0.00	0.00	0.00	0.71	0.00	0.22
Notholca acuminata	3.00	0.67	1.93	0.00	0.09	0.00	0.00
Philodina spp.	0.00	0.00	0.00	0.00	0.00	0.21	0.46
Polyarthra vulgaris	13.02	68.85	23.24	34.67	91.06	293.26	288.82
Synchaeta pectinata	131.19	63.75	96.92	81.36	130.67	114.66	68.84
Trichocerca spp.	0.00	0.00	0.84	13.50	47.13	16.34	45.11
Trichotria pocillum	0.00	0.00	0.00	0.10	0.55	0.00	0.00
Totals	201.29	229.16	240.95	173.79	561.96	560.20	647.92

Appendix Table A28. Zooplankton densities (organisms/L) at John Day Reservoir sampling stations, April 1994 to September 1995. Dashes indicated no taxon present in sample.

Station	Date	Cladocerans		Copepods		Rotifers	
		Mean[a]	SD	Mean	SD	Mean	SD
Lower- and mid-reservoir stations							
LePage	4/11/94	--	--	0.5	0.3	57.7	3.8
Towal	4/11/94	0.0[b]	**c**	0.3	0.3	56.4	4.3
Arlington	4/11/94	--	--	0.5	0.1	31.7	3.1
LePage	5/10/94	0.3	0.1	2.9	1.1	144.6	41.7
Towal	5/10/94	--	--	2.6	0.7	131.9	15.6
Arlington	5/10/94	0.0[b]	**c**	1.5	0.5	102.1	3.5
LePage	6/7/94	2.1	0.7	12.9	3.2	252.0	28.3
Towal	6/7/94	0.5	0.2	4.5	2.3	144.9	6.0
Arlington	6/9/94	0.8	0.5	4.3	1.1	80.7	10.2
LePage	7/6/94	3.7	0.9	13.2	8.4	220.5	35.9
Towal	7/6/94	3.3	1.2	8.4	3.4	252.3	13.1
Arlington	7/6/94	6.6	1.1	10.5	1.5	348.6	28.8
LePage	8/2/94	23.5	1.4	14.4	2.6	13.9	1.8
Towal	8/2/94	38.9	8.7	18.7	2.7	20.7	2.7
Arlington	8/2/94	6.5	4.0	7.8	0.5	69.7	7.3
LePage	9/15/94	1.6	0.6	13.0	1.3	15.3	1.1
Towal	9/15/94	3.9	0.1	18.1	2.3	19.7	2.0
Arlington	9/15/94	6.3	2.0	11.5	0.8	56.2	11.2
LePage	10/4/94	2.7	0.9	32.4	2.3	21.5	4.6
Towal	10/4/94	3.1	1.9	30.7	2.8	27.1	4.0
Arlington	10/4/94	19.2	6.7	18.5	5.9	103.3	21.9
LePage	11/15/94	0.4	0.1	2.5	0.5	9.8	2.5
Towal	11/15/94	2.2	1.0	2.8	1.3	10.0	2.3
Arlington	11/15/94	0.4	0.2	1.0	0.1	8.2	2.1
LePage	1/10/95	0.2	0.0	0.6	0.3	4.7	0.4
Towal	1/10/95	0.1	0.0	0.5	0.3	3.3	1.2
Arlington	1/10/95	0.3	0.2	0.4	0.0	3.1	0.9
LePage	3/13/95	0.2	**c**	0.2	**c**	6.2	3.4
Towal	3/13/95	0.2	**c**	--	--	7.6	3.8
Arlington	3/13/95	--	--	0.6	0.2	8.5	0.2
LePage	4/21/95	0.2	**c**	0.7	**c**	27.3	8.6
Towal	4/21/95	--	--	1.7	1.9	56.6	28.5
Arlington	4/21/95	0.7	0.1	3.0	1.5	163.2	26.6
LePage	5/15/95	--	--	0.5	**c**	50.1	21.7
Towal	5/15/95	3.4	1.2	4.8	1.9	258.6	178.3
Arlington	5/15/95	--	--	--	--	141.9	101.6
LePage	6/12/95	1.2	1.3	2.2	2.2	22.0	25.9
Towal	6/12/95	1.8	0.6	2.8	2.1	37.4	7.1
Arlington	6/12/95	0.6	0.4	2.1	0.7	19.0	10.3
LePage	7/10/95	2.6	0.4	4.6	1.9	145.3	19.6
Towal	7/10/95	2.1	1.2	4.1	1.1	108.2	26.0
Arlington	7/10/95	1.5	0.6	4.0	0.4	108.7	16.9
LePage	8/10/95	93.4	59.0	140.2	80.5	155.5	88.6
Towal	8/10/95	32.5	22.2	84.2	42.0	147.6	67.8
Arlington	8/10/95	10.1	0.7	10.4	1.9	154.4	34.1
LePage	9/8/95	5.1	3.4	17.9	4.7	381.0	21.6
Towal	9/8/95	0.6	**c**	13.5	10.4	271.4	108.0
Arlington	9/8/95	2.3	0.9	6.3	2.5	601.8	90.6

Appendix Table A28. Continued.

Station	Date	Cladocerans		Copepods		Rotifers	
		Mean[a]	SD	Mean	SD	Mean	SD
Upper-reservoir and backwater stations							
Sand Island	4/13/94	0.3	0.2	2.8	2.1	90.9	4.1
Long Walk Isl downstream	4/13/94	0.2	**c**	1.1	0.6	58.7	4.3
Big Blalock Island	4/13/94	--	--	1.1	0.3	69.0	10.4
Long Walk Isl upstream	4/13/94	0.3	0.1	1.2	0.5	83.3	9.2
Paterson Slough	4/13/94	0.3	0.2	2.5	0.6	47.6	6.3
Sand Island	4/26/94	0.2	**c**	5.6	2.5	232.8	31.1
Long Walk Isl downstream	4/26/94	0.3	0.0	3.7	1.9	146.6	10.9
Big Blalock Island	4/26/94	0.4	0.0	6.1	1.9	281.1	15.5
Long Walk Isl upstream	4/26/94	0.1	**c**	6.5	2.8	150.8	4.2
Paterson Slough	4/26/94	0.3	0.0	4.6	0.4	137.5	35.8
Sand Island	5/11/94	0.2	**c**	6.3	2.7	149.8	7.3
Long Walk Isl downstream	5/11/94	0.3	**c**	8.8	1.9	93.9	7.3
Big Blalock Island	5/11/94	0.2	**c**	4.9	0.7	151.4	6.2
Long Walk Isl upstream	5/11/94	0.1	**c**	9.3	1.4	119.5	9.0
Paterson Slough	5/11/94	0.1	**c**	5.6	0.4	121.9	10.2
Sand Island	5/24/94	0.6	0.3	2.2	0.8	76.8	9.9
Long Walk Isl downstream	5/24/94	0.6	0.8	3.5	1.3	38.7	6.0
Big Blalock Island	5/24/94	0.3	**c**	2.8	1.5	90.5	28.1
Long Walk Isl upstream	5/24/94	0.1	**c**	3.6	0.8	47.6	13.5
Paterson Slough	5/24/94	0.6	0.1	2.3	1.6	53.2	3.7
Sand Island	6/8/94	1.5	1.0	4.8	1.4	48.4	5.3
Long Walk Isl downstream	6/8/94	0.6	0.1	5.7	5.8	22.5	11.4
Big Blalock Island	6/8/94	1.5	0.4	5.3	3.0	69.4	14.4
Long Walk Isl upstream	6/8/94	0.2	**c**	8.0	2.0	51.5	10.4
Paterson Slough	6/8/94	3.6	1.0	5.5	1.1	35.9	8.9
Sand Island	6/21/94	1.0	1.1	8.5	1.1	67.4	9.8
Long Walk Isl downstream	6/21/94	0.1	**c**	3.6	1.5	34.9	10.5
Big Blalock Island	6/21/94	0.8	0.7	6.8	0.5	54.2	7.5
Long Walk Isl upstream	6/21/94	0.7	0.9	7.5	1.4	46.0	5.6
Paterson Slough	6/21/94	0.8	0.4	2.8	2.1	59.8	11.9
Sand Island	7/7/94	4.0	3.5	7.3	2.9	89.8	0.9
Long Walk Isl downstream	7/7/94	5.1	2.2	4.2	2.2	45.8	11.1
Big Blalock Island	7/7/94	2.5	1.5	3.5	1.1	82.2	6.6
Long Walk Isl upstream	7/7/94	2.0	2.0	4.9	1.9	50.3	4.9
Paterson Slough	7/7/94	3.2	2.3	5.7	4.6	95.9	4.4
Sand Island	7/20/94	1.9	0.5	5.7	1.7	95.5	7.3
Long Walk Isl downstream	7/20/94	2.4	2.1	6.3	1.7	117.9	9.3
Big Blalock Island	7/20/94	1.5	1.1	5.0	2.0	96.6	7.3
Long Walk Isl upstream	7/20/94	0.9	0.1	3.7	2.7	98.6	5.2
Paterson Slough	7/20/94	1.6	0.8	3.6	1.5	86.8	13.4
Sand Island	8/4/94	2.7	1.1	6.3	1.6	69.1	11.7
Long Walk Isl downstream	8/4/94	2.1	0.6	11.0	2.6	74.5	4.8
Big Blalock Island	8/4/94	4.8	0.8	6.0	1.0	54.9	3.5
Long Walk Isl upstream	8/4/94	2.1	1.0	5.9	2.3	58.3	1.1
Paterson Slough	8/4/94	1.6	0.9	3.3	0.4	27.5	6.1
Sand Island	8/18/94	9.3	0.4	12.4	4.8	65.7	13.4
Long Walk Isl downstream	8/18/94	2.9	2.2	7.6	2.0	30.1	0.8
Big Blalock Island	8/18/94	8.7	0.4	11.6	3.0	78.2	5.5
Long Walk Isl upstream	8/18/94	5.6	2.0	7.6	2.6	54.3	4.5
Paterson Slough	8/18/94	2.8	1.5	7.5	2.3	41.3	2.9
Sand Island	9/14/94	3.9	2.0	7.3	1.5	34.4	4.3
Long Walk Isl downstream	9/14/94	5.5	0.4	7.6	1.6	31.8	3.2

Appendix Table A28. Continued.

Station	Date	Cladocerans		Copepods		Rotifers	
		Mean[a]	SD	Mean	SD	Mean	SD
Big Blalock Island	9/14/94	1.6	0.0	9.7	5.2	76.4	7.4
Long Walk Isl upstream	9/14/94	5.9	2.2	11.5	1.7	97.0	13.4
Paterson Slough	9/14/94	11.8	2.8	10.2	2.0	90.2	8.2
Sand Island	10/6/94	12.0	3.5	15.0	5.1	118.0	2.7
Long Walk Isl downstream	10/6/94	15.3	2.8	14.9	0.2	75.4	2.0
Big Blalock Island	10/6/94	23.3	1.5	12.5	2.7	137.1	11.4
Long Walk Isl upstream	10/6/94	19.9	1.0	16.3	3.2	139.5	13.1
Paterson Slough	10/6/94	24.1	8.5	8.8	4.4	183.4	4.4
Sand Island	11/17/94	0.7	0.6	0.5	0.3	2.4	0.6
Long Walk Isl downstream	11/17/94	0.6	0.2	0.4	0.2	2.2	0.8
Big Blalock Island	11/17/94	0.4	0.3	0.4	0.2	2.0	0.4
Long Walk Isl upstream	11/17/94	0.4	0.1	0.9	0.3	4.8	0.7
Paterson Slough	11/17/94	0.5	0.2	0.6	0.2	3.6	1.1
Sand Island	1/25/95	0.5	0.3	0.3	0.2	0.7	0.1
Long Walk Isl downstream	1/25/95	0.1	**c**	0.3	0.3	0.8	0.2
Big Blalock Island	1/25/95	0.7	0.6	0.5	0.0	1.0	0.4
Long Walk Isl upstream	1/25/95	0.3	0.3	--	--	0.2	0.3
Paterson Slough	1/25/95	5.1	3.2	1.2	0.3	1.7	0.8
Crow Butte	3/15/95	26.0	**c**	3.0	**c**	201.3	**c**
Sand Island	3/15/95	0.4	0.1	0.7	0.4	3.8	2.4
Long Walk Isl downstream	3/15/95	0.2	**c**	1.0	0.4	2.6	0.7
Big Blalock Island	3/15/95	0.2	0.0	0.6	0.5	2.5	1.0
Long Walk Isl upstream	3/15/95	0.4	0.2	0.7	0.7	3.1	1.5
Paterson Slough	3/15/95	0.1	**c**	0.2	**c**	5.0	0.3
Crow Butte	4/4/95	26.3	7.2	8.2	0.5	153.9	6.2
Sand Island	4/4/95	0.0b	**c**	0.3	0.1	4.5	2.6
Long Walk Isl downstream	4/4/95	--	--	0.1	0.0	3.0	1.8
Big Blalock Island	4/4/95	0.2	**c**	0.9	0.4	11.4	5.1
Long Walk Isl upstream	4/4/95	0.2	**c**	0.7	0.1	5.3	2.1
Paterson Slough	4/4/95	0.1	**c**	0.3	0.1	10.1	2.4
Crow Butte	4/18/95	217.1	43.5	34.5	8.4	304.4	32.7
Sand Island	4/20/95	1.0	**c**	2.6	1.2	108.0	12.5
Long Walk Isl downstream	4/20/95	0.8	0.3	0.9	0.5	65.2	18.0
Big Blalock Island	4/20/95	--	--	0.9	0.5	121.2	9.3
Long Walk Isl upstream	4/20/95	--	--	2.6	0.4	108.8	4.6
Paterson Slough	4/20/95	--	--	1.3	0.8	103.9	10.8
Crow Butte	5/1/95	174.7	43.2	20.1	6.4	234.7	60.4
Paterson Slough	5/2/95	3.7	1.3	6.3	1.5	128.3	10.8
Sand Island	5/3/95	3.0	1.4	2.0	0.2	228.3	21.1
Long Walk Isl downstream	5/3/95	--	--	1.0	**c**	153.5	44.4
Big Blalock Island	5/3/95	--	--	3.8	3.5	251.5	11.4
Long Walk Isl upstream	5/3/95	4.0	3.9	4.0	3.9	202.9	12.7
Crow Butte	5/17/95	98.7	57.2	12.1	6.2	73.2	49.2
Sand Island	5/17/95	1.5	0.7	5.0	1.7	324.8	70.5
Long Walk Isl downstream	5/17/95	1.0	**c**	6.5	2.2	133.1	21.3
Big Blalock Island	5/17/95	3.1	5.3	5.5	3.2	167.2	73.2
Long Walk Isl upstream	5/17/95	0.6	**c**	3.2	1.2	111.9	27.2
Paterson Slough	5/17/95	2.2	3.5	2.3	2.9	118.8	70.7
Crow Butte	5/30/95	180.3	76.2	29.3	15.6	414.8	157.2
Sand Island	5/31/95	0.9	0.5	0.9	0.2	57.9	12.5
Long Walk Isl downstream	5/31/95	2.3	2.6	6.3	3.0	113.9	12.3
Big Blalock Island	5/31/95	1.1	0.5	1.9	0.1	71.8	1.9
Long Walk Isl upstream	5/31/95	0.2	**c**	1.3	1.1	47.0	6.4
Paterson Slough	5/31/95	--	--	0.6	0.0	60.5	8.8

Appendix Table A28. Continued.

Station	Date	Cladocerans Mean[a]	Cladocerans SD	Copepods Mean	Copepods SD	Rotifers Mean	Rotifers SD
Sand Island	6/14/95	0.1	**c**	0.6	0.9	4.3	0.8
Long Walk Isl downstream	6/14/95	--	--	2.2	2.3	18.7	3.0
Big Blalock Island	6/14/95	0.2	**c**	1.5	0.4	8.1	2.9
Long Walk Isl upstream	6/14/95	--	--	2.1	0.6	8.2	4.0
Paterson Slough	6/14/95	--	--	0.9	0.4	8.7	5.0
Crow Butte	6/15/95	34.0	15.3	19.2	12.8	63.0	22.1
Crow Butte	6/28/95	18.0	4.8	26.5	5.3	284.6	38.7
Sand Island	6/29/95	1.4	0.7	2.2	0.6	28.5	3.8
Long Walk Isl downstream	6/29/95	0.3	**c**	1.9	1.3	22.8	0.9
Big Blalock Island	6/29/95	0.4	0.2	1.5	0.6	29.5	10.3
Long Walk Isl upstream	6/29/95	0.7	0.5	2.6	0.7	32.3	7.6
Paterson Slough	6/29/95	0.4	0.2	2.6	1.4	33.4	9.2
Sand Island	7/12/95	0.1	**c**	1.6	0.4	18.4	7.8
Long Walk Isl downstream	7/12/95	0.3	0.0	2.0	1.5	17.1	10.3
Big Blalock Island	7/12/95	0.2	**c**	1.5	0.2	21.0	14.7
Long Walk Isl upstream	7/12/95	1.0	0.5	2.5	1.3	65.4	31.0
Paterson Slough	7/12/95	0.5	0.6	1.1	0.7	17.8	7.1
Crow Butte	7/13/95	64.2	42.3	96.3	112.0	926.9	980.3
Crow Butte	7/24/95	29.2	27.0	25.5	18.3	197.0	124.0
Sand Island	7/25/95	0.6	0.7	1.9	1.4	34.0	9.9
Long Walk Isl downstream	7/25/95	0.7	0.2	1.8	0.2	65.4	5.1
Big Blalock Island	7/25/95	0.5	0.6	2.6	1.8	43.3	22.7
Long Walk Isl upstream	7/25/95	0.1	**c**	3.1	1.3	71.0	15.2
Paterson Slough	7/25/95	--	--	1.1	0.8	20.8	11.5
Crow Butte	8/8/95	1.5	**c**	108.8	44.1	864.6	170.5
Sand Island	8/8/95	0.9	0.3	6.1	0.6	89.7	15.7
Long Walk Isl downstream	8/8/95	1.2	0.6	4.7	0.7	137.1	13.5
Big Blalock Island	8/8/95	1.6	0.2	3.6	0.4	81.4	9.9
Long Walk Isl upstream	8/8/95	1.2	1.7	4.1	2.6	112.8	7.4
Paterson Slough	8/8/95	3.8	2.9	3.4	1.5	91.2	42.5
Crow Butte	8/21/95	1.1	**c**	15.3	10.7	255.8	160.7
Sand Island	8/22/95	--	--	0.6	**c**	102.5	7.3
Long Walk Isl downstream	8/22/95	--	--	0.8	**c**	83.8	12.6
Big Blalock Island	8/22/95	0.5	**c**	1.5	1.2	99.6	28.8
Long Walk Isl upstream	8/22/95	2.0	1.2	5.2	3.2	189.0	31.7
Paterson Slough	8/22/95	--	--	2.2	0.4	55.1	6.8
Crow Butte	9/5/95	3.4	1.9	18.6	10.5	609.7	288.2
Sand Island	9/7/95	1.1	**c**	1.1	**c**	166.8	14.7
Long Walk Isl downstream	9/7/95	1.1	**c**	3.1	2.4	86.6	15.2
Big Blalock Island	9/7/95	0.9	**c**	0.9	**c**	131.0	15.5
Long Walk Isl upstream	9/7/95	--	--	3.3	2.8	147.2	11.1
Paterson Slough	9/7/95	1.2	**c**	--	--	147.7	23.7
Crow Butte	9/19/95	16.9	9.9	27.5	16.0	686.1	417.0
Sand Island	9/19/95	0.9	0.7	5.7	1.7	104.6	5.9
Long Walk Isl downstream	9/19/95	1.2	0.9	6.9	2.0	92.1	18.2
Big Blalock Island	9/19/95	0.3	**c**	3.9	0.7	61.4	10.9
Long Walk Isl upstream	9/19/95	0.9	0.4	4.9	1.5	84.3	44.3
Paterson Slough	9/19/95	0.4	**c**	3.3	2.8	92.5	12.0

[a] Means of three samples for all date/station strata except Crow Butte on 3/15/95 (one sample).
[b] Mean density less than 0.1 organism/L.
[c] Taxon present in one sample only.

