Kezar Lake

From Good to Bad, and Back Again
A 70+ Year Retrospective

Photo Source: http://pamperkinsrealestate.com/our-areas/sutton/kezar/

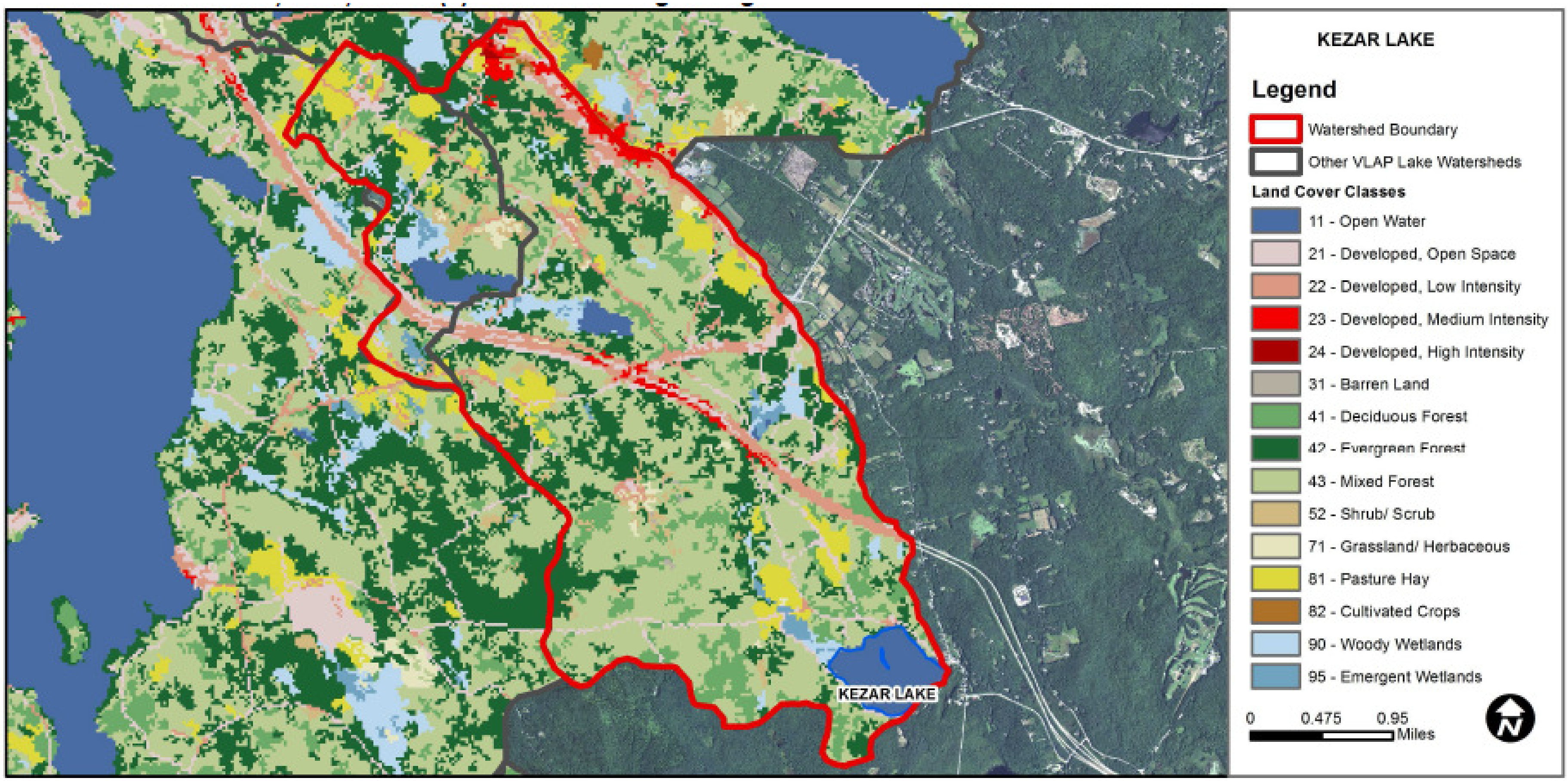
Presentation Overview

- General background and morphology of Kezar Lake
- What made Kezar Lake go bad?
  - History of water quality concerns, studies and remediation techniques
- Water quality of Kezar Lake today
- Current day threats

Morphology of Kezar Lake

- **Location**: North Sutton, New Hampshire
- **Trophic Status**: Mesotrophic
- **Watershed Area**: 6,848 acres
- **Surface Area**: 182 acres
- **Maximum Depth**: 27.06 feet
- **Mean Depth**: 8.91 feet

Land Uses in the Kezar Lake Watershed



First Surveys of Kezar Lake

- **1938**: NH Fish and Game conducted the first chemical, biological, and physical water quality survey on Kezar Lake. Overall, no concerning results. Due to low bottom oxygen, the pond was rated as suitable for warmwater fisheries.

Parameter	Result
Color	Brownish
Transparency	11 Feet
Alkalinity	7-10 mg/L $CaCO_3$
pH	6.2-6.8

- Other water quality assessments from NH DES began in the 1960s and 1970s when lakes programs were initiated

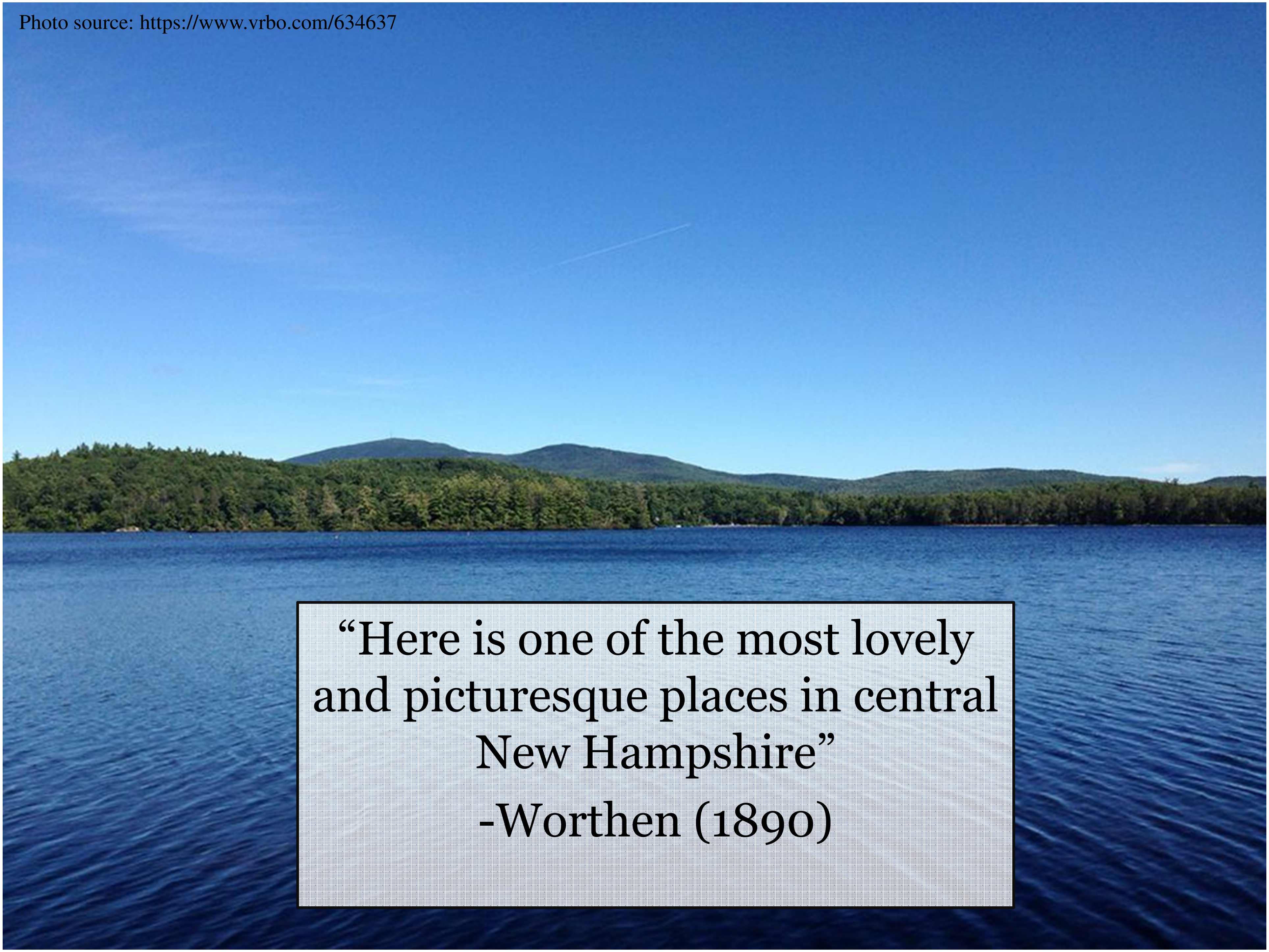


Photo source: https://www.vrbo.com/634637
“Here is one of the most lovely and picturesque places in central New Hampshire”
-Worthen (1890)

Why So Much Focus on Kezar Lake?

- Historically, Kezar Lake was known as a pristine waterbody
  - In 1934, a portion of the Kezar Lake shoreline became the site for Wadleigh State Park due to its beauty and many recreational uses
- But….things started to change when the New London Wastewater Treatment Plant was built in 1931
  - Treatment plant's nutrient-rich effluent (mostly Phosphorus) was discharged into the main tributary of Kezar Lake, Lyon Brook, about 3.5 mi upstream of the lake
  - This stimulated the eutrophication process (lake aging) and had many direct and indirect influences on Kezar Lake's water quality over decades….and so it began…

Eutrophication

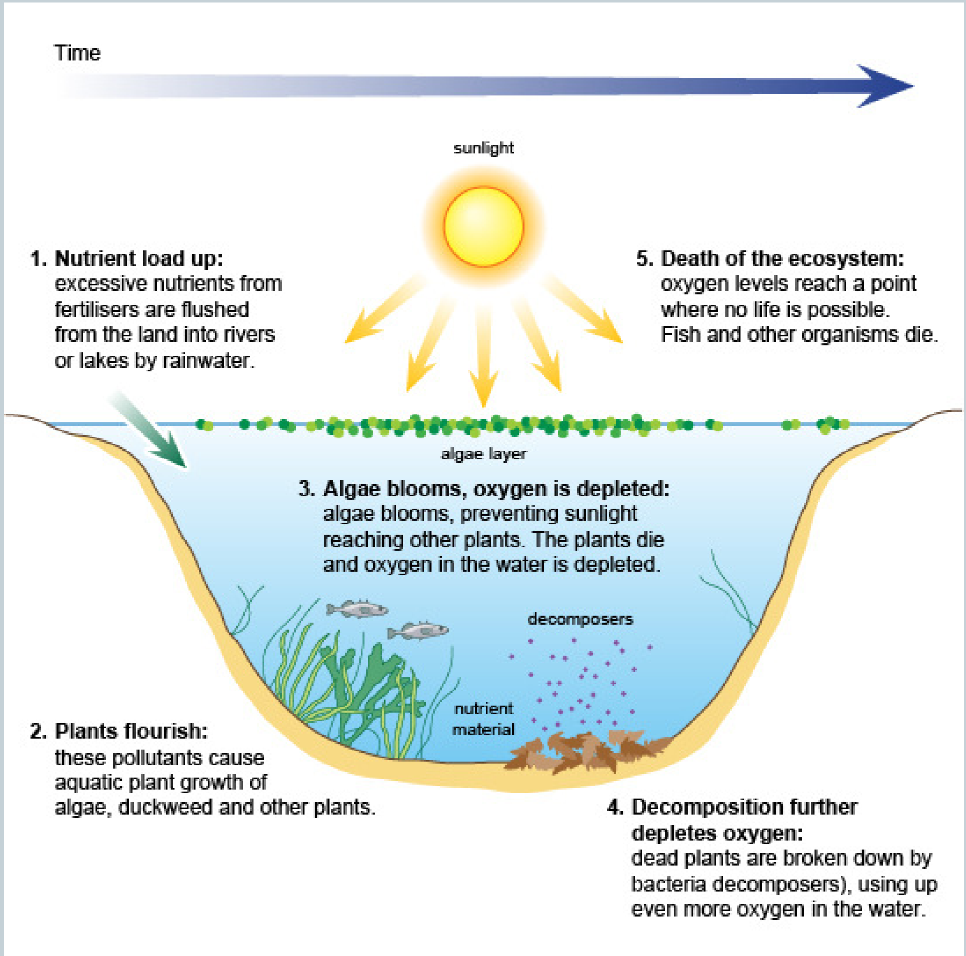


Image Source: http://www.bbc.co.uk/staticarchive/05e29b2e4fb11a0954c97cbe5273999767ea9fff.jpg

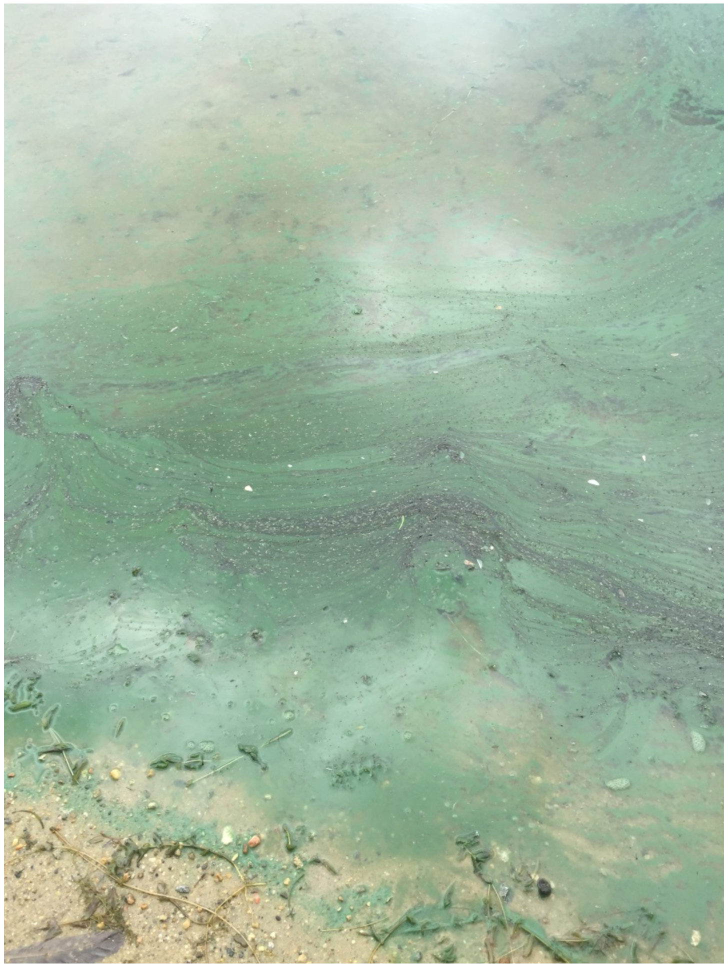
Simply put....

More Phosphorus = More Growth (algae usually)


Approximate Location of Sewage
Treatment Plant along Lyon Brook
Kezar Lake
Google

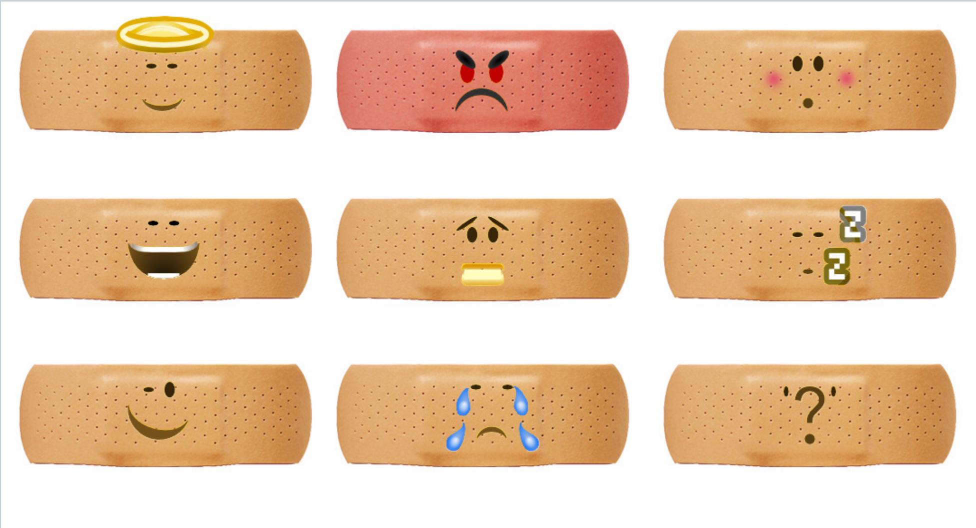
First Documented Water Quality Concern

- **1961:** First documented algae bloom in the lake (*Anabaena*, a cyanobacteria)



