WATER QUALITY STATUS REPORT NO. 103
CITIZEN'S VOLUNTEER MONITORING PROGRAM

CASCADE RESERVOIR
Valley County, Idaho
1988 - 1991

Idaho Department of Health and Welfare

Division of Environmental Quality

1992

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CASCADE RESERVOIR

VALLEY COUNTY, IDAHO

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Boise, Idaho

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ABSTRACT

In 1988 a Citizens Lake Monitoring Program was initiated for Cascade Reservoir, Valley County, Idaho. Volunteers from the Cascade Reservoir Association conducted monitoring during the summer months. The Cascade Reservoir Association is comprised of lake property owners and other citizens interested in water quality of Cascade Reservoir.

The objectives of the citizen's monitoring is to assist state and federal agencies in gathering valuable information needed to determine water quality trends in the Reservoir. Four reservoir monitoring sites were chosen in 1988; the stations were: North Fork Arm, Poison Creek Campground, Sugar Loaf Island and Buoy Line at the Dam. Sampling parameters consisted of nitrogen and phosphorus, chlorophyll a, dissolved oxygen, and Secchi disk transparency. Samples were preserved and transported to the State of Idaho laboratory in Boise for nutrient and chlorophyll a analysis.

The North Fork Arm station appears to have the highest water quality in Cascade Reservoir. At the farthest downstream station, Buoy Line at the Dam, data showed the lowest epilimnetic dissolved oxygen concentrations, the highest nutrient concentrations and the highest chlorophyll a concentrations of any reservoir station. The other stations showed high chlorophyll a concentrations in June, decreasing levels in July and then peak concentrations in August. The Buoy Line station showed increasing concentrations throughout the year. This trend occurred during the four years of the study.

A trend between the 1988 and 1991 data and data collected previously, 1975-1981, shows June hypolimnion dissolved oxygen concentrations have decreased over the last sixteen years. Secchi disk transparency has also decreased, but not enough data is available to determine trends.

ACKNOWLEDGMENT

Special thanks to the members of the Cascade Reservoir Association, without whose participation water quality data for Cascade Reservoir would be very limited. A very special thanks go to the following members: Clare and Monnette Baldwin, Tom Payne, Jim and Donna Haskin, Gordon and Inez Colburn, Glenn Bothwell, Cameron and Faye Taggart, Cliff Day, Don Lojek, Russ Fishback, Hugh Somerton, Dorthy Gestrin-Ireland, Richard Claxton, and Bill Johnson.

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GLOSSARY

Aerobic - living or active in the presence of oxygen; with oxygen.

Algae Bloom - Excessive algae growth occurring during a short period of time when conditions are ideal (warm, lighted, nutrient-rich).

Anaerobic - living or active in the absence of oxygen; without oxygen.

Anoxic - a condition of no oxygen in the water. Often occurs near the bottom of fertile stratified lakes in the summer and under ice cover in the winter.

Chlorophyll - the green pigment of plants necessary for photosynthesis.

Chlorophyll a - a type of chlorophyll present in all types of algae, sometimes in direct proportion to the biomass of algae.

Dissolved oxygen - the oxygen dissolved in water and readily available to aquatic organisms.

Epilimnion - the upper waters of a thermally stratified lake subject to wind action.

Eutrophic - from Greek for "well nourished," describes a lake of high photosynthetic activity and low transparency.

Hypereutrophic - from the Greek for "over-nourished," describes a lake of excessively high productivity.

Hypolimnion - the bottom waters of a thermally stratified lake. The hypolimnion of an eutrophic lake is usually low or lacking oxygen.

Inorganic Nitrogen, Total - the sum of ammonia, nitrate and nitrite nitrogen.

Milligrams per liter (mg/l) - a unit for expressing the concentration of chemical constituents in solution. Milligrams per liter represents the mass of solute per unit volume (liter) of water. It is roughly equivalent to parts per million (ppm).

Micrograms per liter (ug/l) - a unit expressing the concentration of chemical constituents in solution as mass (micrograms) of solute per unit volume (liter) of water. It is roughly equivalent to parts per billion (ppb).

Mesotrophic - the middle range between oligotrophic and eutrophic; a lake that is moderately nourished.

Nutrient - An element or chemical essential to life, such as carbon, oxygen, nitrogen, and phosphorus.

Nutrient cycling - The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae.

Oligotrophic - from the Greek for "poor nourished," describes a lake of low plant productivity and high transparency.

INTRODUCTION

Cascade Reservoir is located in Valley County, Idaho. The Reservoir covers an area of approximately 28,300 acres and has a storage capacity of 703,200 acre-feet (Bureau of Reclamation 1992). Land use in the area varies greatly from timber harvesting, recreational use, agricultural, summer home sites, and winter and summer sports activity. Cascade Reservoir has long been held as an important fishery and is heavily used during the summer and winter months. The Reservoir was designated in 1990 as a Stream Segment of Concern (Dunn 1990). The designation meant the reservoir would receive higher consideration for monitoring activity through the Antidegradation Agreement established in 1988. Past studies had strongly indicated the reservoir was in a eutrophic or hypertrophic state (Clark and Wroten 1975; U.S. Environmental Protection Agency 1977; Zimmer 1983; Klahr 1989; and Entranco Engineers, Inc. 1991). The eutrophic condition of the reservoir was determined to be caused by external loading and internal recycling of phosphorus.

The objectives of the citizen's monitoring of Cascade Reservoir is to increase public awareness through participation in citizen sponsored water quality monitoring and to assist state and federal agencies in gathering valuable information needed to determine water quality trends in the Reservoir. The Citizens Volunteer Water Quality Monitoring Program was initiated for Cascade Reservoir during the summer of 1988. The program was conducted by volunteers from the Cascade Reservoir Association, CRA, a citizen group comprised of lake property owners and supporters for improved water quality in the reservoir.

The initiation of this program filled a vital need for acquiring water quality data to characterize existing conditions and trends. The data in this report represents water quality for Cascade Reservoir for a four year period, 1988 through 1991, collected by the CRA and supplemented by data collected under a state and federal cooperative study, the Cascade Reservoir Watershed Project Water Quality Management Plan (Entranco Engineers, Inc. 1991).

METHODS

In 1988, 1989 and 1990, the CRA initiated monitoring at three stations; Sugar Loaf Island, North Fork Arm and Buoy Line. A station at the Poison Creek campground was also established in 1988, but was dropped after that year. The South Bay Station was established in 1989. In 1991, monitoring was reestablished at four stations, adding the Buoy Line Station. Figure 1 depicts the location of the four monitoring sites. The Buoy Line Station coincided with previous monitoring by Clark and Wroten (1975) and Zimmer (1983).