Appendix Table A29. John Day Reservoir benthic invertebrate collections, April 1994 to September 1995.

Station	Depth (m)	Date	Samples (n)	Taxa (n)	Density (n/m2)	SD
Long Walk Island (downstream)	1	4/12/94	4	10	1,500	1,785
Long Walk Island (downstream)	3	4/12/94	4	15	15,355	3,438
Long Walk Island (downstream)	5	4/12/94	4	12	11,240	1,701
Long Walk Island (upstream)	1	4/12/94	4	17	14,010	4,813
Long Walk Island (upstream)	3	4/12/94	4	10	10,175	5,141
Long Walk Island (upstream)	5	4/12/94	4	10	2,555	606
Paterson Slough	1	4/12/94	2	14	2,380	1,075
Paterson Slough	3	4/12/94	2	9	1,880	481
Paterson Slough	5	4/12/94	2	10	2,470	127
Big Blalock Island	1	4/13/94	2	11	9,940	170
Big Blalock Island	3	4/13/94	2	13	2,920	141
Big Blalock Island	5	4/13/94	2	12	3,070	1,626
Sand Island	1	4/13/94	2	10	7,690	721
Sand Island	3	4/13/94	2	13	4,020	651
Sand Island	5	4/13/94	2	7	2,390	2,107
Big Blalock Island	1	5/12/94	4	10	6,315	4,217
Big Blalock Island	3	5/12/94	4	8	1,575	1,407
Big Blalock Island	5	5/12/94	4	9	665	471
Long Walk Island (downstream)	1	5/12/94	4	12	3,005	3,943
Long Walk Island (downstream)	3	5/12/94	4	18	13,870	2,849
Long Walk Island (downstream)	5	5/12/94	4	18	10,410	3,612
Long Walk Island (upstream)	1	5/12/94	4	10	4,875	1,006
Long Walk Island (upstream)	3	5/12/94	4	10	15,430	10,936
Long Walk Island (upstream)	5	5/12/94	4	14	3,535	3,853
Paterson Slough	1	5/12/94	4	12	9,780	5,063
Paterson Slough	3	5/12/94	4	12	2,050	944
Paterson Slough	5	5/12/94	4	12	2,330	555
Sand Island	1	5/12/94	4	9	5,030	2,045
Sand Island	3	5/12/94	4	9	2,090	1,228
Sand Island	5	5/12/94	4	7	1,010	296
Long Walk Island (downstream)	1	6/8/94	4	13	2,800	1,300
Long Walk Island (downstream)	3	6/8/94	4	16	14,155	3,610
Long Walk Island (downstream)	5	6/8/94	4	15	12,405	2,885
Sand Island	1	6/8/94	4	11	5,275	514
Sand Island	3	6/8/94	4	10	6,430	1,898
Sand Island	5	6/8/94	4	10	3,215	2,065
Big Blalock Island	1	6/9/94	4	10	8,750	4,787
Big Blalock Island	3	6/9/94	4	9	1,460	1,389
Big Blalock Island	5	6/9/94	4	12	4,570	2,237
Long Walk Island (upstream)	1	6/9/94	4	16	17,895	2,625
Long Walk Island (upstream)	3	6/9/94	4	16	20,525	5,305

Appendix Table A29. Continued.

Station	Depth (m)	Date	Samples (n)	Taxa (n)	Density (n/m2)	SD
Long Walk Island (upstream)	5	6/9/94	4	11	3,395	1,782
Paterson Slough	1	6/9/94	4	12	2,810	1,176
Paterson Slough	3	6/9/94	4	9	685	610
Paterson Slough	5	6/9/94	4	9	990	208
Big Blalock Island	1	7/7/94	4	13	5,305	2,609
Big Blalock Island	3	7/7/94	4	10	4,545	2,104
Big Blalock Island	5	7/7/94	4	8	3,505	4,320
Long Walk Island (downstream)	1	7/7/94	4	12	1,385	320
Long Walk Island (downstream)	3	7/7/94	4	9	4,205	2,654
Long Walk Island (downstream)	5	7/7/94	4	11	2,965	1,637
Long Walk Island (upstream)	1	7/7/94	4	20	7,465	13,370
Long Walk Island (upstream)	3	7/7/94	4	14	11,430	7,017
Long Walk Island (upstream)	5	7/7/94	4	9	4,240	2,395
Paterson Slough	1	7/7/94	4	19	5,435	264
Paterson Slough	3	7/7/94	4	10	2,385	1,431
Paterson Slough	5	7/7/94	4	8	1,110	714
Sand Island	1	7/7/94	4	16	6,290	4,861
Sand Island	3	7/7/94	4	10	2,320	1,178
Sand Island	5	7/7/94	4	8	1,425	1,650
Big Blalock Island	1	8/3/94	4	8	3,740	2,448
Big Blalock Island	3	8/3/94	4	10	2,825	1,464
Big Blalock Island	5	8/3/94	4	6	2,215	2,619
Long Walk Island (downstream)	1	8/3/94	4	10	2,720	1,406
Long Walk Island (downstream)	3	8/3/94	4	12	11,625	12,016
Long Walk Island (downstream)	5	8/3/94	4	13	8,155	8,245
Long Walk Island (upstream)	1	8/3/94	4	14	23,645	6,280
Long Walk Island (upstream)	3	8/3/94	4	8	4,735	1,031
Long Walk Island (upstream)	5	8/3/94	4	11	4,745	3,370
Paterson Slough	1	8/3/94	4	11	6,850	7,100
Paterson Slough	3	8/3/94	4	14	3,190	2,707
Paterson Slough	5	8/3/94	4	3	475	214
Sand Island	1	8/3/94	4	13	5,340	388
Sand Island	3	8/3/94	4	12	11,055	13,497
Sand Island	5	8/3/94	4	9	1,690	2,094
Big Blalock Island	1	9/13/94	4	11	8,655	4,951
Big Blalock Island	3	9/13/94	4	13	5,615	3,389
Big Blalock Island	5	9/13/94	4	10	2,285	185
Long Walk Island (downstream)	1	9/13/94	4	12	3,380	830
Long Walk Island (downstream)	3	9/13/94	4	12	25,140	6,726
Long Walk Island (downstream)	5	9/13/94	4	11	24,410	5,778
Long Walk Island (upstream)	1	9/13/94	4	15	27,625	8,326
Long Walk Island (upstream)	3	9/13/94	4	15	22,290	7,596
Long Walk Island (upstream)	5	9/13/94	4	14	12,830	8,256

Appendix Table A29. Continued.

Station	Depth (m)	Date	Samples (n)	Taxa (n)	Density (n/m2)	SD
Paterson Slough	1	9/13/94	4	15	14,340	3,450
Paterson Slough	3	9/13/94	4	13	2,515	556
Paterson Slough	5	9/13/94	4	12	3,405	470
Sand Island	1	9/13/94	4	4	525	226
Sand Island	3	9/13/94	4	10	5,950	1,643
Sand Island	5	9/13/94	4	10	2,245	1,281
Big Blalock Island	1	10/5/94	2	12	4,780	2,461
Big Blalock Island	3	10/5/94	2	8	3,760	2,206
Big Blalock Island	5	10/5/94	2	4	120	113
Long Walk Island (downstream)	1	10/5/94	2	5	4,710	4,822
Long Walk Island (downstream)	3	10/5/94	2	9	12,980	3,705
Long Walk Island (downstream)	5	10/5/94	2	10	15,930	693
Long Walk Island (upstream)	1	10/5/94	2	9	7,170	6,208
Long Walk Island (upstream)	3	10/5/94	2	11	10,290	8,867
Long Walk Island (upstream)	5	10/5/94	2	11	6,000	7,128
Paterson Slough	1	10/5/94	2	11	11,640	396
Paterson Slough	3	10/5/94	2	8	2,590	2,645
Paterson Slough	5	10/5/94	2	11	2,460	85
Sand Island	1	10/5/94	2	3	230	71
Sand Island	3	10/5/94	2	12	1,980	537
Sand Island	5	10/5/94	2	11	2,120	226
Long Walk Island (downstream)	1	11/17/94	4	7	1,290	425
Long Walk Island (downstream)	3	11/17/94	4	9	11,190	2,102
Long Walk Island (downstream)	5	11/17/94	4	10	14,810	2,528
Sand Island	1	11/17/94	4	11	7,425	1,961
Sand Island	3	11/17/94	4	11	4,845	2,137
Sand Island	5	11/17/94	4	10	2,150	1,081
Big Blalock Island	1	11/18/94	4	14	11,750	10,689
Big Blalock Island	3	11/18/94	4	16	3,130	634
Big Blalock Island	5	11/18/94	4	11	2,095	664
Long Walk Island (upstream)	1	11/18/94	4	12	6,685	2,458
Long Walk Island (upstream)	3	11/18/94	4	11	13,650	3,738
Long Walk Island (upstream)	5	11/18/94	4	12	5,035	2,290
Paterson Slough	1	11/18/94	4	9	1,850	220
Paterson Slough	3	11/18/94	4	12	3,925	1,291
Paterson Slough	5	11/18/94	3	9	3,713	722
Big Blalock Island	1	1/24/95	3	11	8,167	5,876
Big Blalock Island	5	1/24/95	1	5	1,840	
Long Walk Island (downstream)	1	1/24/95	4	14	1,885	352
Long Walk Island (downstream)	3	1/24/95	4	12	12,380	8,443
Long Walk Island (downstream)	5	1/24/95	4	14	15,615	2,562
Long Walk Island (upstream)	1	1/24/95	4	11	13,260	6,117
Long Walk Island (upstream)	3	1/24/95	4	8	5,160	3,789

Appendix Table A29. Continued.

Station	Depth (m)	Date	Samples (n)	Taxa (n)	Density (n/m2)	SD
Long Walk Island (upstream)	5	1/24/95	4	15	4,690	3,975
Paterson Slough	1	1/24/95	4	9	10,280	3,369
Paterson Slough	3	1/24/95	4	11	2,730	706
Paterson Slough	5	1/24/95	4	11	1,675	1,637
Sand Island	1	1/24/95	4	12	8,305	902
Sand Island	3	1/24/95	3	11	3,895	2,708
Sand Island	5	1/24/95	4	8	1,345	682
Big Blalock Island	1	3/14/95	1	6	9,040	
Big Blalock Island	5	3/14/95	1	5	620	
Long Walk Island (downstream)	1	3/14/95	4	9	855	387
Long Walk Island (downstream)	3	3/14/95	4	9	3,530	2,693
Long Walk Island (downstream)	5	3/14/95	4	9	8,955	4,615
Long Walk Island (upstream)	1	3/14/95	4	5	2,505	1,146
Long Walk Island (upstream)	3	3/14/95	4	12	6,860	5,321
Long Walk Island (upstream)	5	3/14/95	4	10	6,630	6,415
Paterson Slough	1	3/14/95	4	15	4,900	2,776
Paterson Slough	3	3/14/95	4	12	4,840	2,334
Paterson Slough	5	3/14/95	4	8	1,465	872
Sand Island	1	3/14/95	4	7	480	668
Sand Island	3	3/14/95	4	10	2,100	1,297
Sand Island	5	3/14/95	4	10	900	719
Crow Butte	3	4/18/95	1	10	6,680	
Crow Butte	5	4/18/95	3	13	11,387	1,399
Big Blalock Island	1	4/19/95	3	9	4,980	1,611
Big Blalock Island	3	4/19/95	2	8	1,790	410
Long Walk Island (downstream)	1	4/19/95	4	9	565	353
Long Walk Island (downstream)	3	4/19/95	2	13	9,000	8,004
Long Walk Island (upstream)	3	4/19/95	2	11	6,260	4,497
Long Walk Island (upstream)	5	4/19/95	4	14	3,705	4,101
Paterson Slough	1	4/19/95	4	8	1,200	402
Paterson Slough	3	4/19/95	4	7	810	571
Paterson Slough	5	4/19/95	4	9	1,160	604
Sand Island	1	4/19/95	4	5	655	727
Sand Island	3	4/19/95	4	9	650	194
Sand Island	5	4/19/95	4	10	1,240	1,088
Big Blalock Island	5	5/16/95	4	8	990	596
Long Walk Island (downstream)	1	5/16/95	4	8	685	104
Long Walk Island (downstream)	3	5/16/95	4	14	6,635	4,480
Long Walk Island (downstream)	5	5/16/95	4	15	5,975	3,111
Paterson Slough	1	5/16/95	4	8	1,255	531
Paterson Slough	3	5/16/95	4	11	1,275	390
Paterson Slough	5	5/16/95	4	12	955	588
Sand Island	1	5/16/95	4	5	250	99

Appendix Table A29. Continued.

Station	Depth (m)	Date	Samples (n)	Taxa (n)	Density (n/m2)	SD
Sand Island	3	5/16/95	4	11	1,450	1,405
Sand Island	5	5/16/95	4	10	1,135	541
Crow Butte	1	5/30/95	4	18	9,750	4,526
Crow Butte	3	5/30/95	2	13	7,200	3,988
Long Walk Island (upstream)	1	6/13/95	3	14	12,273	1,134
Long Walk Island (upstream)	3	6/13/95	3	10	10,893	3,442
Long Walk Island (upstream)	5	6/13/95	4	8	3,515	1,600
Paterson Slough	1	6/13/95	4	10	1,125	171
Paterson Slough	3	6/13/95	4	8	2,010	1,945
Paterson Slough	5	6/13/95	4	12	8,690	4,759
Sand Island	1	6/13/95	4	9	675	467
Sand Island	3	6/13/95	2	9	6,270	71
Crow Butte	1	6/15/95	3	19	32,480	4,787
Crow Butte	3	6/15/95	2	11	5,640	651
Long Walk Island (downstream)	1	7/11/95	4	15	4,160	1,024
Long Walk Island (downstream)	3	7/11/95	4	15	7,075	5,667
Long Walk Island (downstream)	5	7/11/95	4	12	6,185	1,843
Long Walk Island (upstream)	1	7/11/95	2	9	2,840	537
Long Walk Island (upstream)	3	7/11/95	4	9	6,490	3,392
Long Walk Island (upstream)	5	7/11/95	4	6	2,235	2,285
Paterson Slough	1	7/11/95	4	14	2,885	714
Paterson Slough	3	7/11/95	4	13	3,985	3,131
Paterson Slough	5	7/11/95	4	12	4,120	2,403
Sand Island	1	7/11/95	4	13	1,950	452
Sand Island	3	7/11/95	4	8	265	200
Sand Island	5	7/11/95	4	4	130	62
Crow Butte	1	7/13/95	1	11	15,700	
Crow Butte	1	8/8/95	4	23	14,120	7,508
Crow Butte	3	8/8/95	2	11	5,770	4,342
Long Walk Island (downstream)	1	8/9/95	4	10	2,505	390
Long Walk Island (downstream)	3	8/9/95	4	14	8,425	6,229
Long Walk Island (downstream)	5	8/9/95	3	12	9,440	6,632
Long Walk Island (upstream)	1	8/9/95	4	8	2,855	1,357
Long Walk Island (upstream)	3	8/9/95	2	12	7,510	3,719
Paterson Slough	1	8/9/95	4	17	4,900	2,064
Paterson Slough	3	8/9/95	4	12	4,595	2,715
Paterson Slough	5	8/9/95	4	12	5,370	1,600
Sand Island	1	8/9/95	4	12	4,305	2,303
Sand Island	3	8/9/95	4	13	2,800	409
Sand Island	5	8/9/95	4	9	470	181
Long Walk Island (downstream)	1	9/6/95	4	11	3,260	1,581
Long Walk Island (downstream)	3	9/6/95	4	15	16,165	6,407
Long Walk Island (downstream)	5	9/6/95	4	13	8,120	2,648
Sand Island	3	9/6/95	2	11	5,510	71
Sand Island	5	9/6/95	4	9	3,375	896

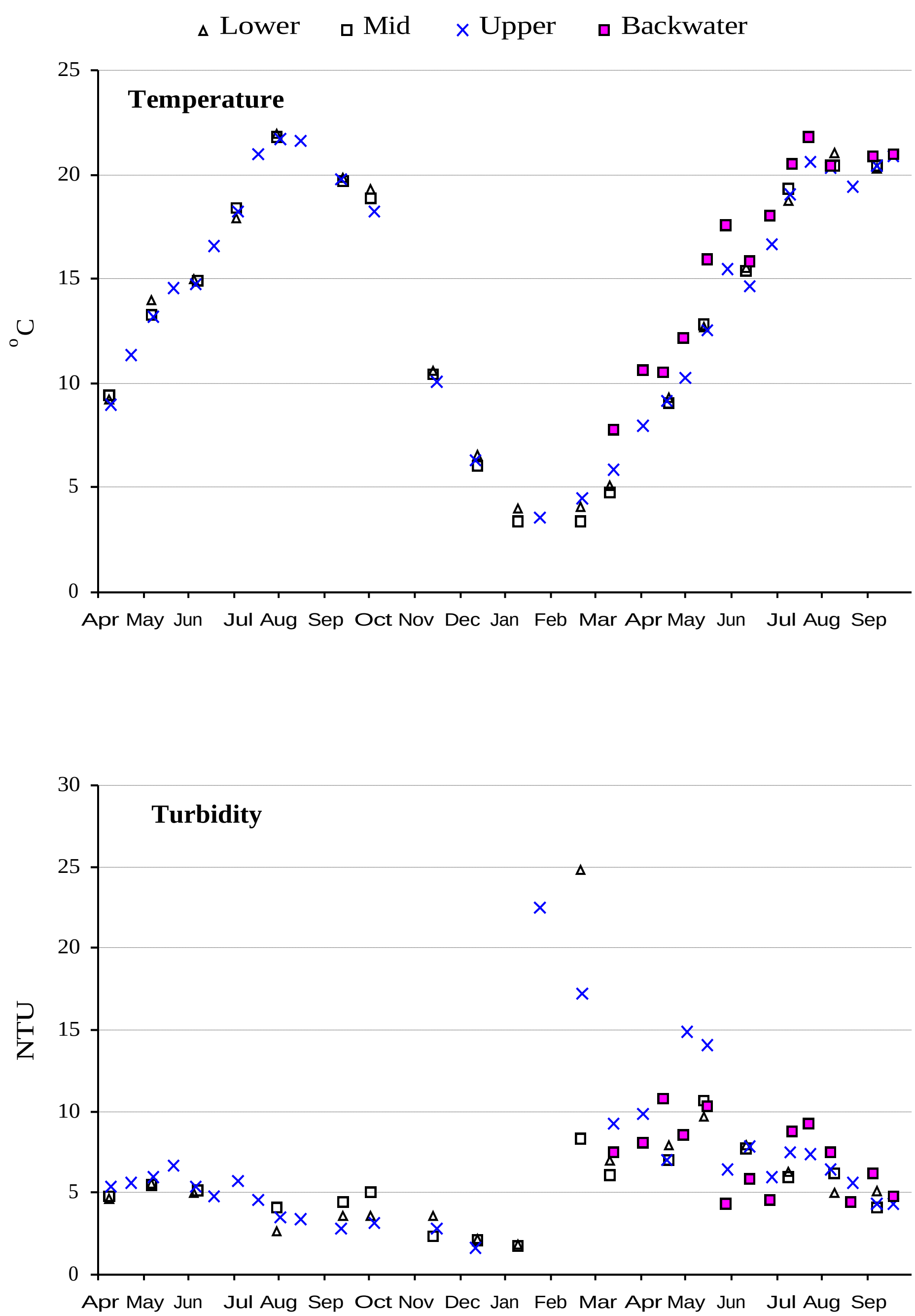
Appendix Table A30. Invertebrate taxa identified in John Day Reservoir benthic samples, April 1994 to September 1995.

