Perception of Water Quality by Select Respondent Groupings in Inland Water-Based Recreational Environments

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OUTLINE

Abstract

This paper examines four lake environments which are paired by lake size and by trophic state, where trophic state is employed as an identifier of water quality. Two large lakes and two intermediate-sized lakes, with each pair having one oligotrophic lake and one eutrophic lake are selected for cross-sectional survey-oriented questionnaire research. This paper focuses upon one aspect of the research, namely the perception of water quality as perceived by three different user groups. The user groups examined are recreationists, cottage and homeowners, and fishermen, where these user groups are compared and contrasted utilizing percentage response profiles and cluster level groupings. It appears from a preliminary analysis of the data that the lakes selected are viable trophic state endpoints for questionnaire analysis of respondents. Each user group surveyed does appear sensitive to select water quality parameters, and there appear to be shifts in sensitivity within and between user groups with changes in ecological settings, as well as there being factors which appear independent of ecological settings.

Keywords: Water quality, Water quality perception, Perception, Attitudes, Survey Research, Lakes

Introduction to the Experimental Design

The data results presented within this paper represent selected summaries of data from over 5,700 questionnaires which were gathered on four recreational lakes in New York State. The lakes were selected as pairings by lake size and by trophic state, where trophic state serves as a general identifier for water quality (Refer to Figure 1). Two large lakes (Lake George and Oneida Lake) and two intermediate-sized lakes (Schroon Lake and Saratoga Lake) were selected for study. Lake George and Schroon Lake are oligotrophic lakes (low productivity lakes), while Lakes Oneida and Saratoga are eutrophic lakes (highly productive lakes).[1] Selected morphological features of the lakes are presented in Table 1.

Selection of the lakes was based primarily on three criteria, namely, that each lake had to possess a distinct trophic state, that each lake had to be of equivalent size to its comparator lake, and that each lake had to be basically a recreational lake. The lake selection pattern was made in order to obtain lake systems which had many factors in common, such as accessibility and distance from urban centers, but which had water quality as the single most obvious difference between the environments. This selection pattern of environments seeks to isolate the water quality dimension as a clearly obvious parameter in peoples' values and in its relationship to the local economies.

The data were gathered through the summers of 1970 and 1971, using six different form types and a boating addendum. The form types utilized and the specific groups examined are presented in Table 2. Table 3 presents a summary of returns by form type, indicating

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[1] The terms nutrient-poor and nutrient-rich shall also be employed in this paper as identical to the terms oligotrophic and eutrophic respectively.

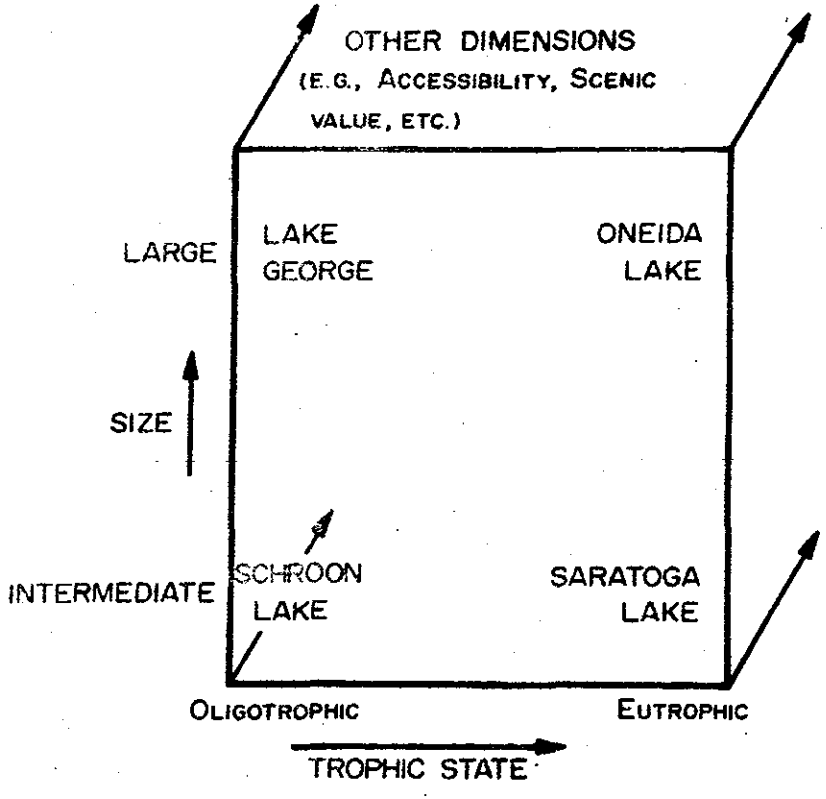

FIGURE 1 - Conceptual Sample Spacing of the Four Lake Study Areas

LAKE	LENGTH (KILOMETERS AND MILES)	WIDTH (KILOMETERS AND MILES)		DEPTH (METERS AND FEET)		SHORELINE LENGTH (KILOMETERS AND MILES)	SURFACE AREA (KILOMETERS^2 AND MILES^2)	DRAINAGE AREA PER SURFACE AREA
		MAX.	AVE.	MAX.	AVE.			
GEORGE	51.5 (32)	4.8 (3.0)	2.2 (1.4)	59.4 (195)	16.8 (55)	210.8 (131)	114.0 (44.0)	5.3
ONEIDA	33.6 (20.9)	8.8 (5.5)	6.1 (3.8)	16.8 (55)	6.8 (22.3)	88.0 (54.7)	206.7 (79.8)	17.3
SCHROON	14.5 (9.0)	2.0 (1.25)	1.2* (0.72*)	46.3 (152)	14.3* (47*)	39.9 (24.8)	16.7 (6.45)	50
SARATOGA	6.8 (4.2)	2.4 (1.5)	2.1* (1.3*)	29.3 (96)	7.9* (26*)	21.2 (13.2)	16.3 (6.30)	38.8

* ESTIMATED VALUE

TABLE 1 - SELECT MORPHOLOGICAL FEATURES OF THE FOUR RECREATIONAL LAKES.

