STATEWIDE SURVEY OF AQUATIC ECOSYSTEM CHEMISTRY; 1986

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INTRODUCTION

California has approximately 5,000 lakes and 25,000 miles of rivers and streams. Many are located in granite basins with small watershed areas, possess thin watershed soils, and have low alkalinity waters, features which often characterize areas sensitive to acid deposition.

Fifty waters throughout the State (Figure 1, Appendix A) were sampled to (i) survey the water chemistry of selected California lakes and streams, (ii) determine the vulnerability of these waters to acidification, (iii) examine the seasonal variability of water chemistry parameters, (iv) provide a background database against which future measurements can be compared, and (v) identify geographical regions sensitive to acid deposition.

The first year of the 2 year study was completed in December 1985 (M^{c}Cleneghan et al. 1985). It was concluded that surface waters in certain regions of California demonstrated low alkalinity, low ionic strength, and low conductivity. Water with these characteristics are generally accepted as being very sensitive to acid deposition and susceptible to acidification because of their inability to buffer acidic inputs.

METHODS AND MATERIALS

Sampling Locations

Selected lakes and streams were sampled twice, once during spring run-off and again in late summer or fall, 1986. Major mountain ranges scattered throughout the State were selected based on:

i) suspected sensitivity to acidification
ii) geological characteristics
iii) elevation
iv) accessibility
v) lack of extraneous water quality influences
vi) presence or absence of fish or other aquatic organisms.

Sample Collection

All tubing, filters, and storage bottles were chemically cleaned prior to collection (Appendix B). Water samples were collected near the lake outlet using a battery powered Geotech peristaltic pump. Tubing extended from the pump along a floating pvc boom to 4.5 m from the shore and 0.5 m below the surface. Water was pumped through the tubing for approximately 5 minutes before sample collection in linear polyethylene bottles.

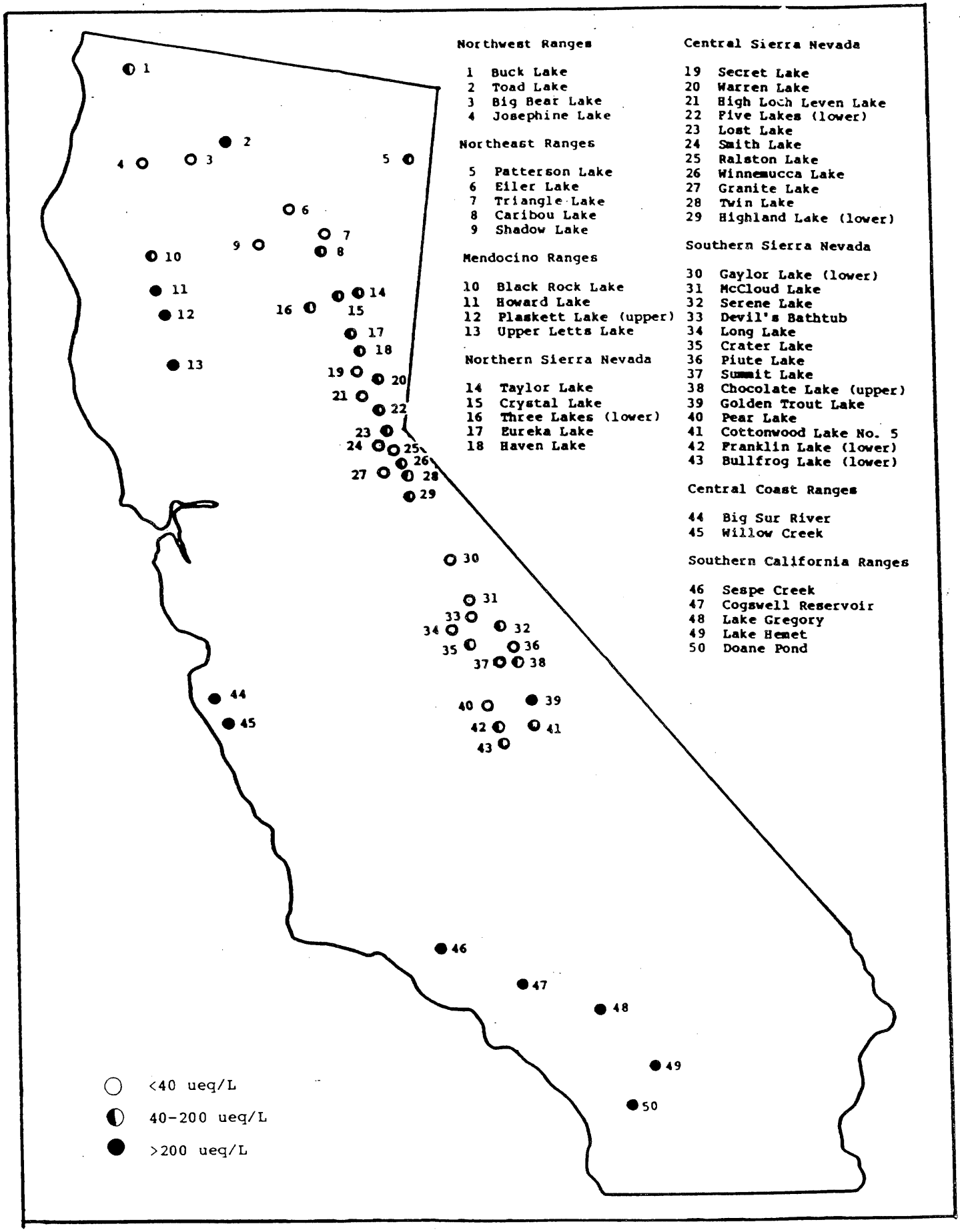

Figure 1. Station Locations; Statewide Survey of Aquatic Ecosystem Chemistry, 1986.

Water samples collected for metal (total and dissolved) and phosphate analyses were preserved shortly after collection with 0.25 ml 6N nitric acid per 60 ml of sample and 0.2 ml of concentrated (36N) hydrochloric acid per 125 ml of sample, respectively. Water samples for anions, cations, and nitrates were not fixed immediately but were analyzed within 30 days, the time specified by the U.S. Environmental Protection Agency (U.S. EPA), (Hillman et al. 1984).

On-Site Analyses

Three parameters were analyzed at the sampling site:

i) pH
ii) temperature
iii) conductivity

Prior to July 30, 1986, pH and temperature were measured using a temperature compensating Beckman 21 pH meter with a Beckman combination electrode (Star series) and temperature probe immersed in a continuous flowing sample. Most lakes sampled were located at relatively high elevations. Water temperature below 5°C and air temperature below 10°C were common. Typically these waters demonstrated very low conductivity. The combination of harsh environment and dilute waters caused instruments to require very long periods for reading stabilization; there was even occasional electrode failure. Galloway and Likens (1979) and Boyle et al. (1986) encountered similar problems of accurately measuring low ionic strength precipitation. Therefore, a revised procedure for measuring pH was adopted for the fall sampling period (Appendix C).

During the fall sampling period, pH and temperature were measured using two temperature compensating Beckman model 21 pH meters. One meter was equipped with an Orion combination electrode and the other meter with a Beckman combination electrode; both used the Beckman temperature probe. In addition, a third pH measurement was obtained using the Hach Models 17D and 17H colormetric kits. These simple tools provided quick and easy methods of determining the proper value range when discrepencies between pH meter readings occurred.

Conductivity measurements were obtained using the Beckman-Altex conductivity bridge model RC-16C with a 0.1 cm cell. Readings were temperature compensated to 25°C in accordance with American Public Health Association (APHA) 1985.

A 250 ml carboy was filled with unfiltered lake water for later determination of alkalinity. All alkalinity samples were analyzed within 12 hours except for Bullfrog and Franklin lakes which were analyzed within 24 hours. Alkalinity was determined using the potentiometric method with Gran plot as described by Hillman et al. 1984 (Appendix C).

Laboratory Analyses

Laboratory analyses for anions, cations, and trace elements were determined using various instruments and techniques (Appendix C). Sample preparations and analyses were performed according to instrument manufacturer's instruction and APHA (1985) unless otherwise noted (Appendix C). Tannin-like dissolved organic compounds and silica were two additional parameters analyzed during the 1986 sampling season. Tannins were analyzed because these may contribute to pH decrease. Silica was examined because concentrations in the water indicate the extent of chemical weathering in the bedrock of the surrounding watershed (Driscoll 1980).

Quality Assurance

A number of precautions were taken to ensure the validity of reported data. Quality assurance measures tested the precision and accuracy of instruments, equipment, analytical methods, and techniques of laboratory personnel techniques.

Intralaboratory Analyses

All sample collection bottles, filters, and filter housings were chemically cleaned (Appendix B) and tested for the presence of each measured parameter prior to use for sample collection. Any bottles, filters, or housings found to be contaminated were re-cleaned and re-tested.

Interlaboratory Analyses

Interlaboratory analyses were performed on U.S. EPA water samples (Appendix D). All parameters were within acceptable limits. The EPA water samples analyzed for quality control were more concentrated than water samples collected from the field. As a result, the EPA samples were diluted to concentrations which simulated typical alpine lake water. This ensured field samples and EPA samples had similar concentration ranges and were analyzed by similar laboratory and instrumentation conditions.

Replicate Analyses and Field Duplicates

Replicate analyses of each parameter analyzed in the laboratory were performed on approximately 10% of all samples. Duplicate field samples were collected at 10% of the stations. Results of replicate and duplicate analyses are reported (Appendix D).

Major Ion and Conductivity Balances

The ion balance for 96% of both spring and fall sampling stations were within guidelines for anion-cation balance (Appendix D) set by the U.S. EPA (Hillman et al. 1984). For purposes of the balance calculations, a "less than" value was equal to zero (even though the actual value was probably greater than zero but less than the detection limit). This calculating procedure may account for those stations where the anion-cation balance value lies outside the U.S. EPA guidelines. Instrument variation and sensitivity may also contribute to error, causing summed measurements to lie outside the guidelines.

The conductivity balance for 97% of the spring and fall stations (Appendix D) were within the U.S. EPA guidelines (Hillman et al. 1984. Instrument variation and sensitivity may account for those measurements which lie outside the guidelines.

For both the percent ion difference and the percent conductance difference, the median percent difference was within 0±5%, as specified by the U.S. EPA (Hillman et al. 1984). Consequently, measurement bias is not indicated.

DATA REPORT

The intent of the 1986 survey is to report the chemical characteristics of selected aquatic ecosystems in California; no interpretation of these results is made.

The results of field and laboratory analyses are presented by mountain range and season (Tables 1, 2, 3, 4, 5, and 6); results presented in alternate units are also reported (Appendix E). Means and ranges of measurements for the major water quality parameters-- pH, alkalinity, conductivity, calcium, and magnesium-- are summarized (Table 7). The pH values measured during the fall using the modified technique described in the Materials and Methods section are summarized (Table 8). Water quality parameters measured during the 1985 sampling season are included for comparison (Appendix E).

Several instances of trace element contamination of samples occurred; these were apparent because dissolved concentrations exceeded total concentrations (Table 3 and 6). All filters and sample containers were chemically cleaned and tested prior to field use. Contamination most likely occurred during field collection under adverse conditions (wind, rain, or snow). However, in those instances where dissolved trace element concentrations are only slightly greater than total trace element concentrations, the cause is most likely due to instrument variability and does not necessarily indicate sample contamination.

The vulnerability of California's pristine aquatic ecosystems to damage from acid deposition is cause for concern. However, neither the magnitude of the threat nor the extent of natural resources at risk are well defined. These circumstances justify the need for a comprehensive, systematic survey of water quality conditions in California lakes to clarify the acidification process, its progress, and to determine the existing or potential threat to the State's aquatic resources and habitats.

TABLE 1. Sampling dates, field measurements, and hardness for spring sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp. °C
NORTHWEST RANGES							
Buck Lake	15 May 86	Siskiyou	6.5	70	3.7	11.6	11.1
Toad Lake	13 May 86	Trinity Divide	6.6	295	15.8	30.2	1.2
Toad Lake (Duplicate)	13 May 86	"	ND[1/]	299	15.4	ND	ND
Big Bear Lake	14 May 86	Scott-Salmon	6.0	32	1.4	5.53	2.0
Josephine Lake	13 May 86	Trinity Alps	5.8	19	1.8	4.62	3.1
NORTHEAST RANGES							
Patterson Lake	18 Jun 86	Warner Mts.	6.6	113	4.5	13.6	1.2
Eiler Lake	28 May 86	So. Cascade	6.5	53	1.8	6.10	18.4
Triangle Lake	29 May 86	"	5.9	65	2.9	6.60	9.5
Caribou Lake	29 May 86	"	6.5	98	4.4	11.6	16.4
Shadow Lake	17 Jun 86	"	5.4	0	0.60	3.42	1.1
Shadow Lake (Duplicate)	17 Jun 86	"	ND	0	0.60	ND	ND
MENDOCINO RANGES							
Black Rock Lake	27 May 86	Yolla Bolly	6.4	120	4.7	11.4	13.3
Howard Lake	16 Apr 86	Mendocino	6.4	997	60.0	122	11.0
Plasket Lake (Upper)	16 Apr 86	"	7.4	1300	61.6	109	6.7
Upper Letts Lake	15 Apr 86	"	7.6	1240	56.3	120	9.7
NORTHERN SIERRA NEVADA							
Taylor Lake	9 May 86	No. Sierra	7.0	125	4.4	13.9	2.3
Crystal Lake	8 May 86	"	5.9	60	2.9	7.05	0.5
Three Lakes (Lower)	2 Jul 86	"	6.6	66	2.5	11.0	25.3
Eureka Lake	7 May 86	"	6.2	71	2.7	9.72	5.5
Haven Lake	7 May 86	"	5.6	41	2.3	7.13	2.0
CENTRAL SIERRA NEVADA							
Secret Lake	3 Jun 86	Cen. Sierra	6.0	25	2.4	6.78	9.7
Warren Lake	1 Jul 86	"	6.7	41	2.4	9.06	14.9
High Loch Leven Lake	2 Jun 86	"	5.6	15	0.89	7.47	7.5
High Loch Leven Lake (Duplicate)	2 Jun 86	"	5.5	16	0.90	ND	7.2
Five Lakes (Lower)	4 Jun 86	"	5.6	70	3.4	11.9	2.6
Lost Lake	19 Jun 86	"	6.3	48	1.8	6.58	15.8
Smith Lake	5 Jun 86	"	5.6	4	0.39	3.50	1.7
Ralston Lake	6 Jun 86	"	5.7	2	0.62	3.45	1.6
Winnemucca Lake	13 Jun 86	"	6.3	71	4.1	10.9	1.1
Granite Lake	12 Jun 86	"	5.1	21	1.3	4.07	12.4
Granite Lake	24 Jun 86	"	6.2	21	ND	3.93	18.1
Twin Lake	24 Jun 86	"	6.5	78	3.4	11.8	14.0
Highland Lake (Upper)	11 Jun 86	"	6.4	165	9.0	22.3	2.7

TABLE 1. (continued)

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp. °C
SOUTHERN SIERRA RANGES							
Gaylor Lake (Lower)	25 Jun 86	So. Sierra	6.1	30	2.1	6.03	1.1
McCloud Lake	7 Jul 86	"	6.3	23	1.3	5.16	13.3
Serene Lake	8 Jul 86	"	6.5	80	2.5	9.35	15.8
Devils Bathtub Lake	27 Jun 86	"	6.4	34	1.6	7.73	11.5
Long Lake	25 Jun 86	"	5.9	30	1.4	7.07	6.5
Crater Lake	26 Jun 86	"	6.4	50	2.2	7.34	ND
Piute Lake	11 Jul 86	"	6.4	22	1.3	4.09	10.4
Piute Lake (Duplicate)	11 Jul 86	"	ND	23	1.3	ND	ND
Summit Lake	11 Jul 86	"	6.3	28	1.5	4.87	7.1
Chocolate Lake (Upper)	8 Jul 86	"	6.2	118	5.4	15.7	6.7
Golden Trout Lake	9 Jul 86	"	7.2	294	18.3	45.9	1.8
Pear Lake	15 Jul 86	"	5.9	0	0.70	3.04	7.0
Cottonwood Lake No. 5	10 Jul 86	"	7.3	103	3.9	12.6	11.4
Franklin Lake (Lower)	17 Jul 86	"	6.7	69	6.5	19.0	9.9
Bullfrog Lake (Lower)	16 Jul 86	"	6.6	44	3.7	10.4	5.5
CENTRAL COAST RANGE							
Big Sur River	2 Apr 86	Santa Lucia	8.2	2010	100	230	12.4
Willow Creek	3 Apr 86	"	8.0	1930	93.6	235	12.1
SOUTHERN CALIFORNIA RANGES							
Sespe Creek	10 Apr 86	Topatopa	8.7	4040	380	799	16.7
Sespe Creek (Duplicate)	10 Apr 86	"	ND	3590	378	ND	ND
Cogswell Reservoir	8 Apr 86	San Gabriel	7.6	2390	125	266	16.1
Lake Gregory	8 Apr 86	San Bernardino	8.7	1060	52.2	142	11.7
Lake Hemet	9 Apr 86	San Jacinto	8.9	2490	104	295	16.1
Doane Pond	9 Apr 86	Palomar	7.8	972	39.6	131	14.7

1/ Not Determined

TABLE 2. Results of cation and anion analyses for spring sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
NORTHWEST RANGES											
Buck Lake	58.9	14.6	21.9	1.4	97	108	70	<0.1	25	13	0.08
Toad Lake	80.3	236	14.4	1.1	332	352	295	0.2	55	2	0.12
Toad Lake (Duplicate)	78.3	230	12.6	1.0	322	354	299	0.3	52	3	0.19
Big Bear Lake	21.8	5.3	15.4	2.0	44	62	32	1.2	27	3	0.09
Josephine Lake	33.0	3.6	7.4	2.6	47	49	19	1.3	26	2	<0.06
NORTHEAST RANGES											
Patterson Lake	58.4	32.0	26.8	11	128	135	113	4.3	14	3	0.3
Eiler Lake	26.0	10.0	15.7	3.9	56	68	53	<0.1	10	5	0.07
Triangle Lake	24.0	33.6	11.0	2.6	71	78	65	0.22	10	3	<0.06
Caribou Lake	46.8	42.3	19.0	3.4	112	122	98	<0.1	21	3	<0.06
Shadow Lake	10	1.9	2.2	0.6	15	21	0	<0.1	18	3	<0.06
Shadow Lake (Duplicate)	9.9	2.2	2.5	0.7	15	21	0	<0.1	19	2	<0.06
MENDOCINO RANGES											
Black Rock Lake	73.8	19.6	16.0	1.3	111	156	120	<0.1	30	6	0.24
Howard Lake	900	300	133	19.7	1353	1224	997	<0.1	216	11	0.36
Plasket Lake (Upper)	900	332	85.7	8.9	1327	1394	1300	<0.1	81	13	0.17
Upper Letts Lake	850	276	74.4	4.6	1205	1313	1240	<0.1	58	15	0.24
NORTHERN SIERRA NEVADA											
Taylor Lake	68.9	19.7	34.3	5.0	128	150	125	0.3	21	4	0.16
Crystal Lake	35.8	22.6	18.7	4.6	82	88	60	<0.1	25	4	0.12
Three Lakes (Lower)	36.5	13.9	31.9	8.9	91	105	66	<0.1	31	7	0.1
Eureka Lake	33.0	21.3	30.4	2.8	88	83	71	0.28	8	4	0.1
Haven Lake	26.4	20.1	16.4	0.6	64	76	41	0.38	29	5	0.07
CENTRAL SIERRA NEVADA											
Secret Lake	36.8	11.3	18.3	1.0	67	63	25	0.21	33	5	0.06
Warren Lake	36.4	11.2	17.1	6.0	71	62	41	<0.1	18	4	<0.06
High Loch Leven Lake	14	3.8	11.6	1.0	30	38	15	<0.1	17	6	0.07
High Loch Leven Lake (Duplicate)	14	3.9	11.4	1.0	30	40	16	<0.1	17	7	0.09
Five Lakes (Lower)	50.3	16.9	32.4	2.0	102	93	70	<0.1	18	4	0.1
Lost Lake	30.6	6.3	25.9	4.6	67	73	48	<0.1	20	5	<0.06
Smith Lake	5.5	2.3	9.1	1.4	18	32	4	6.7	17	4	<0.06
Ralston Lake	10	2.3	6.4	1.7	20	26	2	2.9	17	4	<0.06
Winnemucca Lake	62.4	19.2	10.4	4.1	96	100	71	3.9	21	4	0.1
Granite Lake	21.5	4.6	9.5	2.2	38	49	21	<0.1	24	4	0.09
Twin Lake	51.4	15.8	21.1	8.2	96	96	78	<0.1	14	4	0.09
Highland Lake (Upper)	157	22.4	23.0	2.2	205	209	165	2.4	37	5	0.1