Taxon	Identified
Phylum Annelida	
Hirudinea	x
Oligochaeta	x
Polychaeta	x
Nereidae	
Neanthes limnicola	x
Phylum Arthropoda	
Arachnida	
Ixodides	x
Prostigmata	x
Araneae	x
Crustacea	
Amphipoda	
Corophidae	
Corophium spp.	*x*
Corophium salmonis	x
Corophium spinicorne	x
Gammaridae	
Ramellogammarus spp.	x
Ramellogammarus oregonensis	x
Hyalellidae	
Hyalella azteca	x
Isopoda	x
Mysidacea	x
Cladocera	x
Leptodoridae	x
Leptodora kindtii	x
Copepoda	x
Calanoida	x
Cyclopoida	x
Harpacticoida	x
Ostracoda	x
Insecta	x
Coleoptera	x
Collembola	x
Diptera	x
Ceratopogonidae	x
Culicoides spp.	x
Chironomidae	x
Diamesinae	x
Orthocladiinae	x
Tanypodinae	x
Psychodidae	x
Simuliidae	x
Tipulidae	x

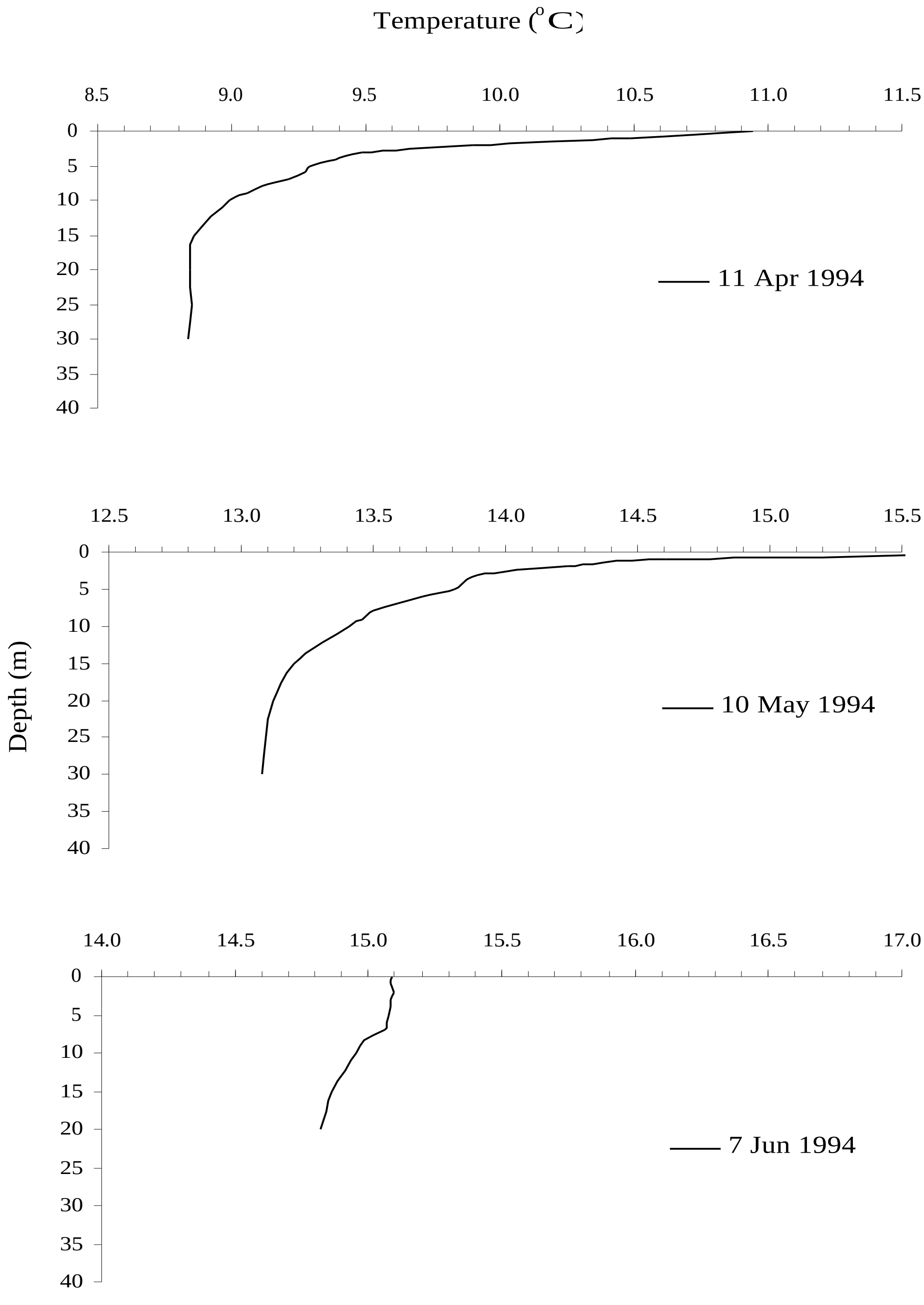
Appendix Table A30. Continued.

Taxon	Identified
Phylum Arthropoda (continued)	
Ephemeroptera	x
Caenidae	x
Caenis spp.	x
Ephemerellidae	
Ephemerella spp.	x
Ephemeridae	
Hexagenia spp.	x
Leptophlebiidae	
Choroterpes spp.	x
Tricorythidae	
Tricorythodes spp.	x
Hemiptera	x
Homoptera	x
Lepidoptera	x
Odonata	
Anisoptera	x
Gomphidae	x
Octogomphus specularis	x
Zygoptera	x
Coenagrionidae	x
Thysanoptera	x
Trichoptera	x
Phylum Cnidaria	
Hydrazoa	
Hydridae	
Hydra spp.	x
Phylum Mollusca	
Gastropoda	x
Archaeogastropoda	x
Pelecypoda	x
Phylum Nematoda	x
Phylum Nematomorpha	x
Phylum Nemertea	x
Phylum Platyhelminthes	
Turbellaria	x
Phylum Tardigrada	x
Total	62

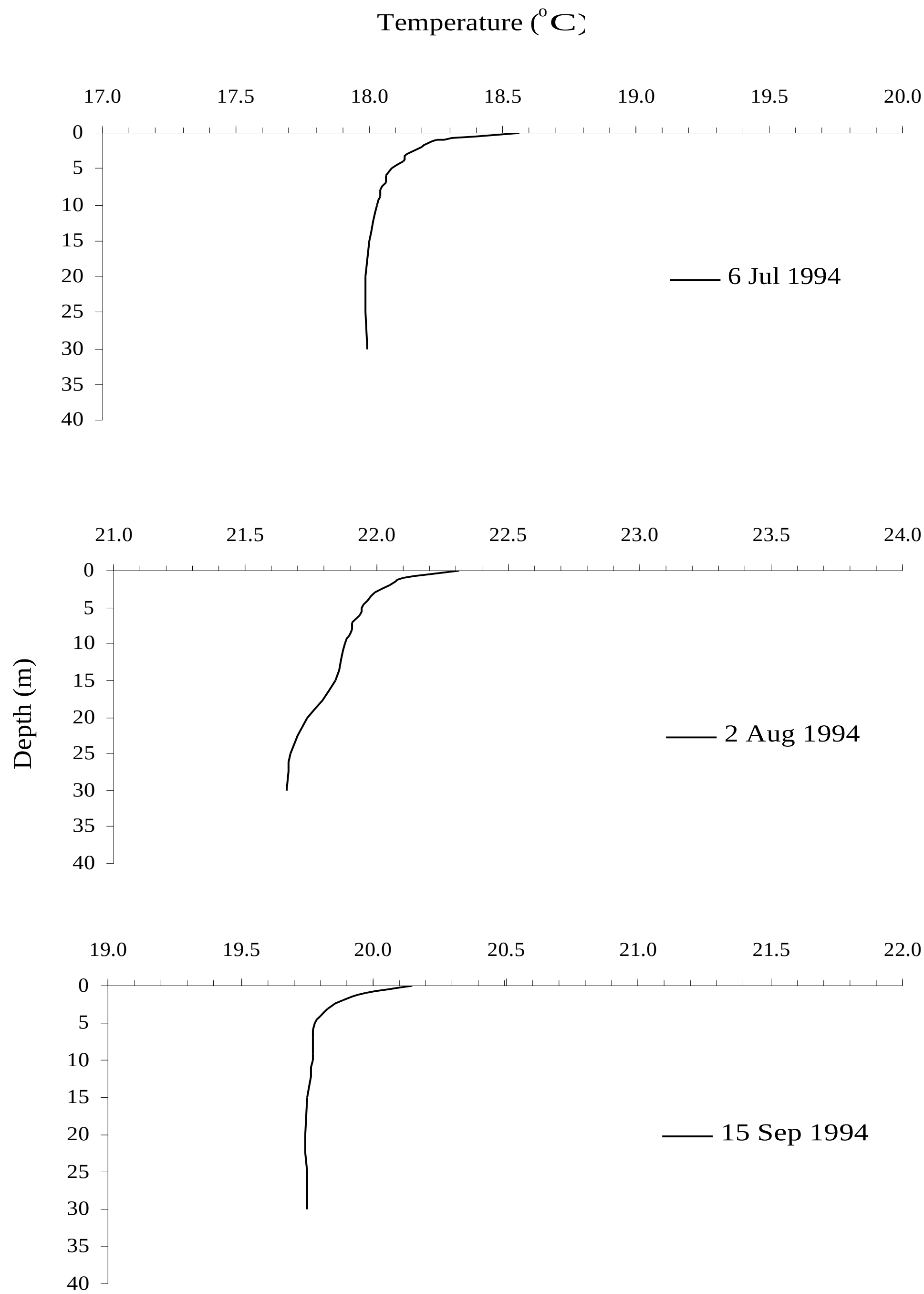
APPENDIX B



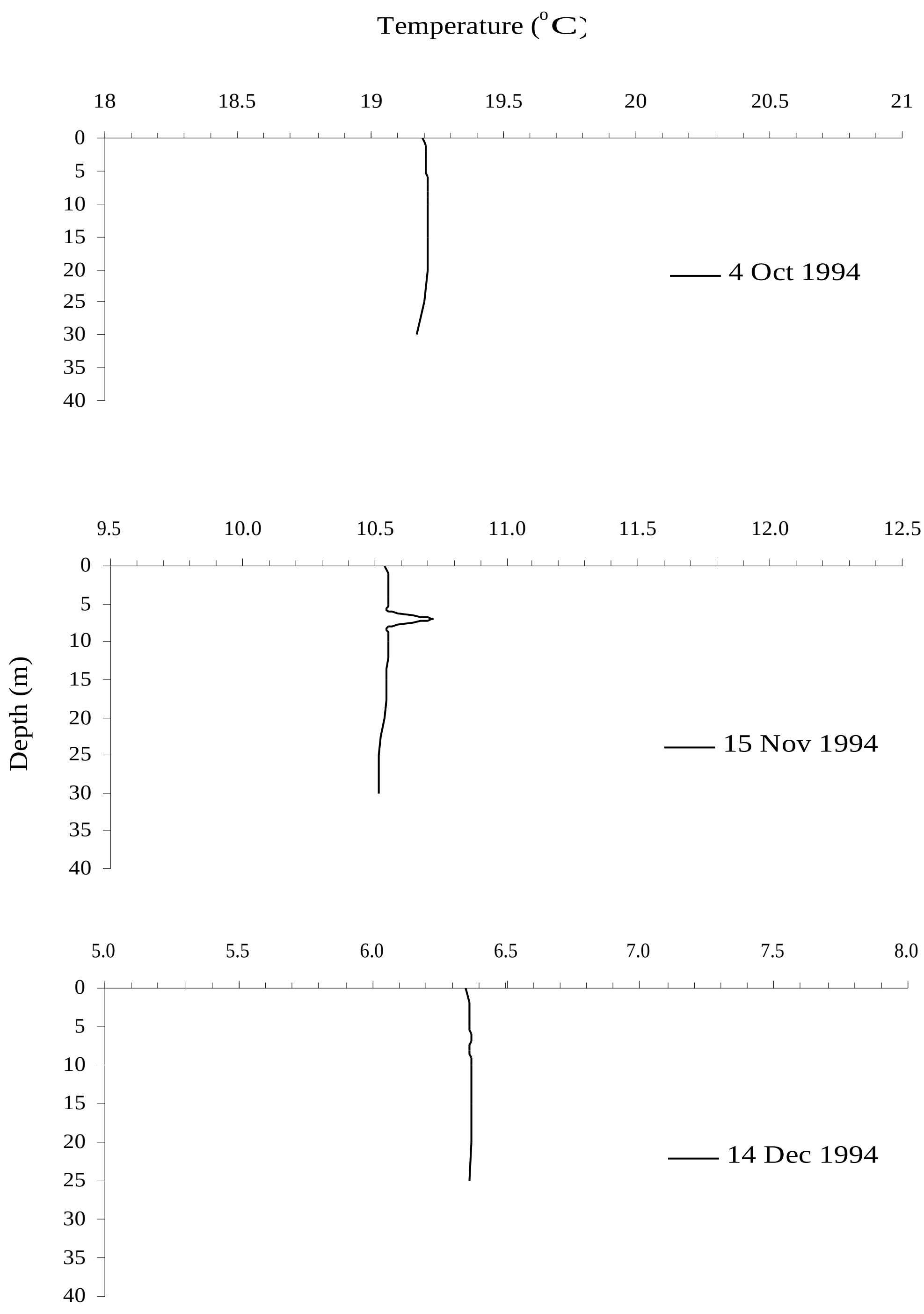
Appendix Figure B1. Temporal and spatial variation of John Day Reservoir water temperature and turbidity, April 1994 to September 1995. Results from sampling at lower-, mid-, and upper-reservoir stations and at Crow Butte backwater.



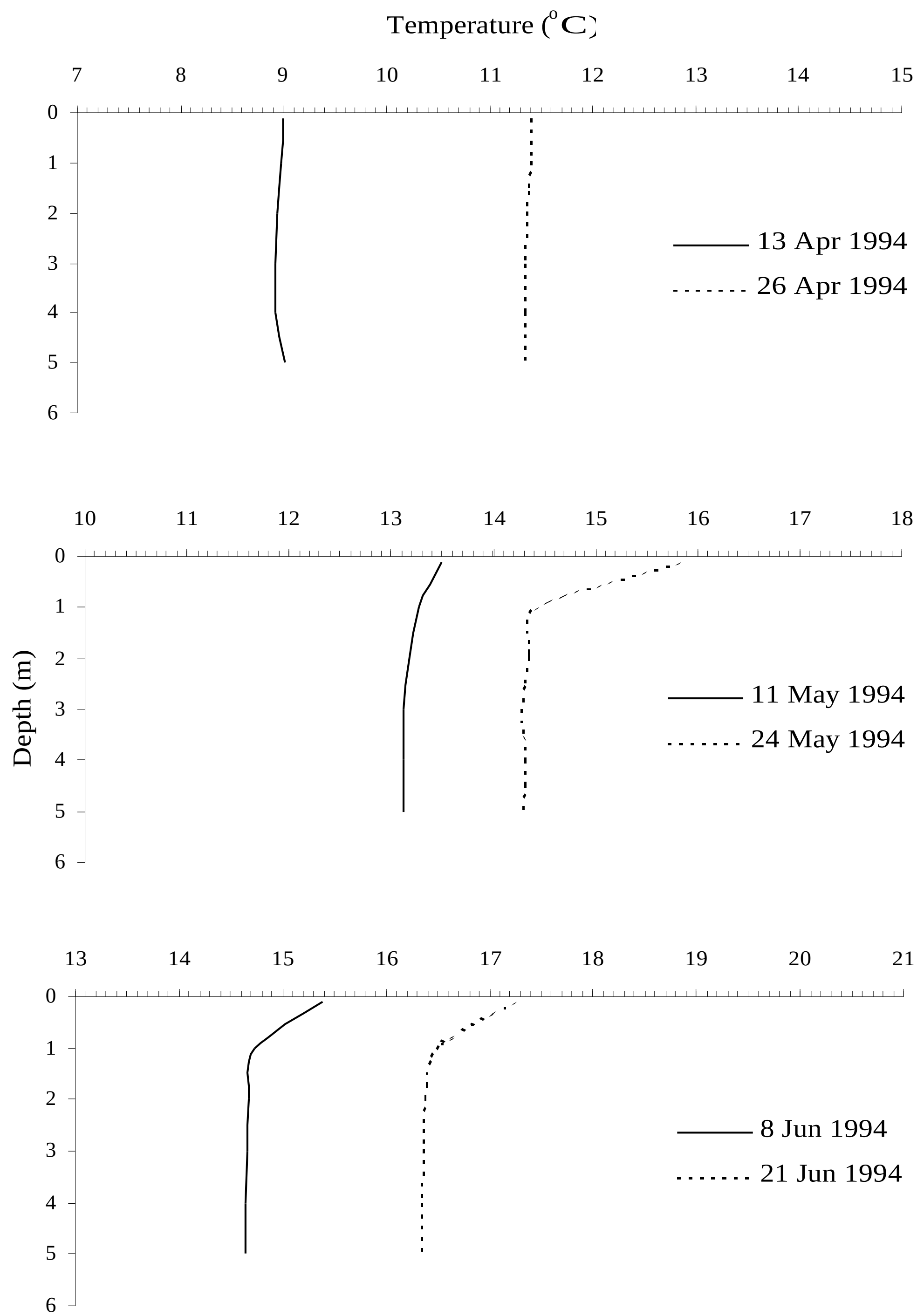
Appendix Figure B2. John Day Reservoir surface-to-bottom temperature profiles. Combined data for lower- and mid-reservoir stations, April to December 1994.



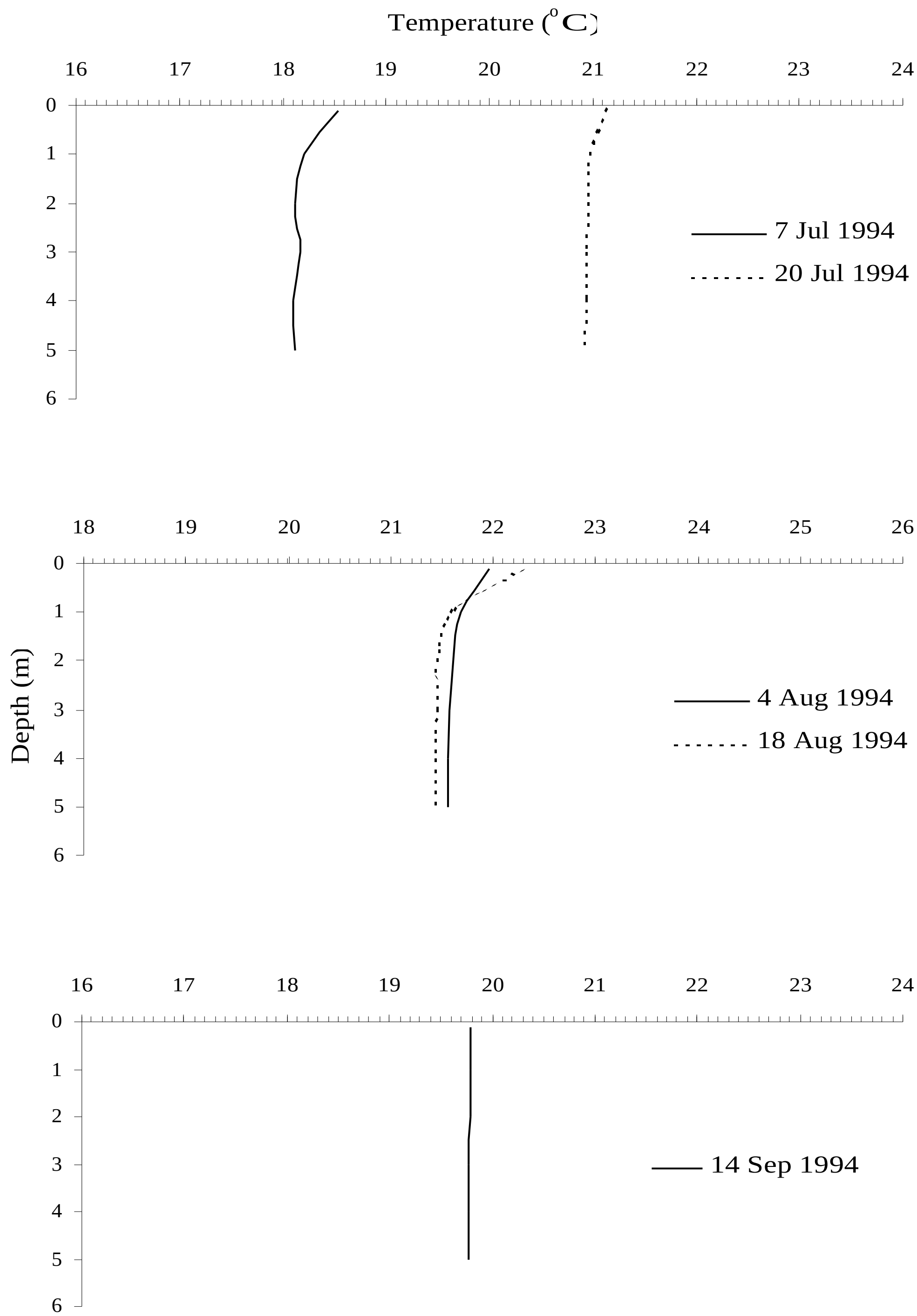
Appendix Figure B2. Continued.



