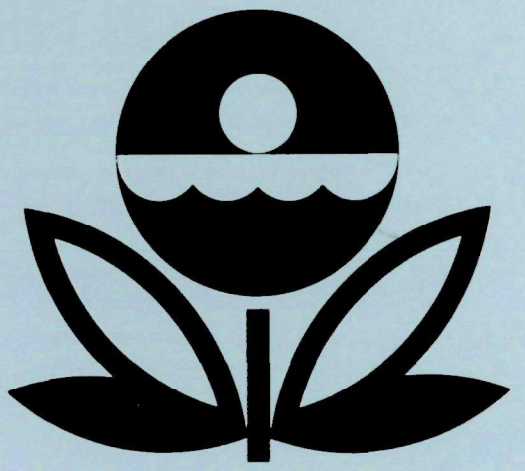
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

LOWER TWIN LAKE

MONO COUNTY

CALIFORNIA

EPA REGION IX

WORKING PAPER No. 761

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPORT

ON

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CALIFORNIA

EPA REGION IX

WORKING PAPER No. 761

WITH THE COOPERATION OF THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

AND THE

CALIFORNIA NATIONAL GUARD

JUNE, 1978

CONTENTS

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentration (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the California State Water Resources Control Board and the nine Regional Water Quality Control Boards for professional involvement, to the California National Guard for conducting the tributary sampling phase of the Survey, and to those California wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Division of Planning and Research of the State Water Resources Control Board provided invaluable lake documentation and counsel during the Survey, coordinated the reviews of the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

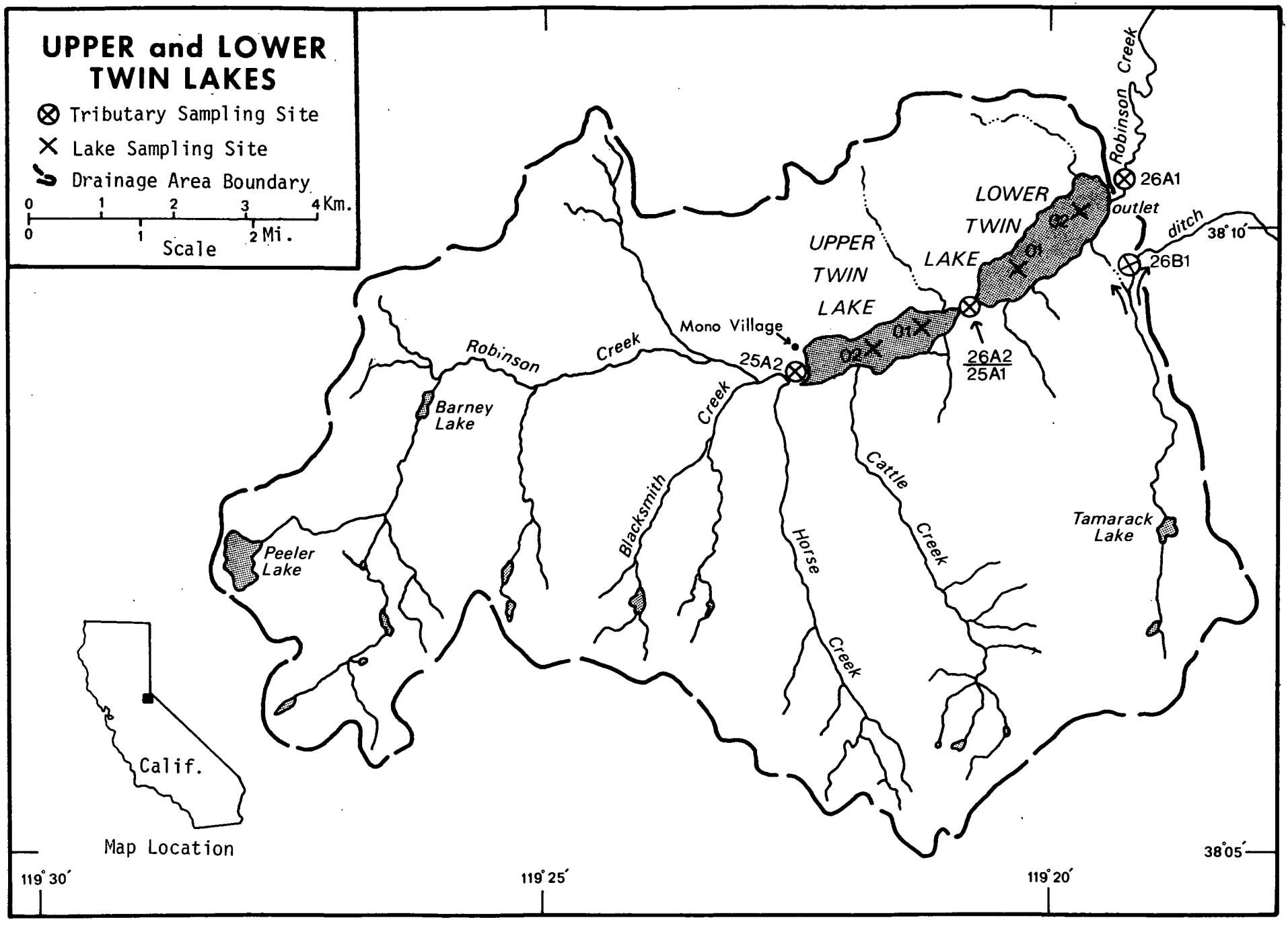
Major General Glen C. Ames, the Adjutant General of California, and Project Officer Second Lieutenant Terry L. Barrie, who directed the volunteer efforts of the California National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of California