TABLE 2. (continued)

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^- uM	SO_4^{2-} ueq/L	Cl^- ueq/L	PO_4^{3-} uM
SOUTHERN SIERRA NEVADA											
Gaylor Lake (Lower)	38.4	3.4	10.4	2.7	55	51	30	1.1	17	3	0.07
McCloud Lake	19.4	7.4	16.7	4.8	48	47	23	<0.1	21	3	0.07
Serene Lake	38.7	10.6	27.5	11.6	88	106	80	<0.1	21	5	0.07
Devils Bathtub Lake	26.2	4.9	25.1	5.0	61	56	34	0.97	17	4	0.07
Long Lake	23.0	4.0	19.4	4.6	51	43	30	1.0	8	4	0.06
Crater Lake	38.0	6.0	19.3	7.0	70	68	50	<0.1	14	3	0.08
Piute Lake	22.6	2.8	7.2	3.2	36	36	22	1.3	13	<1	<0.06
Piute Lake (Duplicate)	22.6	2.8	8.2	3.2	37	38	23	1.3	14	<1	0.07
Summit Lake	26.2	3.2	11.4	2.8	44	38	28	<0.1	10	<1	0.11
Chocolate Lake (Upper)	96.3	12.3	25.5	12.3	146	146	118	2.2	23	3	0.07
Golden Trout Lake	350	16.2	20.4	9.0	396	401	294	9.3	96	2	<0.06
Pear Lake	12	1.9	6.7	1.7	22	21	0	1.4	20	<1	<0.06
Cottonwood Lake No. 5	70.8	8.0	33.5	7.2	120	118	103	<0.1	14	1	0.08
Franklin Lake (Lower)	124	6.2	19.3	5.4	155	130	69	5.7	54	2	<0.06
Bullfrog Lake (Lower)	68.9	5.1	15.0	3.5	92	80	44	6.0	29	1	0.11
CENTRAL COAST RANGE											
Big Sur River	1570	434	270	26.1	2270	2407	2010	0.3	287	110	0.35
Willow Creek	1300	571	350	46.3	2270	2483	1930	<0.1	433	120	0.45
SOUTHERN CALIFORNIA RANGES											
Sespe Creek	5190	2410	1410	43.3	9053	8185	4040	4.9	3950	190	0.37
Sespe Creek (Duplicate)	5190	2380	1390	43.8	9004	7855	3590	4.9	4060	200	0.41
Cogswell Reservoir	1800	695	400	64.5	2960	2654	2390	0.2	180	84	0.32
Lake Gregory	800	244	339	37.4	1420	1452	1060	13.1	150	229	0.38
Lake Hemet	1640	440	957	82.9	3120	3206	2490	0.1	356	360	1.63
Doane Pond	550	242	396	42.5	1230	1364	972	<0.1	222	170	0.85

TABLE 3. Trace element, silica, and organic acid concentrations of water samples for spring sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Aluminium ug/L Tot.	Aluminium ug/L Diss.	Iron ug/L Tot.	Iron ug/L Diss.	Manganese ug/L Tot.	Manganese ug/L Diss.	Silica uM Tot.	Organic acids mg/L Tot.
NORTHWEST RANGES								
Buck Lake	22	13	7	3	0.5	0.9	35	0.17
Toad Lake	52	20	25	33	1.0	2.1	70	0.27
Toad Lake (Duplicate)	18	18	20	9	0.9	4.8	70	0.27
Big Bear Lake	56	49	7	4	0.7	0.8	39	0.31
Josephine Lake	37	31	17	8	1.5	1.5	25	0.24
NORTHEAST RANGES								
Patterson Lake	11	4	10	2	2.8	2.1	46	0.08
Eiler Lake	35	35	8	6	2.4	2.4	28	0.20
Triangle Lake	34	23	7	14	2.2	3.5	26	0.22
Caribou Lake	34	23	11	4	2.3	1.6	54	0.31
Shadow Lake	52	40	5	4	1.3	1.1	7	0.1
Shadow Lake (Duplicate)	31	43	5	4	1.0	1.1	7	0.1
MENDOCINO RANGES								
Black Rock Lake	29	20	11	15	1.5	2.3	40	0.39
Howard Lake	100	40	148	18	124	71.0	160	0.20
Plasket Lake (Upper)	24	20	642	482	29.0	26.0	165	0.41
Upper Letts Lake	13	10	46	11	8.2	2.6	145	0.1
NORTHERN SIERRA NEVADA								
Taylor Lake	19	12	37	22	18.1	22.8	51	0.29
Crystal Lake	9	2	7	2	3.8	4.1	19	0.42
Three Lakes (Lower)	68	57	59	45	6.3	5.9	79	0.70
Eureka Lake	8	5	148	17	85.0	63.5	47	0.1
Haven Lake	40	29	29	24	3.4	3.6	43	0.44
CENTRAL SIERRA NEVADA								
Secret Lake	52	50	17	11	1.3	1.3	53	0.23
Warren Lake	34	21	37	10	2.2	1.8	68	0.17
High Loch Leven Lake	66	62	32	23	2.8	2.7	34	0.32
High Loch Leven Lake (Duplicate)	61	57	30	22	2.8	2.6	34	0.32
Five Lakes (Lower)	60	53	48	40	4.5	4.5	64	0.23
Lost Lake	37	14	91	15	4.9	4.1	34	0.31
Smith Lake	29	26	3	2	1.1	1.1	21	0.07
Ralston Lake	31	26	6	3	0.8	0.8	18	0.34
Winnemucca Lake	12	7	17	8	11.2	9.9	24	0.07
Granite Lake	85	73	25	17	2.8	2.7	32	0.43
Twin Lake	25	8	53	13	31.6	22.0	56	0.14
Highland Lake (Upper)	35	20	23	11	3.9	3.7	57	0.20

TABLE 3. (continued)

Station	Aluminium ug/L Tot.	Aluminium ug/L Diss.	Iron ug/L Tot.	Iron ug/L Diss.	Manganese ug/L Tot.	Manganese ug/L Diss.	Silica uM Tot.	Organic acids mg/L Tot.
SOUTHERN SIERRA NEVADA								
Gaylor Lake (Upper)	18	15	12	6	4.5	4.1	41	0.08
McCloud Lake	25	4	46	18	2.7	1.3	62	0.17
Serene Lake	14	9	16	4	6.9	5.7	34	0.13
Devils Bathtub Lake	32	28	26	5	8.4	7.5	75	0.15
Long Lake	35	23	71	18	7.4	6.6	53	0.15
Crater Lake	47	31	23	17	3.4	3.3	64	0.32
Piute Lake	39	3	23	2	2.0	1.7	31	0.07
Piute Lake (Duplicate)	40	6	28	3	1.9	1.8	31	0.07
Summit Lake	15	7	21	8	1.0	0.9	46	0.1
Chocolate Lake (Upper)	7	2	132	33	6.2	3.0	66	0.07
Golden Trout Lake	6	3	11	5	0.9	0.5	50	<0.05
Pear Lake	11	4	21	4	5.4	5.5	20	0.07
Cottonwood Lake No.5	5	2	94	15	3.6	2.5	87	0.08
Franklin Lake (Lower)	21	12	9	1	5.3	2.3	55	<0.05
Bullfrog Lake (Lower)	9	5	9	3	2.1	1.8	54	<0.05
CENTRAL COAST RANGE								
Big Sur River	27	18	13	10	1.2	1.0	406	0.1
Willow Creek	29	8	17	7	2.2	1.1	529	0.1
SOUTHERN CALIFORNIA RANGES								
Sespe Creek	62	14	39	12	17.2	14.4	230	0.39
Sespe Creek (Duplicate)	52	11	40	9	17.1	15.1	218	0.40
Cogswell Reservoir	52	10	68	24	32.0	29.2	369	0.29
Lake Gregory	47	23	106	25	48.5	3.2	10	0.36
Lake Hemet	140	220	138	182	74.0	76.0	306	0.48
Doane Pond	200	23	658	161	73.0	53.0	469	0.46

TABLE 4. Sampling dates, field measurements, and hardness for fall sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Date Sampled	Mountain Range	pH[2]	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp °C
NORTHWEST RANGES							
Buck Lake	28 Aug 86	Siskiyou	6.3	90	4.6	12.6	21.8
Buck Lake (Duplicate)	28 Aug 86	Trinity Divide	ND[3]	80	4.6	ND	ND
Toad Lake	26 Aug 86	"	7.6	730	30	72.4	19.3
Big Bear Lake	27 Aug 86	Scott-Salmon	6.0	22	1.5	5.13	19.5
Josephine Lake	26 Aug 86	Trinity Alps	6.1	15	1.4	4.30	20.7
NORTHEAST RANGES							
Patterson Lake	18 Aug 86	Warner Mts.	6.7	118	4.9	14.5	16.0
Eiler Lake	21 Aug 86	So. Cascade	6.4	37	1.9	6.29	20.9
Triangle Lake	20 Aug 86	"	6.4	38	2.4	8.88	20.4
Caribou Lake	20 Aug 86	"	6.6	106	5.1	13.2	22.0
Shadow Lake	21 Aug 86	"	5.8	0	0.71	2.69	17.8
Shadow Lake (Duplicate)	21 Aug 86	"	ND	0	0.69	ND	ND
MENDOCINO RANGES							
Black Rock Lake	7 Aug 86	Yolla Bolly	6.4	73	4.6	12.4	21.8
Howard Lake	6 Aug 86	Mendocino	8.9[4]	1420	74	166	26.2
Plasket Lake (Upper)	6 Aug 86	"	8.8	1500	65	132	20.3
Upper Letts Lake	5 Aug 86	"	8.6	1320	58	139	25.5
NORTHERN SIERRA NEVADA							
Taylor Lake	14 Aug 86	No. Sierra	7.2	148	6.2	18.0	22.8
Crystal Lake	14 Aug 86	"	6.4	85	3.5	10.1	19.8
Three Lakes (Lower)	13 Aug 86	"	6.2	79	2.8	10.6	21.4
Eureka Lake	12 Aug 86	"	6.4	49	2.3	8.61	23.4
Haven Lake	12 Aug 86	"	6.4	58	2.8	8.90	20.9
CENTRAL SIERRA NEVADA							
Secret Lake	20 Oct 86	Cen. Sierra	6.6	52	4.0	12.5	8.9
Warren Lake	21 Oct 86	"	6.2	41	2.9	9.39	8.6
High Loch Leven Lake	24 Oct 86	"	5.4	11	1.5	6.28	7.9
High Loch Leven Lake (Duplicate)	24 Oct 86	"	ND	15	1.5	ND	ND
Five Lakes (Lower)	22 Oct 86	"	6.2	47	3.1	9.31	7.8
Lost Lake	23 Oct 86	"	6.0	53	1.6	6.88	7.9
Smith Lake	4 Sep 86	"	5.6	3	0.5	2.58	15.6
Ralston Lake	29 Sep 86	"	5.6	15	0.86	3.28	9.0
Winnemucca Lake	3 Sep 86	"	6.7	92	5.3	12.9	13.4
Granite Lake	2 Sep 86	"	6.0	31	1.1	4.26	21.2
Twin Lake	2 Sep 86	"	6.5	89	3.4	10.5	19.8
Highland Lake (Upper)	3 Sep 86	"	7.8	213	11	29.3	18.7

TABLE 4. (continued)

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp °C
SOUTHERN SIERRA NEVADA							
Gaylor Lake (Lower)	30 Sep 86	So. Sierra	6.4	41	3.7	9.69	5.5
McCloud Lake	1 Oct 86	"	6.2	23	1.4	5.52	4.1
Serene Lake	1 Oct 86	"	6.5	59	2.6	9.28	7.5
Serene Lake (Duplicate)	1 Oct 86	"	ND	62	2.6	ND	ND
Devils Bathtub Lake	15 Oct 86	"	6.2	51	1.4	6.52	9.8
Long Lake	16 Oct 86	"	6.0	32	1.1	4.96	7.6
Crater Lake	16 Sep 86	"	6.3	72	2.8	8.89	14.1
Piute Lake	7 Oct 86	"	6.2	33	2.0	5.79	3.4
Summit Lake	7 Oct 86	"	6.4	59	2.7	7.69	5.0
Chocolate Lake (Upper)	6 Oct 86	"	6.8	128	7.2	20.0	5.4
Golden Trout Lake	8 Oct 86	"	7.0	330	23	52.3	5.2
Pear Lake	11 Sep 86	"	6.0	25	0.84	2.73	16.0
Pear Lake (Duplicate)	11 Sep 86	"	ND	18	0.85	ND	ND
Cottonwood Lake No. 5	9 Oct 86	"	6.4	94	4.1	12.9	5.4
Franklin Lake (Lower)	10 Sep 86	"	6.8	108	7.6	19.5	14.2
Bullfrog Lake (Lower)	9 Sep 86	"	6.6	86	5.2	14.0	11.5
CENTRAL COAST RANGE							
Big Sur River	30 Jul 86	Santa Lucia	8.5[4/]	2420	120	279	18.8
Willow Creek	31 Jul 86	"	8.2[4/]	2510	120	289	16.5
SOUTHERN CALIFORNIA RANGES							
Sespe Creek	5 Nov 86	Topatopa	8.2[5/]	4560	355	767	14.6
Cogswell Reservoir	4 Nov 86	"	7.4	3700	150	345	16.6
Lake Gregory	4 Nov 86	San Gabriel	7.6	1320	48	164	13.2
Lake Hemet	4 Nov 86	San Bernardino	8.0[5/]	2520	87	299	14.0
Doane Pond	5 Nov 86	San Jacinto	7.5[5/]	1490	58	188	11.7
Doane Pond (Duplicate)	5 Nov 86	Palomar	ND	1450	58	ND	ND

2/ Mean of pH Hach Kit and pH Orion Meter.
3/ Not Determined.
4/ Orion Meter reading only.
5/ Hach Kit reading only.

TABLE 5. Results of cation and anion analyses for fall sampling period, 1986: Statewide survey of Aquatic Ecosystem Chemistry.

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
NORTHWEST RANGES											
Buck Lake	73.8	17.7	28.5	2.2	122	132	90	<0.1	27	15	0.08
Buck Lake (Duplicate)	73.4	17.8	27.8	2.2	121	124	80	<0.1	29	15	0.07
Toad Lake	120	481	16.8	1.6	619	765	730	<0.1	32	3	0.06
Big Bear Lake	24.2	4.9	15.6	2.4	47	38	22	<0.1	14	2	<0.06
Josephine Lake	26.0	2.7	6.0	2.9	38	31	15	2.1	13	1	<0.06
NORTHEAST RANGES											
Patterson Lake	61.0	36.1	32.4	11.9	141	146	118	0.1	27	1	0.08
Eiler Lake	27.3	10.9	17.3	5.3	61	42	37	0.1	<5	5	<0.06
Triangle Lake	14	34.3	12.0	3.3	64	42	38	0.1	<5	4	<0.06
Caribou Lake	50.0	51.0	23.5	4.9	129	120	106	0.26	10	4	0.09
Shadow Lake	9.0	5.1	6.6	1.3	22	12	0	<0.1	9	3	<0.06
Shadow Lake (Duplicate)	8.5	5.2	6.7	1.3	22	12	0	<0.1	9	3	<0.06
MENDOCINO RANGES											
Black Rock Lake	66.9	25.2	15.2	2.0	109	142	73	<0.1	64	5	0.35
Howard Lake	905	582	167	2.0	1656	1766	1420	<0.1	340	6	0.68
Plasket Lake (Upper)	641	648	108	0.9	1398	1595	1500	<0.1	87	8	0.29
Upper Letts Lake	809	341	92.2	1.9	1244	1387	1320	<0.1	50	17	0.17
NORTHERN SIERRA NEVADA											
Taylor Lake	97.3	25.7	52.7	6.1	182	189	148	0.2	37	4	0.11
Crystal Lake	43.1	25.9	32.4	5.3	107	103	85	0.22	15	3	<0.06
Three Lakes (Lower)	40.2	15.6	35.7	10.2	102	117	79	<0.1	31	7	0.14
Eureka Lake	28.4	17.5	31.4	2.3	80	71	49	0.2	20	2	0.06
Haven Lake	28.6	27.9	26.7	1.7	85	81	58	0.1	19	4	0.06
CENTRAL SIERRA NEVADA											
Secret Lake	60.2	20.3	29.2	1.4	111	150	52	1.8	89	7	0.21
Warren Lake	45.1	13.7	20.8	6.1	86	57	41	<0.1	14	2	<0.06
High Loch Leven Lake	23.6	6.7	18.8	3.1	52	52	11	<0.1	27	14	<0.06
High Loch Leven Lake (Duplicate)	23.3	6.7	18.5	3.1	52	56	15	<0.1	27	14	0.09
Five Lakes (Lower)	47.2	14.3	17.6	3.4	82	91	47	0.1	40	4	0.09
Lost Lake	25.5	6.8	26.5	4.2	63	74	53	0.1	17	4	<0.06
Smith Lake	8.0	2.0	9.0	1.5	20	13	3	2.5	6	2	<0.06
Ralston Lake	15.0	2.3	7.8	2.3	27	22	15	0.49	6	1	<0.06
Winnemucca Lake	79.8	25.5	11.0	4.6	121	110	92	<0.1	16	2	<0.06
Granite Lake	16.4	5.8	13.5	3.9	40	34	31	0.2	<5	3	0.21
Twin Lake	50.6	17.8	24.8	9.8	103	124	89	0.30	31	4	0.15
Highland Lake (Upper)	196	29.9	33.8	0.9	261	278	213	<0.1	64	1	0.22

TABLE 5. (continued)

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
SOUTHERN SIERRA NEVADA											
Gaylor Lake (Lower)	67.6	6.3	15.4	3.2	92	83	41	<0.1	42	<1	<0.06
McCloud Lake	19.0	8.2	18.7	5.4	51	36	23	0.1	10	3	<0.06
Serene Lake	39.5	11.6	31.0	12.3	94	89	59	0.23	25	5	<0.06
Serene Lake (Duplicate)	39.2	11.6	31.1	12.3	94	92	62	0.2	25	5	<0.06
Devils Bathtub Lake	21.7	5.5	28.1	5.3	61	63	51	<0.1	10	2	<0.06
Long Lake	17.9	4.0	18.3	4.9	45	39	32	0.1	5	2	<0.06
Crater Lake	46.5	9.5	26.9	9.4	92	89	72	<0.1	15	2	<0.06
Piute Lake	35.7	4.0	11.4	4.2	55	52	33	0.45	17	1	<0.06
Summit Lake	47.1	5.9	22.6	3.2	79	86	59	0.1	27	<1	0.16
Chocolate Lake (Upper)	127	16.9	32.1	12.1	188	178	128	<0.1	50	<1	0.06
Golden Trout Lake	432	19.5	23.3	9.2	484	486	330	3.00	150	3	<0.06
Pear Lake	15	1.9	7.6	1.7	26	26	25	<0.1	<5	1	<0.06
Pear Lake (Duplicate)	15	2.0	7.0	1.7	26	20	18	<0.1	<5	2	<0.06
Cottonwood Lake No. 5	72.8	8.7	35.4	7.1	124	112	94	<0.1	14	4	0.17
Franklin Lake (Lower)	146	6.7	22.0	5.4	180	159	108	2.7	46	2	<0.06
Bullfrog Lake (Lower)	98.3	6.6	20.3	4.6	130	115	86	2.8	24	2	<0.06
CENTRAL COAST RANGE											
Big Sur River	1880	560	358	33.3	2831	2806	2420	0.25	374	12	0.34
Willow Creek	1600	750	481	53.8	2885	3121	2510	0.50	599	12	0.47
SOUTHERN CALIFORNIA RANGES											
Sespe Creek	4830	2260	1540	40.8	8670	8640	4560	<0.1	3800	280	0.37
Cogswell Reservoir	2050	953	505	102	3610	4170	3700	<0.1	250	220	0.19
Lake Gregory	714	246	326	37.1	1323	1570	1320	0.45	130	120	0.42
Lake Hemet	1240	504	1050	96.9	2891	3130	2520	2.4	160	450	1.90
Doane Pond	803	363	578	67.0	1811	1870	1490	<0.1	250	130	0.81
Doane Pond (Duplicate)	798	364	585	68.3	1815	1830	1450	<0.1	240	140	0.82