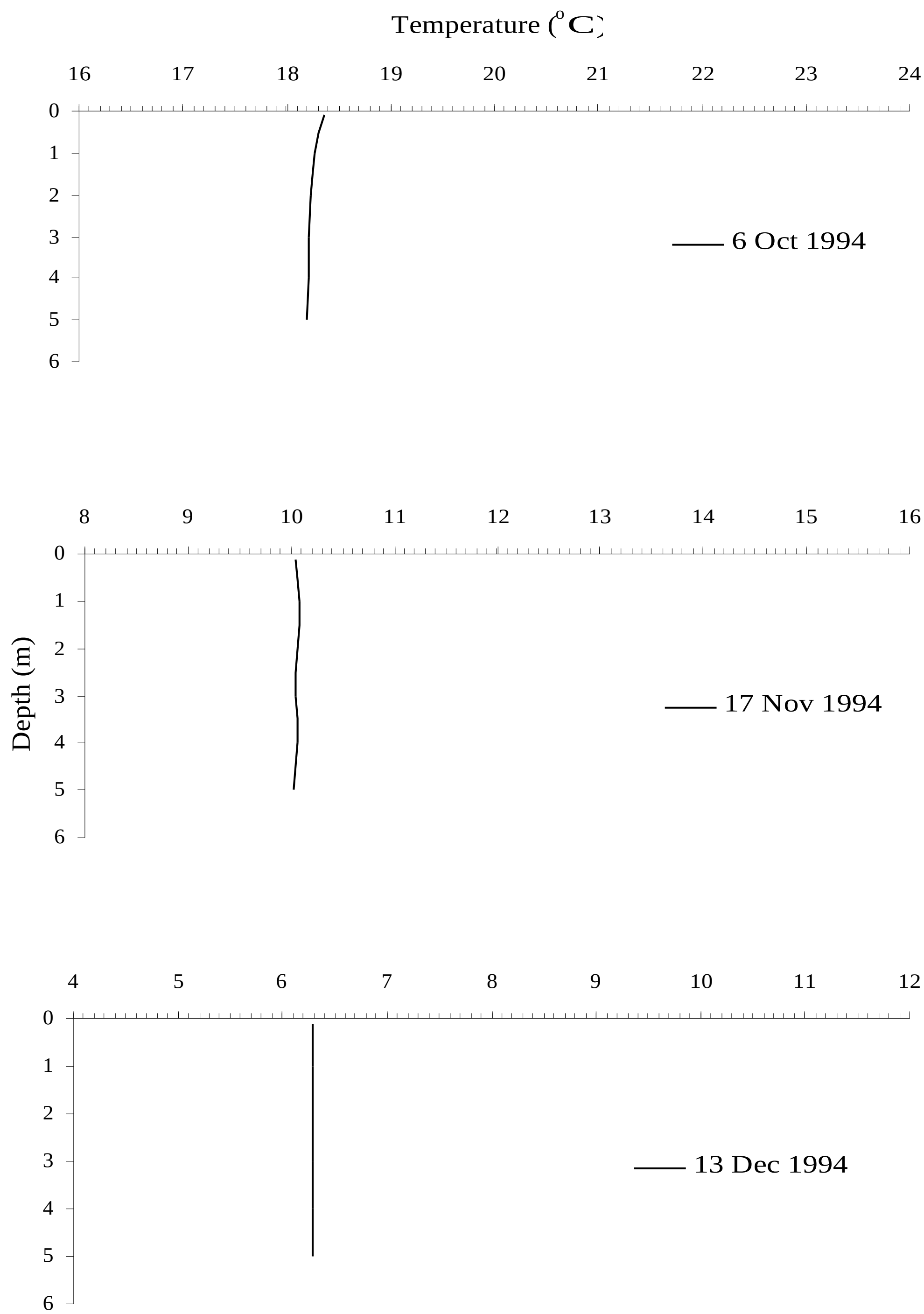
Appendix Figure B2. Continued.



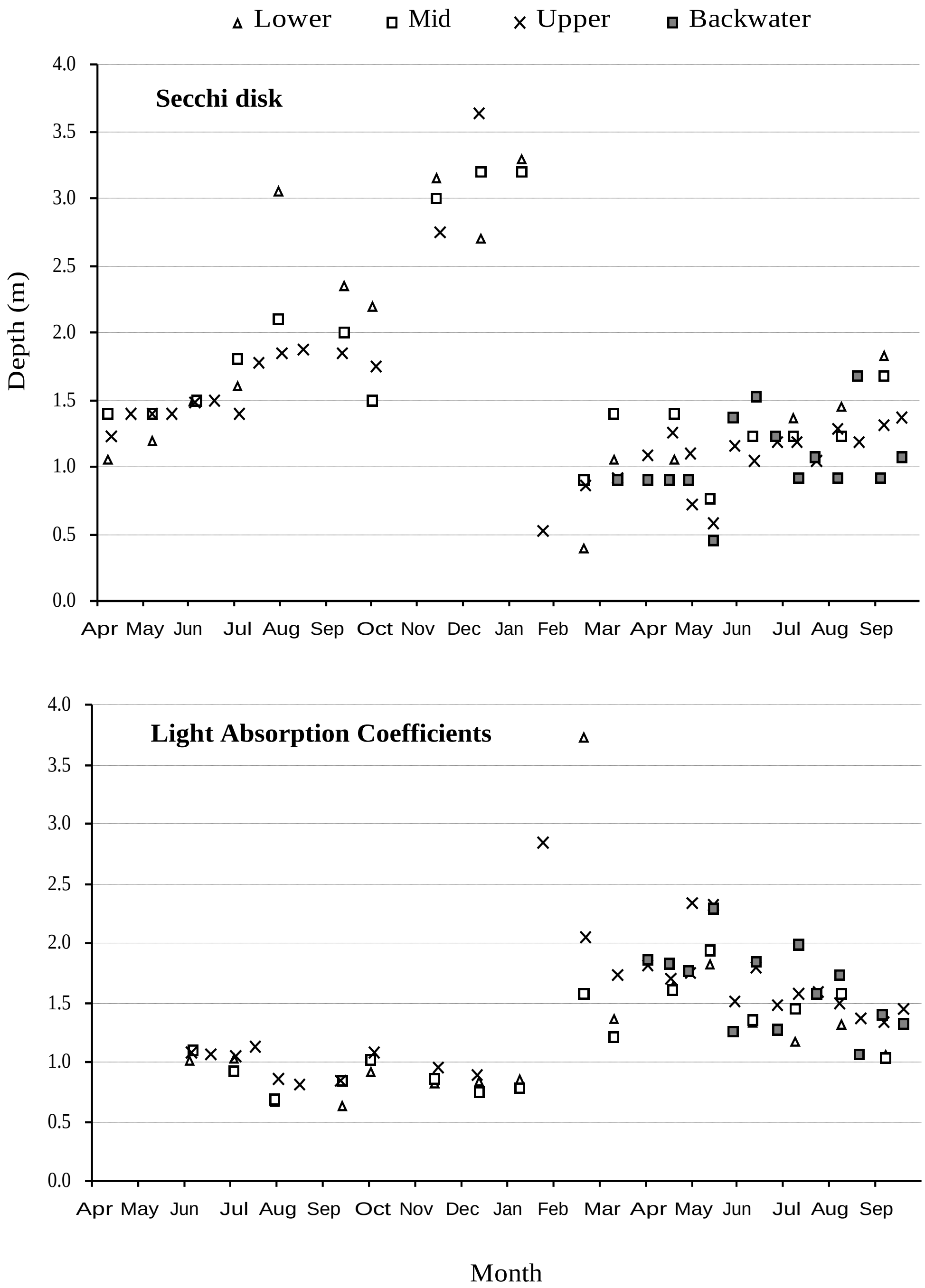
Appendix Figure B3. John Day Reservoir surface-to-bottom temperature profiles. Combined data for five upper-reservoir stations, April to December 1994.



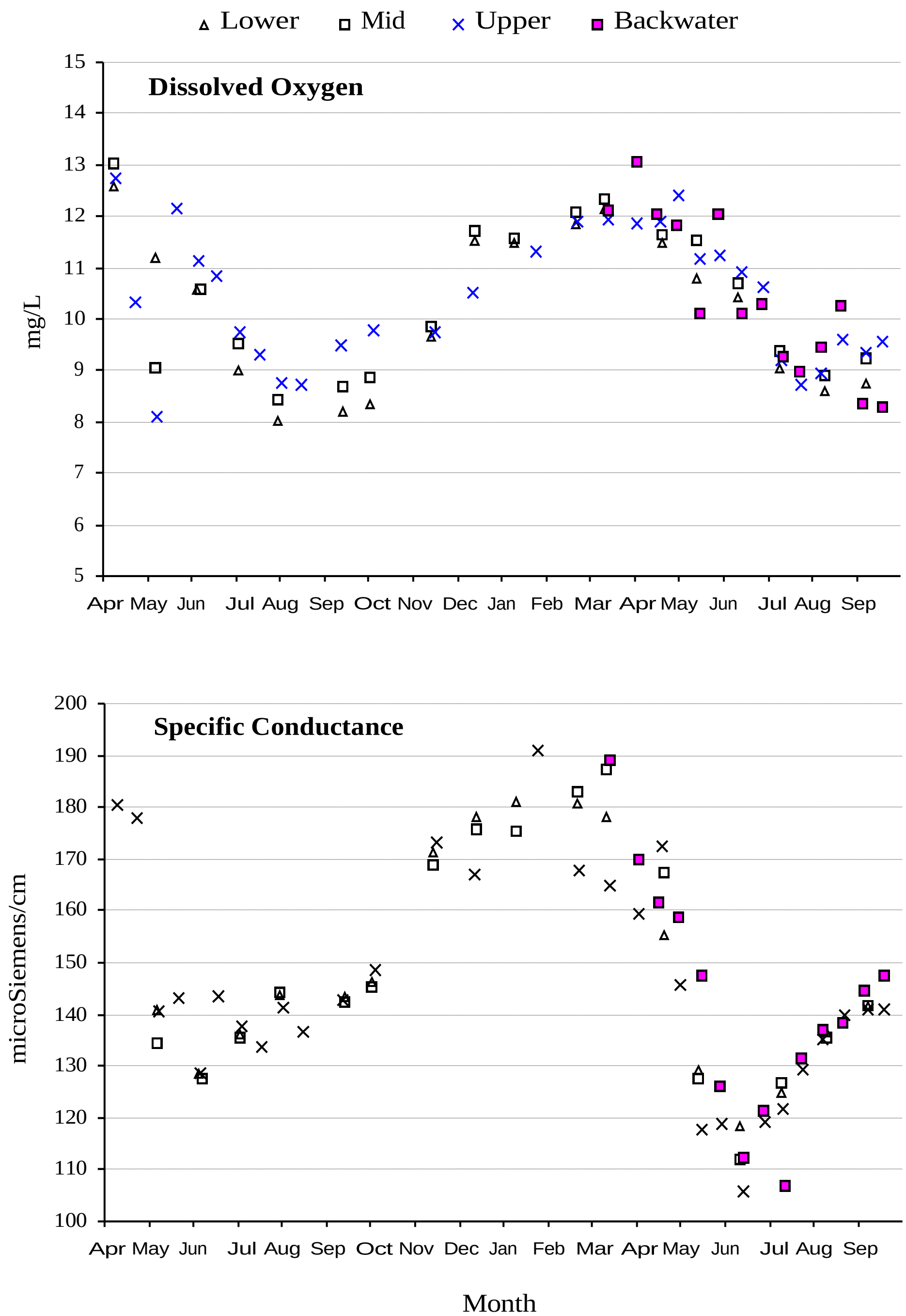
Appendix Figure B3. John Day Reservoir surface-to-bottom temperature profiles. Combined data for five upper-reservoir stations, April to December 1994.



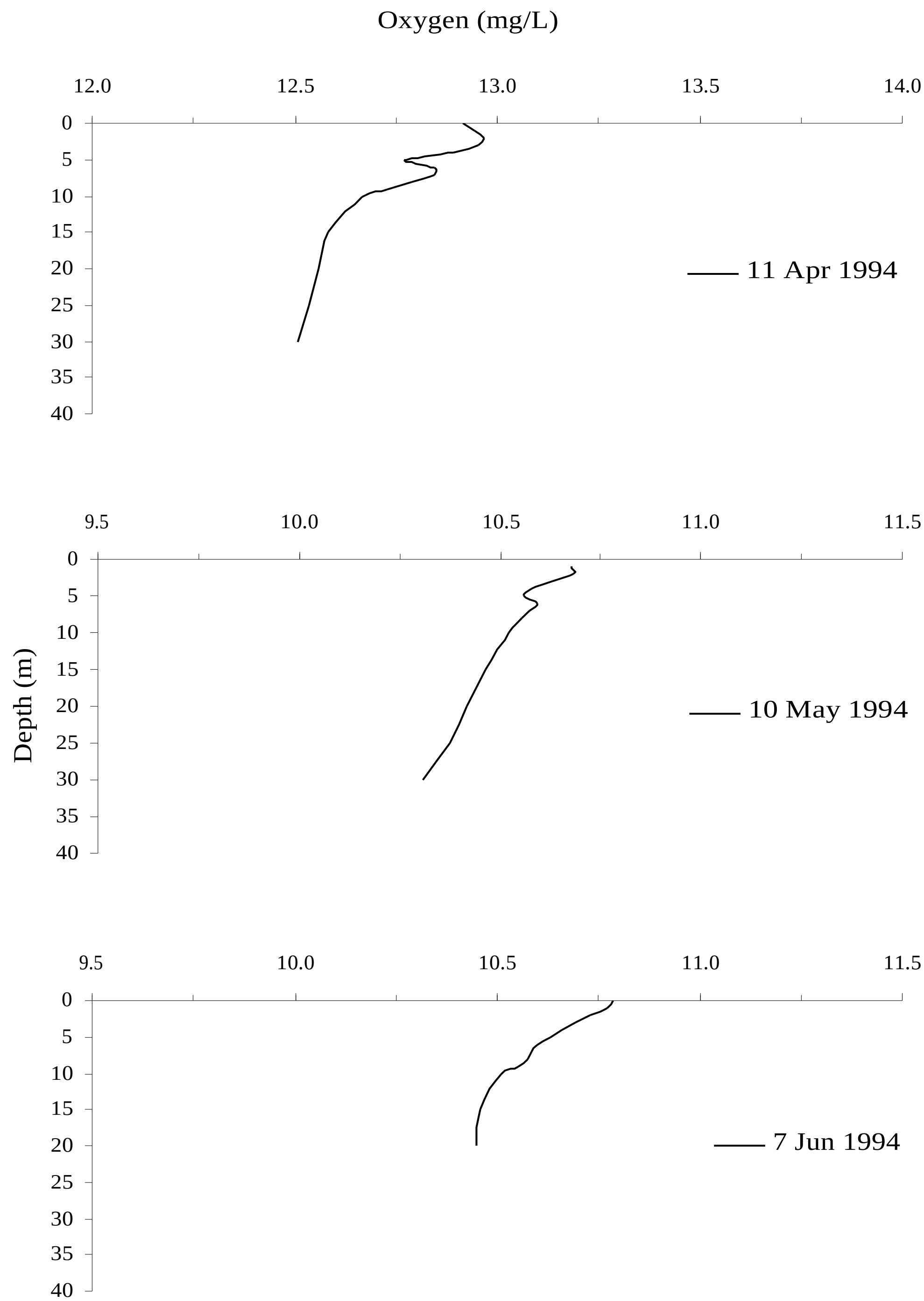
Appendix Figure B3. Continued.



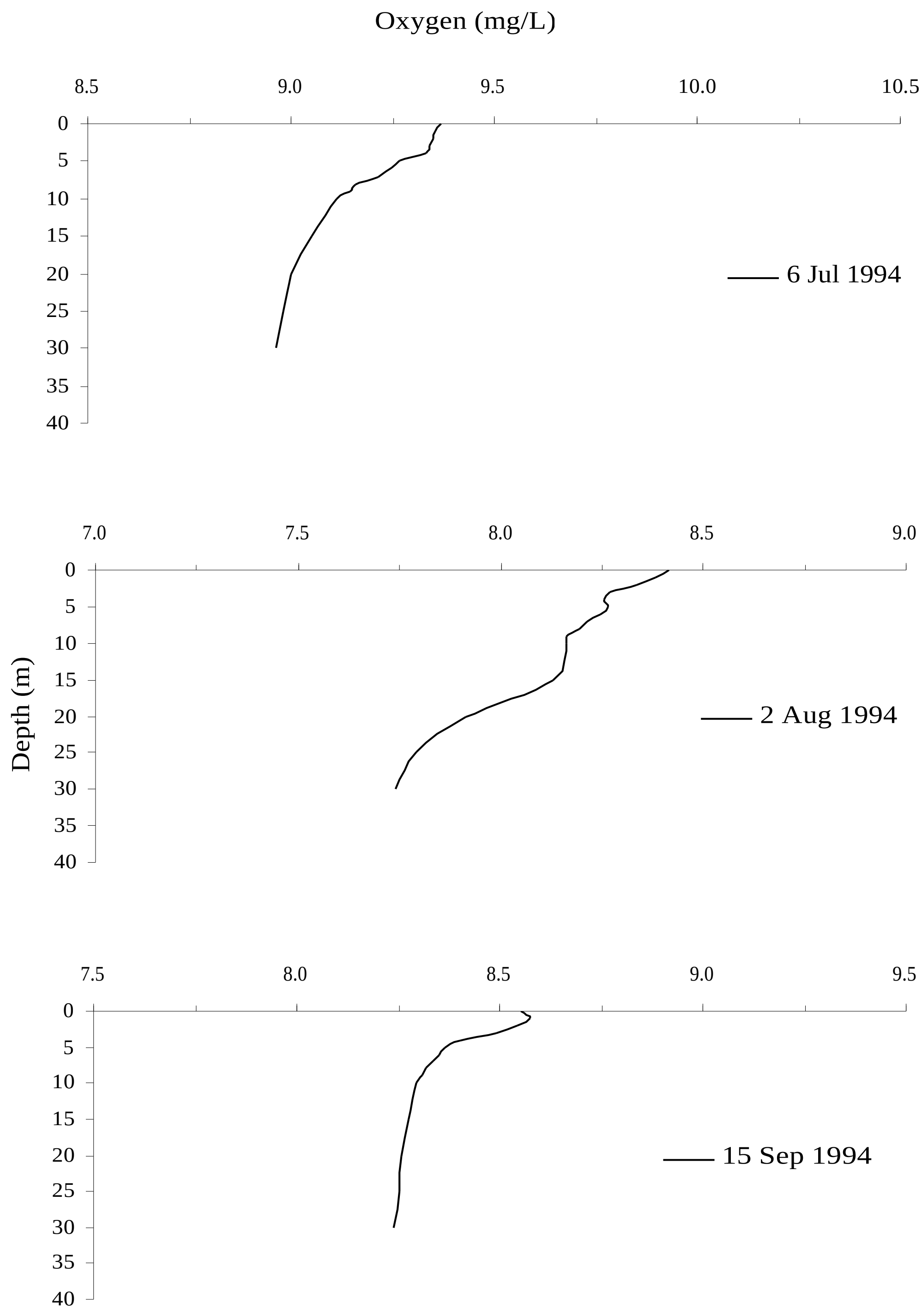
Appendix Figure B4. Temporal and spatial variation of John Day Reservoir Secchi disk readings and vertical light absorption coefficients, April 1994 to September 1995. Results from sampling at lower-, mid-, and upper-reservoir stations and at Crow Butte backwater.



