United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research Note
NE-326

1985

Impact of Backcountry Recreationists on the Water Quality of an Adirondack Lake

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Abstract

This study reports the effects of recreational use on the water quality of an Adirondack lake. Phosphates, nitrates, conductivity, fecal coliform, transparency, and temperature were regularly measured over a period of 2 years and related to the recreational use that the lake received during that time. An adjacent lake, which was not visited by recreationists, served as a control. There was no apparent relationship between water quality and fluctuations in use at any of the sampling sites. There was also no significant variation in water quality between sites even though the use between the sites varied. Differences in water quality between the lake receiving recreational use and the control lake were negligible.

Outdoor recreation and use of backcountry areas have increased demonstrably due at least in part to more leisure time, money, and improved outdoor equipment. This increase is particularly significant in the Northeast because of its high population density and relatively limited wilderness area. Lakes located in remote wildlands are among the most popular destinations for backcountry recreationists. Unfortunately, these same lakes and streams are often the most sensitive components of wilderness ecosystems since they are receiving basins for any disturbances on their watersheds. Water quality is an important factor in the attractiveness and safety of remote water resources. Consequently, the effect of recreational use on water quality is a concern, especially at lakes receiving moderately heavy camping use (Barton 1969).

Previous research on the impact of dispersed recreational use on water quality has not been conclusive. Several studies were unable to find any substantial lowering of water quality in backcountry areas receiving recreational use (Aukerman and Springer 1976, Silverman and Erman 1979, Surgenor 1977), while others have associated increased water pollution with recreational use of a backcountry area (Dickman and Dorais 1977, Varness et al. 1978). These different results suggest that the relationship between recreational use and water quality may depend heavily on the specific local situation. To determine what effects such activities are having on water quality in the Adirondack Mountains of New York, we examined two similar backcountry lakes, only one of which received recreational use.

Methods

From the more than 50 lakes that make up the 7300-ha St. Regis Canoe Area, we studied: (1) St. Regis Pond with moderately heavy camping use at about 35 campsites and (2) Little Clear Pond that has been closed to camping since 1968. Both are dimictic lakes with mixing periods occurring in the spring and fall. St. Regis Pond has an area of 137.6 ha, a maximum depth of 10.9 m, a volume of 7.7 km^3, and area drainage of 2.428 km^2. Little Clear Pond has an area of 145.7 ha, a maximum depth of 21.9 m, a volume of 15.6 km^3, and area drainage of 2.023 km^2. Eight water sampling sites were established on St. Regis Pond—four on the lake proper, and three inlet sites, and one outlet site. One site, near the center of the lake, was established on Little Clear Pond as a control. Sample sites were chosen according to use levels and locations, and are categorized as follows:

Site	Use
Lean-to site	heavy
Island site	moderate
Tent platform site	low
Center of lake	none
Little Clear Pond	none

Results and Discussion

Surface water samples were taken in 1976 and 1977 at all stations, and a vertical series was taken at the center of the lake. Collections were made biweekly through the summer months and monthly, when possible, during the rest of the year. The amount of recreational overnight and day use occurring at St. Regis Pond was recorded at the time of water sampling using information from sign-in registers and direct head counts on sampling dates.

Water-quality measurements were made for factors that could be altered by: (1) the discharge of human waste products, directly or indirectly as leachate from the soils into the pond and (2) soil runoff from bare campgrounds into the pond. These selected parameters were: transparency, pH, total dissolved solids, total alkalinity, dissolved oxygen, nitrate, phosphate, conductivity, calcium, magnesium, sodium, potassium, temperature, and fecal coliforms. Specifically, three of the more sensitive parameters—phosphate, nitrate and conductivity—were related to the use level at each site. Standard analytical procedures (APHA 1971) were used in the evaluation of these procedures.

The sampling design was developed to make:

1. Spatial comparisons—comparison of sites undergoing different levels of use at approximately the same time. Sites 1, 2, and 3 with site 4.
2. Short-term temporal comparisons —comparison of a site before the busy season with that same site during and after the heavy-use season. Sites 1 and 2.
3. Comparison between St. Regis Pond and the control, Little Clear Pond.