TABLE 6. Trace element, silica, and organic acid concentrations of water samples for fall sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Aluminium ug/L Tot.	Aluminium ug/L Diss.	Iron ug/L Tot.	Iron ug/L Diss.	Manganese ug/L Tot.	Manganese ug/L Diss.	Silica uM Tot.	Organic acids mg/L Tot.
NORTHWEST RANGES								
Buck Lake	38	31	29	12	1.3	1.1	39	0.50
Buck Lake (Duplicate)	40	29	22	12	1.3	1.3	39	0.41
Toad Lake	17	14	23	11	3.5	3.0	162	0.12
Big Bear Lake	35	15	14	4	2.3	2.1	20	0.1
Josephine Lake	32	12	46	8	3.9	2.4	11	0.15
NORTHEAST RANGES								
Patterson Lake	11	6	16	8	3.8	1.6	24	0.08
Eiler Lake	104	48	5	3	0.8	1.0	36	0.09
Triangle Lake	68	34	3	3	1.0	0.8	25	0.10
Caribou Lake	116	76	10	2	2.2	1.1	52	0.16
Shadow Lake	16	7	6	2	1.3	5.8	10	<0.05
Shadow Lake (Duplicate)	15	13	5	4	1.2	1.7	10	<0.05
MENDOCINO RANGES								
Black Rock Lake	36	28	57	27	5.1	2.1	49	0.54
Howard Lake	31	30	65	45	49.5	29.5	8	0.26
Plasket Lake (Upper)	11	14	100	31	6.6	0.9	42	0.24
Upper Letts Lake	22	13	75	12	27.5	2.2	120	0.22
NORTHERN SIERRA NEVADA								
Taylor Lake	29	16	26	11	9.4	3.0	39	0.28
Crystal Lake	14	13	4	3	6.4	4.4	7	0.05
Three Lakes (Lower)	44	31	51	51	5.8	5.3	64	0.75
Eureka Lake	17	14	38	13	6.5	3.3	46	0.1
Haven Lake	54	30	18	6	2.5	1.1	27	0.24
CENTRAL SIERRA NEVADA								
Secret Lake	33	31	72	80	3.2	5.3	8	0.58
Warren Lake	20	10	48	14	5.1	3.3	60	0.17
High Loch Leven Lake	50	36	17	8	2.9	2.6	15	0.55
High Loch Leven Lake (Duplicate)	50	42	17	11	2.8	2.5	15	0.57
Five Lakes (Lower)	31	20	26	10	0.8	1.0	16	0.27
Lost Lake	22	14	25	10	0.5	0.5	5	0.30
Smith Lake	14	5	5	1	2.1	1.8	18	<0.05
Ralston Lake	14	6	22	4	3.2	2.5	14	0.06
Winnemucca Lake	5	5	3	1	7.0	5.7	12	0.07
Granite Lake	51	11	70	6	3.4	2.9	16	0.42
Twin Lake	14	14	34	15	2.7	2.7	36	0.16
Highland Lake (Upper)	33	28	62	23	5.7	0.5	28	0.1

TABLE 6. (continued)

Station	Aluminium ug/L Tot.	Aluminium ug/L Diss.	Iron ug/L Tot.	Iron ug/L Diss.	Manganese ug/L Tot.	Manganese ug/L Diss.	Silica uM Tot.	Organic acids mg/L Tot.
SOUTHERN SIERRA NEVADA								
Gaylor Lake (Lower)	12	10	18	4	3.5	2.0	34	0.05
McCloud Lake	33	10	33	6	1.9	1.5	50	0.11
Serene Lake	14	12	18	10	2.2	2.1	25	0.12
Serene Lake (Duplicate)	14	11	17	7	2.2	1.6	24	0.12
Devils Bathtub Lake	14	7	16	6	4.0	2.3	68	0.12
Long Lake	17	12	20	7	2.0	1.7	29	0.19
Crater Lake	14	9	42	10	5.7	4.4	51	0.22
Piute Lake	15	9	47	10	4.7	4.3	37	0.05
Summit Lake	36	18	24	8	0.4	0.5	65	0.09
Chocolate Lake (Upper)	7	6	20	8	1.0	0.5	46	0.09
Golden Trout Lake	10	9	2	2	0.2	0.4	28	<0.05
Pear Lake	12	10	14	4	3.8	2.1	16	<0.05
Pear Lake (Duplicate)	12	7	12	5	3.7	2.5	16	<0.05
Cottonwood Lake No. 5	5	8	40	17	1.7	1.5	53	0.07
Franklin Lake (Lower)	25	24	8	5	2.7	3.0	43	<0.05
Bullfrog Lake (Lower)	22	17	14	4	1.7	0.6	52	<0.05
CENTRAL COAST RANGE								
Big Sur River	11	7	8	2	0.7	0.3	352	0.06
Willow Creek	11	10	23	13	2.7	1.4	547	0.06
SOUTHERN CALIFORNIA RANGES								
Sespe Creek	9	9	80	24	25.2	20.8	280	0.75
Cogswell Reservoir	24	9	100	8	125	23.2	310	0.27
Lake Gregory	11	6	140	24	220	157	14	0.28
Lake Hemet	67	8	60	9	44.5	24.8	258	0.26
Doane Pond	78	16	360	110	40.4	7.7	407	0.37
Doane Pond (Duplicate)	70	44	370	120	40.4	7.6	402	0.38

TABLE 7. A comparison of the 1986 spring and fall mean values[6/] (ranges in parentheses) for five water chemistry parameters grouped by mountain range[7/]. Statewide Survey of Aquatic Ecosystem Chemistry.

Mountain Range	pH	Alkalinity (ueq/L)	Conductivity (uS/cm)	Calcium (ueq/L)	Magnesium (ueq/L)
NORTHWEST					
Spring	6.2 (5.8--6.6)	104 (19--297)	13.0 (4.62--30.2)	48.2 (21.8--79.3)	64.1 (3.6--233)
Fall	6.5 (6.0--7.6)	213 (15--730)	23.6 (4.30--72.4)	61.0 (24.2--120)	127 (2.7--481)
NORTHEAST					
Spring	6.2 (5.4--6.6)	55 (0--113)	8.26 (3.42--13.6)	33 (10--58.4)	24.0 (24.0--42.3)
Fall	6.4 (5.8--6.7)	59.8 (0--118)	9.11 (2.69--14.5)	32.2 (14.0--61.0)	27.5 (5.2--36.1)
MENDOCINO					
Spring	7.0 (6.4--7.6)	914 (120--1300)	90.6 (11.4--122)	681 (73.8--900)	232 (19.6--332)
Fall	8.2 (6.4--8.9)	1078 (73--1500)	112 (12.4--166)	605 (66.9--905)	399 (25.2--648)
NO. SIERRA					
Spring	6.3 (5.6--7.0)	73 (41--125)	9.76 (7.05--13.9)	40.1 (26.4--68.9)	19.5 (13.9--22.6)
Fall	6.5 (6.2--7.2)	83.8 (49--148)	11.2 (8.61--18.0)	47.5 (28.4--97.3)	22.5 (15.6--27.9)
CEN. SIERRA					
Spring	6.0 (5.1--6.7)	47 (2--165)	8.48 (3.45--22.3)	43.3 (5.5--157)	10.6 (2.3--22.4)
Fall	6.2 (5.4--7.8)	59 (3--213)	9.74 (2.58--29.3)	51.6 (8.0--196)	13.2 (8.0--196)
SO. SIERRA					
Spring	6.4 (5.9--7.3)	66 (0--294)	11.3 (3.04--45.9)	68.2 (12.0--350)	6.6 (1.9--16.2)
Fall	6.4 (6.0--7.0)	81 (22--330)	12.8 (2.73--52.3)	84.7 (15.0--432)	8.2 (2.0--19.5)
CEN. COAST					
Spring	8.1 (8.0--8.2)	1970 (1930--2010)	232 (230--235)	1435 (1300--1570)	502 (434--571)
Fall	8.4 (8.2--8.5)	2465 (2420--2510)	284 (279--289)	1740 (1600--1880)	655 (560--750)
SOUTHERN CAL					
Spring	8.3 (7.6--8.9)	2145 (972--3815)	327 (131--799)	1996 (550-5190)	803 (242--2395)
Fall	7.7 (7.4--8.2)	2714 (1320--4560)	353 (164--767)	1927 (714--4830)	865 (246--2260)

6/ means were calculated for duplicate stations.
7/ Includes only waters sampled during both sampling periods.

TABLE 8. pH values using three separate instruments for measurement, fall sampling period 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Date Sampled	pH[8/] Hach	pH[9/] Orion	pH[9/] Beckman
NORTHWEST RANGES				
Buck Lake	28 Aug 86	6.4	6.33	6.81
Buck Lake (Duplicate)	28 Aug 86	ND	ND	ND
Toad Lake	26 Aug 86	7.5	7.55	7.81
Big Bear Lake	27 Aug 86	6.0	6.08	6.64
Josephine Lake	26 Aug 86	6.0	6.20	ND
NORTHEAST RANGES				
Patterson Lake	18 Aug 86	6.6	6.78	6.37
Eiler Lake	21 Aug 86	6.4	6.45	ND
Triangle Lake	20 Aug 86	6.4	6.38	6.96
Caribou Lake	20 Aug 86	6.6	6.74	ND
Shadow Lake	21 Aug 86	5.8	5.81	6.28
Shadow Lake (Duplicate)	21 Aug 86	ND	ND	ND
MENDOCINO RANGES				
Black Rock Lake	7 Aug 86	6.3	6.38	6.80
Howard Lake	6 Aug 86	>8.5	8.94	9.13
Plasket Lake (Upper)	6 Aug 86	8.3	9.42	9.75
Upper Letts Lake	5 Aug 86	8.5	8.67	ND
NORTHERN SIERRA NEVADA				
Taylor Lake	14 Aug 86	7.0	7.26	7.53
Crystal Lake	14 Aug 86	6.4	6.55	7.04
Three Lakes (Lower)	13 Aug 86	6.3	6.00	6.46
Eureka Lake	12 Aug 86	6.4	6.38	7.08
Haven Lake	12 Aug 86	6.3	6.36	6.97
CENTRAL SIERRA NEVADA				
Secret Lake	20 Oct 86	7.0	6.07	ND
Warren Lake	21 Oct 86	6.3	6.06	6.64
High Loch Leven Lake	24 Oct 86	5.3	5.38	ND
High Loch Leven Lake (Duplicate)	24 Oct 86	ND	ND	ND
Five Lakes (Lower)	2 Oct 86	6.3	6.12	6.6
Lost Lake	23 Oct 86	6.0	5.95	ND
Smith Lake	4 Sep 86	5.7	5.44	6.01
Ralston Lake	29 Sep 86	5.8	5.49	6.70
Winnemucca Lake	3 Sep 86	6.5	6.88	7.22
Granite Lake	2 Sep 86	6.2	5.70	5.95
Twin Lake	2 Sep 86	6.6	6.45	6.70
Highland Lake (Upper)	3 Sep 86	7.2	8.45	8.70

TABLE 8. (Continued)

Station	Date Sampled	pH Hach	pH Orion	pH Beckman
SOUTHERN SIERRA NEVADA				
Gaylor Lake (Lower)	30 Sep 86	6.5	6.29	ND
McCloud Lake	1 Oct 86	6.3	6.04	ND
Serene Lake	1 Oct 86	6.6	6.35	ND
Serene Lake (Duplicate)	1 Oct 86	ND	ND	ND
Devils Bathtub Lake	15 Oct 86	6.2	6.25	6.98
Long Lake	16 Oct 86	6.1	5.95	5.62
Crater Lake	16 Sep 86	6.3	6.27	6.64
Piute Lake	7 Oct 86	6.3	6.08	6.55
Summit Lake	7 Oct 86	6.3	6.47	ND
Chocolate Lake (Upper)	6 Oct 86	6.7	6.79	7.25
Golden Trout Lake	8 Oct 86	6.9	7.00	ND
Pear Lake	11 Sep 86	6.0	5.94	6.74
Pear Lake (Duplicate)	11 Sep 86	ND	ND	ND
Cottonwood Lake No. 5	9 Oct 86	6.6	6.24	ND
Franklin Lake (Lower)	10 Sep 86	6.6	6.99	7.52
Bullfrog Lake (Lower)	9 Sep 86	6.6	6.71	7.27
CENTRAL COAST RANGE				
Big Sur River	30 Jul 86	ND	8.48	8.40
Willow Creek	31 Jul 86	ND	8.23	8.20
SOUTHERN CALIFORNIA RANGES				
Sespe Creek	5 Nov 86	8.2	ND	8.23
Cogswell Reservoir	4 Nov 86	7.4	7.51	7.80
Lake Gregory	4 Nov 86	7.5	7.77	7.63
Lake Hemet	4 Nov 86	8.0	ND	8.16
Doane Pond	5 Nov 86	7.5	ND	7.84
Doane Pond (Duplicate)	5 Nov 86	ND	ND	ND

8/ Colormetric Kit
9/ Electrode

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APPENDIX A

STATION LOCATION

APPENDIX A. Station locations; Statewide Survey of Aquatic Ecosystem Chemistry, 1986.

Station	County	Mountain Range	T	R	S	N.Lat.	W.Long.	Elev. (ft)
NORTHWEST RANGES								
Buck Lake	Siskiyou	Siskiyou	16N	04E	01	41°49'	123°41'	4240
Toad Lake	Siskiyou	Trinity Divide	40N	06W	36	41°17'	122°30'	6720
Big Bear Lake	Trinity	Scott-Salmon	39N	07W	31	41°12'	122°43'	5840
Josephine Lake	Trinity	Trinity Alps	37N	09W	31	41°01'	122°57'	5840
NORTHEAST RANGES								
Patterson Lake	Modoc	Warner	41N	15E	22	41°01	122°57'	5840
Eiler Lake	Shasta	So. Cascades	33N	04E	07	40°44'	121°34'	6403
Triangle Lake	Lassen	"	31N	07E	20	40°32'	121°13'	7080
Caribou Lake	Lassen	"	31N	07E	34	40°30'	121°10'	6600
Shadow Lake	Shasta	"	30N	04E	07	40°28'	121°28'	7680
MENDOCINO RANGES								
Black Rock Lake	Trinity	Yolla Bolly	27N	10W	04	40°13'	123°00'	6160
Howard Lake	Mendocino	Mendocino	23N	10W	05	39°52'	122°59'	3680
Plaskett Lake (Upper)	Glenn	"	22N	09W	26	39°43'	122°51'	5974
Upper Letts Lake	Colusa	"	17N	08W	24	39°19'	122°43'	4482
NORTHERN SIERRA NEVADA								
Taylor Lake	Plumas	No. Sierra	27N	11E	35	40°09'	120°43'	6760
Crystal Lake	Plumas	"	25N	10E	08	40°03'	120°53'	6680
Three Lakes (Lower)	Plumas	"	24N	07E	05	39°58'	121°12'	6120
Eureka Lake	Plumas	"	22N	11E	23	39°46'	120°43'	6180
Haven Lake	Sierra	"	21N	12E	21	39°39'	120°38'	6720

APPENDIX A (continued).

Station	County	Mountain Range	T	R	S	N.Lat.	W.Long.	Elev. (ft)
CENTRAL SIERRA NEVADA								
Secret Lake	Nevada	Cen. Sierra	18N	13E	05	39°27'	120°32'	6400
Warren Lake	Nevada	"	18N	14E	25	39°21'	120°24'	7200
High Loch Leven Lake	Placer	"	16N	13E	03	39°17'	120°30'	6800
Five Lakes (Lower)	Placer	"	15N	16E	06	39°10'	120°15'	8480
Lost Lake	El Dorado	"	14N	16E	35	39°01'	120°11'	7680
Smith Lake	El Dorado	"	12N	16E	--	38°51'	120°11'	8720
Ralston Lake	El Dorado	"	12N	17E	34	38°50'	120°05'	7820
Winnemucca Lake	Alpine	"	10N	18E	34	38°40'	120°00'	9040
Granite Lake	Amador	"	09N	17E	04	38°39'	120°05'	7680
Twin Lake	Alpine	"	09N	18E	25	38°36'	119°57'	8160
Highland Lake (Upper)	Alpine	"	07N	20E	--	38°29'	119°47'	8740
SOUTHERN SIERRA NEVADA								
Gaylor Lake (Lower)	Tuolumne	So. Sierra	01N	25E	30	37°55'	119°16'	10400
McCloud Lake	Mono	"	04S	27E	--	37°37'	119°02'	9120
Serene Lake	Mono	"	06S	30E	--	37°27'	118°45'	10320
Devil's Bathtub Lake	Fresno	"	06S	27E	14	37°26	119°00'	9167
Long Lake	Fresno	"	07S	26E	19	37°18'	119°04'	8040
Crater Lake	Fresno	"	08S	27E	10	37°15'	119°00'	9440
Piute Lake	Inyo	"	08S	29E	--	37°14'	118°40'	10963
Summit Lake	Fresno	"	08S	30E	--	37°14'	118°41'	11200
Chocolate Lake (Upper)	Inyo	"	09S	31E	24	37°06'	118°33'	10500
Golden Trout Lake	Inyo	"	12S	32E	--	36°47'	118°22'	11360
Pear Lake	Tulare	"	15S	30E	24	36°36'	118°40'	9510
Cottonwood Lake No. 5	Inyo	"	16S	34E	--	36°28'	118°14'	11005
Franklin Lake (Lower)	Tulare	"	17S	32E	--	36°25'	118°31'	10320
Bullfrog Lake (Lower)	Tulare	"	18S	32E	--	36°24'	118°31'	11040

APPENDIX A. (Continued).

Station	County	Mountain Range	T	R	S	N.Lat.	W.Long.	Elev. (ft)
CENTRAL COAST RANGE								
Big Sur River	Monterey	Santa Lucia	19S	02E	29	36°15'	121°46'	240
Willow Creek	Monterey	"	21S	03E	24	36°13'	121°32'	1200
SOUTHERN CALIFORNIA RANGES								
Sespe Creek	Ventura	Topatopa	05N	22W	05	34°33'	119°11'	3200
Cogswell Reservoir	Los Angeles	San Gabriel	02N	10W	--	34°14'	118°57'	2400
Lake Gregory	San Bernardino	San Bernardino	02N	04W	15	34°14'	117°17'	4520
Lake Hemet	Riverside	San Jacinto	06S	03E	09	33°40'	116°40'	4335
Doane Pond	San Diego	Palomar	10S	01E	05	33°20'	116°54'	4640

APPENDIX B

CLEANING SUMMARY AND PROCEDURES

APPENDIX B. Cleaning summary and procedures.

Sample volume, cleaning agent, filter pore size, and filter type for water sample collection.