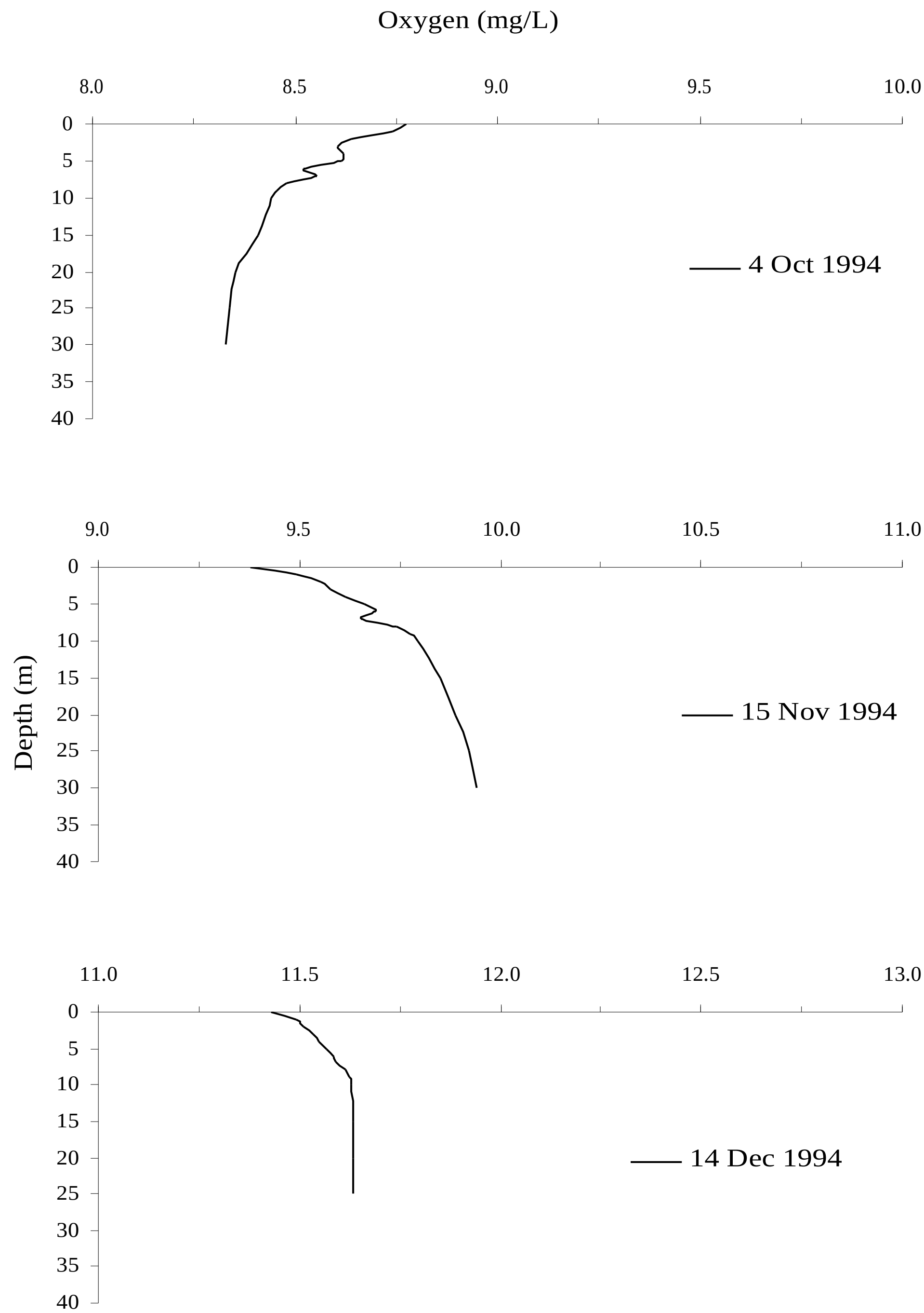
Lower
Mid
Upper
Backwater
Dissolved Oxygen
mg/L
15
14
13
12
11
10
9
8
7
6
5
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
Specific Conductance
microSiemens/cm
200
190
180
170
160
150
140
130
120
110
100
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
Month



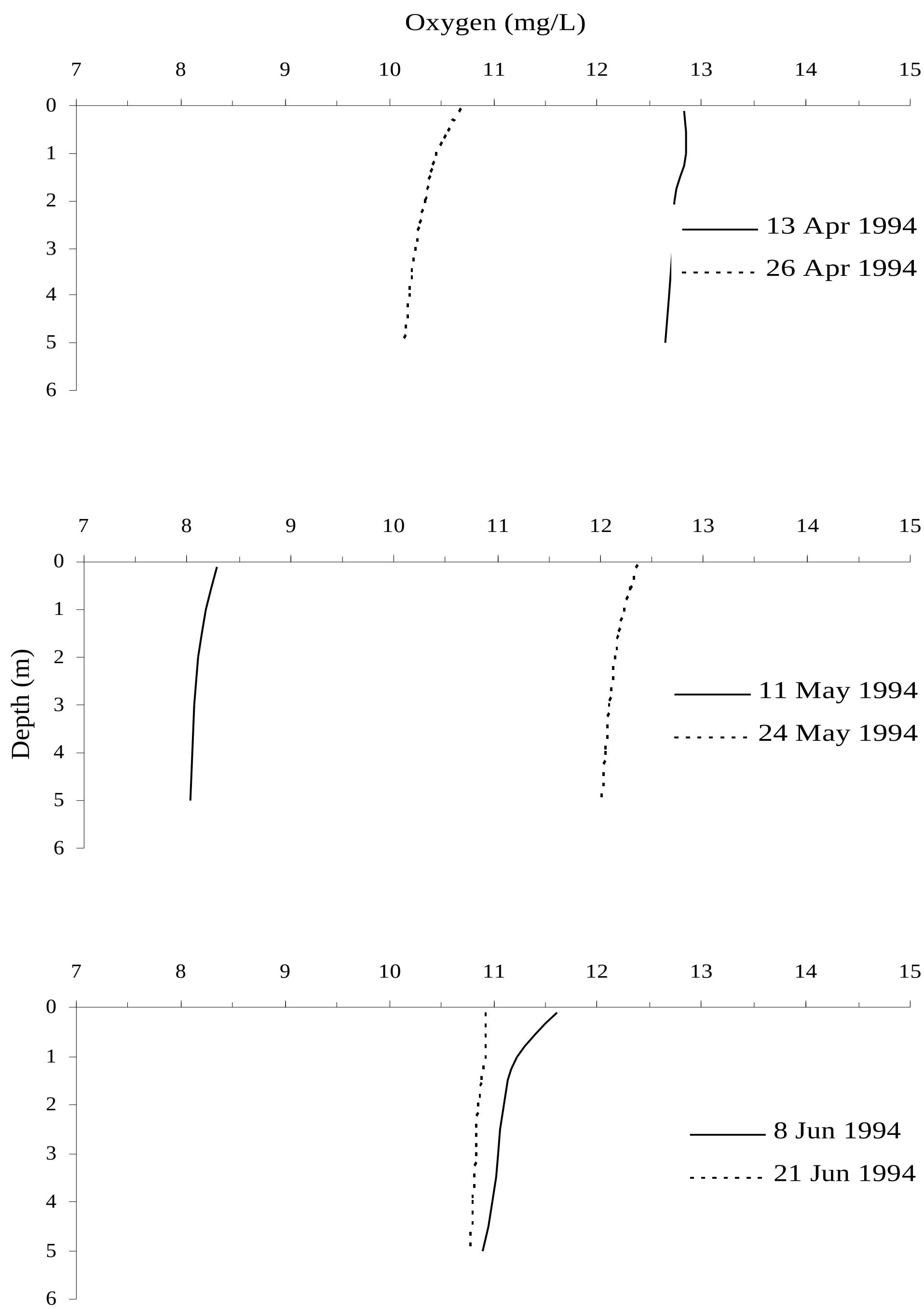
Appendix Figure B5. Temporal and spatial variation of John Day Reservoir dissolved oxygen levels and specific conductance, April 1994 to September 1995. Results from sampling at lower-, mid-, and upper-reservoir stations and at Crow Butte backwater.



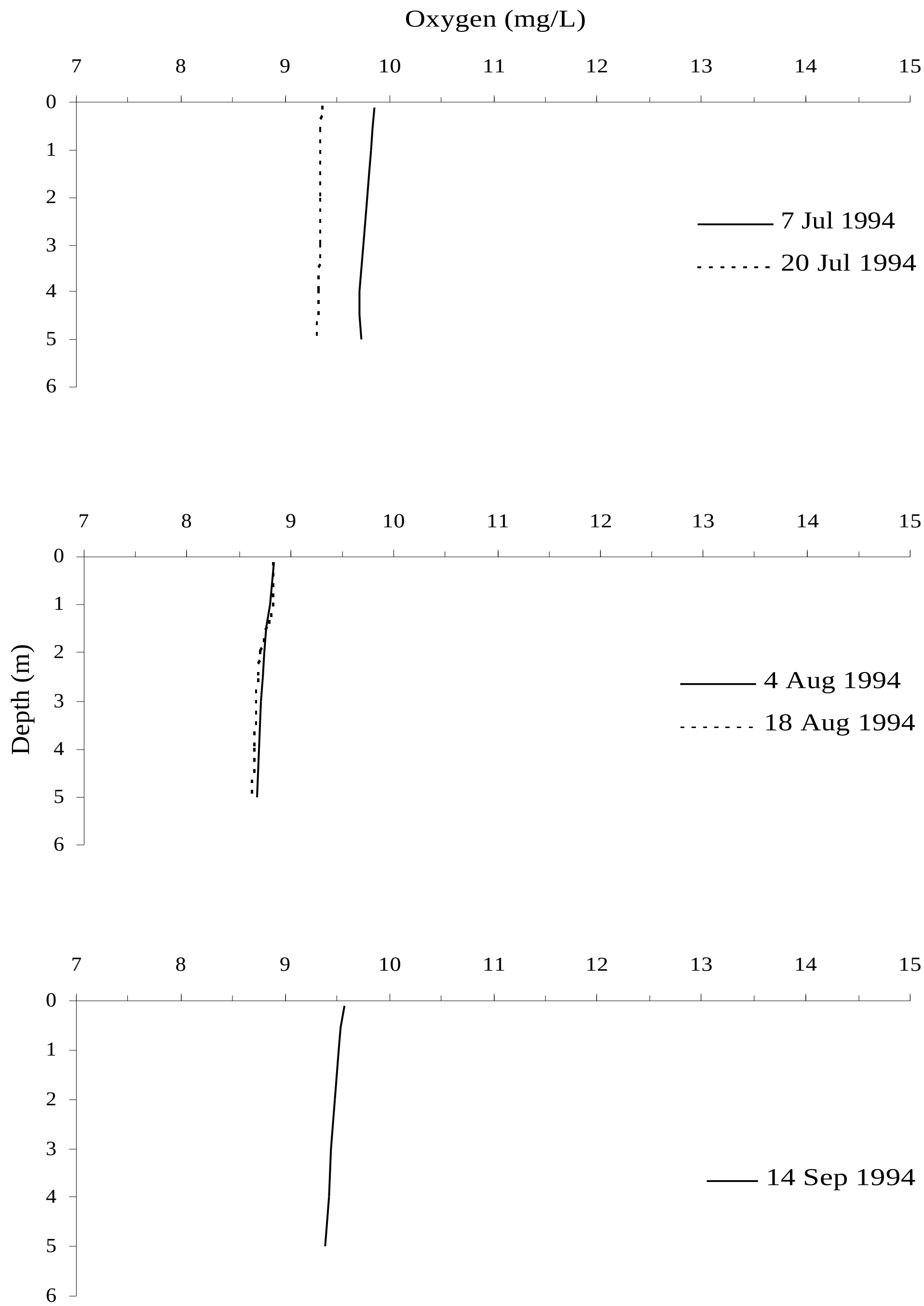
Appendix Figure B6. John Day Reservoir surface-to-bottom oxygen profiles. Combined data for lower- and mid-reservoir stations, April to December 1994.



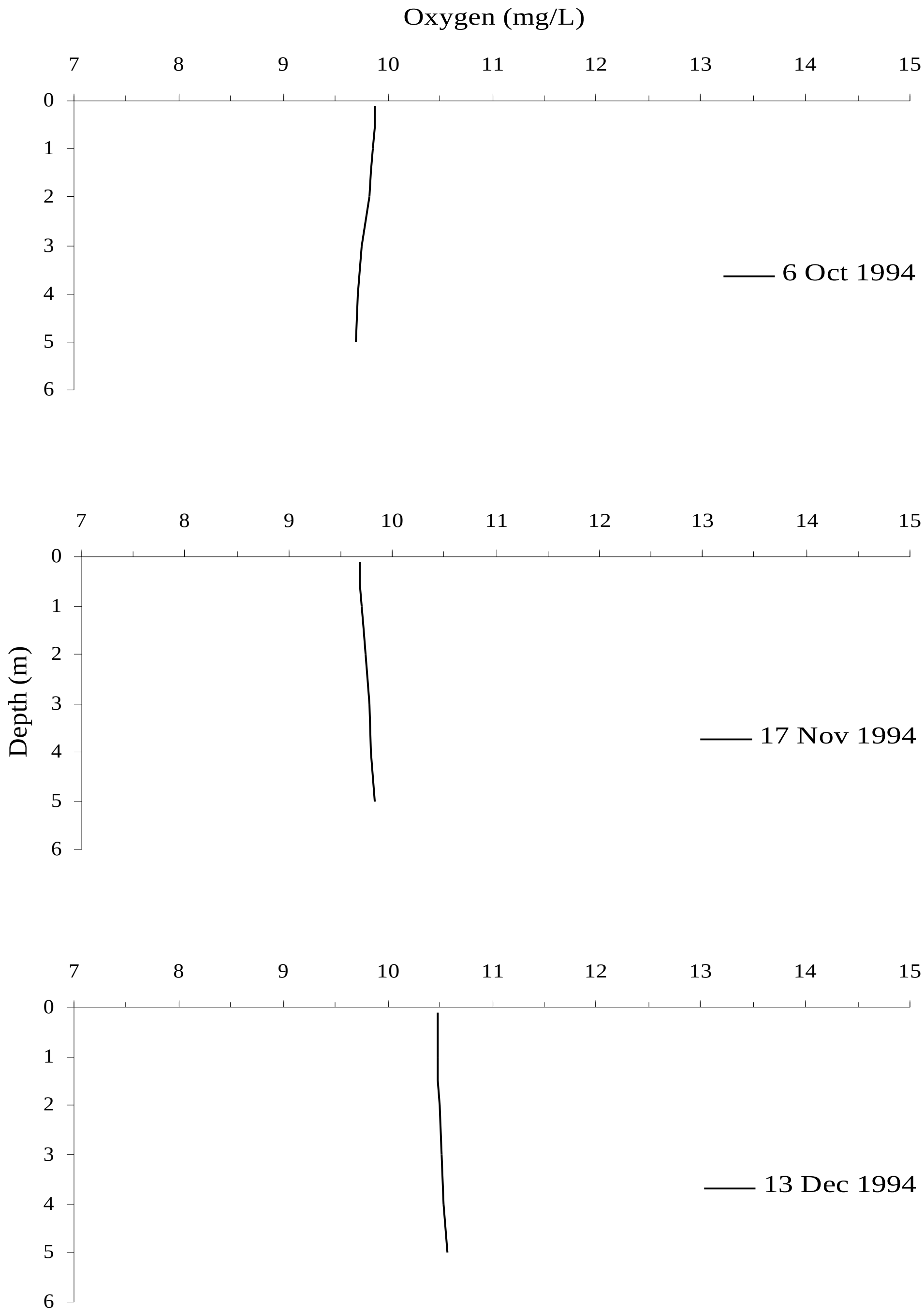
Appendix Figure B6. Continued.



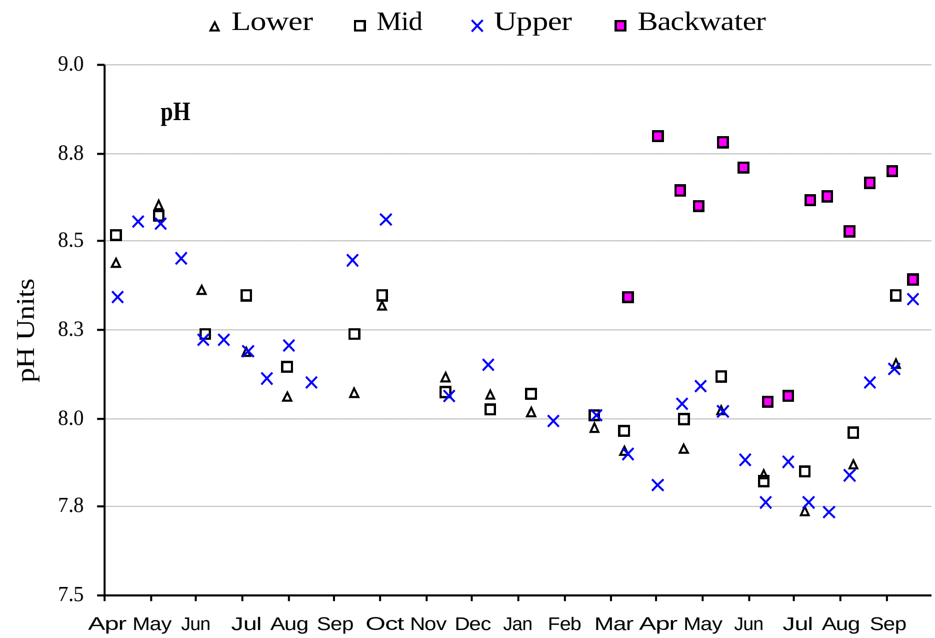
Appendix Figure B6.   Continued.

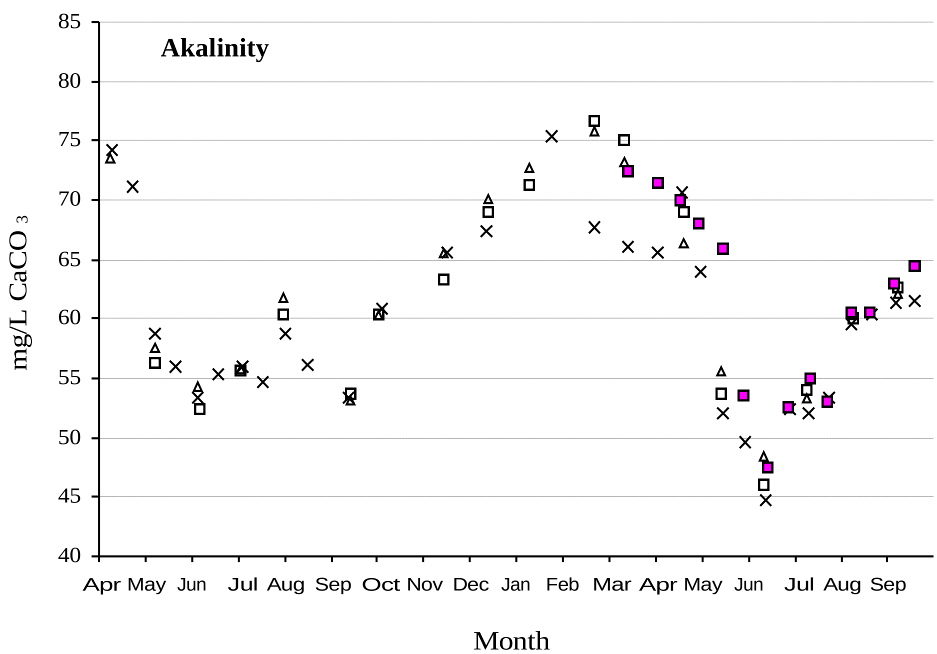


Appendix Figure B7. John Day Reservoir surface-to-bottom oxygen profiles. Combined data for five upper-reservoir stations, April to December 1994.