GROUP INTENDED AND FORM TYPE	SPECIFIC COVERAGE OBTAINED
RECREATIONISTS, FORM A	INCLUDES PRIMARY, SECONDARY AND TERTIARY CONTACT CATEGORIES SUCH AS SWIMMERS AND BOATERS THROUGH SIGHTSEERS. BOTH PRIVATE AND PUBLIC RECREATION SITES ON EACH LAKE WERE CANVASSED.
COTTAGE AND HOMEOWNERS, FORM B	INCLUDES SEASONAL AND PERMANENT RECREATIONISTS WHO OWN OR RENT THESE FACILITIES. SPECIFIC INFORMATION ON WATER SUPPLY, WASTE DISPOSAL FACILITIES, USE OF FERTILIZERS, ETC. IS ALSO OBTAINED.
HOTEL-MOTEL, LODGING COMMERCE, FORM C	INCLUDES OWNERS OR MANAGERS OF COMMERCIAL LODGING FACILITIES. SPECIFIC INFORMATION ON FACILITIES, IMPORTANCE OF WATER QUALITY TO BUSINESS, AND UNIQUE QUESTIONS TO THIS TYPE OF COMMERCE IS OBTAINED.
NON-LODGING COMMERCE, FORM D	INCLUDES OWNERS OR MANAGERS OF COMMERCIAL NON-LODGING FACILITIES AND COVERS A BROAD RANGE OF COMMERCE SUCH AS RESTAURANTS, AMUSEMENT PARKS, DRUG STORES, GAS STATIONS, TOURIST SHOPS, ETC.
MARINAS, FORM E	INCLUDES SPECIFIC INFORMATION ON FACILITIES AND SERVICES PROVIDED, GAS AND OIL SALES, AND THE LIKE.
FISHERMEN, FORM F	INCLUDES ALL TYPES OF RECREATIONISTS WHO FISH AND COVERS BOTH THE SERIOUS AND THE CASUAL TYPE OF FISHERMAN.
BOATING ADDENDUM FORM G	THIS IS ATTACHED TO THE A AND THE B FORMS AND IS ALSO USED SEPARATELY. IT DEALS WITH SPECIFICS CONCERNING BOATING USAGE, RECREATIONIST EVALUATION OF BUOY SYSTEMS, ZONING PROBLEMS, BOATING LAUNCHING SITES, WASTE DISPOSAL PRACTICES AND THE LIKE.

TABLE 2 - THE QUESTIONNAIRE PACKAGE.

FORM TYPE	# DIST'D	# RETURNS	% RETURN
RECREATIONISTS, FORM A	29,574	4,368	14.77%
COTTAGE AND HOMEOWNERS, FORM B	7,151	859	12.01%
HOTEL-MOTEL, FORM C	242	55	22.73%
NON-LODGING COMMERCE, FORM D	304	70	23.03%
MARINAS, FORM E	50	14	28.00%
FISHERMEN, FORM F	5,453	390	7.15%
BOATING ADDENDUM, FORM G	10,617	1,051	9.90%
TOTAL (LESS FORM G)	42,774	5,756	13.46%

TABLE 3 - SUMMARY OF QUESTIONNAIRE RETURNS BY FORM TYPE

also the percent rate-of-return by each form type. This survey utilized mail-back forms which were filled out by respondents on the field, or at home. Most forms were completed and returned from the field.

This paper presents a brief data analysis of the questionnaire survey forms, employing three groups of respondents for analysis, namely recreationists (Form A), cottage and homeowners (Form B), and fishermen (Form F). These three groupings of respondents are analyzed for their response to water quality. The particular question of the survey instrument to be analyzed is listed in Table 4. Upon examination of the content of the question, it is obvious that it is structured to examine response to trophic state factors, morphological site suitability factors, and crowding and stress factors, as well as water quality.

Data Analysis Procedure

In order to characterize response to the water quality spectrum, a percentage response profile was generated by each form grouping by dividing each absolute response value in the water quality profile by the respective sample size of the form grouping. Thus, if there are any differences in sample size for each form grouping, then these differences are essentially eliminated by obtaining the respective percentage response profile. This approach appears to be valid as long as the sample sizes are not very small (e.g., generally not less than 50 respondents). All samples selected for analysis in this paper are larger than 50 respondents, so bias from small sample size is not considered to be a problem.

Interpretation of Percentage Response Profiles

The percentage response profiles may be examined for high and low percentage response to given items within the water quality profile.

DO YOU OBJECT TO ANYTHING ABOUT THE LAKE WATER? (YOU MAY CHECK MORE THAN ONE. YOU MAY PLACE ADDITIONAL CHECK MARKS OR STARS NEXT TO THOSE ITEMS WHICH ARE MOST OBJECTIONABLE).

___NO OBJECTIONS

___TOO COLD
___TOO WARM
___TOO CHOPPY & ROUGH
___NOT VERY CLEAR; MUDDY
___BUILD-UP OF SHORELINE GROWTHS
___STRANGE ODORS
___STRANGE COLORS
___STRANGE TASTE
___GROWTH OF ALGAE, PLANTS OR SCUM
___FILM OF GASOLINE OR OIL
___DEAD FISH

___IRRITATING TO EYES OR SKIN
___FLOATING OBJECTS
___MUDDY BOTTON
___ROCKY BOTTOM
___STEEP SLOPE
___TOO SHALLOW SLOPE
___TOO MANY SHALLOW SPOTS
___TOO MANY BOATS
___TOO MANY PEOPLE
___NOT ENOUGH PEOPLE
___TOO MANY WATER SKIERS
___TOO MANY FISHERMEN

___OTHER (PLEASE SPECIFY)_____

TABLE 4 - GENERAL WATER QUALITY QUESTION EMPLOYED FOR DATA ANALYSIS

Thus, a logical first-scan of the data would be examination of extremes, but moderate percentage response for given items in the profile may also characterize a given user group.

In order to rank the significance of a given item or group of items in the percentage response profiles, cluster level assignments were made as shown in Table 5. The assignment of cluster levels is not to be confused with cluster analysis, where the former is an arbitrary scheme for pattern recognition and the latter is a quantitative technique. There is obviously a large gap between the former and the latter approach. Where data require cross-tabulations, conditional strings of logic, or other multiple-item relationships, quantitative techniques are most useful for maintaining a consistent logic for identifying patterns. The authors have not been able at this point in time to complete the computerization and programming aspects of this project, because of our choice to concentrate upon developing a comprehensive computerized information system as a research tool which will have greater applicability to long-term research. As a result of this decision, program development and other necessities have precluded immediate feedback, except through reliance on hand-tally analysis of the data. As a result of this approach to the research, reliance has been placed on the former approach of cluster level assignments, although it is acknowledged as not being as powerful a technique as cluster analysis or other multivariate methods which are employed for pattern recognition. In defense of our initial scan of the data, we cite Uhr (1966) who states, ".... As horrifying as it may sound to some, the chief sources of specification of a model for pattern recognition are intuition and introspection, and in this we all draw upon our own resources as human beings ...." The use of cluster level groupings to analyze percentage response profiles is employed in this paper for analysis of the most obvious and simple patterns. While flexibility is lost employing such an approach, its inherent simplicity may also be considered an advantage.

CLUSTER LEVEL	% RESPONSE OR % DIFFERENCE
1	≥ 45%
2	44% - 30%
3	29% - 15%
4	14% - 5%
5	< 5%

TABLE 5 - A SUGGESTED CLASSIFICATION SCHEME FOR CLUSTER LEVEL GROUPING OF MULTIPLE ITEM QUESTIONS.