The station locations vary from the survey done in 1988. The 1989-1991 data does not have the results from the station across from

Poison Creek Campground. To reduce duplication of effort, monitoring was not done by the CRA at the Buoy Line (Dam site) Station in 1989 or 1990. Data from water sampling by Entranco Engineers, Inc. (1991) will be used. The 1989 data collected for North Fork Arm, Sugar Loaf Island and South Bay was used to supplement the Cascade Reservoir Watershed Project Water Quality Management Plan (Entranco Engineer, Inc. 1991). Table 1 shows monitoring stations and the years of monitoring effort.

Monitoring focused on nutrients, chlorophyll a, water transparency (or Secchi disk depth), temperature, and dissolved oxygen. The Division of Environmental Quality (DEQ) provided training for the CRA at the beginning of each monitoring season. Correct use of equipment and sampling procedures were explained at each training session, along with proper transportation and storage of samples.

The CRA provided personnel, boats and one set of monitoring equipment. The equipment included a Kemmerer Sampler, Secchi disk, and Yellow Springs Instrument Dissolved Oxygen Meter (model 54A). DEQ provided back up equipment, one (1) quart cubitainers and laboratory analysis report forms. DEQ also provided funding for laboratory analysis.

Sample collection for water chemistry analyses was scheduled to occur monthly during the summer season (June through September). Frequency of sampling was consistent for all years except 1991 in which only three sampling dates were completed. Two samples were collected at each station; surface, 1 meter depth; and bottom, 1 meter above reservoir bottom. The surface samples were analyzed for all chemical constituents including Chlorophyll a. Bottom samples were not subject to Chlorophyll a analysis. Depth was determined using a rope with one (1) meter intervals clearly marked. A depth/fish finder was utilized to locate the old North Fork Payette River channel.

Temperature and dissolved oxygen water column profiles were determined with a Yellow Springs Instrument Dissolved Oxygen meter. Data was collected at one meter intervals beginning at one meter below the surface to one meter above the reservoir bottom.

Quality Assurance/Quality Control (QA/QC)

Samples were collected and cooled to 4°C and transported to State of Idaho Bureau of Laboratories in Boise, Idaho. Sample collection used a Kemmerer subsurface sampler. Samples were dispensed into one (1) quart containers. Containers with Chlorophyll a samples were wrapped in tin foil to reduce light penetration. All sample cubitainers were quickly placed on ice and kept cooled for the remainder of the sampling date. Samples were usually collected on a Sunday and transported to Boise by a CRA member the following morning. Laboratory analysis procedures followed standard methods (American Public Heath Association 1985).

Dissolved oxygen (DO) levels for the water column profile were measured with a Yellow Springs Instrument Dissolved Oxygen meter calibrated each day before collection. Calibration was completed by CRA members following manufacture's specifications.

All field data were reported to DEQ Field Office personnel for analysis and interpretation. All laboratory results were supplied directly to DEQ staff.

Table 1. Stations and Year of Monitoring *

STATION DESCRIPTION	YEAR 1988	1989	1990	1991
Sugar Loaf Is.	X	X	X	X
Poison Creek Campground	X			
North Fork Arm	X	X	X	X
Buoy Line (Dam Site)	X	X*	X**	X
South Bay		X	X	X

*Cascade Reservoir Management Plan (Entranco Engineers, Inc. 1991)
**Klahr (Special Monitoring)

TROPHIC CLASSIFICATION

Lakes can be classified according to their trophic status, or biological productivity. Table 2 is an example of such a trophic classification system (Wetzel 1975). Lakes characterized by low productivity are classified as oligotrophic, and highly productive lakes are termed eutrophic or even hyper-trophic (Burr et al. 1987).

Lake productivity is regulated by many chemical and physical factors, but probably the most important of these are the nutrients, phosphorus and nitrogen, from external sources. Lakes with very low concentrations of phosphorus and nitrogen in available form are typically very low in productivity. Phosphorus, in particular, is the single most important factor in determining lake productivity or trophic status (U.S. Environmental Protection Agency 1988).

Eutrophication is synonymous with increased growth rates of the biota of lakes. The most basic and accurately measurable criterion of accelerated productivity is increasing rates of annual photosynthesis by algae (Wetzel 1975). Chlorophyll a is present in all algae and is the most widely accepted indicator of algal biomass or productivity.

Table 2. Trophic Classification System.*

General Level of PRODUCTIVITY	Phosphorus (mg/l)**	Chlorophyll a (ug/l)**	Secchi disk Depth (meters)	Inorganic-N (mg/l)**
oligotrophic	0.003-0.009	0.3-2.0	7.0-16	0.2-0.4
mesotrophic	0.009-0.024	2.0-6.0	2.0-6.0	0.3-0.6
eutrophic	0.024-0.075	6.0-40.0	0.75-2.0	0.5-1.5
hyper-eutrophic	>0.065	>40.0	<0.75	>1.5