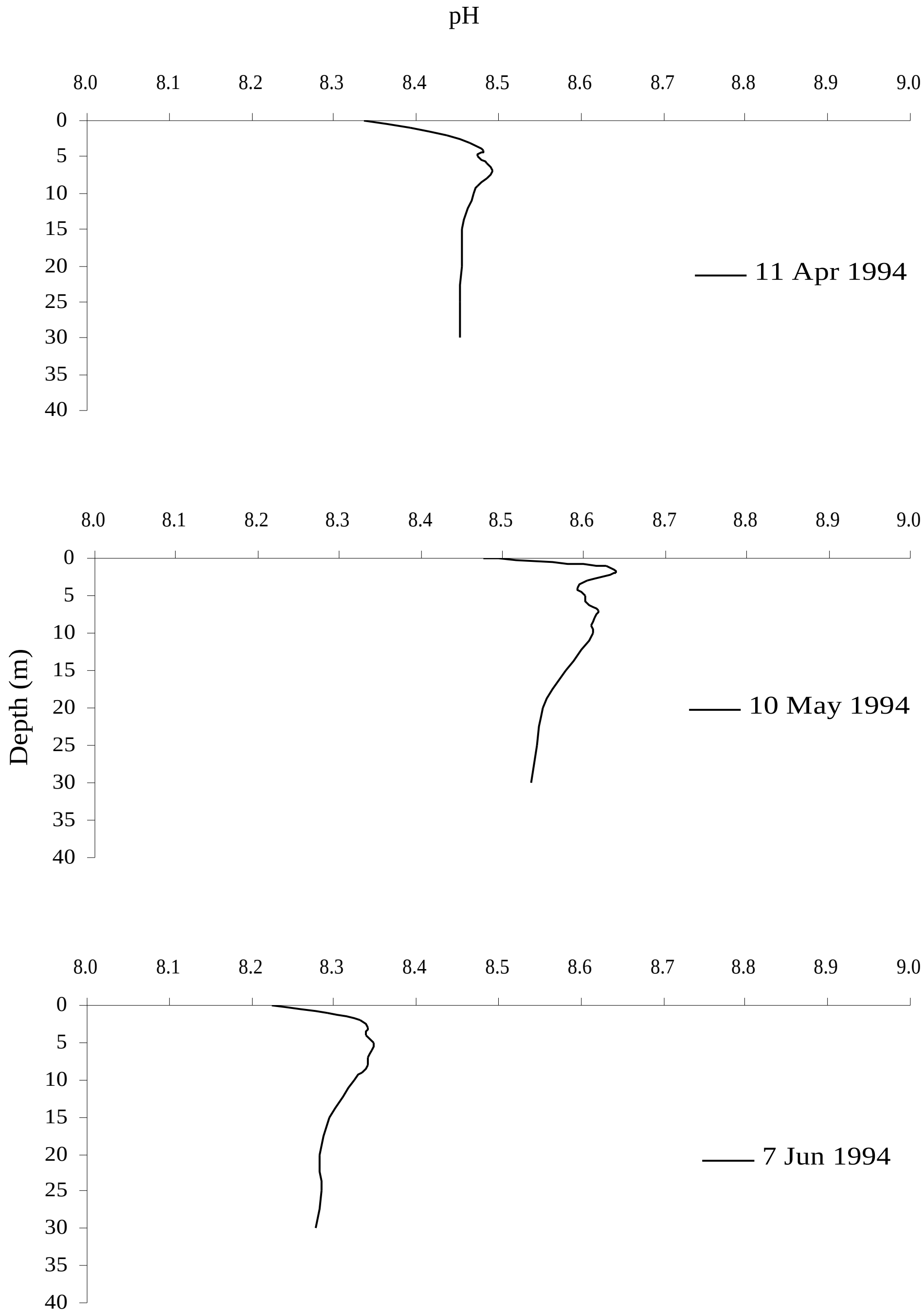


Appendix Figure B7. Continued.

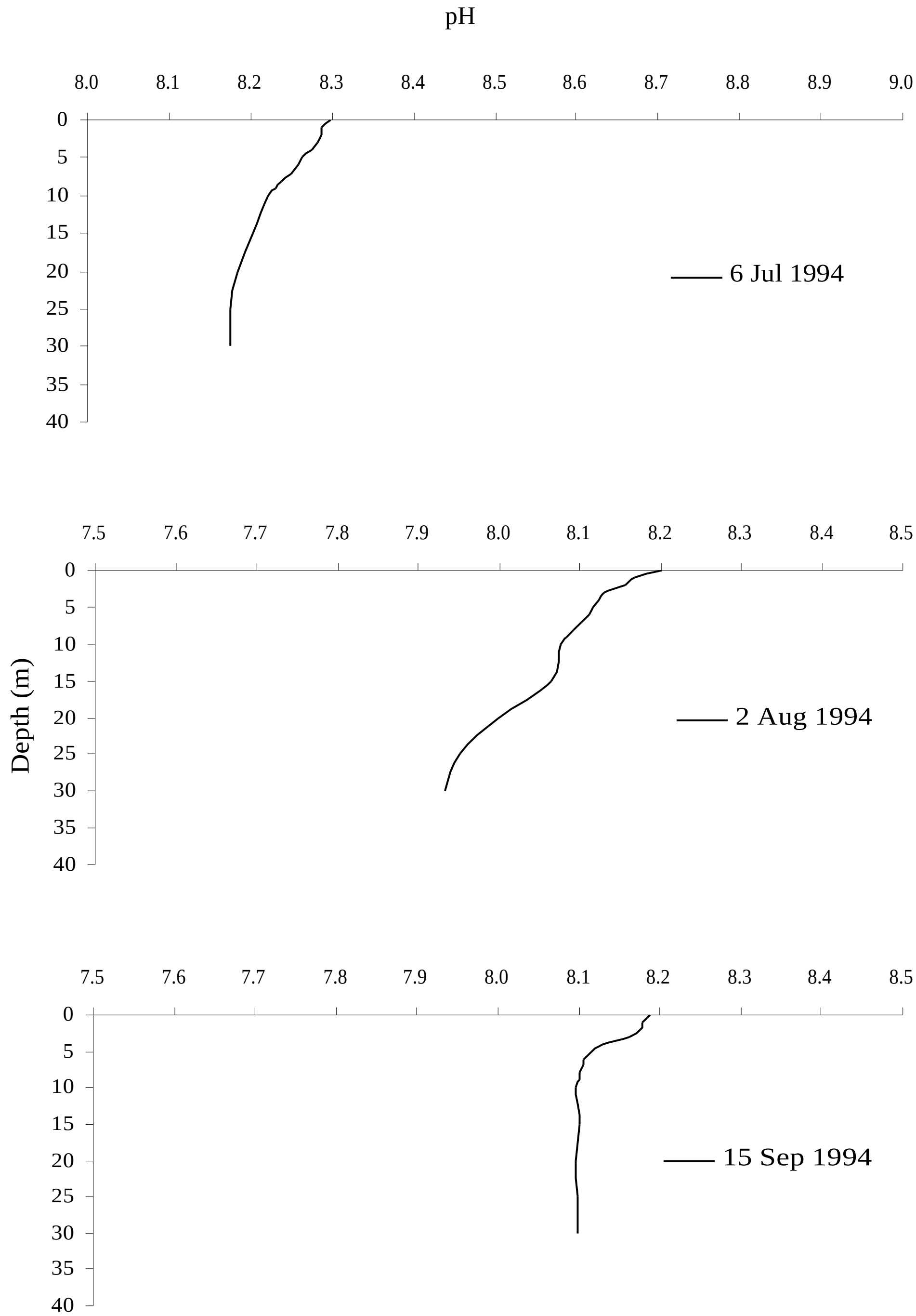




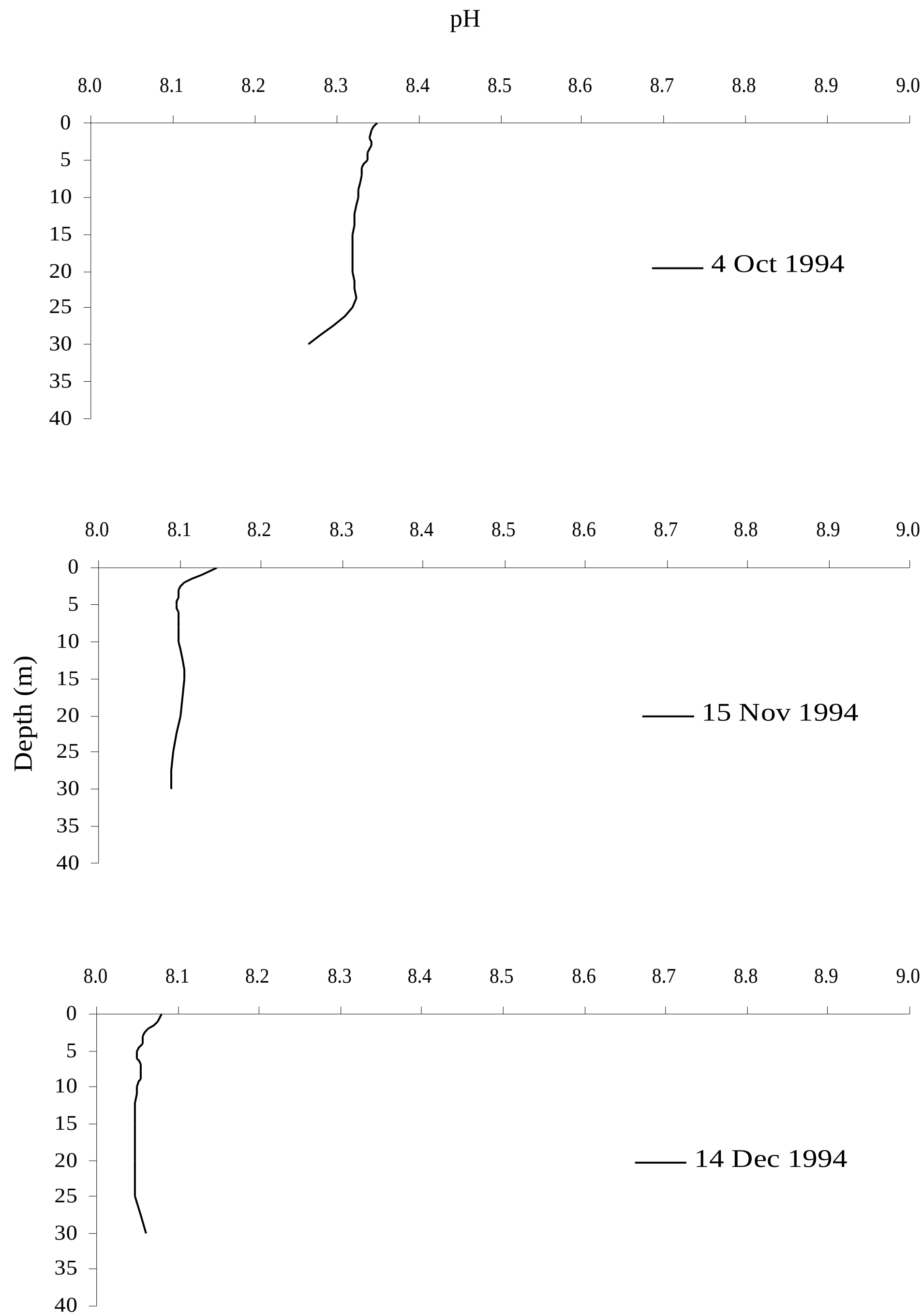
Appendix Figure B7. Continued.



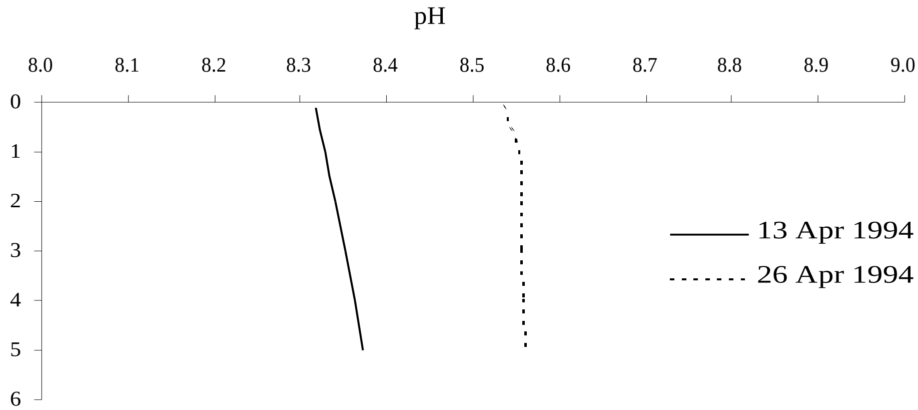
Appendix Figure B8. Temporal and spatial variation of John Day Reservoir pH and alkalinity, April 1994 to September 1995. Results from sampling at lower-, mid-, and upper-reservoir stations and at Crow Butte backwater.

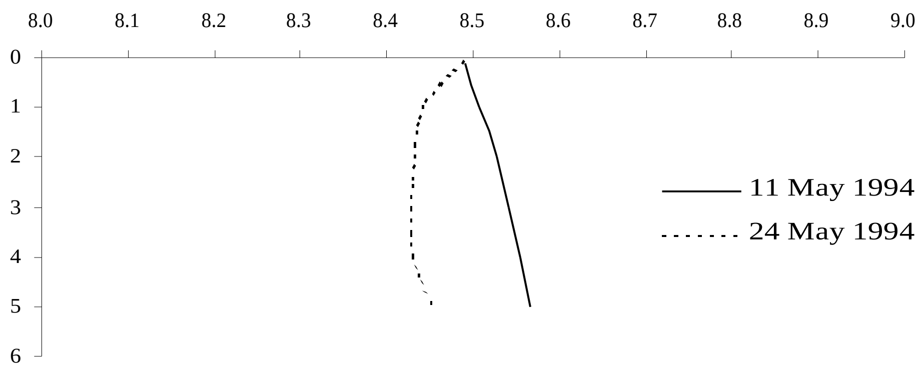


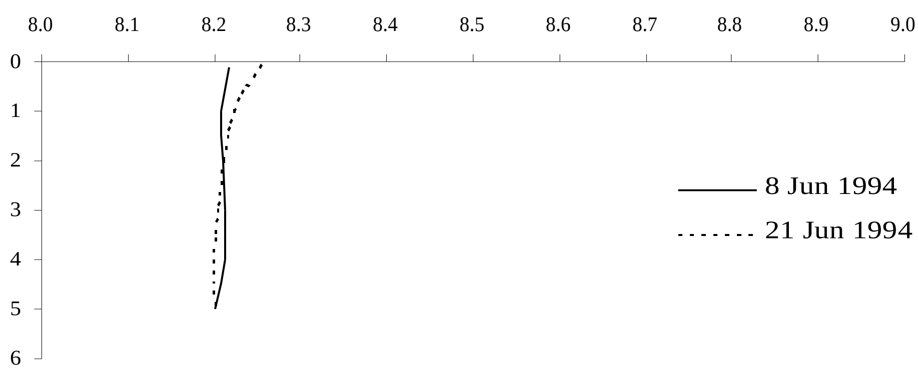
Appendix Figure B9. John Day Reservoir surface-to-bottom pH profiles. Combined data for lower- and mid-reservoir stations, April to December 1994.



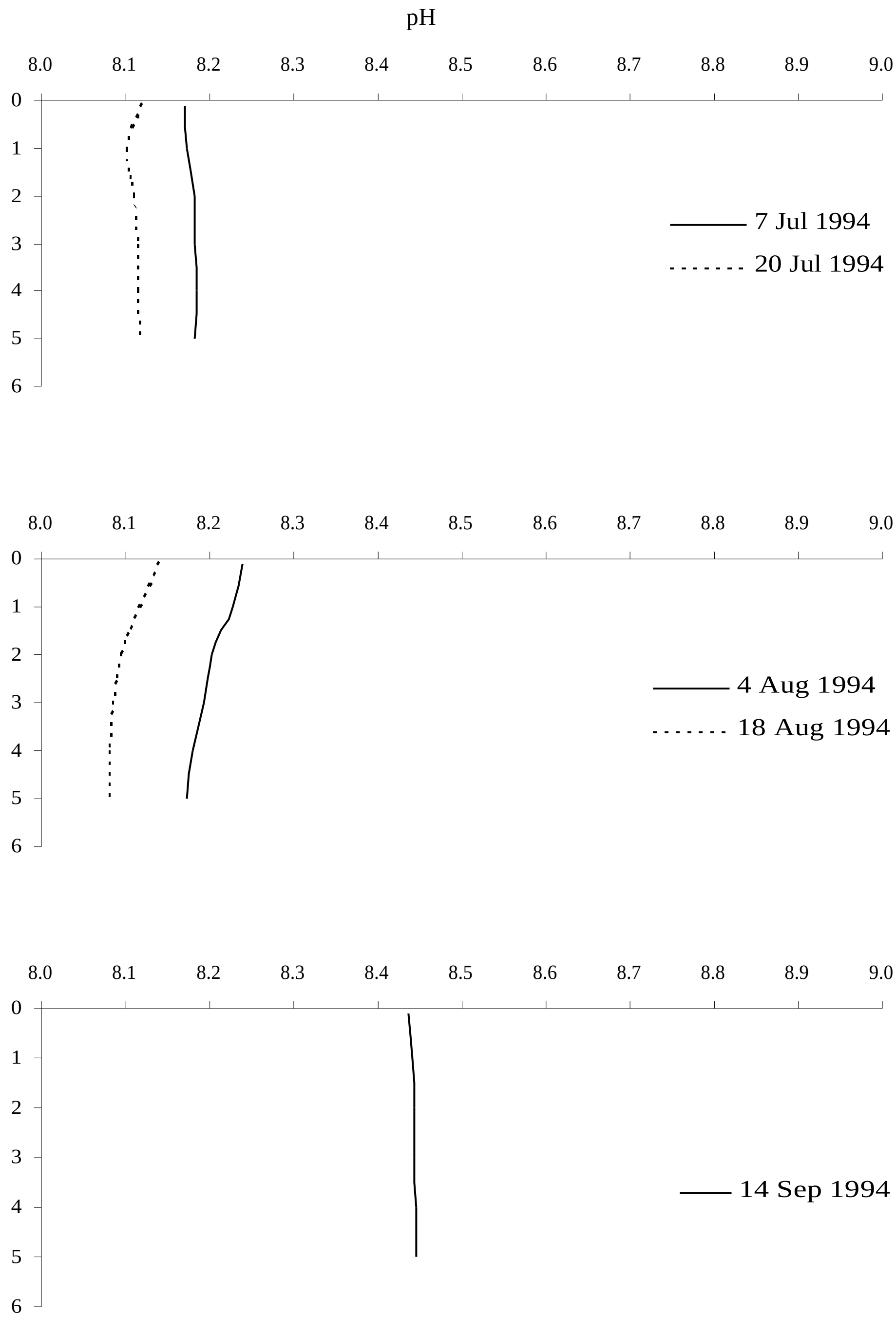
Appendix Figure B9. Continued.