Interpretation of Cluster Levels

In reference to the cluster level assignments for the percentage response profiles, cluster level 1 (C. L. 1) implies that any item or group of items which fits this category is very important or very characteristic of the profile. Appearance of items in C. L. 4 or 5 may also be very characteristic of the profile, because the very lack of predominance denotes a meaningful result which may further characterize the profile just as much as a C. L. 1 response.

Data Results

The objective of this analysis is briefly stated as, (1) to characterize each ecological setting for its validity as a trophic state endpoint as perceived by the respondents, and (2) to determine which water quality parameters are more sensitive to each user group within each ecological setting. Percentage response profiles which show shifts in high or low percentage response for given items within a form type grouping may be indicative of shifts related to the ecological settings. The respective shifts must then be examined for their relevance to the ecological setting. Where any items are reported at equal response levels within the same form grouping in two vastly different ecological settings, these items may be inferred as independent of the ecological setting, whereas any items which are vastly different may be inferred as strongly dependent upon the ecological setting.

There is the possibility that some percentage response profiles will have to be examined for differences which appear to defy a-priori logic. These differences may very possibly be attributed to exogenous factors which are unique to each ecological setting. While care was taken to minimize as many exogenous factors as possible when selecting the ecological settings, it is acknowledged that real-world environments are unique in many ways, and that exogenous factors will

inevitably be encountered. It should be further acknowledged that the following analysis represents only a partial treatment of the subject, and serves merely as an illustration of one possible method of approach for data analysis.

Overview

Referring to Figures 2b and 3b, it is observed that recreationists at the nutrient-rich lakes (Oneida Lake and Saratoga Lake) complain much more intensively regarding the overall water quality spectrum. The most predominant pattern which emerges at the nutrient-poor lakes (Lake George and Schroon Lake) is that many of the recreationists have no objections (38% @ C.L. 2 for Lake George, and 35% @ C.L. 2 for Schroon Lake), but those that do object to the lake water at nutrient-poor lakes consider dead fish (21% @ C.L. 3 for Lake George, and 20% @ C.L. 3 for Schroon Lake), and films of gasoline or oil (18% @ C.L. 3 for Lake George, and 17% @ C.L. 3 for Schroon Lake) as the major problems. The consistency among complaints at the two oligotrophic lakes is very strong, as is evidenced by the difference profile of Figure 4a. All differences are in the C.L. 5 grouping, excepting muddy bottom (11% @ C.L. 4) for Schroon Lake relative to Lake George. The smaller oligotrophic lake (Schroon Lake) appears to have slightly more water quality problems, such as slightly heavier shoreline growths, algae growths, and taste problems. The larger oligotrophic lake (Lake George) appears to have slightly more crowding problems, such as too many people, too many boats and too many waterskiers. The differences between the oligotrophic lakes are not great, however, and appear to be well suited as matching endpoints as oligotrophic lakes.

As expected, the nutrient-rich lakes (Figures 2b and 3b) contrast greatly in lake water quality problems as compared to the nutrient-poor lakes (Figures 2a and 3a). Both nutrient-rich lakes have a C.L. 1

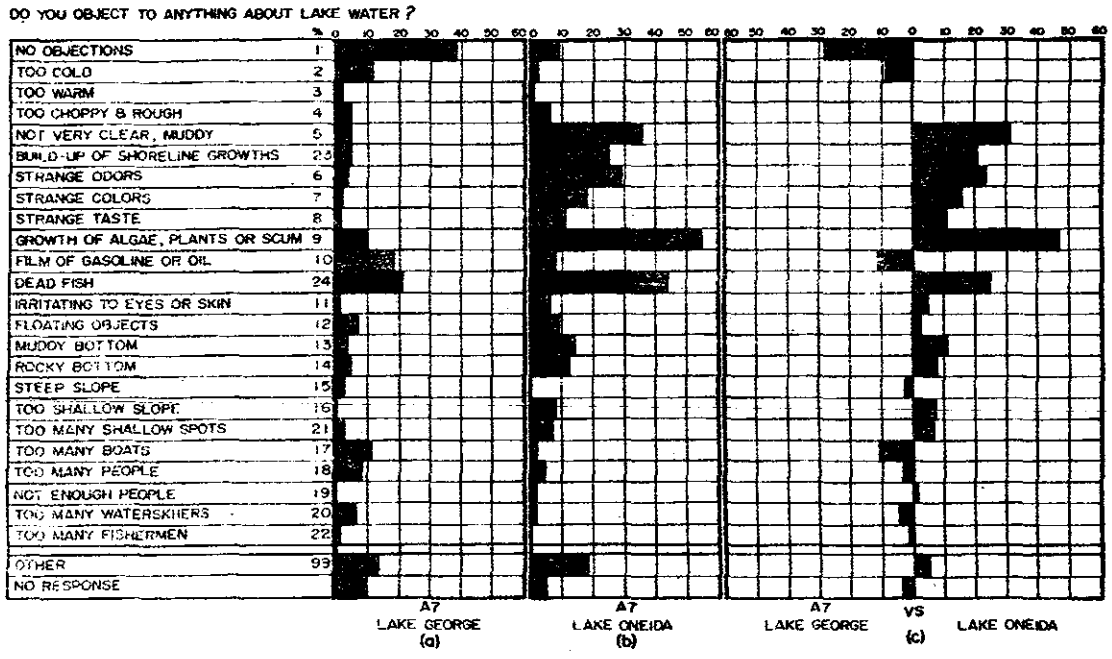

FIGURE 2 - Profiles of Recreationists (a-Lake George, b-Oneida Lake, c-Difference Profile)