*From: Wetzel 1975. and Wetzel 1983.)
**Conversion from mg/m^3

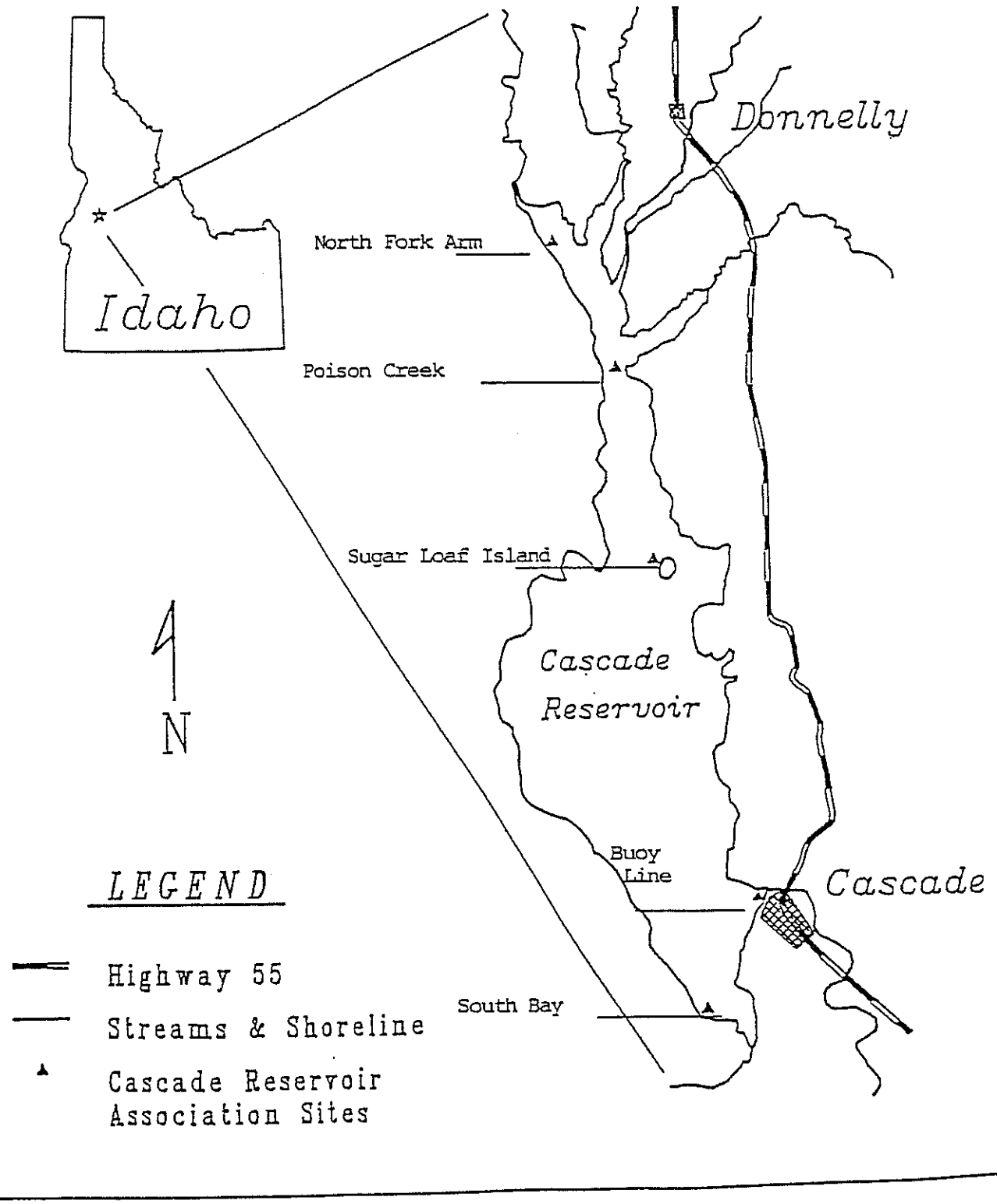

FIGURE 1. Monitoring stations for the Citizen's Volunteer Water Quality Monitoring Program on Cascade Reservoir for 1988, 1989, 1990, and 1991.

RESULTS AND DISCUSSION

A complete tabulation of all results for 1988 through 1991 are located on Tables 5 through 20. Results for 1991 Buoy Line station are obtained from monitoring by Entranco Engineers, Inc. (1991). Because temperature and dissolved oxygen results are not available for 1990, this data will not be used for comparison with the other three years.

A brief discussion of the results and possible trends for each station are discussed as follows:

1) NORTH FORK ARM

The North Fork Arm is located at the northern most portion of Cascade Reservoir and is formed by the North Fork of the Payette River (Figure 1). It is the shallowest station monitored. Average depth for June for the four year period was 5.25 meters. September average depth was 3.5 meters.

Average secchi depth reading for June was 2.25 meters, July 2.4 meters, August 1.25 meters, and September 1.9 meters. Chlorophyll a values ranged from 3.7 ug/l to 17.1 ug/l. Total phosphorus ranged from below the detection limit of 0.05 mg/l to 0.08 mg/l in July 1991. Dissolved Ortho-phosphates ranged from 0.048 mg/l in July 1988 to below the detection limit of 0.001 mg/l. Refer to Tables 7, 10, 14, and 18.

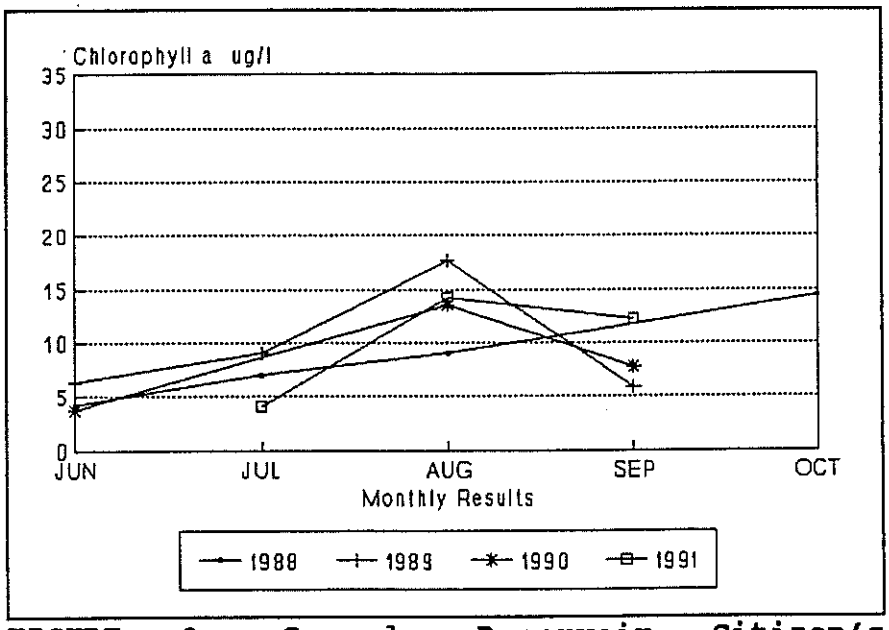

FIGURE 2. Cascade Reservoir Citizen's Volunteer Monitoring Program. North Fork Arm, Chlorophyll a Concentration, 1988-1991,

Klahr (1989) determined that the North Fork Arm is too shallow for stratification to occur. It was also determined that water quality in the North Fork Arm was similar to that of the North Fork of the Payette River. Evidence of stratification did occur in July of 1989 and 1991 when epilimnetic dissolved oxygen concentrations were higher than those reported at the hypolimnetic layer. Refer to

Tables 10 and 18. Hypolimnetic dissolved oxygen readings for July 1989 was 2.3 mg/l and for July 1991 3.4 mg/l. Epilimnetic results were 6.9 mg/l for July 1989 and 7.9 mg/l for July 1991. Although not an anoxic condition, the data would indicate very little mixing between the two stratified layers. It would also indicate that during stratified conditions portions of the North Fork Arm of Cascade Reservoir are not suitable for fisheries.

Chlorophyll a concentrations were generally lower compared to other stations and were below normal threshold of bloom concentrations. However, the same pattern of yearly increasing concentrations of chlorophyll a was noted. Figure 2 shows chlorophyll a concentration patterns over the four year period. Nutrient concentrations and chlorophyll a concentrations still indicate an eutrophic condition for this portion of the reservoir.

2) SUGAR LOAF ISLAND

The Sugar Loaf Island station is located west of Sugar Loaf Island and is monitored at the old channel of the North Fork of the Payette River (Figure 1). The channel is located using a depth/fish finder. Average depth for June hypolimnetic sampling was 12.5 meters, August 9.9 meters, and September 9.4 meters. Average Secchi readings were 3.0 meters in June, 1.8 meters in July and 1.6 meters in August. Surface Chlorophyll a concentrations ranged from 33.9 ug/l in October 1988 to 0.62 ug/l in June 1989. Surface concentrations for total phosphorus ranged from 0.36 mg/l in July 1988 to below the detection limit of 0.05 mg/l. Both total phosphorus and ortho-phosphates reached peak concentrations, 0.36 mg/l and 0.015 respectively, in the hypolimnion in July 1988. However, for years 1989, 1990, and 1991 the highest concentrations were recorded in August. In the same period, high concentrations of chlorophyll a were recorded in the epilimnion. Low dissolved oxygen readings in the bottom were observed during corresponding high phosphorus concentrations and surface algal blooms. Tables 5, 9, 13, and 17 show monitoring results for Sugar Loaf Island.