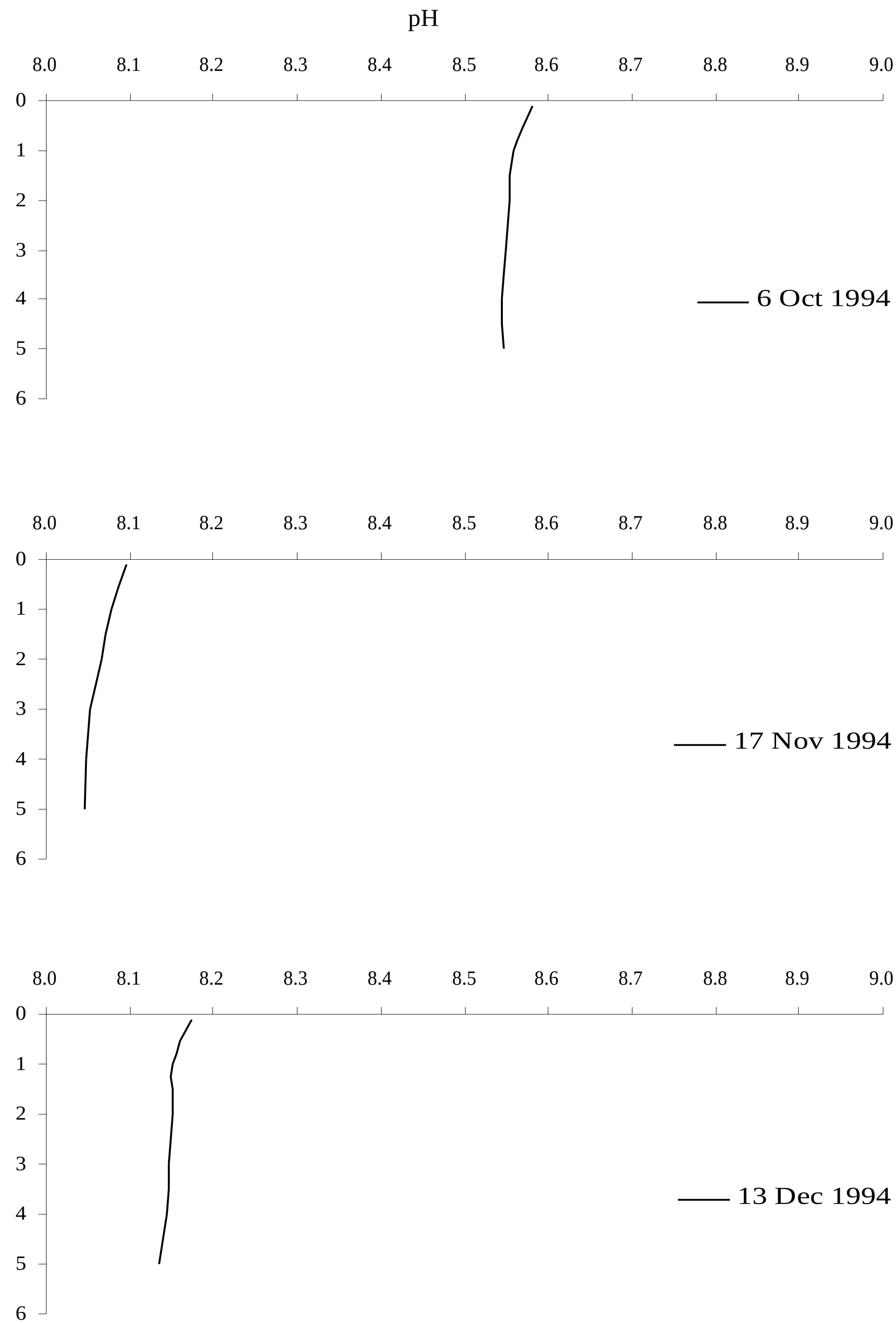




Appendix Figure B9. Continued.

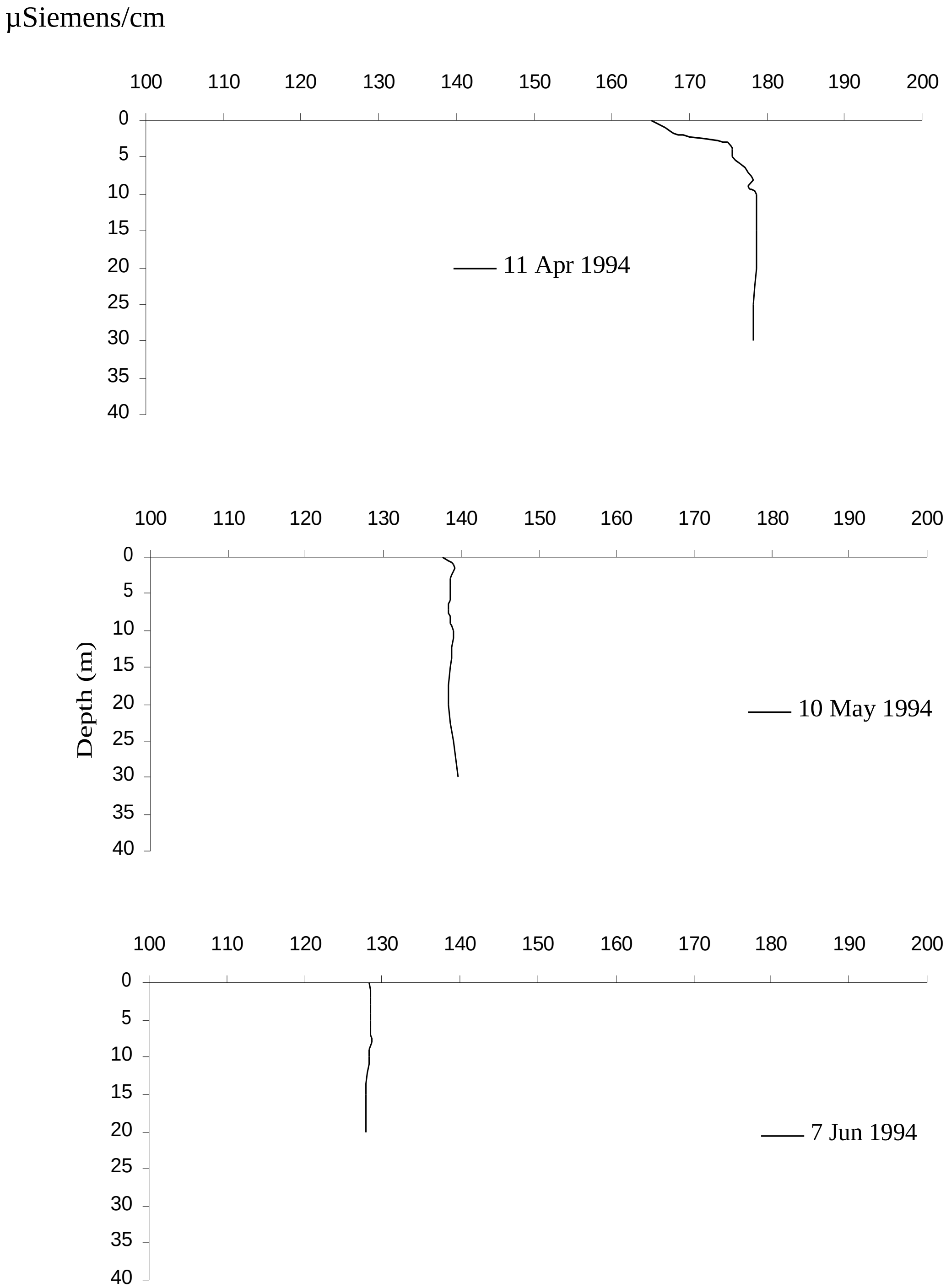


Appendix Figure B10. John Day Reservoir surface-to-bottom pH profiles. Combined data for upper-reservoir stations, April to December 1994.

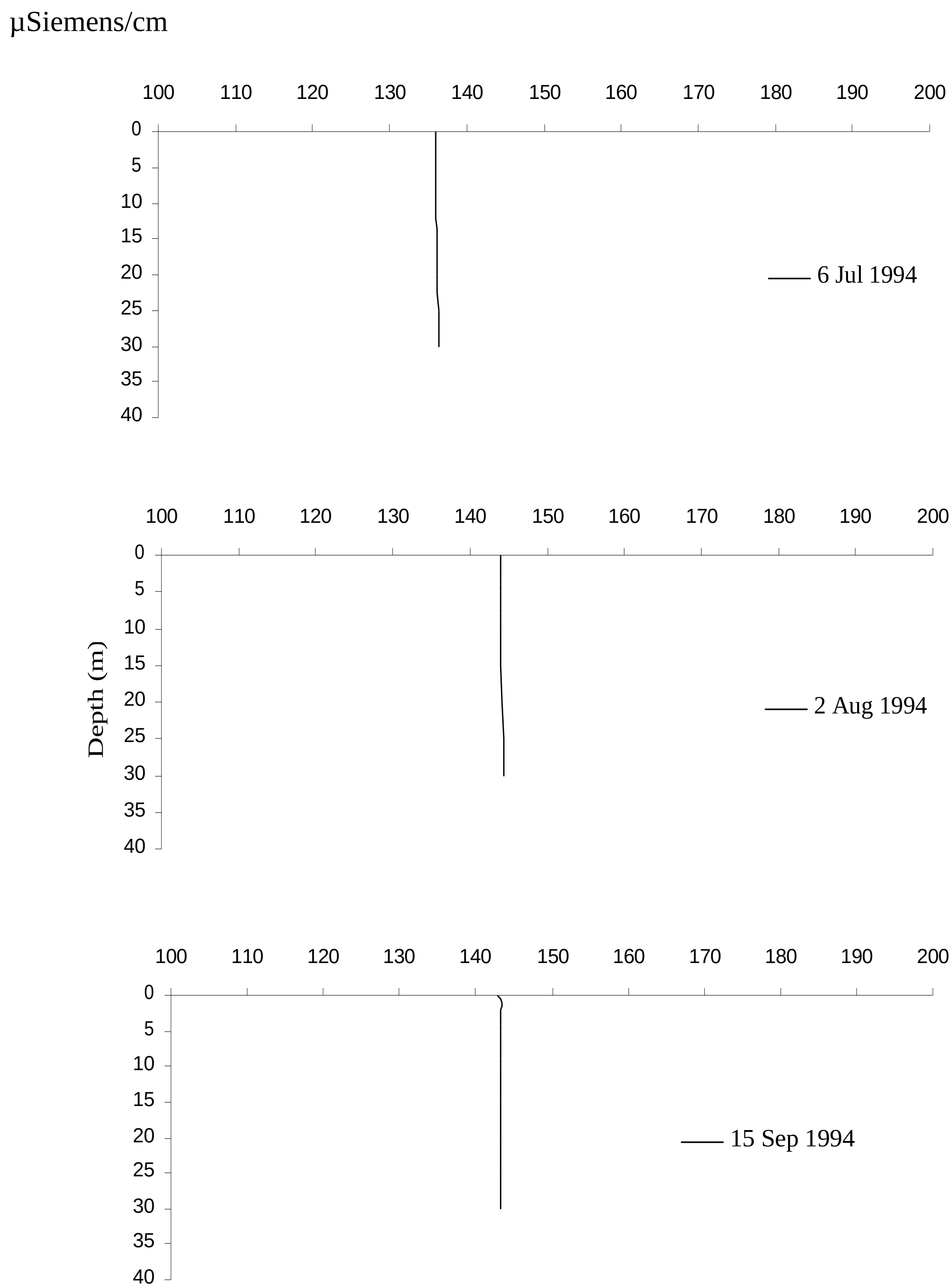


Appendix Figure B10. Continued.

Appendix Figure B10. Continued.

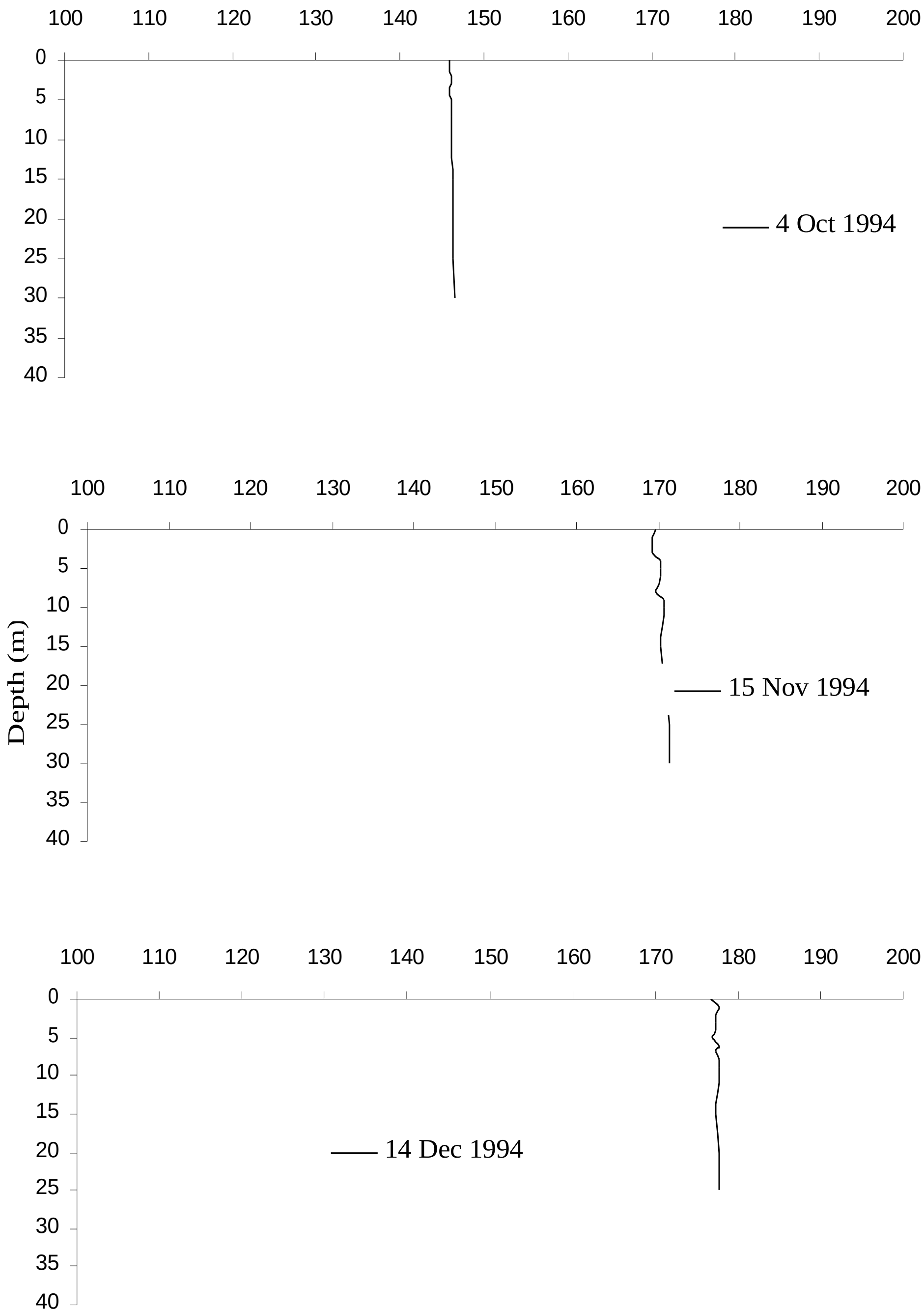


Appendix Figure B11. John Day Reservoir specific conductance profiles. Combined data for lower- and mid-reservoir stations, April to December 1994.

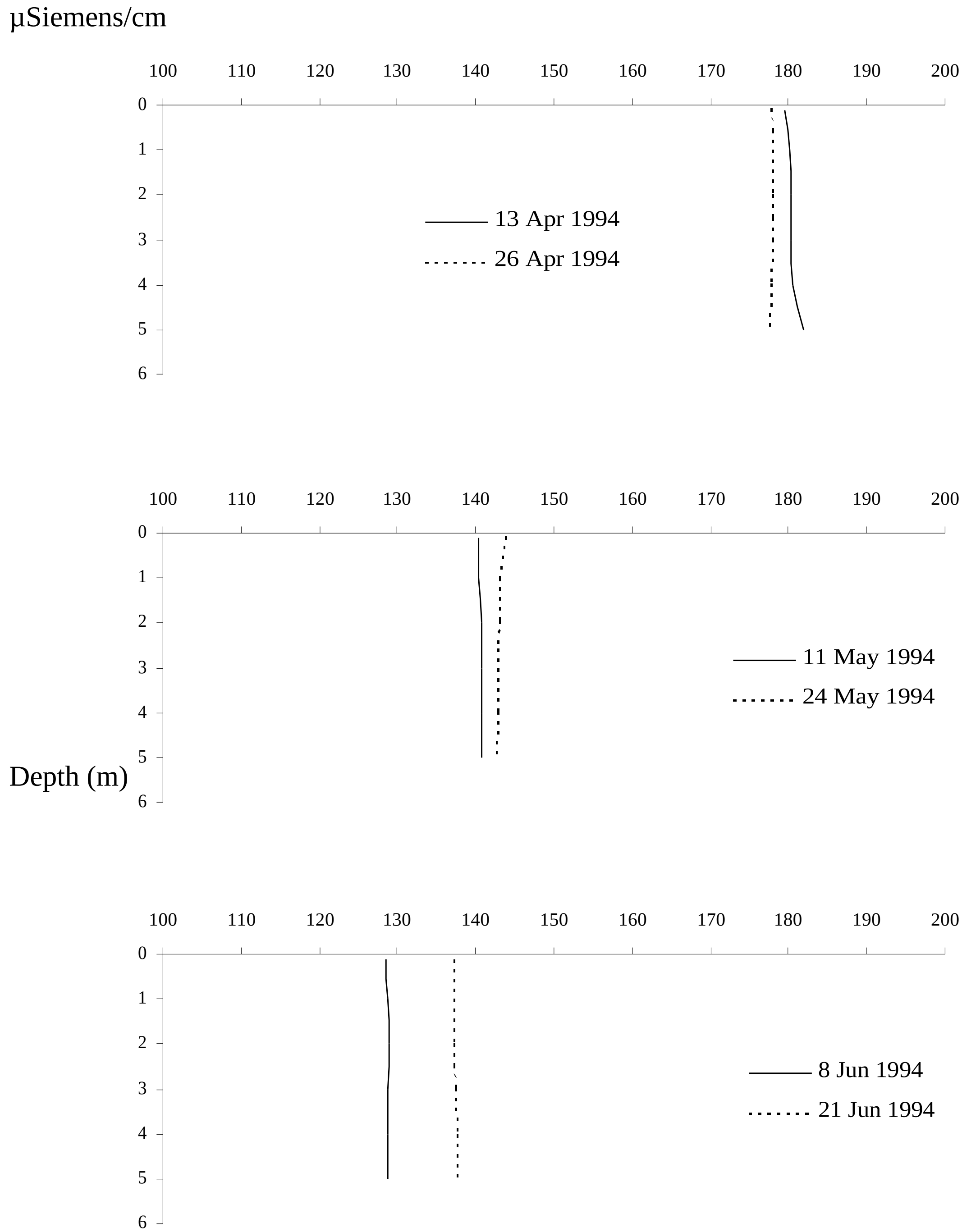


Appendix Figure B11. Continued.