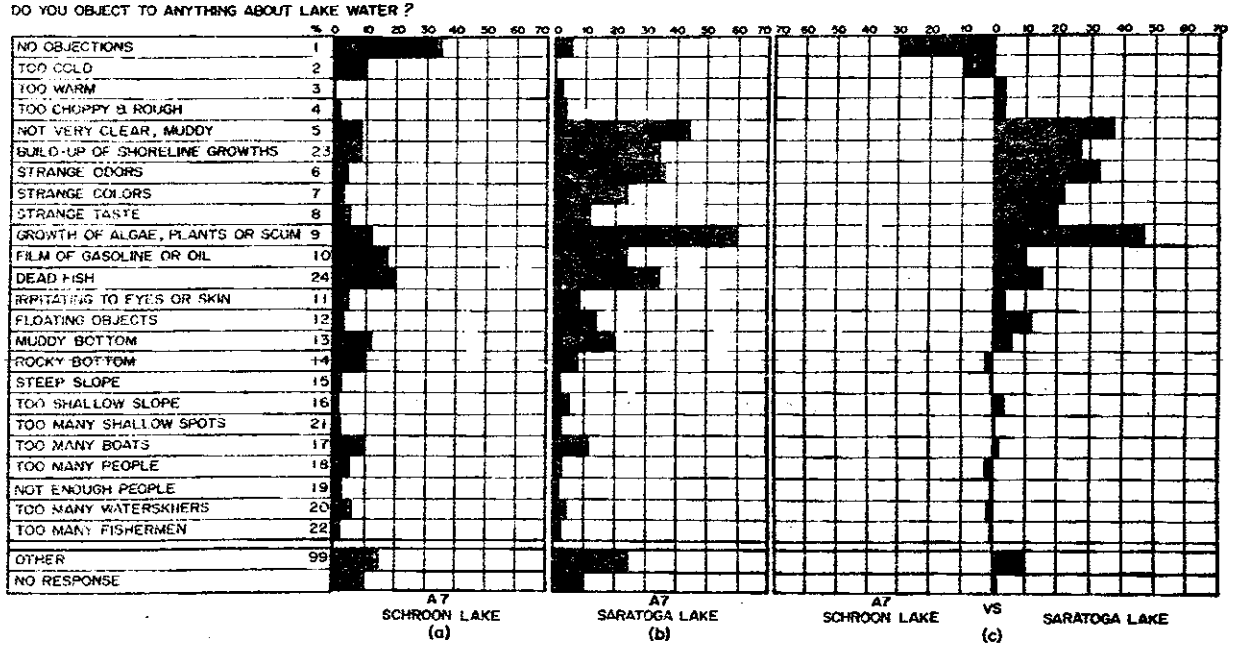

FIGURE 3 - Profiles of Recreationists (a-Schroon Lake, b-Saratoga Lake, c-Difference Profile)

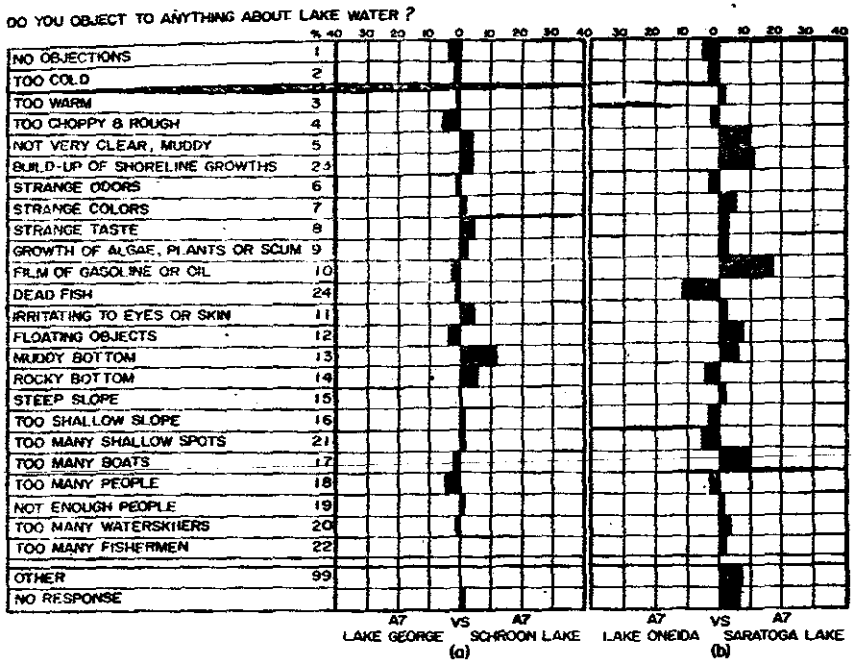

FIGURE 4 - Difference Profiles of Recreationists (a-Lake George and Schroon Lake, b-Oneida Lake and Saratoga Lake)

complaint of growth of algae, plants or scum (56% at Oneida Lake, and 60% at Saratoga Lake). Saratoga Lake has an additional C.L. 1 complaint of not very clear, muddy (45%), whereas this complaint is C.L. 2 at 36% for Oneida Lake. Other common complaints at these eutrophic lakes which appear at C.L. 2 and 3 include strange odors (29% @ C.L. 3 for Oneida Lake, and 36% @ C.L. 2 for Saratoga Lake), buildup of shoreline growths (25% @ C.L. 3 for Oneida Lake, and 35% @ C.L. 2 for Saratoga Lake), and strange colors (18% @ C.L. 3 for Oneida Lake, and 24% @ C.L. 3 for Saratoga Lake).

The consistency among complaints at the two eutrophic lakes is rather strong, as is evidenced by the difference profile of Figure 4b. All differences are in the C.L. 4 or 5 groupings, excepting film of gasoline or oil (17% @ C.L. 3) for Saratoga Lake relative to Oneida Lake. While there seems to be more of a problem of dead fish (11% @ C.L. 4) for Oneida Lake, the smaller eutrophic lake (Saratoga Lake) appears to be generally more stressed. Recreationists at Saratoga Lake report more problems compared to Oneida Lake such as build-up of shoreline growths (11% @ C.L. 4), too many boats (10% @ C.L. 4), not very clear, muddy (10% @ C.L. 4), floating objects (7% @ C.L. 4), strange colors (6% @ C.L. 4), muddy bottom (4% @ C.L. 5), strange taste (3% @ C.L. 5), growth of algae, plants or scum (3% @ C.L. 5), irritating to eyes or skin (3% @ C.L. 5) and other complaints. The differences between the eutrophic lakes are not great, however, and appear to be well suited as matching endpoints as eutrophic lakes.

Examination of the difference profiles of Figures 2c and 3c further indicate major differences between the two large lakes and the two intermediate-sized lakes. Both difference profiles are almost identical in appearance, however, with the oligotrophic lakes again characterized by no objections. The large oligotrophic lake also indicates some stress factors from crowding (e.g., too many boats, and film of gasoline or oil, both at 11% @ C.L. 4, and other crowding complaints). The

intermediate-sized oligotrophic lake (Schroon Lake) does not appear to be stressed by crowding as is Lake George. The eutrophic lakes, as evidenced also from the difference profiles of Figures 2c and 3c, have a broad spectrum of complaints which are nearly identical.

Examination by Form Type within the Large Lakes

Examining the difference profiles by form type within each lake should provide insite as to how each group differs in perception of the spectrum of water quality problems at each ecological setting. Figures 5 and 6 examine the difference profiles of recreationists, cottage and homeowners, and fishermen at the two large lakes (Lake George and Oneida Lake respectively). As these profiles are examined, the authors shall provide an a-priori rationale for the differences. The rationale reflects opinion and informed judgement, and is by no means a critical final word on the patterns observed. In order to provide a meaningful format for discussion of the differences, items will be discussed separately or in small groups.