Initial Attempts at a Fix- 1960s

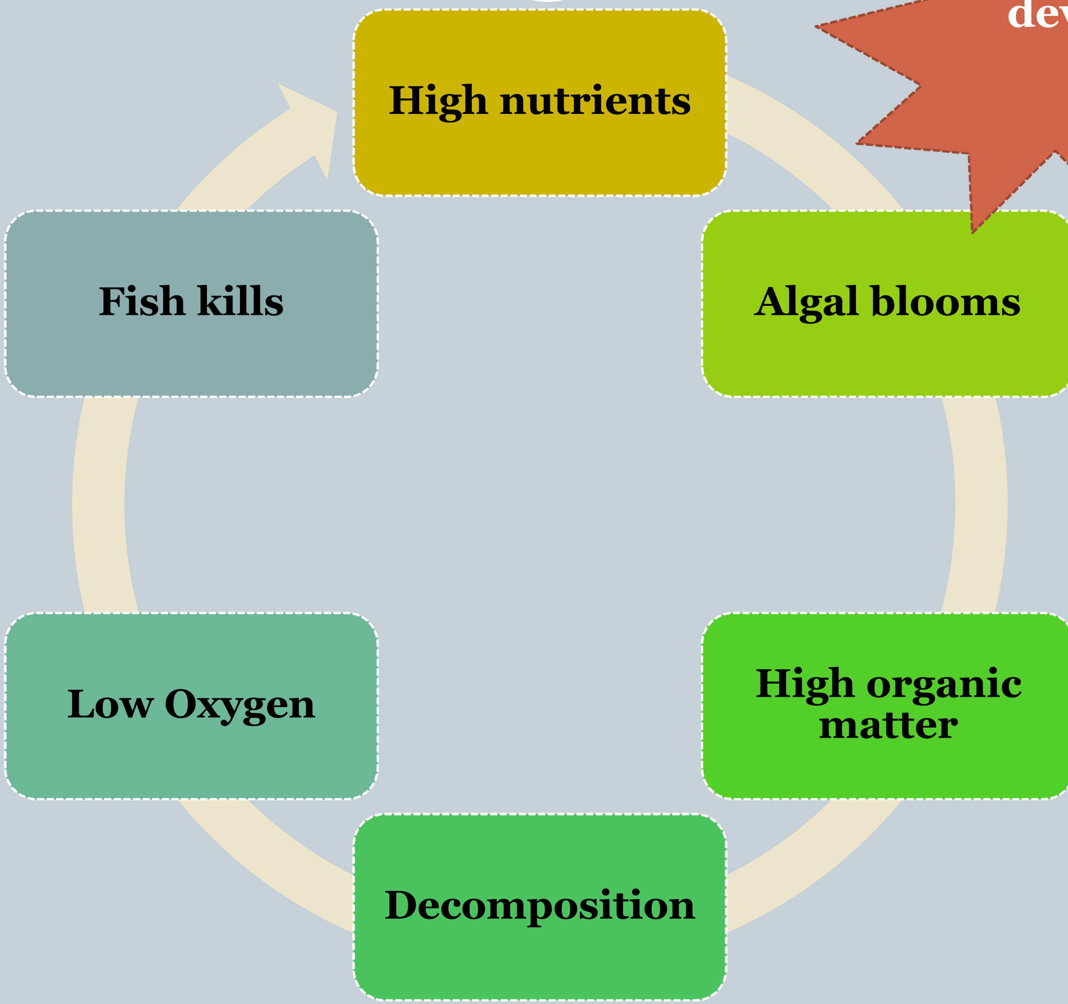
- Several attempts to fix the problems in the lake were implemented
- Most were “Bandaid” approaches



1960s Copper Sulfate (Algaecide Treatments)

- **1963/1964:** Copper sulfate treatments to reduce algae growth from initial blooms
- **1966**: Another algal bloom was reported and treated with copper sulfate. Treatment was not effective this time, possibly because the algae resisted the copper sulfate. A large fish kill followed.
- Successive blooms were of another type of cyanobacteria known as *Aphanizomenon*, at the time known to be a serious toxin producer, so copper sulfate treatments were suspended

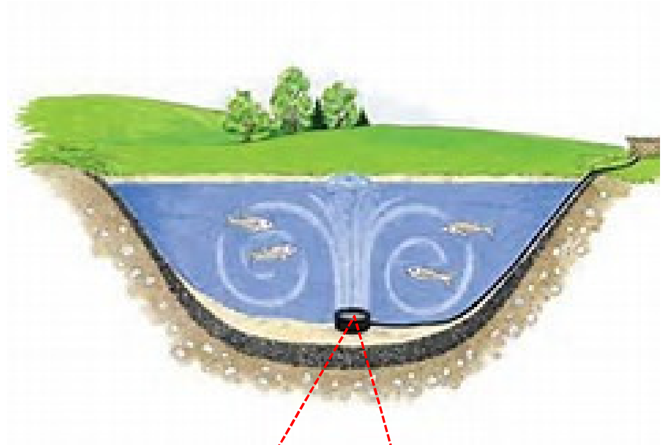
Stuck in a Bad Cycle



Shorefront properties devalued in 1968!

Mechanical Destratification

- **1969**: Mechanical destratification was initiated to stimulate lake mixing
  - Compressed air sent to the bottom of the lake released bubbles that lifted cool water to the surface
  - Algae was mixed throughout the water column, preventing dense colonies from blooming
  - This process allowed for short-term water quality successes



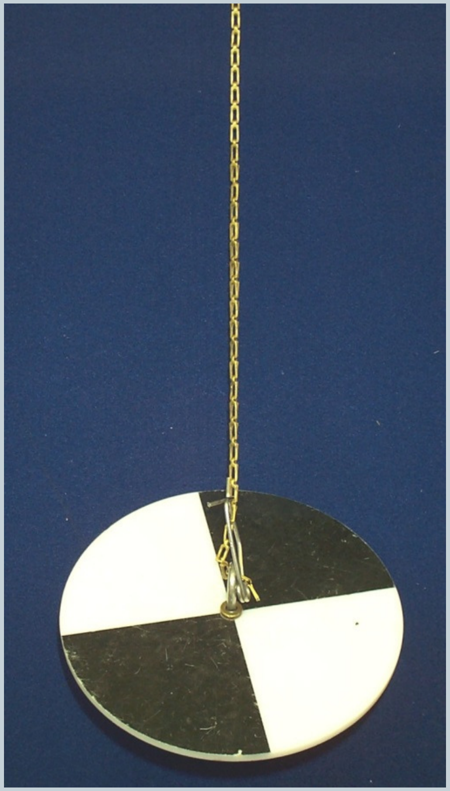
Mechanical destratification mixed dissolved oxygen throughout the water column, preventing dense algal growth at the surface

Image source: http://www.hakkoairpumps.com/UserFiles/upwelling%20current.jpg(3).jpg

Dense Algal Blooms from Increased Nutrients: No Fun for Lake Residents or Park Visitors

- Blooms and Clarity

Year	Bloom Duration	Clarity (<4 ft)
1968	20 weeks	14 weeks
1969	14 weeks	4 weeks
1970	8 weeks	6 weeks
1971	4 weeks	4 weeks
1972	8 weeks	7 weeks
1973	14 weeks	14 weeks
1974	9 weeks	7 weeks
1975	10 weeks	7 weeks



Mechanical Destratification, cont.

- **1970**: Dense algal blooms appeared again despite destratification practices.
  - Treatment plant initiated tertiary treatment processes of sewage.
- **1972/1973**: Cycle of algae blooms returned back to pre-destratification levels
- **1974**: Last season destratification was used

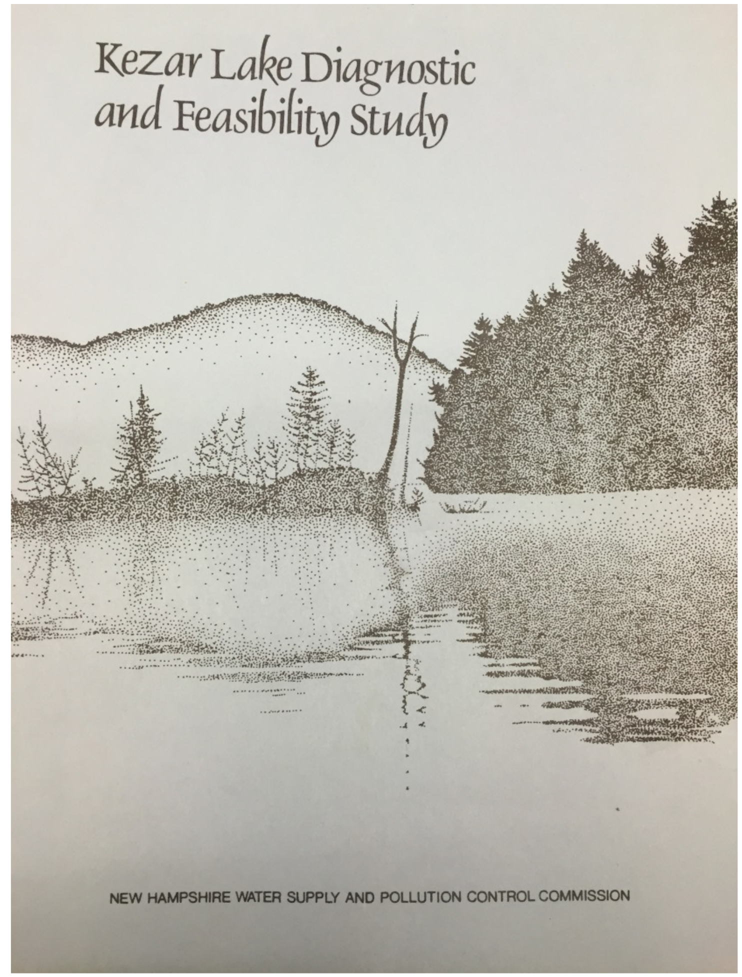
Environmental Protection Agency Involvement

- **1978**: Section 314 of the Clean Water Act brought the EPA to Kezar Lake to survey water quality
  - Classified Kezar Lake as eutrophic (worst rating)
  - Concentrations of phosphorus were measured at over 80 ug/L (over 10 ug/L is undesireable for a healthy lake)
  - Kezar Lake ranked #1 out of 71 eligibile lakes for restoration efforts
  - **Resulted in a 19 year, three-phase study funded by the EPA**
    - Phase I- Diagnostic/Feasibility Study
    - Phase II- Implementation Project
    - Phase III- Follow Up Monitoring and Reporting

Study Phase I: Diagnostic and Feasibility Study

- **1979**: Diagnostic and Feasibility study grant was awarded to Kezar Lake

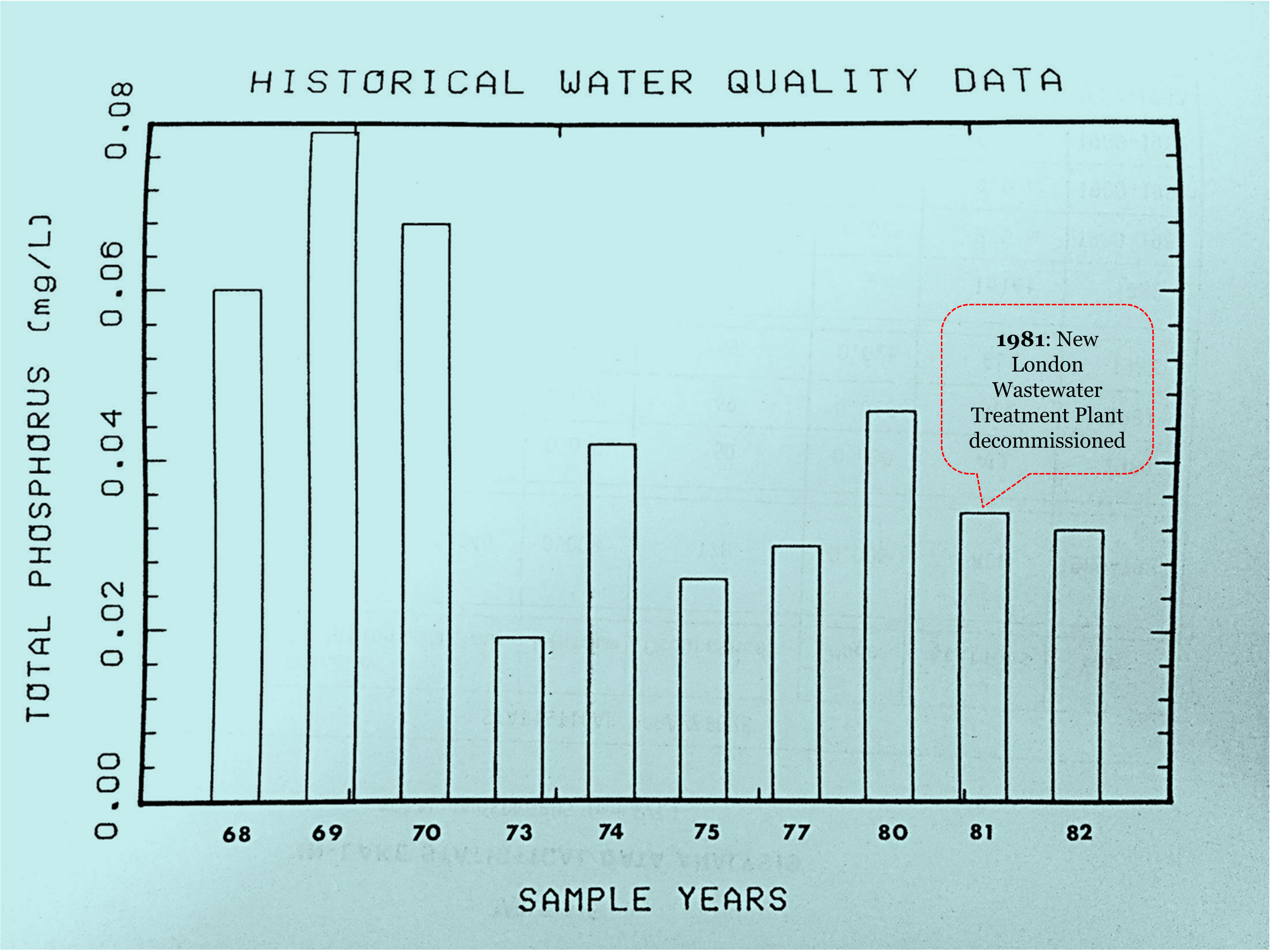
"To determine the causes and extent of pollution, evaluate potential solutions to water quality problems, and recommend an effective and feasible method for restoring and maintaining water quality in a particular lake"



Diagnostic and Feasibility Study Field Procedures

- Established 12 set sampling locations within the lake and watershed that were regularly sampled
- Parameters Included:

  - Temperature
  - Dissolved Oxygen
  - Turbidity
  - Plankton
  - Transparency
  - Chlorides
  - pH
  - Alkalinity
  - Hardnesss
  - Phosphorus
  - Nitrogen
  - Chlorophyll-a



HISTORICAL WATER QUALITY DATA
TOTAL PHOSPHORUS (mg/L)
0.00
0.02
0.04
0.06
0.08
68
69
70
73
74
75
77
80
81
82
SAMPLE YEARS
1981: New London Wastewater Treatment Plant decommissioned

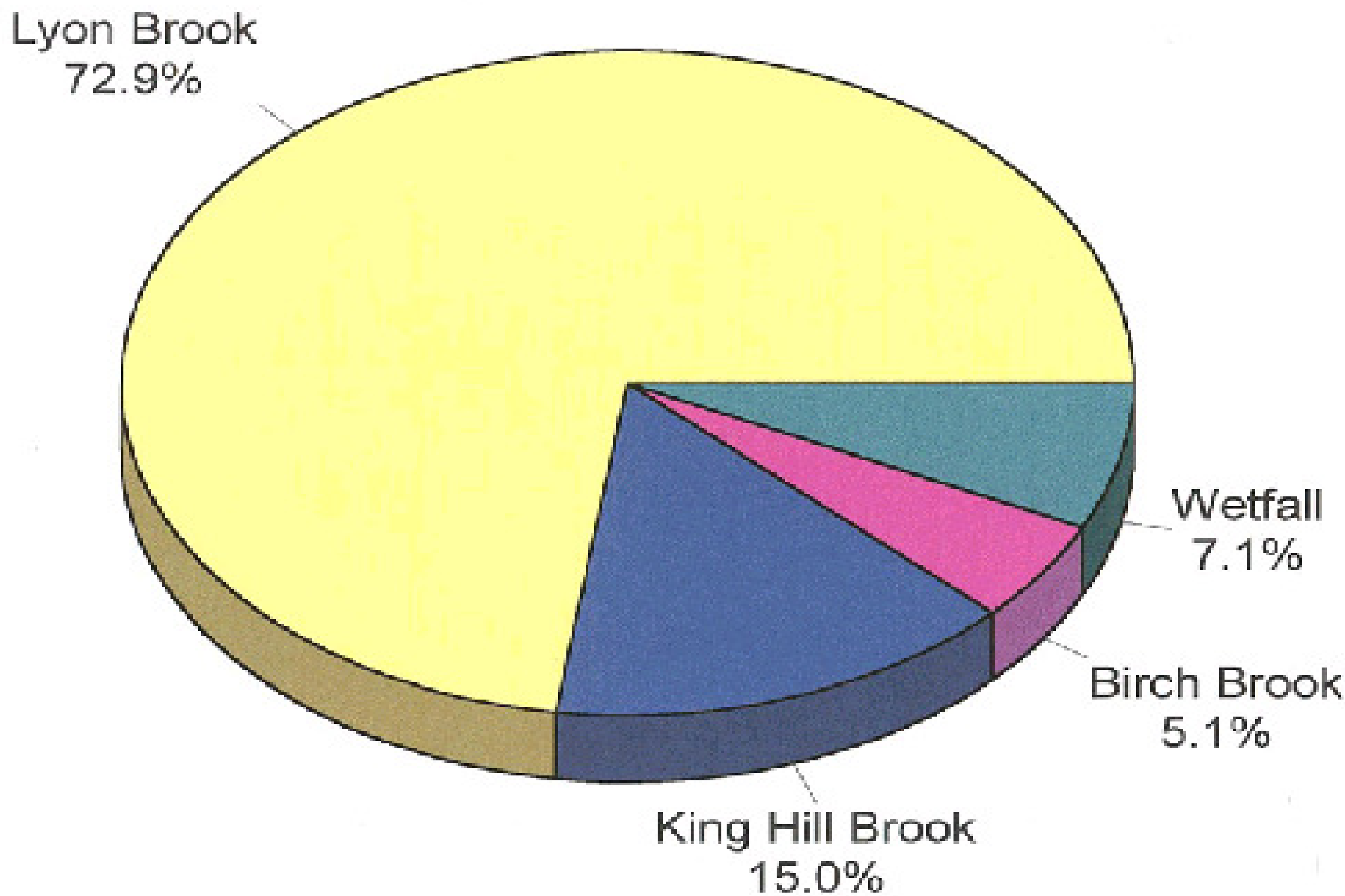


Figure - VI-1: Total Inflow and Wetfall Contributions to Kezar Lake for 1990-91 Phase III