Name	County
Amador	Amador
Boca	Nevada
Britton	Shasta
Casitas	Ventura
Crowley	Mono
Don Pedro	Tuolumne
Elsinore	Riverside
Fallen Leaf	El Dorado
Hennessey	Napa
Henshaw	San Diego
Iron Gate	Siskiyou
Lopez	San Luis Obispo
Mary	Mono
Mendocino	Mendocino
Nicasio	Marin
Lower Otay	San Diego
Pillsbury	Lake
Santa Margarita	San Luis Obispo
Shasta	Shasta
Shaver	Fresno
Silver	Mono
Tahoe	El Dorado, Placer, CA; Carson City, Douglas, Washoe, NV
Tulloch	Calaveras, Tuolumne
Lower Twin	Mono
Upper Twin	Mono


UPPER and LOWER TWIN LAKES
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 1 2 3 4 Km.
0 1 2 Mi.
Scale
Robinson Creek
26A1
outlet
ditch
38° 10´
LOWER TWIN LAKE
UPPER TWIN LAKE
26B1
Mono Village
25A2
26A2
25A1
Robinson Creek
Barney Lake
Creek
Blacksmith
Horse Creek
Cattle Creek
Tamarack Lake
Peeler Lake
Calif.
Map Location
38°05´
119° 30´
119° 25´
119° 20´

LOWER TWIN LAKE

STORET NO. 0626

I. CONCLUSIONS

A. Trophic Condidion*:

Survey data indicate that Lower Twin Lake is early mesotrophic. It ranked sixth in overall trophic quality among the 24 California lakes and reservoirs sampled in 1975 when compared using a combination of six water quality parameters**. Five of the water bodies had less and one had the same median total phosphorus, one had less and two had the same median dissolved orthophosphorus, none had less but four had the same median inorganic nitrogen, five had less mean chlorophyll a, and one had greater mean Secchi disc transparency. Moderate depression of dissolved oxygen with depth occurred at station 1 in July (3.6 mg/l at 27.4 meters).

Survey limnologists did not observe macrophytes or surface concentrations of algae.

Others indicate the quality of the lake is good and assess it as oligotrophic (Johns, 1975).

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake at the times samples were collected (03/19/75 and 11/06/75). The lake data indicate nitrogen limitation in March and phosphorus limitation in July and November.

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* Trophic assessment is based on levels of nutrients, dissolved oxygen, and chlorophyll a; phytoplankton kinds and numbers; and transparency (Allum et al., 1977).