No Objections

The recreationists as a group appear to be more satisfied with the lake water quality, while the cottage and homeowners appear least satisfied, and the fishermen appear mid-way between these extremes. Many reasons may be offered for this pattern, which also seems to be consistent at the eutrophic lake (Figure 6), as well, but one major reason shall be offered. It is believed that opportunity for repeated contact with the lake water is greatest for cottage and homeowners and least for recreationists, with fishermen falling between. The cottage and homeowner lives on the lake generally as a permanent or seasonal resident, and thus has more opportunity for contact with the water, whereas the recreationist frequents the lake only occasionally or infrequently -- mainly through day use, weekend use or vacations and

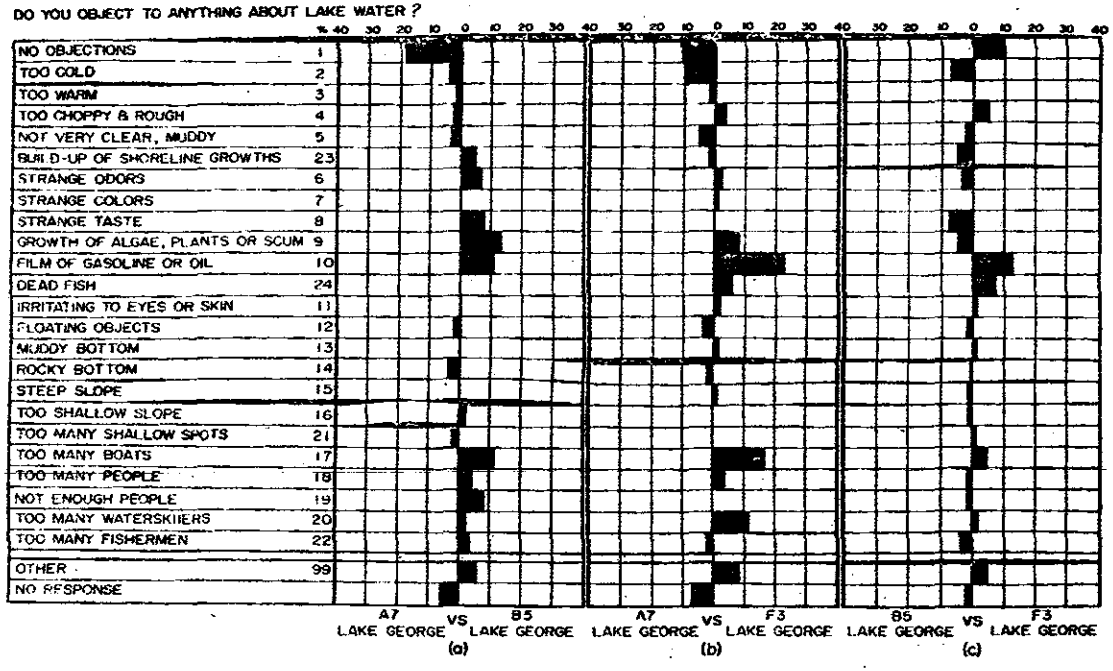

FIGURE 5 - Difference Profiles by Form Type at Lake George (a-Recreationists and Cottage Owners, b-Recreationists and Fishermen, c-Cottage Owners and Fishermen)

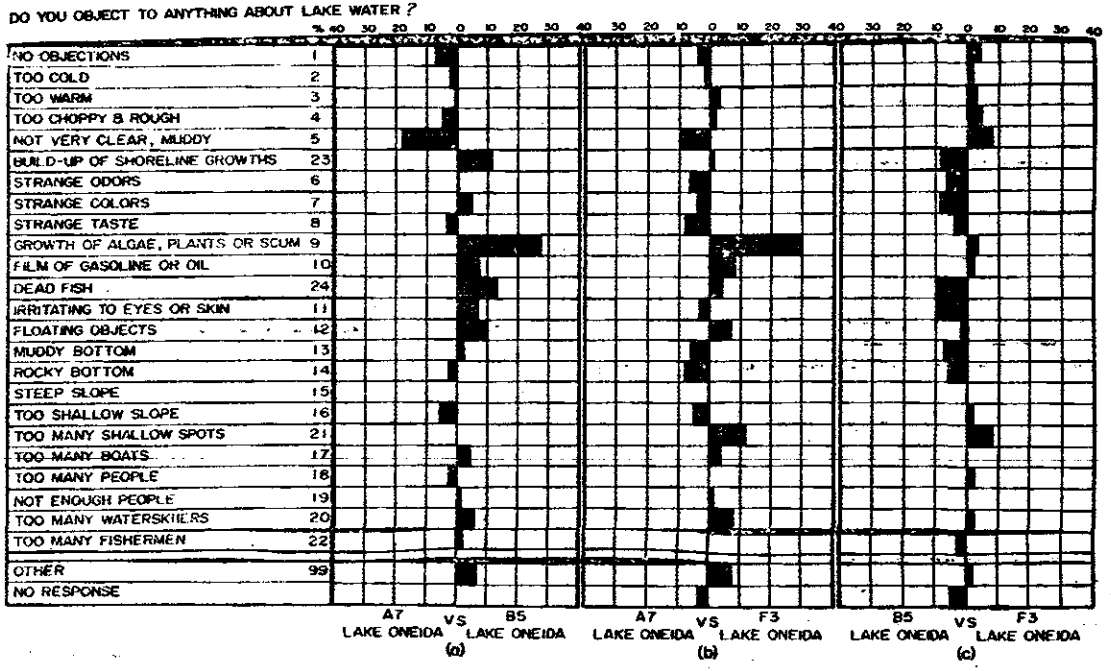

FIGURE 6 - Difference Profiles by Form Type at Oneida Lake (a-Recreationists and Cottage Owners, b-Recreationists and Fishermen, c-Cottage Owners and Fishermen)

does not have as much opportunity for contact.

Too Cold

The recreationist appears as the most sensitive group at the oligotrophic lake, followed by cottage and homeowners as the next sensitive group and by fishermen as the least sensitive group. This pattern implies that the highest frequency of primary-contact water-based recreation is among the recreationists and the lowest frequency of primary-contact water-based recreation is among the fishermen, or that the tolerance threshold levels to water temperature is different for these user groups. At the eutrophic lake, the incidence of complaints in this category is very low, but the recreationist still is more sensitive, and the cottage and homeowner least sensitive. The levels are too low to make any further statement as to the relevancy of this pattern at the eutrophic lake. The oligotrophic lake has generally colder temperatures than the eutrophic lake and this is also evidenced by the differences in the response profiles between Figures 5 and 6.

Too Warm

The differences at both lakes are too low to make any significant comparison between the groups. The eutrophic lake should be warmer than the oligotrophic lake, but the lake water at the eutrophic lake should not be so warm as to be objectionable. It is suggested that maximum water temperature should not exceed 85°F (30°C) in primary-contact recreation waters, except where caused by natural conditions (FWPCA, 1968, p. 4). This temperature maximum is not likely to be achieved often at a eutrophic lake. Oneida Lake's August surface temperature is generally no higher than 77°F (25°C) (Refer to Greeson and Meyers, 1969, p. 21 and Greeson, 1971, pp. 156-170), and thus it is expected and confirmed that very few respondents should complain about the water being too warm for primary-contact recreation.

