REPORT 68

WATER QUALITY BENCHMARKS IN THE NORTH CASCADES

by

William H. Funk, Ervin Hindin, Barry C. Moore
Environmental Engineering/Environmental Science
Washington State University

and

C. Robert Wasem, National Park Service

Co-Investigators:

Christen P. Larsen, Tony C. McKarns,
Steve T. J. Juul, Cynthia K. Trout,
John P. Porter, and Jeffrey E. Lafer

STATE OF WASHINGTON
WATER RESEARCH CENTER

WASHINGTON STATE UNIVERSITY AND
THE UNIVERSITY OF WASHINGTON

Pullman, Washington 99164-3002 March, 1987

WATER QUALITY BENCHMARKS IN THE NORTH CASCADES

By

William H. Funk, Ervin Hindin, Barry C. Moore
Environmental Engineering/Environmental Science
Washington State University
and
C. Robert Wasem, National Park Service

Co-Investigators

Christen P. Larsen
Tony C. McKarns
Steve T. J. Juul
Cynthia K. Trout
John P. Porter
Jeffrey E. Lafer

National Park Service
Pacific Northwest Region

for

RFP-9000-84-21
Contract CX-9000-4-E067

March 4, 1987

ACKNOWLEDGEMENTS

The authors express their appreciation to the North Cascades National Park Service rangers for their able help during field sampling operations.

Appreciation is extended to Tony McKarns, Susan Ratcliffe, and Dawn Wulf for their help in initial laboratory work.

Our thanks and appreciation to the State of Washington Water Research Center staff, especially Kevin Palmer for manuscript preparation, to Sandra Johnson for budget tracking, and to David Flaherty for manuscript review. Acknowledgement is made to the National Park Service for major financial support for the project and to the State of Washington Water Research Center for matching assistance.

ABSTRACT

The North Cascades National Park Service complex is located in the northwest section of Washington State and includes over 276,914 hectares (684,245 acres) of the most scenic and relatively undisturbed areas of the United States. The larger bodies of water, Lake Chelan, Ross, and Diablo Lakes, within the park attract a great number of visitors to the area to observe apparently pristine water conditions. However, there has been a paucity of information on water quality constituents. This study was instituted to help fill the lack of information and to provide a "benchmark" from which continued studies and management decisions could be made.

Sampling on the streams and lakes was conducted seasonally from November, 1984 to July, 1986. Numerous physical, chemical, and biological parameters were measured including pesticide and herbicide content of the sediment, water, and fish, as well as water quality indicators.

Results of the data and samples collected indicate that the water quality of the lakes and streams is excellent. Evaluation of the chemical, physical, and biological parameters place the lakes and streams in a low nutrient, oligotrophic classification.

There are some minor anthropogenic impacts--most likely from early low-level usage of pesticides and herbicides in the watershed and atmospheric deposition. No evidence was found of possible human impact upon nutrient levels or other water quality indicators.

KEYWORDS: Water quality investigation, North Cascades Lakes, North Cascades National Park, high mountain lakes, glacial lakes, oligotrophic lakes, nutrients, pesticides, herbicides.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

In recent years, people have become aware of the need to protect, enhance, and even create bodies of water for recreation, peace of mind, and just to be near to so as to unwind from the ever-increasing pressures of society. Increased human populations are accompanied by an upsurge in leisure time as well as a strong desire to spend more time near water. In addition, parks such as the North Cascades provide an educational and observational opportunity for scientists and others to observe natural conditions with minimal anthropogenic input.

The 204,366 hectares (505,000 acres) in the North Cascades National Park present an ideal opportunity to observe pristine water conditions. Streams draining much of the area are fed by glaciers. In fact, one-third of the glaciers in the contiguous United States are in the park complex.

Two major recreation areas are adjacent to the Park. The Skagit and Stehekin Rivers drain most of the park's land. The Skagit River passes through the cold, deep reservoirs of Ross, Diablo, and Gorge. The Stehekin River drains into Lake Chelan, a glacial trough exceeding 457 m (1,500 ft) in depth. Lake Chelan is the largest lake in Washington (13,397 hectares or 33,104 acres) and the third deepest in the United States (Cunningham and Pine, 1968).

STUDY OBJECTIVES

The major objectives of this study were to document the present water quality conditions of selected areas in the North Cascades National Park Service Complex, exclusive of microbiological, with particular emphasis placed on those pollutants caused by human activities. In addition, an attempt was to be made to identify the probable sources of pollutants, if significant amounts were found. The following procedures were used in an attempt to achieve study objectives:

a) Review published information concerning natural and man-caused impairment of the water quality in the North Cascades study area and other regions having the same geohydrology and meteorology.

b) Measure selected physical, chemical, and biological parameters of water, bottom sediments, and fish specimens needed to meet the aims of the study.

c) Suggest probable causes and sources of chemical pollutants where the magnitude of the parameters measured significantly deviated from pristine conditions.

d) Suggest future monitoring strategies that could be utilized to determine changes in water quality.

METHODS AND PROCEDURES

Study Sites

To carry out the goals of this project, three water sampling sites were established on Ross Lake and one site each on Diablo Lake and the Skagit River. Two sites on Lake Chelan proper and one site at the mouth of Stehekin River, and one site on Company Creek also were chosen.

Chelan Station 1 was at the mouth of the Stehekin River. Station 2 was directly off Weaver Point. Station 3 was mid-lake, off Castle Creek.

The Diablo Lake Station was located at mid-lake.

Ross Lake Station 1 was 200 meters east of the mouth of Ruby Arm. Ross Lake Station 2 was mid-lake off Lightning Creek. Ross Lake Station 3 was 250 meters east of the mouth of Lightning Creek arm.

The Skagit River Station was directly below Newhalem.

Sample sites are shown in Figure 1.

General Procedures

Measurements and sample analysis on the North Cascade Lakes were performed both *in situ* and in the laboratories of the Environmental Engineering Research Section, Department of Civil and Environmental Engineering, at Washington State University (WSU). Analytical methods and sample handling are described in the following section for selected parameters. Unless otherwise noted in the discussion of each individual parameter, analyses were performed in the laboratory.

Water samples were obtained at various levels in the lakes by submerging 2 cm (3/4 in) diameter (i.d.) tygon tubing to the desired depth and pumping with a battery-powered pump. Water was pumped through the tubing for a sufficient period of time to allow for complete flushing of any water remaining in the hose from the previous sample. Stream samples were taken by grab methods.

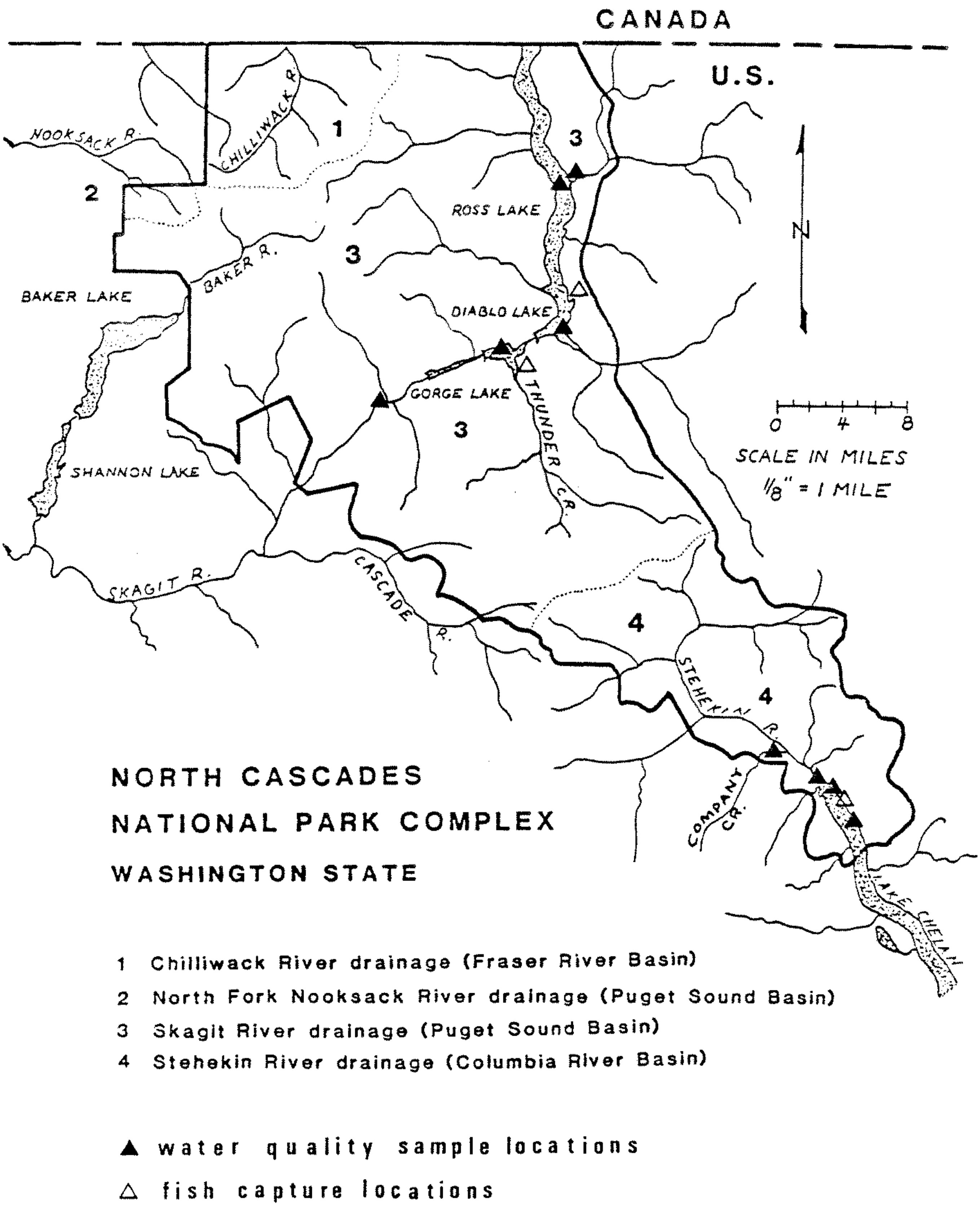

Figure 1. North Cascades National Park Complex.

Samples were collected and stored in Nalgene polypropylene bottles (autoclavable), except for phosphorus samples, which were collected and stored in Pyrex glass bottles. Pesticide samples were collected in heat cleaned amber glass bottles. The collected samples were placed in coolers and iced for transport back to the laboratory. In the laboratory, the samples were stored at 4°C (39°F) until analyzed. Besides cooling, nitric acid was added to stablize chlorides, silicates, aluminum, iron, and other metals. Magnesium carbonate was added to samples taken for chlorophyll *a*. Bioreactive samples were analyzed within one to three days from the time of collection. The maximum time lapse between collection and analysis for metals was approximately three weeks. Pesticide analyses were extended over a much longer time period because of lengthy extraction and purification procedures.

Field Methods

Alkalinity

Alkalinities were determined titrimetrically at the sample site, using methyl-orange (MO) and phenothalein as end-point indicators. Reagents were prepared as detailed in American Public Health Association Standard Methods for Examination of Water and Wastewater (APHA, 1985). The normality of the titrant was adjusted so that one mℓ of titrant was equivalent to ten mg/ℓ (10 ppm) of alkalinity.

Conductivity

Conductivity was measured with a Hydrolab Model 6 Surveyor Unit with a cabled sonde containing the conductivity probe. Calibration and measurements were made in accordance with Standard Methods (APHA, 1985).

Dissolved Oxygen

The dissolved oxygen (DO) concentrations in the lake were measured with a Hydrolab Model 6 Surveyor Unit. The DO probe was calibrated by Winkler titration according to Standard Methods (APHA, 1985). Dissolved oxygen concentrations in the inlet streams were measured titrimetrically, using the Winkler method.

pH

The pH of the inlets and the lakes were measured on site with an Orion pH meter. Calibration of the pH meter was performed with standard buffer solutions.

Light

Light penetration was estimated by use of a standard Secchi disk (20 cm diameter). At Diablo Lake on June 25, 1985, light penetration was measured with a Kahl Scientific submarine photometer during ^{14}C productivity measurements. The intensity of incident light at each meter interval was determined with the photometer at blue, green, and red wavelengths, and at all wavelengths (clear).

Laboratory Methods

(Nutrient and Water Quality Indicators)

Phosphorus

Phosphorus concentrations in the waters were determined colormetrically by Technicon Auto Analyzer II methods. Samples for phosphorus analysis were taken in acid-washed glass bottles and stored at 4°C (39°F). The samples were fractionated by filtration on .45 µm pore-size filters (manufactured by Millipore Corporation). Filtering was performed in the laboratory with 24 hours of sample collection. Orthophosphate samples were analyzed within 48 hours of collection. Filtered and unfiltered fractions were subjected to an acid digestion (using sulfuric acid and ammonium persulfate) in an autoclave at 121°C (250°F) for 30 minutes. The phosphorus content of the various fractions were determined on the Technicon Auto Analyzer II using the molybdate reaction as described by Standard Methods (APHA, 1985). The fractions were labeled as follows: soluble reactive phosphorus (filtered, undigested); total soluble phosphorus (filtered, digested); total phosphorus (unfiltered, digested).

Nitrogen

Nitrogen compounds and fractions determined were nitrates, nitrites, ammonia, and total Kjeldahl nitrogen (TKN). Nitrates and nitrites were determined colorimetrically by Technicon Auto Analyzer II methods. This method utilizes formation of a reddish purple azo dye complex that follows Beer's Law. Nitrates are converted to nitrites with a cadmium catalyst reduction column. The combined nitrate and nitrite content of the water is measured with the column in line. The column is then removed and the nitrite content determined. The nitrate concentration is determined by the difference between the combined nitrate plus nitrite concentrations and the measured nitrite concentration (APHA, 1985).

Ammonia was also determined colorimetrically by Technicon Auto Analyzer II methods. The reaction is the reaction of ammonia with hypochlorite and phenol in the presence of a manganous salt catalyst which forms a blue complex that follows Beer's Law (APHA, 1985).

TKN refers to the organic nitrogen and ammonia that are determined when the Kjeldahl digestion is performed. The difference in TKN and ammonia nitrogen yields the organic nitrogen concentration. Digestions were performed on a Technicon Block Digestor Model BD-20, using sulfuric acid, potassium diphosphate, and mercury chloride, with a programmed digestion period of 3.5 hours at 120°C (248°F) followed by 1 hour at 180°C (356°F). A 25 mℓ aliquot of sample was digested and diluted to 250 mℓ following digestion. The digestion converts the organic nitrogen to ammonia, which is determined colorimetrically by Technicon Auto Analyzer II methods.

Chloride

Chloride analysis was accomplished using the automated ferricyanide method on a Technicon Auto Analyzer II according to the manufacturer's recommendations.