These ponds are oligotrophic, characterized by relatively low levels of total dissolved solids (24 to 34 mg/l), rather transparent (Secchi disc readings that average 4.2 m), aerobic hypolimnia in summer, and generally supporting modest plant and animal populations. The dissolved oxygen concentrations fluctuated broadly from 3.8 to 9.9 mg/l. The pH of the ponds averaged above 6. Only one sample had a pH below 6 (5.3) at a site near an acid bog inlet. The ponds are low in total alkalinity (9.7 to 19.6 mg/l as $CaCO_3$), which makes them poorly buffered against acidic imputs (Table 1).

Overnight use of campsites at St. Regis Pond, considering only those times when they were occupied, averaged between 13 and 15 persons per night with most of the use occurring at six of the campsites. Day use was more difficult to monitor, but was between 100 and 300 persons per summer season (100 days). The high-use period at St. Regis Pond was during August and September.

A brief correlation analysis of the relationship between use (number of users present at the site on the sampling date) and phosphate, nitrate, and conductivity measurements between sites demonstrates that there is little statistical relationship between use and any of these water-quality parameters (Table 2).

On St. Regis Pond, variations in levels of nutrients over the season were relatively small and seemed to be the result of normal climatic influences and lake mixing during spring and fall turnover rather than the result of recreational use. Variations in water-quality parameters between sample sites showed no relationship to the level of recreational use at each site, with the exception of one popular camping site with one high nitrate reading of 3.5 mg/l. The nitrate levels at the site during the rest of the study period ranged from .03 to .50 mg/l. In general, natural "clean" waters have concentrations of less than 1 mg/l nitrate. Phosphate values ranged from undetectable levels to 0.24 mg/l with an average of approximately 0.0422 mg/l. Oligotrophic lakes characteristically have average levels of phosphate near 0.0241 mg/l or 8.0 mg/cu m when expressed as total P, the range for categorization as oligotrophic is broad, however, 0.0092 mg/l to 0.0542 mg/l phosphate (Wetzel 1983). The values for St. Regis Pond place it at the upper end of the oligotrophic range. Conductivity measurements varied slightly over the study period or between sites. Spatial comparisons between sites 1, 2, 3, and 4 indicate there was no relationship between water quality and use. Temporal comparisons indicate that seasonal fluctuations in use had no significant effect on any of the parameters measured. This is shown graphically in Figure 1 where the water-quality parameters are plotted against use at the most frequently visited site, the lean-to campground.

Differences in water-quality parameters between St. Regis Pond and Little Clear Pond (control) were negligible. The control pond showed the higher alkalinity (19.6 mg/l) and slightly higher concentrations of sodium and potassium.

Fecal coliforms, measured by the Hach Modification of the Multiple Tube Fermentation technique, were undetected on St. Regis Pond. On two sample days in July, Little Clear Pond had a low level of fecal coliforms (2.2 MPN/100 ml), which could have been due to wildlife (Stuart et al. 1971).

This study does not take into account very small-scale changes that may not have been measurable by our techniques, nor does it address the question of the effect of small changes accumulating over long time periods. It simply attempts to look at the question of direct impact of dispersed recreationists on water quality of two particular Adirondack lakes. Based on this data, we conclude that moderate recreational use has little or no effect on water quality.

Table 1.—Summary of selected water-quality measurements for each study site and for the control lake. Concentrations are expressed as mg/l; conductivity is in micromhos/cm (25 deg C); and use is expressed as mean number of campers/day on the days that samples were taken.