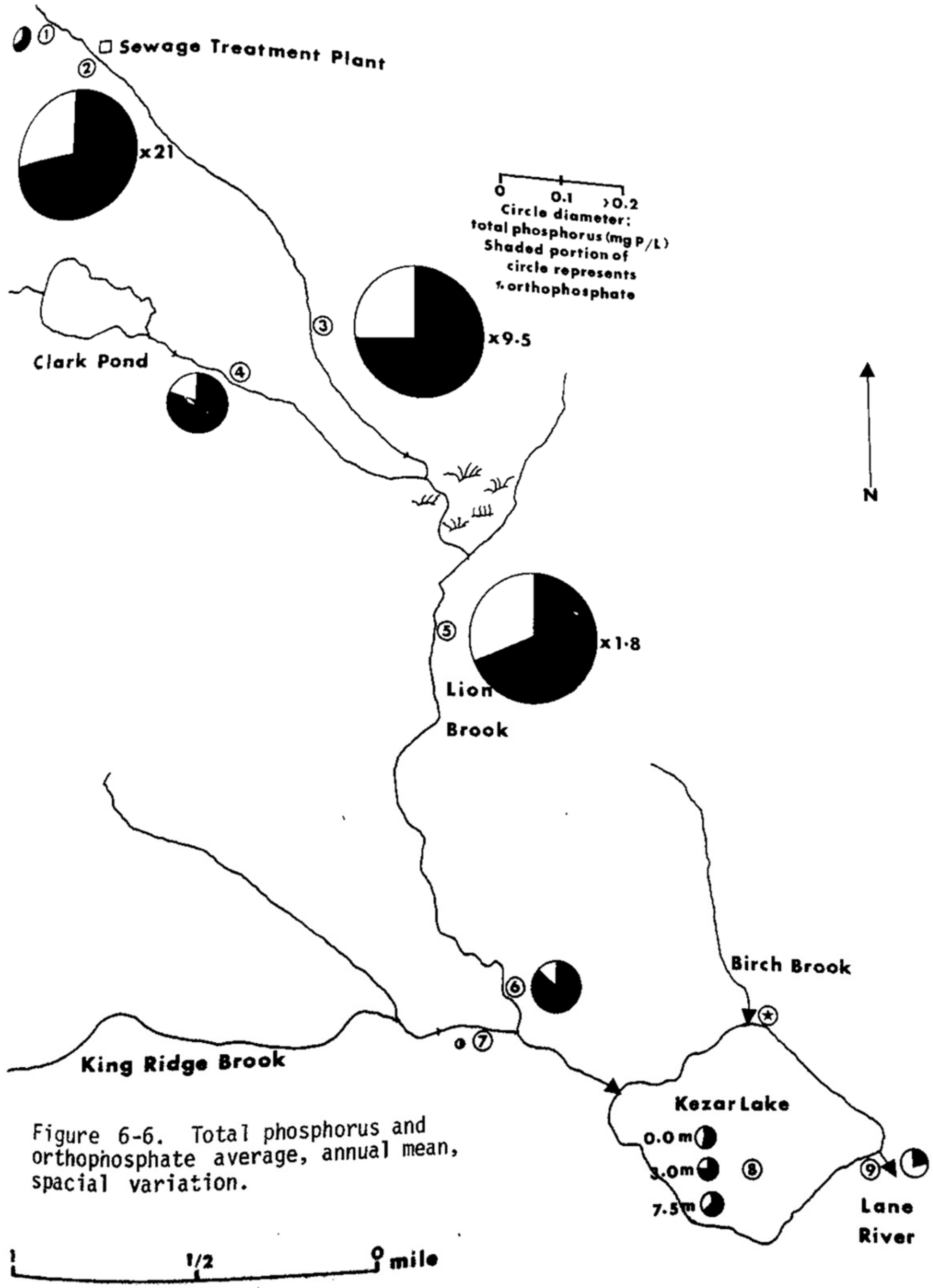


Figure 6-6. Total phosphorus and orthophosphate average, annual mean, spacial variation.

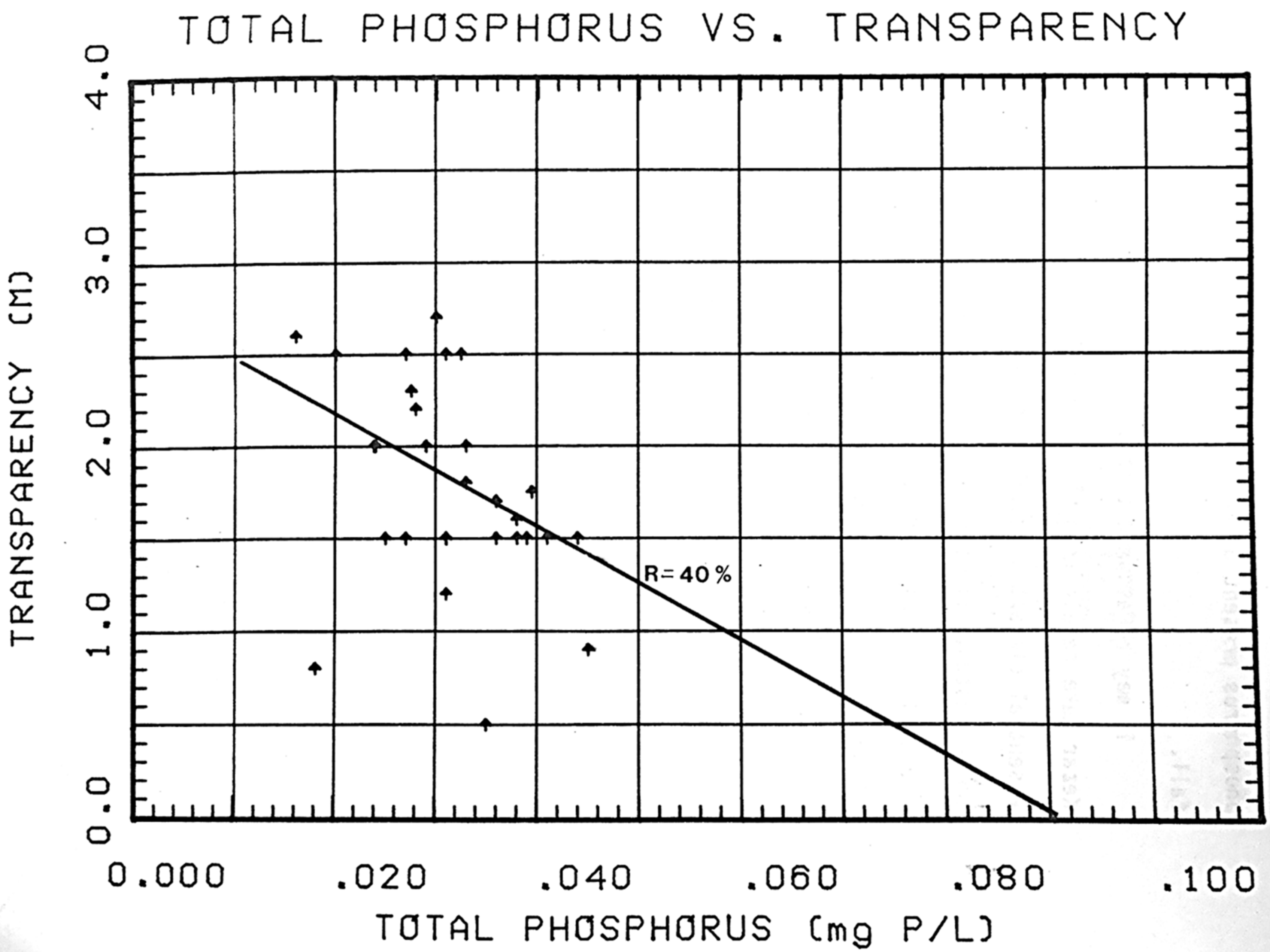


Figure 6-5. Linear relationship of phosphorus and transparency in Kezar Lake.

Study Phase II: Restoration/Protection Project

- **1984**: Beginning of Restoration/Protection Project
  - Two Strategies
    1. Aluminum salt additions to inactivate excess phosphorus that settled into the sediments
       - Inflowing sources remediated
         - ✓ Time and distance from initial high loadings
         - ✓ Decommissioning of old plant
         - ✓ Addition of tertiary treatment step
         - Needed to address internal sources of Phosphorus (internal loading from bottom sediments)
    2. Use wetlands to lock up phosphorus into wetland vegetation
       - Cleaning up residual phosphorus in the stream

Aluminum Salt Additions

- Aluminum forms complexes around phosphorus which restricts it from being taken up by organisms such as phytoplankton
  - Immediate Results
    - Shorter period of anoxia (low to no oxygen)
    - Shift in dominant phytoplankton species
    - Decreased total phosphorus levels
    - Increased transparency
    - Decreased Chl-a
    - Increased plant density (due to increased clarity)

Manipulation of Riparian Wetlands: Use What You've Got!

- Chadwick Meadows Wetlands were created along Lyon Brook in 1983
  - Impounded existing wetlands
  - Added additional vegetation (wild rice) to take up phosphorus during the growing season, so it was not free for algae in the lake to use to grow
  - Immediate results
    - Phosphorus levels were reduced in Kezar Lake during some study months
    - Oftentimes, the wetlands were noted to be more of a source than a sink for Phosphorus – possibly due to the wetlands' young age

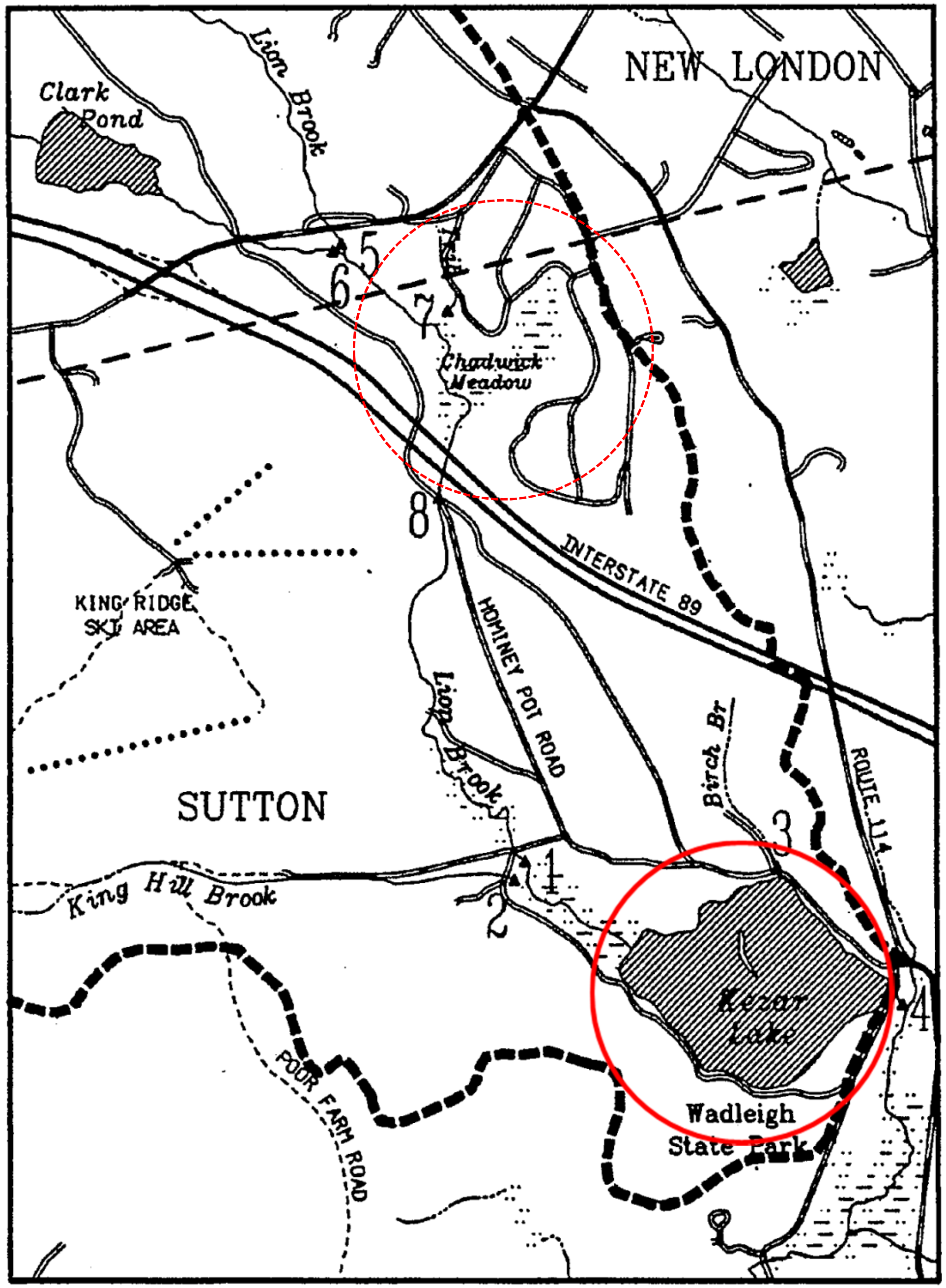
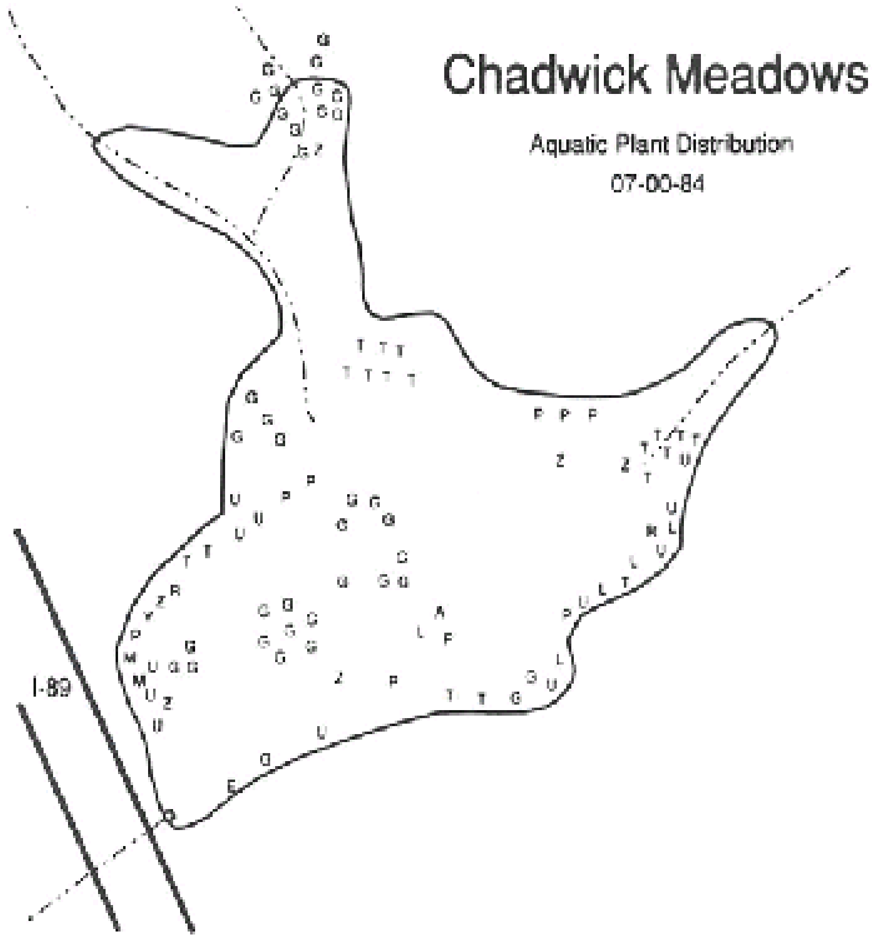
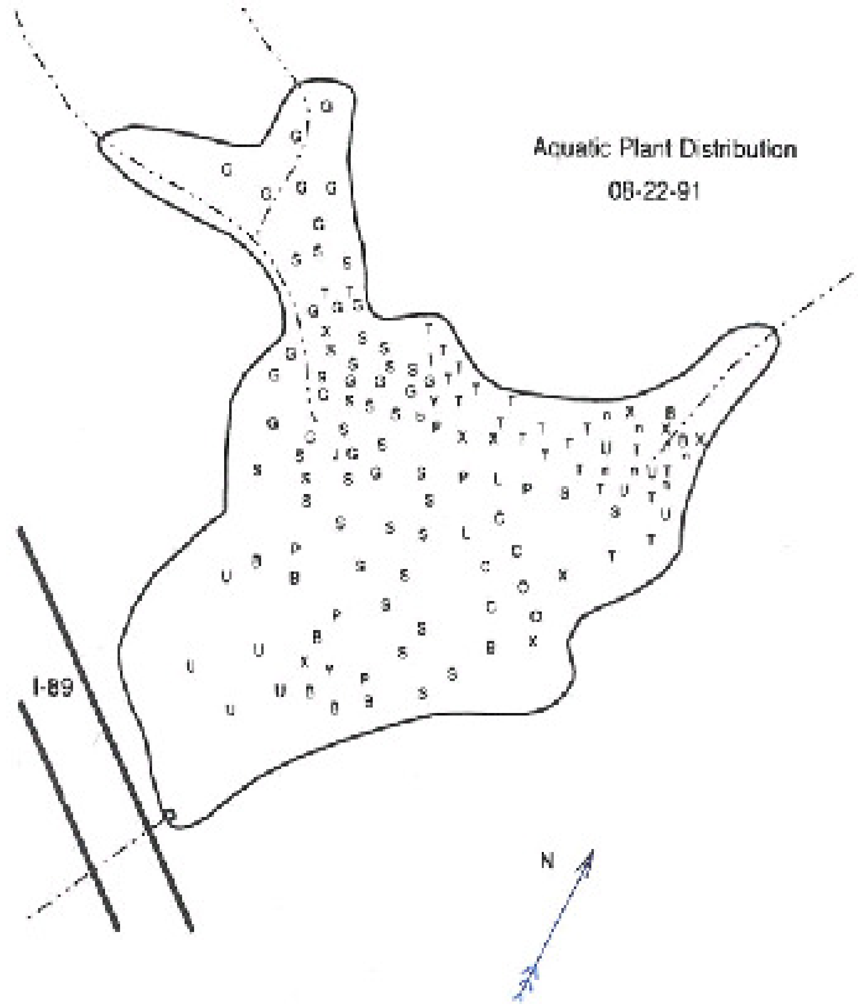