** See Appendix A.

C. Nutrient Controllability:

1. Point sources--No known wastewater treatment plants impacted the lake during the sampling year. Septic tanks serving lakeshore dwellings accounted for an estimated 1.2% of the total phosphorus input, and septic tank contributions to Upper Twin Lake* may add nutrients to this lake; however shoreline surveys would have to be done to determine the significance of those sources. Failure of septic tank systems around the lake in the past has resulted in contamination and enrichment of the adjacent waters (Johns, 1975).

The present phosphorus loading of 0.55 g/m^2/year is about that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading (see page 11). Because the water body is phosphorus limited much of the time, all phosphorus loads should be minimized to protect the present water quality.

2. Non-point sources--Non-point sources accounted for 98.8% of the total phosphorus load during the sampling year. Robinson Creek contributed 73.6%, and the ungaged minor tributaries and immediate drainage contributed an estimated 22.2% of the total load.

* Working Paper No. 762

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 1.52 kilometers^2.
2. Mean depth: 15.2 meters.
3. Maximum depth: 45.4 meters.
4. Volume: 23.104 x 10^6 m^3.
5. Mean hydraulic retention time: 157 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Robinson Creek	76.4	1.303
Minor tributaries & immediate drainage -	23.4	0.396
Totals	99.8	1.699

2. Outlet -

Robinson Creek	101.3**	1.699

C. Precipitation***:

1. Year of sampling: 8.1 centimeters.
2. Mean annual: 14.5 centimeters.

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† Table of metric conversions--Appendix B.
†† Uttormark (in press).
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lower Twin Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at one station in March and two stations in July and November (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 39.6 meters at station 1 and 37.8 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LOWER TWIN LAKES
STORET CODE 0626

	1ST SAMPLING (3/19/75) 1 SITES			2ND SAMPLING (7/ 1/75) 2 SITES			3RD SAMPLING (11/ 6/75) 2 SITES		
PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	2.6 - 2.7	2.6	2.6	5.9 - 12.5	10.1	12.0	10.1 - 10.6	10.5	10.5
DISS OXY (MG/L)	9.8 - 10.0	9.9	10.0	3.6 - 8.6	7.7	8.2	5.8 - 8.8	7.6	7.6
CNDCTVY (MCROMO)	18. - 20.	20.	20.	31. - 53.	43.	43.	21. - 25.	23.	23.
PH (STAND UNITS)	6.5 - 7.2	6.9	6.9	7.4 - 8.6	7.9	7.9	7.4 - 8.9	8.0	7.8
TOT ALK (MG/L)	24. - 28.	26.	26.	23. - 33.	29.	29.	19. - 34.	25.	25.
TOT P (MG/L)	0.010 - 0.013	0.011	0.011	0.013 - 0.028	0.016	0.015	0.009 - 0.019	0.014	0.014
ORTHO P (MG/L)	0.002 - 0.008	0.004	0.003	0.002 - 0.006	0.003	0.003	0.002 - 0.008	0.003	0.002
NO2+NO3 (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020	0.020 - 0.040	0.022	0.020
AMMONIA (MG/L)	0.020 - 0.030	0.023	0.020	0.020 - 0.040	0.025	0.020	0.020 - 0.080	0.032	0.020
KJEL N (MG/L)	0.200 - 0.300	0.217	0.200	0.200 - 0.300	0.221	0.200	0.200 - 0.300	0.208	0.200
INORG N (MG/L)	0.040 - 0.050	0.043	0.040	0.040 - 0.060	0.045	0.040	0.040 - 0.100	0.054	0.040
TOTAL N (MG/L)	0.220 - 0.320	0.237	0.220	0.220 - 0.320	0.241	0.220	0.220 - 0.320	0.231	0.220
CHLRPYL A (UG/L)	3.0 - 3.0	3.0	3.0	1.5 - 1.7	1.6	1.6	4.0 - 4.3	4.1	4.1
SECCHI (METERS)	7.9 - 7.9	7.9	7.9	6.1 - 6.1	6.1	6.1	5.8 - 6.1	5.9	5.9