Variable	Sampling sites				
	Lean-to	Island	Tent platform	Center of lake	Control lake
Total Dissolved Solids					
Mean	26.0	25.9	24.2	33.6	30.7
SD	16.2	21.4	12.1	17.4	10.5
N	37	38	38	36	38
Total Alkalinity					
Mean	9.7	10.0	10.2	9.8	19.6
SD	2.8	3.2	3.7	2.5	3.7
N	46	46	47	49	44
pH					
Mean	6.4	6.4	6.4	6.4	6.7
SD	0.3	0.2	0.3	0.2	0.2
N	48	48	49	51	47
Calcium					
Mean	2.0	2.0	2.1	2.0	2.3
SD	0.5	0.6	0.5	0.6	0.7
N	37	37	38	39	39
Magnesium					
Mean	0.5	0.5	0.5	0.5	1.1
SD	0.2	0.2	0.1	0.2	0.4
N	37	37	38	39	39
Sodium					
Mean	0.9	0.8	1.0	0.8	1.4
SD	0.5	0.3	0.5	0.4	0.8
N	37	37	38	39	39
Potassium					
Mean	0.5	0.5	0.5	0.5	0.6
SD	0.3	0.2	0.3	0.2	0.3
N	37	37	38	39	39
Conductivity					
Mean	22.2	22.2	22.7	21.7	31.4
SD	3.7	2.7	2.8	2.9	4.4
N	48	48	49	51	47
Nitrate					
Mean	0.29	0.21	0.24	0.25	0.16
SD	0.56	0.14	0.17	0.25	0.29
N	37	37	38	39	39
Phosphate					
Mean	0.046	0.038	0.046	0.037	0.044
SD	0.054	0.040	0.052	0.041	0.050
N	36	37	37	38	38
BOD					
Mean	1.4	1.3	1.4	1.1	1.4
SD	0.6	0.8	0.7	0.7	1.0
N	14	16	15	14	16
Recreational Users					
Mean	2.2	0.9	0.1	0.0	0.0
SD	3.6	1.7	0.5	0.0	0.0
N	33	37	33	33	—

Table 2.—Product moment correlation coefficients between degree of use at each site (users/day) and nitrate, phosphate, and conductivity at the same sites

Variable	Sampling sites		
	Lean-to	Island	Tent platform
Nitrate	−0.161	−0.205	0.124
Phosphate	−0.194	−0.198	0.209
Conductivity	−0.124	−0.042	0.151
Number of samples	33	37	33
Critical values for alpha = 0.05	0.344	0.325	0.344

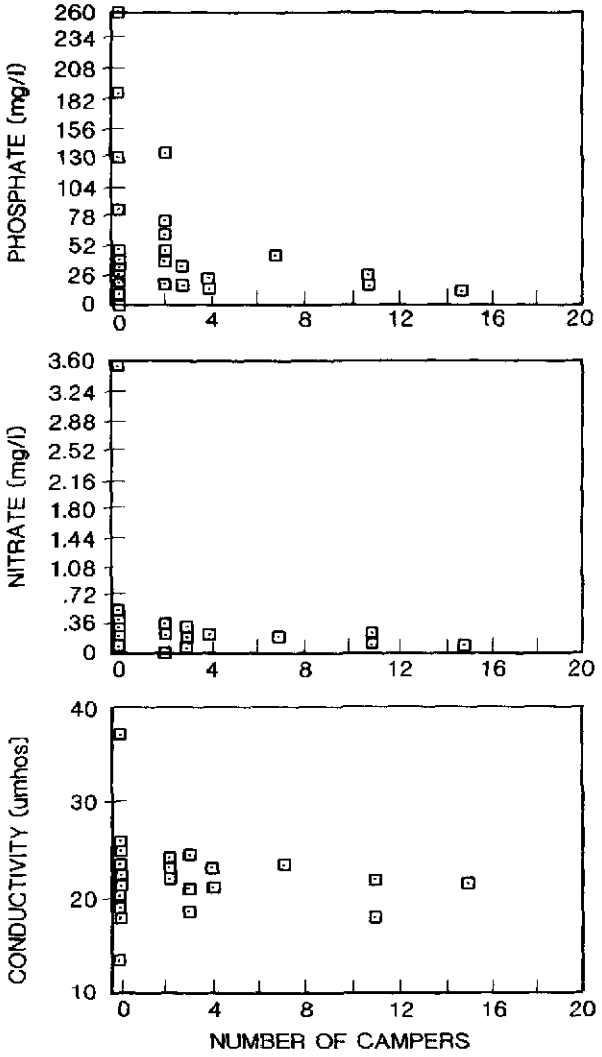

Figure 1.—Water-quality measures as affected by recreational users at the lean-to site. Use is number of campers per day on the day that water samples were taken.

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Manuscript received for publication 28 June 1984

☆ U.S. GOVERNMENT PRINTING OFFICE: 1985—505-026/542