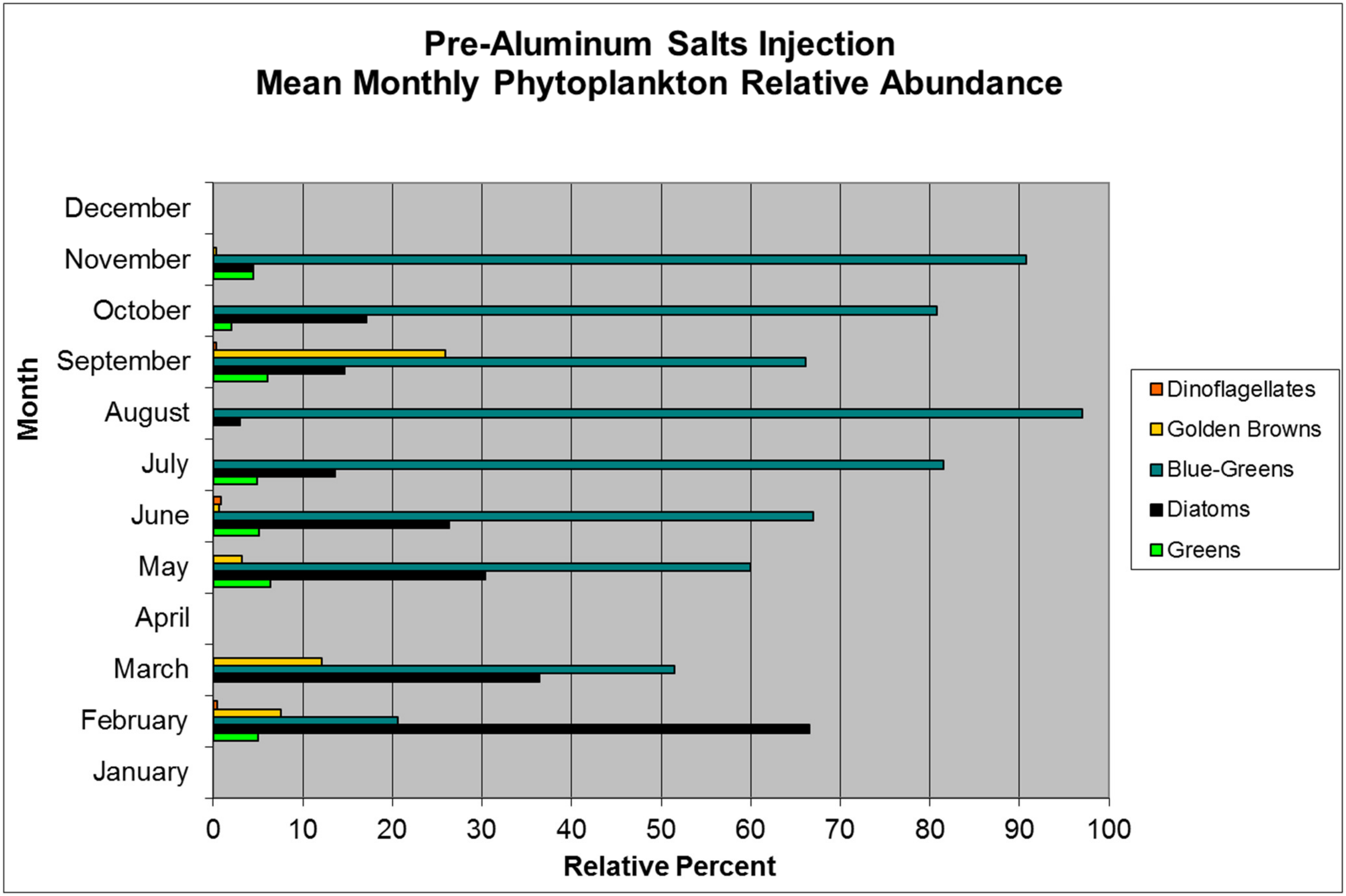
Figure III-1 Sample Stations for the Phase III Study Designated as Numbers 1-8


Chadwick Meadows
Aquatic Plant Distribution
07-00-84
I-89

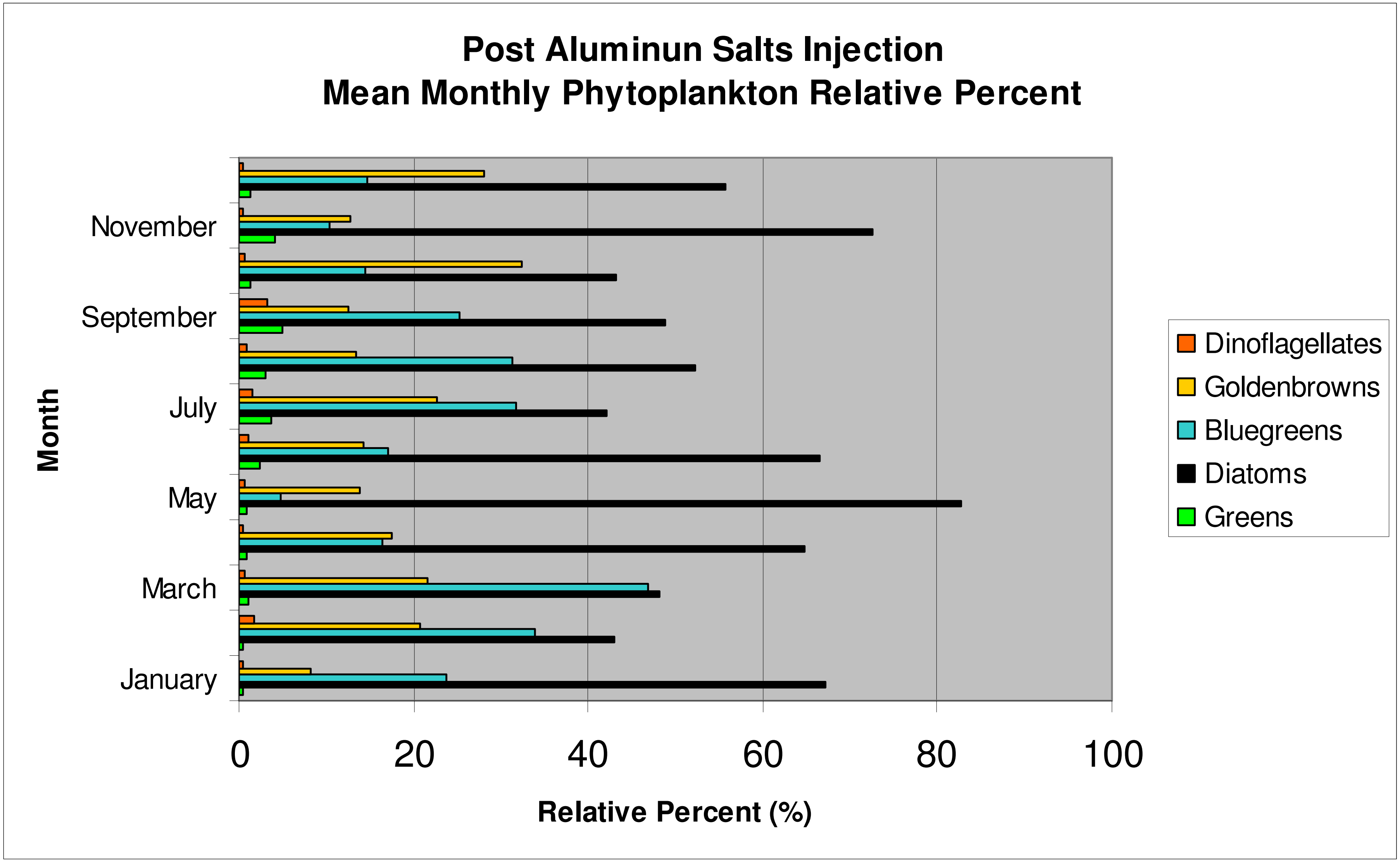

Aquatic Plant Distribution
08-22-91
I-89
N

Study Phase III: Post-Restoration Monitoring Project

- EPA funded the New Hampshire Department of Environmental Services to continue monitoring Kezar Lake from 1984-1994
- Goal was to evaluate the effectiveness of the aluminum salt additions and the Chadwick Meadows Marsh system



Pre-Aluminum Salts Injection
Mean Monthly Phytoplankton Relative Abundance
Month
December
November
October
September
August
July
June
May
April
March
February
January
0
10
20
30
40
50
60
70
80
90
100
Relative Percent
Dinoflagellates
Golden Browns
Blue-Greens
Diatoms
Greens



Post Aluminun Salts Injection
Mean Monthly Phytoplankton Relative Percent
Month
November
September
July
May
March
January
0
20
40
60
80
100
Relative Percent (%)
Dinoflagellates
Goldenbrowns
Bluegreens
Diatoms
Greens

Post-Aluminum Salts Injection Chlorophyll-a Concentrations

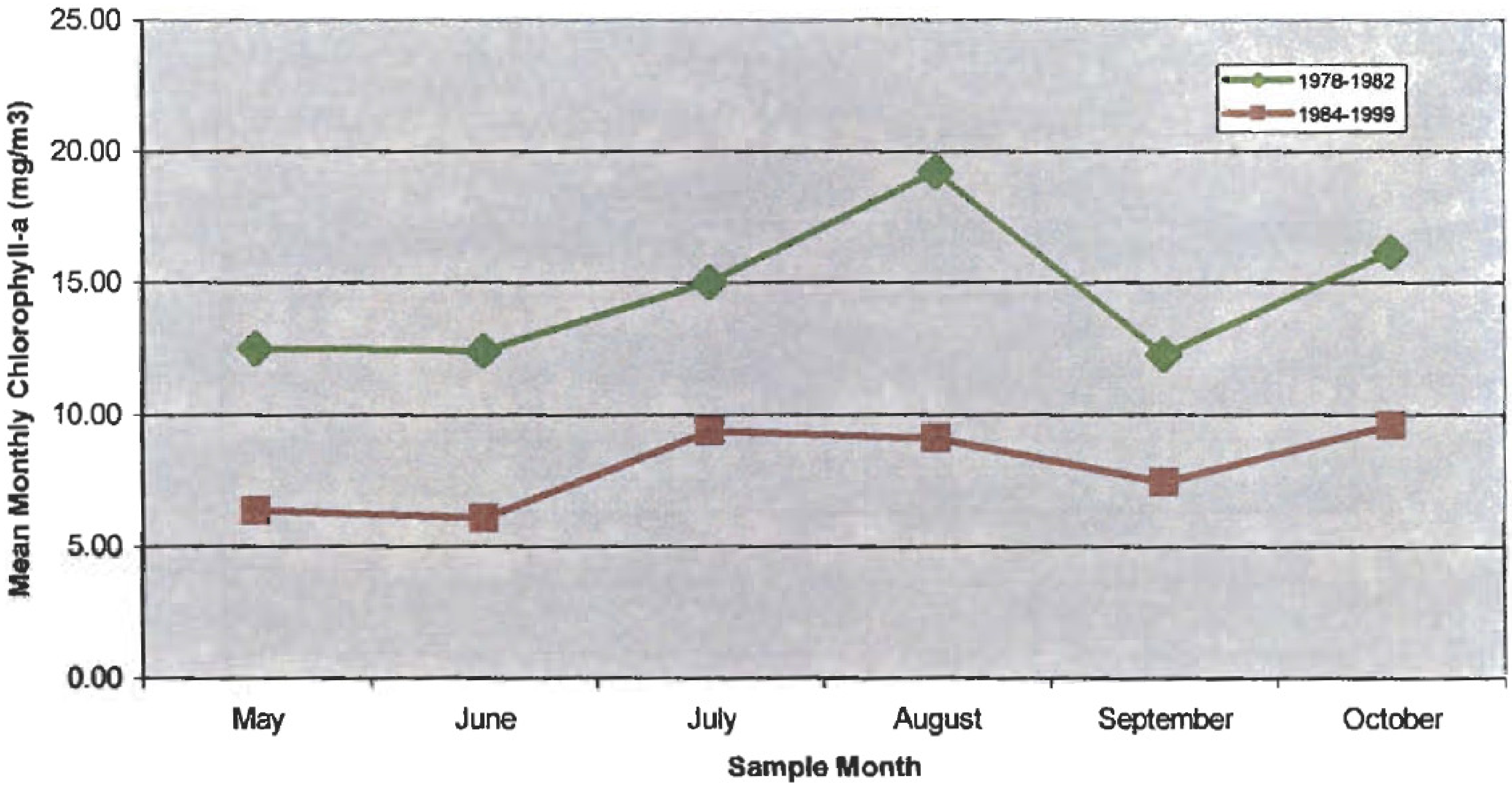


Figure IV-5 The relationship between mean monthly chlorophyll-a concentrations (mg/m3) before and after aluminum salts injection