Parameter	Sample bottle volume (ml)	Cleaning agent	Filter pore size (u)	Filter type
Anions	500	1N nitric acid	0.45	Gelman Acro 50A hydrophyllic
Cations	250	1N hydrochloric acid	0.45	"
Phosphates	60	1N nitric acid	0.45	"
Dissolved Metals	60	1N nitric acid	0.10	Nuclepore Polycarbonate
Total Metals	125	1N nitric acid	unfiltered	---
Tygon tubing	---	1N nitric acid	---	---

APPENDIX B (continued).

SAMPLE BOTTLE CLEANING

Equipment and chemicals:

sample bottles with caps
6N hydrochloric acid (HCl)
6N nitric acid (HNO_3)
deionized water (1 megaohm resistance)
Milli-Q water 1/ (18 megaohm resistance)

1. Rinse bottles with dilute (2%) acid, either HCl or HNO_3 (refer to Table 1 in text).

2. Completely fill bottles with deionized (DI) water and add 1 mL 6N acid/100 mL bottle volume then let stand 24 hours.

3. Empty, then rinse 3 times with DI water and 1 time with Milli-Q water.

4. For each sample type (i.e. cation, anions, etc.), fill one bottle of the specified size with Milli-Q water then transfer the Milli-Q water to each bottle of the same group. No more than 6 bottles should be included in each group.

5. The last bottle of each group is a representative blank which will be analyzed for trace elements and ions and certified clean before any of the bottles in the group are used for field sample collection.

1/ Type 1 reagent grade.

FILTER CLEANING

Equipment and chemicals:

plastic forceps (1)
100 mL beakers (2)
parafilm
0.1 u filter membrane
6N nitric acid (HNO_3)
500 mL wash bottle with dilute (2%) HNO_3 (30 mL 6N HNO_3 diluted to 500 mL with Milli-Q)
250 mL Milli-Q wash bottle

NOTE:
Never Touch Filter Membrane or Mating Faces of Filter Housing!

1. Wash forceps with dilute HNO_3 and rinse with Milli-Q water (18 megaohm resistance) before use. Place forceps in beaker containing dilute HNO_3 between uses and rinse again with Milli-Q water before next use in cleaning procedure.

2. Disassemble filter housing without touching inner surfaces.

3. Place top half of filter housing face up on other beaker.

4. Remove and discard used filter membrane from bottom half of filter housing.

5. Remove 'O'-rings from top and bottom halves. Wash with dilute HNO_3 and rinse thoroughly with Milli-Q water.

6. Wash mating faces and inlet or outlet port of each half with dilute HNO_3 (hold housing by ridges or knobs on back side). Rinse thoroughly with Milli-Q water, replace 'O'-rings.

7. Separate blue sheet from filter membrane and discard.

8. Place filter membrane on bottom half of filter housing while trying to avoid as many wrinkles as possible. Rinse any wrinkles out of membrane with Milli-Q water.

9. Hold housing halves so that faces are vertical, assemble two halves, and tighten.

10. Significant back pressure in filter housing indicates a proper seal between filter housing and membrane.

11. Check for contamination by running Milli-Q water through filter. Collect filtered water in a chemically clean 30 mL bottle labeled to correspond with the filter number. Preserve with 0.12 mL 6N HNO_3 Ultrex and analyze for dissolved metals using the method described in Appendix C.

12. Seal inlet and outlet of filter housing with clean parafilm.

13. Rinse storage container with small portion of Milli-Q water and discard rinse water.

14. Place filter housing and filter blank in storage container and seal lid on tight.

APPENDIX B (continued).

CLEANING PROCEDURE FOR TYGON TUBING

Equipment and chemicals:

500 mL plastic container
25 mL graduated cylinder
Hach Nitraver III powder pillow
Hach Nitraver VI powder pillow
1N nitric acid (HNO_3)
Milli-Q water (18 megaohm resistance)

1. Partially fill special wash container with 500 mL 1N reagent grade HNO_3 (100 mL 6N HNO_3 diluted to 500 mL with Milli-Q).
2. Place suction line in container and flush all 500 mL of dilute HNO_3 through line.
3. Triple rinse container and outside 6 inches of intake end of suction line with Milli-Q water.
4. Put 300 mL Milli-Q water in container and pump through line, repeat.
5. Collect 25 mL of last part of rinse in graduated cylinder known to be clean and free of HNO_3 and nitrate.
6. Add 1 Hach Nitraver VI powder pillow to graduated cylinder, swirl, and let stand 30 seconds.
7. Next add 1 Hach Nitraver III powder pillow to graduated cylinder, swirl, and wait 3 minutes.
8. If no pink color developes, tubing is free of nitric acid. However, if pink color appears, return to step 4 and retest.

APPENDIX C

ANALYTICAL INSTRUMENTATION AND PROCEDURES

APPENDIX C. Analytical instrumentation and procedures.

Instrument and detection limit for water sample parameters.

Parameter	Instrument	Detection Limit	
Cations:			
Calcium	Varian AA-475 Spectrophotometer w/ air-acetylene flame atomic absorption Spectrophotometer	0.025	ueq/L
Magnesium	"	0.0025	"
Sodium	"	0.45	"
Potassium	"	0.75	"
Anions:			
Chloride	Hitachi 200 Spectrophotometer	1	ueq/L
Nitrate	Bausch & Lomb 20 Spectrophotometer	0.1	uM
Phosphate	Hitachi 200 Spectrophotometer	0.06	uM
Sulfate	Hach 16800 or 2100A Turbidimeter	5	ueq/L
Trace Elements:			
Aluminum	Perkin Elmer Spectrophotometer w/ HGA 50 graphite furnace	2	ug/L
Iron	"	1	"
Manganese	"	0.1	"
Organic acids	Bausch & Lomb 20 Spectrophotometer	0.05	mg/L
Silica	"	2	uM

pH PROCEDURE

Equipment and Chemicals:

100 mL volumetric flask	(1)
125 mL carboy	(1)
Beckman Model 21 pH meters	(2)
temperature compensators	(2)
Orion combination pH electrode	(1)
Beckman refillable combination electrode (STAR series)	(1)
peristaltic pump with Tygon tubing	(1)
Hach bromcresol purple pH test kit (pH 5.2-6.8)	(1)
Hach phenol red pH test kit (pH 6.5-8.5)	(1)
250 mL wash bottle with deionized (DI) water	(1)
Hydrion pH 4 and 7 buffer capsules	(1 ea.)
0.1N HCl	

I. PREPARATION OF STANDARD

A. pH 4 standard: Pipet 0.1 mL of 0.1N HCl (use 50 uL auto pipet) into 100 mL volumetric flask containing Milli-Q, dilute to volume, and mix thoroughly.

II. PROCEDURE

A. Calibrate both electrodes using first the pH 7 buffer and then the pH 4 buffer. Readings should be within ± 0.02 pH units.

B. Check the calibrated electrodes with the pH 4 standard. Reading should be 4.0 ± 0.1 pH units.

C. Rinse electrodes with DI water, and then with sample. Place both electrodes in the 125 mL carboy containing sample and let stand for approximately 10 minutes. This step allows the solution inside the electrodes to reach the same temperature as the sample. Both pH meters can be turned off during this time and water in the carboy can be still.

D. After 10 minutes, begin circulating sample water through carboy. Do not accept any pH reading before 5 minutes has elapsed. After readings have stabilized, record pH values from both the Beckman and Orion electrodes.

E. Determine pH of sample using the Hach pH test kit of appropriate range and record this value.

ALKALINITY ANALYSIS

Equipment and Chemicals:

125 mL plastic bottle (titration vessel)
500 mL wash bottle with deionized (DI) water
magnetic stirrer and stir bar
pH meter, electrode and temperature compensator
pH 4 and 7 buffers
pH 4 standard
0.10M potassium chloride (KCl) or 0.10M sodium chloride (NaCl)
0.0200N sulfuric acid (H_2SO_4)

I. PREPARATION OF REAGENTS

A. 0.10M KCl spike; Dissolve 7.5 g KCl into 1.0 liter of DI water. This spike is used for dilute water samples.

B. 0.0200N H_2SO_4: Use VWR Sulfuric Acid Solution 0.0200N ± 0.0002N.

II. ANALYTICAL PROCEDURE

A. Pipet 40.0 mL (use 10.0 mL auto pipet) of sample into clean 125 mL titration vessel containing stir bar and place on a magnetic stirrer.

B. Rinse calibrated pH electrode (see pH measurement procedure) with DI water and sample, then immerse in sample in titration vessel. Allow pH meter reading to stabilize before stirring.

C. Switch on magnetic stirrer and adjust to medium speed (no visible vortex). After pH reading stabilizes, record as initial pH.

D. Add 0.40 mL of 0.10M KCl (use 1000 uL auto pipet), read and record pH after reading has stabilized.

E. Add 0.0200N H_2SO_4 (use 50 uL auto pipet) until pH reading stabilizes at about 4.0. Record pH and volume of acid added (Va).

F. Continue adding acid at increments of 0.05 mL or 0.10 mL to obtain 8-10 pH readings between 4.0 and 3.3. Record each of these pH readings and the total volume of acid added at each reading.

III. CALCULATION OF RESULTS

A. For each data pair (V_1, pH) with pH values between 4.0 and 3.3 calculate the Gran function (F_1) by:

$$F_1 = (Vs + Va)\ [H^+]$$

where: Vs = initial sample volume = (40.0 + 0.400) mL
Va = volume of acid added
$[H^+] = 10^{-pH}$

B. Plot F_1 vs. Va. Using at least 5 points on the linear portion of the plot, perform a linear regression of F_1 on Va. From the linear regression, determine r, a, and b. r should exceed 0.999 and b should be equal to the H_2SO_4 titrant normality (± 15%). If r and b do not meet these criteria, reexamine the plot to insure that only points on the linear portion were used in the regression. Alkalinity procedure must be redone if 5 linear points are not obtained.

C. After obtaining a, b, and r calculate alkalinity by:

$$\text{Alkalinity (ueq/L)} = \frac{\frac{-(a)}{b} \times 0.0200}{40.0}$$

IV. NOTE

A. Each new batch of 0.10M KCl spike is analyzed for contamination prior to use in alkalinity determination. A blank is analyzed by performing the alkalinity titration and calculations described above. The alkalinity of the blank must be ≤10 ueq/L.

V. REFERENCE

Hillman, D.C., F.A. Morris, and S.J. Simon. 1984. Methods Manual for the National Surface Water Survey Project--Phase I. Revision 3. Aug. 29, 1984. Contract No. 68-03-3050. U.S. Environmental Protection Agency, Envir. Monitoring Systems Lab., Las Vegas, NV.

NITRATE ANALYSIS

Equipment and Chemicals:

100 mL volumetric flask	(1)
125 mL erlenmeyer flasks	(3-6)
cadmium column (see pg. C-4)	(1)
culture tubes with caps	(6-12)
250 mL wash bottle with 5-10% hydrochloric acid (HCl)	(1)
dry potassium nitrate (KNO_3)	
concentrated ammonium chloride (NH_4Cl)	
sulfanilamide solution	
N-1-napthyl-ethylenediamine dihydrochloride (NED)	
blue sensitive photo tube for spectrophotometer	
1 cm cuvet for spectrophotometer	

I. INTRODUCTION

Nitrate (NO_3) is reduced almost quantitatively to nitrite (NO_2) in the presence of cadmium (Cd). The (NO_2) produced thus is determined by diazotizing with sulfanilimide and coupling with N-(1-napthyl)-ethylenediamine to form a highly colored azo dye that is measured colorimetrically.

II. STANDARDS

A. Primary standard of 10 mmols KNO_3: Dissolve 1.01 g dry KNO_3 in 1000 mL of Milli-Q water.

B. Secondary standard of 5 uM KNO_3. Standard concentrations linear to 10 uM (use latter if high nitrate levels are expected): Dilute 0.050 or 0.10 mL (use 50 uL pipet) of the primary standard to 100 mL of Milli-Q water in volumetric flask.

III. PREPARATION OF REAGENTS

A. Sulfanilimide solution: Add 5 mL of concentrated hydrochloric acid to 30 mL of Milli-Q water and allow to cool. Dissolve 0.5 g of sulfanilimide in this solution and dilute to 50 mLs. This solution is stable for four months when stored in a refrigerator.

B. N-1-napthyl-ethylenediamine dihydrochloride solution (NED): Dissolve 0.10 g of N-1-napthyl-ethylenediamine dihydrochloride in 100 mL of Milli-Q water. Store this solution in a dark bottle. This solution is stable for one month when stored in a refrigerator.

IV. ANALYTICAL PROCEDURE

All samples, blanks, and standards will be run in duplicate. All final volumes are 2.5 mL. Keep culture tubes capped when possible. All glassware should be cleaned with 5% HCl, rinsed 3 times with deionized water (DI), and 1 time with Milli-Q water. Flow rate of column should be approximately 4-6 mL/minute. **Be careful not to drain the liquid in the column past the top of the copper cuttings at any time.**

A. Transfer 20 mL. of blank, standard, and sample to representative 125 mL flasks using a 10 mL auto pipet.

B. To each flask, add 0.4 mL of concentrated NH_4Cl (0.2 mL per 10 mL aliquot).

C. Blank

1. Using a waste container, drain the column down to the top of the copper cuttings.

2. Add 1 mL of the blank (using a 1 mL auto pipet) as prepared above to the column and drain to top of cuttings.

3. Fill the column to the 0 mL mark with the blank (using a 10 mL auto pipet) and drain to the 6.5 mL mark. Place a clean tube under the column and drain slowly to the 9 mL mark. This is Blank 1.

4. Repeat steps C-1, C-2, and C-3 using the remaining aliquot. This is Blank 2.

D. Sample

1. Drain the column to the top of the copper cuttings.

2. Add 1 mL of the sample as prepared above to the column and drain to the top of the copper cuttings.

3. Fill the column with the sample and drain to the 4 mL mark. Place a clean tube under the column and drain to the 6.5 mL mark. Note: This Color Blank is seldom necessary for Sierran waters.

4. Place a clean tube under the column and drain from the 6.5 mL mark to the 9 mL mark. This is Sample 1.

5. Repeat steps D-1 and D-2.

6. Fill the column with the remaining aliquot and drain to the 6.5 mL mark, place a clean tube under the column and drain to the 9 mL mark. This is Sample 2.

E. Standard

1. Drain the column to the top of the copper cuttings.

2. Add 1 mL of the secondary standard as prepared above to the column and drain to the top of the copper cuttings.

3. Fill the column and drain to the 6.5 mL mark, place a clean tube under the column and drain to the 9 mL mark. This is Standard 1.

4. Repeat steps E-1, E-2, and E-3 using the remaining aliquot. This is Standard 2.

F. Add Reagents

1. To all aliquots, **except the Color Blank**, add 0.19 mL (with the 1 mL auto pipet) sulfanilamide and agitate. After 2 minutes but before 10 minutes add 0.19 mL of NED and agitate. After 20 minutes and before 2 hours read the absorption on the spectrophotometer. Use a 543 nm wavelength, a blue sensitive phototube, and a 1 cm cuvet.

   Note: Refer to instruction manual for proper use of the spectrophotometer.

V. COLUMN STORAGE

A. After analyses completed

1. Rinse column with dilute NH_4Cl (2 mL of concentrated NH_4Cl to 100 mL of DI water) making sure not to drain past the copper cuttings.

2. Fill the column with dilute NH_4Cl and stopper.

3. Store column securely in an upright position.

VI. COLUMN REJUVENATION

A. Between every complete analytical procedure (blank, standard and samples)

1. Add 1 mL of concentrated NH_4Cl to the column.

2. Drain the column to the top of the copper cuttings.

3. Fill the column with dilute NH_4Cl.

VII. PREPARATION OF NITRATE COLUMNS

A. Materials

10 mL microburet (Kimball 17026 F) with needle valve, teflon stopcock (Kimball 41575 F); ring stand, buret clamp; very fine copper wire, copper wire (16 gauge), and granular cadmium (Merck coarse powder 2001).

B. Solutions

1. Copper sulfate: dissolve 4 g $CuSO_4$ in 100 mL of Milli-Q water.

2. 5% HCl

3. Dilute NH_4Cl as above

C. Cadmium wash and coating

1. Wash cadmium with 5% HCl until bright and shiny; rinse repeatedly with DI water then decant liquid.

2. Swirl cadmium with $CuSO_4$ solution until blue color has left solution and semi-colloidal copper enters supernatant.

3. Rinse cadmium with DI water until most of the semi-colloidal material is gone.

D. Column filling

1. Roll very fine copper wire between fingers to make a small plug and push this to the bottom of buret; add several pieces (approximately 1 cm long) of 16 gauge copper wire.

2. Fill column with dilute NH_4Cl. Dispense cadmium to column using beaker, tapping gently to pack; fill to 9.5 mL mark. Do rapidly to avoid contact of cadmium with air.

3. Add several 1 cm pieces of 16 gauge copper wire to top of cadmium.

4. Drain column to top of copper cuttings and repeat several times.

5. Adjust flow rate to 4-6 mL/minute.

6. Refill with dilute NH_4Cl and let sit for several hours, repeat.

E. Column testing

Run a 10 uM NO_3 standard through three times. Absorbance of NO_2 produced should be greater than 0.270 in a 1 cm cell; if not, try altered flow rate; if still too low, reactivate column.

1. Remove cadmium and copper wire from buret and separate.

2. Follow steps in C1-3 and D1-6 above.

VIII. REFERENCES

American Public Health Association. 1985. Standard methods for the examination of water and wastewater. 16th Edition. A.E. Greenberg, R.R. Trussel, L.S. Clesceri, and M.H. Franson (eds.). American Public Health Association, Washington, DC. 1268 p.

CHLORIDE ANALYSIS

Equipment and Chemicals:

100 mL volumetric flasks	(3)
25 mL volumetric flasks	(5-12)
500 mL wash bottle with 5% nitric acid (HNO_3)	(1)
ferric nitrate ($Fe(NO_3)_3 \cdot 9H_2O$)	
70% nitric acid (HNO_3, reagent grade acid)	
mercury (II) thiocyanate ($Hg(SCN)_2$)	
95% ethanol	
dry reagent grade sodium chloride (NaCl)	
blue sensitive photo tube for spectrophotometer	
2.5 cm cuvet for spectrophotometer	

I. INTRODUCTION

Chloride reacts with mercury (II) thiocyanate to form a chloromercurate (II) complex ion with the liberation of thiocyanate ions, which then react with iron (III) to give a golden color which can be measured spectrophotometrically. This method is modified from Florence and Farrar (1971). The lower limit of sensitivity is between 0.5-1.0 uM/l chloride.

II. STANDARDS

A. Primary standard of 10 mmols NaCl: Dissolve 0.5844 g of NaCl (dried at 140° C) into 1000 mL of Milli-Q water.

B. Secondary standards of 2.0, 5.0, and 10.0 uM chloride: Dilute 0.020, 0.050, and 0.10 mL (use adjustable 500 uL autopipet or equivalent) of the primary standard into 3 representative 100 mL volumetric flasks, and dilute to volume with Milli-Q water.

III. PREPARATION OF REAGENTS

A. Ferric nitrate: Dissolve 15.1 g of $Fe(NO_3)_3 \cdot 9H_2O$ in 45 mL of 70% HNO_3 and dilute with Milli-Q water to 100 mL. Although reagent grade HNO_3 causes high blanks, other sources of HNO_3 are poorer. It is important that this acid and the ferric nitrate reagent be protected from strong light. Nitric acid exposed to strong light will form nitrogen peroxide which can lead to low and erratic readings.

B. Mercury (II) thiocyanate: Saturated solution in ethanol. This will be approximately 0.5 g $Hg(SCN)_2$ in 100 mL of 95% ethanol.

IV. ANALYTICAL PROCEDURE

A. Pipette 20 mL aliquots of blank, standards, and samples (containing less than 50 uM of chloride) into 25 mL volumetric flasks. To each flask add 2 mL of ferric nitrate reagent, 2 mL of mercuric thiocyanate, and fill with Milli-Q water to 25 mL, then mix.

B. Measure the absorbance at 460nm after 5 minutes using a 2.5 cm cell.

C. Prepare a calibration curve with blank, 2.0, 5.0, and 10.0 uM chloride or concentrations that will bracket the expected sample concentrations. Samples above 40 uM will have to be diluted accordingly.

V. NOTES

A. Use appropriate safe techniques when using nitric acid and mercury thiocyanate.

B. Do not excessively mix the sample with the reagents as this will result in high and erratic absorbance readings.

C. A sample run should be completed in 1-2 hours to avoid errors from unstable color.

D. Analytical grade ferric ammonium sulfate has 3 ppm chloride whereas ferric nitrate has 5 ppm chloride. Problems with erratic readings using ferric nitrate may be corrected by switching to the ferric ammonium sulfate reagent. To make this reagent: Dissolve 6 grams ferric ammonium sulfate into 45 mL of 70% nitric acid and dilute with Milli-Q water to 100 mL.

E. A blank of 0.120 absorbance units or less should be attained with the reagents previously described using a 2.5 cm cell.

VI. REFERENCE

Florence, T.M. and Y.J Farrar. 1971. Spectrophotometric determination of chloride at the parts-per-billion level by the mercury (II) thiocyanate method. Anal. Chem. Acta 54:373-377.

PHOSPHATE ANALYSIS

Equipment and Chemicals:

125 mL erlenmeyer flasks	(4-11)
100 mL volumetric flasks	(2)
50 mL graduated cylinder	(1)
250 mL wash bottle with 10% HCl	(1)
glass scoop (0.1 g)	(1)
hot plate	(1-2)
boiling chips	
phenolphthalein indicator solution	
10N sulfuric acid (H_2SO_4)	
5N sulfuric acid (H_2SO_4)	
1N sodium hydroxide (NaOH)	
ammonium persulfate $(NH_4)_2S_2O_8$	
5 cm cuvet for spectrophotometer	

I. INTRODUCTION

Digestion of samples releases phosphorus from combination with organic matter and converts it to dissolved orthophosphate. Orthophosphate then reacts with potassium antimonyl tartrate and ammonium molybdate in an acid medium to form a heteropoly acid that is reduced to intensely colored molybdenum blue by ascorbic acid.

II. STANDARDS

A. Stock phosphate solution of 1 mM: Dissolve 0.174 g of dry KH_2PO_4 or 0.136 g KH_2PO_4 in 1000 mL of Milli-Q water.

B. Secondary standards of 0.5 and 1.0 mM phosphate: Dilute 0.05 mL and 0.10 mL (use 500 uL auto pipet) of stock solution into 2 representative 100 mL volumetric flasks, and dilute to volume with Milli-Q water.

III. PREPARATION OF REAGENTS

All reagents are prepared as described in the Persulfate Digestion and Ascorbic Acid Method sections of Standard Methods (1985).

IV. ANALYTICAL PROCEDURE

A. Persulfate Digestion

1. Pipet 50.0 mL (using a 50.0 mL volumetric pipet) of blank, standards, and samples into 125 mL flasks cleaned with 10% HCl and deionized water (DI), and rinsed with Milli-Q water.

2. Add to each erlenmeyer flask:

   a. 0.05 mL (1 drop) of phenolphthalein indicator solution: if pink color develops, add 5N H_2SO_4 dropwise to discharge color. The addition of acid is rarely necessary for Sierran waters as their pH is generally ≤ 7.
   b. 1.0 mL of 10N H_2SO_4
   c. 0.4 g (4 scoops) of solid $(NH_4)S_2PO_8$
   d. boiling chip

3. Place on a preheated hot plate and boil gently for 15-20 minutes or to approximately 20 mL.

4. Let cool, dilute with Milli-Q to approximately 30 mL.

5. Add 0.05 mL (1 drop) of phenolphthalein indicator solution to each flask.

6. Neutralize to a faint pink color with 1N NaOH.

7. Dilute blank, standards, and samples to 50 mL with Milli-Q water in a 50 mL graduated cylinder.

B. Ascorbic Acid Method

1. Discharge pink color by adding 1-3 drops of 5N H_2SO_4, and mix thoroughly.

2. Add 8.0 mL (use 10 mL auto pipet) of the combined reagent, and mix thoroughly.

3. After at least 10 minutes but before 30 minutes, measure absorbances of blank, standards, and samples at 880nm in a 5 cm cuvet.

V. NOTES

A. Using a 5 cm cuvet and a wavelength of 880 nm, a blank corrected absorbance of approximately 0.090 should be obtained from a 1.0 uM solution of phosphate.

B. If sample was filtered through a 0.45 um filter the results should be reported as total dissolved phosphate.

VI. REFERENCE

American Public Health Association. 1985. Standard methods for the examination of water and wastewater. 16th Edition. A.E. Greenberg, R.R. Trussell, L.S. Clesceri, and M.A.H. Franson (eds.). American Public Health Association, Washington, DC. 1268 p.

SILICA ANALYSIS

From procedure outlined in Standard Methods (1985) for Silica, Heteropoly Blue Method (pg. 460) with the exception that all blank, standard, sample and added reagent volumes are halved.

SULFATE ANALYSIS

From procedure outlined in Standard Methods (1985) for Sulfate, Turbidimetric Method (pg. 467) using a nephelometer and buffer solution for sulfate concentrations <10 mg/L.

ORGANIC ACID ANALYSIS

From procedure outlined in Standard Methods (1985) for Tannin and Lignin analysis (pg. 590) with the following exceptions and recommendations:

1. All blank, standard, sample and added reagent volumes are halved.
2. Use HACH TanniVer 3 Tannin-Lignin Reagent.
3. Measure absorbances at 650nm.

APPENDIX D

INTERLABORATORY RESULTS AND ION AND CONDUCTIVITY BALANCES

APPENDIX D. Intralaboratory and interlaboratory analytical results, and ion and conductivity balances.

Intralaboratory results: measure of precision using average relative standard deviation from data compiled during spring and fall 1986.

Parameter	Lab. Replicates N	Lab. Replicates Aver. Relative Std. Deviation	Field Duplicates N	Field Duplicates Aver. Relative Std. Deviation
Cations:				
Calcium	20	1%	11	1%
Magnesium	18	1%	11	2%
Sodium	20	1%	11	4%
Pottasium	20	2%	11	2%
Anions:				
Chloride	20	7%	10	14%
Nitrate	20 1/	7%		
Phosphate	13	6%	11	12%
Sulfate	20	10%	11	3%
Organic acids	19	5%	11	3%
Silica	16	2%	11	<1%
Trace Elements:				
Aluminum (Tot.) 2/	20	5%	11	15%
(Diss.) 3/	20	6%	11	20%
Iron (Tot.)	20	3%	11	8%
(Diss.)	20	2%	11	18%
Manganese (Tot.)	20	3%	11	5%
(Diss.)	20	4%	11	7%
Alkalinity	--	---	11	7%

1/ All samples were analyzed in duplicate; the average relative standard deviation was determined for 10 randomly selective samples, spring and fall, 1986.

2/ Total concentration

3/ Dissolved concentration

APPENDIX D. (continued)

Interlaboratory results: DFG analytical results for U.S. EPA Water Pollution Performance Evaluation Study; WP016, May 1986 and WP017, November 1986.

Parameter	(units)	Reported Value	EPA Value	Acceptance Limits
pH		6.70	6.70	6.54 - 6.83
		4.44	4.50	4.38 - 4.59
Alkalinity	(mg/L)	11.5	12.0	8.51 - 16.0
Conductivity	(uS/cm)	136	135	125 - 153
Hardness	(mg/L)	26.6	26.1	21.9 - 30.1
Chloride	"	18.1	18.5	15.4 - 21.5
Nitrate	"	0.185	0.200	0.131 - 0.266
		1.39	1.50	1.20 - 1.78
Phosphorus(total)	"	1.08	1.10	0.848 - 1.39
Sulfate	"	20.4	18.0	13.9 - 21.6
Calcium	"	10.0	9.80	8.20 - 11.3
Magnesium	"	0.398	0.400	0.289 - 0.497
Sodium	"	9.50	9.90	8.29 - 11.5
Potassium	"	8.17	8.00	6.34 - 9.39
Aluminium	(ug/L)	2320	2119	1780 - 2430
Iron	"	1260	1260	1120 - 1440
Manganese	"	525	510	448 - 564

APPENDIX D (continued).

Ion and Conductivity Balances.[1/]

Station	FALL 1986				
	Total Ion Strength (ueq/L)	% Ion Difference	Conductance (uS/cm) measured	Conductance (uS/cm) calculated	% Conductivity Difference
NORTHWEST RANGES					
Buck Lake	255	4	13	13	0
Buck Lake (Duplicate)	245	1	ND	ND	ND
Toad Lake	1384	10	72	64	-11
Big Bear Lake	85	-11	5.1	4.6	-10
Josephine Lake	69	-10	4.3	3.8	-12
NORTHEAST RANGES					
Patterson Lake	287	2	14	14	0
Eiler Lake	103	-18	6.3	5.1	-19
Triangle Lake	106	-21	8.9	5.1	-43
Caribou Lake	249	4	13	12	-8
Shadow Lake	34	-29	2.7	2.0	-26
Shadow Lake (Duplicate)	34	-29	ND	ND	ND
MENDOCINO RANGES					
Black Rock Lake	251	13	12	14	17
Howard Lake	3422	3	170	170	0
Plasket Lake (Upper)	2993	7	130	140	8
Upper Letts Lake	2631	5	140	130	-7
NORTHERN SIERRA NEVADA					
Taylor Lake	371	2	18	19	6
Crystal Lake	210	-2	10	10	0
Three Lakes (Lower)	219	7	11	12	9
Eureka Lake	151	-6	8.6	7.8	-9
Haven Lake	166	-2	8.9	8.5	-4
CENTRAL SIERRA NEVADA					
Secret Lake	261	15	12	15	25
Warren Lake	141	-22	9.4	7.4	-21
High Loch Leven Lake	104	0	6.3	6.2	-2
High Loch Leven Lake (Duplicate)	108	4	ND	ND	ND
Five Lakes (Lower)	173	5	9.3	9.5	2
Lost Lake	137	8	6.9	7.1	3
Smith Lake	34	-18	2.6	2.0	-23
Ralston Lake	49	-10	3.3	2.6	-21
Winnemucca Lake	231	-5	13	12	-8
Granite Lake	74	-8	4.3	3.7	-14
Twin Lake	227	9	10	12	20
Highland Lake (Upper)	539	3	29	27	-7

APPENDIX D (continued).

Station	Total Ion Strength (ueq/L)	% Ion Difference	Conductance (uS/cm) measured	Conductance (uS/cm) calculated	% Conductivity Difference
			FALL 1986		
SOUTHERN SIERRA NEVADA					
Gaylor Lake (Lower)	175	-5	10	9.7	-3
McCloud Lake	87	-17	5.5	4.6	-16
Serene Lake	183	-3	9.3	9.9	6
Serene Lake (Duplicate)	186	-1	ND	ND	ND
Devils Bathtub Lake	124	2	6.5	6.2	-5
Long Lake	85	-6	5.0	4.3	-14
Crater Lake	181	-2	8.9	9.2	3
Piute Lake	107	-3	5.8	5.7	-2
Summit Lake	165	4	7.7	8.6	12
Chocolate Lake (Upper)	366	-3	20	19	-5
Golden Trout Lake	970	0.2	52	51	-2
Pear Lake	46	-13	2.7	2.5	-7
Pear Lake (Duplicate)	52	0	ND	ND	ND
Cottonwood Lake No. 5	236	-5	13	12	-8
Franklin Lake (Lower)	339	-6	20	18	-10
Bullfrog Lake (Lower)	245	-6	14	13	-7
CENTRAL COAST RANGE					
Big Sur River	5637	-0.4	280	280	0
Willow Creek	6006	4	290	300	3
SOUTHERN CALIFORNIA RANGES					
Sespe Creek	1741	0.4	770	940	22
Cogswell Reservoir	7780	7	340	380	12
Lake Gregory	2893	8	160	140	-12
Lake Hemet	6023	4	300	300	0
Doane Pond	3681	2	190	180	-5
Doane Pond (Duplicate)	3645	0.4	ND	ND	ND

1/ EPA criteria for acceptable anion-cation and conductivity balances. If the percent difference exceeds these values, the sample is suspect and should be reanalyzed.

Anion-Cation Balance		Conductivity Balance	
Total Ion Strength (ueq/L)	Ion Difference (%)	Measured Conductance (uS/cm)	Conductance Diff. (%)
<50	>±60	<5	>±50
≥50 or <100	>±30	≥5 or <30	>±30
≥100	>±15	≥30	>±20

APPENDIX D (continued).

Ion and Conductivity Balances.[1]

Station	SPRING 1986				
	Total Ion Strength (ueq/L)	% Ion Difference	Conductance (uS/cm) measured	Conductance (uS/cm) calculated	% Conductivity Difference
NORTHWEST RANGES					
Buck Lake	205	5	12	11	-8
Toad Lake	684	3	30	33	10
Toad Lake (Duplicate)	676	5			
Big Bear Lake	106	17	5.5	5.8	5
Josephine Lake	96	2	4.6	5.5	20
NORTHEAST RANGES					
Patterson Lake	263	3	14	12	-14
Eiler Lake	124	10	6.1	6.3	3
Triangle Lake	149	5	6.6	7.3	11
Caribou Lake	234	4	12	12	0
Shadow Lake	36	17	3.4	2.7	-20
Shadow Lake (Duplicate)	36	17			
MENDOCINO RANGES					
Black Rock Lake	267	17	11	14	27
Howard Lake	2577	-5	120	130	8
Plasket Lake (Upper)	2721	2	110	130	18
Upper Letts Lake	2518	4	120	120	0
NORTHERN SIERRA NEVADA					
Taylor Lake	278	8	14	14	0
Crystal Lake	170	4	7.0	8.9	27
Three Lakes (Lower)	196	7	11	10	10
Eureka Lake	171	-3	9.7	8.4	-13
Haven Lake	140	8	7.1	7.5	6
CENTRAL SIERRA NEVADA					
Secret Lake	130	-3	6.8	7.2	6
Warren Lake	133	-7	9.1	7.0	-23
High Loch Leven Lake	68	12	7.5[2]	3.9	-48
High Loch Leven Lake (Duplicate)	70	14			
Five Lakes (Lower)	195	-5	12	9.8	-18
Lost Lake	140	4	6.6	7.4	12
Smith Lake	50	28	3.5	3.2	-8
Ralston Lake	46	13	3.4	3.0	-12
Winnemucca Lake	196	2	11	10	-9
Granite Lake	87	13	4.1	5.0	22
Twin Lake	192	0	12	9.7	-19
Highland Lake (Upper)	414	1	22	21	-4

APPENDIX D (continued).

Station	SPRING 1986 Total Ion Strength (ueq/L)	% Ion Difference	Conductance (uS/cm) measured	Conductance (uS/cm) calculated	% Conductivity Difference
SOUTHERN SIERRA NEVADA					
Gaylor Lake (Lower)	106	-4	6.0	5.7	-5
McCloud Lake	95	-1	5.2	5.4	4
Serene Lake	194	9	9.4	10	6
Devils Bathtub Lake	117	-4	7.7	6.3	-18
Long Lake	94	-8	7.1	5.0	-30
Crater Lake	138	-1	7.3	7.1	-3
Piute Lake	72	0	4.1	4.0	-2
Piute Lake (Duplicate)	75	1			
Summit Lake	82	-7	4.9	4.2	-14
Chocolate Lake (Upper)	292	0	16	15	-6
Golden Trout Lake	797	1	46	42	-9
Pear Lake	43	-2	3.0	2.7	-10
Cottonwood Lake No. 5	238	-1	13	12	-8
Franklin Lake (Lower)	285	-9	19	15	-21
Bullfrog Lake (Lower)	172	-7	10	9.4	-6
CENTRAL COAST RANGE					
Big Sur River	4677	3	230	234	2
Willow Creek	4753	4	235	241	2
SOUTHERN CALIFORNIA RANGES					
Sespe Creek	17238	-5	799	934	17
Sespe Creek (Duplicate)	16859	-7			
Cogswell Reservoir	5614	-5	266	276	4
Lake Gregory	2872	1	142	149	5
Lake Hemet	6326	1	295	322	9
Doane Pond	2594	5	131	132	1

1/ EPA criteria for acceptable anion-cation and conductivity balances. If the percent difference exceeds these values, the sample is suspect and should be reanalyzed.

Anion-Cation Balance		Conductivity Balance	
Total Ion Strength (ueq/L)	Ion Difference (%)	Measured Conductance (uS/cm)	Conductance Diff. (%)
<50	>±60	<5	>±50
≥50 or <100	>±30	≥5 or <30	>±30
≥100	>±15	≥30	>±20

2/ Conductivity measured in laboratory.

APPENDIX E

WATER QUALITY PARAMETERS (ALTERNATE UNITS)

APPENDIX E. Water quality parameters for spring and fall sampling periods, 1986.

Sampling dates, field measurements, and hardness for spring sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Date Sampled	Mountain Range	pH	Alkalinity[1] mg/L	Hardness mg/L	Conduc. umhos/cm	Temp. °C
NORTHWEST RANGES							
Buck Lake	15 May 86	Siskiyou	6.5	3.5	3.7	11.6	11.1
Toad Lake	13 May 86	Trinity Divide	6.6	15	15.8	30.2	1.2
Toad Lake (Duplicate)	13 May 86	"	ND[2]	15	15.4	ND	ND
Big Bear Lake	14 May 86	Scott-Salmon	6.0	1.6	1.4	5.53	2.0
Josephine Lake	13 May 86	Trinity Alps	5.8	1.0	1.8	4.62	3.1
NORTHEAST RANGES							
Patterson Lake	18 Jun 86	Warner Mts.	6.6	5.6	4.5	13.6	1.2
Eiler Lake	28 May 86	So. Cascade	6.5	2.6	1.8	6.10	18.4
Triangle Lake	29 May 86	"	5.9	3.2	2.9	6.60	9.5
Caribou Lake	29 May 86	"	6.5	4.9	4.4	11.6	16.4
Shadow Lake	17 Jun 86	"	5.4	0	0.60	3.42	1.1
Shadow Lake (Duplicate)	17 Jun 86	"	ND	0	0.60	ND	ND
MENDOCINO RANGES							
Black Rock Lake	27 May 86	Yolla Bolly	6.4	6.0	4.7	11.4	13.3
Howard Lake	16 Apr 86	Mendocino	6.4	50	60.0	122	11.0
Plasket Lake (Upper)	16 Apr 86	"	7.4	65	61.6	109	6.7
Upper Letts Lake	15 Apr 86	"	7.6	62	56.3	120	9.7
NORTHERN SIERRA NEVADA							
Taylor Lake	9 May 86	No. Sierra	7.0	6.2	4.4	13.9	2.3
Crystal Lake	8 May 86	"	5.9	3.0	2.9	7.05	0.5
Three Lakes (Lower)	2 Jul 86	"	6.6	3.3	2.5	11.0	25.3
Eureka Lake	7 May 86	"	6.2	3.6	2.7	9.72	5.5
Haven Lake	7 May 86	"	5.6	2.0	2.3	7.13	2.0
CENTRAL SIERRA NEVADA							
Secret Lake	3 Jun 86	Cen. Sierra	6.0	1.2	2.4	6.78	9.7
Warren Lake	1 Jul 86	"	6.7	2.0	2.4	9.06	14.9
High Loch Leven Lake	2 Jun 86	"	5.6	0.80	0.89	7.47	7.5
High Loch Leven Lake (Duplicate)	2 Jun 86	"	5.5	0.80	0.90	ND	7.2
Five Lakes (Lower)	4 Jun 86	"	5.6	3.5	3.4	11.9	2.6
Lost Lake	19 Jun 86	"	6.3	2.4	1.8	6.58	15.8
Smith Lake	5 Jun 86	"	5.6	0.20	0.39	3.50	1.7
Ralston Lake	6 Jun 86	"	5.7	0.10	0.62	3.45	1.6
Winnemucca Lake	13 Jun 86	"	6.3	3.6	4.1	10.9	1.1
Granite Lake	12 Jun 86	"	5.1	1.0	1.3	4.07	12.4
Granite Lake	24 Jun 86	"	6.2	1.0	ND	3.93	18.1
Twin Lake	24 Jun 86	"	6.5	3.9	3.4	11.8	14.0
Highland Lake (Upper)	11 Jun 86	"	6.4	8.2	9.0	22.3	2.7

APPENDIX E (continued).

Station	Date Sampled	Mountain Range	pH	Alkalinity mg/L	Hardness mg/L	Conduc. umhos/cm	Temp. °C
SOUTHERN SIERRA RANGES							
Gaylor Lake (Lower)	25 Jun 86	So. Sierra	6.1	1.5	2.1	6.03	1.1
McCloud Lake	7 Jul 86	"	6.3	1.2	1.3	5.16	13.3
Serene Lake	8 Jul 86	"	6.5	4.0	2.5	9.35	15.8
Devils Bathtub Lake	27 Jun 86	"	6.4	1.7	1.6	7.73	11.5
Long Lake	25 Jun 86	"	5.9	1.5	1.4	7.07	6.5
Crater Lake	26 Jun 86	"	6.4	2.5	2.2	7.34	ND
Piute Lake	11 Jul 86	"	6.4	1.1	1.3	4.09	10.4
Piute Lake (Duplicate)	11 Jul 86	"	ND	1.2	1.3	ND	ND
Summit Lake	11 Jul 86	"	6.3	1.4	1.5	4.87	7.1
Chocolate Lake (Upper)	8 Jul 86	"	6.2	5.9	5.4	15.7	6.7
Golden Trout Lake	9 Jul 86	"	7.2	15	18.3	45.9	1.8
Pear Lake	15 Jul 86	"	5.9	0	0.70	3.04	7.0
Cottonwood Lake No. 5	10 Jul 86	"	7.3	5.2	3.9	12.6	11.4
Franklin Lake (Lower)	17 Jul 86	"	6.7	3.4	6.5	19.0	9.9
Bullfrog Lake (Lower)	16 Jul 86	"	6.6	2.2	3.7	10.4	5.5
CENTRAL COAST RANGE							
Big Sur River	2 Apr 86	Santa Lucia	8.2	100	100	230	12.4
Willow Creek	3 Apr 86	"	8.0	97	93.6	235	12.1
SOUTHERN CALIFORNIA RANGES							
Sespe Creek	10 Apr 86	Topatopa	8.7	200	380	799	16.7
Sespe Creek (Duplicate)	10 Apr 86	"	ND	180	378	ND	ND
Cogswell Reservoir	8 Apr 86	San Gabriel	7.6	120	125	266	16.1
Lake Gregory	8 Apr 86	San Bernardino	8.7	53	52.2	142	11.7
Lake Hemet	9 Apr 86	San Jacinto	8.9	120	104	295	16.1
Doane Pond	9 Apr 86	Palomar	7.8	49	39.6	131	14.7

1/ As $CaCO_3$
2/ Not Determined

APPENDIX E (continued).

Results of cation and anion analyses for spring sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	NO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	PO_4^{3-} ug/L
NORTHWEST RANGES								
Buck Lake	1.2	0.177	0.50	0.055	<0.006	1.2	0.5	2.0
Toad Lake	1.6	2.87	0.33	0.043	0.01	2.6	0.07	3.8
Toad Lake (Duplicate)	1.6	2.79	0.29	0.039	0.02	2.5	0.1	6.0
Big Bear Lake	0.44	0.064	0.35	0.078	0.074	1.3	0.1	3.0
Josephine Lake	0.66	0.044	0.17	0.10	0.081	1.2	0.07	<2
NORTHEAST RANGES								
Patterson Lake	1.2	0.389	0.62	0.43	0.27	0.67	0.1	10
Eiler Lake	0.52	0.122	0.36	0.15	<0.006	0.48	0.2	2.0
Triangle Lake	0.48	0.408	0.25	0.10	0.014	0.48	0.1	<2
Caribou Lake	0.94	0.514	0.44	0.13	<0.006	1.0	0.1	<2
Shadow Lake	0.20	0.023	0.051	0.023	<0.006	0.86	0.1	<2
Shadow Lake (Duplicate)	0.20	0.027	0.058	0.027	<0.006	0.91	0.07	<2
MENDOCINO RANGES								
Black Rock Lake	1.5	0.238	0.37	0.051	<0.006	1.4	0.2	7.6
Howard Lake	18	3.64	3.1	0.77	<0.006	10	0.4	11
Plasket Lake (Upper)	18	4.03	2.0	0.35	<0.006	3.9	0.5	5.4
Upper Letts Lake	17	3.35	1.7	0.18	<0.006	2.8	0.5	7.6
NORTHERN SIERRA NEVADA								
Taylor Lake	1.4	0.239	0.79	0.20	0.02	1.0	0.1	5.1
Crystal Lake	0.72	0.274	0.43	0.18	<0.006	1.2	0.1	3.8
Three Lakes (Lower)	0.73	0.169	0.73	0.35	<0.006	1.5	0.2	3.0
Eureka Lake	0.66	0.259	0.67	0.11	0.017	0.40	0.1	3.0
Haven Lake	0.53	0.244	0.38	0.023	0.024	1.4	0.2	2.0
CENTRAL SIERRA NEVADA								
Secret Lake	0.74	0.137	0.42	0.039	0.013	1.6	0.2	2.0
Warren Lake	0.73	0.136	0.39	0.23	<0.006	0.86	0.1	<2
High Loch Leven Lake	0.28	0.046	0.27	0.039	<0.006	0.82	0.2	2.0
High Loch Leven Lake (Duplicate)	0.28	0.047	0.26	0.039	<0.006	0.82	0.2	3.0
Five Lakes (Lower)	1.0	0.205	0.74	0.078	<0.006	0.86	0.1	3.0
Lost Lake	0.61	0.076	0.60	0.18	<0.006	0.96	0.2	<2
Smith Lake	0.11	0.028	0.21	0.055	0.42	0.82	0.1	<2
Ralston Lake	0.20	0.028	0.15	0.066	0.18	0.82	0.1	<2
Winnemucca Lake	1.2	0.233	0.24	0.16	0.24	1.0	0.1	3.0
Granite Lake	0.43	0.056	0.22	0.086	<0.006	1.2	0.1	3.0
Twin Lake	1.0	0.192	0.48	0.32	<0.006	0.67	0.1	3.0
Highland Lake (Upper)	3.2	0.272	0.53	0.086	0.15	1.8	0.2	3.0

APPENDIX E (continued).

Station	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	NO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	PO_4^{3-} ug/L
SOUTHERN SIERRA NEVADA								
Gaylor Lake (Lower)	0.77	0.041	0.24	0.10	0.068	0.82	0.1	2.0
McCloud Lake	0.39	0.090	0.38	0.19	<0.006	1.0	0.1	2.0
Serene Lake	0.78	0.129	0.63	0.45	<0.006	1.0	0.2	2.0
Devils Bathtub Lake	0.52	0.060	0.58	0.20	0.060	0.82	0.1	2.0
Long Lake	0.46	0.049	0.45	0.18	0.062	0.40	0.1	2.0
Crater Lake	0.76	0.073	0.44	0.27	<0.006	0.67	0.1	2.0
Piute Lake	0.45	0.034	0.16	0.12	0.081	0.62	<0.04	<2
Piute Lake (Duplicate)	0.45	0.034	0.19	0.12	0.081	0.67	<0.04	2.0
Summit Lake	0.52	0.039	0.26	0.11	<0.006	0.48	<0.04	3.5
Chocolate Lake (Upper)	1.9	0.15	0.59	0.48	0.14	1.1	0.1	2.0
Golden Trout Lake	7.0	0.20	0.47	0.35	0.58	4.6	0.07	<2
Pear Lake	0.24	0.023	0.15	0.066	0.087	0.96	<0.04	<2
Cottonwood Lake No. 5	1.4	0.097	0.77	0.28	<0.006	0.67	0.04	2.0
Franklin Lake (Lower)	2.5	0.075	0.44	0.21	0.35	2.6	0.07	<2
Bullfrog Lake (Lower)	1.4	0.062	0.34	0.14	0.37	1.4	0.04	3.5
CENTRAL COAST RANGE								
Big Sur River	32	5.27	6.2	1.0	0.02	14	3.9	11
Willow Creek	26	6.94	8.0	1.8	<0.006	21	4.2	14
SOUTHERN CALIFORNIA RANGES								
Sespe Creek	100	29.3	32	1.7	0.30	190	6.7	12
Sespe Creek (Duplicate)	100	28.9	32	1.7	0.30	190	7.1	13
Cogswell Reservoir	36	8.44	9.2	2.5	0.01	8.6	3.0	10
Lake Gregory	16	2.96	7.8	1.5	0.812	7.2	8.1	12
Lake Hemet	33	5.35	22	3.2	0.006	17	13	52
Doane Pond	11	2.94	9.1	1.7	<0.006	11	6.0	27

APPENEDIX E (continued)

Sampling dates, field measurements, and hardness for fall sampling period, 1986: Statewide Survey of Aquatic Ecosystem Chemistry.

Station	Date Sampled	Mountain Range	pH[1]	Alkalinity[2] mg/L	Hardness mg/L	Conduc. umhos/cm	Temp. °C
NORTHWEST RANGES							
Buck Lake	28 Aug 86	Siskiyou	6.3	4.5	4.6	12.6	21.8
Buck Lake (Duplicate)	28 Aug 86	Trinity Divide	ND[3]	4.0	4.6	ND	ND
Toad Lake	26 Aug 86	"	7.6	36	30	72.4	19.3
Big Bear Lake	27 Aug 86	Scott-Salmon	6.0	1.1	1.5	5.13	19.5
Josephine Lake	26 Aug 86	Trinity Alps	6.1	0.80	1.4	4.30	20.7
NORTHEAST RANGES							
Patterson Lake	18 Aug 86	Warner Mts.	6.7	5.9	4.9	14.5	16.0
Eiler Lake	21 Aug 86	So. Cascade	6.4	1.8	1.9	6.29	20.9
Triangle Lake	20 Aug 86	"	6.4	1.9	2.4	8.88	20.4
Caribou Lake	20 Aug 86	"	6.6	5.3	5.1	13.2	22.0
Shadow Lake	21 Aug 86	"	5.8	0	0.71	2.69	17.8
Shadow Lake (Duplicate)	21 Aug 86	"	ND	0	0.69	ND	ND
MENDOCINO RANGES							
Black Rock Lake	7 Aug 86	Yolla Bolly	6.4	3.6	4.6	12.4	21.8
Howard Lake	6 Aug 86	Mendocino	8.9[4]	71	74	166	26.2
Plasket Lake (Upper)	6 Aug 86	"	8.8	75	65	132	20.3
Upper Letts Lake	5 Aug 86	"	8.6	66	58	139	25.5
NORTHERN SIERRA NEVADA							
Taylor Lake	14 Aug 86	No. Sierra	7.2	7.4	6.2	18.0	22.8
Crystal Lake	14 Aug 86	"	6.4	4.2	3.5	10.1	19.8
Three Lakes (Lower)	13 Aug 86	"	6.2	4.0	2.8	10.6	21.4
Eureka Lake	12 Aug 86	"	6.4	2.4	2.3	8.61	23.4
Haven Lake	12 Aug 86	"	6.4	2.9	2.8	8.90	20.9
CENTRAL SIERRA NEVADA							
Secret Lake	20 Oct 86	Cen. Sierra	6.6	2.6	4.0	12.5	8.9
Warren Lake	21 Oct 86	"	6.2	2.0	2.9	9.39	8.6
High Loch Leven Lake	24 Oct 86	"	5.4	0.60	1.5	6.28	7.9
High Loch Leven Lake (Duplicate)	24 Oct 86	"	ND	0.80	1.5	ND	ND
Five Lakes (Lower)	22 Oct 86	"	6.2	2.3	3.1	9.31	7.8
Lost Lake	23 Oct 86	"	6.0	2.6	1.6	6.88	7.9
Smith Lake	4 Sep 86	"	5.6	0.20	0.5	2.58	15.6
Ralston Lake	29 Sep 86	"	5.6	0.80	0.86	3.28	9.0
Winnemucca Lake	3 Sep 86	"	6.7	4.6	5.3	12.9	13.4
Granite Lake	2 Sep 86	"	6.0	1.6	1.1	4.26	21.2
Twin Lake	2 Sep 86	"	6.5	4.4	3.4	10.5	19.8
Highland Lake (Upper)	3 Sep 86	"	7.8	10.7	11	29.3	18.7

APPENDIX E (continued)

Station	Date Sampled	Mountain Range	pH 1/	Alkalinity mg/L	Hardness mg/L	Conduc. umhos/cm	Temp. °C
SOUTHERN SIERRA NEVADA							
Gaylor Lake (Lower)	30 Sep 86	So. Sierra	6.4	2.0	3.7	9.69	5.5
McCloud Lake	1 Oct 86	"	6.2	1.2	1.4	5.52	4.1
Serene Lake	1 Oct 86	"	6.5	3.0	2.6	9.28	7.5
Serene Lake (Duplicate)	1 Oct 86	"	ND	3.1	2.6	ND	ND
Devils Bathtub Lake	15 Oct 86	"	6.2	2.6	1.4	6.52	9.8
Long Lake	16 Oct 86	"	6.0	1.6	1.1	4.96	7.6
Crater Lake	16 Sep 86	"	6.3	3.6	2.8	8.89	14.1
Piute Lake	7 Oct 86	"	6.2	1.6	2.0	5.79	3.4
Summit Lake	7 Oct 86	"	6.4	3.0	2.7	7.69	5.0
Chocolate Lake (Upper)	6 Oct 86	"	6.8	6.4	7.2	20.0	5.4
Golden Trout Lake	8 Oct 86	"	7.0	16	23	52.3	5.2
Pear Lake	11 Sep 86	"	6.0	1.2	0.84	2.73	16.0
Pear Lake (Duplicate)	11 Sep 86	"	ND	0.90	0.85	ND	ND
Cottonwood Lake No. 5	9 Oct 86	"	6.4	4.7	4.1	12.9	5.4
Franklin Lake (Lower)	10 Sep 86	"	6.8	5.4	7.6	19.5	14.2
Bullfrog Lake (Lower)	9 Sep 86	"	6.6	4.3	5.2	14.0	11.5
CENTRAL COAST RANGE							
Big Sur River	30 Jul 86	Santa Lucia	8.5 4/	120	120	279	18.8
Willow Creek	31 Jul 86	"	8.2 4/	130	120	289	16.5
SOUTHERN CALIFORNIA RANGES							
Sespe Creek	5 Nov 86	Topatopa	8.2 5/	230	355	767	14.6
Cogswell Reservoir	4 Nov 86	"	7.4	180	150	345	16.6
Lake Gregory	4 Nov 86	San Gabriel	7.6	66	48	164	13.2
Lake Hemet	4 Nov 86	San Bernardino	8.0 5/	130	87	299	14.0
Doane Pond	5 Nov 86	San Jacinto	7.5 5/	75	58	188	11.7
Doane Pond (Duplicate)	5 Nov 86	Palomar	ND	73	58	ND	ND

1/ Mean of pH from Hach colormetric kit and pH Orion probe unless otherwise noted.
2/ As $CaCO_3$
3/ Not Determined.
4/ Orion probe reading only.
5/ Hach colormetric kit reading only.

APPENDIX E (continued).

Results of cation and anion analyses for fall sampling period, 1986:
Statewide survey of Aquatic Ecosystem Chemistry.

Station	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	NO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	PO_4^{3-} ug/L
NORTHWEST RANGES								
Buck Lake	1.5	0.215	0.66	0.086	<0.006	1.3	0.5	2.0
Buck Lake (Duplicate)	1.5	0.216	0.64	0.086	<0.006	1.4	0.5	2.0
Toad Lake	2.4	5.84	0.39	0.062	<0.006	1.5	0.1	2.0
Big Bear Lake	0.48	0.60	0.36	0.094	<0.006	0.67	0.07	<2.0
Josephine Lake	0.52	0.033	0.14	0.11	0.13	0.62	0.04	<2.0
NORTHEAST RANGES								
Patterson Lake	1.2	0.439	0.74	0.46	0.006	1.3	0.04	2.0
Eiler Lake	0.55	0.132	0.40	0.21	0.006	<0.2	0.2	<2.0
Triangle Lake	0.28	0.417	0.28	0.13	0.006	<0.2	0.1	<2.0
Caribou Lake	1.0	0.620	0.54	0.19	0.016	0.48	0.1	3.0
Shadow Lake	0.18	0.062	0.15	0.051	<0.006	0.43	0.1	<2.0
Shadow Lake (Duplicate)	0.17	0.063	0.15	0.051	<0.006	0.43	0.1	<2.0
MENDOCINO RANGES								
Black Rock Lake	1.3	0.306	0.35	0.078	<0.006	3.1	0.2	11
Howard Lake	18	7.07	3.8	0.078	<0.006	16	0.2	22
Plasket Lake (Upper)	13	7.87	2.5	0.04	<0.006	4.2	0.3	9.2
Upper Letts Lake	16	4.14	2.1	0.074	<0.006	2.4	0.6	5.4
NORTHERN SIERRA NEVADA								
Taylor Lake	2.0	0.312	1.2	0.24	0.01	1.8	0.1	3.5
Crystal Lake	0.86	0.315	0.74	0.21	0.014	0.72	0.1	<2.0
Three Lakes (Lower)	0.81	0.190	0.82	0.40	<0.006	1.5	0.2	4.4
Eureka Lake	0.57	0.213	0.72	0.090	0.01	0.96	0.07	2.0
Haven Lake	0.57	0.339	0.61	0.066	0.006	0.91	0.1	2.0
CENTRAL SIERRA NEVADA								
Secret Lake	1.2	0.247	0.67	0.055	0.11	4.3	0.2	6.6
Warren Lake	0.90	0.166	0.48	0.24	<0.006	0.67	0.07	<2.0
High Loch Leven Lake	0.47	0.081	0.43	0.12	<0.006	1.3	0.5	<2.0
High Loch Leven Lake (Duplicate)	0.47	0.081	0.43	0.12	<0.006	1.3	0.5	3.0
Five Lakes (Lower)	0.95	0.174	0.40	0.13	0.006	1.9	0.1	3.0
Lost Lake	0.51	0.083	0.61	0.16	0.006	0.82	0.1	<2.0
Smith Lake	0.16	0.024	0.21	0.059	0.16	0.30	0.07	<2.0
Ralston Lake	0.30	0.028	0.18	0.090	0.030	0.30	0.04	<2.0
Winnemucca Lake	1.6	0.310	0.25	0.18	<0.006	0.77	0.07	<2.0
Granite Lake	0.33	0.070	0.31	0.15	0.01	<0.2	0.1	6.6
Twin Lake	1.0	0.216	0.57	0.38	0.019	1.5	0.1	4.8
Highland Lake (Upper)	3.9	0.363	0.78	0.04	<0.006	3.1	0.04	7.0

APPENDIX E (continued).

Station	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	NO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	PO_4^{3-} ug/L
SOUTHERN SIERRA NEVADA								
Gaylor Lake (Lower)	1.4	0.076	0.35	0.12	<0.006	2.0	<0.04	<2.0
McCloud Lake	0.38	0.010	0.43	0.21	0.006	0.48	0.1	<2.0
Serene Lake	0.79	0.141	0.71	0.48	0.014	1.2	0.2	<2.0
Serene Lake (Duplicate)	0.79	0.141	0.72	0.48	0.010	1.2	0.2	<2.0
Devils Bathtub Lake	0.44	0.067	0.65	0.21	<0.006	0.48	0.07	<2.0
Long Lake	0.36	0.049	0.42	0.19	0.006	0.20	0.07	<2.0
Crater Lake	0.93	0.12	0.62	0.37	<0.006	0.72	0.07	<2.0
Piute Lake	0.72	0.049	0.26	0.16	0.028	0.82	0.04	<2.0
Summit Lake	0.94	0.072	0.52	0.12	0.006	1.3	<0.04	5.1
Chocolate Lake (Upper)	2.6	0.205	0.74	0.47	<0.006	2.4	<0.04	2.0
Golden Trout Lake	8.7	0.237	0.54	0.36	0.186	7.2	0.1	<2.0
Pear Lake	0.30	0.023	0.17	0.066	<0.006	<0.2	0.04	<2.0
Pear Lake (Duplicate)	0.30	0.024	0.16	0.066	<0.006	<0.2	0.07	<2.0
Cottonwood Lake No. 5	1.5	0.10	0.81	0.28	<0.006	0.67	0.1	5.4
Franklin Lake (Lower)	2.9	0.081	0.51	0.21	0.17	2.2	0.04	<2.0
Bullfrog Lake (Lower)	2.0	0.080	0.47	0.18	0.17	1.2	0.04	<2.0
CENTRAL COAST RANGE								
Big Sur River	38	6.80	8.2	1.3	0.016	18	0.42	11
Willow Creek	32	9.11	11	2.1	0.031	29	0.42	15
SOUTHERN CALIFORNIA RANGES								
Sespe Creek	97	27.5	35	1.6	<0.006	180	9.9	12
Cogswell Reservoir	41	11.6	11.6	4.0	<0.006	12	7.8	6.0
Lake Gregory	14	2.99	7.5	1.4	0.028	6.2	4.2	13
Lake Hemet	25	6.12	24	3.8	0.15	7.7	16	60
Doane Pond	16	4.41	13	26	<0.006	12	4.6	26
Doane Pond (Duplicate)	16	4.42	13	2.7	<0.006	12	5.0	26

APPENDIX F

WATER QUALITY PARAMETERS; 1985

Appendix F. Water quality parameters; 1985.

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp. °C
NORTHWEST RANGES							
Buck Lake	24 May 85	Siskiyou	6.53	104.	4.4	11.4	14.3
Toad Lake	3 Jun 85	Trinity Divide	6.75	516.	28.	54.9	10.0
Big Bear Lake	21 May 85	Scott-Salmon	6.16	61.1	1.7	5.38	15.0
Josephine Lake	22 May 85	Trinity Alps	6.06	24.4	1.5	4.78	10.8
NORTHEAST RANGES							
Patterson Lake	2 Jul 85	Warner Mts.	6.93	139.	5.3	14.2	7.7
Eiler Lake	4 Jun 85	So. Cascade	6.75	36.2	1.6	5.1	14.0
Triangle Lake	5 Jun 85	"	6.77	45.6	2.8	6.99	15.0
Caribou Lake	4 Jun 85	"	6.99	72.2	5.6	12.5	15.0
Shadow Lake	6 Jun 85	"	5.40	0.17	0.92	3.17	6.3
MENDOCINO RANGES							
Black Rock Lake	16 May 85	Yolla Bolly	6.44	86.9	5.7	12.3	13.0
Howard Lake	15 May 85	Mendocino	8.83	1210.	70.	147.	19.0
Plaskett Lake (upper)	14 May 85	"	7.87	1170.	57.	108.	12.0
Upper Letts Lake	13 May 85	"	8.32	1470.	66.	177.	15.6
NORTHERN SIERRA NEVADA							
Taylor Lake	14 Jun 85	No. Sierra	7.40	151.	7.1	17.7	20.3
Crystal Lake	15 Jun 85	"	6.83	67.0	3.8	9.79	17.5
Three Lakes (lower)	1 Jul 85	"	6.51	52.1	3.1	10.2	19.6
Eureka Lake	14 Jun 85	"	6.72	54.2	2.5	7.79	20.0
Haven Lake	13 Jun 85	"	6.81	64.4	3.6	8.68	23.4
CENTRAL SIERRA NEVADA							
Secret Lake	19 Jun 85	Cen. Sierra	6.54	65.6	3.3	9.85	20.5
White Rock Lake	19 Jun 85	"	6.57	99.5	5.2	13.4	18.8
High Loch Leven Lake	12 Jun 85	"	6.14	4.56	1.2	5.32	20.9
Mountain Meadow Lake	20 Jun 85	"	6.04	30.2	2.2	7.46	23.2
Lost Lake	21 Jun 85	"	6.46	55.2	1.9	7.23	22.6
Smith Lake	24 Jun 85	"	6.25	24.5	0.63	2.92	14.9
Ralston Lake	25 Jun 85	"	6.44	13.3	0.89	3.28	16.1
Winnemucca Lake	15 Jul 85	"	7.21	102.	5.9	13.5	16.7
Granite Lake	27 Jun 85	"	4.83	1.1	1.1	4.30	22.4
Twin Lake	27 Jun 85	"	6.62	36.0	3.7	10.8	19.2
Silver King Creek	26 Jun 85	"	7.53	403.	13.4	43.3	14.0
Highland Lake (lower)	16 Jul 85	"	8.45	199.	13.1	29.5	17.9

Appendix F. (continued)

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp. °C
SOUTHERN SIERRA NEVADA							
Gaylor Lake (lower)	16 Jul 85	So. Sierra	7.08	49.3	4.6	9.77	16.6
McCloud Lake	17 Jul 85	"	6.75	25.9	1.2	5.48	15.6
Serene Lake	30 Jul 85	"	6.85	82.0	2.9	9.62	17.0
(duplicate)	"	"	6.71	80.2	2.9	9.75	17.2
Devil's Bathtub	19 Jul 85	"	6.59	56.9	1.3	6.80	18.1
Ward Lake	18 Jul 85	"	6.61	213.	9.6	21.6	21.2
Deer Lake	18 Jul 85	"	6.56	152.	4.0	12.3	17.6
Piute Lake	3 Aug 85	"	6.88	29.8	1.9	5.25	12.5
Summit Lake	3 Aug 85	"	6.96	16.2	2.5	7.04	14.3
Chocolate Lake (upper)	2 Aug 85	"	8.66	156.	9.2	19.7	12.5
Golden Trout Lake	1 Aug 85	"	8.04	283.	20.	42.8	12.4
Pear Lake	26 Jul 85	"	6.26	28.4	0.84	3.18	18.7
Cottonwood Lake No. 5	31 Jul 85	"	7.19	101.	4.4	12.3	13.4
Franklin Lake (lower)	25 Jul 85	"	7.27	102.	9.0	20.1	12.3
Bullfrog Lake (lower)	25 Jul 85	"	7.54	81.4	5.2	12.3	12.5
CENTRAL COAST RANGES							
Big Sur River	6 May 85	Santa Lucia	8.42	2500.	110.	252.	13.5
Willow Creek	7 May 85	"	8.37	2820.	130.	289.	11.9
SOUTHERN CALIFORNIA RANGES							
Sespe Creek	26 Apr 85	Topatopa	8.40	3100.	480.	861.	16.9
Cogswell Reservoir	23 Apr 85	San Gabriel	8.34	2810.	150.	297.	16.1
Lake Gregory	24 Apr 85	San Bernardino	7.98	1090.	53.	140.	14.5
Lake Hemet	24 Apr 85	San Jacinto	8.64	2710.	130.	310.	13.3
Doane Pond	25 Apr 85	Palomar	9.11	1080.	49.	141.	13.7

Appendix F. (continued)

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
NORTHWEST RANGES											
Buck Lake	70.	17.	27.	3.1	117.	115.	104.	<0.16	<21.	11.	<0.03 1/
Toad Lake	115.	441.	15.	2.8	574.	531.	516.	5.98	<21.	8.	<0.03 1/
Big Bear Lake	28.	6.2	16.	1.5	52.	65.	61.1	1.4	<21.	3.	<0.03 1/
Josephine Lake	26.	3.9	7.8	3.3	41.	47.	24.4	3.13	<21.	20.	<0.03 1/
NORTHEAST RANGES											
Patterson Lake	65.	41.	26.	14.	146.	148.	139.	0.27	<21.	8.	<0.30
Eiler Lake	22.	9.5	14.	2.8	49.	60.	36.2	23.7	<21.	<3.	<0.03 1/
Triangle Lake	17.	40.	11.	2.8	71.	76.	45.6	3.50	<21.	28.	<0.03 1/
Caribou Lake	60.	52.	20.	4.4	136.	138.	72.2	55.0	<21.	11.	<0.03 1/
Shadow Lake	12.	6.0	6.1	3.1	27.	36.	0.17	36.6	<21.	<3.	<0.30 1/
MENDOCINO RANGES											
Black Rock Lake	90.	23.	18.	1.0	132.	95.	86.9	<0.16	<21.	8.	<0.03 1/
Howard Lake	998.	378.	159.	20.	1555.	1584.	1210.	0.85	370.	<3.	<0.03 1/
Plaskett Lake (upper)	798.	331.	83.	6.6	1218.	1180.	1170.	<0.16	<21.	11.	<0.03 1/
Upper Letts Lake	998.	297.	78.	3.3	1376.	1486.	1470.	8.39	<21.	8.	0.10
NORTHERN SIERRA NEVADA											
Taylor Lake	110.	29.	39.	5.6	183.	157.	151.	3.22	<21.	3.	<0.30
Crystal Lake	48.	27.	21.	4.1	101.	84.	67.0	<0.16	<21.	17.	<0.30
Three Lakes (lower)	44.	18.	25.	10.	97.	94.	52.1	0.44	42.	<3.	0.58
Eureka Lake	29.	19.	19.	1.0	68.	54.	54.2	<0.16	<21.	<3.	<0.30
Haven Lake	40.	30.	23.	1.7	95.	64.	64.4	<0.16	<21.	<3.	<0.30
CENTRAL SIERRA NEVADA											
Secret Lake	50.	16.	19.	7.7	93.	66.	65.6	0.16	<21.	<3.	<0.30
White Rock Lake	80.	25.	20.	6.6	132.	100.	99.5	<0.16	<21.	<3.	<0.30
High Loch Leven Lake	18.	5.4	25.	3.8	52.	18.	4.56	1.60	<21.	11.	<0.30
Mountain Meadow Lake	32.	12.	19.	6.6	70.	72.	30.2	0.27	42.	<3.	<0.30
Lost Lake	30.	7.5	21.	4.6	64.	55.	55.2	<0.16	<21.	<3.	<0.30
Smith Lake	10.	2.6	9.1	1.8	24.	31.	24.5	6.08	<21.	<3.	<0.30
Ralston Lake	15.	2.7	8.3	2.8	28.	16.	13.3	2.42	<21.	<3.	<0.30
Winnemucca Lake	90.	27.	10.	5.4	133.	132.	102.	3.40	27.	<3.	<0.30
Granite Lake	15.	6.4	13.	4.1	38.	33.	1.1	1.3	31.	<3.	<0.30
Twin Lake	55.	19.	20.	9.5	104.	100.	63.0	<0.16	37.	<3.	<0.30
Silver King Creek	196.	71.	142.	12.	421.	425.	403.	<0.16	<21.	22.	0.54
Highland Lake (lower)	236.	26.	33.	2.0	297.	284.	199.	<0.16	79.	6.	<0.30

Appendix F. (continued)

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
SOUTHERN SIERRA NEVADA											
Gaylor Lake (lower)	85.	7.9	11.	3.3	107.	93.	49.3	<0.16	33.	11.	<0.30
McCloud Lake	15.	9.0	16.	5.1	45.	60.	25.9	7.10	21.	6.	0.77
Serene Lake	43.	15.	20.	12.	90.	121.	82.0	1.61	37.	<3.	1.2
(duplicate)	43.	15.	20.	11.	89.	122.	80.2	1.5	40.	<3.	<0.30
Devil's Bathtub	20.	5.4	17.	4.4	47.	57.	56.9	0.48	<21.	<3.	<0.30
Ward Lake	160.	32.	49.	20.	261.	275.	213.	<0.16	62.	<3.	<0.30
Deer Lake	70.	11.	24.	6.4	111.	152.	152.	<0.16	<21.	<3.	<0.30
Piute Lake	35.	3.8	7.0	3.6	50.	59.	29.8	<0.16	29.	<3.	<0.30
Summit Lake	45.	5.8	15.	2.8	69.	47.	16.2	<0.16	31.	<3.	<0.30
Chocolate Lake (upper)	165.	19.	22.	12.	218.	209.	156.	<0.16	50.	3.	<0.30
Golden Trout Lake	386.	18.	16.	8.4	428.	407.	283.	3.98	114.	6.	<0.30
Pear Lake	15.	1.8	5.6	2.2	25.	29.	28.4	0.31	<21.	<3.	<0.30
Cottonwood Lake No. 5	80.	8.1	23.	6.4	118.	128.	101.	0.44	27.	<3.	<0.30
Franklin Lake (lower)	175.	5.4	13.	4.9	198.	185.	102.	10.4	73.	<3.	1.4
Bullfrog Lake (lower)	100	4.8	12.	2.8	120.	120.	81.4	2.40	25.	11.	<0.30
CENTRAL COAST RANGES											
Big Sur River	1730.	540.	355.	29.	2654.	3087.	2500.	0.85	499.	87.	0.2 1/
Willow Creek	1780.	780.	522.	55.	3137.	3510.	2820.	0.72	582.	104.	0.2 1/
SOUTHERN CALIFORNIA RANGES											
Sespe Creek	6540.	3030.	2000.	44.	11614.	12734.	3100.	0.3	9200.	434.	0.1 1/
Cogswell Reservoir	2120.	839.	526.	81.	3566.	3359.	2800.	2.	460.	93.	0.1 1/
Lake Gregory	778.	279.	396.	42.	1496.	1522.	1090.	15.	200.	217.	0.1 1/
Lake Hemet	2030.	486.	1070.	84.	3670.	3354.	2710.	0.5	250.	395.	0.3 1/
Doane Pond	679.	300.	478.	47.	1504.	1360.	1080.	0.3	100.	180.	0.2 1/

1/ Reported as ortho-phosphate; all others reported as total dissolved phosphate.

Appendix F. (continued)

Station	ug/L										
	Aluminum		Iron		Manganese		Molybdenum		Copper	Zinc	Selenium
	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Tot.	Tot.
NORTHWEST RANGES											
Buck Lake	17.	15.	12.	6.	0.8	0.8	<1	<1	<0.5	<1	IS[1]
Toad Lake	49.	35.	35.	27.	1.7	2.0	<1	<1	<0.5	0.1	<5
Big Bear Lake	44.	21.	55.	12.	7.3	6.6	<1	<1	<0.5	<1	IS
Josephine Lake	49.	34.	57.	27.	7.7	7.6	<1	<1	<0.5	<1	IS
NORTHEAST RANGES											
Patterson Lake	3.	<2.	58.	6.	21.0	2.1	<1	<1	<0.5	0.6	<5
Eiler Lake	66.	38.	6.	27.	1.1	2.2	<1	<1	0.7	0.3	<5
Triangle Lake	31.	41.[2]	3.	9.[2]	3.6	1.9	<1	<1	<0.5	0.3	<5
Caribou Lake	37.	54.[2]	7.	20.[2]	1.8	4.5[2]	<1	<1	0.9	1.4	<5
Shadow Lake	10.	34.[2]	4.	13.[2]	1.1	1.9	<1	<1	<0.5	1.2	<5
MENDOCINO RANGES											
Black Rock Lake	34.	40.[2]	27.	29.	3.0	15.0[2]	<1	<1	0.5	<1	IS
Howard Lake	33.	15.	215.	32.	128.	67.2	2.	1.	<0.5	<1	IS
Plaskett Lake (upper)	27.	25.	294.	109.	13.6	8.8	<1	<1	0.5	<1	IS
Upper Letts Lake	15.	21.[2]	55.	32.	17.9	4.9	<1	<1	0.5	2.0	IS
NORTHERN SIERRA NEVADA											
Taylor Lake	9.	6.	22.	12	6.9	4.4	<1	<1	<0.5	3.9	<5
Crystal Lake	5.	<2.	7.	1.	11.1	7.6	<1	<1	<0.5	0.3	<5
Three Lakes (lower)	58.	24.	67.	30.	10.6	9.8	<1	<1	<0.5	1.5	<5
Eureka Lake	9.	2.	38.	13.	26.5	23.0	<1	<1	<0.5	0.7	<5
Haven Lake	39.	24.	51.	7.	2.4	0.8	<1	<1	<0.5	0.7	<5
CENTRAL SIERRA NEVADA											
Secret Lake	52.	23.	62.	25.	6.0	6.0	<1	<1	0.7	0.7	<5
White Rock Lake	33.	11.	30.	9.	34.4	29.5	<1	<1	<0.5	0.6	<5
High Loch Leven Lake	57.	41.	46.	19.	3.6	3.9	<1	<1	<0.5	0.6	<5
Mountain Meadow Lake	62.	24.	59.	18.	6.0	5.7	<1	<1	0.5	0.8	<5
Lost Lake	29.	16.	65.	25.	3.6	3.7	<1	<1	<0.5	1.2	<5
Smith Lake	18.	4.	13.	3.	3.5	3.3	<1	<1	<0.5	1.0	<5
Ralston Lake	26.	23.	8.	4.	1.3	0.7	<1	<1	<0.5	0.7	<5
Winnemucca Lake	3.	3.	26.	17.	8.7	1.6	1.	<1	<0.5	2.4	<5
Granite Lake	67.	19.	59.	14.	6.9	6.5	2.	1.	<0.5	0.6	<5
Twin Lake	18.	8.	31.	12.	7.3	5.2	<1	<1	<0.5	0.7	<5
Silver King Creek	44.	10.	78.	39.	11.1	5.1	<1	<1	<0.5	1.4	<5
Highland Lake (lower)	30.	26.	44.	20.	4.8	0.3	<1	ND[3]	<0.5	0.5	<5

Appendix F. (continued)

Station	ug/L										
	Aluminum		Iron		Manganese		Molybdenum		Copper	Zinc	Selenium
	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Tot.	Tot.
SOUTHERN SIERRA NEVADA											
Gaylor Lake (lower)	13.	13.	9.	7.	2.6	2.1	<1	ND	<0.5	2.9	<5
McCloud Lake	25.	13.	24.	5.	2.9	2.5	<1	ND	<0.5	1.0	<5
Serene Lake	20.	13.	10.	4.	1.7	0.9	<1	ND	<0.5	0.6	<5
(duplicate)	22.	12.	10.	4.	1.6	0.9	<1	ND	<0.5	0.7	<5
Devil's Bathtub	14.	7.	14.	4.	3.4	0.9	<1	ND	<0.5	1.4	<5
Ward Lake	9.	8.	19.	9.	6.2	0.6	1.	<1	<0.5	1.9	<5
Deer Lake	43.	10.	262.	43.	18.4	16.0	<1	ND	<0.5	1.0	<5
Piute Lake	16.	9.	8.	2.	1.1	0.9	<1	ND	<0.5	0.5	<5
Summit Lake	51.	25.	34.	9.	1.1	1.0	<1	ND	<0.5	0.7	<5
Chocolate Lake (upper)	11.	8.	38.	20.	2.8	0.8	<1	ND	<0.5	1.1	<5
Golden Trout Lake	12.	6.	7.	2.	0.9	0.1	<1	ND	<0.5	0.4	<5
Pear Lake	12.	6.	15.	4.	3.0	2.4	<1	ND	<0.5	0.7	<5
Cottonwood Lake No. 5	5.	2.	13.	7.	0.8	0.6	<1	ND	<0.5	0.8	<5
Franklin Lake (lower)	28.	23.	5.	4.	1.7	0.7	<1	ND	<0.5	0.8	<5
Bullfrog Lake (lower)	20.	11.	12.	6.	1.4	1.1	1.	<1	<0.5	1.0	<5
CENTRAL COAST RANGES											
Big Sur River	8.	4.	12.	5.	0.9	1.0	2.	2.	<0.5	<1	IS
Willow Creek	9.	5.	46.	23.	4.2	2.7	3.	3.	<0.5	<1	IS
SOUTHERN CALIFORNIA RANGES											
Sespe Creek	7.	10.	38.	25.	5.4	6.9	1.	1.	0.6	<1	<5
Cogswell Reservoir	19.	4.	65.	14.	22.7	4.3	4.	3.	2.1	<1	<5
Lake Gregory	44.	8.	87.	14.	50.7	14.9	<1	<1	1.2	<1	<5
Lake Hemet	129.	9.	130.	10.	19.8	2.7	3.	3.	1.7	<1	<5
Doane Pond	257.	15.	650.	163.	87.0	45.6	<1	<1	1.0	21.	<5

1/ IS = Insufficient Sample.

2/ Dissolved trace element concentrations should not be greater than the total trace element concentration; these results indicate that the water sample for dissolved trace element analyses was somehow contaminated. The cleaning procedure for both pump and filter was subsequently revised.

3/ ND = Not Determined.

Appendix F. (continued)

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp. °C
NORTHWEST RANGES							
Buck Lake	9 Oct 85	Siskiyou	6.86	4.4	63.	13.1	12.7
(duplicate)	9 Oct 85	"	--	4.4	63.	—	--
Toad Lake	7 Oct 85	Trinity Divide	7.80	700.	37.	66.2	12.3
Big Bear Lake	8 Oct 85	Scott-Salmon	5.96	48.1	1.7	5.45	12.5
Josephine Lake	7 Oct 85	Trinity Alps	5.89	24.8	2.3	5.99	12.0
NORTHEAST RANGES							
Patterson Lake	13 Aug 85	Warner Mts.	7.40	150.	5.2	9.55	15.4
Eiler Lake	15 Aug 85	So. Cascade	7.14	56.7	1.6	5.65	18.8
Triangle Lake	14 Aug 85	"	7.10	56.4	2.6	6.49	19.4
Caribou Lake	14 Aug 85	"	7.35	143.	3.9	15.5	18.8
Shadow Lake	15 Aug 85	"	6.18	6.8	0.64	2.93	19.1
MENDOCINO RANGES							
Black Rock Lake	22 Oct 85	Yolla Bolly	6.60	27.1	5.8	12.9	13.4
Howard Lake	26 Nov 85	Mendocino	8.14	1720.	90.	200.	4.4
Plaskett Lake (upper)	23 Oct 85	"	9.25	2160.	70.	142.	8.0
(duplicate)	23 Oct 85	"	—	2150.	71.	—	—
Upper Letts Lake	24 Oct 85	"	7.94	2140.	66.	137.	11.5
NORTHERN SIERRA NEVADA							
Taylor Lake	16 Aug 85	No. Sierra	7.46	181.	6.8	18.9	18.9
Crystal Lake	20 Aug 85	"	7.00	90.2	3.4	9.83	18.7
Three Lakes (lower)	20 Aug 85	"	7.14	198.	6.1	20.4	17.3
Eureka Lake	21 Aug 85	"	7.09	111.	2.7	8.08	19.0
(duplicate)	21 Aug 85	"	—	103.	—	—	—
Haven Lake	19 Aug 85	"	7.25	109.	3.0	8.93	20.6
CENTRAL SIERRA NEVADA							
Secret Lake	23 Aug 85	Cen. Sierra	6.37	57.0	3.9	11.6	16.8
Warren Lake	22 Aug 85	"	6.90	71.3	3.1	9.71	19.3
High Loch Leven Lake	23 Aug 85	"	6.41	0.7	1.1	4.03	19.9
Five Lakes (lower)	27 Aug 85	"	6.86	82.0	3.4	9.38	18.4
Lost Lake	27 Aug 85	"	6.77	60.6	5.1	7.57	19.3
Smith lake	30 Sep 85	"	7.05	4.6	0.64	2.98	11.0
Ralston Lake	28 Aug 85	"	6.42	29.3	1.1	3.71	16.6
Winnemucca Lake	29 Aug 85	"	7.09	100.	5.5	16.5	12.3
Granite Lake	29 Aug 85	"	6.32	25.1	0.98	4.40	18.9
Twin Lake	1 Oct 85	"	6.90	63.5	3.5	11.2	10.8
Highland Lake (lower)	1 Oct 85	"	7.50	220.	14.	33.4	12.6

Appendix F. (continued)

Station	Date Sampled	Mountain Range	pH	Alkalinity ueq/L	Hardness mg/L	Conduc. uS/cm	Temp. °C
SOUTHERN SIERRA NEVADA							
Gaylor Lake (lower)	1 Oct 85	So. Sierra	7.22	54.1	3.8	10.6	9.6
McCloud Lake	16 Sep 85	"	6.61	31.8	1.2	5.49	13.9
Serene Lake	17 Sep 85	"	7.20	76.3	2.6	9.26	13.9
Devil's Bathtub	10 Sep 85	"	6.75	53.5	1.3	6.50	14.1
Long Lake	2 Oct 85	"	6.54	31.6	2.3	5.36	13.3
Crater Lake	3 Oct 85	"	6.55	45.4	3.0	9.49	15.3
Piute Lake	20 Sep 85	"	6.43	23.5	2.1	6.25	7.8
Summit Lake	20 Sep 85	"	6.37	62.0	2.8	9.59	8.4
Chocolate Lake (upper)	17 Sep 85	"	8.22	147.	8.2	22.1	9.3
Golden Trout Lake	18 Sep 85	"	7.63	309.	24.	46.6	6.9
Pear Lake	6 Sep 85	"	5.78	11.0	0.90	3.72	14.2
Cottonwood Lake No. 5	19 Sep 85	"	6.84	91.3	4.2	12.9	8.9
Franklin Lake (lower)	5 Sep 85	"	6.12	81.4	12.	21.3	14.3
Bullfrog Lake (lower)	4 Sep 85	"	7.47	59.7	5.4	14.7	10.8
CENTAL COAST RANGES							
Big Sur River	1 Nov 85	Santa Lucia	8.02	2850.	130.	291.	10.8
Willow Creek	31 Oct 85	"	7.05	2710.	140.	332.	11.3
SOUTHERN CALIFORNIA RANGES							
Sespe Creek	7 Nov 85	Topatopa	7.87	7600.	250.	924.	10.9
(duplicate)	7 Nov 85	"	—	7680.	260.	—	—
Cogswell Reservoir	4 Nov 85	San Gabriel	7.62	3560.	160.	331.	20.1
Lake Gregory	4 Nov 85	San Bernardino	8.96	1450.	58.	158.	14.3
Lake Hemet	5 Nov 85	San Jacinto	8.90	3030.	110.	317.	14.2
Doane Pond	6 Nov 85	Palomar	7.50	1550.	64.	186.	11.7

Appendix F. (continued)

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
NORTHWEST RANGES											
Buck Lake	70.	18.	26.	1.6	116.	127.	63.3	<0.16	44.	20.00	<0.30
(duplicate)	70.	18.	26.	1.6	116.	128.	62.8	<0.16	46.	19.	<0.30
Toad Lake	132.	603.	18.	1.8	755.	777.	700.	<0.16	75.	3.1	<0.30
Big Bear Lake	27.	6.0	15.	2.1	50.	50.	48.1	<0.16	<10.	2.0	<0.30
Josephine Lake	42.	4.4	7.4	2.4	56.	69.	24.8	<0.16	40.	3.7	<0.30
NORTHEAST RANGES											
Patterson Lake	65.	40.	34.	11.	150.	163.	150.	<0.16	12.	<1.	<0.30
Eiler Lake	24.	7.9	15.	3.8	51.	61.	56.7	0.29	<10.	2.8	<0.30
Triangle Lake	14.	38.	9.6	2.8	65.	58.	56.4	<0.16	<10.	1.7	<0.30
Caribou Lake	55.	57.	25.	4.4	141.	172.	143.	<0.16	27.	2.5	<0.30
Shadow Lake	8.5	4.4	6.1	1.3	20.	8.	6.80	<0.16	<10.	1.4	<0.30
MENDOCINO RANGES											
Black Rock Lake	90.	26.	15.	1.3	132.	115.	27.1	<0.16	83.	3.9	<0.30
Howard Lake	1250.	550.	205.	8.7	2014.	2109.	1720.	<0.16	378.	11.	<0.30
Plaskett Lake (upper)	700.	710.	113.	1.8	1525.	2287.	2150.	<0.16	120.	17.	<0.30
(duplicate)	700.	720.	113.	2.4	1535.	2297.	2160.	<0.16	120.	17.	<0.30
Upper Letts Lake	950.	380.	91.	2.3	1423.	2205.	2140.	<0.16	48.	17.	<0.30
NORTHERN SIERRA NEVADA											
Taylor Lake	110.	26.	41.	6.6	184.	224.	181.	1.0	37.	3.7	<0.30
Crystal Lake	45.	23.	20.	4.4	92.	111.	90.2	0.35	14.	2.8	<0.30
Three Lakes (lower)	80.	43.	65.	17.	205.	274.	198.	<0.16	66.	9.9	0.38
Eureka Lake	34.	21.	30.	3.3	88.	135.	107.	<0.16	25.	2.8	<0.30
(duplicate)	33.	18.	29.	3.3	83.	136.	108.	0.16	25.	3.4	<0.30
Haven Lake	33.	29.	30.	1.9	94.	142.	109.	<0.16	29.	3.9	<0.30
CENTRAL SIERRA NEVADA											
Secret Lake	60.	19.	27.	1.6	108.	140.	57.0	<0.16	79.	2.8	<0.30
Warren Lake	49.	13.	21.	7.2	90.	106.	71.3	<0.16	35.	<1.	<0.30
High Loch Leven Lake	17.	4.4	16.	<1.	37.	39.	0.70	<0.16	33.	4.8	<0.30
Five Lakes (lower)	55.	13.	21.	4.6	94.	146.	82.0	<0.16	60.	4.2	<0.30
Lost Lake	27.	7.4	30.	6.4	71.	92.	60.6	0.84	27.	3.9	<0.30
Smith Lake	10.	2.8	11.	1.0	25.	11.	4.60	3.34	<10.	2.8	<0.30
Ralston Lake	20.	2.4	9.6	2.5	35.	41.	29.3	<0.16	10.	1.4	<0.30
Winnemucca Lake	85.	26.	10.	5.9	127.	134.	100.	<0.16	33.	1.4	<0.30
Granite Lake	14.	5.2	18.	4.1	42.	52.	25.1	8.77	19.	1.7	<0.30
Twin Lake	50.	20.	29.	7.9	107.	106.	63.5	<0.16	40.	3.9	0.48
Highland Lake (lower)	252.	33.	40.	1.3	326.	342.	220.	<0.16	120.	2.0	0.80

Appendix F. (continued)

Station	Ca^{2+} ueq/L	Mg^{2+} ueq/L	Na^{+} ueq/L	K^{+} ueq/L	Cations ueq/L	Anions ueq/L	Alkalinity ueq/L	NO_3^{-} uM	SO_4^{2-} ueq/L	Cl^{-} ueq/L	PO_4^{3-} uM
SOUTHERN SIERRA NEVADA											
Gaylor Lake (lower)	70.	7.1	17.	2.4	96.	106.	54.1	<0.16	52.	<1.	<0.30
McCloud Lake	16.	8.5	19.	4.4	48.	44.	34.2	<0.16	10.	<1.	<0.30
Serene Lake	38.	13.	31.	12.	94.	112.	76.3	<0.16	33.	2.8	<0.30
Devil's Bathtub	20.	6.0	27.	4.6	58.	94.	53.5	<0.16	40.	<1.	<0.30
Long Lake	21.	4.5	30.	4.1	60.	45.	31.6	<0.16	10.	2.8	0.97
Crater Lake	49.	10.	27.	6.6	93.	78.	45.4	<0.16	27.	5.1	0.35
Piute Lake	37.	4.1	10.	2.3	53.	27.	23.5	1.3	<10.	1.7	<0.30
Summit Lake	48.	6.4	20.	2.3	77.	86.	62.0	0.90	21.	2.0	0.32
Chocolate Lake (upper)	146.	19.	39.	13.	217.	195.	147.	<0.16	48.	<1.	<0.30
Golden Trout Lake	470.	17.	21.	6.1	514.	423.	309.	3.26	110.	<1.	<0.30
Pear Lake	15.	2.5	8.7	2.6	29.	32.	11.0	1.61	19.	<1.	<0.30
Cottonwood Lake No. 5	75.	9.7	30.	4.9	120.	105.	91.3	0.16	10.	1.7	<0.30
Franklin Lake (lower)	163.	7.1	23.	5.6	199.	147.	81.4	3.72	62.	<1.	<0.30
Bullfrog Lake (lower)	100.	7.2	23.	4.6	135.	108.	59.7	2.26	46.	<1.	<0.30
CENTRAL COAST RANGES											
Big Sur River	2100.	579.	403.	32.	3114.	3126.	2470.	0.52	466.	190.	<0.30
Willow Creek	2000.	848.	574.	60.	3482.	3644.	2710.	<0.16	774.	160.	<0.30
SOUTHERN CALIFORNIA RANGES											
Sespe Creek	3200.	1740.	6220.	42.	11202.	11870.	7600.	<0.16	2970.	1300.	0.52
(duplicate)	3400.	1710.	6180.	42.	11332.	12210.	7680.	<0.16	3200.	1330.	0.55
Cogswell Reservoir	2200.	963.	548.	120.	3831.	4015.	3560.	1.1	314.	140.	<0.30
Lake Gregory	850.	310.	431.	47.	1638.	1811.	1450.	6.26	110.	240.	<0.30
Lake Hemet	1700.	511.	1090.	95.	3396.	3735.	3030.	0.95	304.	400.	1.0
Doane Pond	900.	380.	618.	74.	1972.	2110.	1550.	1.77	272.	285.	0.90

Appendix F. (continued)

Station	ug/L									
	Aluminum		Iron		Manganese		Molybdenum		Copper	Zinc
	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Tot.
NORTHWEST RANGES										
Buck Lake	36.	22.	13.	9.	0.7	0.6	<1	ND[1]	<0.5	0.4
(duplicate)	36.	21.	13.	8.	0.7	0.4	<1	ND	<0.5	0.6
Toad Lake	8.	9.	42.	22.	8.7	1.4	<1	ND	<0.5	0.2
Big Bear Lake	27.	20.	12.	3.	2.4	0.9	<1	ND	<0.5	0.4
Josephine Lake	54.	28.	75.	34.	8.3	5.2	<1	ND	<0.5	1.5
NORTHEAST RANGES										
Patterson Lake	12.	2.	10.	4.	2.0	1.3	<1	ND	<0.5	4.0
Eiler Lake	112.	44.	4.	2.	0.7	0.5	<1	ND	<0.5	1.6
Triangle Lake	78.	62.	5.	2.	1.1	0.6	<1	ND	<0.5	0.9
Caribou Lake	111.	92.	50.	6.	2.7	1.6	<1	ND	<0.5	1.5
Shadow Lake	8.	10.	2.	2.	1.6	1.0	<1	ND	<0.5	1.0
MENDOCINO RANGES										
Black Rock Lake	32.	32.	27.	21.	2.2	2.5	<1	ND	<0.5	0.3
Howard Lake	33.	6.	142.	86.	55.4	23.8	1.	<1	<0.5	1.0
Plaskett Lake (upper)	15.	12.	183.	53.	8.5	3.9	<1	ND	<0.5	0.3
(duplicate)	15.	9.	176.	50.	9.1	3.6	<1	ND	<0.5	0.6
Upper Letts Lake	19.	9.	110.	41.	21.1	10.5	<1	ND	<0.5	0.1
NORTHERN SIERRA NEVADA										
Taylor Lake	22.	22.	12.	12.	3.6	3.1	<1	ND	<0.5	1.8
Crystal Lake	10.	37.[2]	7.	8.	6.3	3.7	<1	ND	<0.5	0.6
Three Lakes (lower)	105.	63.	135.	164.[2]	22.3	16.0	<1	ND	0.5	0.8
Eureka Lake	12.	10.	63.	15.	10.8	0.9	<1	ND	<0.5	0.7
(duplicate)	14.	11.	66.	14.	8.0	1.0	<1	ND	<0.5	0.9
Haven Lake	22.	84.[2]	22.	7.	2.6	0.8	<1	ND	<0.5	1.7
CENTRAL SIERRA NEVADA										
Secret Lake	63.	34.	123.	121.	9.0	6.4	<1	ND	0.9	2.5
Warren Lake	23.	12.	58.	15.	4.1	0.7	3.	<1	<0.5	0.7
High Loch Leven Lake	90.	14.	61.	6.	1.7	1.2	<1	ND	<0.5	0.7
Five Lakes (lower)	69.	40.	73.	27.	3.4	2.1	<1	ND	<0.5	1.7
Lost Lake	35.	19.	30.	8.	1.6	1.1	<1	ND	<0.5	0.7
Smith Lake	16.	5.	8.	2.	5.7	3.8	<1	ND	<0.5	2.9
Ralston Lake	31.	11.	39.	5.	2.6	2.0	<1	ND	<0.5	0.7
Winnemucca Lake	4.	2.	8.	3.	7.8	6.2	<1	ND	<0.5	0.9
Granite Lake	71.	12.	17.	7.	2.2	2.1	4.	2.	<0.5	1.1
Twin Lake	22.	15.	51.	35.	6.1	0.7	<1	ND	<0.5	0.9
Highland Lake (lower)	22.	20.	43.	22.	4.5	2.1	<1	ND	<0.5	1.4

Appendix F. (continued)

Station	ug/L									
	Aluminum		Iron		Manganese		Molybdenum		Copper	Zinc
	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Diss.	Tot.	Tot.
SOUTHERN SIERRA NEVADA										
Gaylor Lake (lower)	19.	9.	18.	6.	2.8	0.4	<1	ND	<0.5	1.2
McCloud Lake	33.	8.	92.	11.	4.1	3.1	2.	<1	<0.5	2.9
Serene Lake	24.	18.	11.	4.	1.2	1.1	2.	<1	<0.5	2.3
Devil's Bathtub	9.	7.	22.	4.	3.2	0.2	<1	ND	<0.5	1.3
Long Lake	22.	11.	39.	10.	2.2	1.0	<1	ND	<0.5	0.4
Crater Lake	11.	7.	60.	27.	7.3	4.8	<1	ND	<0.5	1.3
Piute Lake	22.	11.	21.	8.	1.2	0.6	<1	ND	<0.5	1.0
Summit Lake	68.	46.	29.	23.	0.7	0.5	2.	<1	<0.5	1.2
Chocolate Lake (upper)	12.	10.	47.	30.	1.7	0.7	3.	2.	<0.5	1.5
Golden Trout Lake	9.	7.	8.	3.	0.9	0.5	4.	1.	<0.5	0.4
Pear Lake	9.	2.	33.	6.	6.1	3.7	<1	ND	<0.5	2.5
Cottonwood Lake No. 5	4.	3.	48.	12.	2.1	1.8	3.	1.	<0.5	1.6
Franklin Lake (lower)	36.	29.	27.	7.	9.3	7.0	<1	ND	<0.5	2.7
Bullfrog Lake (lower)	24.	25.	78.	7.	2.7	1.5	2.	1.	<0.5	0.6
CENTRAL COAST RANGES										
Big Sur River	8.	7.	5.	3.	0.4	0.3	2.	2.	<0.5	0.2
(duplicate)	8.	5.	5.	2.	0.4	0.3	2.	2.	<0.5	0.2
Willow Creek	8.	5.	31.	17.	4.3	2.5	3.	3.	<0.5	0.2
SOUTHERN CALIFORNIA RANGES										
Sespe Creek	2.	<2.	45.	3.	24.8	0.1	4.	<1	<0.5	0.2
(duplicate)	4.	8.2/	45.	25.	24.9	22.9	4.	<1	<0.5	0.5
Cogswell Reservoir	13.	124.2/	162.	80.	154.	18.5	3.	3.	<0.5	0.4
Lake Gregory	82.	52.	65.	41.	78.0	43.8	1.	<1	1.0	0.4
Lake Hemet	44.	3.	80.	8.	31.6	15.3	4.	3.	0.9	0.2
Doane Pond	400.	70.	1800.	40.	272.	9.0	3.	2.	0.8	2.0

1/ ND = Not Determined.

2/ Dissolved trace element concentration should not be greater than the total trace element concentration; these results indicate that the water sample for dissolved trace element analyses was somehow contaminated.