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/19/75	1. Chroomonas (?) sp.	275
	2. Melosira sp.	78
	3. Synedra sp.	78
	4. Stephanodiscus sp.	39
	5. Asterionella sp.	39
	Other genera	40
	Total	549
07/01/75	1. Melosira sp.	81
	2. Cryptomonas sp.	33
	3. Stephanodiscus sp.	16
	4. Synedra sp.	16
	5. Fragilaria sp.	16
	Total	162
11/06/75	1. Fragilaria sp.	72
	2. Cryptomonas sp.	72
	3. Chroomonas (?) sp.	72
	4. Tabellaria sp.	36
	Total	252

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
03/19/75	1	3.0
	2	-
07/01/75	1	1.7
	2	1.5
11/06/75	1	4.3
	2	4.0

C. Limiting Nutrient Study:

Due to significant changes in nutrients in the samples during shipment from the field to the laboratory, the algal assay results are not considered representative of conditions in the lake at the time samples were collected (03/19/75 and 11/06/75).

The lake data indicate nitrogen limitation in March and phosphorus limitation in July and November. The mean inorganic nitrogen/orthophosphorus ratios were 11/1 in March, 15/1 in July, and 18/1 in November. Nitrogen limitation would be expected when N/P ratios are less than 14/1.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the California National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of May and July when two samples were collected. Sampling was begun in November, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the California District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Robinson Creek at station 25A-1/26A-2 and the mean annual ZZ flow.

No known wastewater treatment plants impacted the lake during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Robinson Creek	615	73.6
b. Minor tributaries & immediate drainage (non-point load) -	185	22.2
c. Known municipal STP's - None	-	-
d. Septic tanks* -	10	1.2
e. Known industrial - None	-	-
f. Direct precipitation**-	25	3.0
Total	835	100.0

2. Outputs -

Lake outlet - Robinson Creek 695

3. Net annual P accumulation - 140 kg.

* Estimate based on 27 lakeshore dwellings and one campground; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Robinson Creek	36,200	73.6
b. Minor tributaries & immediate drainage (non-point load) -	11,000	22.4
c. Known municipal STP's - None	-	-
d. Septic tanks*-	360	0.7
e. Known industrial - None	-	-
f. Direct precipitation** -	1,640	3.3
Total	49,200	100.0

2. Outputs -

Lake outlet - Robinson Creek 51,060

3. Net annual N loss - 1,860 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Robinson Creek	8	474

E. Mean Nutrient Concentrations in Ungaged Stream:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Unnamed Creek B-1	0.018	1.142

* Estimate based on 27 lakeshore dwellings and one campground; see Working Paper No. 175.
** See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.55	0.09	32.4	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lower Twin Lake:

"Dangerous" (eutrophic loading)	1.12
"Permissible" (oligotrophic loading)	0.56

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, underestimation of septic tank contributions, or (possibly) insufficient outlet sampling in relation to the hydraulic retention time of the lake. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

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Uttormark, Paul D. (in press). TSI and LCI: A comparison of two lake classification techniques. North American Proj. Rept., EPA Order No. P3J11904-J, Corvallis, OR.