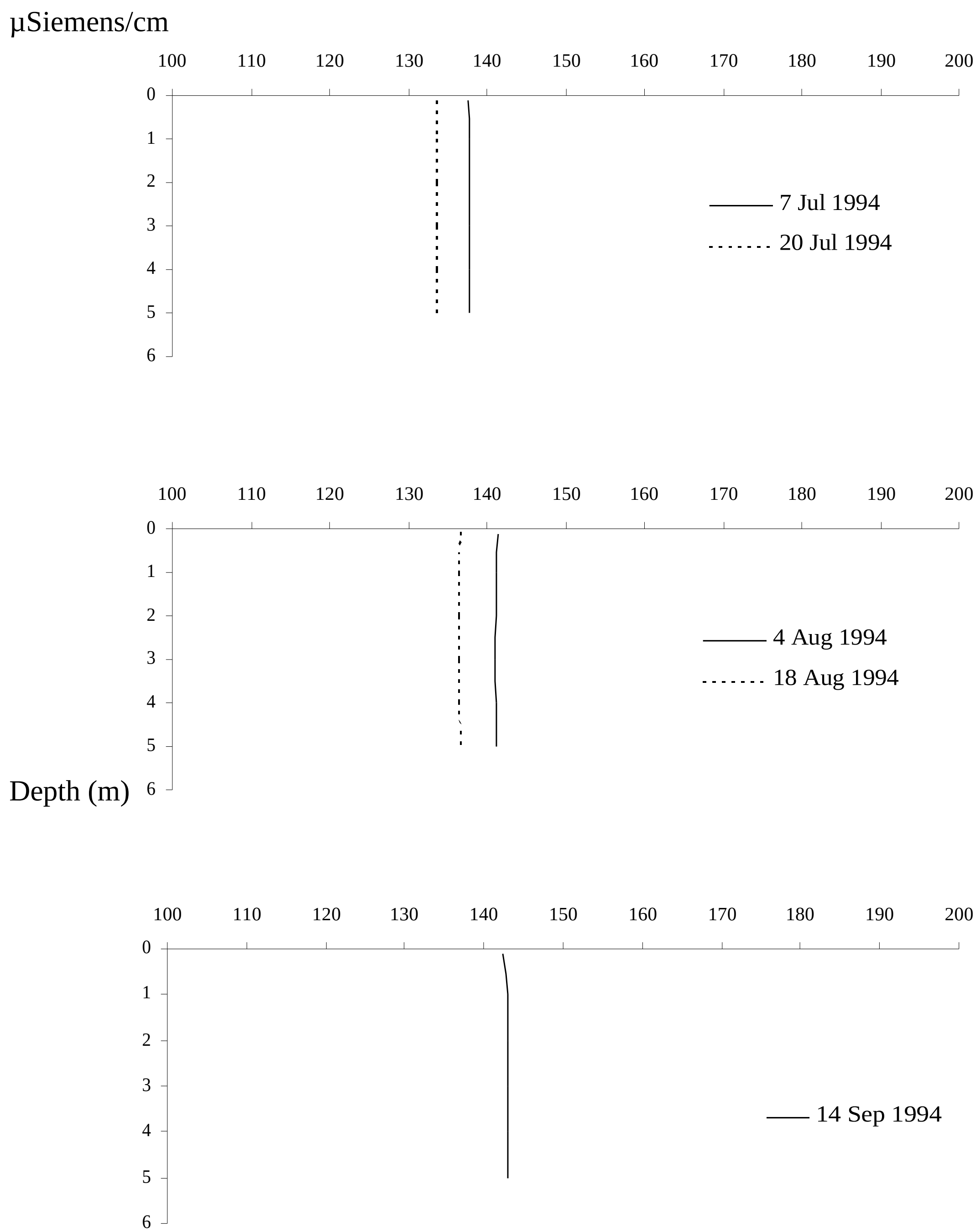
μSiemens/cm



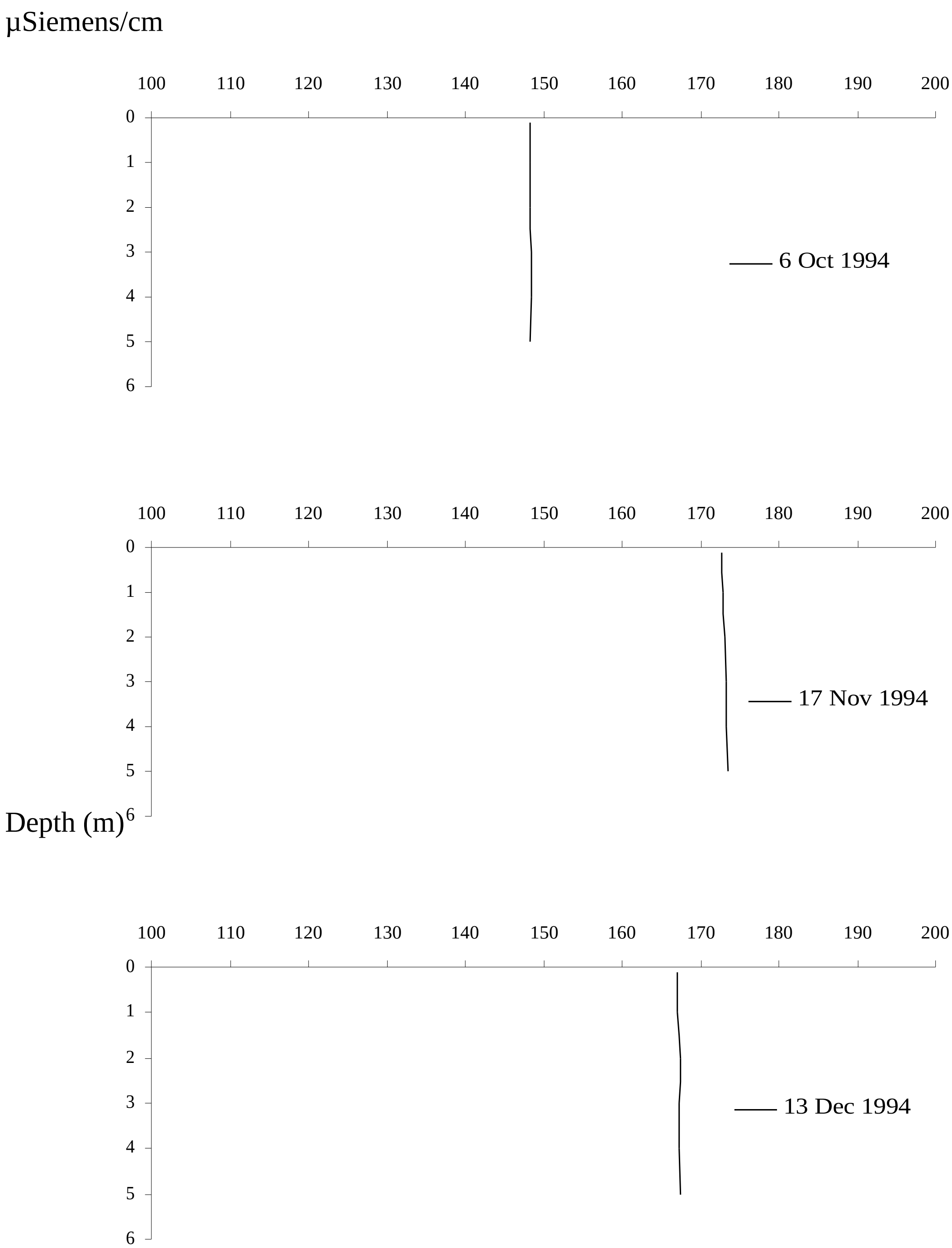
Appendix Figure B11. Continued.



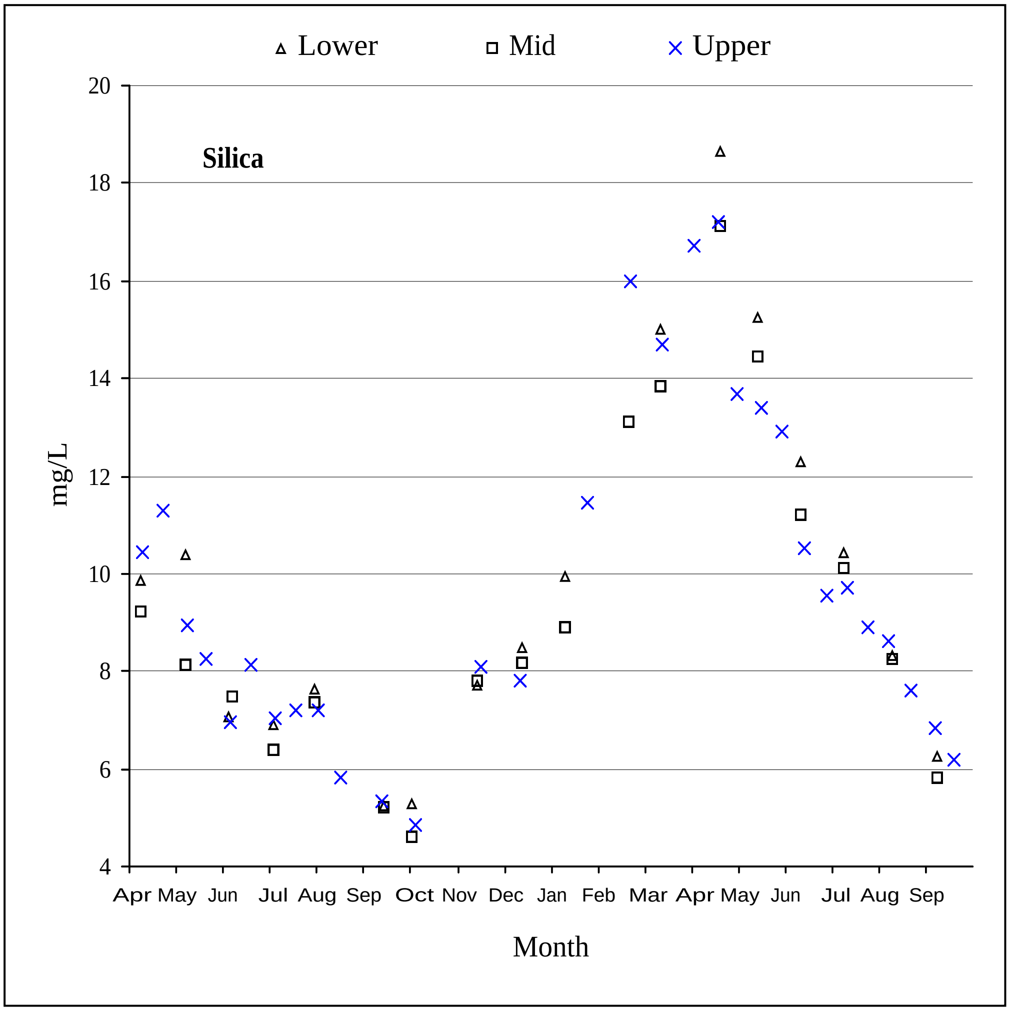
Appendix Figure B12. John Day Reservoir specific conductance profiles. Combined data for upper-reservoir stations, April to December 1994.



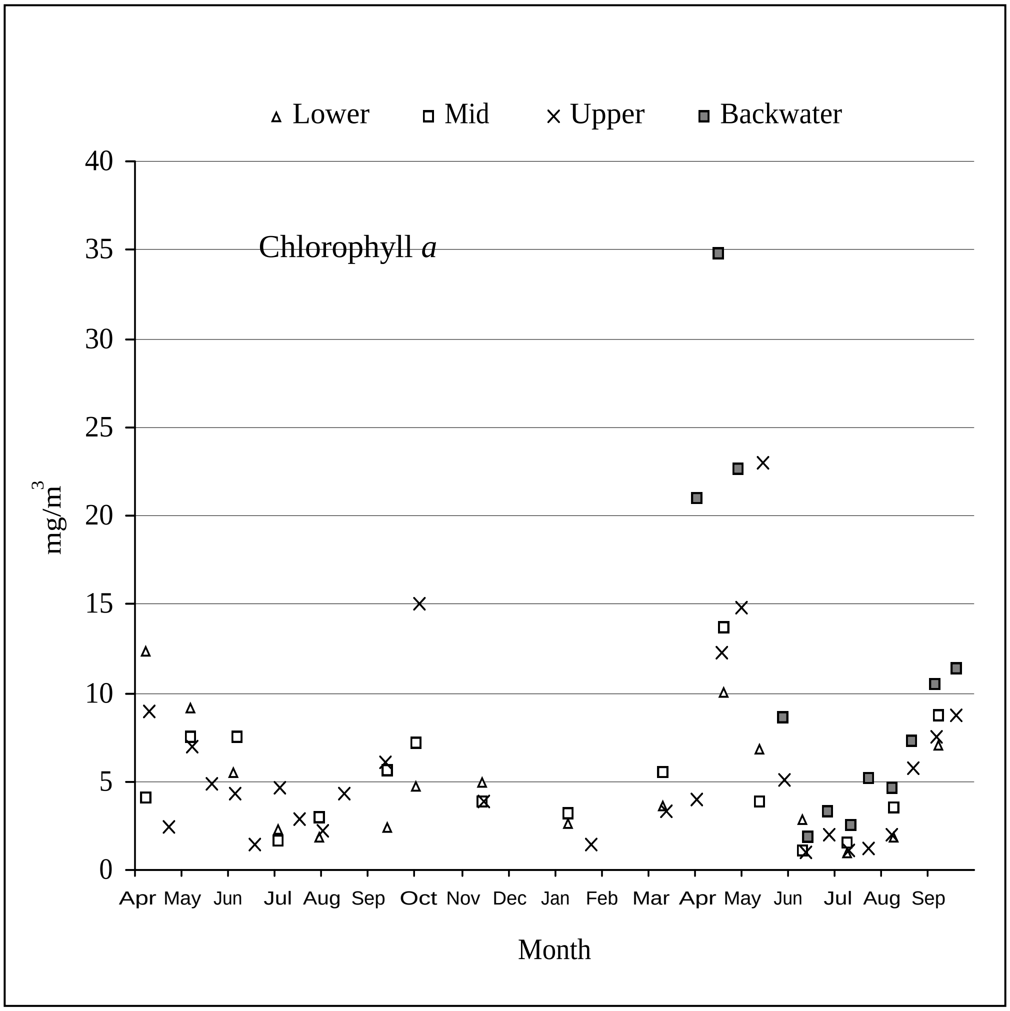
Appendix Figure B12. Continued.



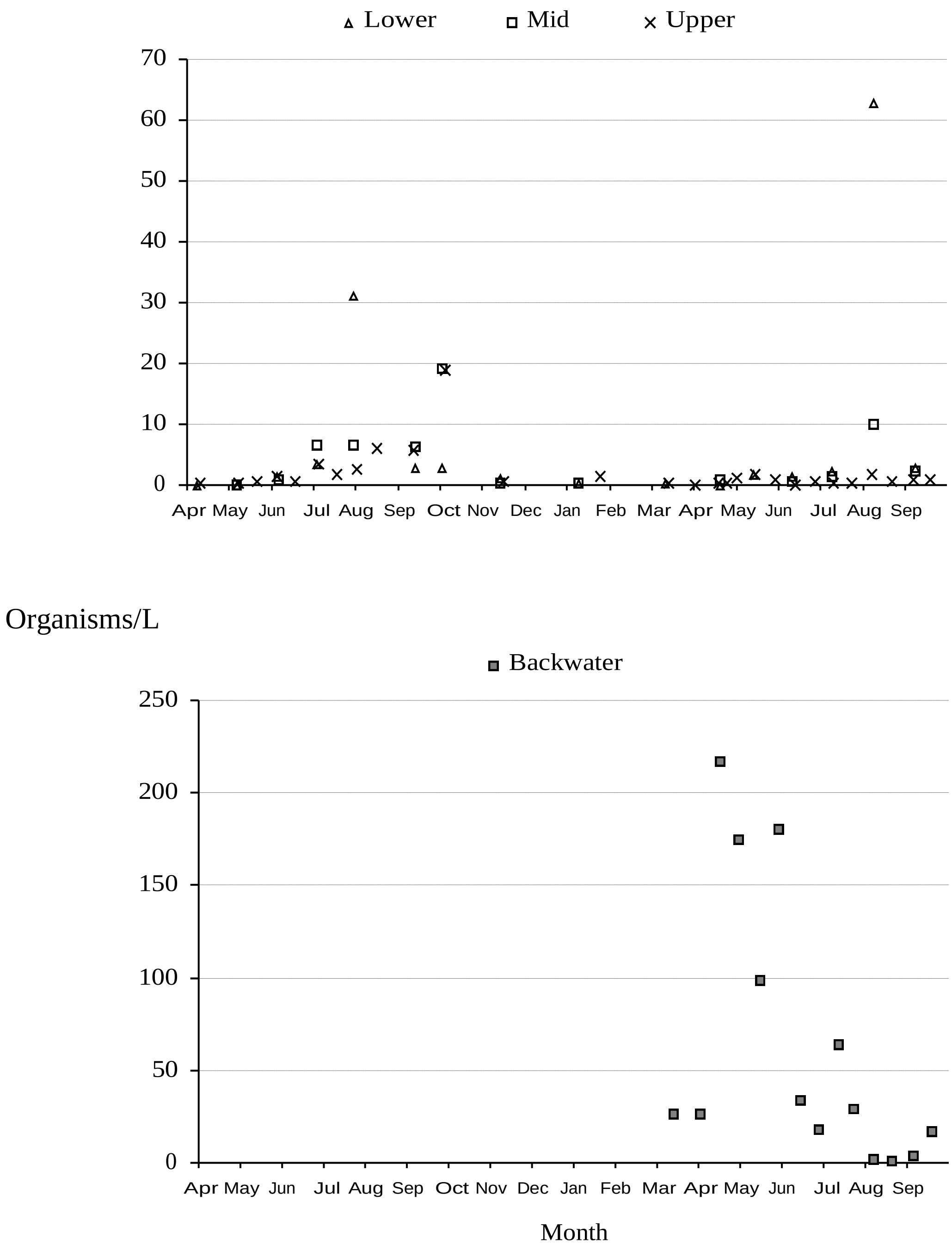
Appendix Figure B12. Continued.



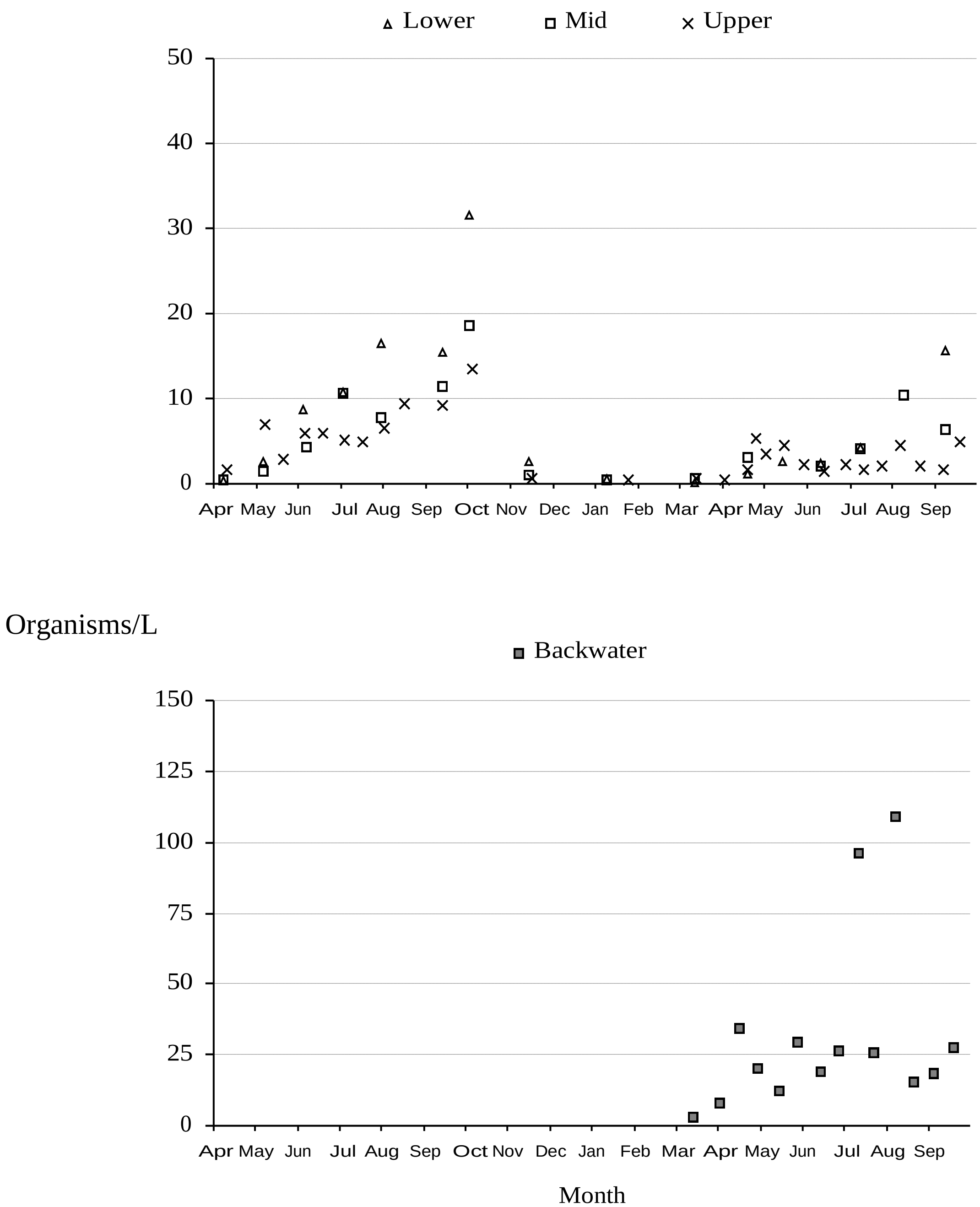
Appendix Figure B13. Temporal and spatial variation of John Day Reservoir silica content, April 1994 to September 1995. Results from sampling at lower-, mid-, and upper-reservoir stations and at Crow Butte backwater.



Appendix Figure B14. Temporal and spatial variation of John Day Reservoir chlorophyll *a* content, April 1994 to September 1995. Results from sampling at lower-, mid-, and upper-reservoir stations and at Crow Butte backwater.



Appendix Figure B15. Temporal and spatial variation in cladoceran densities at John Day Reservoir lower-, mid-, and upper-reservoir locations and at Crow Butte backwater during 1994 and 1995.



Appendix Figure B16. Temporal and spatial variation in copepod densities at John Day Reservoir lower-, mid-, and upper-reservoir locations and at Crow Butte backwater during 1994 and 1995.