This may indicate nutrient release from the sediment at this time, or may be particulate phosphorus resulting from algal sedimentation (die-off) following a bloom event. However, it is unlikely that nutrients released at this time were transferred to the surface since low phosphorus concentrations were reported in the epilimnion.

For 1989, 1990 and 1991 the highest chlorophyll a concentrations were recorded in July, while in 1988 the highest concentrations were recorded in late September and early October. All stations in 1989, 1990 and 1991 showed decreased concentrations in late

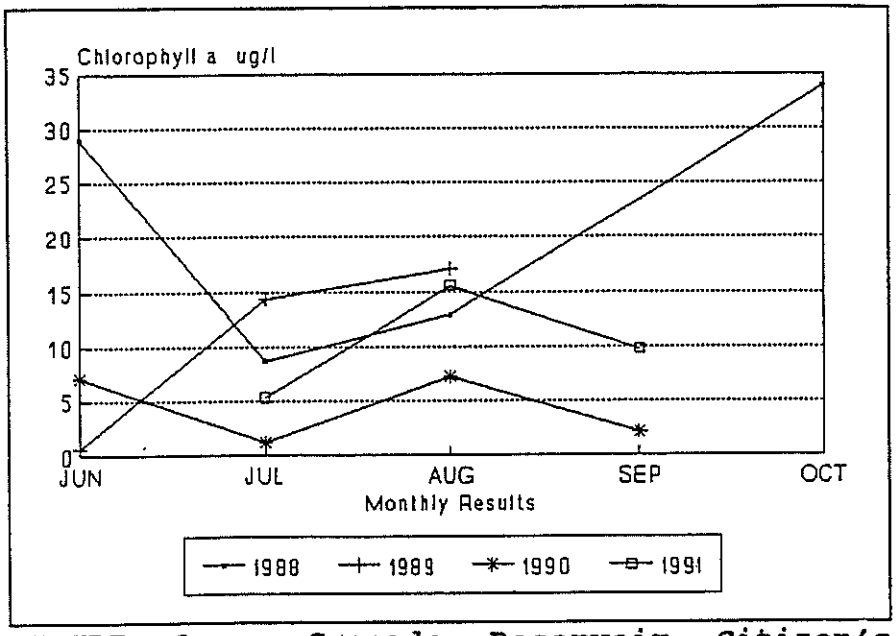

FIGURE 3. Cascade Reservoir Citizen's Volunteer Monitoring Program. Sugar Loaf Island Chlorophyll a Concentrations 1988-1991.

September. Figure 3 depicts the increasing and decreasing concentration patterns during the four years of the study.

The Sugar Loaf Island station stratifies most of the year. The 1988-1991 data may indicate a turnover in the reservoir occuring in late June. This allows nutrient rich hypolimnetic waters to be mixed with the epilimnetic. This turnover could be a natural condition or may be attributed to wind action as suggested by Zimmer (1983).

3) SOUTH BAY

The South Bay Station was added to the volunteer monitoring in 1989 while other personnel, Entranco Engineers, Inc. 1991, were monitoring the Buoy Line station. Average hypolimnion monitoring depth for the three year period were: June 9.0 meters, July 7.8 meters, August 8.0 meters and September 6.7 meters. Average Secchi depth readings were: June 4.5 meters, July 2.7 meters, August 2.2 meters, and September 2.1 meters. For the three year period, chlorophyll a concentrations progressively increased each month and were highest in September of each year. In June 1989, chlorophyll a concentrations were less that 0.08 ug/l, but in September, concentrations reached the highest level recorded over the three years of monitoring, 28.3 ug/l. Figure 4 shows the pattern of chlorophyll a concentrations for the three year period.

The highest total phosphorus and ortho-phosphate readings in the hypolimnion were recorded in August 1989. Tables 11, 15 and 19 show chemical and physical parameter results. August 1989 concentration were 0.24 and 0.116 mg/l, respectively. Dissolved oxygen concentrations also indicated the hypolimnion was anoxic at this time. This low oxygen concentration may enhance the release of phosphorus from the sediment and contribute to high chlorophyll

a concentrations thirty days later in September, via recycling and recirculation. When the dissolved oxygen concentration increased in the hypolimnion during September, nutrient concentrations decreased. The 1991 data shows the same pattern.

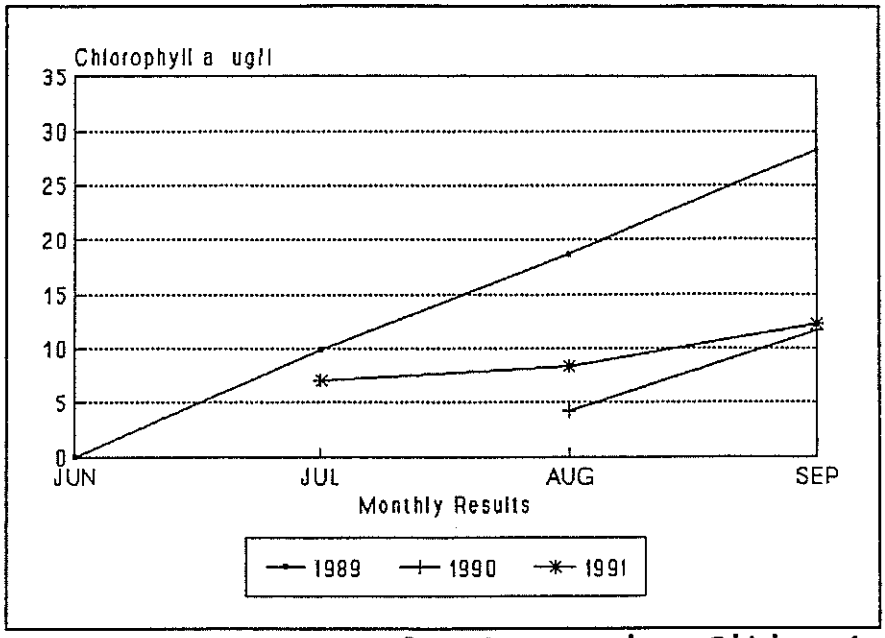

FIGURE 4. Cascade Reservoir Citizen's Volunteer Monitoring Program. South Bay, Chlorophyll a Concentrations, 1989-1991.

The South Bay Station exhibited similar interannual patterns for the three years of monitoring. Although shallower, patterns of nutrient availability and Chlorophyll a production are similar to those observed at the Buoy Line Station.

4) BUOY LINE (@ DAM)

The Buoy Line Station was monitored by CRA in 1988 and 1991. To help in the determination of trends, data for 1989 and 1990 from others (Entranco Engineers, Inc. 1991 and Klahr 1990) were incorporated into this report.