Too Choppy and Rough

A eutrophic lake may be more choppy and rough than an oligotrophic lake. This is due to the larger movement of water mass to be found in shallow eutrophic bodies of water, where wind-generated water movement of the total water column will create larger waves on a shallow body of water as compared to a deep body of water which is thermally stratified. This factor may not be of significance because other factors may also be involved, such as weather conditions, surrounding topography and prevailing wind direction and speed.

The pattern which emerges from Figures 5 and 6 is that the fishermen appear more sensitive to this condition and the recreationists appear least sensitive, with cottage and homeowners falling between these extremes. This is reasonable if one considers the fact that the fishermen primarily engage in the boating activities which are surface-sensitive. However, this problem of choppy and rough conditions does not appear to be different between the two lakes.

Not Very Clear, Muddy

It would seem logical to assume a-priori that all users participating in primary-contact recreational activities would be sensitive to water clarity. Thus, since recreationists as a group appear to engage more preferentially in primary-contact activities, then this group is likely to be the most sensitive. This pattern is apparent at the oligotrophic lake (Figure 5), but is much more evident at the eutrophic lake (Figure 6). The next most sensitive group appears to be the fishermen, and this pattern is consistent at both lakes. While the fishermen may be primarily engaged in secondary-contact activities such as fishing and boating, their opportunity for contact with the water via the fishing activity appears also to place them as more sensitive a group than the cottage and homeowners for this item.

Build-up of Shoreline Growths

It is reasoned that the frequency of contact with the lake shoreline should be highest for the cottage and homeowners, and that the recreationists and the fishermen should have about equal opportunities for contact with the lake shoreline. It appears from Figures 5 and 6 that the cottage and homeowners are the most sensitive group to this problem, and that there is no strong difference between the recreationists and the fishermen. The frequency of complaints is much greater for all groups at the eutrophic lake, but the difference profiles do indicate a consistency with cottage and homeowners as the most sensitive group to shoreline growths.

Strange Odors, Strange Colors and Strange Taste

It is reasoned that the most sensitive group to strange odors and taste should be the cottage and homeowners. The cottage and homeowners may also have a different threshold of acceptance or tolerance to these problems at a nutrient-rich lake than the recreationist, and this may be evident by group sensitivity shifts between nutrient-poor and nutrient-rich lakes. For instance, Figure 5 indicates that the problem of strange odors and strange taste is more noticeable on the nutrient-poor lake by cottage and homeowners than at the nutrient-rich lake. The cottage and homeowners drink the lake water, sometimes without any treatment at the nutrient-poor lake. If there are any taste or odor problems, then this group should report it more frequently, because they drink the lake water, whereas recreationists or fishermen as a group do not utilize the lake as a water supply to the same extent. This pattern seems to be reasonable, as is evident from Figure 5.

At a nutrient-rich lake, one would expect, a-priori, the water to be of such poor quality that residents would not use it as a water supply. Alternative sources for water supply such as wells, municipal supply or bottled water would be employed. Since the cottage and

homeowners would avoid drinking the lake water at a nutrient-rich lake, this group should not report strange tastes and odors to the same extent. This fact appears to be borne out by Figure 6.

It is reasoned that recreationists at a nutrient-poor lake should be more unaware of taste problems as recreationists at a nutrient-rich lake. Further, it is expected that taste problems may be reported more frequently at a nutrient-rich lake by recreationists than by cottage and homeowners. This rationale is offered because recreationists would probably be involved in primary-contact recreation where some ingestion of lake water is inevitable. This rationale also seems to be evident from Figures 5 and 6. Figure 6 indicates that cottage and homeowners seem to be equally sensitive to strange odors as recreationists.

Strange colors may bother recreationists more than cottage and homeowners at a nutrient-rich lake. However, strange colors do not appear to be a problem at the nutrient-poor lake. The logic offered for the apparent higher sensitivity of the recreationists to strange colors at a nutrient-rich lake is that the colors of the lake water are probably accepted by the cottage and homeowners as "natural," because it is like that most of the time. Thus, while the cottage and homeowners may be conditioned to the water color and have a different tolerance threshold, the recreationists, who most probably visit other lake areas as well, may not be so conditioned.

Growth of Algae, Plants or Scum

The problem of algal, plant or scum growths should probably be reported most frequently by the cottage and homeowners. The reasoning offered for this is simply the continuous contact of the cottage and homeowners with the lake by virtue of their living on its shores. Fishermen may object to this problem and may be particularly annoyed with surface scums, as these are visible on the surface and to rooted aquatic

plants, as these may foul the fishing lines. Overall, the fishermen at the nutrient-rich lakes may object as vociferously to growths of algae, plants or scum as the cottage and homeowners.

Examination of Figure 5 indicates that growth of algae, plants or scum at a nutrient-poor lake are perceived most by cottage and homeowners, secondly by fishermen and least by recreationists. Examination of Figure 6 indicates that growths of algae, plants or scum at a nutrient-rich lake are perceived most by fishermen, followed by cottage and homeowners, and lastly by recreationists. This slight shift in sensitivity by fishermen to a predominant position in the latter case is possibly indicative of the effect of heavy algal growths upon hindering the fishing activity. The fishermen at the nutrient-rich lake may also perceive the relationship between algal blooms and fish kills, but this fact is not provided by the water quality question and must be ascertained through other questions in the data.

Film of Gasoline or Oil

It is expected that user groups which engage in activities having more intimate involvement with the surface of the water will be more sensitive to films of gasoline or oil. Most gasoline and oil discharged to lake water by outboard engines accumulate in the top few inches of water (Shuster 1971). Possible sources of oil that may occur in natural water bodies are enumerated as follows (Strickler 1972):

1. Natural petroleum and gas seeps
2. Oil discharges from human activities
    a. Petroleum-based oils
    b. Non-petroleum-based oils
3. Natural oils formed by contemporary biological activity.

Eutrophic lakes have natural oil forming agents present in the algal flora, whereas oligotrophic lakes have starch-formers present (Prescott 1939). All lakes examined are rather heavily used recreational lakes and it is

suspected that the major oil discharges are from human activities.

A likely group which should be rather sensitive to films of gasoline or oil would be the fishermen. They troll the lake surface slowly and spend many hours close to the water surface. The fishermen should also be sensitive to extreme problems of gas and oil films as may be evidenced from the tainting of fish flesh and taste problems of fish. Other sensitive groups should include island campers which are surrounded completely by water and non-power boaters, which are generally close to the water surface. Cottage and homeowners who are seasonal or permanent residents should be another rather sensitive group, since their activities are oriented towards the water or along the shoreline. As a contrast, it is suspected that mainland sightseers who do not swim would be a least sensitive group to gas and oil films. In this analysis, however, we shall confine the examination to differences between recreationists, cottage and homeowners and fishermen.