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
0601	AMADOR RESERVOIR	0.040	0.390	408.667	22.383	14.600	0.020
0602	BOCA LAKE	0.012	0.040	372.833	1.700	6.800	0.003
0603	LAKE BRITTON	0.067	0.115	448.500	4.811	11.200	0.047
0604	CASITAS RESERVOIR	0.029	0.050	400.250	3.192	14.000	0.014
0605	CROWLEY LAKE	0.046	0.045	374.750	5.800	12.200	0.034
0606	DON PEDRO RESERVOIR	0.013	0.060	381.733	3.564	11.400	0.004
0607	LAKE ELSINORE	0.469	0.120	489.214	70.572	8.000	0.092
0608	FALLEN LEAF RESERVOIR	0.007	0.040	24.357	0.786	8.800	0.005
0609	LAKE HENNESSEY	0.027	0.060	416.000	4.525	15.000	0.012
0610	LAKE HENSHAW	0.138	0.070	461.000	26.783	9.800	0.073
0611	IRON GATE RESERVOIR	0.184	0.690	440.333	6.217	13.800	0.124
0614	LOPEZ LAKE	0.371	0.090	372.000	8.658	15.000	0.343
0615	LAKE MARY	0.010	0.040	296.000	2.550	10.600	0.002
0616	LAKE MENDOCINO	0.020	0.050	436.500	3.100	9.400	0.008
0617	NICASIO RESERVOIR	0.055	0.345	482.778	6.633	9.800	0.013
0618	LOWER OTAY RESERVOIR	0.058	0.180	447.250	15.933	15.000	0.013
0619	LAKE PILLSBURY	0.022	0.060	466.667	6.389	8.200	0.008
0620	SANTA MARGARITA LAKE	0.037	0.070	400.000	9.122	14.800	0.014
0621	SHASTA LAKE	0.021	0.060	381.542	4.087	9.000	0.015
0622	SHAVER	0.014	0.060	346.400	1.700	7.400	0.004
0623	SILVER LAKE	0.012	0.055	356.000	1.800	7.000	0.003
0624	TULLOCK RESERVOIR	0.025	0.060	433.000	13.878	7.400	0.009
0625	UPPER TWIN LAKES	0.015	0.040	300.200	3.340	7.400	0.004
0626	LOWER TWIN LAKES	0.014	0.040	248.000	2.900	11.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
0601	AMADOR RESERVOIR	35 (8)	4 (1)	43 (10)	9 (2)	17 (4)	26 (6)	134
0602	BOCA LAKE	89 (20)	98 (22)	70 (16)	91 (21)	100 (23)	91 (20)	539
0603	LAKE BPITTON	17 (4)	22 (5)	17 (4)	48 (11)	43 (10)	17 (4)	164
0604	CASITAS RESERVOIR	43 (10)	74 (17)	48 (11)	70 (16)	22 (5)	37 (8)	294
0605	CROWLEY LAKE	30 (7)	78 (18)	65 (15)	43 (10)	30 (7)	22 (5)	268
0606	DON PEDRO RESERVOIR	83 (19)	54 (11)	57 (13)	61 (14)	37 (8)	78 (17)	370
0607	LAKE ELSINORE	0 (0)	17 (4)	0 (0)	0 (0)	78 (18)	9 (2)	104
0608	FALLEN LEAF RESERVOIR	100 (23)	87 (19)	100 (23)	100 (23)	70 (16)	70 (16)	527
0609	LAKE HENNESSEY	48 (11)	54 (11)	39 (9)	52 (12)	4 (0)	52 (12)	249
0610	LAKE HENSHAW	13 (3)	33 (7)	13 (3)	4 (1)	54 (12)	13 (3)	130
0611	IRON GATE RESERVOIR	9 (2)	0 (0)	26 (6)	39 (9)	26 (6)	4 (1)	104
0614	LOPEZ LAKE	4 (1)	26 (6)	74 (17)	26 (6)	4 (0)	0 (0)	134
0615	LAKE MARY	96 (22)	87 (19)	91 (21)	83 (19)	48 (11)	100 (23)	505
0616	LAKE MENDOCINO	65 (15)	70 (16)	30 (7)	74 (17)	61 (14)	63 (14)	363
0617	NICASIO RESERVOIR	26 (6)	9 (2)	4 (1)	30 (7)	54 (12)	46 (10)	169
0618	LOWER OTAY RESERVOIR	22 (5)	13 (3)	22 (5)	13 (3)	4 (0)	46 (10)	120
0619	LAKE PILLSBURY	57 (13)	41 (9)	9 (2)	35 (8)	74 (17)	63 (14)	279
0620	SANTA MARGARITA LAKE	39 (9)	33 (7)	52 (12)	22 (5)	13 (3)	37 (8)	196
0621	SHASTA LAKE	61 (14)	54 (11)	61 (14)	57 (13)	65 (15)	30 (7)	328
0622	SHAVER	78 (18)	41 (9)	83 (19)	96 (22)	87 (19)	78 (17)	463
0623	SILVER LAKE	89 (20)	65 (15)	78 (18)	87 (20)	96 (22)	91 (20)	506
0624	TULLOCK RESERVOIR	52 (12)	54 (11)	35 (8)	17 (4)	87 (19)	57 (13)	302
0625	UPPER TWIN LAKES	70 (16)	98 (22)	87 (20)	65 (15)	87 (19)	78 (17)	485
0626	LOWER TWIN LAKES	74 (17)	87 (19)	96 (22)	78 (18)	37 (8)	91 (20)	463