In June 1990, the Division of Environmental Quality and Idaho Department of Fish and Game responded to reports of a substantial algal bloom in Cascade Reservoir. In the epilimnion, the chlorophyll a concentration was 120.9 ug/l at the Buoy Line Station. Other sampling showed high dissolved oxygen concentrations, 12.3 mg/l, high nutrient concentrations and low Secchi disk readings, 0.5 meters. Hypolimnetic phosphorus concentrations were below the detection limit of 0.05 mg/l, but total organic nitrogen concentrations were 2.04 mg/l, the highest recorded at that station for the four year period. Dissolved oxygen was 4.6 mg/l in the hypolimnion. Dissolved oxygen readings are not available for the remainder of the year, so a comparison was not possible. The remainder of the monitoring season was comparable to trends noted in 1988, 1989 and 1991.

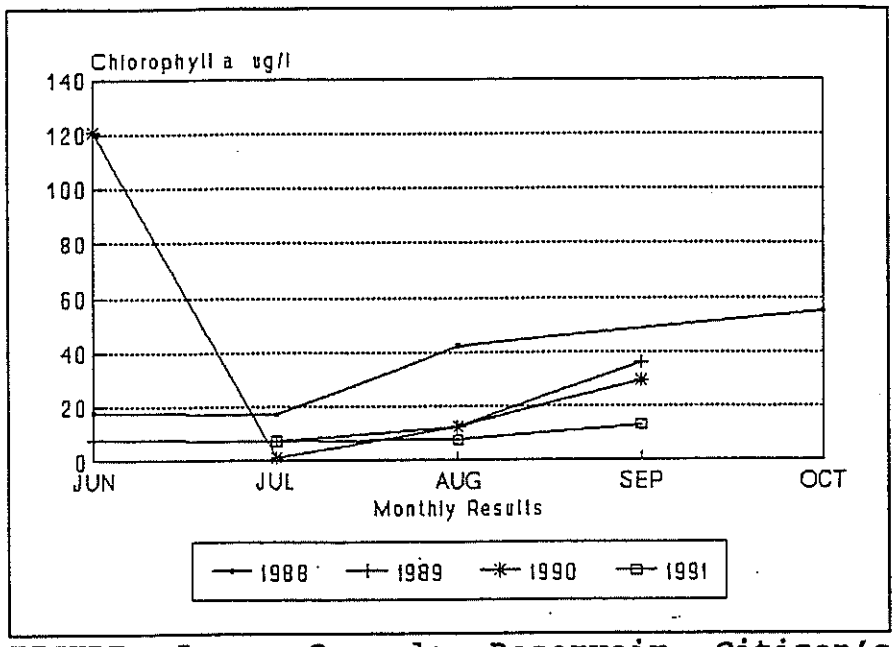

FIGURE 5. Cascade Reservoir Citizen's Volunteer Monitoring Program. Buoy Line, Chlorophyll a Concentrations, 1988-1991.

Except for the results obtained in 1990 and the evidence of a very early algal bloom, a pattern exists which shows that the chlorophyll a concentration steadily increased each month at an almost predictable rate during the four years of monitoring. Figure 5 shows Chlorophyll a concentrations for the four year period.

Based on the hypolimnetic dissolved oxygen concentrations for the years 1988 through 1991, this portion of the reservoir would have been inhabitable for either coldwater or warmwater fish for the two month period from late July through late September of each year. Dissolved oxygen concentrations at the Buoy Line Station exceeded the U.S. Environmental Protection Agency's, U.S. EPA, dissolved oxygen criteria for both warmwater fish and coldwater fish (Table 3). The criteria listed in Table 3 are estimates of the threshold concentrations for dissolved oxygen below which detrimental effects are expected. If the dissolved oxygen concentrations are at or above these levels then the U.S. EPA believes a reasonable and adequate degree of protection is provided for freshwater aquatic life (U.S. Environmental Protection Agency 1986).

Table 3. Water quality criteria for ambient dissolved oxygen concentrations. Values are expressed in milligrams per liter, mg/l (U.S. EPA 1986).

	Coldwater Criteria		Warmwater Criteria	
	Early Life Stages [1]	Other Life Stages	Early Life Stages	Other Life Stages
30 DAY Mean	NA[2]	6.5	NA	5.5
7 Day Mean	6.5	NA	6.0	NA
7 Day Mean Minimum	NA	5.0	NA	4.0
1 Day Minimum [3]	5.0	4.0	5.0	3.0

[1] Includes all embryonic and larval stages and all juvenile forms to 30 days following hatching

[2] Not applicable

[3] All minimums should be considered as instantaneous concentrations to be achieved at all times.

Comparison with previous data

The Buoy Line Station is the only station consistently monitored for the previous sixteen years. This station is the best indicator of water quality trends in the reservoir due to its depth and the amount of data available. Table 4 summarizes data collected from this station since 1975. The data was compiled from Clark and Wroten (1975) and Zimmer (1983). One early summer sample (eg. June) and late summer sample (eg. August) was tabulated from each year of monitoring. Dissolved oxygen concentrations for June appear to be decreasing from 1980 to 1990 (Figure 6). This could be the beginning of a trend or a variation determined by climatic factors. The data indicate a seasonal cycle with oxygenated waters in June turning into an anaerobic situation by August. This situation is enhanced by warmer water temperature and less of an opportunity for turnover to occur and by greater amounts of nutrients, namely, phosphorus being released from the sediment. Oxygen concentrations have been shown to be indirectly proportional to nutrient concentrations; as oxygen is depleted the nutrient values increase (Klahr 1989).

A negative trend in Secchi disk transparency may be occurring over the last sixteen years. Klahr (1989) determined that shallower Secchi depth readings have occurred since 1975. With the current data it is difficult to determine a trend. Further evaluation and data will be needed to determine if a seasonal or yearly trend is occurring in transparency. Figure 7 depicts secchi disk readings for years 1975, 1978, 1979, 1980, 1981, 1988, and 1991.

SUMMARY

As summarized by Klahr (1989) water quality degrades as it moves through the reservoir towards the outlet. Water quality in the North Fork tends to be of higher quality, but still exhibits poor conditions when the other stations exhibit poor conditions. This may be attributed to dilution effects from the North Fork of the Payette River and less opportunity for stratification to occur due to the lack of depth at this station.

A difference in water quality is expected due to increased residence time in the southern end of the reservoir. There is more opportunity for longer stratification periods which depletes dissolved oxygen in the hypolimnion and contributes to the release of nutrients from the sediment. As wind action or seasonal mixing occurs, released nutrients are then available for aquatic plant use. Increased algal concentrations affect primary and secondary recreation contact by reducing water clarity and sometimes, contributing to odor problems. As the plants die off from lack of readily available nutrients or other limiting factors, decomposition begins to deplete dissolved oxygen within the water column. Lower dissolved oxygen levels will greatly affect fishery abundance, growth and spawning activity.

RECOMMENDATIONS

Currently, many changes in land use practices, point source elimination, and possible construction of a year round destination resort are beginning to occur in the Cascade Reservoir watershed. Although these changes will occur over a period of time and changes to water quality will occur even more slowly, monitoring should continue to allow for determination of yearly climatic variation and the establishment of good trend data. It is believed that the Cascade Reservoir Association's Citizen's Monitoring Program will be an important instrument in achieving good data.

Table 4. Water quality data from Buoy Line (@ Dam) Station Cascade Reservoir studies. Data compiled from Clark and Wroten (1975), Zimmer (1983), and CRA monitoring program 1988, 1989, 1990, and 1991. 1991 data suplimented by Entranco (1991).

DATE	Total Phos. (mg/l) (top)	(bottom)	Secchi Depth (M)	Chlor. a ug/L	DO (mg/l) (bottom)	T. Inorg. Nit. (mg/l) (top)	(bottom)
JUN-75			2.4	3.4	4.5	0.04	0.05
AUG-75			2.7	12.0	0.5	0.06	0.16
AUG-78	0.06	0.23	1.3	119.6	0.1	0.01	0.20
JUN-79	0.03	0.25	3.9	0.7	0.1	0.07	0.47
AUG-79	0.06	0.35	1.3	35.8	0.2	0.03	0.66
JUN-80	0.02	0.04	3.7	3.1	7.1	0.04	0.05
AUG-80	0.01	0.16	3.4	7.0	0.2	0.11	0.34
JUN-81	0.01	0.02	4.0	2.7	2.3		
SEP-81	0.03	0.22	4.2	2.0	0.1		
JUN-88	0.05	0.06	2.0	17.8	5.8	0.041	0.11
AUG-88	0.05	0.33	1.0	42.2	0.5	0.064	0.53
JUN-89	<0.05	<0.05	0.5	7.6	4.8	0.017	0.02
AUG-89	<0.05	0.19	0.5	12.6	0.3	0.210	0.25
JUN-90	<0.05	<0.05	0.5	120.9	4.6	0.123	0.03
AUG-90	<0.05	<0.05	0.5	12.3		<0.005	0.31
JUL-91	0.05	0.15	3.0	7.3	0.5	0.114	0.516
AUG-91	0.021	0.247	2.5	7.6	0.2	0.038	0.821

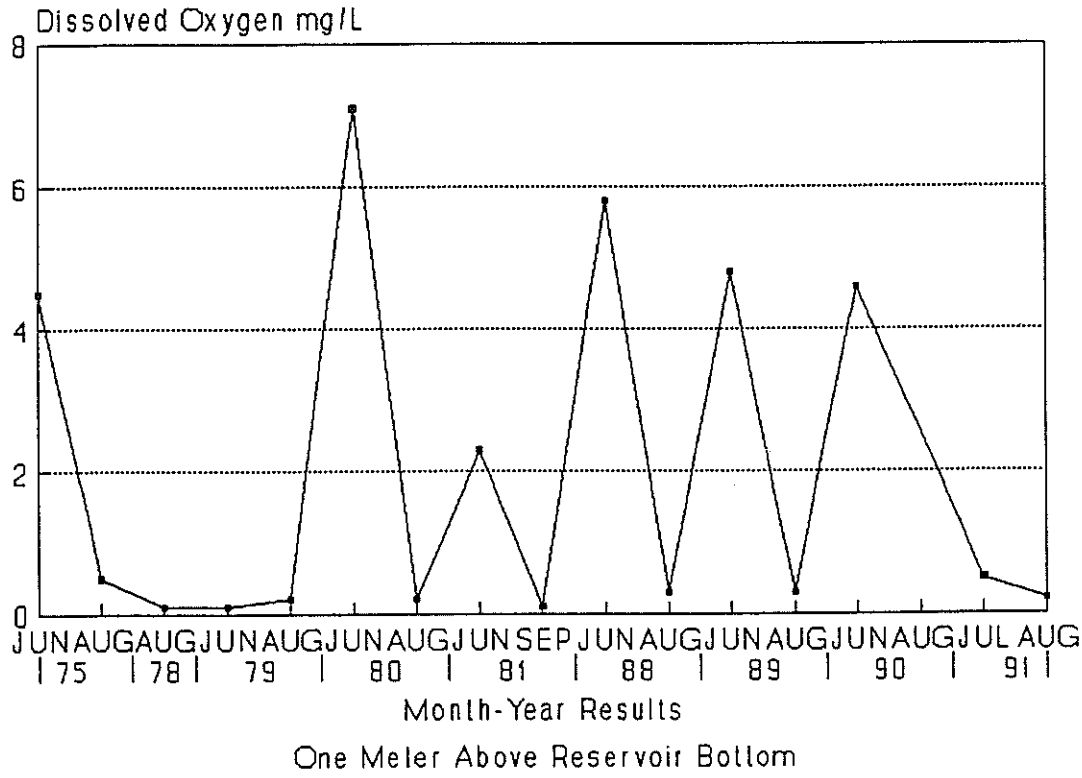

FIGURE 6. Cascade Reservoir Citizen's Volunteer Monitoring Program. Buoy Line Station, Dissolved Oxygen Results, 1975 through 1991.

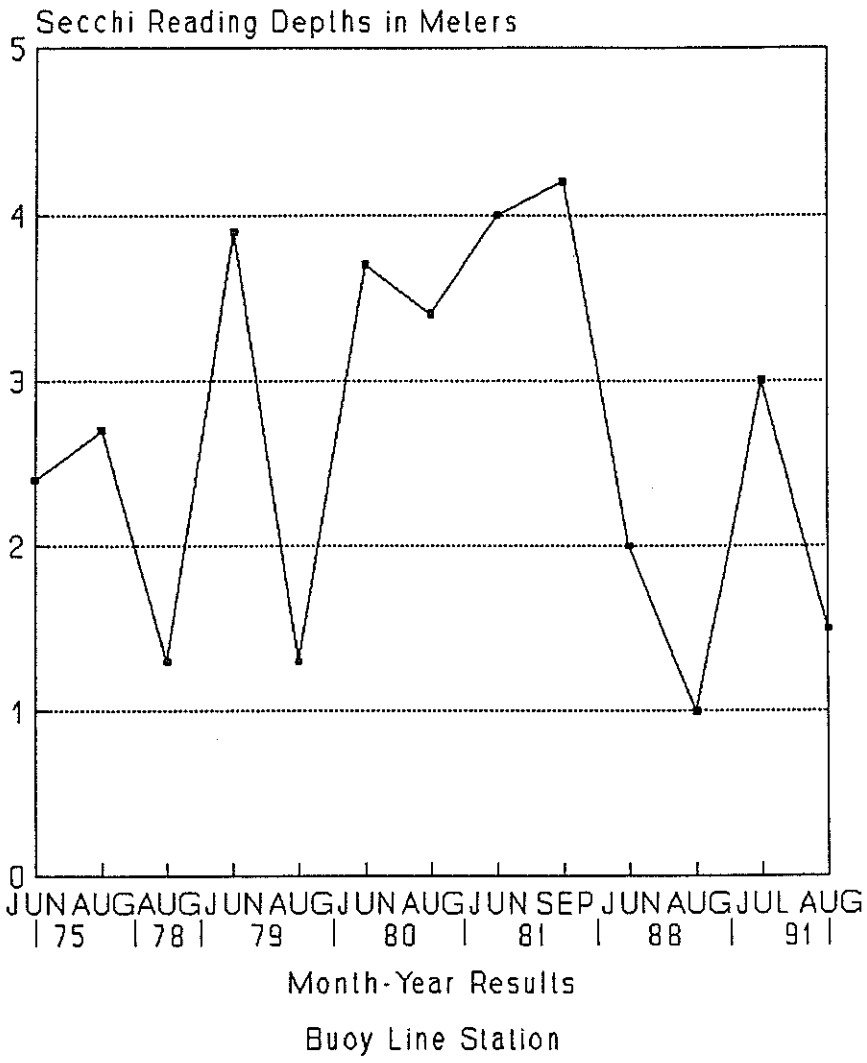

FIGURE 7. Cascade Reservoir Citizen's Volunteer Monitoring Program. Buoy Line Station, Secchi Depth Results, 1975 through 1991.

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Table 5.
Water Quality data for the Sugar Loaf Island Station, Cascade Res 1988

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
06/12/88	1.5	29.0	0.022	<0.001	0.39	<0.05	0.004	NA
06/12/88	10.0		0.041	0.001	0.41	0.05	0.005	NA
07/24/88	2.5	8.7	0.059	0.009	0.45	<0.05	0.005	9.0
07/24/88	15.0		0.346	<0.001	1.59	0.36	0.015	0.7
08/28/88	1.5	12.9	0.018	0.017	0.56	<0.05	0.004	7.0
08/28/88	8.2		0.171	0.014	0.68	0.09	0.011	2.5
10/02/88	1.5	33.9	0.018	0.037	0.76	0.06	0.004	9.2
10/02/88	7.5		0.010	<0.001	0.71	0.06	0.002	7.8

Table 6.
Water Quality data for the Poison Creek Boat Ramp, Cascade Res 1988

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
06/12/88	1.5	21.9	0.051	0.054	0.40	<0.05	0.002	11.0
06/12/88	8.5		0.066	0.040	0.32	<0.05	0.002	12.0
07/24/88	2.5	5.0	0.037	<0.001	0.47	<0.05	0.003	NA
07/24/88	7.2		0.035	<0.001	0.57	0.06	0.003	5.0
08/28/88	1.2	17.8	0.014	0.032	0.59	<0.05	0.004	9.0
08/28/88	6.5		0.096	0.026	0.65	0.06	0.011	12.0
10/02/88	1.2	30.0	0.037	0.002	0.59	0.08	0.007	11.0
10/02/88	4.5		0.028	0.003	0.52	0.06	0.006	11.0

Table 7.
Water Quality data for the North Fork Arm Station, Cascade Res 1988

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
06/12/88	1.7	4.2	0.022	0.008	0.13	<0.05	0.001	11.0
06/12/88	4.5		0.022	0.009	0.14	<0.05	0.002	11.0
07/24/88	1.7	7.0	0.017	0.017	0.39	<0.05	0.001	NA
07/24/88	3.5		0.015	0.008	0.44	<0.05	0.003	8.0
08/28/88	1.2	9.0	0.026	0.064	0.42	0.05	0.009	10.0
08/28/88	2.0		0.029	0.059	0.43	0.05	0.010	11.0
10/02/88	2.0	14.5	0.010	0.006	0.24	<0.05	0.018	11.0

Table 8.
Water Quality data for the Bouy Line (Dam) Station, Cascade Res 1988

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
06/12/88	2.0	17.8	0.041	<0.001	0.60	0.05	0.005	9.0
06/12/88	17.4		0.078	0.029	0.35	0.06	0.015	5.8
07/24/88	2.0	17.3	0.068	0.013	0.48	<0.05	0.003	9.7
07/24/88	15.0		0.312	<0.001	0.60	0.13	0.048	0.5
08/28/88	1.0	42.4	0.021	0.043	1.06	0.05	0.004	8.0
08/28/88	14.7		0.526	0.016	1.03	0.33	0.110	0.5
10/02/88	1.0	55.1	0.013	0.003	1.03	0.07	0.002	8.8
10/02/88	15.5		0.163	0.009	0.75	0.06	0.014	4.5

Table 9.
Water Quality data for the Sugar Loaf Is. Station, Cascade Res 1989

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
								NA
6/18/89	3.5	0.62	0.061	0.045	0.30	<0.05	<0.00	18.5
6/18/89	12.5		0.105	0.066	0.30	<0.05	0.010	5.9
7/23/89	2.5	14.4	0.028	0.006	0.38	<0.05	N/A	8.5
7/23/89	12.0		0.069	0.007	0.42	0.14	N/A	0.3
8/20/89	1.5	17.1	0.025	0.016	0.49	0.05	0.005	7.3
8/20/89	NA		0.254	0.007	0.61	0.24	0.116	NA
9/24/89	2.0	N/A	0.70	0.013	0.52	<0.05	0.007	8.3
9/24/89	9.0		0.026	0.008	0.51	0.06	0.027	7.2

Table 10.
Water Quality data for the North Fork Arm Station, Cascade Res 1989

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
6/18/89	2.5	6.3	0.048	0.027	0.21	<0.05	<0.001	8.5
6/18/89	5.5		0.038	0.022	0.37	<0.05	0.005	5.6
7/23/89	2.5	9.0	0.05	0.013	0.36	<0.05	N/A	6.9
7/23/89	5.0		0.027	0.002	0.41	<0.05	N/A	2.3
8/20/89	1.0	17.7	0.076	0.043	0.59	0.06	0.009	6.2
8/20/89	4.0		0.075	0.034	0.59	0.06	0.004	6.2
9/24/89	2.5	5.9	0.025	0.012	0.34	0.05	0.012	8.5

Table 11.
Water Quality data for the South Bay Station, Cascade Res 1989

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
6/18/89	4.5	<0.08	0.039	0.012	0.56	<0.05	0.002	7.6
6/18/89	9.0		0.067	0.022	0.46	<0.05	0.004	5.5
7/23/89	2.0	9.8	0.021	0.002	0.47	<0.05	N/A	7.9
7/23/89	8.0		0.051	0.008	0.27	<0.05	N/A	2.7
8/20/89	1.5	18.7	0.028	0.007	0.53	0.06	0.010	7.7
8/20/89	8.0		0.254	0.007	0.61	0.24	0.116	0.4
9/24/89	1.5	28.3	0.045	0.017	0.69	0.06	0.012	9.8
9/24/89	6.0		0.065	0.023	0.53	0.05	0.009	6.0

Table 12.
Water Quality data for the Buoy Line (Dam) Station, Cascade Res 1989
(Data Obtained from Watershed Management Plan, Entranco 1991)

DATE	Sample Depth Meters	Chloro. A ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
6/21/89	0.5	7.6	0.017	0.005	0.28	<0.05	0.002	8.3
6/21/89	14.0		0.019	0.006	0.38	<0.05	0.003	4.8
7/17/89	0.5	7.4	0.021	<0.001	0.35	<0.05	<0.001	8.6
7/17/89	10.0		0.051	0.007	0.25	<0.05	NA	2.8
8/20/89	0.5	12.6	0.21	<0.001	0.37	<0.05	<0.001	9.0
8/20/89	14.0		0.249	<0.001	0.47	0.19	0.187	0.3
9/24/89	0.5	36.0	0.135	0.011	0.28	0.06	0.003	10.4
9/24/89	14.0		0.151	0.001	0.57	<0.05	0.006	4.1

Table 13.
Water Quality data for the Sugar Loaf Island Station, Cascade Res 1990

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
06/11/90	2.5	7.1	.061	.020	.63	<.050	<.005	NA
06/11/90	12.5		.034	.031	.79	<.050	.009	NA
07/15/90	3.5	1.2	.091	.025	.43	.036	<.005	8.0
07/15/90	11.0		.114	.056	.45	.024	<.005	4.4
08/19/90	2.2	7.3	.057	<.005	.35	.036	.006	NA
08/19/90	11.0		.299	<.005	.48	.160	.050	NA
09/16/90	1.5	2.2	.050	<.005	.27	.061	<.005	NA
09/16/90	11.0		.408	<.005	.45	.253	.041	NA

Table 14.
Water Quality data for the North Fork Arm Station, Cascade Res 1990

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
06/11/90	2.5	3.7	.019	.020	.62	.070	.006	NA
06/11/90	5.5		.013	.020	.38	<.050	.009	NA
07/15/90	3.0	n/a	.090	.028	.48	.026	<.005	8.4
07/15/90	7.0		.195	.066	.55	.031	<.005	3.3
08/19/90	1.3	13.5	.082	<.005	.52	.051	.009	NA
08/19/90	4.5		.084	<.005	.54	.045	.011	NA
09/16/90	1.75	7.7	.040	<.005	.20	.053	.016	NA
09/16/90	4.0		.041	<.005	.22	.067	.009	NA

Table 15.
Water Quality data for the South Bay Station, Cascade Res 1990

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
07/15/90	3.5	n/a	.118	.029	.51	.021	<.005	8.0
07/15/90	7.5		.123	.034	.60	.033	.009	7.9
08/19/90	2.5	4.2	.087	<.005	.40	.035	.012	NA
08/19/90	7.5		.134	<.005	.39	.053	.024	NA
09/16/90	3.5	11.7	.037	<.005	.22	.045	.009	NA
09/16/90	7.0		.073	<.005	.21	.061	.006	NA

Table 16.
Water Quality data for a Special Collection Date at Dam site,
Cascade Res 1990

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Diss. Ortho. mg/l	Diss. Oxygen mg/l
06/26/90*	0.5	120.9	0.123	<0.005	2.04	<.050	<.005	12.3
06/26/90*	17.5		0.028	0.019	0.36	<.050	0.015	4.6
07/17/90**	0.5	1.3	0.115	0.011	0.49	0.035	<0.005	NA
07/17/90**	19.0		0.276	0.018	0.54	0.15	0.027	NA
08/26/90***	0.5	12.3	<0.005	<0.005	0.31	0.029	0.009	NA
08/26/90**	18.0		0.313	<0.005	0.58	0.223	0.118	NA
09/30/90***	0.5	29.7	0.026	<0.005	0.73	0.047	<0.005	NA
09/30/90***	17.0		0.968	<0.005	1.29	0.58	0.538	NA

*Data collected by Klahr and IF&G
**Entanco Study, Gene Ralston
***Entranco Study, Gene Ralston, Average from duplicates samples

Table 17.
Water Quality data for the Sugar Loaf Island Station, Cascade Res 1991.

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
7/28/91	3.5	5.4	0.138	<0.005	0.41	0.06	0.013	7.6
7/28/91	12.0		0.319	0.016	0.75	0.09	0.053	0.8
8/25/91	2.0	15.6	0.37	<0.005	0.63	0.036	<0.005	8.0
8/25/91	10.5		0.533	<0.005	0.45	0.201	0.106	0.4
9/15/91	1.5	9.8	0.121	0.007	0.45	0.059	0.024	4.2
9/15/91	10.0		0.802	<0.005	0.59	0.26	0.085	0.2

Table 18.
Water Quality data for the North Fork Arm Station, Cascade Res 1991.

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
7/28/91	2.5	4.1	0.132	<0.005	0.48	0.07	NA	7.7
7/28/91	5.5		0.171	<0.005	0.61	0.08	0.011	2.2
8/25/91	1.0	14.3	0.044	<0.005	0.59	0.032	<0.005	7.9
8/25/91	4.5		0.061	<0.005	0.65	0.045	0.026	3.4
9/15/91	1.5	12.2	0.022	0.007	0.11	0.054	0.017	6.9
9/15/91	4.0		0.025	0.008	0.35	0.056	0.016	6.7

Table 19.
Water Quality data for the South Bay Station, Cascade Res 1991.

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
7/28/91	2.5	7.0	0.101	<0.005	0.52	<0.05	0.016	8.6
7/28/91	8.0		0.151	0.026	0.60	0.09	<0.005	3.7
8/25/91	2.5	8.3	0.035	<0.005	0.30	0.02	<0.005	7.5
8/25/91	8.5		0.315	<0.005	0.89	0.156	0.014	1.7
9/15/91	1.5	16.0	0.074	0.011	0.76	0.065	0.016	6.2
9/15/91	7.0		0.083	0.017	0.63	0.54	0.013	6.0

Table 20.
Water Quality data for the Buoy Line (Dam) Station, Cascade Res 1991.

DATE	Sample Depth Meters	Chloro. a ug/l	Ammonia mg/l	NO2+NO3 mg/l	T. Nitrogen mg/l	T. Phos mg/l	Ortho. Phos mg/l	Diss. Oxygen mg/l
7/28/91	3.0	7.3	0.114	0.054	0.43	0.05	0.008	8.8
7/28/91	18.0		0.516	<0.005	0.87	0.15	0.113	0.5
8/25/91	2.5	7.6	0.038	<0.005	0.59	0.021	0.008	6.8
8/25/91	16.5		0.821	<0.005	1.02	0.247	0.113	0.2
9/15/91	1.5	13.2	0.110	0.009	0.34	0.057	0.016	5.6
9/15/91	16.0		1.270	0.007	1.50	0.39	0.210	0.3