Examination of Figure 6 indicates that fishermen are slightly more sensitive to films of gasoline or oil than are cottage and homeowners, while recreationists are the least sensitive group at the nutrient-rich lake. Figure 5 indicates that the gas and oil film problem is much more evident at the nutrient-poor lake, with the fishermen as the most sensitive group, followed by the cottage and homeowners, and the recreationist as the least sensitive. At the nutrient-poor lake, this problem ranks as high as a C. L. 3 on the difference profiles, whereas at the nutrient-rich lake it ranks as high as C. L. 4. The ranking of sensitivity between groups maintains a consistency, however, with the fishermen as most sensitive and the recreationists as least sensitive, regardless of trophic state conditions.

Floating Objects and Dead Fish

Floating objects and dead fish should be objectionable to all groups, with perhaps the cottage and homeowners being most voceriferous where

these problems are rampant. Floating objects may be esthetically unpleasant and some objects, such as logs, may pose as threats to navigation. Dead fish are much more unpleasant, because they wash up on beach areas, decay and cause nuisance conditions such as foul odors and create a waste disposal problem. Since recreationists visit the area generally for day use, weekend use, or vacations, then one would suspect that they would be less sensitive to these problems than the cottage and homeowners or the fishermen who generally have more intimate overall contact with the lake.

Examination of Figures 2 and 3 indicates that at nutrient-rich lakes complaints of dead fish is a C.L. 2 problem, whereas floating objects is a C.L. 3 or 4 problem. At nutrient-poor lakes, complaints of dead fish is a C.L. 3 problem, whereas floating objects is a C.L. 4 or 5 problem. Thus complaints of dead fish or of floating objects are displaced at least by one cluster level when comparing these problems at nutrient-poor versus nutrient-rich lakes.

At the large nutrient-poor lake (Lake George, Figure 5), the fishermen appear most sensitive to dead fish, followed by cottage and homeowners, with recreationists as least sensitive. Floating objects, however, are most annoying to recreationists and least annoying to fishermen. This sensitivity between these two complaints is reversed between the groups, but does not indicate very strong shifts at the cluster 5 level. At the large nutrient-rich lake (Oneida Lake, Figure 6), the cottage and homeowners appear most sensitive to dead fish, and the fishermen as least sensitive. While the differences between these groups do not vary beyond C. L. 4 for floating objects, cottage and homeowners are the most sensitive group both to dead fish and floating objects, while the recreationist is the least sensitive group for these items.

Irritating to Eyes or Skin

All users involved with primary-contact recreation activities should be susceptible to possible irritations of eyes or skin. It is suspected that a nutrient-poor lake would have very few complaints in this category, whereas a nutrient-rich lake would have a higher incidence of complaints. One line of reasoning offered for this is that of exceeding the buffering capacity of the lacrimal fluid of the human eye. The lacrimal fluid of the human eye has a pH of approximately 7.4 and also has a very high buffering capacity. Once the buffering capacity of the eye is exhausted, however, extreme discomfort or pain may occur. The pH of water should thus be approximately the same as the pH of lacrimal fluid which is about 7.4 for most people (Mood, 1968). As stated by Mood (1968), "....Since the lacrimal fluid has a high buffering capacity, a range of pH values from 6.5 to 8.3 can be tolerated under average conditions. If the recreation water is relatively free of dissolved solids and has a very low buffer capacity, pH values from 5.0 to 9.0 should be acceptable ...."

Eutrophic lakes have high solids content and usually have a pH ranging from 6.8 to 9.8 (Prescott 1939). It is expected, therefore, that recreationists at a eutrophic lake will complain about eye or skin irritations to some extent. An oligotrophic lake, on the other hand, has a low solids content and a pH ranging from 4.5 to 7.0, with values closer to 7.0. It is expected, therefore, that a lower incidence of eye or skin irritations would be reported on the oligotrophic lakes examined, since they are nearer to pH values of 7.0.

As is evident from Figure 5, this problem does not appear to be present at Lake George, while at Oneida Lake it is reported as high as C. L. 4 on the difference profiles. The most sensitive group appears to be cottage and homeowners, followed by recreationists and lastly the fishermen. This pattern appears as reasonable, since cottage and homeowners or some members of their family are most likely to have had

some past experience with the water and will report this. The recreationists engage in primary-contact water-based recreation and would appear to be a very susceptible group, as is evident also from their response profile to this item. The fishermen engage heavily in the fishing activity, which is secondary-contact and thus appear as least susceptible, because of their more limited opportunities for contact within the water.

Muddy Bottom and Rocky Bottom

An oligotrophic lake should possess a somewhat rocky bottom as compared to a eutrophic lake which should possess a muddy bottom. The rocky bottom of an oligotrophic lake should be somewhat objectionable to recreationists who swim or wade along the shoreline, unless fine sand has been trucked in as fill in the beach areas. The eutrophic lake should have a more muddy bottom than an oligotrophic lake, and it is expected that recreationists will complain of this, unless the beach areas have been filled in with sand and maintained properly.

It is expected, a-priori, that recreationists which spend their time swimming and wading and in other shoreline activities should be sensitive to rocky or muddy bottoms. The recreationists as a group probably are shoreline oriented, but probably not as much as the cottage and homeowners. Thus, the cottage and homeowners are probably equally sensitive to bottom conditions to the extent that they swim or wade, or because their swimming areas are not adequately sanded. The fishermen should be a less sensitive group towards bottom conditions, because more of their time is spent on the water surface than in shoreline activities.

Examining the large oligotrophic lake (Lake George, Figure 5), it is observed that there are no or very few complaints between all groups regarding a muddy bottom. Regarding complaints of a rocky bottom, it is seen that the differences are not great among all groups, but that the recreationists appear to be most sensitive to rocky bottom conditions at

Lake George. Examining the large eutrophic lake (Oneida Lake, Figure 6), it is observed that there are complaints of a rocky bottom, with the recreationists as the most sensitive group and the fishermen as the least sensitive group. The complaints of a muddy bottom are most evident among cottage and homeowners, secondly among recreationists and lastly among fishermen. From Figure 2b, it is observed that recreationists complain more about both rocky and muddy bottom conditions at the eutrophic lake (Oneida Lake). These complaints may also be indicative of less well maintained beach areas at Oneida Lake as compared to Lake George, in addition to the inherent trophic state characteristics of these lakes.

More reliance regarding complaints of a muddy or rocky bottom probably should be placed on cottage and homeowners at any lake, because their shoreline properties are most probably not well sanded and contoured as one might find at a public beach area. The cottage and homeowners or any private owner of lake property is greatly discouraged from adding fill to his beach area, such as sand, although this was not the case perhaps a decade ago. If the property owner wants to alter the lake bottom conditions, he encounters problems with permits and regulations, and is thus greatly discouraged from altering the bottom conditions of his shoreline property.

Steep Slope, Too Shallow Slope, Too Many Shallow Spots

An oligotrophic lake should have generally steep slopes, even in bathing areas; whereas a eutrophic lake should have very shallow slopes and many shallow spots well beyond the shoreline. Shallow slopes are expected to be ideal for bathers, but extremely shallow slopes may be somewhat objectionable.

It is a-priori expected that the most sensitive group to complaints about slope conditions would be the recreationists, followed by the cottage and homeowners and lastly by the fishermen. The fishermen spend much

time boating on the water surface and may be most sensitive to very shallow spots in the lake, because they must navigate these areas frequently. The cottage and homeowners may be equally sensitive to too many shallow spots, but this depends on their frequency of boating and the size of their boats as compared to the fishermen. Recreationists may complain least about too many shallow spots, since as a group they may engage in less boating.

Referring to the users at the large oligotrophic lake (Lake George, Figure 5), and users at the large eutrophic lake (Oneida Lake, Figure 6), neither lake appears to have steep slope problems. This may be attributed to the fact that the respondents at the oligotrophic lake either expect the slope to be steep, and those that may not (the recreationists), find the public or private beach areas well graded and sanded. It is also observed at the oligotrophic lake that all users do not complain of the slope being too shallow or of having too many shallow spots, which is expected. The eutrophic lake, on the other hand, does have too shallow a slope and too many shallow spots. While the recreationists are most sensitive to shallow slopes, the cottage and homeowners are about equal in perception of this problem. The fishermen complain most frequently about too many shallow spots, while the recreationists and cottage and homeowners are less sensitive and similar in this respect.

Too Many Boats, Too Many People, Not Enough People, Too Many Waterskiers, Too Many Fishermen

The above items deal with crowding indicators. It is expected that the oligotrophic lake shall receive more complaints about too many boats, too many people, and too many waterskiers, mainly because it has less nuisance conditions and better features for these activity groupings than a eutrophic lake. Both lakes are expected to have crowding problems, because they are water-based recreational environments, but the oligotrophic lake should receive more boating pressure and more people of all

categories (excluding fishermen and other high productivity related activities), assuming other things as equal.

It is expected that the eutrophic lake should receive more complaints about too many fishermen, because it has more opportunity for good fishing and should attract many people for this activity. Thus, while oligotrophic lakes may have many users, it is expected that a small percentage shall be fishermen as compared to the case at the eutrophic lakes.

Regarding the perception of crowding factors among different user groups, the following a-priori logic is offered. Since the cottage and homeowners have a vested interest in their lakeshore property, and since they expect a certain minimal amount of privacy and enjoyment of their immediate lakeshore area, the cottage and homeowners as a group should be most annoyed by intrusion or crowding by others. Thus, it is suspected that the cottage and homeowners may complain most vociferously about too many fishermen, too many boats, too many people, and too many waterskiers.

While the recreationists may complain of crowding, they may also prefer more people in some cases. One case, for instance, may be a recreationist alone on a beach area, where he would prefer some people nearby for safety considerations. Another example may be the urban campers or picnickers which prefer to be near others. For instance, while most campers want to be within 50 to 100 feet of other campers, and a smaller group wishes to be at least 250 to 400 feet of other campers, there is an even smaller group which would like campsites 10 to 15 feet apart (Hopkins 1968, p. 12). Lucas (1962) has examined attitude differences between canoeists and powerboat enthusiasts regarding wilderness perception. He found that canoeists and wilderness hikers had much more stringent definitions of the border lines of the Quetico-Superior wilderness, whereas powerboaters considered more of the area as wilderness. Wilderness canoeists were actually annoyed to meet too many people. This

prompts one to conclude that different meanings of wilderness may be associated with different user groups and that these definitions are social or psychological, rather than strictly physical.

It is expected that fishermen should be most sensitive to buzzing by powerboats and waterskiers and may thus complain more vociferously about too many boats and too many waterskiers. Examination of Figures 5 and 6 indicates more stress and crowding at the oligotrophic lake, with fishermen complaining most frequently about too many boats and too many waterskiers. The recreationists are least sensitive to these items with the cottage and homeowners falling between. This same pattern is evident at the eutrophic lake, but is a less frequent complaint.

Regarding too many people, the cottage and homeowners complain most frequently about this item at the oligotrophic lake, while the recreationist complains most frequently at the eutrophic lake. The cottage and homeowners complain mostly about too many fishermen at both lakes. The cottage and homeowners also appear to complain about not enough people at the oligotrophic lake. This seems contrary to a-priori logic, but may be due to many factors such as large tracts of inaccessible areas at Lake George. Since the differences between all groups does not vary more than approximately 10%, one must rationalize sensitivity to crowding by other factors as well, such as by referring to the questions which polarize attitudes by examining the most positive attributes or most annoying aspects of the lake environments as viewed by the different respondent groupings.

Conclusions

The partial analysis of respondents and their perceptions of water quality indicates that the lakes selected appear as reasonable trophic state endpoints for polarizing attitudes toward water quality. While the above analysis is only a partial treatment of the subject, significant patterns do emerge relating to the ecological settings and to the different

respondent types. The oligotrophic lakes appear to have less intense complaints by all users as compared to the eutrophic lakes. The major water quality problems on the smaller lakes appear to be more intense than at the larger lakes, and this may relate to the association of generally higher productivity at smaller lakes.

Examination of the various profiles at the two large lakes indicates environmental-related shifts in the perception of water quality between the respondent groupings. The C.L. 1 complaints at the large eutrophic lake appear with essentially equal intensity by all user groups. These complaints are growth of algae, plants or scum and dead fish. The highest level of complaints at the large oligotrophic lake appears generally dispersed between C.L. 3 and 4, and are reported as films of gasoline or oil, growth of algae, plants or scum, dead fish, buildup of shoreline growths, strange odors and strange taste, as well as crowding and stress factors.

The fishermen appear as a sensitive group to surface effects such as surface roughness, films of gasoline and oil and crowding factors, such as too many boats and too many waterskiers. The fishermen are also most sensitive to too many shallow spots at the large eutrophic lake. The recreationists are least critical towards overall water quality conditions, but appear most sensitive to water contact factors such as cold water temperatures, clarity of the water, and bottom conditions. The cottage and homeowners as a group appear most sensitive to shoreline problems, odors, colors, and taste. In addition, group sensitivity shifts are evident between ecological endpoints. Further refinements in establishing special sub-groupings within each form type, such as the serious fishermen versus the casual fishermen, or seasonal residents versus permanent residents, or swimmers versus sightseers should offer insight as to differences in perception of water quality by the different user groups. Linking activity classifications and other logical separators of group type shall further aid in discriminating unique groupings of respondents.

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