Post-Treatment Transparency

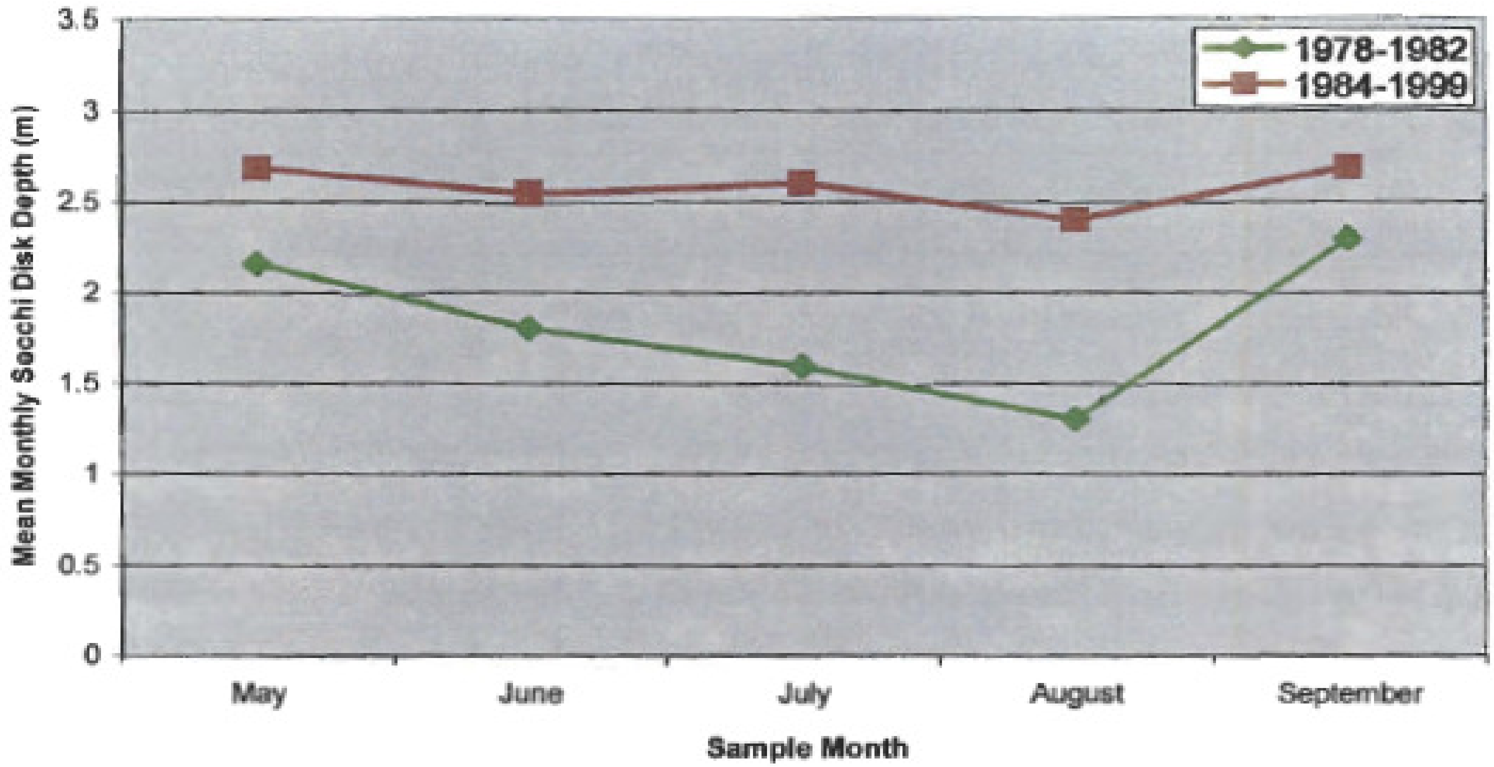
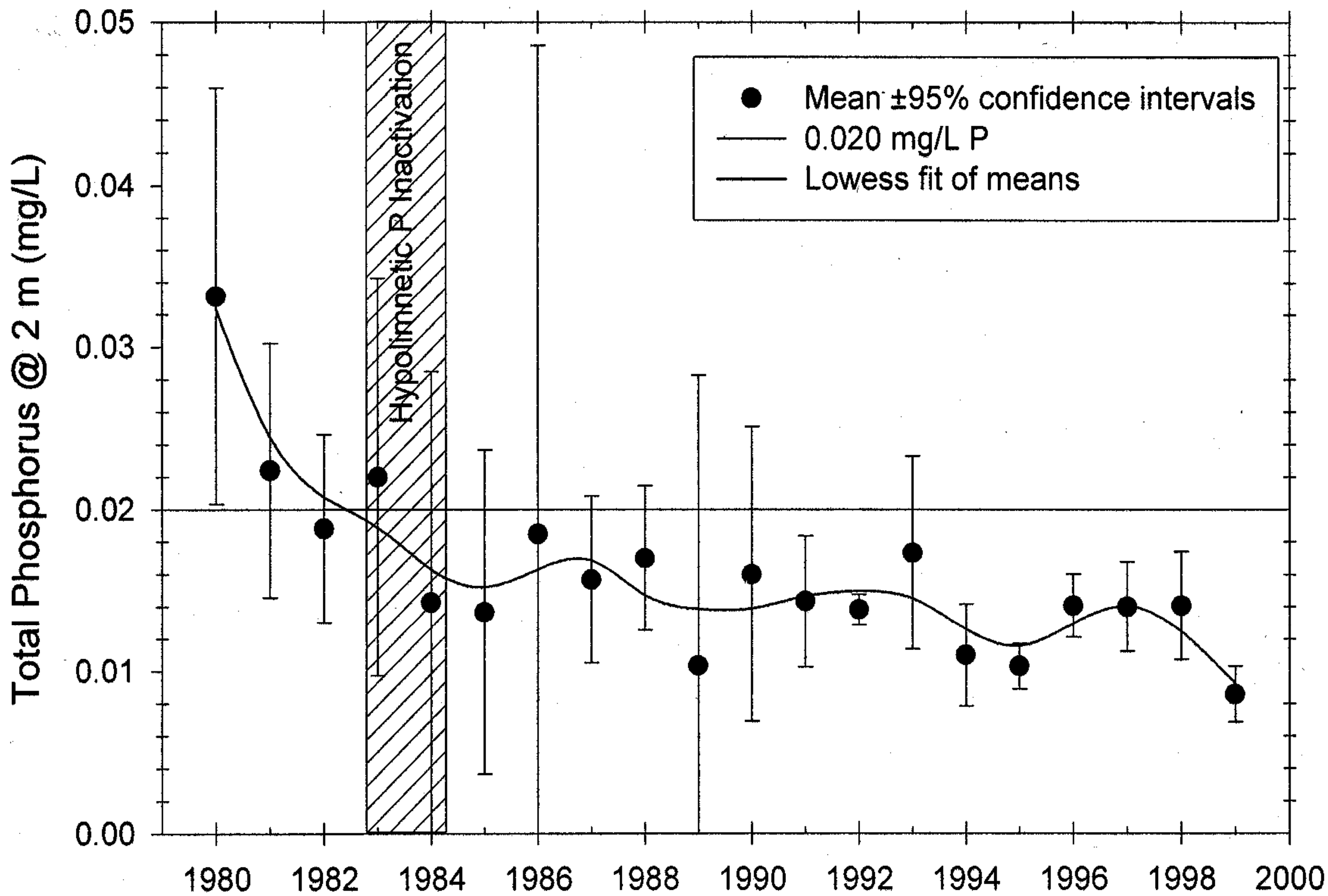
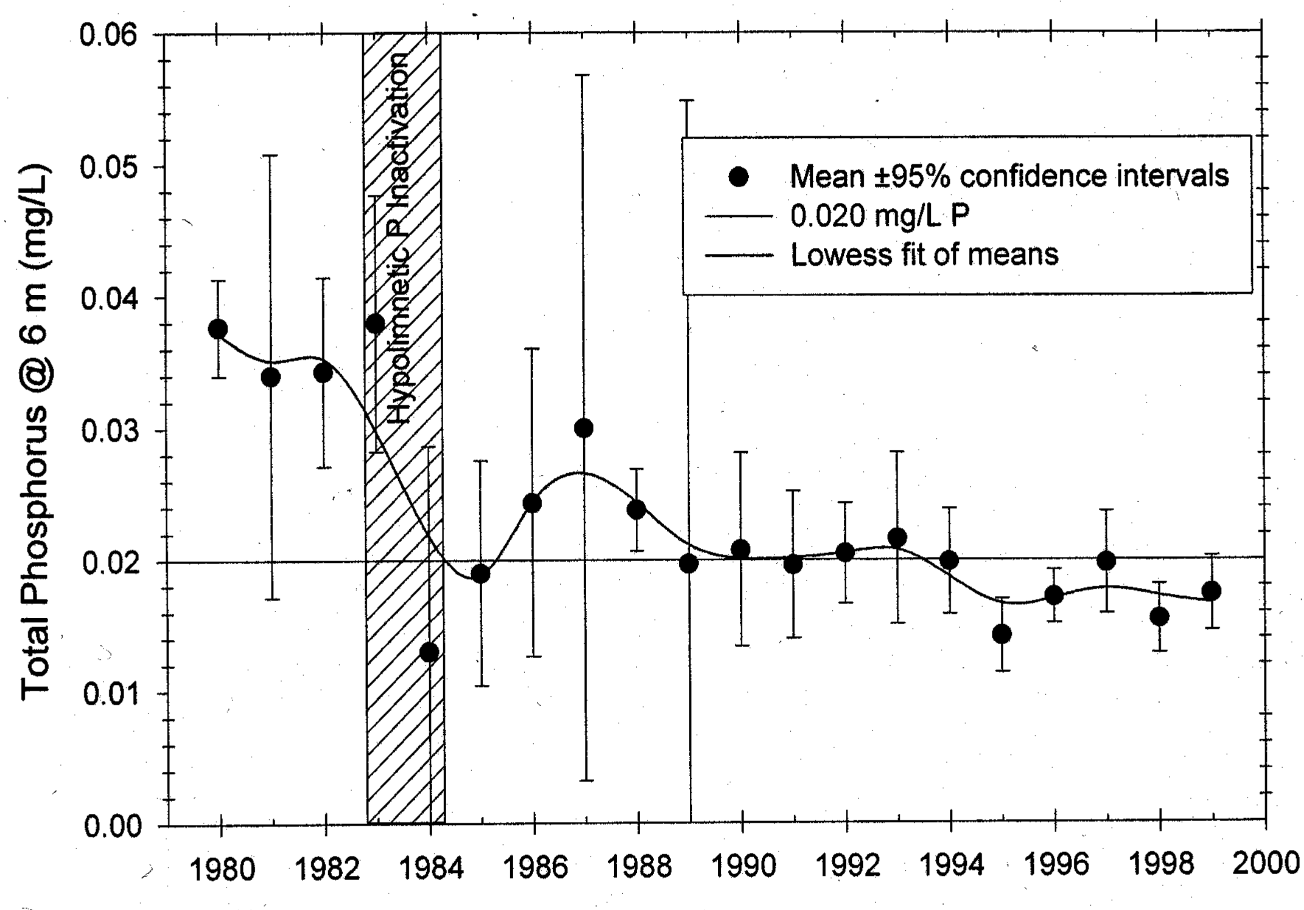


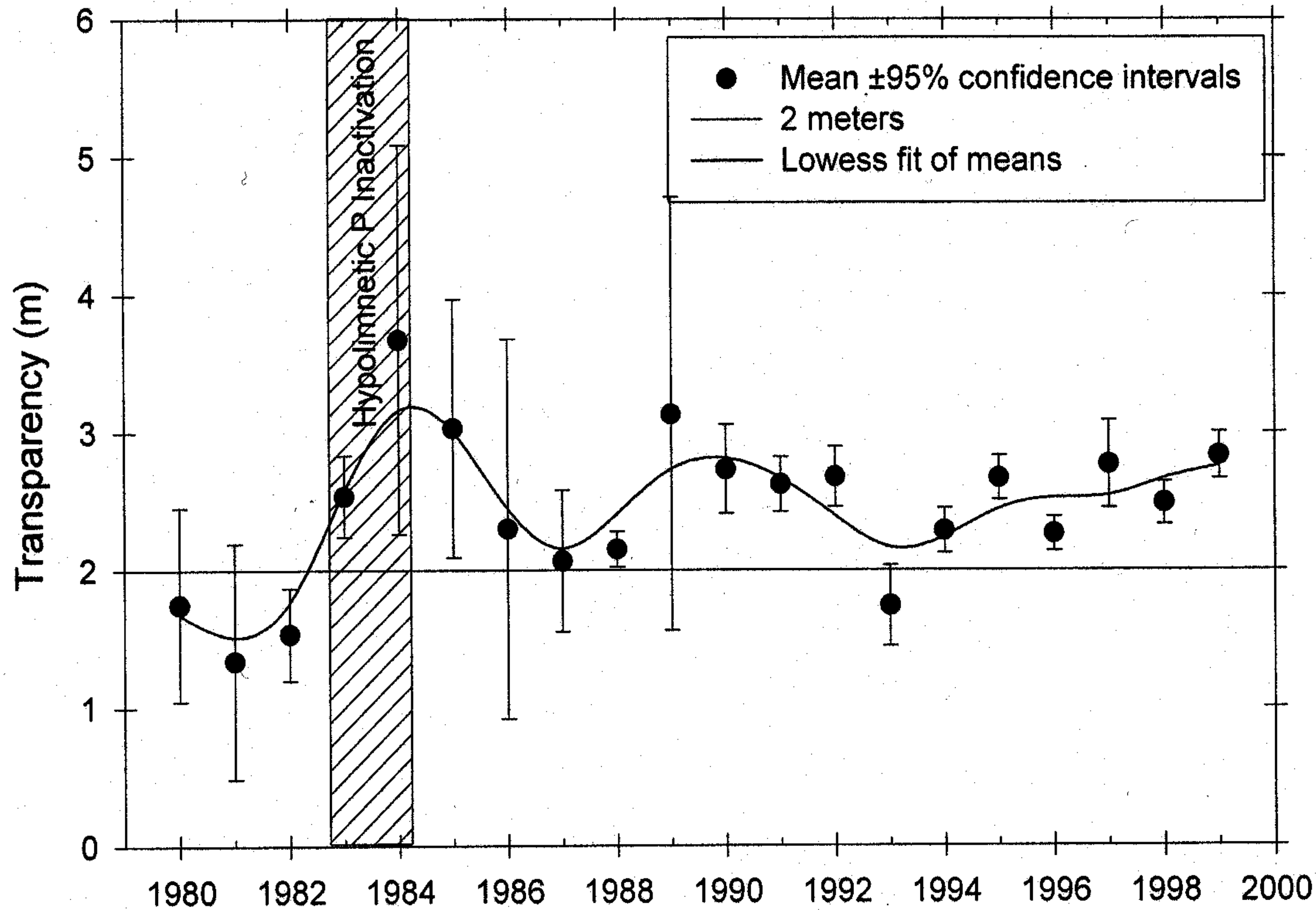
Figure IV-6 A comparison of pre- and post treatment mean monthly transparency (m) in Kezar Lake, North Sutton



Total Phosphorus @ 2 m (mg/L)
0.00
0.01
0.02
0.03
0.04
0.05
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Hypolimnetic P Inactivation
Mean ±95% confidence intervals
0.020 mg/L P
Lowess fit of means



Total Phosphorus @ 6 m (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Hypolimnetic P Inactivation
Mean ±95% confidence intervals
0.020 mg/L P
Lowess fit of means



Transparency (m)
0
1
2
3
4
5
6
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Hypolimnetic P Inactivation
Mean ±95% confidence intervals
2 meters
Lowess fit of means

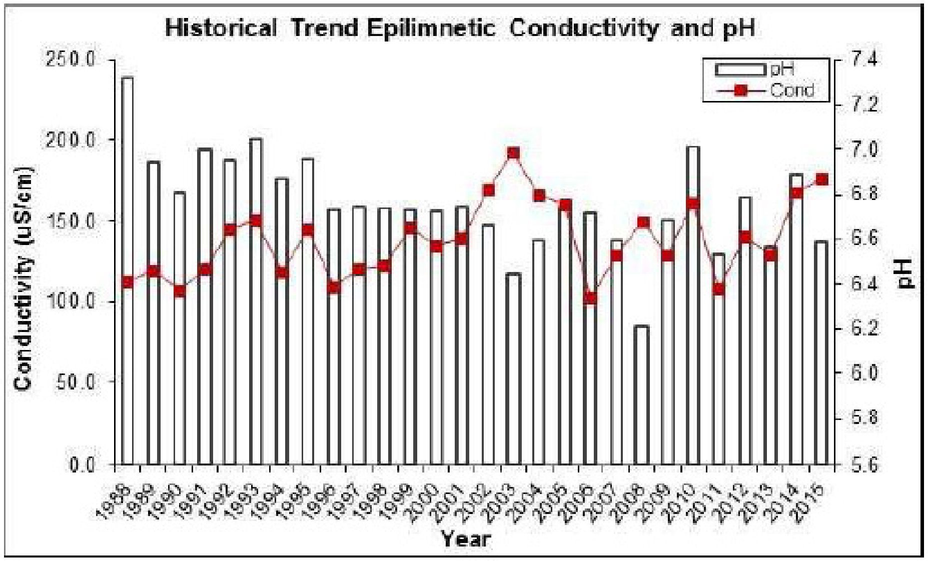
Water Quality Since Remediation

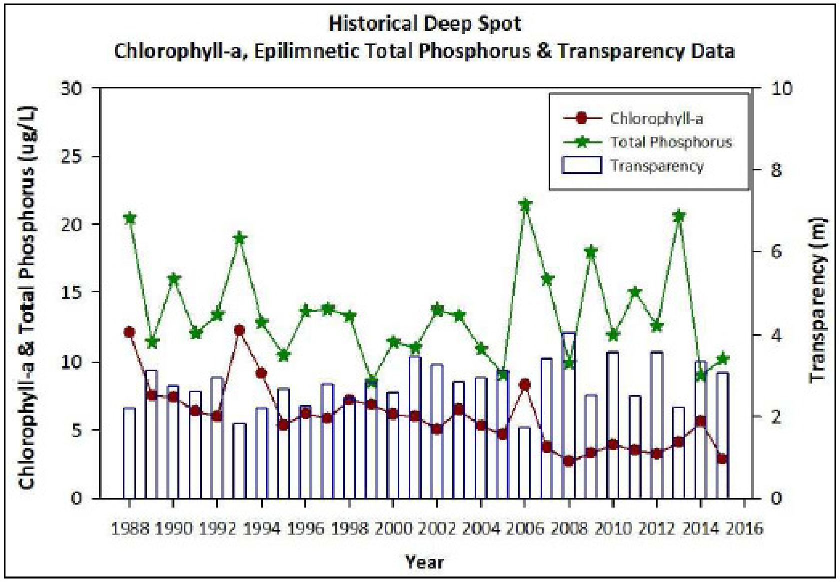
- The NH DES Volunteer Lake Assessment Program has been monitoring the water quality of Kezar Lake since 1988
- Recent water quality tests show:
  - Good phosphorus, dissolved oxygen, and chlorophyll-a concentrations
  - Cyanobacteria still present but not at a level of concern

Current Water Quality (2015 data)

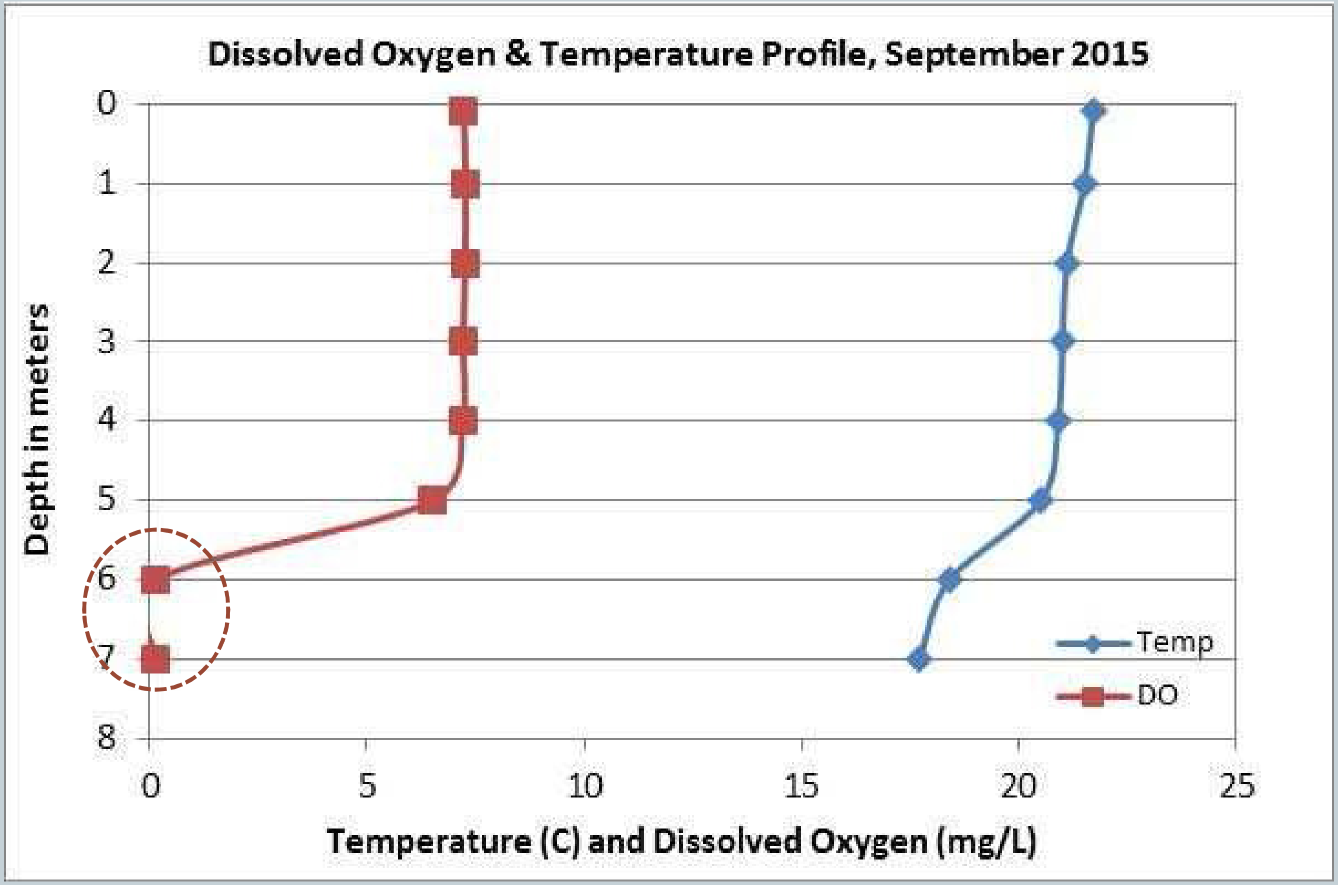
HISTORICAL WATER QUALITY TREND ANALYSIS

Parameter	Trend	Explanation	Parameter	Trend	Explanation
Conductivity	Worsening	Data significantly increasing.	Chlorophyll-a	Improving	Data significantly decreasing.
pH (epilimnion)	Worsening	Data significantly decreasing.	Transparency	Stable	Trend not significant; data highly variable.
			Phosphorus (epilimnion)	Stable	Trend not significant; data moderately variable.