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	0602	BOCA LAKE	539
2	0608	FALLEN LEAF RESERVOIR	527
3	0623	SILVER LAKE	506
4	0615	LAKE MARY	505
5	0625	UPPER TWIN LAKES	485
6	0626	LOWER TWIN LAKES	463
7	0622	SHAVER	463
8	0606	DON PEDRO RESERVOIR	370
9	0616	LAKE MENDOCINO	363
10	0621	SHASTA LAKE	328
11	0624	TULLOCK RESERVOIR	302
12	0604	CASITAS RESERVOIR	294
13	0619	LAKE PILLSBURY	279
14	0605	CROWLEY LAKE	268
15	0609	LAKE HENNESSEY	249
16	0620	SANTA MARGARITA LAKE	196
17	0617	NICASIO RESERVOIR	169
18	0603	LAKE BRITTON	164
19	0614	LOPEZ LAKE	134
20	0601	AMADOR RESERVOIR	134
21	0610	LAKE HENSHAW	130
22	0618	LOWER OTAY RESERVOIR	120
23	0607	LAKE ELSINORE	104
24	0611	IRON GATE RESERVOIR	104

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 - cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR CALIFORNIA 09/24/76

LAKE CODE 0626 LOWER TWIN LAKES

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 101.3

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
0626A1	101.3	0.28	0.39	0.41	1.39	2.89	5.24	4.45	2.79	1.46	0.58	0.22	0.14	1.699
0626A2	76.4	0.21	0.28	0.31	1.13	2.49	4.67	3.82	2.41	1.22	0.45	0.16	0.11	1.303
0626ZZ	23.1	0.12	0.13	0.15	0.31	0.88	1.25	0.74	0.31	0.17	0.13	0.13	0.14	0.396

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 101.3
SUM OF SUB-DRAINAGE AREAS = 99.5
TOTAL FLOW IN = 21.73
TOTAL FLOW OUT = 20.24

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0626A1	11	74	0.152	15	0.215				
	12	74	0.025	13	0.024				
	1	75	0.014	15	0.013				
	2	75	0.023						
	3	75	0.182	14	0.018	15	0.023		
	4	75	0.631	27	0.510	29	1.671		
	5	75	2.798	12	2.322	30	4.332		
	6	75	6.994	6	8.014				
	7	75	5.069	7	5.607	24	4.304		
	8	75	2.917	4	2.379	15	2.860		
	9	75	2.263	11	2.350				
	10	75	0.654						
0626A2	11	74	0.255	15	0.396				
	12	74	0.008	13	0.023				
	1	75	0.057	15	0.045				
	2	75	0.425						
	3	75	0.453	14	0.396	15	0.396		
	4	75	0.396	27	0.368				
	5	75	2.124	12	1.048	30	4.049		
	6	75	5.607	6	6.768				
	7	75	4.078	7	4.842	24	3.341		
	8	75	1.529	4	1.699	15	1.642		
	9	75	1.557	11	1.812				
	10	75	0.566						
0626ZZ	11	74	0.133						
	12	74	0.122						
	1	75	0.113						
	2	75	0.116						
	3	75	0.130						
	4	75	0.142						
	5	75	0.878						
	6	75	1.586						
	7	75	0.906						
	8	75	0.311						
	9	75	0.204						
	10	75	0.0						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/09/24