Silicates

Silicates were determined via the automated methods for molybdate-reactive silica on the Technicon Auto Analyzer II. A modification was utilized with a cam calibrated for 30 samples per hour rather than the 40 samples per hour specified in Standard Methods (APHA, 1985).

Sulfates

Sulfates were measured by the barium chloride-methylthymol method described in Standard Methods (APHA, 1985) using Technicon Auto Analyzer II automated procedures. Interfering cations were removed with an ion exchange column.

Trace Metals and Conservative Elements

Metallic constituents were determined on a Perkin-Elmer Model 303 atomic adsorption spectrophotometer equipped with a graphite furnace--in accordance with Standard Methods (APHA, 1985).

Pesticide Analysis

Methods utilized to measure organochlorine, organophosphorus, carbamate, and triazine compounds followed those methods outlined in U.S. Geological Survey Methods for Determination of Organic Substances in Water and Fluvial Sediments (Wershaw et al, 1983). Organochlorine and organophosphorus compounds are extracted from water and water-suspended sediment mixtures with hexane. Organophosphorus compounds are determined on a gas chromatograph with flame-photometric detectors. The extracts are then purified using adsorption chromatography on an alumina column. If toxaphene was present the extracts were further purified using a silica gel column. The organochlorine compounds are then determined by gas chromatography using electron capture detectors. Sensitivities of the various methods are given in the following sections.

Method I

Organochlorine and organophosphorus compounds, total recoverable (0-3104-83) and dissolved (0-1104-83) in water and water suspended sediments.

Concentrations of organochlorine compounds (except chlordane and toxaphene) and organophosphorus insecticides are reported as follows: less than 0.01 $\mu g \cdot \ell^{-1}$ as less than 0.01 $\mu g \cdot \ell^{-1}$; 0.01 to 0.10 $\mu g \cdot \ell^{-1}$, one significant figure; 0.10 $\mu g \cdot \ell^{-1}$ and above, two significant figures.

Concentrations of chlordane, perthane, PCBs, and PCNs are reported as follows: less than 0.1 $\mu g \cdot \ell^{-1}$ as less than 0.1 $\mu g \cdot \ell^{-1}$; 0.1 $\mu g \cdot \ell^{-1}$ and above, two significant figures.

Concentrations of toxaphene are reported as follows: 1.0 $\mu g \cdot \ell^{-1}$, as less than 1.0 $\mu g \cdot \ell^{-1}$; 1.0 $\mu g \cdot \ell^{-1}$ and above, two significant figures.

Method II

Carbamate pesticides, total recoverable (0-3107-83), high performance liquid chromatographic methods in water or water suspended sediments.

Concentrations of carbamates in water or water suspended sediment mixtures are reported as follows: less than 2 $\mu g \cdot \ell^{-1}$, as less than 2.0 $\mu g \cdot \ell^{-1}$; 2.0 $mg \cdot \ell^{-1}$ and above, two significant figures.

Method III

Triazines, total recoverable (0-3106-83), gas chromatographic methods in water or water suspended sediments.

Concentrations of total recoverable triazines, alachlor, and trifluralan are reported as follows: less than 0.1 $\mu g \cdot \ell^{-1}$, as less than 0.1 $\mu g \cdot \ell^{-1}$; 0.1 to 1.0 $\mu g \cdot \ell^{-1}$, one decimal; 1.0 $\mu g \cdot \ell^{-1}$ and above, two significant figures.

Biological Analysis

Carbon-14 Productivity

The light/dark bottle carbon-14 (^{14}C) technique for estimating primary productivity was employed in Diablo and Chelan Lakes. The method utilizes a radio-carbon-labelled bicarbonate ($NaH^{14}CO_3$) to directly measure the conversion of inorganic carbon to organic carbon compounds by phytoplankton. Water samples were taken from the lake at different depths, injected with the labeled bicarbonate, and incubated in glass bottles at the depth from which the samples were obtained. Two light bottles and one dark bottle were used at each depth. Following the incubation period, usually three to four hours, an aliquot from each bottle was filtered in the field through a .45 μm Millipore filter to retain the algal cells. The filters with the retained materials were placed in a scintillation cocktail solution (Sciniverse) and counted on a scintillation counter at the Washington State University Nuclear Radiation Center. This procedure was used on Diablo Lake June 25, 1985, and in Lake Chelan on July 22, 1986, to determine a general level of productivity in the North Cascades area.

Chlorophyll *a*

Chlorophyll *a* samples were collected in dark polyethylene bottles and preserved in the field with magnesium carbonate. Samples were transported back to the laboratory and stored at 4°C (39°F). The samples were filtered within 24 hours of collection under low light conditions through 0.45 μm Millipore membrane filters. The filters were frozen until analysis to aid in disrupting the algal cell walls. Chlorophyll was extracted from the filtered algal cells by 24-hour suspension in a 90% aqueous acetone solution followed by sonification. The resulting extract was clarified by centrifuging for 15 minutes. Optical density of the extract was determined at 630 nm, 645 nm, 663 nm, and 750 nm with a Beckman DU-2 Spectrophotometer. The extract was then acidified with 1 N HCl, and optical densities at 663 nm and 750 nm were determined. Chlorophyll *a* and pheophytin concentrations were calculated using optical density readings and standard equations (APHA, 1985).

Phytoplankton

A 500 mℓ aliquot from each plankton sample bottle (unpreserved) sample was concentrated by centrifugation at 15,000 rpm. The concentrate was diluted to 10 mℓ, and a 1 mℓ subsample was pipetted into a Sewick-Rafter counting cell for identification and counting, utilizing a Nikon microscope equipped with a Whipple disk. Samples not immediately identified were preserved by a 6-3-1 solution. Identification, counting, and preservation methods follow those outlined by Standard Methods (APHA, 1985).

Zooplankton

Zooplankton samples were taken as composite samples of the top, middle, and bottom layers of the lake. Samples were collected by pumping water, at a known rate, for a specified period of time (2 or 3 minutes) at each depth. Collected zooplankton were concentrated to a volume of about 100 mℓ by pumping the samples through a 60 μm mesh nylon plankton net and cup. A formalin, ethanol, and glycerin preservative solution (Schwoerbel, 1970) was added to the concentrated sample at a dose of 5 mℓ preservative/100 mℓ of sample.

The analysis was conducted by first measuring the volume collected in a graduated cylinder. The sample was stirred to evenly distribute the organisms, and subsamples taken with a large-bore pipette. At least two 2 mℓ or 5 mℓ subsamples were counted for each sample, using a zooplankton counting wheel. The organisms were identified to species using the keys of Pennak (1953), Brooks (1957), and Ward and Whipple (1959). Zooplankton enumerations were expressed as organisms per m^3 by multiplying the counts by appropriate factors to account for concentration and subsampling.

Pesticides (Fish Analysis)

Fish collected for analysis were taken by U.S. National Park Service personnel under the direction of Robert Wasem, National Park Service biologist.

The procedure for determining pesticides in fish followed U.S. Geological Survey Methods for Determination of Organic Substances in Water and Fluvial Sediments (Wershaw et al, 1983). Homogenized samples of whole fish/fish fillets are extracted with petroleum ether to isolate the fat. The organochlorine compounds are extracted from the fat with acetonitrile. The acetonitrile extract is diluted with water and extracted with petroleum ether to partition the organochlorine compounds. The petroleum ether extract is concentrated and purified using adsorption chromotography. Organochlorine compounds are identified and quantified by gas chromotography using electron capture detectors.

The methods followed required 50 grams of fish tissue for determination of pesticide content. It was necessary for that reason to pool fish specimens of the same species and from the same collection area. The data are reported as follows, in accordance with guidelines of the cited reference.

Concentrations of organochlorine compounds (except chlordane, perthane, and toxaphene) in fish samples are reported as follows: less than 0.1 $\mu g \cdot kg^{-1}$, as less than 0.1 $\mu g \cdot kg^{-1}$; 0.1 to 1.0 $\mu g \cdot kg^{-1}$, one decimal; 1.0 $\mu g \cdot kg^{-1}$ and above, two significant figures.

Concentrations of chlordane, perthane, PCBs, and PCNs in fish samples are reported as follows: less than 1.0 $\mu g \cdot kg^{-1}$, as less than 1.0 $\mu g \cdot kg^{-1}$; 1.0 $\mu g \cdot kg^{-1}$ and above, two significant figures.

Concentrations of toxaphene in fish samples are reported as follows: less than 10 $\mu g \cdot kg^{-1}$, as less than 10 $\mu g \cdot kg^{-1}$; 10 $\mu g \cdot kg^{-1}$ and above, two significant figures.

Quality Assurance

(For Field and Laboratory Water Analyses)

In all cases, procedures outlined by Standard Methods (APHA, 1985) and generally accepted methods of laboratory practice were strictly observed.

For field measurements, all reagents were prepared within 24 hours prior to each sampling trip. All instruments were calibrated prior to each trip or in the field (for example, pH and DO probes were calibrated or standardized in the field).

Analyses performed on the Technicon Auto Analyzer instruments were checked by replicate samples and by replicates of standard solutions on each analytical run. Any questionable values or runs in which standard replicates indicated possible problems were reanalyzed. For all parameters, unknown quality control samples were analyzed periodically with the regular samples. These quality control samples were obtained from the Washington State Department of Ecology, the U.S. Environmental Protection Agency, and the U.S. Bureau of Standards. Quality control unknowns were analyzed at intervals of one to three months.

RESULTS AND DISCUSSION

Literature Search

Data from earlier studies made by Seattle City Light on Ross Lake were reviewed for comparison with the Washington State University (WSU) first year physicochemical sampling series. The comparisons are shown in tabular form in later sections of this report. Data from Lake Chelan taken by the National Park Service, State of Washington Water Pollution Control Commission (the forerunner of the Washington State Department of Ecology), and the U.S. Geological Survey were reviewed. Additional data for the middle and southern portion of Lake Chelan have been gathered and compiled by several consultants, the Washington State Department of Ecology and the Washington State Department of Game.

Physicochemical

Field Data

Field data results for Lake Chelan, Diablo Lake, Ross Lake, and key streams are shown in Tables 1 & 2. Data taken by the Washington Water Pollution Control Commission at Lake Chelan are shown in Table 3. Additional data taken by the National Park Service are shown in Tables 4a & b.

Data from all three sources are similar. Conductivity field data taken by WSU Hydrolab equipment are slighly lower than the WSU laboratory or Washington Water Pollution Control Commission measurements. Other constituents, such as pH, dissolved oxygen (DO), alkalinity, HCO_3, CO_3, and CO_2, are similar. No other Diablo Lake data were available for comparison at this time. Ross Lake field data (shown in Table 5) are similar to those taken earlier by Seattle City Light with the exception of conductivity.

Temperatures at Lake Chelan ranged from 3.5°C early in the spring to 14°C in late summer. Diablo and Ross Lake temperatures were also low, ranging from 2.0°C to 14°C. All lakes were high in oxygen levels due to low temperatures, organic, and nutrient contents. The pH values for the lakes and inflowing streams were slightly acidic to neutral. Conductivity measurements taken to date indicate that the lakes are in the moderately soft water range.

Nutrient Measurements

At the turn of the century it was understood that phosphorus and nitrogen were essential reactive nutrients required for aquatic food chains (Hutchinson, 1957, 1969; Eyster, 1964, Rodhe, 1969). By the late 1960s, it was generally accepted that phosphorus was the single most critical element in controlling primary production and that phosphorus control is the key to reduction and prevention of nuisance algae growth and associated water quality problems. Many elements such as calcium, magnesium, sodium, potassium, sulfur, and chlorine are also needed by algae in considerable amounts, while iron, zinc, manganese, cobalt, and molybdenum are essential elements needed in trace quantities. In most instance, waters draining the soil mantle and bedrock of watersheds have sufficient levels of these essential elements to support aquatic life. Sometimes, however, a single element can be limiting to primary production, and additions of small quantities can have a profound effect (Goldman and Horne, 1983).

Human beings can excrete 1.8 to 2.7 kg (4 to 6 lbs) of phosphorus and 3.6 to 5.0 kg (8 to 11 lbs) of nitrogen yearly as by-products of body processes. Deposition of these wastes in a lake watershed may result in increased nutrient loading to the lake. Also important are substances which might be carried in and disposed of in the watershed, such as foods, cans, and fuels. Changes in elemental loading and composition of inputs to a lake can often be detected by careful analysis of water and bottom sediments.

Phosphorus

Data analyzed during the study as well as that reviewed from other investigations indicate that the three major bodies of water contained within the North Cascades National Park complex are relatively cold, deep, and with little impairment by human generated pollutants. In most instances, the waters are nutrient limiting. Phosphorus is present in just enough quantity to support small to moderately sized algae populations. These plants form the basis for viable primary production in the aquatic food chain. The algae present were mainly diatoms, green and yellow green forms. Very few blue-green algae (nuisance algae) were present. The phosphorus measurements are shown in Table 6.

Nitrogen

The various forms of nitrogen measured in the North Cascades--nitrates, nitrites, ammonia, and organic nitrates (that contained in both living and dead organisms)--was so low as to constitute a limitation to higher production. Nitrogen levels below .3 $mg \cdot \ell^{-1}$ are considered limiting (Chu, 1943 and Sawyer, 1947) but ample phosphorus (constant supply of phosphorus above .01 $mg \cdot \ell^{-1}$) can stimulate growth of nitrogen-fixing algae. The nitrogen constituents measured in the study area are shown in Table 7.

Conservative Water Quality Components

Chlorides can be utilized in many instances as anthropogenic indicators of sewage or man-made contributions to water bodies. The chloride content at all stations in the three lakes was at very low levels, ranging from .2 to .5 $mg \cdot \ell^{-1}$--indicating no increase above background.

Silica is a necessary nutrient for diatoms and some yellow green algae's cell wall constituents. The amount present at all stations sampled was at low to moderate levels. Enough silica was present so that it would not become limiting at current levels of diatom populations. If major nutrients such as phosphorus and nitrogen were sharply increased and larger algae populations resulted, silica could then become limiting to future diatom growth.

Sulfur may be present in considerable amounts in rocks in watersheds. The amount released by weathering and carried into lakes by streams may be augmented by atmospheric deposition, human and animal wastes, and industrial products. Sulfur is a required nutrient for all living organisms--in both organic and inorganic forms. Sulfur, as sulfate measurements, in Lake Chelan were 3.6 to 4.4 $mg \cdot \ell^{-1}$, as was the Stehekin River. Company Creek was slightly higher at 6.9 to 7.6 $mg \cdot \ell^{-1}$. Diablo lake was 2.0 to 5.2 $mg \cdot \ell^{-1}$, Ross Lake ranged from 4.9 to 8.3 $mg \cdot \ell^{-1}$ with Lightning Creek higher at 6.0 to 8.3 $mg \cdot \ell^{-1}$. The Skagit River was 4.4 $mg \cdot \ell^{-1}$. Data for sulfates, chlorides, and silica are shown in Tables 8 to 16.