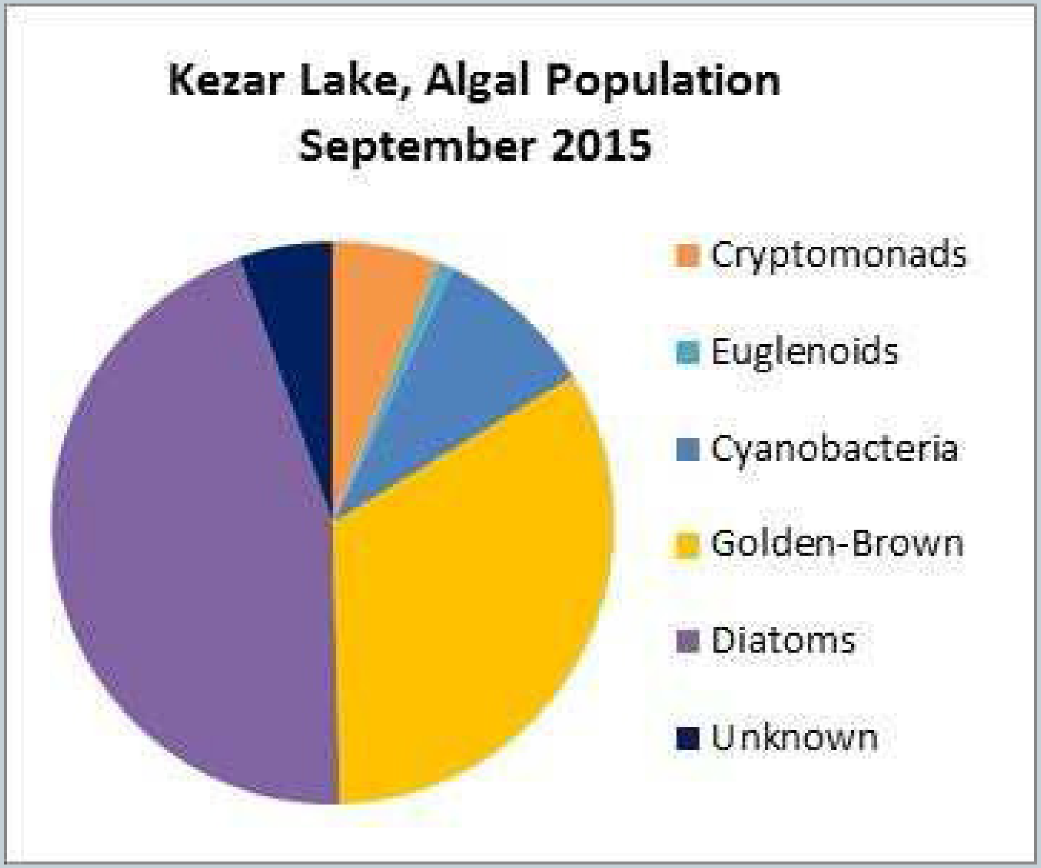




Oxygen and Temperature in Kezar Lake



Kezar Lake Algal Community



Before and After Three-Phase Study

	1980	2015
Total Phosphorus	50 ug/L	9 ug/L
Dissolved Oxygen	7.8 mg/L	~7.5 mg/L
pH	6.15	6.89
Chloride	24.5 mg/L	45 mg/L
Turbidity	4.7 NTU	1.13 NTU
Chlrophyll-a	13,800 ug/L	5.68 ug/L

(Connor and Smith, 1983) (DES, 2015)

Impaired Waters List

Designated Use	Parameter	2014 (not finalized)	2012	2010	2008	2006
Primary Contact Recreation (swimming)	E.coli	FS	II	II	FS	FS
	CHLa	FS	FS	FS	FS	FS
	Cyano	NS	NS	NS	NS	NA (process poorly developed at this time.)
Aquatic Life Use	CHLa	FS	Delisted, now FS	NS	NA (Not assessed – method had not yet been developed)	NA (Not assessed – method had not yet been developed)
	TP	FS	Delisted, now FS	NS	NA (Not assessed – method had not yet been developed)	NA (Not assessed – method had not yet been developed)
	DO %sat	NS	NS	NS	NS	NS
	DO mg/L	FS	FS	FS	FS	FS
	pH	NS	NS	NS	Observed effect – (Old method replaced in more recent cycles)	Observed effect – (Old method replaced in more recent cycles)

NA – Not Assessed
II – Insufficient information
FS – Full support
NS – Non support

Kezar Lake “Report Card”

Designated Use	Parameter	Category	Comments
Aquatic Life	Phosphorus (Total)	Good	The calculated median is from 5 or more samples and is < indicator and > 1/2 indicator and the chlorophyll a indicator is okay.
	pH	Slightly Bad	>10% of samples exceed criteria by a small margin (minimum of 2 exceedances).
	Oxygen, Dissolved	Good	There are at least 10 samples with one, but < 10% of samples, exceeding criteria.
	Dissolved oxygen satura	Slightly Bad	There are >10% of samples (minimum of 2), exceeding criteria.
	Chlorophyll-a	Good	The calculated median is from 5 or more samples and is < indicator and > 1/2 indicator.
Primary Contact Recreation	Escherichia coli	Very Good	Where there are no geometric means, all bacteria samples are < 75% of the geometric mean. Where there are geometric means all single bacteria samples are < the SSMC and all geometric means are < geometric mean criteria.
	Cyanobacteria hepatoto	Slightly Bad	Cyanobacteria bloom(s).
	Chlorophyll-a	Very Good	There are a total of at least 10 samples with 0 exceedances of indicator.

BEACH PRIMARY CONTACT ASSESSMENT STATUS

KEZAR LAKE - WADLEIGH STATE PARK BEACH	Escherichia coli	Good	There are geometric means and all geometric means are < geometric mean criteria; and there has been a single sample exceedance.
KEZAR LAKE - WADLEIGH STATE PARK BEACH	Cyanobacteria	Slightly Bad	Cyanobacteria bloom(s).

Kezar Lake Water Quality Event Time Line

1931- Sewage Treatment facility discharge begins

1934- Wadleigh State Park established on the shores of Kezar Lake

1938- First water quality survey of Kezar Lake (Fish and game Survey)

1961- First noted algal bloom and decrease in lake clarity

1963- First copper sulfate treatment

1964- Construction of new dam

- Construction of I-89
- Second copper sulfate treatment

1966- Massive fish kill

1968- Lake-shore property devaluated

1968- Mechanical destratification (mixing) of the lake

- Treatment Plant upgraded

Kezar Lake WQ Event Time Line, cont.

1970- Tertiary treatment initiated at treatment plant

1972- Decrease in effectiveness of destratification

1974- Final season for destratification

1979- Kezar given highest priority for restoration

- Diagnostic/Feasibility Federal Grant Application

1980- Phase I Diagnostic/Feasibility Study

1980- New London Wastewater Treatment Facility decommissioned

1983- Completion of Diagnostic/Feasibility Study

- Creation of Chadwick Meadows Marsh
- Pilot phosphorus inactivation

1984- E.P.A. Phase II Implementation Grant

- Sediment phosphorus inactivation
- Water quality improvements

Kezar Lake WQ Event Time Line, cont.

1985- Monitoring.

- Evaluation of Aluminum Salts Injection and Wetlands Management (EPA Report).
- Record transparency recordings.

1986- First Year Response (EPA Report).

1989- E.P.A. Final Phase II Report.

1989- Kezar Lake Consent Decree

1995- Kezar Watershed Committee formation

2000- E.P.A. Final Phase III Report.

Last 28 years- Monitoring through Volunteer Lake Assessment Program

Emerging Threats: Now What?!?!

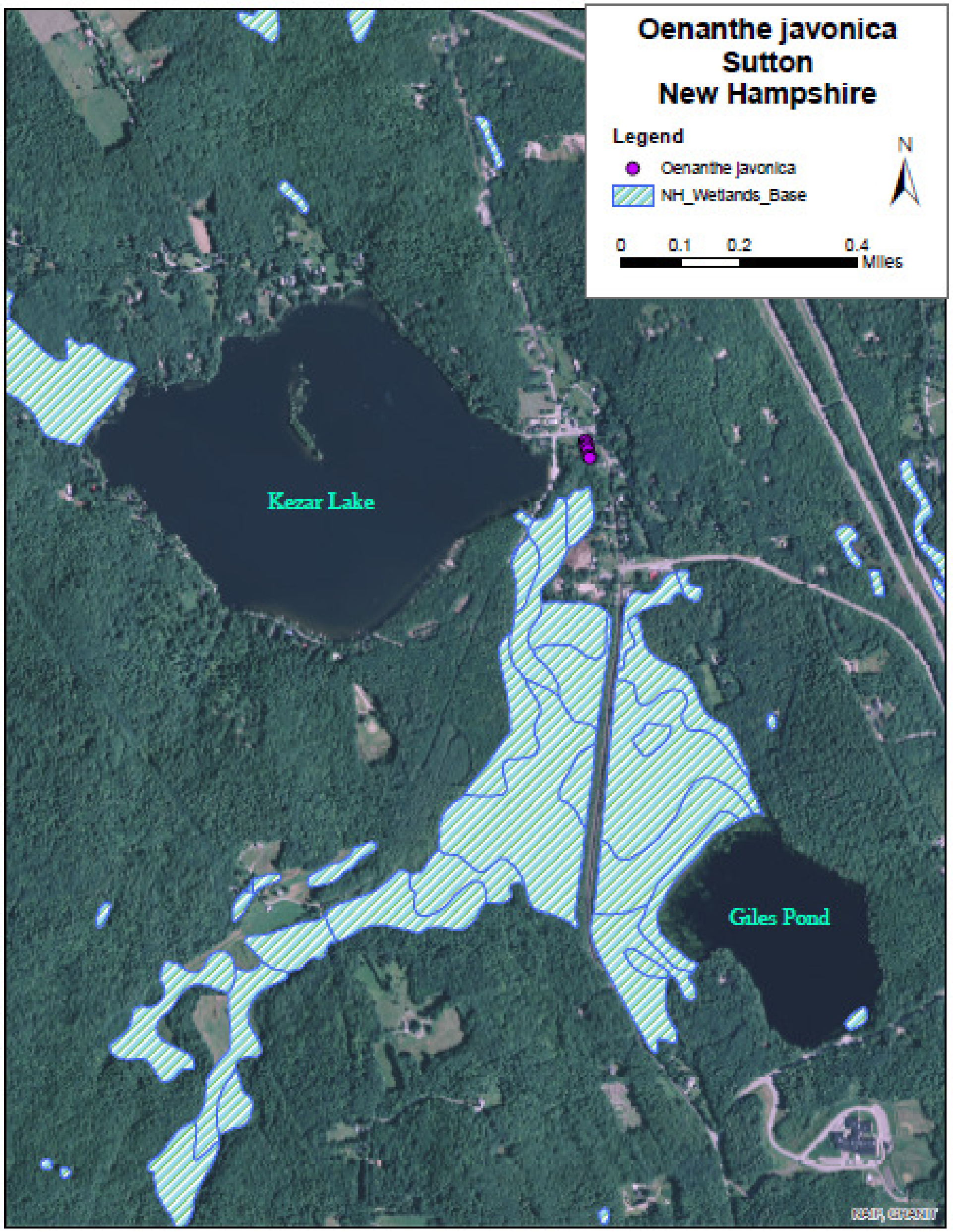
- Increasing conductivity in the lake
  - Road salting
- Invasive species
  - Wild celery in nearby stream
  - Variable milfoil and other species nearby

Increasing Conductivity

- Likely due to road salting on majors roads in the watershed
- Lakes are settling basins, so the watershed is constantly feeding Kezar Lake
- Suggesting having local road agents obtain a NH Voluntary Salt Applicator license through UNH Technology Transfer Center's *Green SnowPro Certification Program*.

Aquatic Invasive Species

- Here, and nearby!
- 2015 find of Wild Celery by local consultant
  - Also known as Java water droplet
  - Ornamental plant popular as a food source in Asian cuisine
  - Located in the small stream in the park adjacent to the outlet of Kezar Lake
  - Long-Term Management plan developed by DES for the site
  - Fragment barriers and silt fencing set up around the site by local consultant and volunteers
  - One hand pull conducted in 2016, others to follow


Oenanthe javonica
Sutton
New Hampshire
Legend
Oenanthe javonica
NH_Wetlands_Base
N
0 0.1 0.2 0.4
Miles
Kezar Lake
Giles Pond
NAIP, GRANIT

Other Aquatic Invasive Species Near Kezar Lake

Organizations Involved in Kezar Lake Studies

- New Hampshire Department of Environmental Services
- New Hampshire Fish and Game
- United States Environmental Protection Agency
- Kezar Lake Association
- Town of Sutton

Long-Term Recommendations

- Continue to monitor Kezar Lake and inflowing tributaries through the Volunteer Lake Assessment Program
- Be good watershed stewards, both on your own property, and as observers of what is happening in your watershed
- Practice prevention (Lake Host) and early detection (Weed Watcher) efforts to keep Kezar Lake free of invasive aquatic species

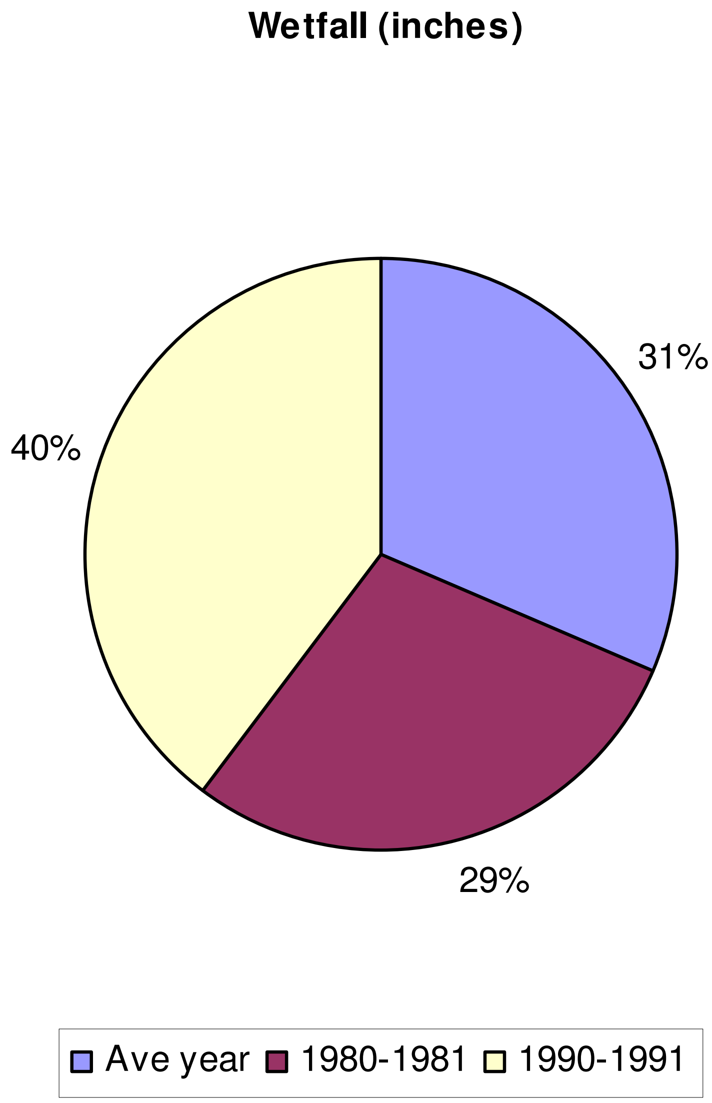
Questions and Discussion

AMY P. SMAGULA
LIMNOLOGIST/EXOTIC SPECIES PROGRAM COORDINATOR
NH DES
AMY.SMAGULA@DES.NH.GOV

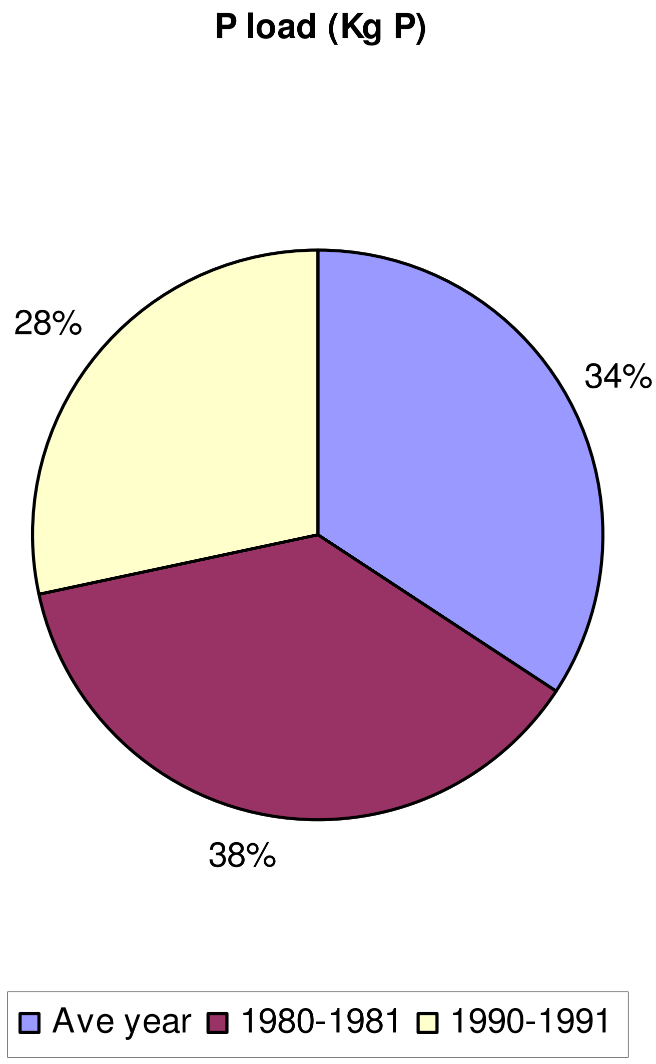
TIMOTHY.DUNLEAVY@DOS.NH.GOV

Recommendations From VLAP

- Continue monitoring and on phosphorus concentrations and transparency levels on Kezar Lake – variability in the trends may be due to storm water runoff
- Conductivity levels could improve with changes in icing practices in winter months
- Overall, great work!



Wetfall (inches)
31%
29%
40%
Ave year
1980-1981
1990-1991



P load (Kg P)
34%
38%
28%
Ave year
1980-1981
1990-1991

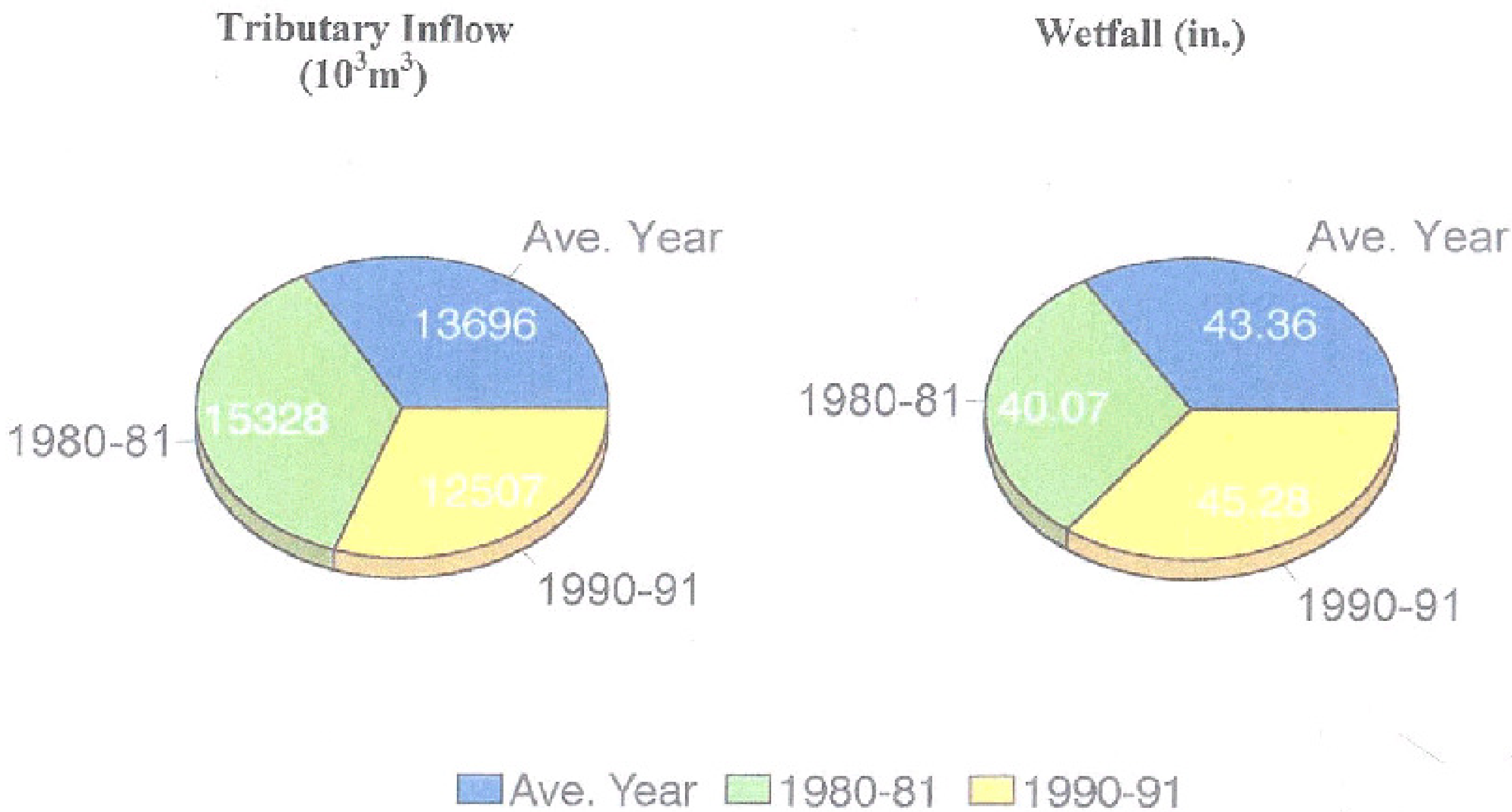


Figure VI-2 A Comparison of Annual Tributary Inflow and Wetfall for Two Budget Years and Average Year

MORPHOMETRIC DATA

Watershed Area (Ac.):	6,848	**Max. Depth (m):**	8.2	**Flushing Rate (yr^{1})**	8.2
Surface Area (Ac.):	182	**Mean Depth (m):**	2.7	**P Retention Coef:**	0.46
Shore Length (m):	3,400	**Volume (m^{3}):**	1,975,500	**Elevation (ft):**	906

TROPHIC CLASSIFICATION

Year	Trophic class
1984	MESOTROPHIC
2003	MESOTROPHIC

KNOWN EXOTIC SPECIES

Station Name	Table 1. 2015 Average Water Quality Data for KEZAR LAKE								
	Alk. mg/l	Chlor-a ug/l	Chloride mg/l	Cond. uS/cm	Total P ug/l	Trans. m		Turb. ntu	pH
						NVS	VS		
Epilimnion	9.1	2.85	41	177.2	10	2.85	3.53	1.25	6.52
Hypolimnion				179.1	23			4.84	6.55
Inlet			63	246.2	23			1.83	6.30
Lyon Brook at Trussel Ridge			120	448.0	15			1.04	6.83
Outlet			42	175.4	9			1.14	6.96

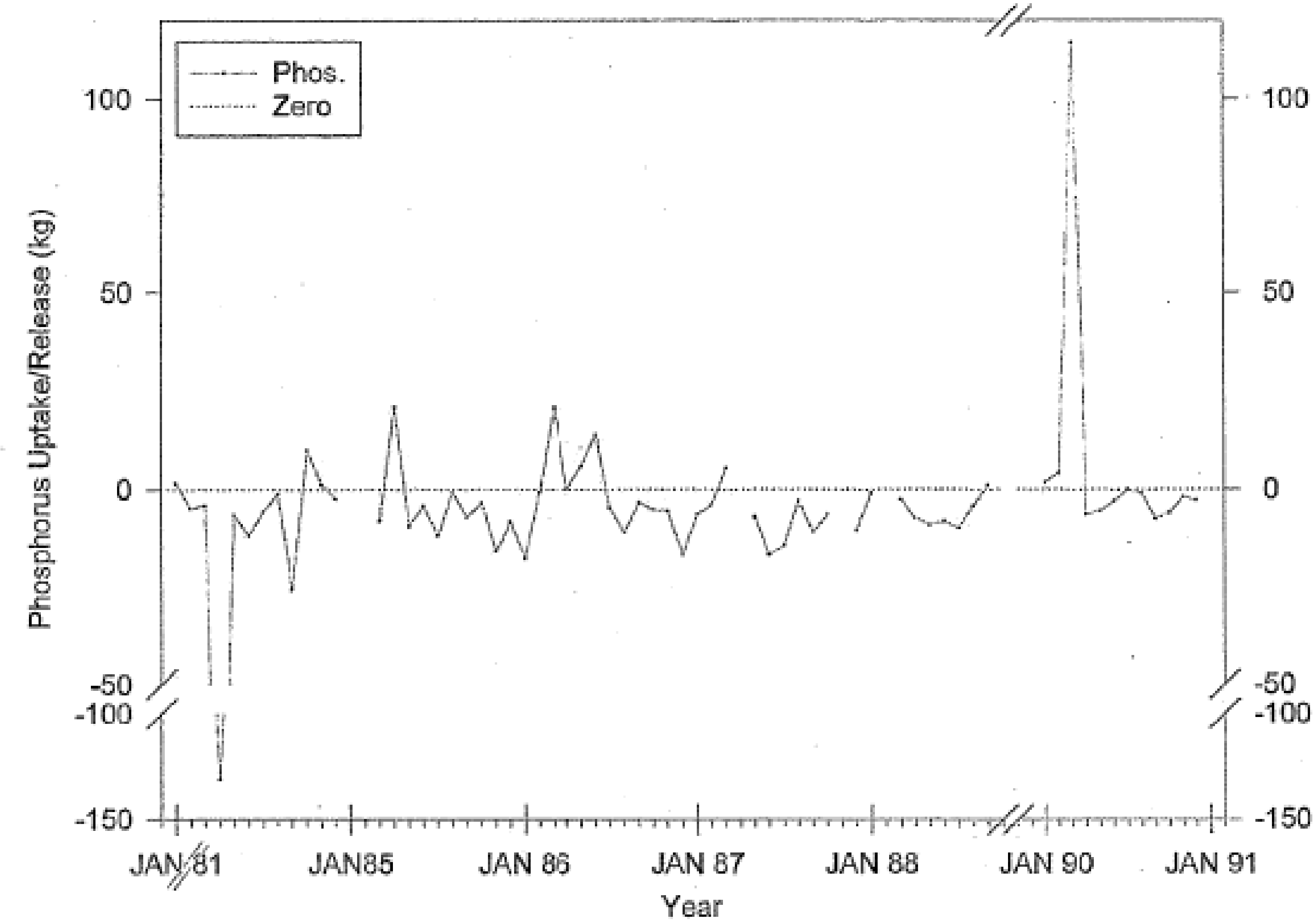


Figure V-4 Chadwick Meadows Performance Assimilation of Phosphorus

OBSERVATIONS *(Refer to Table 1 and Historical Deep Spot Data Graphics)*

- **CHLOROPHYLL-A:** Chlorophyll levels were average in June and August and then decreased to low levels in September. The 2015 average chlorophyll level decreased from 2014 and was less than the state median. Historical trend analysis indicates significantly decreasing (improving) chlorophyll levels since monitoring began. We hope to see this continue!
- **CONDUCTIVITY/CHLORIDE:** Epilimnetic (upper water layer), hypolimnetic (lower water layer), Inlet, and Outlet conductivity and chloride levels were slightly elevated and much greater than the state medians. Historical trend analysis indicates significantly increasing (worsening) epilimnetic conductivity since monitoring began. Lyon Bk. at Trussel Ridge conductivity and chloride levels were greatly elevated and this station is likely impacted by I-89 upstream as well as local roads.
- **TOTAL PHOSPHORUS:** Epilimnetic phosphorus was low in June, increased slightly in August and then decreased in September. Average epilimnetic phosphorus remained stable from 2014 and was less than the state median. Historical trend analysis indicates relatively stable epilimnetic phosphorus with moderate variability between years. Hypolimnetic phosphorus was elevated in June due to bottom sediment contamination. Phosphorus decreased to average levels in August and September. Inlet, Lyon Bk. at Trussel Ridge and Outlet phosphorus levels were relatively stable from June through September and within average ranges for that stations.
- **TRANSPARENCY:** Transparency was low (worse) in June and then increased (improved) to slightly above average levels in August and September. Average transparency decreased slightly from 2014 and was slightly less than the state median, however was above average (good) for the lake. Historical trend analysis indicates highly variable transparency since monitoring began. Transparency measured with the viewscope (VS) was generally much better than that measured without (NVS) and is likely a better representation of actual conditions.
- **TURBIDITY:** Epilimnetic turbidity was slightly above average for that station but remained stable from June through September. Hypolimnetic turbidity was elevated in June due to bottom sediment contamination and then decreased to average levels in August and September. Inlet and Lyon Bk. at Trussel Ridge turbidities were within average ranges for those stations. Outlet turbidity was slightly elevated in June and a recent storm event combined with low flow conditions likely led to sediment and organic material accumulating at the Outlet.
- **PH:** Epilimnetic and Hypolimnetic pH fluctuated below the desirable range 6.5-8.0 units however average pH levels were approximately equal to 6.5. Historical trend analysis indicates significantly decreasing (worsening) epilimnetic pH since monitoring began. Inlet pH levels were low due to an extensive wetland system and Lyon Bk. at Trussel Ridge and Outlet pH levels were within the desirable range.

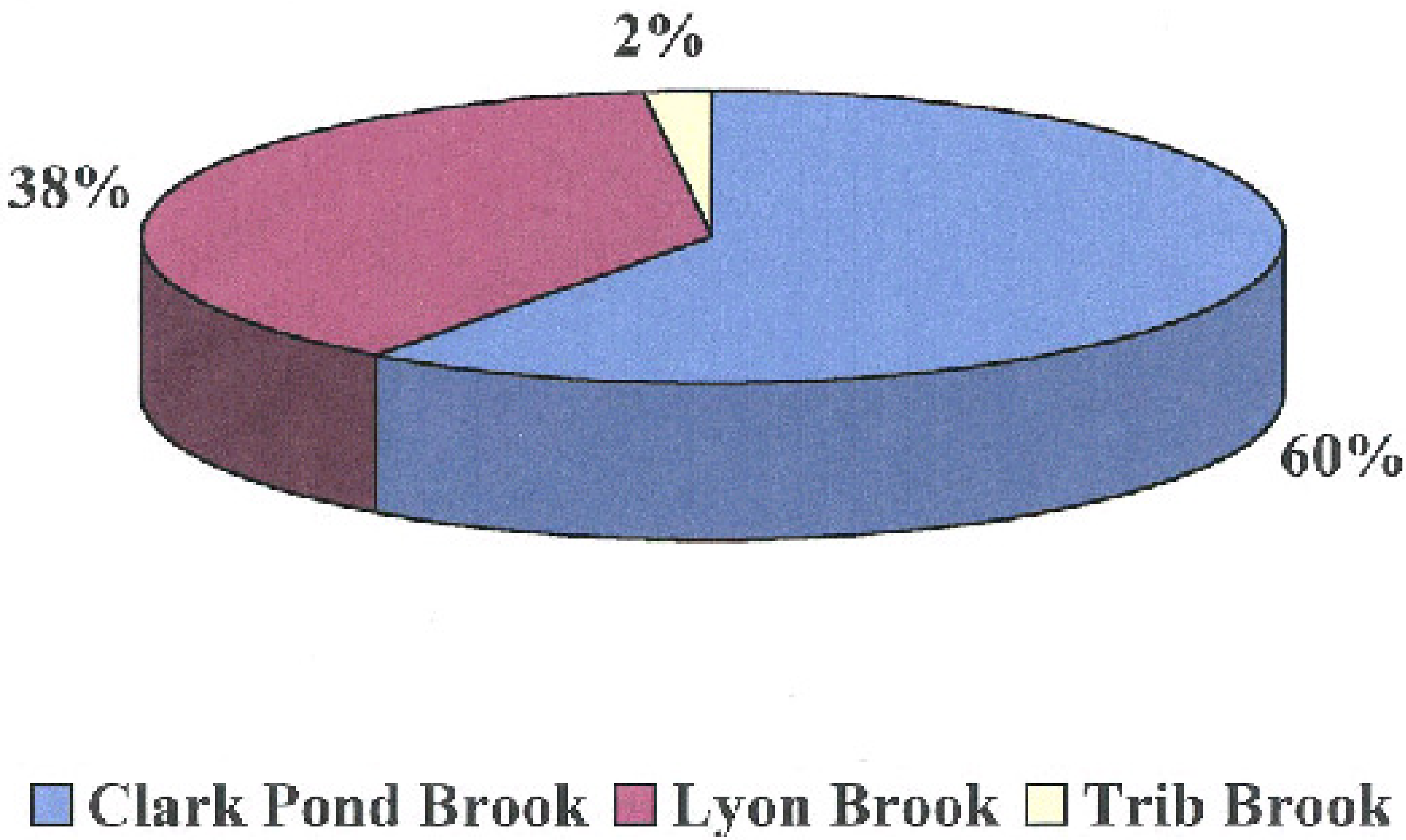
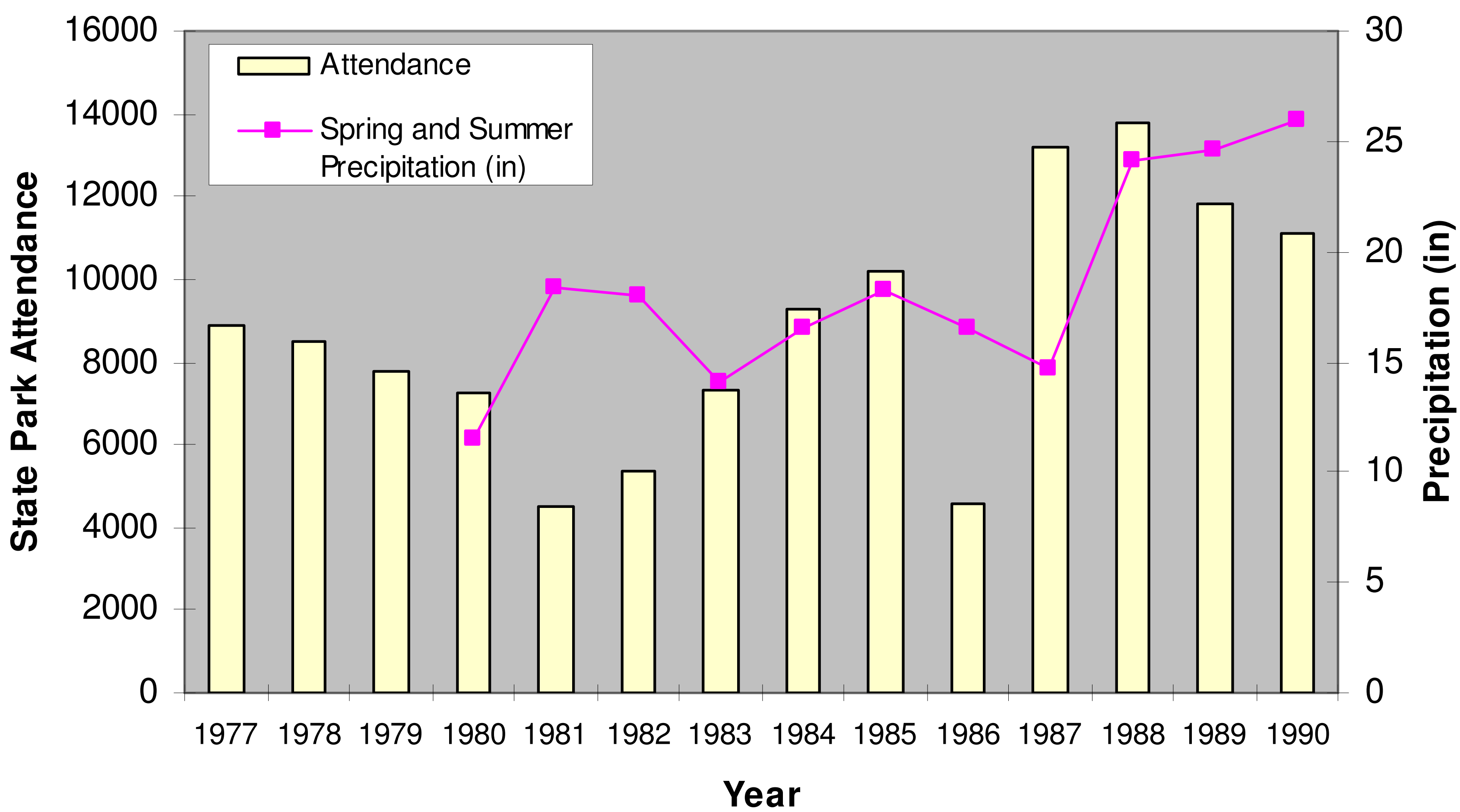


Figure VIII-4 Relative Percent of Tributary Inflow to Chadwick Meadows

(Connors et. al., 2000)



Attendance
Spring and Summer Precipitation (in)
State Park Attendance
16000
14000
12000
10000
8000
6000
4000
2000
0
30
25
20
15
10
5
0
Precipitation (in)
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
Year

References

Connor, J. 1981. *A Historical Outlook on Kezar Lake: Then, Now and In the Future?* New Hampshire Department of Environmental Services, New Hampshire Water Supply and Control Division, Staff Report Number 124.

Connor, J and G Smith. 1983. *Kezar Lake Diagnostic/Feasibility Study*. New Hampshire Department of Environmental Services, New Hampshire Water Supply and Pollution Control Division, Staff Report Number 135.

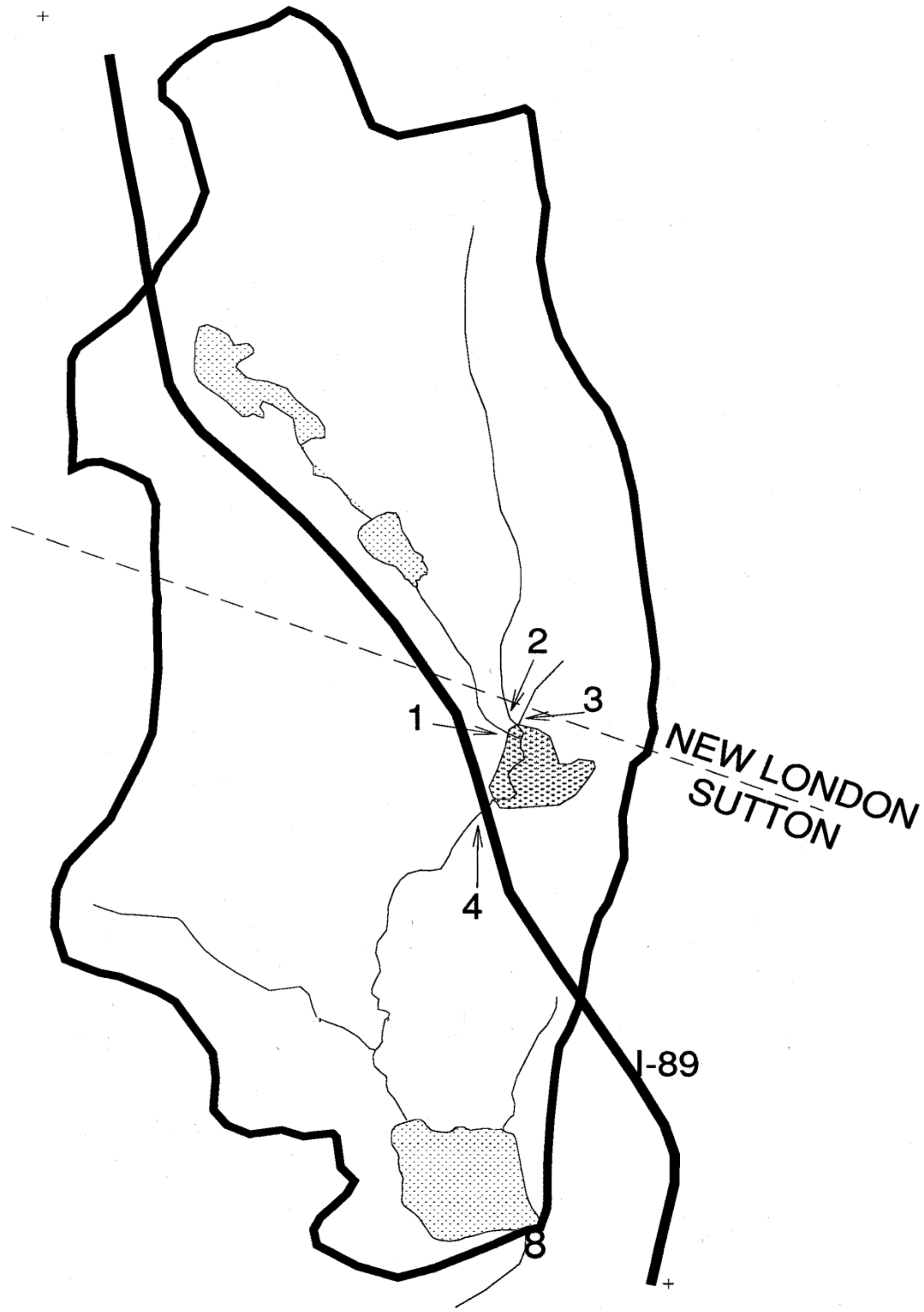
Connor, J and M. Martin. 1989. *An Assessment of Wetlands Management and Sediment Phosphorus Inactivation: Kezar Lake, New Hampshire*. New Hampshire Department of Environmental Services, New Hampshire Water Supply and Pollution Control Division, Staff Report Number 161.

Connor, J, R.W. Varney, G.D. Bisbee, H.T. Stewart, P.M. Currier. 2000. *A study of the effectiveness, longevity, and ecological impacts of hypolimnetic aluminum injection in Kezar Lake, North Sutton, New Hampshire*. New Hampshire Department of Environmental Services, Watershed Management Bureau, Concord, New Hampshire. Available at: http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/nhdes-wd-00-2.pdf

New Hampshire Department of Environmental Services. 2015. *Volunteer Lake Assessment Program Individual Lake Report: Kezar Lake, Sutton*. Concord, NH. Available at: http://des.nh.gov/organization/divisions/water/wmb/vlap/annual_reports/2015/documents/kezar-sutton.pdf

US Environmental Protection Agency. 1995. *Watershed Protection: Clean Lakes Case Study. Phosphorus Inactiviation and Wetland Manipuluation Improve Kezar Lake, NH. US EPA Office of Water. EPA 841-F-95-002.*

Questions?



Chadwick Meadows Sampling Station Locations, Kezar Lake,North

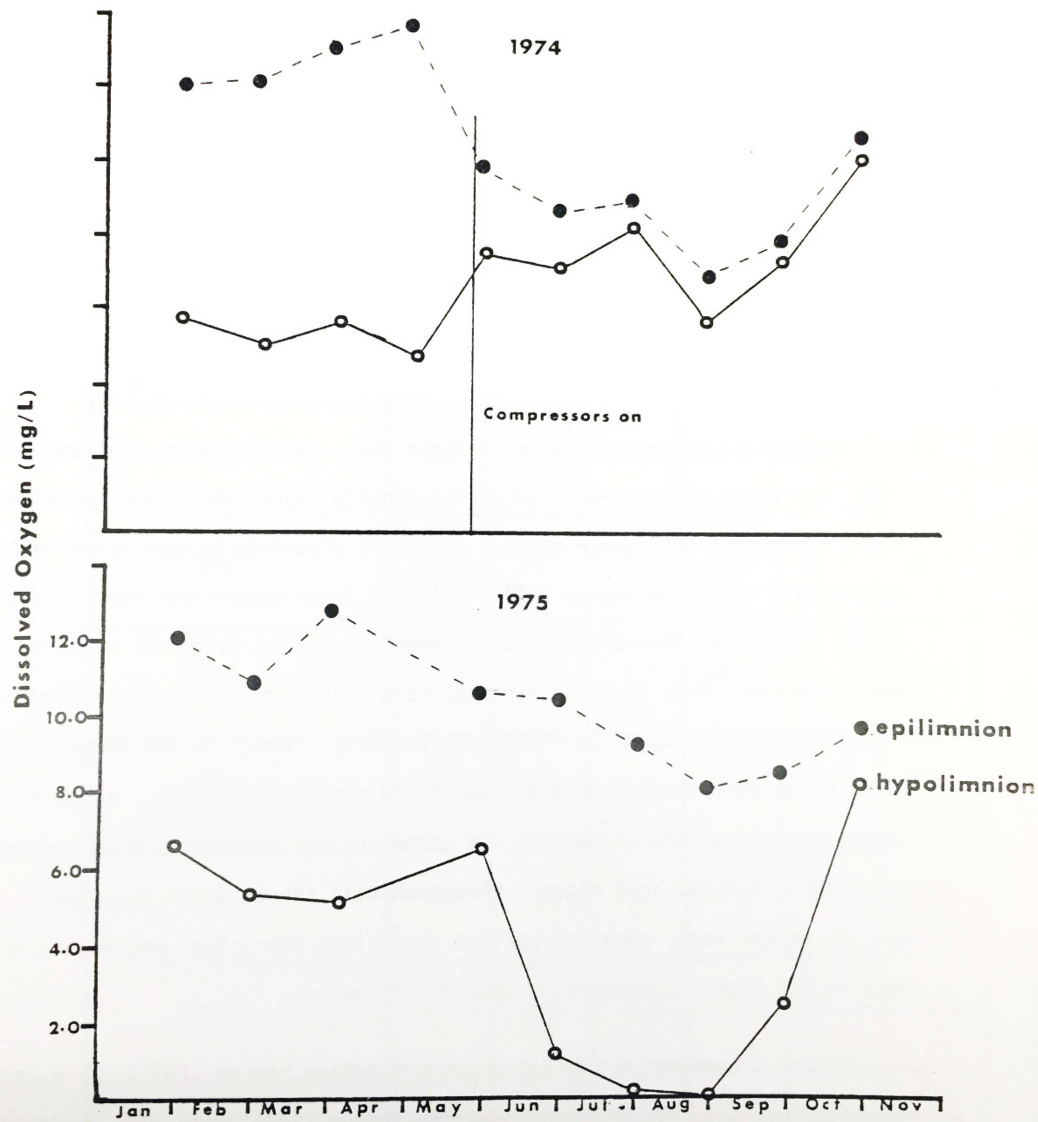
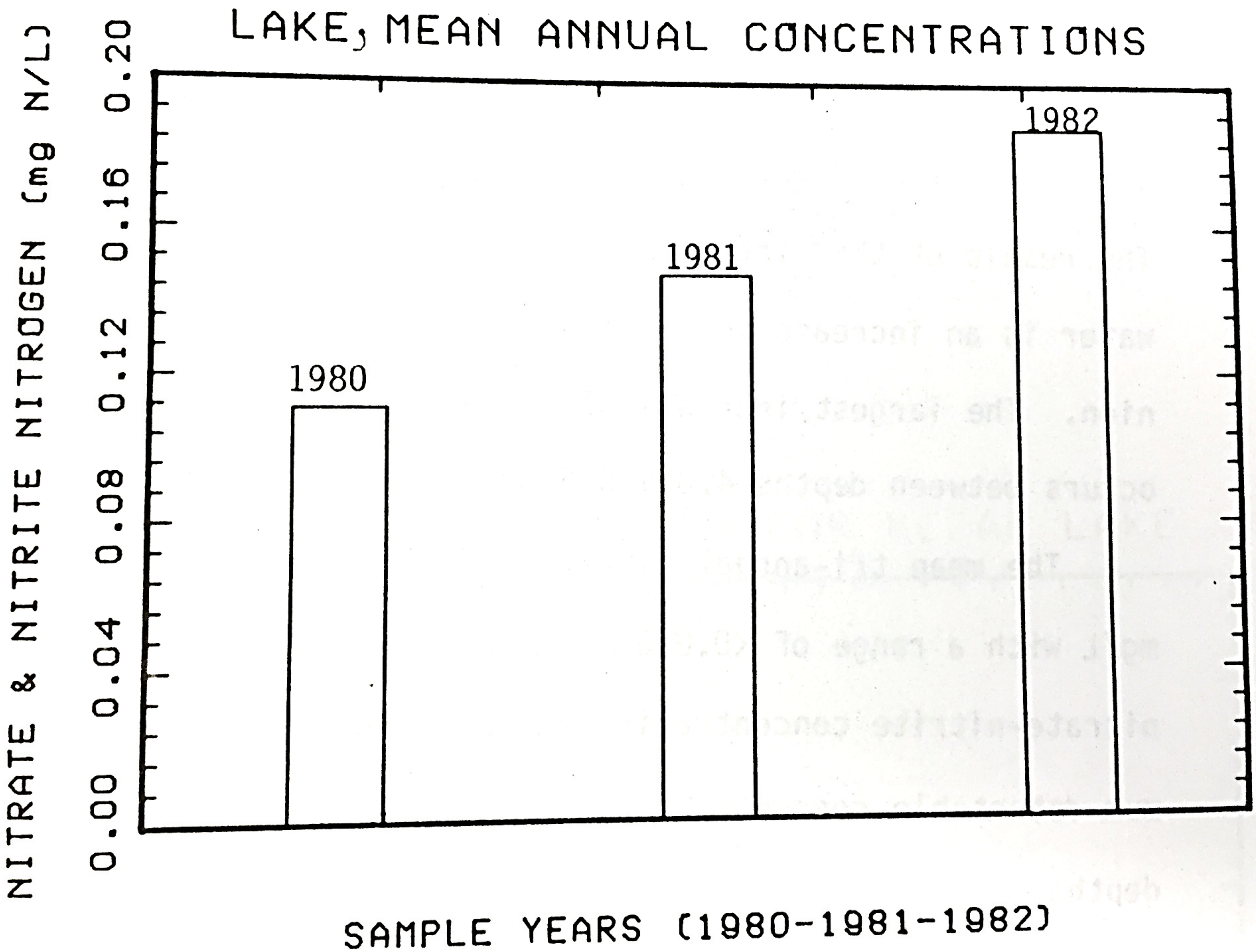


Figure 9. A comparison of mean, monthly, dissolved oxygen concentrations; mechanical destratification (1974), versus natural conditions (1975).


LAKE, MEAN ANNUAL CONCENTRATIONS
NITRATE & NITRITE NITROGEN (mg N/L)
0.00
0.04
0.08
0.12
0.16
0.20
1980
1981
1982
SAMPLE YEARS (1980-1981-1982)