062601
38 09 30.0 119 20 25.0 3
LOWER TWIN. LAKES
06051 CALIFORNIA
150193

11EPALES 2111202
0114 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/19	10 45	0000	2.6	10.0	312	18	6.50	26	0.030	0.200	0.020K	0.004
	10 45	0005	2.6	10.0		20	6.80	26	0.020	0.200K	0.020K	0.003
	10 45	0030	2.6	9.8		20	6.80	25	0.020K	0.200K	0.020K	0.002
	10 45	0060	2.6	10.0		20	7.00	24	0.020	0.200K	0.020K	0.003
	10 45	0090	2.6	9.9		20	7.20	25	0.020K	0.200	0.020K	0.002
	10 45	0110	2.7	10.0		20	7.20	28	0.030	0.300	0.020K	0.008
75/07/01	12 00	0000	12.5	8.2	240	53	7.90	33	0.030	0.200	0.020K	0.004
	12 00	0005	12.5	8.2		45	8.40	31	0.020	0.200	0.020K	0.003
	12 00	0015	12.1	8.2		43	8.10	31	0.030	0.200K	0.020K	0.003
	12 00	0035	11.9	8.2		31	7.90	23	0.020	0.200	0.020K	0.002
	12 00	0060	9.9	8.4		44	7.75	25	0.020	0.200	0.020K	0.003
	12 00	0090	6.7	3.6		42	7.60	27	0.020	0.200	0.020K	0.003
	12 00	0130	5.9	6.6		50	7.40	31	0.040	0.200	0.020K	0.006
75/11/06	13 25	0000	10.6	8.0	228	21	8.90	19		0.200K	0.020K	0.002
	13 25	0005		7.6			8.50	22		0.200K	0.020K	0.002K
	13 25	0015	10.6	7.6		23	8.30	25	0.020K	0.200K	0.020K	0.002
	13 25	0033	10.5	7.4		23	8.20	25	0.080	0.200K	0.020K	0.002K
	13 25	0070	10.4	7.8		23	7.95	23	0.020K	0.200K	0.020	0.002
	13 25	0110	10.4	8.8		23	7.90	25	0.020K	0.200K	0.030	0.003

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

062601
38 09 30.0 119 20 25.0 3
LOWER TWIN LAKES
06051 CALIFORNIA
150193

11EPALES 2111202
0114 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/19	10	45 0000	0.011	3.0	
	10	45 0005	0.010		
	10	45 0030	0.011		
	10	45 0060	0.010		
	10	45 0090	0.011		
	10	45 0110	0.013		
75/07/01	12	00 0000	0.017	1.7	
	12	00 0005	0.016		
	12	00 0015	0.015		
	12	00 0035	0.017		
	12	00 0060	0.018		
	12	00 0090	0.015		
	12	00 0130	0.028		
75/11/06	13	25 0000	0.014	4.3	
	13	25 0005	0.012		
	13	25 0015	0.009		
	13	25 0033	0.011		
	13	25 0070	0.016		
	13	25 0110	0.016		

STORET RETRIEVAL DATE 76/09/24

062602
38 10 00.0 119 19 47.0 3
LOWER TWIN LAKES
06051 CALIFORNIA
150193

11EPALES 2111202
0115 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/07/01	12 30	0000	12.4	8.6	240	44	7.90	26	0.020	0.300	0.020K	0.004
	12 30	0005	12.5	8.6		45	8.60	28	0.030	0.300	0.020K	0.003
	12 30	0015	12.4	8.4		39	8.20	27	0.020	0.200	0.020K	0.002
	12 30	0035	12.1	8.2		40	8.05	27	0.020	0.200	0.020K	0.002K
	12 30	0060	8.3	8.0		41	7.80	29	0.020	0.200	0.020K	0.002
	12 30	0085	6.2	7.8		42	7.60	32	0.030	0.200	0.020K	0.003
	12 30	0110	6.0	7.2		42	7.40	32	0.030	0.300	0.020K	0.005
75/11/06	13 05	0000	10.6	8.2	240	25	7.80	34	0.020K	0.300	0.020K	0.004
	13 05	0005	10.6	7.8		23	7.70	25		0.200K	0.020K	0.002
	13 05	0015	10.6	7.6		23	7.70	24		0.200K	0.020K	0.004
	13 05	0035	10.5	7.6		23	7.60	30		0.200	0.020	0.008
	13 05	0075	10.1	6.8		24	7.50	20		0.200K	0.020	0.002
	13 05	0124	10.3	5.8		25	7.45	22		0.200K	0.040	0.005