Metals

Metals found at Lake Chelan stations are shown in Tables 8 to 17. In all samples tested to date, most metal amounts were very low. In fact, in some instances some metals[1] might become limiting to primary productivity if the prime nutrients (nitrogen and phosphorus) were higher.

Pesticides and Herbicides

Pesticides and Herbicides in Water

The pesticides shown in Table 18 were found to be at the lower limits of detectability. This was also shown to be the case when fish flesh was analyzed. It is assumed that the pesticides and herbicides present in Lake Chelan may have come from atmospheric deposition as well as some possible upstream pesticide usage. Pesticides and herbicides present in Ross and Diablo Lakes may come from some upstream use of pesticides in the drainage area. The amounts detected, however, were very low.

Pesticides and Herbicides in Sediment

Pesticide and herbicide amounts were very low in the headwater sediments of Lake Chelan and the Stehekin River. In most instances, the pesticides and

[1] Those used as components of enzymes such as magnesium which forms the tetrapyrrole nucleus in the chlorophyll molecule.

herbicides (shown in Table 19 to 25) were slightly above trace amounts but below the 0.1 μg•kg reporting level except for DDE which was found to be 2.5 μg•kg in the Stehekin River sediments. Ross Lake sediments were similar except that DDE was found at the .4 μg•kg level and DDD at 3.7 μg•kg at Station 1 (Ruby Arm area). Dieldrin was found at .8 μg•kg at Ross Lake Station 2. Aldrin was found at .4 μg•kg at Ross Lake Station (mid-lake out from Lightning Creek) and DDE at .9 μg•kg and DDT at 7.8 μg•kg at the same location.

These amounts are low and possibly represent early use prior to pesticide restrictions or some continued use of previously purchased chemicals in the watershed. Other pesticides and herbicides may also be entering from watershed drainage but may have been deposited by precipitation on the lake and the immediate watershed.

The 31st Report of the University of London Monitoring Assessment Research Centre (MARC, 1985) suggests that banning of substances such as DDT may not affect the sediment concentration for several years. The very cold waters of this region would also retard degradation and dissipation of these chemicals. However, continued monitoring of water and sediment would be advisable over time to discern if deposition is continuing.

<u>Pesticides and Herbicides in Fishes</u>

Extensive fish extractions to date indicate very low pesticide content in fish flesh. In most instances, the pesticides are barely detectable. The amounts present in fish tissue most likely arrived by atmospheric deposition or fish migration as well as by feeding near inlets where pesticides have been applied to the drainage area. Such applications may have been made in the southern portion of Lake Chelan where intensive silviculture has been practiced. The results of the pesticide analyses of fish tissues are shown in Tables 26 through 39.

Metal Content in Fishes

Arsenic, cadmium, lead, and mercury were extracted from fish tissue and measured (Tables 40 through 51). Although there is some variation among the lakes and species, there does not appear to be elevated levels of these metals entering the lake drainage areas. It would be expected that variation would occur from the different diets of the fishes collected and that some bioaccumulation would take place. Sources of the metals most likely are from the rock mantle within the watershed and atmospheric deposition.

Biological Analyses

Carbon-14 Productivity and Total Organic Carbon Measurement

Primary productivity measured by ^{14}C methods in late June, 1985 indicate that Diablo Lake is relatively low ($\cong$40 $mg \cdot m^{-3} \cdot day^{-1}$ in the phototrophic zone). Measurements by ^{14}C methods in Lake Chelan were low ($\cong$13 $mg \cdot m^{-3} \cdot day^{-1}$ in the phototrophic zone). Figures 2 and 3 show the results of the ^{14}C measurements. Total organic carbon measurements made in June and July, 1985 also lend supporting evidence. 3.83 $mg \cdot \ell^{-1}$ carbon was measured at .5m and 4.85 $mg \cdot \ell^{-1}$ at 15m in late June and 5.0 $mg \cdot \ell^{-1}$ at 5m and 5.5 $mg \cdot \ell^{-1}$ at 15m in late July, 1985.

Chlorophyll *a*

Chlorophyll *a* concentrations in all lakes was very low, ranging from .2 to 9.7 $\mu g \cdot \ell^{-1}$ in Lake Chelan; from 0.0 to 2.2 $\mu g \cdot \ell^{-1}$ in Ross Lake; and 0.6 to 1.3 $\mu g \cdot \ell^{-1}$ in Diablo Lake. Concentrations were low or non-existent in the early spring due to high run-off and considerable suspended material in the water. Suspended matter inhibits photosynthesis by reducing light and may injure cells, reducing or preventing reproduction.

Since chlorophyll mediates the process by which sunlight is converted into food material, it is a good index of primary productivity in lakes.

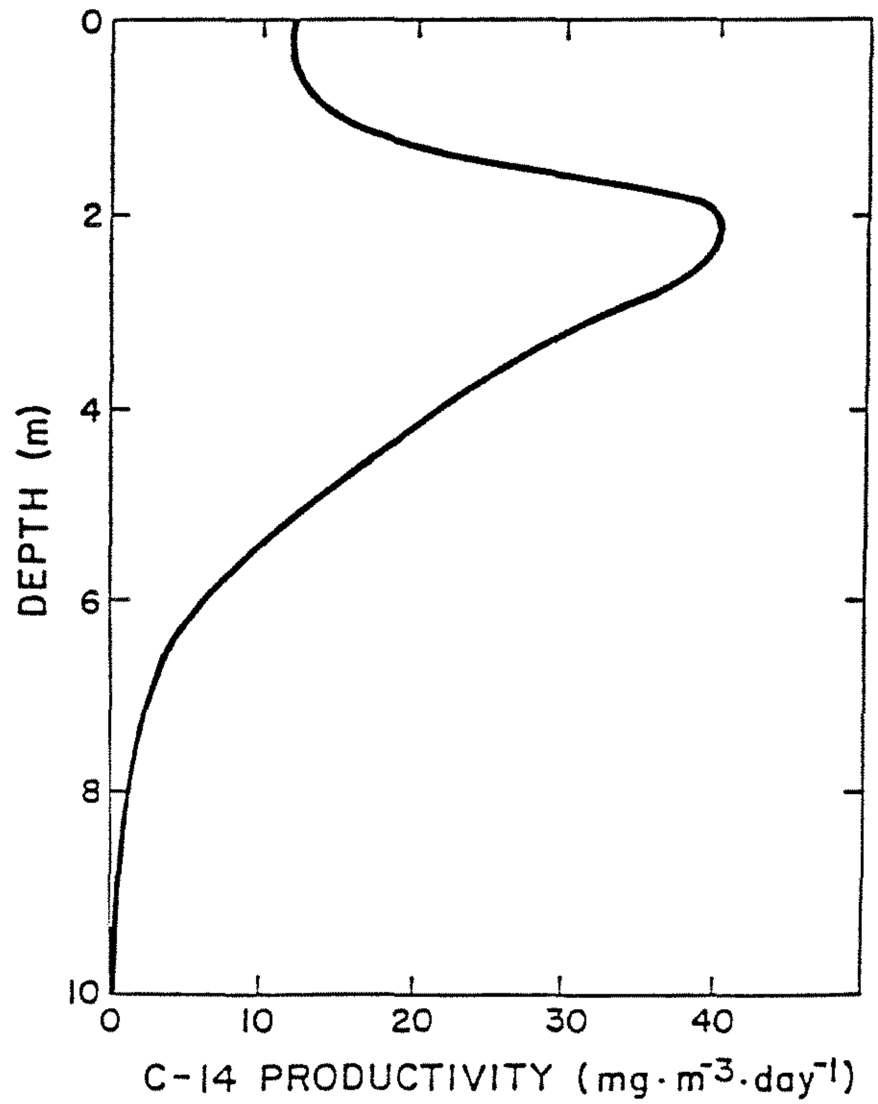

Figure 2. Carbon 14 Primary Productivity in Diablo Lake. June 25, 1985.

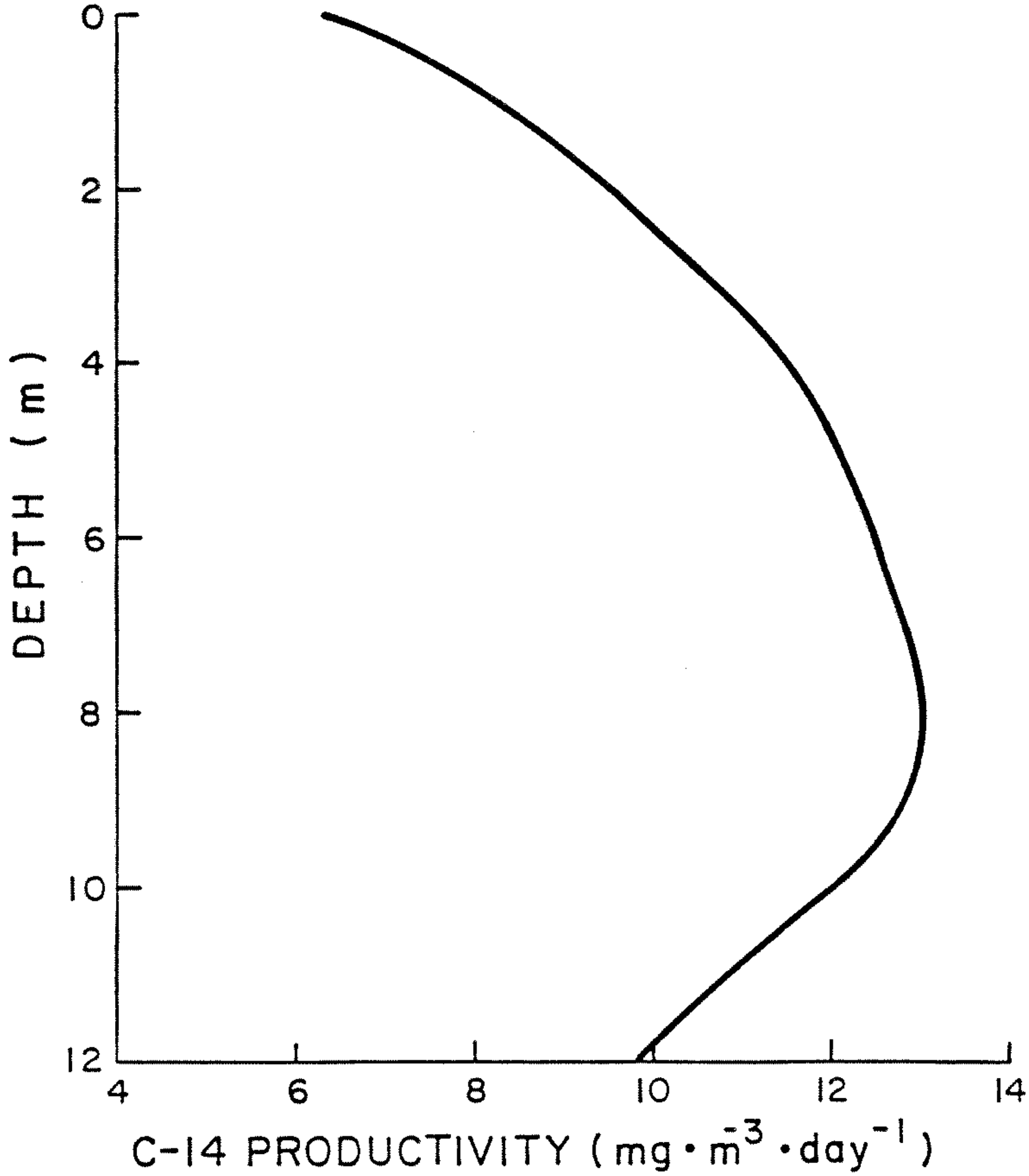

Figure 3. Carbon 14 Primary Productivity in Lake Chelan at Station 2. July 22, 1986.

Chlorophyll may vary in algae due to light, temperature, nutrients, suspended matter, and other factors, but can be used as a general lake trophic condition indicator (Wetzel, 1983), given the following ranges and means for general classification.

		Oligotrophic	Mesotrophic	Eutrophic
Range	$\mu g \cdot \ell^{-1}$	0.3 to 4.5	3.0 to 11.0	3.0 to 80.0
Mean	$\mu g \cdot \ell^{-1}$	1.7	4.7	14.3

The measured chlorophyll *a* levels indicate low productivity or oligotrophic conditions in Diablo and Ross Lakes and the upper portion of Lake Chelan. Data are shown in Table 53.

Phytoplankton

Spring samples (April, May, and June) from all lakes contained a great deal of amorphous plant material and rock particles. Microscopic examination using a Sedgewick-Rafter counting slide revealed that plant debris filled about 1/4 to 1/3 of each microscopic field of the slide. The most likely sources are decayed vegetation in the watershed that was ground-up and reduced to particulate matter and carried into the lakes following snow melt and high run-off.

A portion of this material and associated bacteria were being utilized for food by ciliates and rotifers. These organisms could be seen ingesting the particles in the fresh unpreserved concentrate used in the counting slides. It is likely that other zooplankters were also using some of these materials for food.

Diatoms made up the major component of the spring phytoplankton population. *Asterionella formosa* was present in numbers of 14 to 80 cells$\cdot m\ell^{-1}$. *Synedra ulna* and *Melosira granulata* were present in numbers of 4 to 20 cells$\cdot m\ell^{-1}$, some *Melosira italica, Gomphonema sp, Cymbella sp* and *Fragilaria sp* were present in numbers of 5 to 10 cells$\cdot m\ell^{-1}$. By mid- to late-summer some green and yellow algae, such as *Dictyosphaerium, Ankistrodesmus falcatus,* and *Pediastrum*

Boryanum, increased in numbers. Total numbers usually did not increase over 150 to 200 cells per unit. In comparison to Washington state lakes located at lower elevations, phytoplankton numbers were few and generally indicative of uncontaminated, oligotrophic waters.

Zooplankton

Zooplankton were present in considerable variety at the three lakes studied and most likely are partially responsible for the low numbers of phytoplankton present. The phytoplankton populations as mentioned are mainly diatoms and green algae and most are readily consumed by zooplankton. Fourteen different genera of zooplankton were observed in the North Cascade lakes studies; eight genera in Lake Chelan, six genera in Diablo Lake, and ten genera in Ross Lake. The populations were relatively low, as would be expected due to the limited food supply found in oligotrophic waters.

No single species was overwhelmingly dominant at any of the sites studied, except at Lake Chelan. *Diaptomus* dominated the zooplankton in Lake Chelan, often composing more than 50% of the total zooplankton population. At the other sites studied, seldom did a single species make up more than 50% of the total population. With the exception of one observation in Ross Lake, Lake Chelan was unique in having cyclopoids present.

Ross Lake has several genera not observed in either Diablo Lake or Lake Chelan. The rotifers *Synchaeta, Polyarthra,* and *Conochilus,* and the cladocerans *Holopedium* and *Polyphemus* were found only in Ross Lake. Because the nutrient base is low it is expected that primary producers (phytoplankton) and secondary producers (zooplankton) would be few in numbers. Zooplankton data are shown in Table 54.

SUMMARY

The data collected and analyzed during this study suggest that Diablo and Ross Lakes, and the head of Lake Chelan are relatively cold, fully oxygenated, and with insignificant impairment by pollutants generated by humans.

The waters for the most part are moderately soft with low nutrient content. Phosphorus and nitrogen are present in just enough quantities to support moderately low algal populations which in turn provide food for zooplankton characteristic of oligotrophic waters. Other bioreactive elements such as calcium, magnesium, silica, sodium, potassium, sulfur, and chlorine are present in quantities enough to support aquatic life but are not overly abundant. Nuisance algae such as the blue green species which lend very little to the aquatic food chain were very low in numbers and were not detected in many plankton samples. Carbon-14 experiments and chlorophyll *a* measurements further indicate low productivity, characteristic of oligotrophic lakes.

Increased chlorides, sulfates, and trace metals are characteristic of human activities in watersheds. The levels in the North Cascades Park lake and stream waters tested did not show concentrations much above those believed to be naturally present.

Extensive analyses of water, sediment, and fish for pesticides and herbicides indicated the presence of most of the modern pesticides and herbicides at levels slightly above detection limits but below readily definable amounts. It appears that these chemicals have been used in the headwaters of Diablo and Ross Lakes and possibly Lake Chelan. It is also believed that atmospheric deposition and upstream migration of fish may play some part in the levels found.

The lakes and streams of the North Cascades studied in this investigation represent as close to a pristine environment as can be found in the United States today.

RECOMMENDATIONS

It is recommended that a moderate water quality monitoring program be instituted.

Field data including water temperature, dissolved oxygen, conductivity, pH, and Secchi disk measurements should be carried out seasonally with increased activity in the summer months. Samples for laboratory analyses of basic nutrients, including the phosphorus and nitrogen series, potassium, and silica should be collected at the same time. Other water quality indicators such as chlorides, sodium, sulfates, and zinc should be analyzed at least once yearly. Plankton and zooplankton collections and analyses should be continued seasonally. At least once each year, samples for the metal series--arsenic, cadmium, lead, and mercury, should be collected and measured.

A program for measuring the pesticides and herbicides of the waters and sediments of the lakes and streams should be carried out every three years. Fish tissue analyses should be done every three to five years. It would be prudent to test the sediments and waters of Ruby Arm of Ross Lake, Lightning Creek, and the mid-lake station as soon as feasible to determine dissipation of residual Aldrin, DDT and their breakdown products.

REFERENCES

American Public Health Association. 1985. Standard methods for the examination of water and wastewater. 16th ed. APHA, Washington, D.C.

Brooks, J. L. 1957. The systematics of North American Daphnia. Mem. Conn. Academy of Arts and Sciences. 13: 1-180.

Brown, Larry G. 1984. Lake Chelan fishing investigations. A cooperative project between Public Utility District No. 1 of Chelan County and Washington Department of Game. 238 pp.

Chelan County Planning. 1982. Water quality sampling results. Lake Chelan Coordinating Committee, Wenatchee, WA.

Chu, S. P. 1943. The influence of the mineral composition of the medium on the growth of planktonic algae. Journal of Ecology, 31: 109-148.

City of Seattle. 1972. The aquatic environment, fisheries and fishery Ross Lake and the Canadian Skagit River. International Skagit-Ross Fishery Committee.

Cunningham, R. K. and R. Pine. 1968. Lake Chelan Water Characteristics Survey Tech. Service Div. State of Washington Water Pollution Control Commission.

Eyster, C. 1964. Micronutrient requirements for green plants, especially algae, *in* Algae and Man, D. F. Jackson (ed.), pp. 86-119, Plenum Press, New York, New York.

Fielder, P. C. Creel census and plankton sampling, Lake Chelan, Washington. Unpublished data. PUD No. 1 of Chelan County, Wenatchee, WA.

Goldman, C. R. and A. J. Horne. 1983. Limnology. McGraw Hill, Inc. San Francisco, California.

Hutchinson, G. E. 1957. A treatise on limnology. I. Geography, physics, and chemistry. John Wiley and Sons, Inc. New York, New York.

Hutchinson, G. E. 1969. Eutrophication past and present, *in* Eutrophication: Causes, consequences, correctives. National Academy of Sciences. Washington, D.C.

Monitoring and Assessment Research Centre (MARC). 1985. Historical Monitoring. MARC Report Number 31, University of London. London, England.

Penak, R. W. 1953. Fresh water invertebrates of the United States. Ronald Press Company New York, N.Y.

Prescott, G. W. 1962. Algae of the western Great Lakes area. Wm. C. Brown.

R. W. Beck and Associates. 1981. Lake Chelan "208" Study Data Review. R. W. Beck and Associates, Seattle, WA.

Rodhe, W. 1969. Crystallization of eutrophication concepts in northern Europe. *in* Eutrophication: Causes, consequences, correctives. National Academy of Sciences. Washington, D.C.

Sawyer, C. N. 1947. Fertilization of lakes by agriculture and urban drainage. Jour. New England Water Works Assn. 61:109.

Schwoerbel, J. 1970. Methods of hydrobiology. Pergamon Press, Toronto, Canada.

Technicon Instruments Corp. 1971-1977. Technicon Autoanalyzer II and related publications. Industrial Methods. March 1972-July 1978. Technicon Indus. Systems, Tarrytown, N.Y.

Ward, H. B. and G. C. Whipple. 1959. Freshwater biology. W. T. Edmonson, editor. 2nd ed. John Wiley and Sons, New York, N.Y.

Wasem, C. R. 1972-85. North Cascades fish fauna and limnology studies. Unpublished data. North Cascades Parks, Sedro Woolley, WA.

Wershaw, R. L., M. J. Fishman, R. R. Grobbe, and L. E. Lowe (Editors). 1983. Methods for the determination of organic substances in water and fluvial sediments U.S. Geological Survey techniques of water resources investigation, Book 5, laboratory analysis. U.S.G.S. Open File Report 82-1004. Denver, CO.

Wetzel, R. G. 1983. Limnology. Saunders Publishing Company. Philadelphia, Pennsylvania.

Table 1. Field Data for Lake Chelan.
Measurements are expressed as: Temperature (°C), Dissolved Oxygen ($mg \cdot \ell^{-1}$), pH (-log H^+ activity), conductivity (mhos), Secchi disk (m).

Station 1 (Stehekin River near mouth)

Parameter/Date	11/13/84	4/4/85	6/26/85	7/23/85	10/24/85	4/19/86	7/22/86
Time	11:30am	12:15am	10:10am	11:15am	11:15am	11:30am	11:35am
Air Temp(°C)	6	4.0	22.3	22	10	10.3	21
Water Temp/DO							
1.0m	9.5/11.0	3.0/12.6	11.9/11.2	10.6/12.4	11/10.3	5.5/12.1	10.8/12
2.0m	9.5/10.6	3.0/12.6	11.9/11.2	10.6/12.4	6.8		
pH	7.1	6.9		6.85	6.8	6.9	7.0
Conductivity	34	39	38	35	38	39	38
Secchi disk*	-	-	-	-	-	-	-

*to bottom

Station 2 (off Weaver Point)

Parameter/Date	11/13/84	4/4/85	6/26/85	7/23/85	10/24/85	4/19/86	7/22/86
Time	10:20am	11:30am	10:30am	10:00am	11:00am	10:45am	-
Air Temp (°C)	-	-	-	-	10	10.0	-
Water Temp/DO							
1.0m	10/10.6	3.5/12.7	10/13.2	12.6/12.4	11/10.3	5.7/12.4	-
1.5m	10/10.6	3.5/12.7	9.9/13.2	11.5/12.4	11/10.3	5.7/12/4	-
10.0m	-	-	-	-	10/10.3	5.7/12.4	-
pH	6.8	6.9	7.1	6.7	6.7	6.9	-
Conductivity	38	38	45	39	40	40	-
Secchi disk	8.5	12	13.9	-	9	14	-

Table 1. Field Data for Lake Chelan (Continued).
Measurements are expressed as: Temperature (°C), Dissolved Oxygen ($mg \cdot \ell^{-1}$), pH (-log H^+ activity), conductivity (mhos), Secchi disk (m).

Station 3 (mid-lake, off Castle Creek)

Parameter/Date	11/13/84	4/4/85	6/26/85	7/23/85	10/24/85	4/19/86	7/22/86
Time	9:30am	10:15am	10:30am	9:30am	10:45am	10:20am	-
Air Temp (°C)	6	8	12	10	8	5	-
Water Temp/DO							
1.0m	9.5/11.4	3.5/12.8	/12.8	14/10.6	13/10.2	5.7/12.4	-
10.0m	9.5/11.4	3.5/12.8	/12.8	14/10.5	13/10.2	5.7/12.4	-
20.0m	9.5/11.4	3.5/12.7	/12.8	14/10.5	13/10.2	5.7/12.4	-
30.0m	9.5/11.4	3.5/12.7	/12.8	14/10.5	13/10.2	-	-
pH	6.9	6.9	-	6.75	6.7	6.9	-
Conductivity	38	38	39	39	40	40	-
Secchi disk	14.5	14	12	10	9	-	-

Station 4 (Company Creek, 200 meters above hydroplant)

Parameter/Date	11/13/84	4/4/85	7/23/85	10/24/85	4/19/86	7/22/86
Time	1:00pm	1:30	1:00pm	1:40pm	1:20pm	1:10pm
Air Temp (°C)	8	10	20	8	8	19
Water Temp (DO)						
1.0m	4/14	3.6/12.9	12.7/11.9	4.1/14.4	-	-
pH	6.7	6.6	7.3	-	6.8	7.0
Conductivity	55	54	55	54	52	54
Secchi disk*	-	-	-	-	-	-

*to bottom

Table 2. Field Data for Diablo Lake, Ross Lake, and Skagit River. Measurements are expressed as: Temperature (°C), Dissolved Oxygen ($mg \cdot \ell^{-1}$), pH (-log H^+ activity), conductivity (mhos), Secchi disk (m).

Diablo Lake Station (mid-lake)

Parameter/Data	11/14/84	4/6/85	6/25/85	4/20/86	9/26/86
Time	10:27am	10:30am	10:30am	10:30am	5:00pm
Air Temp (°C)	6	12	17	11	-
Water Temp/DO					
1.0m	8.5/13	2.0/13	6/13.8	6/12.1	10.5/11.3
25.0m	8.5/12.3	2.0/12.9	6/13.9	6/12.2	9.5/11.0
pH	7.2	6.7	7.1	7.1	6.8
Conductivity	45	51	50	68	55
Secchi disk	6.9	6	6.5	5.1	5.0

Ross Lake Station #1

Parameter/Data	11/14/84	4/6/85	6/25/85	4/20/86	9/26/86
Time	1:15pm	1:35pm	1:30pm	1:15pm	11:00am
Air Temp (°C)	6.0	12.0	16	11.0	-
Water Temp/DO					
1.0m	9.0/11.0	4/12	8/12.4	6/12.2	14.5/10
20m	9.0/11.0	3.8/12.2	6/12.1	6/12.2	14.5/10
pH	7.1	7.1	7.2	-	-
Conductivity	64	67	68	66	60
Secchi disk	13.5	7.2	5.0	7.4	10.2

Ross Lake Station #2

Parameter/Data	11/14/84	4/6/85	6/25/85	4/20/86	9/26/86
Time	3:15pm	3:45pm	3:00pm	3:15pm	2:00pm
Air Temp (°C)	6.0	12	16	10	-
Water Temp/DO					
1.0m	3.5/10.2	4/12.4	4/10.1	6/12.1	9.5/11.0
50m	2.0/9.8	4/12.1	4/10.1	6/12.2	-
pH	7.1	7.2	7.1	7.1	-
Conductivity	68	64	70	66	60
Secchi disk	11.2	-	6.5	7	10

Table 2. Field Data for Diablo Lake, Ross Lake, and Skagit River (Continued). Measurements are expressed as: Temperature (°C), Dissolved Oxygen ($mg \cdot \ell^{-1}$) pH (-log H^+ activity), conductivity (mhos), Secchi disk (m).

Ross Lake Station #3

Parameter/Data	11/14/84	4/6/85	6/25/85	4/20/86	9/26/86
Time	3:00pm	3:40pm	3:30pm	5:00pm	7:30pm
Air Temp (°C)	-	14.0	16	-	-
Water Temp/DO					
1.0m	9/11.4	12.5/11.5	-	6/11.2	10/11.3
25.0m	9/11.4	11/11.5	-	6/11.3	10/11.3
pH	7.0	7.2	7.2	-	-
Conductivity	68	63	59	-	64
Secchi disk	-	-	-	-	-

Skagit River at Newhalem Station

Parameter/Date	11/14/84	4/6/85	6/25/85	4/20/86	9/26/86
Time	5:15pm	5:30pm	5:30pm	5:00pm	7:30pm
Air Temp (°C)	8	12	14	6.0	7.0
Water Temp/DO					
.5m	4/13.4	6/14	6/14.1	6.4/13	-
pH	7.5	7.7	7.5	6.8	6.8
Conductivity	51	49	50	-	35
Secchi disk	-	-	-	-	-

TABLE 3. Field and Laboratory Results for Lake Chelan Stations 1 Through 12 and Manson's Domestic Water Supply Intake, March 30 Through October 4, 1967. (Washington Water Pollution Control Commission)

Test	Date	Depth	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	7	8	9	10	11	12	Manson Intake
PO_4(total)*	10/4		.04	.04	.04	.08	.03	.03	.04	.03	.02	--	.08	.07	.06	.06	.07	.06	.06	--
PO_4 (ortho)*	3/30		.02	--	.01	--	.01	--	.01	--	.01	--	.01	.01	.01	.01	.01	.01	.01	--
	5/2		.01	.01	.01	--	.01	.01	.01	--	.01	.00	.01	.01	.01	.01	.01	.01	.02	--
	6/21		.02	.02	.03	--	.12	.00	.00	.07	.00	.00	.00	.00	.01	.04	.02	.06	.04	--
	8/9		.01	.00	.00	--	.00	.01	.00	.01	.00	.00	.00	.00	.00	.00	.01	.00	.01	--
	10/4		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	--
NO_3*	3/30		.16	--	.28	--	.28	--	.32	--	.46	--	.36	.22	.32	.28	.16	.28	.36	--
	5/2		1.00	.38	.26	--	.26	.11	.26	--	.58	.16	.26	.06	.03	.06	.06	.42	.11	--
	6/21		.22	.14	.36	--	.46	.14	.36	.27	.32	.22	.27	.22	.22	.27	.14	.52	.22	--
	8/9		.14	.12	.2	--	.02	.12	.12	.05	.02	.02	.00	.00	.14	.14	.05	.20	.14	--
	10/4		.42	.82	1.0	1.30	1.60	1.90	.08	.22	.36	--	.90	1.10	1.80	1.20	.20	.20	.10	--
C.O.D.*	5/2		3.2	0.8	2.4	--	5.6	2.4	2.4	--	2.4	2.4	1.6	0.8	0.8	0.8	3.2	2.4	.8	--
	6/21		4.5	4.5	4.5	--	4.5	4.5	6.0	6.0	6.0	5.3	3.8	3.8	2.3	5.2	3.7	4.5	4.5	--
	8/9		0.8	1.5	0.8	--	1.5	3.1	1.5	2.3	3.1	3.8	3.8	4.6	4.6	3.8	3.8	3.8	4.6	--
	10/4		2.4	3.2	7.2	8.0	4.0	2.2	3.2	3.2	4.0	--	1.6	3.2	4.0	2.4	0.8	2.4	3.2	--
pH	5/2		7.8	7.9	7.9	--	7.7	7.8	7.8	7.8	7.7	--	7.7	7.8	7.7	7.8	7.8	7.7	7.7	--
Alkalinity* (total)	6/21		17.6	17.0	18.0	--	17.6	17.0	17.6	18.0	17.0	17.6	17.0	17.0	17.0	17.0	16.5	16.5	17.0	--
	8/9		17.0	17.0	17.5	--	17.2	17.0	17.2	17.5	16.9	17.1	17.0	17.0	17.0	17.0	15.5	16.0	16.5	--
NH_3*	6/21		0	0	0	--	0	0	0	0	0	0	0	0	0	0	0	0	0	--
Bacteria per 100 ml	5/2		0	0	0	--	0	0	0	--	0	--	0	0	3	0	6	0	0	1
	6/21		3	7	11	--	4	36	0	4	6	0	0	2	29	0	20	1	0	--
	7/12	@0'	--	--	--	--	--	--	0	--	0	--	--	1	0	1	2	--	0	--
	7/12	@20'	--	--	--	--	--	--	0	--	0	--	--	0	0	5	0	--	--	--
	8/9	@0'	0	0	0	--	0	0	0	--	0	--	--	1	0	3	3	4	0	12
	8/9	@20'	--	--	--	--	--	--	--	--	--	--	--	0	15	0	0	0	--	--
	10/4		14	12	37	30	23	14	1	6	12	--	3	43	52	22	6	25	7	--
	10/4		--	--	--	--	--	--	15	--	--	--	--	--	89	45	37	--	--	--
NPP**	3/13		2.1	--	1.5	--	3.4	--	11.0	--	1.1	--	--	0.9	1.5	1.5	0,6	1.1	1.1	--
	3/30		4.0	--	--	--	--	--	7.5	--	0.2	--	--	0.7	0.9	0.4	0.4	0.4	0.2	--
	5/2		2.8	--	--	--	--	--	--	--	--	--	1.3	2.1	51.2	85.5	37.6	--	1.3	--
	8/9		--	4.1	4.7	--	3.2	--	20.1	1.3	--	--	8.6	--	5.1	--	--	5.3	--	--
	10/4		--	0.5	1.6	--	1.2	0.6	--	2.4	1.0	1.0	1.8	0.7	1.0	3.0	1.7	0.7	1.4	--
D.O.*	5/2		10.0	11.5	11.3	--	11.4	11.3	10.6	11.2	11.3	--	11.6	11.3	11.1	11.5	11.5	11.5	11.5	--
	8/9	@0'	--	--	--	--	--	--	9.2	--	--	--	--	9.3	--	--	9.8	9.3	--	--
	8/9	@20'	--	--	--	--	--	--	9.4	--	--	--	--	9.5	--	--	9.7	9.6	--	--
	10/4	@0'	--	--	--	--	--	--	9.1	--	--	--	9.2	9.0	9.1	9.1	9.1	--	--	--
	10/4	@20'	--	--	--	--	--	--	9.1	--	--	--	9.2	9.0	9.3	9.2	9.1	--	--	--
Temp °C	3/13		6.0	--	6.2	--	6.5	--	6.5	--	6.0	--	--	6.5	6.5	6.5	6.5	6.0	7.0	--
	3/30		8.0	--	8.0	--	7.5	--	8.0	--	7.5	--	--	7.0	7.0	7.0	7.0	7.0	7.0	--
	5/2		10.5	10.5	11.0	--	12.7	13.0	12.5	12.7	11.2	--	12.2	12.0	12.2	11.2	10.7	10.5	10.7	--
	8/9	@0'	23.0	24.0	24.5	23.0	25.5	25.0	24.5	24.5	24.5	24.0	24.0	26.0	26.0	24.0	23.0	21.0	--	--
	8/9	@20'	--	--	--	--	--	--	21.0	--	--	--	24.0	22.5	--	21.0	23.0	20.0	--	--
	10/4		--	18.0	18.0	--	18.0	18.0	18.0	18.0	18.0	--	18.0	18.0	18.0	18.0	17.0	--	--	--

* milligrams/liter

Table 4a. National Park Service Data from the Head of Lake Chelan (7/10/84).

	Station 1 Surface	Station 2 Surface	Station 3 Surface	Station 4 Surface	Station 5 Surface	Station 6 Surface
Time (PDT)	8:25	9:10	10:15	10:45	11:50	12:15
Air Temp. (°C)	12.4	15.5	15.6	15.0	17.5	18.0
Water Temp. (°C)	7.3	9.8	8.8	11.1	10.1	10.4
Secchi disk (m)	4.0*	12.7	-	11.75	9.75	10.5
Turbidity (NTU)	0.55	0.40	0.34	0.48	0.47	0.39
pH Units**	7.10	7.20	7.13	7.12	7.11	7.10
HCO_3^- Alkalinity as $CaCO_3$ ($mg \cdot \ell^{-1}$)	13.50	15.00	15.25	14.25	14.50	14.50
Hardness as $CaCO_3$ ($mg \cdot \ell^{-1}$)						
Total	16.16	17.95	18.32	17.24	16.65	17.46
Ca	14.44	15.03	15.10	14.32	14.81	14.95
Conductivity ($\mu S/cm$)	40.5	46.1	46.2	42.4	42.7	44.4
Calcium ($mg \cdot \ell^{-1}$)	5.78	6.01	6.04	5.73	5.92	5.98
CO_2 ($mg \cdot \ell^{-1}$)	1.70	1.50	1.72	1.80	1.83	1.83
Dissolved Oxygen						
$mg \cdot \ell^{-1}$	12.0	12.6	12.4	11.6	12.0	10.8
% sat.	103	113	-	109	96	100

* Visible resting on bottom

** Colorimetric method

Table 4b. National Park Service Data from the Lower Stehekin River and Company Creek in 1984.

	Lower Stehekin River			Company Creek		
Sample Date	4/10	7/11	10/24	4/10	7/12	10/23
Water Temp. (°C)	4.6	9.4	3.7	4.1	9.7	2.3
Dissolved Oxygen						
$mg \cdot \ell^{-1}$	14.0	12.0	13.0	14.2	-	14.2
% sat.	112	108	103	112	-	108
pH Units*	7.05	7.10	7.10	7.12	7.0	7.18
HCO_3 Alkalinity as $CaCO_3$ ($mg \cdot \ell^{-1}$)	18.25	11.5	17.25	22.5	12.0	18.0
Hardness as $CaCO_3$ ($mg \cdot \ell^{-1}$)						
Total	22.83	13.46	22.03	27.60	17.63	26.25
Ca	20.07	11.83	18.44	24.05	16.24	23.40
Ca^H	8.03	4.73	7.38	9.62	6.50	9.36
Conductivity (μS/cm)	58.0	32.2	51.6	66.0	42.8	62.7
Turbidity (NTU)	0.18	0.67	0.24	0.20	0.51	0.18
CO_2 $mg \cdot \ell^{-1}$	2.58	1.45	2.18	2.84	1.91	2.02

*pH with Hach Colorimeter

Table 5. Water Analysis for Ross Lake (Seattle City Light Company).
Date Collected: May 27, 1971.

	Station[1] 1	Station[2] 2	Station[3] 3	Station[4] 4
Alkalinity	24.5	25.5	28.4	25.5
Calcium	10.4	11.4	11.6	10.4
Free Carbon Dioxide (CO_2)	5.0	2.8	3.7	3.9
Chloride	0.5	BDL	0.5	BDL
Chromium (Cr^{+6})	BDL	BDL	BDL	BDL
Copper	.025	.015	.025	.02
Fluoride	<0.1	<0.1	<0.1	<0.1
Hardness ($CaCO_3$)	32.4	37.0	36.0	32.0
Iron (Fe)	0.05	0.03	0.05	0.03
Lead (Pb)	<0.005	<0.005	<0.005	<0.005
Magnesium (Mg)	1.56	2.07	1.7	1.46
Manganese (Mn)	<0.025	<0.025	<0.025	<0.025
Nitrogen (Ammonia)	---	.03	.015	.015
Nitrogen (Nitrate)	0.25	0.1	<0.05	<.05
Dissolved Oxygen	11.5	11.6	10.9	11.5
Phosphate (PO_4)	.04	.035	.03	.03
Potassium (K)	0.4	0.4	0.45	0.45
Residue (Total)	39	47	24	21
Residue - Filterable	7	8	9	10
Residue - Non-Filterable	32	39	15	11
Silica (SiO_2)	7.0	7.2	7.8	7.0
Sodium (Na)	1.4	1.0	1.5	1.6
Sulfate (SO_4)	4.7	4.3	4.7	3.4
Surfactants	.008	.026	.025	.023
Tannin-Lignin	0.1	<0.1	0.15	0.1
• Color Units	5	5	5	5
• Temperature°C	7½	6½	9½	6
• Turbidity - JTU	1.5	1.0	1.6	0.9
• Secchi Disk	17'		14'	
• pH Units	7.12	7.42	7.31	7.26
• Specific Conductance (mmhos/cm)	64	68	70	64

(Results in milligram per liter (ppm) except BDL - below detectable level)

[1]South End - 25 foot depth
[2]South End - 100 foot depth
[3]North End - 25 foot depth
[4]North End - 100 foot depth

Table 6. Phosphorus Concentrations In North Cascade Lakes.

Sampling Date	Station/Depth	TOTAL P (mg·ℓ$^{-1}$)	SOLUBLE P (mg·ℓ$^{-1}$)	ORTHO P (mg·ℓ$^{-1}$)
10/24/84	Chelan 1 (.5m)	.017	.014	<.001
	Chelan 2 (.5m)	.015	.014	<.001
	Chelan 3 (.5m)	.014	.014	<.001
	Company Creek	.005	.004	<.001
	Diablo (.5m)	.005	.004	<.001
	Ross 1 (.5m)	.010	.007	<.001
	Ross 2 (.5m)	.008	.007	<.001
	Ross 3 (.5m)	.010	.007	<.001
	Skagit River	.012	.008	<.001
4/4/85	Chelan 1 (.5m)	.012	.010	<.001
	Chelan 2 (.5m)	.002	.001	<.001
	Chelan 3 (.5m)	.004	.001	<.001
	Company Creek	.002	.010	<.001
4/5/85	Diablo (.5m)	.002	.001	<.001
	Ross 1 (.5m)	.005	.004	<.001
	Ross 2 (.5m)	.005	.004	<.001
	Ross 3 (.5m)	.005	.004	<.001
	Skagit River	.012	.010	<.001
6/25/85	Diablo (.5m)	.011	<.001	<.001
	Ross 1 (.5m)	.019	.003	<.001
	Ross 2 (.5m)	.009	.001	<.001
	Ross 3 (.5m)	.011	.001	<.001
	Skagit River	.014	.001	<.001
7/23/85	Chelan 1 (.5m)	.007	.002	<.001
	Chelan 2 (.5m)	.002	.001	<.001
	Chelan 3 (.5m)	.002	.001	<.001
	Stehekin River	.004	.001	<.001
	Company Creek	.002	.002	<.001
10/24/85	Chelan 1 (.5m)	.006	.001	<.001
	Chelan 2 (.5m)	.004	.001	<.001
	Chelan 3 (.5m)	.004	.002	<.001
	Company Creek	.007	.005	<.001
4/20/86	Diablo (.5m)	.001	<.001	.001
	Diablo (30m)	.085	.067	.001
	Ross 1 (.5m)	.005	.004	.001
	Ross 1 (30m)	.010	<.001	.001
	Ross 2 (.5m)	.001	<.001	.001
	Ross 2 (30m)	.007	---	.001
	Skagit River	.012	<.001	.001

Table 6. Phosphorus Concentrations In North Cascade Lakes (Continued).

Sampling Date	Station/Depth	TOTAL P ($mg \cdot \ell^{-1}$)	SOLUBLE P ($mg \cdot \ell^{-1}$)	ORTHO P ($mg \cdot \ell^{-1}$)
7/22/86	Chelan 1 (.5m)	.007	.004	<.001
	Chelan 2 (.5m)	.007	.004	<.001
	Chelan 2 (2.0m)	.003	<.001	<.001
	Chelan 3 (.5m)	.001	<.001	<.001
	Chelan 3 (30m)	.007	.002	<.001
	Company Creek	.069	.015	<.001
	Stehekin River	.006	<.001	<.001
9/26/86	Diablo (.5m)	.006	<.001	<.001
	Diablo (15m)	.005	.001	<.001
	Diablo (30m)	.007	<.001	<.001
	Ross 1 (.5m)	.006	<.001	<.001
	Ross 1 (2.0m)	.005	.001	<.001
	Ross 1 (30m)	.002	.001	<.001
	Ross 2 (.5m)	.003	.002	<.001
	Ross 2 (15m)	.006	.003	<.001
	Ross 2 (30m)	.010	.003	<.001
	Lightning Creek	.010	.002	<.001
	Skagit River	.002	<.001	<.001

Table 7. Nitrogen Concentrations in North Cascades Lakes.

Sampling Date	Station/Depth	NO_3 ($mg \cdot \ell^{-1} N$)	NO_2 ($mg \cdot \ell^{-1} N$)	NH_3 ($mg \cdot \ell^{-1} N$)	TKN ($mg \cdot \ell^{-1} N$)
10/24/84	Chelan 1 (.5m)	-	<.01	.023	-
	Chelan 2 (.5m)	-	<.01	.014	-
	Chelan 3 (.5m)	-	<.01	.011	-
	Company Creek	-	-	.024	-
10/25/84	Diablo (.5m)	-	<.01	.03	-
	Ross 1 (.5m)	-	<.01	.03	-
	Ross 2 (.5m)	-	<.01	.03	-
	Ross 3 (.5m)	-	<.01	.03	-
	Skagit River	-	<.01	.074	-
4/4/85	Chelan 1 (.5m)	-	<.01	.01	-
	Chelan 2 (.5m)	-	<.01	.01	-
	Chelan 3 (.5m)	-	<.01	.01	-
	Company Creek	-	<.01	.01	-
4/5/85	Diablo (.5m)	-	<.01	.01	-
	Ross 1 (.5m)	-	<.01	.03	-
	Ross 2 (.5m)	-	<.01	.03	-
	Ross 3 (.5m)	-	<.01	.03	-
	Skagit River	-	<.01	.145	-
6/26/85	Chelan 1 (.5m)	.06	-	<.01	.01
	Chelan 2 (.5m)	.03	-	<.01	.01
	Chelan 3 (.5m)	.03	-	<.01	.01
	Company Creek	.02	-	<.01	.01
	Diablo (.5m)	.07	<.01	<.01	.01
	Ross 1 (.5m)	.06	<.01	<.01	.01
	Ross 2 (.5m)	.03	<.01	<.01	.01
	Ross 3 (.5m)	.06	<.01	<.01	.01
	Skagit River	.05	<.01	<.01	.01
7/23/85	Chelan 1 (.5m)	.05	.01	.01	-
	Chelan 2 (.5m)	.03	.01	.01	-
	Chelan 3 (.5m)	.03	.01	.02	-
	Stehekin River	.02	.01	.01	-
	Company Creek	.03	.01	.01	-
10/24/85	Chelan 1 (.5m)	.04	.01	.02	.01
	Chelan 3 (.5m)	.03	.01	.02	.01
	Company Creek	.14	.01	<.01	.01
4/22-23/86	Chelan 1 (.5m)	.03	<.01	-	0.26
	Chelan 2 (.5m)	.03	<.01	-	0.15
	Chelan 3 (.5m)	.03	<.01	-	0.31
	Company Creek	.05	<.01	-	0.36

Table 7. Nitrogen Concentrations in North Cascades Lakes (Continued).

Sampling Date	Station	NO_3 ($mg \cdot \ell^{-1} N$)	NO_2 ($mg \cdot \ell^{-1} N$)	NH_3 ($mg \cdot \ell^{-1} N$)	TKN ($mg \cdot \ell^{-1} N$)
4/22-23/86	Stehekin River	.09	<.01	-	0.30
(cont)	Diablo (.5m)	.03	<.01	-	0.34
	Diablo (30m)	.03	<.01	-	0.07
	Ross 1 (.5m)	.03	<.01	-	0.25
	Ross 1 (30m)	.06	<.01	-	0.25
	Ross 2 (.5m)	.03	<.01	-	0.20
	Ross 2 (30m)	.03	<.01	-	0.25
	Skagit River	.03	<.01	-	0.24
7/22/86	Chelan 1 (.5m)	.04	<.01	-	0.01
	Chelan 2 (.5m)	.08	<.01	-	0.32
	Chelan 2 (2.0m)	.05	<.01	-	<0.01
	Chelan 3 (.5m)	.05	<.01	-	0.30
	Chelan 3 (30m)	.05	<.01	-	0.12
	Stehekin River	.04	<.01	-	<0.01
	Company Creek	.04	<.01	-	<0.01
9/26/86	Diablo (.5m)	.04	<.01	.012	0.18
	Diablo (15m)	.05	<.01	.014	0.24
	Diablo (30m)	.06	<.01	.007	0.28
	Ross 1 (.5m)	.02	<.01	.004	0.08
	Ross 1 (15m)	.01	<.01	.004	0.20
	Ross 1 (30m)	.07	<.01	.009	0.30
	Ross 2 (.5m)	.01	<.01	.014	0.34
	Ross 2 (15m)	.01	<.01	.006	0.25
	Ross 2 (30m)	.01	<.01	.007	0.34
	Lightning Creek	.04	<.01	.014	0.11
	Skagit River	.07	<.01	.012	0.06

Table 8. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Lake Chelan - Station 3 (1.0m)

Parameter	11/13/84	4/4/85	7/23/85
Color, color units	0.0	<0.5	<0.5
Turbidity, NTU	0.17	0.2	0.1
Conductivity, µS/cm	42 at 23°C	45 at 19°C	33 at 19.5°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	24.0	20.0
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	43.1	25.6	16.4
Calcium, $mg \cdot \ell^{-1}$ Ca	7.5	2.0	5.5
Magnesium, $mg \cdot \ell^{-1}$ Mg	0.82	0.9	0.8
Sodium, $mg \cdot \ell^{-1}$ Na	1.67	1.2	0.9
Chloride, $mg \cdot \ell^{-1}$ C	0.38	0.4	0.3
Potassium, $mg \cdot \ell^{-1}$ K	0.62	1.0	0.7
Mercury, $\mu g \cdot \ell^{-1}$ Hg	<0.2	0.3	0.7
Zinc, $\mu g \cdot \ell^{-1}$ Zn	8.0	11.7	11.7
Aluminum, $\mu g \cdot \ell^{-1}$ Al	14.0	31.5	20.5
Copper, $\mu g \cdot \ell^{-1}$Cu	1.6	6.1	3.5
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	3.1	1.0
Iron, $\mu g \cdot \ell^{-1}$ Fe	13.0	10.7	34.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	0.4	0.3	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	<1.0	1.9	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	1.6	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	20.0	20.0	30.0
Silica, $mg \cdot \ell^{-1}$ Si	4.1	-	-

Table 9. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Lake Chelan - Station 3 (30m)

Parameter	11/13/84	4/4/85	7/23/85
Color, color units	<0.5	<0.5	<0.5
Turbidity, NTU	0.2	0.1	<0.1
Conductivity, µS/cm	42 at 24°C	41 at 22°C	39 at 19°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	22.0	20.0
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	59.5	23.6	27.7
Calcium, $mg \cdot \ell^{-1}$ Ca	7.0	6.1	6.3
Magnesium, $mg \cdot \ell^{-1}$ Mg	0.84	0.9	0.8
Sodium, $mg \cdot \ell^{-1}$ Na	1.10	1.2	1.2
Chloride, $mg \cdot \ell^{-1}$ Cl	0.3	0.3	0.3
Potassium, $mg \cdot \ell^{-1}$ K	0.44	0.8	0.8
Mercury, $\mu g \cdot \ell^{-1}$ Hg	<0.2	<0.2	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	6.0	11.7	13.4
Aluminum, $\mu g \cdot \ell^{-1}$ Al	6.5	7.5	25.5
Copper, $\mu g \cdot \ell^{-1}$ Cu	<1.0	7.0	5.2
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	<1.5
Iron, $\mu g \cdot \ell^{-1}$ Fe	20.5	7.9	11.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	1.3	0.22	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	1.7	1.9	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	50.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	30.0	20.0	30.0
Silica, $mg \cdot \ell^{-1}$ Si	4.6	4.9	4.9

Table 10. Water Constituents and Trace Metal Analyses for North Cascade Lakes. Station: Stehekin River

Parameter	11/13/84	4/4/85	11/23/85
Color, color units	2.5	<0.5	1.0
Turbidity, NTU	0.2	0.5	0.2
Conductivity, µS/cm	46 at 22.5°C	47 at 20°C	28 at 20°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	24.0	-
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	49.2	27.7	16.4
Calcium, $mg \cdot \ell^{-1}$ Ca	8.2	6.9	4.7
Magnesium, $mg \cdot \ell^{-1}$ Mg	0.9	0.9	0.5
Sodium, $mg \cdot \ell^{-1}$ Na	1.25	1.1	0.8
Chloride, $mg \cdot \ell^{-1}$ Cl	0.40	-	-
Potassium, $mg \cdot \ell^{-1}$ K	0.55	0.8	0.7
Mercury, $\mu g \cdot \ell^{-1}$ Hg	1.1	<0.2	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	45.2	13.4	10.0
Aluminum, $\mu g \cdot \ell^{-1}$ Al	9.6	39.0	18.0
Copper, $\mu g \cdot \ell^{-1}$ Cu	1.6	4.0	3.5
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	<1.0
Iron, $\mu g \cdot \ell^{-1}$ Fe	26.8	13.5	35.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	0.5	<0.2	<0.1
Arsenic, $\mu g \cdot \ell^{-1}$ As	<1.0	4.1	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	30.0	28.0	-
Silica, $mg \cdot \ell^{-1}$ Si	6.8	-	-

Table 11. Water Constituents and Trace Metal Analyses for North Cascade Lakes. Station: Company Creek

Parameter	11/13/84	4/4/85	7/23/85
Color, color units	2.5	<0.5	<0.5
Turbidity, NTU	0.14	0.4	<0.1
Conductivity, µS/cm	57 at 24.5°C	55 at 19°C	55 at 18°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	27.0	-
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	45.1	32.8	21.5
Calcium, $mg \cdot \ell^{-1}$ Ca	9.6	8.3	6.3
Magnesium, $mg \cdot \ell^{-1}$ Mg	0.81	0.9	0.5
Sodium, $mg \cdot \ell^{-1}$ Na	1.40	1.3	0.8
Chloride, $mg \cdot \ell^{-1}$ Cl	0.25	0.2	-
Potassium, $mg \cdot \ell^{-1}$ K	0.44	0.9	0.6
Mercury, $\mu g \cdot \ell^{-1}$ Hg	0.25	<0.2	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	<5.0	13.4	11.7
Aluminum, $\mu g \cdot \ell^{-1}$ Al	8.5	46.5	45.5
Copper, $\mu g \cdot \ell^{-1}$ Cu	<1.0	3.3	2.8
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	<1.0
Iron, $\mu g \cdot \ell^{-1}$ Fe	<5.0	29.0	12.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	0.3	0.4	<0.1
Arsenic, $\mu g \cdot \ell^{-1}$ As	6.0	3.8	3.8
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	40.0	35.0	-
Silica, $mg \cdot \ell^{-1}$ Si	8.2	9.3	-

Table 12. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Diablo Lake

Parameter	11/14/84	4/5/85	6/25/85	6/25/85 (Deep)
Color, color units	5.0	<0.5	0.5	1.0
Turbidity, NTU	0.19	0.2	0.2	0.3
Conductivity, μS/cm	55 at 22°C	69 at 29°C	38 at 19°C	42 at 19.5°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	-	37.0	27.0
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	55.4	42.0	15.4	30.8
Calcium, $mg \cdot \ell^{-1}$ Ca	9.9	11.0	4.1	2.5
Magnesium, $mg \cdot \ell^{-1}$ Mg	1.24	1.6	1.6	1.6
Sodium, $mg \cdot \ell^{-1}$ Na	0.97	1.1	0.5	0.8
Chloride, $mg \cdot \ell^{-1}$ Cl	0.38	0.6	0.6	0.6
Potassium, $mg \cdot \ell^{-1}$ K	0.37	0.6	0.7	0.6
Mercury, $\mu g \cdot \ell^{-1}$ Hg	<0.2	0.4	0.6	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	5.0	<5.0	5.1	18.4
Aluminum, $\mu g \cdot \ell^{-1}$ Al	6.5	26.0	12.0	13.0
Copper, $\mu g \cdot \ell^{-1}$ Cu	1.4	3.5	4.0	2.8
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	22.0	<1.0
Iron, $\mu g \cdot \ell^{-1}$ Fe	11.5	50.0	29.5	18.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	3.0	2.1	1.4	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	<1.0	3.9	1.9	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	-	25.0	-	-
Silica, $mg \cdot \ell^{-1}$ Si	5.75	67.0	-	-

Table 13. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Ross Lake - Station 1

Parameter	11/14/84	4/5/85	6/25/85
Color, color units	-	<0.5	0.5
Turbidity, NTU	-	0.6	<0.1
Conductivity, μS/cm	-	72 at 20°C	58 at 20°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	39.0	40.0
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	-	41.0	27.7
Calcium, $mg \cdot \ell^{-1}$ Ca	11.2	4.1	2.7
Magnesium, $mg \cdot \ell^{-1}$ Mg	1.36	1.8	1.6
Sodium, $mg \cdot \ell^{-1}$ Na	1.10	1.1	0.8
Chloride, $mg \cdot \ell^{-1}$ Cl	0.39	0.5	-
Potassium, $mg \cdot \ell^{-1}$ K	0.41	0.6	0.5
Mercury, $\mu g \cdot \ell^{-1}$ Hg	<0.2	<0.2	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	81.5	5.1	<5.0
Aluminum, $\mu g \cdot \ell^{-1}$ Al	88.0	44.0	49.0
Copper, $\mu g \cdot \ell^{-1}$ Cu	<1.0	10.5	2.8
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	22.5
Iron, $\mu g \cdot \ell^{-1}$ Fe	32.5	20.0	9.5
Manganese, $\mu g \cdot \ell^{-1}$ Mn	4.9	3.1	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	<1.0	3.8	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	30.0	30.0	-
Silica, $mg \cdot \ell^{-1}$ Si	5.6	-	-

Table 14. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Ross Lake - Station 2

Parameter	11/14/84	4/5/85	6/25/85
Color, color units	<0.5	<0.5	<0.5
Turbidity, NTU	0.13	0.6	0.1
Conductivity, $\mu S/cm$	69 at 23°C	77 at 19°C	76 at 20°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	40.0	37.0
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	114.8	42.0	44.0
Calcium, $mg \cdot \ell^{-1}$ Ca	19.2	4.4	13.5
Magnesium, $mg \cdot \ell^{-1}$ Mg	2.3	1.7	1.7
Sodium, $mg \cdot \ell^{-1}$ Na	1.8	1.1	1.1
Chloride, $mg \cdot \ell^{-1}$ Cl	0.40	0.5	-
Potassium, $mg \cdot \ell^{-1}$ K	0.24	0.6	0.4
Mercury, $\mu g \cdot \ell^{-1}$ Hg	<0.2	2.2	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	41.5	<5.0	<5.0
Aluminum, $\mu g \cdot \ell^{-1}$ Al	7.2	87.0	20.5
Copper, $\mu g \cdot \ell^{-1}$ Cu	<1.0	3.5	3.0
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	<1.0
Iron, $\mu g \cdot \ell^{-1}$ Fe	11.5	27.2	9.5
Manganese, $\mu g \cdot \ell^{-1}$ Mn	<0.3	7.6	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	<1.0	4.2	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	1.4	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	30.0	30.0	30.0
Silica, $mg \cdot \ell^{-1}$ Si	7.0	6.5	6.5

Table 15. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Ross Lake - Station 3

Parameter	11/14/84	6/25/85	6/25/85 (Deep)
Color, color units	<0.5	<0.5	<0.5
Turbidity, NTU	0.19	<0.1	<0.1
Conductivity, $\mu S/cm$	60 at 27°C	59 at 19°C	68 at 20.5°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	37.0	-
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	20.5	31.8	37.5
Calcium, $mg \cdot \ell^{-1}$ Ca	11.5	9.8	11.7
Magnesium, $mg \cdot \ell^{-1}$ Mg	1.39	1.3	1.4
Sodium, $mg \cdot \ell^{-1}$ Na	1.10	1.0	1.0
Chloride, $mg \cdot \ell^{-1}\ell$ Cl	0.39	-	-
Potassium, $mg \cdot \ell^{-1}$ K	0.33	0.6	0.5
Mercury, $\mu g \cdot \ell^{-1}$ Hg	0.35	<0.2	<0.2
Zinc, $\mu g \cdot \ell^{-1}$ Zn	112.0	5.1	<5.0
Aluminum, $\mu g \cdot \ell^{-1}$ Al	12.0	36.5	31.5
Copper, $\mu g \cdot \ell^{-1}$ Cu	1.7	3.0	4.0
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	5.1
Iron, $\mu g \cdot \ell^{-1}$ Fe	11.5	10.0	10.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	4.0	<1.0	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	<1.0	<1.0	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	30.0	30.0	-
Silica, $mg \cdot \ell^{-1}$ Si	5.6	7.6	-

Table 16. Water Constituents and Trace Metal Analyses for North Cascade Lakes.
Station: Skagit River Below Newhalem

Parameter	11/14/84	4/5/85	7/25/85
Color, color units	2.5	<0.5	<0.5
Turbidity, NTU	0.25	0.1	<0.1
Conductivity, µS/cm	50 at 25.5°C	51 at 19°C	25 at 20°C
Alkalinity, $mg \cdot \ell^{-1}$ $CaCO_3$	Deleted-Field	27.0	-
Total Hardness, $mg \cdot \ell^{-1}$ $CaCO_3$	32.8	40.0	13.3
Calcium, $mg \cdot \ell^{-1}$ Ca	8.5	2.9	2.9
Magnesium, $mg \cdot \ell^{-1}$ Mg	1.09	1.1	1.1
Sodium, $mg \cdot \ell^{-1}$ Na	0.97	1.0	0.6
Chloride, $mg \cdot \ell^{-1}$ Cl	0.42	-	0.7
Potassium, $mg \cdot \ell^{-1}$ K	0.42	0.7	0.7
Mercury, $\mu g \cdot \ell^{-1}$ Hg	<0.2	<0.2	0.5
Zinc, $\mu g \cdot \ell^{-1}$ Zn	12.5	6.6	<5.0
Aluminum, $\mu g \cdot \ell^{-1}$ Al	35.0	28.0	69.0
Copper, $\mu g \cdot \ell^{-1}$ Cu	1.4	5.0	2.3
Lead, $\mu g \cdot \ell^{-1}$ Pb	<1.0	<1.0	<1.0
Iron, $\mu g \cdot \ell^{-1}$ Fe	26.8	13.0	15.0
Manganese, $\mu g \cdot \ell^{-1}$ Mn	2.8	1.2	<1.0
Arsenic, $\mu g \cdot \ell^{-1}$ As	2.1	2.2	<1.0
Fluoride, $mg \cdot \ell^{-1}$ F	<0.2	<0.2	<0.2
Cadmium, $\mu g \cdot \ell^{-1}$ Cd	<1.0	<1.0	<1.0
Boron, $\mu g \cdot \ell^{-1}$ B	30.0	20.0	30.0
Silica, $mg \cdot \ell^{-1}$ Si	5.6	6.1	7.2

Table 17. Metal Analyses for North Cascade Lakes.

Sampling Date	Station	Al ($\mu g \cdot \ell^{-1}$)	B ($\mu g \cdot \ell^{-1}$)	Cl ($mg \cdot \ell^{-1}$)	SO_4^- ($mg \cdot \ell^{-1}$)	Si ($mg \cdot \ell^{-1}$)
10/24/84	Chelan 1 (.5m)	6.5	-	.25	4.4	4.1
	Chelan 2 (.5m)	14.0	-	.38	4.4	4.2
	Chelan 2 (2.0m)	14.0	-	.40	4.4	4.2
	Chelan 3 (.5m)	14.0	-	.39	-	-
	Chelan 3 (15m)	14.0	-	.39	-	-
	Stehekin River	9.6	-	-	-	6.8
	Company Creek	8.5	-	-	7.6	6.8
	Diablo 1 (.5m)	6.5	-	-	5.2	5.7
	Diablo 1 (15m)	6.5	-	-	5.2	5.7
	Ross 1 (.5m)	8.8	-	-	4.9	5.6
	Ross 1 (15m)	-	-	-	4.9	7.0
	Ross 2 (.5m)	7.2	-	-	8.3	7.0
	Ross 2 (15m)	-	-	-	8.3	7.0
	Ross 3 (.5m)	12.0	-	-	5.2	5.6
	Ross 3 (15m)	12.0	-	-	5.1	5.6
	Lightning Creek	-	-	-	8.3	-
	Skagit River	35.0	-	-	4.4	6.8
4/4/85	Chelan 1 (.5m)	-	.02	.3	-	4.6
	Chelan 2 (.5m)	-	.02	.3	-	4.8
	Chelan 2 (2.0m)	-	.02	.4	-	4.8
	Chelan 3 (.5m)	-	.02	.2	-	4.2
	Chelan 3 (15m)	-	.02	-	-	-
	Diablo 1 (.5m)	-	-	.4	-	6.0
	Diablo 1 (15m)	-	-	.3	-	6.0
	Diablo 2 (.5m)	-	-	.4	-	5.8
	Diablo 2 (15m)	-	-	.4	-	5.7
	Ross 1 (.5m)	-	-	.4	-	7.2
	Ross 1 (15m)	-	-	.4	-	7.2
	Ross 2 (.5m)	-	-	.4	-	7.6
	Ross 2 (15m)	-	-	.4	-	7.2
	Ross 3 (.5m)	-	-	.5	-	7.2
	Ross 3 (15m)	-	-	.5	-	7.2
	Skagit River	-	-	.5	-	6.1
6/25/85	Diablo 1 (.5m)	-	.04	0.4	2.0	-
	Diablo 1 (15m)	-	.03	0.3	3.2	-
	Ross 1 (.5m)	-	.03	0.4	3.0	-
	Ross 1 (15m)	-	.03	0.4	3.0	-
	Ross 2 (.5m)	-	.03	0.4	5.7	-
	Ross 2 (15m)	-	.03	-	5.7	-
	Ross 3 (.5m)	-	.03	0.5	4.7	-
	Ross 3 (15m)	-	.03	0.5	4.9	-
	Lightning Creek	-	-	-	6.0	-
	Skagit River	-	.03	0.3	2.2	-

Table 17. Metal Analyses for North Cascade Lakes (Continued).

Sampling Date	Station	Al ($\mu g \cdot \ell^{-1}$)	B ($\mu g \cdot \ell^{-1}$)	Cl ($mg \cdot \ell^{-1}$)	SO_4 ($mg \cdot \ell^{-1}$)	Si ($mg \cdot \ell^{-1}$)
7/23/85	Chelan 1 (.5m)	-	0.03	0.2	3.7	-
	Chelan 2 (.5m)	-	0.03	<0.2	3.6	-
	Chelan 2 (2.0m)	-	-	-	-	-
	Chelan 3 (.5m)	-	-	-	3.6	-
	Chelan 3 (15m)	-	-	-	-	-
	Stehekin River	-	0.04	0.2	3.2	-
	Company Creek	-	0.04	<0.2	6.9	-
10/24/85	Chelan 1 (.5m)	-	0.03	0.2	-	-
	Chelan 2 (.5m)	-	-	-	-	-
	Chelan 2 (2.0m)	-	-	-	-	-
	Chelan 3 (.5m)	-	-	-	-	-
	Chelan 3 (15m)	-	-	-	-	-

Table 17. Metal Analyses for North Cascades Lakes (Continued).

Sampling Date	Station	Al ($\mu g \cdot \ell^{-1}$)	Ca ($\mu g \cdot \ell^{-1}$)	Fe ($mg \cdot \ell^{-1}$)	K ($mg \cdot \ell^{-1}$)	Mg ($mg \cdot \ell^{-1}$)	Na ($mg \cdot \ell^{-1}$)
4/22/86	Chelan 1 (.5m)	45	5.90	0.09	0.55	0.75	1.00
	Chelan 2 (.5m)	30	5.90	0.23	0.55	0.75	1.00
	Chelan 2 (2.0m)	240	5.90	0.15	0.65	0.75	1.00
	Ross 1 (.5m)	225	10.90	0.18	0.40	1.25	1.00
	Ross 1 (30m)	345	11.10	0.10	0.40	1.20	1.00
	Ross 2 (.5m)	265	11.10	0.15	0.40	1.20	1.00
	Ross 2 (30m)	45	11.10	0.13	0.40	1.20	1.00
	Diablo (.5m)	100	9.00	0.15	0.50	1.05	1.00
	Diablo (30m)	55	8.80	0.15	0.45	1.05	1.00
	Stehekin River	130	6.00	0.09	0.45	0.45	1.00
	Company Creek	210	8.00	0.28	0.45	0.60	1.00
	Skagit River	290	7.00	0.13	0.45	0.70	1.00
7/22/86	Chelan 1 (.5m)	100	5.30	0.26	0.55	0.80	1.05
	Chelan 2 (.5m)	45	6.20	0.07	0.70	0.90	1.20
	Chelan 2 (2.0m)	27	6.20	0.07	0.70	0.90	1.45
	Chelan 3 (.5m)	100	6.20	0.07	0.70	0.90	1.20
	Chelan 3 (30m)	112	6.20	0.07	0.65	0.90	1.45
	Ross 1 (.5)	148	10.00	0.05	0.50	1.25	1.20
	Ross 1 (15m)	33	10.00	0.05	0.50	1.25	1.20
	Ross 1 (30m)	38	10.00	0.05	0.50	1.25	1.20
	Ross 2 (.5m)	28	10.30	0.05	0.50	1.25	1.20
	Ross 2 (15m)	50	10.30	0.05	0.55	1.30	1.20
	Ross 2 (30m)	38	10.30	0.05	0.55	1.30	1.20
	Diablo (.5m)	57	6.20	0.07	0.65	0.90	1.05
	Diablo (15m)	100	7.10	0.08	0.65	1.10	1.05
	Diablo (30m)	57	9.00	0.08	0.65	1.25	1.20
	Company Creek	75	6.40	0.10	0.55	0.75	1.20
	Stehekin River	160	5.30	0.40	0.70	0.75	1.05
	Skagit River	52	7.10	<0.05	0.55	1.00	1.75
	Lightning Creek	63	18.60	0.06	0.25	1.90	1.20

Table 18. Pesticides and Herbicides in North Cascades Lakes Waters. Data are expressed as $\mu g \cdot \ell^{-1}$.

Parameter/Station	Chelan Lake	Chelan Lake	Stehekin River	Company Creek	Diablo Lake	Ross Lake 1	Ross Lake 2	Ross Lake 3	Skagit River
α 2BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lindane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DDE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
op-DDD (TDE)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ppDDP	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mirex	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Methoxychlor	-	-	<0.10	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Toxaphene	<0.10	<0.01	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chlordane	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Phosphorganic Insecticides									
Malathion	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Parathion	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Diazinon	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Fenthion	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Methylparathion	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Fensulfothion	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Fetrothion	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Carbamate Insecticides									
Carbaryl (Sevin)	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Carbofuran	<4.00	<4.00	<4.00	<4.00	<4.00	<4.00	<4.00	<4.00	<4.00
Herbicides									
Paraquat	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00
Diquat	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00	<10.00
Atrazine	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
2,4-D	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silvex	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
2,4,5T	<0.10	<0.10	<0.10	<0.10	<0.10	-	<0.10	<0.10	<0.10

Table 19. Herbicides and Pesticides in Sediment
Ross Lake - Station 1 (Ruby Arm)
Collected: 4/5/85

Herbicide/Pesticide	Concentration μg/kg (Dried Wt.)
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	0.4
Dieldrin	<0.1
op DDD(TDE)	3.7
Endrin	<0.1
*pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 20. Herbicides and Pesticides in Sediment
Ross Lake - Station 2
Collected: 4/5/85

Herbicide/Pesticide	Concentration μg/kg (Dried Wt.)
α BHC	Trace
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	<0.1
Dieldrin	0.8
op DDD(TDE)	<0.1
Endrin	<0.1
*pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	<0.1
2,4,5T	3.4

*Trace: Less than 0.1 μg/kg. Detectable but not quantified.

Table 21. Herbicides and Pesticides in Sediment
Ross Lake - Station 3 (mid-lake, out from Lightning Creek)
Collected: 4/5/85

Herbicide/Pesticide	Concentration $\mu g/kg$ (Dried Wt.)
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	0.4
DDE	0.9
Dieldrin	<0.1
op DDD(TDE)	1.1
Endrin	<0.1
pp DDT	7.8
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 22. Herbicides and Pesticides in Sediment
Lightning Creek Station
Collected: 6/25/85

Herbicide/Pesticide	Concentration $\mu g/kg$ (Dried Wt.)
α BHC	Trace
Lindane	Trace
Heptachlor	<0.1
Aldrin	<0.1
*DDE	Trace
Dieldrin	<0.1
op DDD(TDE)	0.1
Endrin	<0.1
pp DDT	0.9
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*Trace: Less than 0.1 $\mu g/kg$. Detectable but not quantified.

Table 23. Herbicides and Pesticides in Sediment
Stehekin River Sediments
Collected: 6/25/85

Herbicide/Pesticide	Concentration µg/kg (Dried Wt.)
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	2.5
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
*pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 24. Herbicides and Pesticides in Sediment
Lake Chelan - Station 2 (head of lake)
Collected: 7/23/85

Herbicide/Pesticide	Concentration µg/kg (Dried Wt.)
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
*pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	Trace
2,4,5T	Trace

*Trace: Less than 0.1 µg/kg. Detectable but not quantified.

Table 25. Herbicides and Pesticides in Sediment
Mouth of Stehekin River
Collected: 7/23/85

Herbicide/Pesticide	Concentration μg/kg (Dried Wt.)
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	Trace
Dieldrin	<0.1
op DDD(TDE)	Trace
Endrin	<0.1
*pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	-
Chlordane	-
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*Trace: Less than 0.1 μg/kg. Detectable but not quantified.

Table 26. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
One Northern Squawfish
Collected: 7/10/84

Herbicide/Pesticide	Concentration μg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 27. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
Four Longnose Suckers
Collected: 7/10/84

Herbicide/Pesticide	Concentration μg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	D
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
*pp DDT	D
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*D, denotes a detected amount less than 0.1 μg/kg.

Table 28. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
One Longnose Sucker
Collected: 7/10/84

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
*pp DDT	D
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*D, denotes a detected amount less than 0.1 µg/kg.

Table 29. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
Three Northern Squawfish - Pooled Fish No. 1, 4 and no tag.
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 30. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
Northern Squawfish - Pooled Fish No. 3, 5, 6, 8, 9, and 10
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	D
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*D, denotes a detected amount less than 0.1 µg/kg.

Table 31. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
Rainbow Trout
Pooled Fish No. 2, 7, 11, and 13
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	0.4
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
*pp DDT	D
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*D, denotes a detected amount less than 0.1 µg/kg.

Table 32. Herbicides and Pesticides in Fish
Lake Chelan (head of lake)
Northern Squawfish - Pooled Fish No. 12 and no tag
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	0.2
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 33. Herbicides and Pesticides in Fish
Diablo Lake (Thunder Arm)
Dolly Varden - Pooled Fish No. 7, 10, 13, 16, 17, 18, and 19
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 34. Herbicides and Pesticides in Fish
Diablo Lake (Thunder Arm)
Brook Trout - Pooled Fish No. 20 and 21
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration μg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 35. Herbicides and Pesticides in Fish
Diablo Lake (Thunder Arm)
Trout and Dolly Varden - Pooled Fish No. 1, 4, 12, and 14
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration μg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 36. Herbicides and Pesticides in Fish.
Diablo Lake (Thunder Arm)
Rainbow Trout - Pooled Fish No. 3, 5, 6, 8, 11
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration μg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 37. Herbicides and Pesticides in Fish
Diablo Lake (Thunder Arm)
Rainbow Trout - Pooled Fish No. 2, 9, and 15
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration μg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	D
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*D, denotes a detected amount less than 0.1 μg/kg.

Table 38. Herbicides and Pesticides in Fish.
Ross Lake - E Roland Point Bay (Casino Bay)
Six Rainbow Trout - Pooled Fish No. 1, 3, 4, 6, 7, and 10
Collected: 8/21-22/86
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
DDE	<0.1
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	<0.1
Mirex	<0.1
Methoxychlor	<0.1
Ioxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

Table 39. Herbicides and Pesticides in Fish
Ross Lake - E Roland Point Bay (Casino Bay)
Four Rainbow Trout - Pooled Fish No. 2, 5, 8, and 9
Collected: 8/21-22/86
(pooling was necessary to obtain enough sample for analyses)

Herbicide/Pesticide	Concentration µg/kg
α BHC	<0.1
Lindane	<0.1
Heptachlor	<0.1
Aldrin	<0.1
*DDE	D
Dieldrin	<0.1
op DDD(TDE)	<0.1
Endrin	<0.1
pp DDT	0.12
Mirex	<0.1
Methoxychlor	<0.1
Toxaphene	<10.0
Chlordane	<1.0
2,4-D	<0.1
Silvex	<0.1
2,4,5T	<0.1

*D, denotes a detected amount less than 0.1 µg/kg.

Table 40. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
One Longnose Sucker
Collected: 7/10-12/85

Metal	Concentration μg/kg
Arsenic	0.39
Cadmium	<0.10
Lead	0.29
Mercury	0.14

Table 41. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
One Northern Squawfish
Collected: 7/10-12/85

Metal	Concentration μg/kg
Arsenic	0.28
Cadmium	<0.10
Lead	<0.10
Mercury	0.39

Table 42. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
One Northern Squawfish
Collected: 7/10-12/85

Metal	Concentration μg/kg
Arsenic	0.39
Cadmium	<0.10
Lead	0.29
Mercury	0.14

Table 43. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
Four Longnose Suckers
Collected: 7/10-12/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration μg/kg
Arsenic	<0.25
Cadmium	<0.10
Lead	0.11
Mercury	0.73

Table 44. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
Chinook Salmon
Collected: 7/10-12/85

Metal	Concentration μg/kg
Arsenic	0.51
Cadmium	0.10
Lead	0.10
Mercury	0.09

Table 45. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
Three Cutthroat Trout
Collected: 7/10-12/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration μg/kg
Arsenic	0.45
Cadmium	0.10
Lead	<0.10
Mercury	0.25

Table 46. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
Three Northern Squawfish - Pooled Fish-No. 1, 4 - no tag.
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration µg/kg
Arsenic	---
Cadmium	<0.10
Lead	0.35
Mercury	0.25

Table 47. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan (Head of Lake)
Northern Squawfish - Pooled Fish-No. 3, 5, 6, 8, 9, and 10
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration µg/kg
Arsenic	0.52
Cadmium	<0.10
Lead	<0.10
Mercury	0.16

Table 48. Metal Concentrations in Fishes of North Cascades Lakes.
Lake Chelan Head of Lake)
Rainbow Trout - Pooled Fish-No. 2, 7, 11, and 13
Collected: 7/22-23/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration µg/kg
Arsenic	0.75
Cadmium	0.10
Lead	<0.10
Mercury	0.23

Table 49. Metal Concentrations in Fishes of North Cascades Lakes.
Diablo Lake (Thunder Arm)
Rainbow Trout - Pooled Fish-No. 3, 5, 6, 8, 11
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration µg/kg
Arsenic	0.47
Cadmium	<0.10
Lead	0.35
Mercury	0.43

Table 50. Metal Concentrations in Fishes of North Cascades Lakes.
Diablo Lake (Thunder Arm)
Brook Trout - Pooled Fish-No. 20 and 21
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration µg/kg
Arsenic	0.38
Cadmium	<0.10
Lead	<0.10
Mercury	0.39

Table 51. Metal Concentrations in Fishes of North Cascades Lakes.
Diablo Lake (Thunder Arm)
Dolly Varden - Pooled Fish-No. 1, 11, 12, 14
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration µg/kg
Arsenic	0.58
Cadmium	0.10
Lead	0.10
Mercury	0.72

Table 52. Metal Concentrations in Fishes of North Cascades Lakes.
Diablo Lake (Thunder Arm)
Brook Trout - Pooled Fish-No. 13, 16, 17, 18, and 19.
Collected: 9/9-10/85
(pooling was necessary to obtain enough sample for analyses)

Metal	Concentration μg/kg
Arsenic	0.45
Cadmium	<0.10
Lead	0.82
Mercury	0.11

Table 53. Chlorophyll *a* Content in North Cascades Lakes.

	Station/Depth	Chlorophyll ($\mu g \cdot \ell^{-1}$)	Phaeophytin ($\mu g \cdot \ell^{-1}$)
4/22/85	Chelan 1 (.5m)	1.0	0.1
	Chelan 2 (.5m)	4.1	0.0
	Chelan 2 (2.0m)	0.4	0.4
	Ross 1 (.5m)	0.0	0.5
	Ross 1 (30m)	0.7	0.0
	Ross 2 (.5m)	1.2	0.0
	Diablo (.5m)	0.7	0.0
	Diablo (30m)	1.1	0.0
	Company Creek	0.1	0.0
	Stehekin River	0.0	0.9
	Skagit River	0.3	0.1
6/25/85	Diablo (.5m)	1.3	1.0
	Diablo (30m)	0.6	0.7
	Ross 1 (.5m)	0.6	0.7
	Ross 1 (30m)	0.0	0.0
	Ross 2 (.5m)	1.1	0.0
	Ross 3 (.5m)	0.6	0.0
	Ross 3 (30m)	0.0	0.0
	Skagit River	1.2	0.0
7/23/85	Chelan 1 (.5m)	6.9	0.0
	Chelan 2 (.5m)	9.7	0.0
	Stehekin River	0.6	2.8
	Company Creek	8.3	0.0
10/24/85	Chelan 3 (.5m)	2.71	0.0
	Chelan 3 (30m)	2.82	0.0
	Company Creek	0.64	0.96
4/23/86	Chelan 1 (.5m)	2.2	0.8
	Chelan 2 (.5m)	0.74	1.2
	Chelan 2 (2.0m)	0.0	3.94
	Ross 1 (.5m)	0.74	1.2
	Ross 1 (30m)	1.54	0.0
	Ross 2 (.5m)	0.0	1.87
	Ross 2 (30m)	2.2	0.33
	Diablo (.5m)	1.61	0.0

Table 53. Chlorophyll *a* Content in North Cascades Lakes (Continued).

	Station/Depth	Chlorophyll ($\mu g \cdot \ell^{-1}$)	Phaeophytin ($\mu g \cdot \ell^{-1}$)
7/22/86	Chelan 1 (.5m)	5.89	4.38
	Chelan 2 (.5m)	4.02	0.00
	Chelan 2 (2.0m)	3.53	1.28
	Chelan 3 (.5m)	1.76	6.25
	Chelan 3 (30m)	1.18	5.29
9/26/86			
	Ross 1 (.5m)	1.18	0.0
	Ross 1 (15m)	1.23	0.0
	Ross 1 (30m)	0.58	0.21
	Ross 2 (.5m)	1.18	0.0
	Ross 2 (15m)	1.48	0.0
	Ross 2 (30m)	1.28	0.0
	Diablo (.5m)	1.28	0.0
	Diablo (15m)	0.58	0.21
	Diablo (30m)	1.54	0.0

Table 54. Zooplankton Data for North Cascades Lakes.

Sampling Date	Station	Zooplankton	Individuals·m^{-3}
4/4/85	Chelan 1 - Station 3		
		Rotifera	
		Keratella cochlearis	4
		Eucopepoda	
		nauplii	128
		copepodid	34
		Diaptomus spinicornis	362
		Epischura nevadensis	4
	Chelan 2 - Station 1		
		Eucopepoda	
		nauplii	2,304
		Diaptomus spinicornis	602
	Diablo		
		Rotifera	
		Asplanchna priodonta	150
		Kellicottia longispina	55
		Cladocera	
		imm. cladocera	5
		Bosmina longirostris	30
		Daphnia pulex	85
		Daphnia spp.	5
		Eucopepoda	
		nauplii	5
		copepodid	5
	Ross 1		
		Rotifera	
		Asplanchna priodonta	196
		Kellicottia longispina	45
		Cladocera	
		Bosmina longirostris	85
		Daphnia pulex	45
		Daphnia spp.	40
		Eucopepoda	
		copepodid	5

Table 54. Zooplankton Data for North Cascades Lakes (Continued).

Sampling Date	Station	Zooplankton	Individuals·m^{-3}
4/4/85	Ross 2		
		Rotifera	
		Asplanchna priodonta	1,843
		Kellicottia longispina	90
		Cladocera	
		imm. cladocera	35
		Bosmina longirostris	90
		Daphnia pulex	146
		Daphnia spp.	40
		Eucopepoda	
		nauplii	10
		Diaptomus spinicornis	25
		Diaptomus spp.	10
6/25/85	Diablo		
		Rotifera	
		Asplanchna priodonta	197
		Keratella quadrata	66
		Kellicottia longispina	1,378
		Cladocera	
		Bosmina longirostris	2,625
		Daphnia spp.	197
		Eucopepoda	
		nauplii	262
	Ross 1		
		Rotifera	
		Asplanchna priodonta	2,805
		Kellicottia longispina	738
		Synchaeta spp.	2,215
		Cladocera	
		Bosmina longirostris	3,100
		Daphnia spp.	295
		Eucopepoda	
		nauplii	148
		Diaptomus spp.	443

Table 54. Zooplankton Data for North Cascades Lakes (Continued).

Sampling Date	Station	Zooplankton	Individuals·m^{-3}
6/25/85	Ross 3		
		Rotifera	
		Asplanchna priodonta	2,953
		Kellicottia longispina	1,280
		Polyarthra suryptera	197
		Cladocera	
		Bosmina longirostris	2,854
		Eucopepoda	
		nauplii	394
		calenoid copepodid	197
		Diaptomus spp.	492
7/23/85	Chelan 1 - Station 3		
		Rotifera	
		unidentified *rotifer*	148
		Cladocera	
		Bosmina longirostris	2,067
		Eucopepoda	
		nauplii	295
		calenoid copepodid	738
		cyclopoid copepodid	295
		Diaptomus spp.	28,199
		Tropocyclops prasinus	2,657
	Chelan 2 - Station 1		
		Cladocera	
		Bosmina longirostris	6,398
		Daphnia spp.	492
		Eucopepoda	
		nauplii	1,969
		cyclopoid copepodid	2,461
		Diaptomus spp.	14,272
		Tropocyclops prasinus	3,937

Table 54. Zooplankton Data for North Cascades Lakes (Continued).

Sampling Date	Station	Zooplankton	Individuals·m⁻³
7/22/86	Chelan 1		
		Rotifera	
		Kellicottia longispina	5,906
		Keratella cochlearis	787
		Cladocera	
		Bosmina longirostris	787
		Daphnia sp.	1,181
		Eucopepoda	
		nauplii	394
		copepodid	1,181
		Diaptomus	5,512
		Tropocyclops prasinus	787
	Chelan 2		
		Rotifera	
		Kellicottia bostoniensis	236
		Kellicottia longispina	1,890
		Keratella cochlearis	118
		Trichocerca cylindrica	118
		Cladocera	
		Bosmina longirostris	236
		Daphnia sp.	236
		Eucopepoda	
		nauplii	118
		copepodid	1,181
		Diaptomus sp.	12,520
		Tropocyclops prasinus	709
	Chelan 3		
		Rotifera	
		Kellicottia bostoniensis	354
		Kellicottia longispina	945
		Keratella cochlearis	709
		Cladocera	
		Daphnia sp.	354
		Eucopepoda	
		nauplii	591
		copepodid	1,535
		cyclopoid sp.	354
		Diaptomus sp.	4,724

Table 54. Zooplankton Data for North Cascades Lakes (Continued).

Sampling Date	Station	Zooplankton	Individuals·m^{-3}
9/26/86	Diablo		
		Rotifera	
		Asplachna priodonta	15
		Kellicottia longispina	29
		Cladocera	
		Bosmina longirostris	263
		Daphnia rosea - adult	849
		- juvenile	205
		Eucopepoda	
		nauplii	29
		copepodid	132
		Diaptomus sp.	278
	Ross 1		
		Rotifera	
		Asplachna priodonta	6,082
		Conochilus sp.	183
		Kellicottia longispina	1,646
		Cladocera	
		Daphnia sp.	2,104
		Holopedium gibberum	137
		Polyphemus pediculus	91
		Eucopepoda	
		cyclopoid sp.	46
		Diaptomus sp.	1,189
	Ross 2		
		Rotifera	
		Asplachna priodonta	1,683
		Conochilus sp.	183
		Kellicottia pediculus	329
		Cladocera	
		Bosmina longirostris	1,537
		Daphnia sp.	1,207
		Polyphemus pediculus	439
		Eucopepoda	
		copepodid	37
		Diaptomus sp.	732