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/07/01	12 30	0000	0.015	1.5	
	12 30	0005	0.014		
	12 30	0015	0.013		
	12 30	0035	0.015		
	12 30	0060	0.013		
	12 30	0085	0.015		
	12 30	0110	0.017		
75/11/06	13 05	0000	0.019	4.0	
	13 05	0005	0.016		
	13 05	0015	0.014		
	13 05	0035	0.012		
	13 05	0075	0.011		
	13 05	0124	0.015		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/09/24

0626A1
38 10 20.0 119 19 25.0 4
ROBINSON CREEK
06 15 MATTERHORN PK
O/LOWER TWIN LAKES 150193
SEC RD BRDG .1 MI N OF TWIN LKS CAMPGRND
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/15	12 40		0.008	0.100	0.025	0.005K	0.020
74/12/13	10 25		0.032	0.400	0.015	0.005	0.010K
75/01/15	11 15		0.040	0.650	0.016	0.005K	0.010K
75/03/14	12 05		0.020	2.100	0.035	0.005	0.010K
75/03/15	11 45		0.024	0.200	0.008K	0.008K	0.010K
75/04/29	08 30		0.070	0.650	0.035	0.005K	0.010K
75/05/12	13 35		0.005	1.350	0.010	0.005K	
75/05/30	10 15		0.010	2.100	0.090	0.005K	0.010
75/06/06	10 30		0.070	0.800	0.050	0.005K	0.020
75/07/07	15 10		0.005	0.300	0.040	0.005K	0.020
75/07/24	11 00		0.025	3.150	0.085	0.015	0.015
75/08/04	14 41		0.005	0.300	0.017	0.005K	0.010
75/08/15	10 35		0.020	0.300	0.020	0.005K	0.020
75/09/11	17 50		0.005	0.600	0.035	0.005K	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

0626A2
38 09 15.0 119 20 55.0 4
ROBINSON CREEK
06 15 MATTERHORN PK
T/LOWER TWIN LAKES 150193
UNPVD RD BRDG 1.5 MI E OF MONO VILLAGE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/15	11 50		0.005K	0.100K	0.008	0.005	0.025
75/01/15	10 50		0.012	1.300	0.016	0.005K	0.010K
75/03/14	11 30		0.005	1.280	0.025	0.005K	0.010K
75/03/15	11 00		0.008	0.500	0.008K	0.008K	0.010K
75/04/27	09 12		0.010	1.000	0.020	0.005K	0.010K
75/05/12	13 10		0.010	0.800	0.010	0.005K	0.020
75/05/30	09 35		0.010	2.500	0.090	0.005K	0.010K
75/06/06	09 45		0.050	0.150	0.010	0.005K	0.020
75/07/07	14 52		0.005		0.080	0.005K	
75/07/24	10 30		0.005	0.050K	0.010	0.010	0.010
75/08/04	13 45		0.005	0.200	0.010	0.005K	0.010K
75/08/15	10 50		0.005	0.350	0.020	0.005K	0.020
75/09/11	16 30		0.005	0.400	0.030	0.005K	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/09/24

062681
38 09 15.0 119 20 30.0 4
UNNAMED CREEK
06 15 MATTERHORN PK
T/LOWER TWIN LAKES 150193
SEC RD BRDG 1.5 MI SW TWIN LKS CAMPGRND
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/15	12	20	0.008	0.100	0.015	0.020	0.040
75/05/30	09	59	0.005	1.150	0.050	0.005K	0.010K
75/06/06	10	10	0.075	2.300	0.260	0.005K	0.020
75/07/07	14	30	0.005	0.100	0.015	0.005	0.010
75/07/24	13	48	0.005	0.100	0.005	0.010	0.010
75/08/04	11	25	0.005	0.050	0.005K	0.005	0.010
75/08/15	11	00	0.010	4.200	0.850	0.005K	0.015
75/09/11	16	50	0.020	1.000	0.025	0.005K	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED