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AN INVESTIGATION OF THE SELF-HELP WATER QUALITY MANAGEMENT POTENTIAL OF MICHIGAN LAKE ASSOCIATIONS

By

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ABSTRACT

AN INVESTIGATION OF THE SELF-HELP
WATER QUALITY MANAGEMENT POTENTIAL
OF MICHIGAN LAKE ASSOCIATIONS

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Michigan's inland recreational lakes have become increasingly developed in recent years to the extent that cultural eutrophication is a growing problem. At present there are no sufficient institutional remedies for the management of these lakes. If abatement of this degradation is to be achieved within a reasonable amount of time, the management effort will have to originate with residents of the lake community. These residents, usually represented by a lake association, have demonstrated concern for their lake resources, but are unaware of the options available to them for self-initiated lake water quality management.

This research paper includes a review of the technical literature from which a documentation of lake management options suitable for community implementation has been prepared. The four areas of feasible action are: 1) effluent and nutrient discharge abatement; 2) water quality investigation; 3) symptomatic (algae and weed control) management; and 4) sociopolitical involvement by lake residents to induce institutional change and agency cooperation for lake management.

A random sample of 21 Michigan Lower Peninsula lake associations was interviewed to determine the "state of the art" of Michigan lake

association self-help management. Management success was based on a comparison of reported management performance by association representatives with the option criteria developed above.

The associations were found to be fairly active in the areas of sociopolitical involvement indicating the potential to influence local government to assist in lake management. There was little accomplishment in the other three areas more directly related to physical lake improvement performance.

An attempt to equate social and physical characteristics of the associations with relative lake management success was essentially inconclusive. This was because the lake associations sampled are all relatively homogeneous in character and because little significant self-help management has been accomplished to date.

It is believed that the cause of the lake association's management impairment is a lack of sufficient knowledge of management options combined with member apathy. This results in poor participation in management projects, the failure of which reinforces the initial sense of apathy and perpetuates a cycle of relative inefficiency.

To remedy this problem, a residential lake management committee, coordinated by the county Cooperative Extension Service agent, is proposed as a pilot project. Part of the lake communities' frustration with respect to management is related to their skepticism with regard to centralized public agency management of lake resources. This proposal, therefore, emphasizes local initiative and control over the decision making process as well as financial responsibility for the projects implemented. Under this proposal, regional resource agencies and other public institution specialists would assume a primarily

advisory role to the lake community which would draw upon their services for enforcement, planning, and assistance implementing projects determined by the lake residents. It is these residents who ultimately are a major source of both the problems and solutions to Michigan inland lake water quality management.

To my wife and parents; with respect, gratitude, and love.

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Particular recognition is due my wife, Ellen, for her material and moral support throughout this phase of our life.

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CHAPTER I

INTRODUCTION AND OBJECTIVES

Michigan inland lake residents have expressed growing concern for the quality of their lake resources in recent years. They perceive changes in the lake such as reduced clarity or increased weed or algae growth. These changes often follow increased residential development. In increasing numbers they are seeking assistance from university or state agencies.

It is clear that concern over lake degradation exists in the riparian sector. But the riparians, many of whom are represented by a lake association, are frequently unaware of the particular causes of their lake quality problems, the severity of the problems, or of the remedial options available to them.

The Michigan Department of Natural Resources has attempted to respond to this growing concern through the creation of an inland lakes management division in 1974. This office, however, has limited manpower and no field staff; and in just two years of operation, it already has more requests for assistance than it can handle.

Similarly, requests to local Public Health Department officials may not produce the results desired by lake residents. Like the Department of Natural Resources, State and County Health Departments have limited manpower and many other areas of responsibility beyond the lake community. Further, the public health obligation of local or state

sanitarians does not necessarily extend to concern for attendant lake eutrophication problems. Existing public health codes may require particular design and setback criteria for household septic tank systems which are intended to protect the lake and groundwater from disease pathogens, but do little to prevent accompanying phosphorus and nitrogen nutrients from entering either system and contributing to lake enrichment.

It is evident that until adequate public institutional response evolves, lake associations must initiate and carry out much lake water quality management on their own. If riparian rights to lake resources are to remain within the purview of lake shore property owners, the bulk of this management initiative may always have to be assumed by them. As a public agency, the Department of Natural Resources (DNR) tends to place its greatest emphasis on those management programs where the resource is most accessible to the general public. If a lake community or association[1] wishes to preserve some degree of exclusiveness over lake access, it must at present concede to a rather low interest in its lake by the DNR. Short of changing this policy, the lake association's primary option is management by their own initiative.

Clearly then, there is a need for a self-help lake water quality management program which can be initiated and controlled by the lake

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[1]For the purposes of this study, "lake community" and "lake association" are defined as follows: Lake community - Those people living permanently or seasonally within a quarter mile of the lake and directly influenced by it, i.e., those having an aesthetic concern, recreational users, or those dependent upon some aspect of the lake or its uses for at least a portion of their livelihood. Lake association - Those members of the lake community who are formally organized to actively pursue group objectives related to the lake and community. As the lake association expands its activities and membership, it is envisioned, in the context of this paper, as becoming progressively more representative of the lake community which generated it.

community. Interest in such a program is evident from the growing number of requests for assistance received by water resource specialists at Michigan State University. The consistent nature of these requests to the Department of Resource Development is in terms of "show us what is wrong and tell us what we can do." It is important to note that these people are rarely demanding a service; rather they want information so they can make decisions and implement programs on their own. A tendency toward self-help lake management already exists by both inclination and default. However, the lake residents, while recognizing the symptoms of lake quality decline, are not always sufficiently informed to initiate or carry through the necessary remedial programs.

Objectives

It is evident that because of development pressures there is a need for inland lake management, particularly with respect to the abatement of residential effluents. This need is not being sufficiently met by public agencies and must, at least on an interim basis, be dealt with at the local community (i.e., lake association) level. Given this problem, the objectives of this study are as follows: 1) Determine what management options are feasible for localized implementation by riparians; 2) assess present characteristics and performance of the lake associations in Michigan with respect to these management options by interviewing selected lake association representatives; and 3) Design an assistance program based on the concept of lake association self-help management which incorporates local resources and accommodates the priorities and interests of the lake community members as indicated by the interviews.

CHAPTER II

RESEARCH APPROACH

Feasible Lake Management Options

In pursuit of the first objective, the identification of feasible lake management options which can be implemented by the residents, a survey of technical literature in the fields of limnology, sanitary engineering, soil science, and resource management was made. Obviously, such a broad review cannot be all inclusive of any one field. The literature survey was, therefore, primarily directed at the identification of those methods which appear to lend themselves to a realistic "grass roots" localized approach to lake management. The rationale for this grass roots emphasis lies in the recognition that federal and state institutions for resource management will likely assume a greater role in inland lake quality management in the future. As citizen concern for this resource increases, public officials will respond. Thus, the emphasis of this literature search is to concentrate on what lake residents can do themselves to deal with their problem until public institutions respond to the need. Consequently, the methods selected for inclusion in this study were chosen because of their relatively low cost, simplicity of application, and significance of effect upon lake quality. These factors are essential to successful self-help management implementation by lake residents.

It is evident that a self-help approach to lake quality management, in which cost is a major consideration, must concentrate on abatement

and preventive processes. Major restoration techniques, such as lake basin dredging, central sewage treatment, or watercourse diversions tend to be prohibitively expensive and beyond the authority of lake communities or associations.

An alternative approach is a program directed at the curtailment and prevention of degrading influents to the lake at their local origins. To this end, emphasis has been placed on methods for the abatement of septic tank-tile field effluents and surface runoff to lakes. Incidental to this, symptomatic control of algae and aquatic weeds was investigated. This was because these nuisance growths are often paramount concerns of lake residents and constitute a factor in lake nutrient recycling and oxygen deficiencies.

Assessment of Lake Associations in Michigan

To meet the second objective, to better understand the nature of Michigan lake associations and assess their water quality management status, a random sample of Lower Peninsula associations was taken, and officers of the selected associations were personally interviewed.

The population sampled consisted of a listing of lake associations provided by the Michigan Lake and Stream Associations, Inc. (MLSA), a non-profit, statewide organization of lake and stream associations. This list consisted of 128 identified officers of member organizations and their mailing addresses. An additional data list of 210 lake or stream organizations not belonging to MLSA was also obtained from that organization. The initial study population, therefore, consisted of 338 lake associations or individuals in Michigan. This listing is apparently the most complete documentation of lake associations available in the state at this time. Only five associations were reported in

the Upper Peninsula. Because of this small representation and the travel expenses involved, these associations were deleted from the sample. Any information derived is, therefore, applicable only to the above 333 documented lake associations of Michigan's Lower Peninsula.

A stratified random sample of 50 lake associations was selected by use of a table of random numbers. This sample consisted of 25 MLSA member associations and 25 non-member associations drawn from each respective list. This segregation was done in order to measure, among other variables, the possible significance of membership by the associations in the MLSA as a factor of lake management performance.

The actual interview sample, because of economic and time constraints, was set at 30. This goal of 30 interviews was also chosen because it traditionally represents the cutoff point for parametric statistical techniques, and because it approximates ten percent of the study population. There were 15 interviews in each category. The extra 10 associations drawn from each group were held in reserve for replacement should any associations refuse interviews, not be available, or simply not exist. The telephone number of the initial contact for each association in the sample was obtained by consulting the appropriate local directory for that address in the Lansing City Library collection of current telephone books. The combined 30 associations were then plotted on a map of the state and contacted by telephone to arrange interviews in order of geographical convenience of travel. Whenever a contact was not possible or was refused, a replacement association was drawn from the appropriate MLSA or non-MLSA pool.

Interviews were conducted from late June through early October 1976 at the convenience of the interviewees, who generally preferred weekend appointments. The summer's work was unavoidably interrupted twice by other responsibilities for a total delay of about four weeks. By the end of the summer season, a total of 21 interviews had been completed (11 MLSA interviews and 10 non-MLSA interviews) and the pool of 50 associations had been exhausted. Table 1 presents the disposition of the 50 associations originally drawn. The approximate geographical distribution of the completed interviews is presented in Figure 1. No listing of interviewees or their lake associations is provided because a promise of confidentiality was made to encourage candid responses to the questions asked.

Table 1.--Disposition of the 50 Lake Associations Comprising the Sample Pool (25 MLSA and 25 non-MLSA)

Disposition	Number	Affiliation
Interview refused	2	non-MLSA
No lake association exists	3	non-MLSA
No phone listing available	8	3 MLSA, 5 non-MLSA
Unable to contact	10	5 MLSA, 5 non-MLSA
Alternatives not attempted[1]	6	MLSA
Interviews completed	21	11 MLSA, 10 non-MLSA
	50	

[1]Interviewing terminated because of time and financial constraints and to preserve a comparative balance between MLSA and non-MLSA associations sampled.

Figure 1.--Approximate Locations of the Interviewed Lake Associations. Triangles indicate lake associations in the higher performance category. Circles designate the associations classified as lower performing. All symbols are positioned in the center of each county and do not reflect the actual location of each lake.

The interview technique consisted of a combination of the "elite and specialized" interview method described by Dexter (1970) and standard interview and questionnaire methods described by Moser and Kalton (1972) and Phillips (1966). This hybrid approach was chosen to accommodate the particular objectives of the study. First, the Dexter method was perceived to be highly applicable to the objective of determining the character, perception, and needs of lake associations as expressed by their representatives. The interviewees were always officers or members of long standing in their lake associations. As such, they may be presumed to have extensive knowledge of the lake and community. In this context, they qualify according to Dexter's definition of "experts," (Dexter, 1970, p. 5). They were, therefore, given the latitude he advises to express their perceptions free of rigid direction or guidance. The first section of the interview or "open questions" incorporates this approach (Appendix A). By opening the interview with broad questions (such as "What are your association's problems? What are its accomplishments? What are its objectives?"), the respondents were allowed to initially develop subject areas of their choosing which provided a certain amount of insight with respect to their knowledge of lake management.

The second objective (since little published material could be found on Michigan lake associations) was to get some form of initial understanding of the associations as a management institution. To do this, a comparative technique was required. It was, therefore, necessary to standardize much of the interview format using techniques usually associated with formal interviewing (Moser and Kalton, 1972, p. 296). By following up the relatively open and loose initial

conversation with consistent, standardized questions about sepcific community characteristics or association activities, it was also possible to get some feeling for how much of what the interviewees expressed initially was substantive information as opposed to wishful thinking.

The Interview Procedure

The initial contact with prospective interviewees consisted of a phone call to the listed lake association representative. A brief description of the purpose of the research was provided. The cooperation of the Michigan State University Cooperative Extension Service was stressed to demonstrate the nonpartisan motives of the study. This agency enjoys a generally neutral reputation with the public and is viewed as usually unbiased and service oriented. The prospective benefit to inland lake associations of the research was also indicated to further induce their cooperation. Objectives of the research were defined as an attempt to better understand the needs, accomplishments, and nature of Michigan lake associations so that information and assistance pertinent to their interests and needs can be provided. Discussion concerning the area of water quality management was avoided until the actual interview to reduce the possibility of respondent bias. The initial contact was informed of the need to interview an officer or recent past officer of the association who was familiar with the community, operations of the association, and the lake. In some instances, this conversation resulted in referrals to other individuals judged by the initial contact to be better informed. These referrals, on four occasions, resulted in joint interviews with two or more cooperating association officers. While this often prolonged an already lengthy

interview because of the need for consensus on the issues, the information provided may be more reliable than the opinions of a single respondent.

The average interview took about two hours. Pretesting with colleagues and residents of the Lake Lansing community indicated that the interview was too lengthy and tended to tax the attention of respondents. The questions were then considerably reduced. The result was a one and a half to two-hour interview which represented a difficult compromise between collecting the desired information and imposing on the time of respondents.

Initially, an attempt was made to tape record the interviews to increase data gathering efficiency and reduce interpretive errors. After two attempts, the approach was abandoned because of concern for a possible inhibitory effect on the interviewees (Moser and Kalton, 1972, p. 281; Warner, 1976, p. 286). Recording of data, thereafter, was based entirely on encoding of the standardized interview forms and note taking. Additional comments and impressions were always made immediately after each interview. At the end of each week's work, the interview notes were again reviewed and further comments or recollections added.

The Interview Format

The following outline describes the major questions posed in the interviews. A copy of the actual interview form used is provided in Appendix A.

A. Open Questions
   1. Lake association objectives
   2. Problems
   3. Water quality problems
   4. Accomplishments of the lake association
   5. Factors which would help improve effectiveness of the lake association
   6. Recreational uses of the lake

B. Characteristics

1. Population (by households)
   a. Lake community size (residents within 1/4 mile of lake)
   b. Membership of lake association
   c. Active membership of lake association
   d. Seasonal membership
   e. Seasonal active membership

2. Organization
   a. Age of lake association
   b. Enabling authority of lake association
   c. Frequency of general meetings
   d. Other lake associations on the lake
   e. Relationship with local community and government
   f. Issue related or social orientation of association
   g. Apathy, compatibility of members

3. Finances
   a. Estimated average annual household income of lake association members
   b. Retirees in the association
   c. Lake association annual dues
   d. Other sources of income
   e. Annual income of lake association

4. Lake Characteristics
   a. Size (acres), maximum depth (feet), most frequent depth (feet)
   b. Bottom type
   c. Extent of development
   d. Average front footage of residential lots
   e. Political jurisdictions associated with lake communities

C. Performance

1. Nutrient and Effluent Abatement
   a. Septic tank maintenance and use restrictions
   b. Alternatives to septic tanks
   c. Lawn fertilization abatement
   d. Natural vegetation buffer strip around lake
   e. Erosion control, marsh protection
   f. Drainage diversions

2. Water Quality Investigation
   a. Lake water sampling program
   b. Septic tank dye testing or inspections

3. Symptomatic Management
   a. Fish management
   b. Algae control
   c. Aquatic weed control
   d. Winter drawdown of lake level for weed control

4. Sociopolitical Involvement
   a. Information, education, and persuasion
   b. Public exposure (media utilization)
   c. Economic function
   d. Legal function
   e. Political function

Sections A and B are intended to provide some insight into the nature, state of awareness, priorities, and characteristics of the associations sampled. Many of the parameters included in this portion of the interview are derived from the approach taken by Klessig and Yanggen (1972) when they investigated the nature of Wisconsin lake associations by mailed questionnaires to officers of 200 associations.

Section C, the lake management performance function, is developed from the literature survey mentioned earlier. This section is the primary component of the interview research. The relative extent of positive responses here provides an indication of the "state of the art" of lake management performance by the associations.

Analytical Methods

In addition to the general recognition of the level of water quality management performance and innate character of the lake associations, this research was also intended to investigate the possibility that some of those characteristics measured may be related to that relative degree of management performance observed. There might be elements such as wealth, size of membership, or geographical location which correlate with the relative success or failure of the associations attempting self-help lake management. If such paramount characteristics exist, any effort to develop programs to assist lake associations in self-help management would have to take them into account. Their existence could mean that much more than technical assistance is necessary to help some associations implement lake management.

In order to test for such correlations, a quantitative index of relative performance success by the interviewed associations is necessary.

To accomplish this, section "C" of the interview was treated as a test of lake association management accomplishments. Before any interviews were conducted, numerical values were assigned to each question of this part of the interview. This created a segmental index similar to the system used to grade students on standardized college examinations (see Appendix B). While being somewhat arbitrary in its weighting of different sections of the questionnaire, the technique is consistent and impartial for all interviews. It is, therefore, considered adequate for sorting the sampled lake associations into two groups of relatively higher and lower performance categories. The possible points assigned a given lake association can range from zero to 163 on this index. Assignment of an association to either performance category was determined by whether its score was lower than or equaled or exceeded the sample median of seventy points.

By assigning each lake association a numerical performance score, one can not only compare the attributes of the higher and lower performance groups, but can also test for linear relationships between quantifiable characteristics and the graded performance.[2] Specifically, coefficients of correlation were computed to estimate such possible relationships where:

$$r = \frac{\sum_{i=1}^{n} x_i y_i}{n} - \frac{\bar{x}\,\bar{y}}{s_x s_y} \quad \text{and,}$$

[2]This technique is similar to methods commonly used in education research where student test scores are compared to various family or community factors such as number in family, age or weight, or income level (Glass and Stanley, 1970).

$$s_x = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n} - \bar{x}^2}$$

$$s_y = \sqrt{\frac{\sum_{i=1}^{n} y_i^2}{n} - \bar{y}^2}$$

The regression equation used is of the form

$$y = mx + b, \text{ where } m = \frac{r \cdot s_y}{s_x}$$

$$\text{Therefore, } y = \frac{r \cdot s_y}{s_x} x + b$$

All analytical assessments were made using the 0.1 level of significance as a decision rule.

To test for a significant difference between the mean characteristics of the two performance categories a t-test comparison was made using the equation:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Sample variances in this instance were computed using the equation:

$$s_x = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n - 1} - \bar{x}^2}$$

The possibility that there might be a combined effect of the various characteristics on lake association performance was also investigated. A multiple linear regression analysis was conducted on two sets of total sample data selected as most promising of such a combined effort.

Lake association membership, average estimated annual household income, lake association annual income, and estimated most frequent lake depth were compared to performance score. These particular characteristics were selected because they were judged to represent major potential factors of performance, i.e., community involvement, social accomplishment and status of the members, association wealth, and extent of possible lake eutrophication response based on an approximation of the extent of its littoral zone.

The second multiple regression analysis investigated member participation as a factor of lake management success. Specifically, the element of available time for involvement in lake association activities (percent seasonal residents in the association and percent retirees) was combined with the estimate of social accomplishment (average household income) and compared to association performance scores. Klessig and Yanggen (1972, p. 12) and Klessig (1973, p. A85) also suspected the influence of seasonality on lake association performance.

For both analyses, a Hewlett-Packard 9815 A calculator with a preprogrammed analysis of variance and regression analysis capacity (Volume 09815 - 15014, May 1976, Revision B. Hewlett-Packard Calculator Products Division, Loveland, Colorado) was used. In neither instance were significant regression statistics (R^2) detected at the 0.1 level. It was therefore concluded, after consideration of Klessig's 1973 study and consultation with a departmental research specialist, that further investigations of this nature were not indicated.

Strengths and Weaknesses of the Survey Research Approach

W. Edwards Deming, in his paper "On Errors in Surveys" (1944), documented several areas of survey research subject to error. His typology was consulted in the design and conduct of this research in an effort to eliminate, reduce, or accommodate potential errors. The following discussion of various possible sources of error is presented in compliance with Deming's particular admonition that ". . . in the presentation of data the omission of an adequate discussion of all the errors present and the difficulties encountered constitutes a serious defect in the data and is sure to lead to misinterpretation and misuse. . ."

Variability in Response

Two kinds of variability in response cause different descriptions of the same situation: 1) given by the same person at different times, and 2) given by different persons. Both forms of response variability are possible in this study. The first form of variability is difficult, if not impossible, to correct. A given respondent may always change his opinion or acquire additional information between the original interview and any subsequent follow-up. This problem is a component of the perpetual "lag phase" imposed by the passage of time which all investigators must live with when attempting to measure parameters of a dynamic system.

The second form of variability, different responses by different people, was controlled for as far as practical by interviewing long term lake residents who were officers in their associations. By so doing, these people were accorded Dexter's status of local "experts." Their opinions may still differ from others in the community or

association, but it is presumed that they are more likely to present opinions correlative with the facts due to their considerable local experience and responsibility. The fact remains that information about each lake association, in most instances, was based on the perceptions and opinions of individuals.

Variability Associated with the Interview Technique

The personal interview technique generates more information per unit of effort than mailed questionnaires or other impersonal information gathering techniques. This is because the personal encounter provides greater motivation and pressure for response than a circulated questionnaire, especially if mailed. The interview is also a more flexible instrument, allowing the interviewer to probe for additional information and to assess motivations behind the responses to questions. (Hyman, 1975, p. 14 passim; Selltiz et al, 1959, p. 214; Phillips, 1966, p. 121). Because of these advantages, the interview approach was chosen as the data gathering method for this study. In making this decision the insightful gains from interviewing had to be weighed against its primary drawbacks of expense, limited coverage of respondents in the available time frame, and possible error and bias associated with interviewer influence on responses and their interpretation.

The constraints of limited sample size and greater operating expense were accepted in return for increased insight per lake association interviewed. This trade-off is considered positive in light of the absence of any other information about Michigan lake associations. Interviewer error was reduced by having all interviews conducted by the same person. Bias was reduced by using a standardized interview

format, and by the conscious awareness by the interviewer of his potential impact on responses. The advise of Hyman (Interviewing in Social Research, 1954) and Moser and Kalton (Survey Methods in Social Investigation, 1972) was carefully followed to elicit information as effectively as possible without implying direction to the responses provided. Encoding of the data gathered and later analyses of it were also performed by the interviewer which reduced potential errors of interpretation.

A cross check for misinformed or deceptive responses was incomplete because the appropriate references often were either not available or were inaccurate. Quantitative data from the interviews such as population estimates and estimated average annual income of residents, could not be checked because local tax and census figures are deficient with regard to seasonal residents. Local property assessment records were dismissed as a comparative reference for household wealth because the assessment process is generally recognized as inconsistent both within and between tax districts (Barlowe, 1972, p. 596).[3]

Respondent estimates of average lake lot front footage did agree with the development plats consulted for three of the lakes. This knowledge is not surprising since most of the lake communities sampled were platted in a consistent, systematic manner. Respondent estimates of lake acreage and depths also compared favorably with Department of Natural Resources maps and the tabular reference "Michigan Lakes and

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[3]Klessig (1973, p. A75) reports frequent complaints by Wisconsin lake residents about their property assessments. Similar opinions of assessment inequity were expressed to the author in this study.

Ponds" (Humphrys, et al, 1965). The maps are available to the public and are probably the respondent's source of information too.

While confirmation of the interview data is not complete, the overall impression drawn from the personal interview experience is that the great majority of individuals who consented to be interviewed were cooperative and honest in their responses.

Bias of the Auspices

Deming points out that identification of the sponsor of a social research project may influence the motivation and nature of answers provided by respondents. In anticipation of various attitudes in the lake communities toward particular personalities or agencies affiliated with lake management, every effort was made to restrict identification of the research affiliation to "Michigan State University" and the "Cooperative Extension Service." Both of these terms were believed to denote an essentially neutral, non-political, service oriented entity. Subsequent interview information revealed that this identity was appropriate as most respondents indicated limited familiarity with either institution.

Bias Arising from Non-response

The bias of non-response is a factor commonly associated with mailed questionnaires. The motives of non-respondents are investigated by follow-up interviews in an attempt to help explain or qualify the data which was collected.

In a study such as this, where the initial data gathering effort is an interview, efforts to investigate non-response bias are difficult.

If the contact refuses the initial interview, he is unlikely to consent to a second one asking him why.

Of the twenty-three representatives of lake associations actually contacted, only two refused to be interviewed. The refusal conversations provided some explanation of why. One contact was straightforward in explaining his refusal. He stated that his association had received no help from the State of Michigan or any other public agency in the past, and he saw no reason to cooperate now as he anticipated no benefit to his association from doing so. The other contact was a retired administrator who utilized evasive tactics rather than directly refuse the interview or provide an explanation. After three telephone conversations, the interview attempt was abandoned because of his obvious negative attitude. The two refusals were similar in that both contacts indicated a suspicion of the research motives, and a presumption that they would gain little from the project.

The sample of non-respondents is very small and thus restricts any applied inference. But it does suggest that the credibility of the state with at least a portion of the riparian community is rather strained. This presumption is further indicated in Chapter IV when interviewees were asked their opinions of services provided by various agencies.

The Time Element as a Factor of Sampling Efficiency

The interview schedule was planned for the summer months on the premise that seasonal residents would be more receptive when questioned at the lake site. While the percentage of seasonal residents was not known at the time, observation indicated that this would be a factor

regarding contact success, and that the probability of reaching them would be greater in the summer. Subsequent experience with the interview technique has demonstrated that the number of successful contacts does drop off considerably after Labor Day. Not only do the number of "no answers" to phone calls increase, but those contacts reached appear less interested in being interviewed. Apparently with the end of summer, lake residents' attention shifts away from the lake and perhaps returns to routine matters neglected during the vacation season.

Within the summer sampling period, weekends definitely appear to be the more opportune time of week for interviews. Even when it involves a conflict with activities or guests, most respondents still prefer to schedule the interview for some time during a weekend and to have it at their lake residence. For those interviewees employed full time, the weekend is obviously more convenient. This arrangement also seems beneficial in that respondents interviewed on the weekends appear more relaxed and less distracted by other matters than those interviewed on week days.

In almost all instances the interviewees were pleasant, hospitable, and cooperative even though the interview was lengthy. In fact, there were occasions where, because of interviewee response, the usually two hour process extended to as long as four and a half hours. When this did not conflict with other scheduled interviews, the protracted conversation was pleasant and very informative. While extending the time of the interview, such incidental conversation often contributes considerable insight to particular responses and is simply good manners. Such cooperation by the interviewer, together with thank-you

notes later mailed to all respondents, also improves the potential for lake association assistance in subsequent projects.

However, such prolonged interviews do tend to reduce interviewer alertness and occasionally generate anxiety about completing his schedule for the day. Both factors tend to reduce observational efficiency. If the interview time must be somewhat lengthy, as was the case here, the interviews should be limited to three per day. While three ostensibly two hour interviews may not appear taxing, inclusion of the time for post interview notations, meals, and transit between locations can easily lead to a twelve or fourteen hour day.

Representation of the Study Sample

The population sampled consisted of 333 Lower Peninsula Michigan lake associations. While selection of the sample was randomized, Upper Peninsula associations were excluded, and no Detroit metropolitan area associations were interviewed.

The Measurement Process

Sample error is indicated by provision of the standard error notations accompanying the quantitative data presented in Chapter IV. Measurement error must also be considered in the interpretation of this study. A search of the social science literature for a sophisticated scaling technique for association management performance was fruitless. Almost all methods investigated were designed to interpret "why" respondents provide particular answers. The primary objectives of such scales are to assess respondent motivations and intensity of such, i.e., Guttman and Likert scales and their modifications. Little attention was devoted in the sociological literature to methods for obtaining the

facts from the interviewees beyond Dexter's straightforward premise that they know their subject area. Consequently, the direct approach of indexing responses on a performance continuum described earlier was selected.

Both Young (1966, p. 249) and Riley, et al (1954, p. 46 passim) describe this approach as elemental. While short on sophistication, it does get the job done. The method is arbitrary in that the rationale used for weighting the scoring process was qualitatively derived and was not generated from within by the interview data. The professional literature constituted the index criteria (i.e., Section C of the interview). The combined interpretation of this material and consultation with water resource specialists of the Department of Resource Development generated the weights applied to each positive response in the interview. The specific criteria used in weighting each question was: 1) How easy is it for the lake association to do this in terms of monetary costs and technical logistics? 2) How significant to lake quality improvement would such action be? In keeping with the body of the technical literature, effluent abatement attempts received the highest potential points. Lawn fertilization prohibition received the highest discrete point assignment because of the presumption of financial and technical ease of implementation, and because significant phosphorus abatement is achieved in developed communities. Where on site observation indicated that lawn fertilizers were not as significant, the points assigned were reduced. The absence of need for a given option at a particular lake, or impossibility of performance, i.e., winter drawdown on a lake without an outflow, resulted in the assignment of full credit for that option.

Because of the nature of the ranking system used, the reader is cautioned that the quantitative interview results of this study were analyzed on the basis of this entirely valid but subjective index.

CHAPTER III

RESULTS OF THE LITERATURE SURVEY

Feasible Lake Management Options

In the course of the selective literature review, a framework of lake association self-help management options evolved. This framework divides into the following four major elements: Effluent Abatement - the curtailment primarily of septic tank discharges and lawn fertilizer runoff to the lake; Lake Water Quality Investigation - the initiation of a water sampling program to assess problems and progress of the association; Symptomatic Lake Management - options for the control of algae and aquatic weeds; and Socio-Political Involvement - the extension of association efforts to the institutional aspects of lake management.

Effluent Abatement

A major impression gained from the literature survey is that most of the lake restoration techniques now available are prohibitively expensive for most lake communities unless funded by outside sources such as state or federal agencies. For example, dredging costs at 1974 prices ran 60 to 80 cents per cubic meter of material removed (Dunst, et al 1974). Estimates for this type of restoration treatment for Lake Lansing, Ingham County, Michigan (453 acres) exceed 1.6 million dollars including spoil disposal. This project could not have reached its present state of advanced planning were not county, state, and federal funding of most costs anticipated.

Similarly, other major engineering attempts such as wastewater treatment plants and major drainage diversions are beyond the financial scope of most of Michigan's lake communities. Even with federal support of such projects, a state like Michigan with over 35,000 inland lakes, is likely to be funded for only a few of the basins in need of help.

Restoration then should be attempted only on the most seriously degraded and ecologically or economically significant lakes. For the majority of the Michigan lakes, which vary from oligotrophic to enriched and declining, but not yet severely degraded, pollution prevention and abatement practices are in order. These practices of lake management are most feasible for local community implementation. They essentially involve the prevention or correction of cultural eutrophication (i.e., the prevention or correction of human activities on or near a given lake which contribute to its enrichment, filling-in, or contamination).

Phosphorus, Sewage Effluent, Runoff, and Lake Degradation

It is generally recognized by limnologists and lake management specialists that sewage discharges from the lake community are a major contributor of the nutrients, especially phosphorus, causing lake enrichment and respondent nuisance growths of algae or aquatic weeds. Schindler's (1974) fertilization studies convincingly demonstrated the significance of phosphorus, in comparison to nitrogen and carbon, as the limiting factor of algal blooms on many hard water lakes of the Great Lakes region. The following quote from Wetzel (1975, p. 642) further emphasizes the importance of phosphorus control, and relates this to sewage discharge abatement:

> ". . . it is important to emphasize once more that phosphorus abatement will not return all lakes to pre-enrichment conditions.

> But the importance of the relation of phosphorus demand to supply for plant growth is such that its reduction in inputs to fresh waters is the first place to begin and most likely to succeed in a majority of cases. Further, if phosphorus inputs to surface water are to be reduced most effectively, point sources should be eliminated as rapidly as possible. . . The scientific basis for the importance of phosphate and nitrogen in eutrophication is so overwhelming that an international resolution was ratified at the 19th International Congress of Theoretical and Applied Limnology in 1974. This resolution emphasizes the critical role of phosphorus in the rapid eutrophication of inland waters and the need to control the addition of this element to any inland water by any means available. In addition to secondary treatment of sewage, methods of control include: (a) restrictions on the use of cleaning products that contain phosphates or other ecologically harmful substances, (b) removal of phosphate at sewage treatment facilities discharging effluents into such water, and (c) control of drainage from feedlots, agricultural areas, septic tanks, and other diffuse sources of phosphorus. Control measures for nitrogen also should be considered in basins in which there is evidence that such controls are appropriate. Implementation of such controls is socially complex, but attainable with existing technology."

A specific example of the control implementation referred to by Wetzel above is documented by Edmondson's (1972) Lake Washington study. He reported a reduction of phosphate and phytoplankton in that lake of about 28 percent in the six years following diversion of municipal sewage discharges. The significance of this study to lake management by pollution abatement was its emphasis on the importance of sewage as a causative agent in lake degradation by phosphate loading. Edmondson demonstrated a regression of eutrophic symptoms (decreased phosphorus and phytoplankton and increased clarity) when municipal effluents were diverted from the lake. While the abatement emphasis here was treated secondary effluent, rather than septic tank discharges, diversion of sewage from the lake was shown to be a highly beneficial water quality management technique.

Human waste disposal for most Michigan lake communities is by on site septic tank - drain field treatment. While secondary municipal

sewage treatment systems existed for portions of some lake communities interviewed in this study, on site septic tank disposal systems were the prevailing method in use. This indicates that the prevalent source of human sewage enrichment of Michigan inland lakes may be expected to be on site septic tank disposal systems.

The premise that community septic tank discharges are a major contribution to lake enrichment is supported by Ellis (1971) who conducted studies at Gull Lake, Kalamazoo County, Michigan. His research indicated that 63 percent of that highly developed lake's annual phosphorus loading came from septic tank - drain field discharges. Another 24 percent was contributed by lawn fertilizer runoff. The remaining 13 percent came from soil percolation. These data suggest that more than 85 percent of the phosphorus enrichment of Gull Lake came from cultural sources subject to control to some extent by local residents.

The particular impact of septic tank discharge on lake ecosystems was graphically revealed by 1973 studies of Houghton Lake, Roscommon County, Michigan conducted by Ellis and Childs. Nineteen septic tank sites around the lake were evaluated by test borings and monitor wells. The results suggested greater below ground movement of septic tank effluent, particularly phosphorus, than had been traditionally presumed. The traditional theory associated with on-site soil percolation of waste water presupposes that under ideal conditions an essentially complete immobilization of phosphorus is achieved by adsorption to soil particles. Ellis and Childs discovered that phosphorus was moving through the intervening soil and into the groundwater system draining to the lake at six of their nineteen study sites. They also found that while only ten percent of the lawns surrounding Houghton Lake

were fertilized by their owners, ". . . of this 10% approximately one-half of the lawns showed phosphorus movement through the soil into the groundwater." (Ellis and Childs, 1973, p. i).

Apparently, this phosphorus mobility is a reflection of varying soil types, slope, and relative depth to the water table (Cain and Beatty, 1965; Wall and Webber, 1970). Bouma (1971) has also reported that age and extent of use of on-site drain fields reduces adsorptive efficiency of the soil. Once phosphorus enters the groundwater system, it has the potential to move considerable distance to the lake. Ellis and Childs observed lateral phosphorus and nitrate movements down gradient in the groundwater of 140 and 330 feet respectively. At one study site where the drain field was approximately 120 feet from the shore, orthophosphate phosphorus concentrations ranged from 8 to 14 mg/l in a wide zone extending from the adsorption site to the lake. A dense weed bed was observed at the lake shore directly in front of this study site, and samples of the lake water here revealed an orthophosphate concentration of 1.09 mg/l. The conspicuous weed growth was not evident on either side of this site, and background orthophosphate concentrations collected elsewhere in the lake ranged between 0.03 and 0.08 mg/l.

It is evident that in Michigan significant factors causing inland residential lake degeneration (insofar as one may generalize) are likely to be phosphorus inputs associated with inefficiencies of on-site waste disposal systems and the practice of lawn fertilization. In some instances road drains or agricultural runoff have also been implicated, as well as commercial discharges to lakes associated with car washes or laundromats. But the significance of lawn fertilizers

and septic tanks is their ubiquitous nature in Michigan inland lake communities. These factors of cultural eutrophication and degradation reside entirely within the sphere of responsibility of individual lake property owners. Therefore, the control of these two sources of lake degradation is a responsibility of the lake community or association, which is a collective of individual property owners. The right and responsibility of the community or association to attempt to abate these degradation sources located on private holdings is implied by the common property resource nature of the lake and the doctrines of riparian rights and public welfare inherent in Michigan law.

With an aspect of lake degradation pertinent to the problem defined, and its suitability to localized initiative recognized, it remains next to identify options for remedial action.

Lawn Fertilization and Septic Tank System Management

The lesser of these two primary factors of lake eutrophication, lawn fertilization, is the most easily remedied from a physical standpoint. The residents need only to stop applying fertilizer to their lawns. Or they may consult the Soil Conservation Service or Cooperative Extension Service personnel of the Michigan State University Department of Crop and Soil Sciences for an assessment of actual lawn fertilizer needs. They may then apply only that type and amount of fertilizer actually needed and at rates conducive to personal economies and minimal runoff.

The second major factor, septic tank - drain field discharges, requires more involvement and expense. But as indicated by the Gull

Lake and Houghton Lake studies, the potential returns in nutrient input abatement are also greater. This sewage discharge problem may also constitute a public health threat in the form of bacterial or viral contaminations of groundwater or the lake. Mack and D'Itri (1973) reported coliform bacteria in Lake Michigan at Naubinway Harbor. The source of these organisms was related to both over the side discharges from watercraft and seepage from a marina septic tank drain field. (The detected levels in this instance were within the limits established by the State of Michigan for safe body contact.) Mack, et al (1972) also reported that the source of polio virus detected in a southeastern Michigan well was associated with contamination of that water supply by effluent from a defective septic - tank system. The problem of bacterial contamination of lakes or streams may be compounded by the nature of the receiving environment. Geldrich (1970) states, ". . . the water-sediment interface of a stream or lake bottom can be a transient reservoir for fecal pollution 'fallout' from such contamination being transported in the overlying water." He further points out that this sediment factor is particularly important to recreational (i.e., swimming) waters, ". . . since sedimentation does entrap a large proportion of the bacterial population, does place these organisms in a more protective menstruum for extended survival, and does slow their movement downstream and away from a designated recreational area."

Cain and Beatty (1965) state that the bulk of septic tank problems can be grouped into three general categories: 1) The use of septic tanks on small lots in crowded subdivisions; 2) Failure of the

systems due to faulty design and construction; and 3) Installation of the systems in soils not suitable for waste disposal. A possible fourth category might be the nonexistent or inadequate maintenance of the system. Kusler and Owen (Lake Property Sanitary Surveys, undated, p. 7) report that improper maintenance is the most serious problem encountered in their survey of common violations of Wisconsin septic tank - soil absorption system regulations. (In this writer's personal experience, interviewees often reported never having inspected their systems or pumped their septic tanks.)

While the lake association may be greatly restricted in its independent efforts to correct past errors of installed systems on small, crowded lots or use of the wrong soils (especially sandy soils which "perc test" very well, but tend to drain effluents almost unimpeded into the groundwater system or lake), it can exert considerable effort to correct design or installation errors and operational abuses.

The first action which should be taken in any septic tank management program is inspection for system efficiency. Obvious symptoms of failure, such as obstruction, odors, and wet spots in the drain field indicate system failure. However, lake or groundwater contamination is possible even without such blatant indicators. Consequently, any septic tank system should be regularly inspected by a licensed septic tank service or public health sanitarian. The investigation process is further facilitated by flourescein dye testing to trace the path of the water from the system and its rate of dispersal. This procedure is particularly important because it may be the only indicator of lake contamination by an individual septic system.

Where deficiencies are revealed, several corrective options are possible. These include repair, relocation or expansion of the drain field, and replacement or augmentation of the septic tank with another one to enhance retention time.

A particularly helpful modification (if not already present) for increasing the efficiency of any system is the installation of a dosage chamber. This consists of a tank constructed as a second chamber between the septic tank and the drain field. It is equipped with either an automatic syphon or pump, so that when the water within the chamber reaches a predetermined level it is emptied into the drainage system. The dosage chamber is intended to retain effluent from the septic tank until an amount appropriate to the distribution capacity of the drainage field is reached. It then releases this measured amount into the distribution system. In this manner the receiving soils have a greater opportunity to dry out between wetting cycles, then when the effluent flows uninterrupted from the septic tank to the drain field. The dosage chamber is particularly helpful in reducing massive "slugs" of effluent to the soil during periods of peak use, such as weekend visitors or extensive use of washers or other large volume water uses. The incorporation of a dosage chamber in the system, in effect, "buys time" for the soil to adsorb and filter the household effluent. This extends the life of the system as well as its efficiency.

With respect to the maintenance and operation of septic systems, the literature reveals that adherence to a few common sense rules will greatly enhance performance efficiency of the septic tank system and will reduce operational costs. Otis (1974) describes three basic rules for the householder: 1) be conservative in the use of water; 2) do

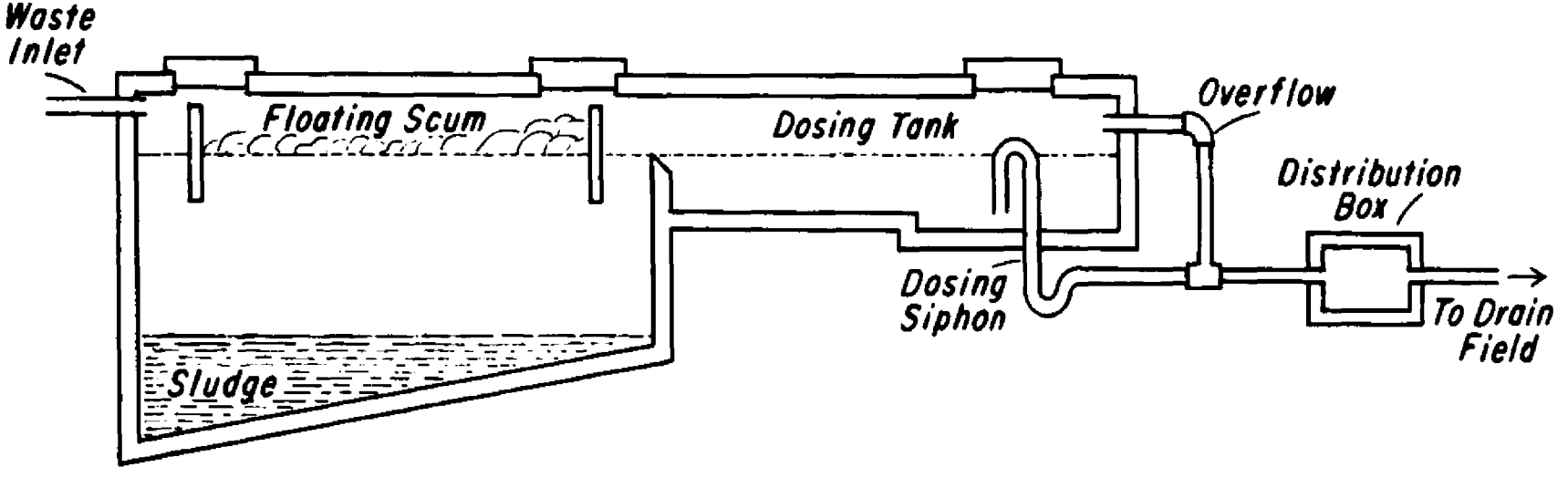

Figure 2.--Illustration of the Dosing Chamber (or tank) with Dosing Siphon Presented in Schematic Form. Adapted from "Manual of Septic-Tank Practice," 1963 by U.S. Dept. of Health, Education and Welfare (Publication number 526) p. 51.

not use the on-site sewage system as a "dispose-all;" and 3) pump the septic tank regularly.

The conservative use of water simply and logically refers to reducing the volume of water passing through the system so that retention and soil exposure times are maximized. Coulter, et al (1960) in a Tennessee study found that as household water use increased, the percentage of septic tank system failures also increased. Practical applications of this water conservation proposal include spacing out laundry loads through the week, rather than doing all the wash on one day and placing a considerable strain on the system; only using the washing machine for full wash loads; applying the same rational, i.e., full loads only to dishwashing; and if possible, avoiding all together the installation and use of dishwashers or garbage grinders which are water wasting luxury items. Otis also advises the judicious use of water for bathing, showering, and flushing of toilets. The simple expediency of bending the float arm down or putting a couple of bricks in the tank to displace some of its volume will reduce the amount of water used by the toilet.

With respect to substances disposed of through the system, all references reviewed advise against flushing grease, solvents, or paper products such as disposable diapers or sanitary napkins into the system. The use of garbage grinders is advised against by Otis as mentioned above. Cain and Beatty (1965), however, suggest the more tolerant approach of increasing the size of the septic tank and drain field to accommodate this additional organic load and water volume. The emphasis here is upon preserving the bacterial flora of the septic tank, reducing its sludge load, and reducing the possibility of a clogged pipe or drain

field. Given the preceding emphasis on the importance of phosphorus content in the leachate, it is obvious the lake property owner should be particularly careful to use only phosphate free cleaning products and bath items.

Otis' recommendation that the residential septic tank be pumped regularly every two or three years is consistent with other references encountered (Cain and Beatty, 1965; Vogt and Boyd, 1973). The seasonal lake resident may be able to extend this service interval but should do so only upon the advise of a sanitarian or septic tank service specialist.

Alternatives to Septic Tank Disposal Systems

Currently, there are three technologically feasible alternatives to the use of septic tank - drain field systems. These are aeration chambers, holding tanks, and municipal sewage systems.

The aeration chamber consists of an elaboration of the basic septic tank. Air is pumped into the standing effluent in the tank to introduce more oxygen. Digestion is more completely accomplished by aerobic bacteria as opposed to the anaerobic system of the traditional septic tank. The resultant effluent released to the tile field imposes considerably less strain on the soil biota and is lower in suspended solids and BOD. However, the nutrient component remains a factor of the dispersed effluent, and its ramifications in terms of potential lake enrichment are still viable.

Conversion to holding tanks entails the likely expansion of the holding capacity of the existing septic tank. All effluent is pumped from the tank by a contract disposal service and the liquid waste and

sludge is taken either to a municipal sewage treatment plant or approved land surface disposal site. This option would involve an expense to residents of subscribing to a disposal service and the constraint of judicious use of water to reduce the frequency of pumpage. Wisconsin and Maine studies indicate the cost to be about $1,000 per year for a family of four (Otis, 1974; Maine Department of Environmental Protection, 1974).

Another option to septic tank - drain field systems still in the early marketing stages is the use of self-contained disposal systems. These include propane incinerator toilets and a variety of more recently developed systems, such as the "Clivus Multrum" dry toilet based on the concept of organic material composting. Mineral oil recycling flush systems are also available. Here the oil is cleaned and reused while heavier wastes carried by it settle out in a holding tank.

The advantage of these systems over regular flush toilet plumbing is the reduced liquid volume of the wastes and a subsequent reduction in the frequency required for pumping the holding tank. Unfortunately, installation of these systems ranges from about $800 to $4,000 (1976 Manufacturers' brochures) and often involves maintenance and operation costs for recycling pumps and filters, in addition to propane and/or pumpage fees. Pumping of these tanks, however, is required far less frequently than with a standard holding tank system.

For the individual riparian who can afford the initial expense, this option--if proven to be hygenically and aesthetically acceptable--may prove superior in long run costs and environmental risks to the interim septic-holding tank approach. It must be noted that these self-contained units, while showing great potential, remain to be proven technically effective or publicly acceptable.

At present the holding tank option to septic tank systems seems an appropriate short-term interim measure for providing relief from lake eutrophication and contamination until a more permanent measure in the form of municipal sewage treatment facilities can be established. Eventually, the self-contained disposal systems may provide a superior and economical answer to residential pollution of surface waters, but this option is yet to be sufficiently developed and tested.

Lake Water Quality Investigation

Regular water sampling of the lake is essential to any effluent abatement program. Such investigation helps suggest locations of point and non-point effluent sources around the lake requiring particular attention. The records of regular water quality sampling also provide baseline data essential to the assessment of relative progress or setbacks in cleaning up the lake.

Lake water sampling designs are of basically two types: the objective, random sampling of the basin, usually stratified by a grid or transit design approach; and the more subjective, diagnostic approach of collecting samples near sources of likely effluent inputs. The former technique is essential if general conclusions are to be made about the entire lake, or if the data is to be used to generate information comparing several lakes to one another. The latter technique is more directly applicable to the identification of discharge locations and is highly appropriate to surveillance or monitoring objectives. But conclusions and comparisons with this technique are appropriate only to specific sample locations within that lake. This

data does not readily lend itself to statistical analysis or to conclusions about the general condition of the lake.

The choice of sampling design and frequency depends to a considerable extent on the nature of the lake, the objectives for which the information is being collected, and the amount the association is willing to spend on the study. Lake associations should obtain professional assistance in this respect by contacting their county extension agent. He, the local public health sanitarian, or officers of other lake associations should be able to recommend state, university, or private firms active in limnological and water resource investigation.

The parameters selected for analysis of lake water quality may constitute any number of measurements and are dependent upon the objectives of the research. They may include the full gammet of sediment, phytoplankton, benthic organisms, fish, and a host of bacterial and chemical measurements, as well as depth, area, and flushing characteristics of a lake. The proposals presented here are not intended to be all inclusive. Rather they are deliberately limited to those water quality tests sufficiently general in nature to be readily applied, and which traditionally demonstrate a reliable assessment of potential sewage effluent contamination. With this limited objective in mind, the following water quality tests are recommended as the basic data source for the lake survey.

Soluble or Orthophosphate Phosphorus and Nitrate-Nitrogen

A variety of factors contribute to the growth and survival of algae and aquatic weeds, including light, carbon, pH, nutrients, and various trace minerals. With respect to the nutrients, phosphorus and

nitrogen (particularly phosphorus) have shown a consistent relationship to weed and algal growth, and both are common to sewage effluents. Of the two, nitrogen is less pertinent to algal problems because the blue-green species are able to fix atmospheric nitrogen in the absence of aquatic nitrogen and can thrive so long as their other required nutrients are present. Also, much of the nitrogen in a lake is assimilated from the atmosphere or groundwater and is so ubiquitous that removal efforts from effluents have little promise of significant reduction (D. King, Institute of Water Research, Michigan State University, personal communication). From the standpoint of a lake association, the phosphorus concentration is of greater significance. Its presence in very small amounts, as long as other growth constituents are also available, permits the extensive growth of aquatic vegetation. Most limnological texts suggest as a general rule of thumb that a threshold PO_4-P concentration of about 0.01 mg/l is sufficient to promote expansive growth (Ehrenfeld, 1970; Lund, 1969). As mentioned above, the common source of the allochthonous (i.e., non-lake produced) phosphorus to recreational lakes is through sewage effluent and fertilizer runoff. Once phosphorus is in the lake, it has the potential to recycle through algae and weeds as they die and decompose. Bacterial action in the sediments may then release the phosphorus to the water for reassimilation by subsequent generations of vegetation.

The reasons for recommending the testing of both nitrate and phosphate are based on their common occurrence in sewage and fertilizer effluents, and the fact that one or the other may, at the time of sampling, be bound up in growing aquatic organisms.

While much of this discussion regarding nutrient investigation pertains specifically to diagnostic sampling, it should also be noted that the objective approach to the sampling of these loadings is also pertinent. The sediments, lake volume, depth, and flushing rate in concert are influential upon the potential impact on that lake of any given nutrient loading. All lakes have a certain assimilative capacity which determines the extent to which they can receive cultural effluents without precipitous decline. An idea of this "carrying capacity" and consequently the extent of development allowable and "lead time" available to managers of lake water quality can be approximated only by objective sampling of lake nutrients. This objective approach is also pertinent if public funds are to be requested for lake management projects. State and federal agencies are inclined to prefer the objective form of data presentation at least as a component of formal proposals for grants or other aid.

Chlorides

Chlorides are a common component of lakes due to the dissolving of mineral salts by both surface and groundwaters. They are also highly concentrated in sewage effluent as a component of urine. It is primarily for this reason that chlorides should be tested; i.e., high concentrations relative to other areas of the lake may indicate sewage inflow. Another source of high chloride concentrations in a lake sample is the leaching and runoff of salts as a consequence of winter highway deicing practices. Extremely high salt concentrations can result from road drainage near a lake where excessive salting was practiced during winter (Schraufnagel, 1967; Diment, 1973). It has been shown that the leaching of this salt from road shoulders can continue into the summer

months (Kunkle, 1972). Hence, high chloride concentrations can indicate either sewage effluent or road drainage which may entail attendant other contaminants as well. Or in some cases a high chloride reading may indicate brine leakage from wells or unusually salty groundwater.

Bacteria

From the perspective of the threat to public health from septic tank wastes or storm water runoff, water samples should be examined for at least three ecological types of bacteria: Total Coliform organisms, Fecal Coli, and Fecal Streptococcus. These bacteria in high numbers indicate the recent entrance of excretory wastes to the water. In the case of storm runoff, the source of fecal material may be rodents, wildlife, dogs, cats, or livestock.

The State of Michigan water quality standards originally set 1,000 colonies to Total Coli bacteria in 100 mls of water sample as the maximum acceptable level for body contact activities, i.e. swimming, in the state's surface waters. If the geometric average of any series of 10 consecutive samples exceeded 1,000 or any 20% of the samples exceed 5,000 colonies, the water was considered unsafe for recreational swimming. This criteria has since been dropped from the regulations in favor of a single Fecal Coliform standard requiring that waters considered suitable for total body contact not exceed 200 colonies/100 mls. Still, testing for Total Coliform remains a helpful index for the evaluation of bacterial water quality by augmenting the Fecal Coliform analysis.

There are no present standards for Fecal Streptococcus in the Michigan law. However, the presence of Fecal Streptococcus bacteria specifically indicates recent fecal waste contamination by warm-blooded

animals (Geldreich, 1970). A correlation has been observed between the ratio of Fecal Coli to Fecal Streptococcii; and the source may be inferred as follows: FC/FS $\geq$ 4.0 is strong evidence of human wastes; FC/FS = 0.7 implies livestock or poultry wastes; FC/FS = a range from 2 to 4 suggests a mix of human and livestock wastes; FC/FS = 0.7 to 1.0 suggests a mix of livestock and poultry wastes. If the ratio falls between 1 and 2, the interpretation is uncertain and the sample was probably taken too far from the source of pollution to be indicative. If low Fecal Streptococcus concentrations (below 100 colonies/100 ml) are obtained, or the effluent exposure is more than 24 hours old, the ratio interpretation may be very dubious (Geldreich, personal communication, 1975).

In addition to the type of pollution indicated by an FC/FS ratio, it should be readily evident that high results for all three bacterial cultures, plus high nutrient and chloride concentrations strongly indicates the presence of sewage effluent. Test results of such proportions should prompt the researcher or lake association to further investigate that portion of the lake or stream for a suspected source of contamination.

Conductivity

Another evaluative procedure helpful in the investigation of possible water pollution is the measurement of the electrical conductance of the water. If the initial bacterial, nutrient, and chloride data suggest contamination, the sampling site may be carefully and slowly cruised in a small boat and sampled with a field conductivity meter to delineate the shape and size of the effluent plume. Conductivity is the electrical measurement in mhos of the dissolved ions in water.

to overall eutrophication abatement, if responsibly attempted, this area of lake management has also been investigated.

Algae Control

In the continuing research for control of algae blooms considerable effort has been directed to the study of their basic life needs. The objective is to find a critical component essential to algal survival and growth. This research has yet to generate a workable management technique. The problem appears to revolve around the opportunistic nature of algae and the vagaries of environmental settings.

The algal characteristics of rapid growth, universal occurrence, water column mobility, and photosynthetic metabolism complicate the limiting factor approach to its management. There does not appear to be a consistently singular factor controlling its growth. Rather, a combination of factors may be involved, including carbon, light, phosphorus, nitrogen, iron, and pH (Provasoli, 1969; Keenan, 1973; Foree and Scroggin, 1973; and Round, 1973, p. 151 passim). While phosphorus is most often the limiting factor controlling algae growth, the particulars of each lake environment can also be influential. The particular combination of circumstances and nutrients necessary to generate a bloom on one lake are not necessarily the same for another; nor will the species of algae causing problems always be the same.

In any reasonably enriched lake, periodic algal blooms may be expected. All possible nutrient combinations cannot be controlled, and it is impossible to remove all algae from the system. The organisms and their reproductive spores are simply too numerous and well distributed. Consequently, control has been traditionally directed at efforts to restrict the extent of blooms when they occur or to reduce their potential to develop.

Chemical Methods of Control

A traditional, temporary, and cosmetic approach to algal control has been the application of copper sulfate ($CuSO_4$), commonly known as blue vitrol, to the lake surface. The copper sulfate interferes with physiological processes of the cells. This effect is often evident within hours of application and results in death and decomposition of the cells. The mechanism of the copper toxicity is not precisely known, but various researchers have suggested that it interferes with photosynthesis, respiration, and/or cell division (Gibson, 1971). The copper sulfate may be applied by liquid spray or by towing fabric bags of the dissolving crystals behind a moving boat. The rate of application recommended to control blue-green planktonic algae is usually about 5 1/2 pounds per acre, or a one part per million concentration in the upper 2 feet of water (Lueschow, 1972).

The copper sulfate is also toxic to fish and many invertebrates, but in higher concentrations than the approximate 1 ppm effective against blue-green algae. Further, in hard water lakes, the copper sulfate quickly reacts with carbonate ions to form relatively biologically inert copper carbonate which precipitates to the bottom sediments. Because of these points, it has been generally considered that copper sulfate is a "safe" chemical for the treatment of nuisance algal conditions as well as swimmers itch.

It must be emphasized that such control measures are only temporary, and the treatment process must often be frequently repeated throughout the summer season, in some instances, as often as every few weeks. This may result in large concentrations of copper accumulating in the bottom sediments of problem lakes which have received long term

copper sulfate treatment. Some lakes such as Monona and Waubesa in Wisconsin have received hundreds of tons of this compound over the years (Lueschow, 1972). Houghton Lake in Michigan has received approximately one million pounds of copper since copper sulfate treatments began there in 1944 (Novy et al, 1973).

One possible benefit associated with the continued addition of copper compounds to lakes is in the reduction of nitrogen fixation by blue-green algae. Bioassays conducted by Horne and Goldman (1974) suggest that the addition of trace amounts of copper as copper sulfate ($CuSO_4$-Cu), in 5 to 10 ug/l concentrations, significantly reduces the nitrogen fixation rate of the blue-green algae, Aphanizomenon and Anabaena. They propose that the application of trace amounts of copper to lakes might help control late spring and fall blooms of blue-green algae by suppression of their nitrogen fixation potential. They caution that such management potential is supplemental to the need to curtail sewage effluent entrance to lakes.

Concern for the possible long term adverse effects of the accumulation of copper salts in sediments, an apparently developing resistance of some forms of blue-green algae, particularly Aphanizomenon (Prows and McIlhenny, 1973); and the risk to other life forms if the treatment dosage is too great, makes the use of copper sulfate a less than ideal algal control technique. Its potential hazard to humans may further increase if our growing needs for drinking water supplies extend to the use of recreational lakes as water supply reservoirs.

Because of this growing concern over the possible ramifications of indiscriminate chemical treatment of recreational lakes, the Michigan Department of Natural Resources requires that anyone proposing to chemically treat such waters first obtain a permit from that agency.

A recent study by Prows and McIlhenny (1973) suggests that two new compounds might be environmentally safer than either copper sulfate or the commercial copper preparation "Cutrine," which is also commonly used. These are 2, 5-Dichloro- 3, 4- dinitrothiphene (experimental compound 23), and p-chlorophenyl-2-hienyl-iodonium chloride (experimental compound 73). Both are reported to be 94 to 100% active against two common forms of blue-green algae (Microcystis aeruginosa and Anabaena flos-aquae) in concentrations of 0.2 ppm and 0.8 ppm respectively. Compound 23 under initial experimental studies demonstrated no known environmental or human hazards under ordinary safe handling procedures, and compound 73 appears to have very low environmental and human hazards. Prows and McIlhenny suggest that, economically, both compounds also may prove to be cheaper than copper sulfate or "Cutrine," for lake treatment.

The problem remains that the use of chemical substances to control algae may result in fish kills from lowered dissolved oxygen content when the treated algae begin to decompose. Similarly, the decomposing algae may release in a short period of time relatively high concentrations of toxic substances, rendering the water poisonous to some forms of life including livestock and humans (Gorham, 1964; Lueschow, 1972). It should be noted, however, that neither of these problems are inevitable nor frequent, and can, in fact, occur subsequent to an algal bloom where no algaecides have been applied. The large concentration of algae which constitute the blooms, while generating oxygen by photosynthesis during the day, will consume oxygen from the water at night or during periods of cloudy weather. The net result in the long run can be an oxygen deficiency. The eventual death and decomposition of the algal bloom, whether naturally or artificially induced, may also cause oxygen depletions and the generation of toxic substances.

Biological Controls

Due to the growing concern over the release and accumulation of man-made chemicals in the environment, it is important that natural control measures for the restriction of nuisance algae be investigated. In many instances though, this approach, like chemical treatment, may generate a problem where the cure is worse than the original ailment. A good example is the disagreeable consequences which have developed as a result of introducing the carp (Cyprinus carpio) to American surface water environments. It was at one time thought to be a good idea for weed control, but many people view the carp as a greater nuisance than the original problem. More recently, the white amure or grass carp (Ctenopharyngodon idella) has been used as a new approach to aquatic weed control. But biologists and the public as well, both appear to be wary of the potential additional problems that the introduction of new biological species may create. This concern based on past experiences is justifiable, and any research in biological control must certainly proceed with considerable caution.

Research in this area is attempting to discover and develop control organisms to stem the growth of algal blooms. Cook, et al (1974) reported the presence of an amoeboid organism in lakes of Northeast Georgia which appears to feed voraciously on Anabaena species of blue-green algae. However, as a result of its feeding methods the green scum on the water surface is replaced by a milky white scum. It appears that this form of biological control at present stages of research may simply replace one form of aesthetically displeasing appearance with another.

Prows and McIlhenny (1973) while working on the development of a more acceptable algaecide, also discovered the apparently ubiquitous presence of a biflagellate protozoan Ochromonas ovalis which preys upon Microcystis spp. of blue-green algae with sufficient efficiency to have disrupted their studies of the algalcidal effects of the compounds being tested. They do not report any aesthetically displeasing side effects and continued research with the organism as a form of biological control would seem promising. On the whole, however, while biological control techniques may eventually provide a safer and more convenient form of algae control, they do not at this time constitute a viable alternative to chemical treatment.

Mechanical Control

The large colonial forms of algae which look very much like aquatic plants, i.e., chara, may be controlled to some extent by mechanical harvesting. These and the filamentous alga may, with some difficulty, be raked from the lake as a means of limited control.

The planktonic forms of algae, since they float within the water mass and are microscopic in size, are too small for efficient mechanical removal. Harvest would have to consist of seining the organisms by pulling a plankton net through the water. Such nets to be efficient would have to be fairly large and durable. After one or two passes with such a net, it would have to be removed from the lake area and either disposed of, or laborously washed to remove the entrapped algae. Either alternative would be expensive in terms of material and labor costs. Further, the attendant benefits might be short lived and negligible since algae not removed would be able to reestablish the bloom in short time if environmental conditions were appropriate.

At present algal control is at best a difficult and incomplete procedure. The only practical approach, until further research is accomplished, is the combined method of judicious chemical treatment for short term cosmetic effects, together with a concerted effort to reduce the amount of nutrients, particularly sewage and fertilizer (both lawn and agricultural), entering the lake.

Particular caution should be exercised in the chemical control of algae. Not only because of the potential environmental risks, but also because a form of dynamic stability often exists between species of algae and between the algae and aquatic plants. The removal of one form of algae, i.e., the green algae, may result in subsequent replacement by the more noxious blue-green forms. Removal of the algae in general may mean that nuisance aquatic weeds will thrive in their place.

Aquatic Weed Control

Like algae, the higher plant forms serve a valid function in the aquatic ecosystem and become nuisances only when they exist in superabundance. They, like the algae, constitute a source of oxygenation to the water and provide both food and shelter to a variety of fish and other organisms including wildlife (Martin, Zim, and Nelson, 1951; Fassett, 1957). Aquatic vegetation often is of value in stabilizing and intercepting nutrient enriched and sediment laden water of influent streams and marshes. It removes available nutrients and, because the vegetative biomass reduces current velocity, enhances clarity by trapping suspended material. However, the too lush growth of emergent vegetation and aquatic weed beds is indicative of lake enrichment and cultural eutrophication.

In moderate densities the weed beds are a source of good fish habitat and recreational fishing. When weeds are too prevalent, however, they reduce the efficiency of predatory fish consumption of prey species. The result may be considerable disruption of the ecological balance. This disruption may be manifested in a reduction of both species composition and carrying capacity. The frequently observed dense populations of stunted pan fish in recreational lakes reflects this condition.

Over sufficient time, the expanded weed beds will also influence the transition from a firm, sandy lake bottom to soft, organic sediments. This results from the annual die-back and decomposition of each crop of weeds. By extending this process over many years, it becomes evident that eutrophication and the expansion of aquatic weed growth can contribute heavily to the filling-in process of a lake.

A weed choked lake is obviously detrimental to the interests of man and fish alike and represents the advanced stages of lake evolution to a marsh and eventually a terrestrial habitat. But the complete removal of all aquatic weeds from a lake would consist of the destruction of a natural and beautiful ecosystem. In seeking to control aquatic weeds, man must be judicious in his approach if the fish, wildlife, and birds are to be preserved as a part of the system. The over zealous eradication of aquatic vegetation to promote waterskiing and swimming can be disasterous for fishing and aesthetic appreciation.

Aquatic weed control, as with algae control, should be conducted in a careful and systematic manner. The first step in any such program should be the mapping of weed beds, their extent, and dominant

species. Next, in consultation with an aquatic botanist and/or fisheries biologist, those areas to be treated and those to be protected should be designated. Once the plan of control is formulated, the method of control should be selected. Currently in Michigan the alternatives for plant control are: chemical treatment with herbicides, mechanical harvesting with weed cutters, and environmental manipulation such as lake drawdown and dredging. Biological control techniques, as with algae, remain essentially in the realm of experimentation at this time and center mostly on control by the use of herbivorous fish species such as the white Amur (Ctenopharyngdon idella) (Bennett, G. W., 1971, p. 421; Bennett, F. D., in Mitchell 1974, p. 104).

Chemical Methods of Control

Chemical control techniques are extremely variable in cost, ranging from $15 to $90 per acre (Nichols, 1974). They involve possible environmental hazards including poisoning of fish or wildlife. The distribution of the chemicals is difficult to control both within the water column and in sediments and may therefore entail restricted swimming or similar recreation for some time after application. The decomposing vegetation may also create an oxygen demand as well as release nutrients back into the lake (Brooker and Edwards, 1975).

Conversely, this method of treatment tends to be simple and fast, many compounds are species specific, and Michigan licensing restrictions for the herbical treatment of lakes and streams makes most approved chemical compounds relatively safe in terms of public or environmental health. [See Appendix C: List of Herbicides Registered with the Michigan Department of Agriculture, and the Environmental Protection

Agency for Use in the Aquatic Environment. Inland Lakes Management Section, Michigan Department of Natural Resources, 1976.]

Mechanical Methods of Control

The advantages of mechanical harvesting are that no chemical residue is involved, area control is complete (weeds are cropped only where the operator takes the equipment), recreational uses can be restored immediately after treatment, and the harvested weed biomass together with its nutrient components can be removed from the lake.

The disadvantages of mechanical harvesting are that it has no specificity, anything in the path of the cutting bar is harvested; the process is slow; often shallow areas (2 feet or less) can't be treated with the same equipment thus requiring a second, smaller machine or laborous hand cutting; and since the weeds should be removed to fully benefit from mechanical harvesting, additional labor and expense may be involved in trucking the sodden material to a landfill or other suitable disposal site. If cut weeds are not removed, there is the risk that floating particles of some species may take root elsewhere and spread the weeds to other portions of the lake.

Environmental Manipulation

This method of weed control relies on the changing of some aspect of the plants' habitat making it unsuitable for their continued proliferation. Some of the techniques attempted include: staining the water with dye to deprive plants of sunlight; shading by covering the water with floating sheets of plastic; covering the vegetation with a layer of sand; dredging; and winter-drawdowns of lakes.

The dye technique has shown promise of success in small ponds and a recently marketed product "Aquishade" is presently being tested by the University of Wisconsin, but definitive results are not yet available (Nichols, 1974). The dye is reported to be an aesthetically pleasing shade of blue. The use of black plastic sheeting would seem more appropriate to small ponds than recreational lakes as its placement is subject to wind disruption and obviously hampers recreationists while in place.

Sand blanketing consists of spreading a layer of sand 6 to 10 inches deep over winter ice intended to settle to the bottom with the spring thaw. Often the covering is spread over black plastic sheeting. When successfully accomplished, the method creates a good sandy beach area free of weeds. However, a University of Wisconsin study using this technique in 1971 showed that by 1973 more weeds were growing on the new surface than were originally there. Consequently, it would appear that further long term studies are needed before this technique can be confidently recommended (Nichols, 1974).

Dredging, when conducted on a large scale with considerable deepening of the lake basin, can significantly rejuvenate a lake (Nichols, 1974; Pierce, 1970). This technique deepens the lake and, if the bottom is lowered below the photic zone, makes it inhospitable to most aquatic vegetation as the plants do not receive adequate sunlight. [However, Eurasian Milfoil, Myriophyllum spicatum, may resist dredging because it has considerable depth tolerance (McNabb, 1975).] The method employed is usually hydraulic dredging. But on small lakes, shore based drag lines may also be used. The process has the added advantage of removing

nutrient laden sediments from the lake. However, as mentioned earlier, the process is extremely expensive and is generally beyond the means of most lake communities. To be effective the spoil must be trucked to an area away from the lake to prevent the material or its nutrients from draining back into the basin. This necessity further adds to the costs involved. Simply depositing the dredged sediments in a nearby marsh or low area as fill may reduce the expense involved, but it also reduces the effectiveness of the operation thus giving the lake community less return on their investment. Further, since deep dredging is necessary to effectively reduce the weed growth, extensive treatment would require modification of the shoreline to create a rapid steep drop-off. This could result in a hazard to swimmers and possible subsequent erosion problems. The process, if adequately funded does, however, offer a long term control for the center of shallow, weed filled lakes. Other control techniques would still have to be maintained along the shore.

Winter drawdown for lakes having suitable dams or other lake level control structures offers an inexpensive method of controlling some aquatic weeds (Beard, 1969, 1973; Nichols, 1974, 1975). The plants are exposed to frost damage and drying when the water level is lowered. Coontail (Ceratophyllum demersum), water lilies (Nuphar spp.), milfoil (Myriophyllum spp.), and pondweed (Potamogeton amplifolius, and P. robbinsii) are among those forms most responsive to this technique.

However, 1975 studies by Nichols on the Mondeaux Flowage in Wisconsin indicate some constraints on the process. He found that

successive annual drawdowns may lead to reinvasion by drawdown tolerant species which replace the original vegetation and restore the problem. A risk of fish kills due to low dissolved oxygen is a possibility during drawdown, and increased concentrations of nutrients from exposed sediments and decaying vegetation may result. Nichols' studies with respect to dissolved oxygen and nutrient concentrations at the Mondeaux Flowage were inconclusive, and he recommended further research. The aquatic plant reinvasion response was evident from Nichols' sampling of the flowage for species frequency and stem densities. He observed significant control with the first drawdown, a repeat drawdown a year later gained little additional control, and rapid reinvasion occurred within two years after drawdown ceased. Nichols contends that drawdown is a useful technique for aquatic plant management if conducted no more frequently than every other or third year and if combined with other management techniques.

Before any drawdown attempt is made (presuming the weed species composition and lake basin configuration, and refilling rate are appropriate to drawdown management), it is imperative that the lake community by fully informed and in accord with the proposal. This concensus is particularly important with respect to those Michigan lakes having an established legal lake level in order to avoid possible law suits associated with impaired recreation or dry wells.

If the practice is adopted, supplemental projects can also be incorporated with the drawdown. Depending upon its extent, dragline dredging, weed removal, beach renovation, litter control, and fish management projects may be appropriate.

Neither chemical treatment nor mechanical harvesting methods of weed control offer long term solutions to aquatic plant nuisances, but mechanical harvesting does have the advantage of removing the weeds and thus some of the nutrients which are at the base of the problem. In any case, complete eradication is neither feasible nor appropriate as the lake vegetation, in proper balance, is an essential component of the lake ecosystem and of recreational fishing and aesthetics.

Deep water dredging, if properly conducted, is an effective control technique but is prohibitively expensive for most lake communities. A reasonable and cheap alternative is the practice of intermittant winter drawdown, and some lake associations may want to consider the possibility of installing engineering structures (where they do not already exist) to make this possible.

The combined practice of summer control by mechanical harvesting and removal together with occasional winter drawdown and its opportunity for incidental management projects seems a wise, if labor intensive approach having the least negative environmental risks involved.

Such a program would involve the costs of the rental of weed harvesting services and removal only. (An approach to this service which is growing in popularity is the cooperative purchase of the necessary equipment by county or municipal governments with the costs reimbursed by rental fees paid by cooperating lake associations of that area.)[5] The winter drawdown phase of the operation if properly managed by a serious lake community should involve mainly the voluntary time and energy of its members.

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[5]Oakland County, Michigan has successfully operated a cooperative weed harvesting operation for several years.

Sociopolitical Involvement of the Lake Association

Once the lake association has initiated a management program, consideration may be shown for an expansion of its influence beyond the immediate lake community. The paramount concern of the association should always be the interests of its membership with respect to the lake resource, but often the accomplishment of this objective requires making the association's views known to others not directly affiliated with the lake community. Township, county, or state agencies, sometimes considerably removed from the lake environment, are often the sources of policy decisions having important effects upon it. For example, land use planning, road construction and maintenance operations, zoning laws and amendments or exceptions, tax proposals, and environmental legislation can all have considerable impact upon lake communities.

To effectively respond to these external effects, influence their application, or initiate such regulation or legislation in its own interests, the lake association should have some awareness of the institutional "tools" at its disposal. Donald Holtrop of the Continuing Education Service at Michigan State University has written a concise pamphlet on sociopolitical influence called "Changing Things: A Citizen's Guide (1973)." In it he documents six such "tools" available to people who want to peacefully and legally achieve change in their communities. These are: information, education and persuasion, legal power, public exposure, economic power, and political power. The following descriptions of these tools consists of an elaboration and interpretation of his concepts as applied to lake associations.

Information Function

Obviously, before embarking on any concerted program to cause change, the association must be sure of the facts of the matter and of the validity and justification of its position. The information tool is simply the process of being secure in these facts and presenting them to the appropriate people. Quite often in matters of social or political dispute, one side (or both) is concealing the truth or facts of the matter to protect their position. If you have nothing to hide, the informational tool derived from careful and accurate research is a potent instrument. If you can support your own position by indisputable fact and can present facts contrary to the allegations of your opponent, honest public decision makers may be able to take it from there. Unfortunately, in our world of imperfect human nature, "good guys don't always win ball games," thus the importance of the other five social tools.

Education and Persuasion

Education and persuasion are an extension of information. When the simple presentation of the facts does not change things, it is necessary to apply some interpretation and assessment in a well-constructed argument. For example, the information that septic tank effluent enriches lake waters and may create a health hazard may not alone convince one's neighbors or local government that such systems should be checked and where necessary modified. But, they may be convinced by a presentation of this same information by an invited speaker who is a recognized authority on water management or limnology, especially if he backs up his statement with data, photographs, or a demonstration of a positive dye test.

Legal Power

Legal power, as the term implies, is the process of bringing the force of the law to bear when a violation of rights has occurred. In a straighforward instance of clear illegality, this kind of law enforcement should be readily utilized. However, if court action is implied, particularly with respect to civil suits, two basic rules of thumb should be observed. The first of these is the presumption that the courts should be used as an instrument of last resort. Prosecution of a court case can be expensive and the outcome may not always be favorable. Further, the additional expense of entanglement in long drawn out appeals processes could mollify the importance of the final outcome. The continuing court history of the annexation provisions of the Michigan 1929 Summer Resort Act is an example of this consequence. It is wise, therefore, to apply the other "tools" for change first, reserving court suit or the threat of going to court as an option. The second rule of thumb is if an association is planning to sue, it should always be sure to approach the bar with "clean hands." It makes no sense whatever to take a developer into court for a zoning violation if any association members are also remiss in their own construction practices.

Public Exposure

Public exposure is perhaps one of the most effective tools available to the lake association, particularly when faced with the traditional bureaucratic "run-around" by public agencies. If the association has scrupulously followed the prescribed channels in pursuit of a legitimate objective and been repeatedly frustrated, the release of

their story to the press or media can often achieve near miraculous results. Politicians, bureaucrats, and businessmen alike are sensitive to disclosure of performance discrepancies in their public image.

News releases are also an excellent way to publicize association projects and generate interest or concern for the lake. Similarly, the expression of viewpoints in the editorial section of the local paper can stimulate action, particularly with respect to voter issues in the lake community. This approach is often used in school millage controversies to sway the vote. In a recent Lansing election, millage had been defeated by the electorate. A few months later the same proposal was again offered. However, this time balloting was preceded by daily editorials in the Lansing paper written by teachers and favorable parents arguing, often emotionally, in favor of preserving a quality education for the children. This letter writing campaign (perhaps bolstered by other canvasing and "get out the vote" approaches) succeeded in swaying the voters, and the issue passed the second time around.

Economic Function

The economic tool is another approach readily available to the well organized lake association. Local townships may or may not be concerned with the interests of the "lake people," but are influenced by the spending power of that community for groceries, sundries, and ancillary recreation products. The selective patronization (or boycott) of a store owned by an influential member of the township government can have considerable impact on the services provided the lake community.

Another aspect of the economic power available to the lake community is the influence wealthier members may have by way of their contributions to local social or religious organizations. The significance of their monetary support provides a right to a forum for their views on public matters involving such organizations and the lake community.

Political Power

The sixth social tool available is political power. Lake people often complain of being disenfranchised in the lake community government because they are vacation residents. This is not an unsolvable problem because the individual does have the option of changing his voting address from "home" to his lake residence, thus qualifying him to participate in the local political processes. For members of the lake community approaching retirement who eventually intend to live at the lake anyway, this option should not involve too serious a trade-off of voting interests. They could then function as political spokesmen for the other non-voting riparians. In either instance, the lake community should encourage and support the local political candidacy of their qualified members. While the local voting strength of the association may or may not be significant, it can still employ the social tools mentioned above to support or oppose particular candidates or policies in the local political arena. Of particular significance to the association should be the investigation of the possibility of forming and/or joining a township zoning board. Michigan state law (P.A. 183, 1943, "Township Rural Zoning Act;" M.C.L.A. 125.271 - .301) permits townships to develop their own land use plans and implement them

via a township zoning board. By becoming involved in this key function, the association can influence the direction and extent of lake shore development. This planning and enforcement function is particularly important with respect to insuring adequate space and soil characteristics for efficient on-site waste disposal systems, control of road drain discharges to the lake, and control of runaway multiple dwelling or commercial development which may accompany the installation of a municipal sewage system.

In the broader sector of state politics, voting address is less of a handicap. The lake association should keep its membership advised, via its newsletter, of all pending legislation pertinent to their interests and of its policy toward such proposals (information, education, and persuasion internalized). The members may then write or call their respective state delegates and inform them of their position, as constituents, on the given legislation. It is imperative in this respect that members establish a working communication with their elected representatives. A politician's performance is always enhanced by the certain knowledge that his constituents are interested in how he votes and what legislation he sponsors.

A further augmentation of association influence on legislation and policy can be derived by the organization of the many discrete lake associations into a statewide body. Lake associations, like individual riparians, can be most effective if organized. And again like individual riparians, they have a commonality of interests and problems. The Michigan Lake and Stream Associations, Inc. represents one means of so organizing. It has a membership of over a hundred

associations and publishes its own magazine The Michigan Riparian which carries articles dealing with lake and stream management issues. In particular, the Riparian serves as an inter-association communication link with respect to laws and regulations pertaining to their interests. Membership in this organization provides the potential for likeminded riparians to be represented before the state legislature and state agencies such as the Department of Natural Resources, Department of Agriculture, and the Highway Department. Because of its growing membership and the increasing environmental strain on recreational waters, the MLSA shows promise of becoming a significant voice in behalf of the lake and stream property owners of Michigan.

The direction this organization takes, and how well it represents the interests of its member associations will be determined to a great extent by how actively they participate in it. It seems certain that if riparian interests at the state level are to become politically significant, some form of organization with lobbying potential such as MLSA will have to be supported.

In considering the six options to implement social change discussed above, it is important to recognize that they may be employed in concert; not just individually or in sequence. The coordination of any of these approaches is dependent upon broad communication within and among the lake or stream associations, particularly by keeping members informed of policy and programs through the regular circulation of newsletters or similar motivational correspondence.

Lastly, in any such political involvement, honest forthright reasoning with the opposition should not be presumed as out of the question.

All of the "tools" mentioned are legitimate social means to bring pressure to bear on others to accomplish a particular goal. As one goal leads to another, the use of the social tools becomes repetitive and the same people will be encountered again. Therefore, it is wise to preserve the opportunity for ongoing, reasonable discussion throughout the procedure. This facilitates intelligent compromise and trade-offs which are the essence of long run political success.

CHAPTER IV

RESULTS OF THE LAKE ASSOCIATION INTERVIEWS

The data and analysis results of the compiled interviews are presented here in the same order as outlined in Chapter II (Research Approach, Interview Format). The presentation sequence is: Open Questions; Lake Association Characteristics; and Lake Management Performance by the Associations.

In order to lend continuity to this lengthy presentation and to include the perspective of interview observations, brief assessments and pertinent remarks are provided in this section as well as the specific results. The extensive presentation of tabular data is done to assist the reader in the interpretation of the results of this relatively small sample. This approach was also judged advisable because so little information is presently available with respect to Michigan lake associations.

Open Questions

Objectives of Lake Associations

The descriptive statements in the tables relating to these open questions consist of condensed responses from interviews with each of the 21 lake associations sampled. They often had the option of providing as many as five or more responses. All responses were listed and then summarized under the general descriptive headings used in each table with the frequency of such generally similar responses shown in each column.

The sampled lake associations (LAs) stated as existing and/or originating objectives the following in descending order of frequency: 1) water quality protection or pollution abatement, 2) aesthetic or environmental concerns, and 3) fish management, usually stocking operations (Table 2).

While both the higher performing (HP, i.e., associations with a management performance score greater than 70 points) and the lower performing (LP, i.e., associations assigned 70 points or less) associations shared concern for water quality and aesthetic protection, fish management was one of the most frequently reported objectives of the LPs. In the LPs, it ranks first along with aesthetic concerns but is fifth among the HPs which rank water quality and/or pollution abatement most often as an objective.

Another noticeable distinction between the two performance classes of LAs is the provision of social amenities such as activities and recreational facilities. This objective was one of the five most frequently reported objectives of the HPs. The LPs listed socialization only once as an objective.

The rank ordering of the frequency of stated objectives suggests that all LAs are environmentally concerned, but the HPs may be a little more gregarious and cosmopolitan, leaning toward the organizational approach for lake management. The LPs seem more direct and material in their objectives, i.e., improve the fishing, fix the roads, etc., while social amenities and political involvement as a means to achieve management goals seem to be relegated to a secondary status by them. The assignment of these differing priorities by the HPs and LPs also reflect the influence of social values as indicated by income level. There

Table 2.--Frequency Distribution of Stated Lake Association Objectives

OBJECTIVES	FREQUENCY		
	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Water Quality or Pollution Abatement	13	9	4
Aesthetic or Lake Environmental Concerns	13	7	6
Fish Management	10	4	6
Protection of Property Rights of Residents	6	1	5
Control of Land Development	6	5	1
Road Maintenance	6	1	5
Socialization or Provision of Recreation Facilities	6	5	1
Facilitate Lake Community - Government Dialogue	5	5	0
Weed Control	3	1	2
Lake Level Control	3	2	1
Nuisance Abatement (pet control, indecency)	2	0	2
Vandalism Problems	2	1	1
Public Access Concerns	2	1	1
Pest Control (mosquitoes, swimmer's itch)	2	0	2
Tax Problems	1	1	0
Road Drainage Diversion	1	1	0
Fire Protection	1	1	0

was a significant difference in average household income for the two classifications with the LPs having considerably less annual income than the HPs (Table 25).

Problems of Lake Associations

Contrary to the relatively low frequency of reported weed control objectives of the LAs, weed or algae control was listed as a second most frequent problem faced by the combined associations (Table 3). It was reported most often, however, by the LPs suggesting either greater concern over the weeds or more extensive eutrophication at these lakes.

Pollution abatement (a major source of eutrophication and weeds or algae and the most frequently stated objective of the LAs) is a major problem for both categories as is boating safety and regulation. Both problems are common to highly developed lakes, but only the HPs revealed any concern for controlling land development or a priority concern over public access. Only one LA, in the LP category, identified lawn fertilization as a concern.

Membership apathy was a problem for both categories of LAs, stated three times in each subsample and ranking second and third in frequency for the LPs and HPs respectively.

In spite of possible differences of attitudes as suggested by the objectives of the two categories of LAs, both share common recognized problems of pollution abatement; membership apathy (i.e., less participation in the activities and meetings of the associations than desired by the interviewees); and boating use conflicts.

Table 3.--Frequency Distribution of Stated Lake Association Problems

PROBLEM	FREQUENCY		
	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Pollution Abatement (including bacterial contamination, septic tank problems, tributary pollution, and difficulty implementing sewage projects)	10	7	3
Weed and/or Algae Control	6	2	4
Membership Apathy	6	3	3
Boating Safety (including user conflicts)	6	3	3
Public Access Concerns (including "abuses" and conditions of access site)	5	4	1
Nuisance and Disturbing Peace	3	2	1
Vandalism	3	1	2
Development Control	3	3	0
Taxation	2	2	0
Road Maintenance	2	0	2
No Problems	2	1	1
Aesthetics	1	0	1
Lawn Fertilizers	1	0	1
Low Dues	1	0	1
Erosion	1	0	1
Creeping Sand Dune	1	0	1
Lack of Public Agency Cooperation	1	1	0
Conflict Potential over Possibility of Dreding Lake	1	1	0
Fish Management	1	1	0

When the two categories are combined, the interviewees most frequently report problems of lake water quality, weed and algae control, apathy, boating conflicts, public nuisance and vandalism, and residential development control. These reported problems are comparable to the data obtained from two mailed questionnaires circulated in Michigan at the same time (Appendix D).

Recognition of Decreased Lake Water Quality as a Problem

Forty-three percent of the LAs recognized water quality problems in their lake to some extent (Table 4), both categories responding in the affirmative with similar frequency. It is interesting that both categories perceived lake water quality as a problem with such close frequencies when presented with only a yes or no response option. In the previous open ended question about problems, the higher performance respondents volunteered observations about pollution problems on their lake twice as frequently as the lower performance group. It would appear that water quality concerns are less predominant in the minds of lower performance respondents.

Table 4.--Frequency of Lake Associations Reporting Lake Water Quality Problems (i.e., "pollution, nutrient enrichment or high bacteria counts")

RESPONSE	Total Sample of Lake Assn's	FREQUENCY Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Water Quality Problem	9	5	4
No Lake Water Quality Problem	12	6	6

Member Apathy and Discord as Problems

About 60 percent of the associations in both performance categories reported problems of member apathy (Table 5). Similarly, in the earlier question asking respondents to list the problems of their associations, member apathy along with boating safety was the second most frequent problem voiced. When asked, "What if anything would help improve your association's performance?" the most frequent response expressed was a desire for greater participation by the membership.

Thus, member apathy would appear to be a major problem for lake associations irrespective of the relative performance status of the association. This being the case, perhaps much of what is said about lake association performance in general, should more realistically be attributed to association officer performance in particular. The accomplishments of an association may not reflect the efforts of its members as a whole so much as the efforts of those few who carry the weight of the organization.

While apathy may be a recognized problem of the lake associations, the opposite extreme of social intercourse, bickering and discord, apparently is not. One hundred percent of the sample indicated that lake association members in both performance categories get along well on a personal basis and that the great majority are able to deal with lake issues without serious rifts or schisms developing in the associations (Table 6). Many respondents qualified their remarks with comments to the effect that no human community can ever be expected to live in perfect harmony at all times, but that in the general context of human socialization, they all felt their lake communities to be remarkably cooperative.

This response by the lake associations is contradictory to the impressions of a local prosecuting attorney. He earlier stated that in his county, the constant internal bickering of the lake associations was a factor preventing them from accomplishing coordinated land use management by means of legal action.

Table 5.--Frequency Distribution of Lake Associations Reporting Problems with Member Apathy

RESPONSE	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Problem of Member Apathy	12	6	6
No Problem of Member Apathy	9	5	4

Table 6.--Frequency Distribution of Lake Association Responses to the Question: Are the Members of Your Association Compatible, i.e., Is the Community Harmonious with No Long Standing Feuds or Factions of Any Significance? a) Compatibility on an informal, personal basis among members; b) Compatibility when association business or issues are involved

A) ON A PERSONAL BASIS	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Yes	21	11	10
No	0	0	0
B) WITH RESPECT TO ISSUES	**Total Sample of Lake Assn's**	**Higher Perform. Lake Assn's**	**Lower Perform. Lake Assn's**
Yes	18	10	8
No	3	1	2

A separate questionnaire mailed to local representatives of five regional management professions in 23 counties (Appendix D) included questions on lake association "quibbling," "fighting with local communities and government in general," and "disputes over local municipal authority vs. lake association rules and regulations." The following table presents their responses to these three questions.

Table 7.--Responses of Regional Resource Managers to Questions Regarding Their Perception of the Extent of Lake Association Conflicts

	"YES" ANSWERS		
REGIONAL PROFESSIONALS POLLED	Quibbling in Lake Ass'n	LA fights with local community	Jurisdictional Disputes
Regional Soil Conservation Service Directors, n = 5	20%	40%	60%
Cooperative Extension Service Directors, n = 15	33%	33%	33%
Local Public Health Authorities n = 13	46%	15%	8%
Drain Commissioners, n = 8	38%	38%	13%
Department of Natural Resources Regional Fishery Biologists, n = 8	50%	25%	25%

The response of these regional administrators appears to support the original contention of the prosecuting attorney. This suggests that from the perspective of local authorities, internal lake association disputes are a factor of performance to be considered which perhaps the association representatives do not recognize or admit.

However, it must also be noted that the officials querried represent service-oriented professions which are often at odds with lake

associations over resource management issues and policies. Under such circumstances, it is not surprising that the officials may be particularly sensitive to any disputes involving or within lake associations. Similarly, when asked about the quality of technical assistance they received from some of these same agencies, the association representatives for their part were equally critical.

Accomplishments of Lake Associations

Water quality protection and pollution abatement were the most frequently reported objectives and problems of the sampled LAs. Yet, control of development is the most frequently reported accomplishment (Table 8) followed closely by boating safety and fish management, with pollution abatement and water quality monitoring fifth and sixth overall and not reported as accomplishments at all by the LPs.

While control of structural development in the lake community certainly helps abate pollution of the lake water, it appears that the direct approach to water quality management involving water quality testing and remedial action has met with considerably less effort or success among the LAs. Their three most frequently stated accomplishments seem to indicate project priorities associated with the more tangible, immediate, and visible aspects of lake utilization.

The attention to immediate, physical, user priorities by the lake associations may reflect a rudimentary state of organizational sophistication and resource management awareness. The relatively high incidence of "accomplishments" referring to improved lake resident cooperation and the formation and continued existence of the associations, supports the contention that organization occupies much of the

Table 8.--Frequency Distribution of Reported Accomplishments Volunteered by Lake Association Respondents

ACCOMPLISHMENTS	FREQUENCY		
	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Development Control and/or Removal of Objectional Structures	11	5	6
Boating Regulation and Safety Enforcement or Enhancement	8	5	3
Fish Management	6	4	2
Road Maintenance and/or Street Lights	6	0	6
Lake Resident Cooperation Improved	4	4	0
Formation and Continued Existence of LA	4	1	3
Weed Control	4	3	1
Lake Level Control	4	3	1
Progress in Septic Tank Pollution Abatement	3	3	0
Formation of Newsletter or Lake Community Directory	3	2	1
Membership Increase	2	2	0
Water Quality Monitoring Program by LA	2	2	0
Recognition by Local Government	2	2	0
County Government Response to Drainage or Erosion Problems	2	2	0
Wetlands Protection, Wildlife Sanctuary	2	2	0
Social Events	2	1	1
Recreation Facilities Provided	2	1	1
Restriction of Public Access Abuses	1	1	0
Fire Protection	1	1	0
Tax Information to Lake Community	1	1	0
Property Rights Information to Lake Community	1	0	1
Increased Dues	1	0	1
Control of Swimmer's Itch	1	0	1
Favorable Court Decision Regarding Lake Shore Channelization	1	0	1

LAs attention. The low incidence of water quality management or abatement accomplishments suggests either low priorities, limited information, or a low incidence of success in such attempts. Until a more formalized plane of organization evolves to facilitate information dissemination and project implementation, the associations may be constrained from more limnologically pertinent management.

Perceived Value of the Lake Associations

Irrespective of accomplishments vs. objectives or problems, ninety percent of both lake association categories considered their associations beneficial (Table 9). Officers in one instance for each subsample were negative about their association. In both cases they seemed frustrated and bitter at having attempted projects but having recieved minimal or no cooperation from other members. While "apathy" has been several times mentioned by LA officers as a problem, these two individuals appeared to be unable to reconcile themselves to the matter.

It is also interesting to note that, in spite of the apparent disagreement between regional resource managers and the associations over the LA's relative rapport with the local community, those managers overwhelmingly expressed the opinion that the associations were an asset to their own professional performance and to the community.

Table 9.--Frequency of Lake Association Interviewee Responses to the Question: Do You Consider Your Lake Association to Be Necessary and Meaningful (i.e., without it the people and lake would be worse off)?

	FREQUENCY		
RESPONSE	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Yes	19	10	9
No	2	1	1

Factors Which Would Help Improve the Lake Associations

By far the most frequently stated factor which would help improve LA performance centered on increased participation in the association by residents such as a desire for increased membership, better meeting attendance, or a greater sense of commitment (Table 10). This perception is supported further by the response of 57 percent of the LAs (12 out of 21) that they have problems with membership apathy.

However, many respondents (excepting the two rather bitter individuals mentioned earlier) were not greatly concerned about this, rather they seem to understand their neighbors reluctance to get extensively involved in the LA and were content to have them simply pay their dues and attend annual meetings. The impression is that most LA representatives are fairly confident that if an issue of significance should develop, they can depend upon the membership to rise to the occasion.

This impression is perhaps further substantiated (other than statements directly to that effect made by interviewees) by the almost unanimous response that LA members were compatible and harmonious in

Table 10.--Frequency Distribution of Interviewee Responses to the Question: What Would Help Improve Your Lake Association's Performance?

RESPONSES	FREQUENCY		
	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Greater Involvement of Lake Residents in LA (increased membership, meeting attendance, sense of commitment)	15	5	10
More Cooperation from Local Government	2	1	1
Increased Information, i.e., Technical and Legal	2	2	0
No Improvement Needed	2	1	1
More Cooperation from DNR	1	1	0
Social Program for Young People	1	0	1
Tax Equity for Lake Property Owners	1	0	1
Unification of LA's on Lake or in Area	2	1	1
Increased Dues	1	0	1
Don't Know	1	0	1
Research and Development Program for Lake Management	1	1	0
Employment of a Lake Manager	1	1	0
Greater Performance by Board Members	1	1	0
Expansion of Board of Directors	1	1	0
Greater Enforcement by Authorities of Existing Rules and Laws	1	1	0

their day-to-day socilization as well as when dealing formally with LA business and issues. In only one instance was the existence of a serious schism or faction reported and that incident (leading to formation of a separate LA) occurred several years ago.

Recreational Uses of the Lakes

Fishing, skiing, and boating are the recreational use favorites on the lakes sampled (Tables 11 and 12). Swimming ran a rather distant fourth place. This may be a factor in overall association lack of attention to water quality issues. The public health and eutrophic ramifications of lake quality may not be that obvious to association members because they (or at least the decision makers) don't spend that much time in the water. Water skiiers would not be readily vocal about water quality either since their use of the lake tends to be out near the center away from septic tank effluents and the symptomatic response of increased weed growth.

On the basis of this lake use data and interpretation, serious user concern about lake water quality may not arise until the degradation reaches impressive proportions. Fishing may have to decline drastically, and boating become greatly impaired by extensive weed beds before enough lake residents will become aroused to initiate remedial action.

Table 11.--Most Frequently Volunteered Lake Recreational Uses in the Opinions of the Interviewees. (These frequencies are based on the several uses reported. No use options were suggested to the interviewees.)

USE	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
1. Fishing	19	11	8
2. Skiing	14	8	6
3. Power Boating	13	8	5
4. Swimming	6	1	5
5. Sailing	5	4	1
6. Snowmobiling	3	1	2
7. Skating	1	0	1

Table 12.--Most Popular Recreational Lake Uses. (Based on the single most popular lake use stated by respondents or interpreted as such from the interview.)

USE	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
1. Fishing	5	3	2
2. Power Boating	4	2	2
3. Skiing (associated with power boating	4	2	2
4. Swimming	3	1	2
5. Fishing and Boating	1	1	0
6. Fishing and Swimming	1	0	1
7. Fishing, Skiing, Boating, and Snowmobiling	1	1	0
8. Fishing and Skiing	1	0	1
9. Skiing, Sailing, and Fishing	1	1	0
	21	11	10

Characteristics

Population Characteristics

Average Lake Community Size

The average lake community size based on the total sample appears to be about 370 households (Table 13). A t-test comparison of the mean community size of each category revealed no significant differences in this characteristic at the 0.1 level.

However, there is a much narrower range for community size in the higher performance group. This suggests that an upper and lower community size threshold may exist which has some influence upon the performance of lake associations. A regression analysis of community size for the entire sample on performance score, revealed a positive correlation ($r = 0.7383$) significant at the 0.1 level.

Perhaps a lake community of something less than 100 households lacks the combined resources necessary to implement management and may not be pressing the carrying capacity of the lake to the point where problems develop. On the other hand, too large a community may entail prohibitive transaction and communication costs which restrict successful management efforts.

Average Lake Association Size

The average lake association size in the study consists of about 135 households or slightly more than a third the average lake community size (Table 14). As with lake community size, the average and total number of households in the two categories are similar. There is no significant difference between their means, but the higher performance group again has a much narrower range and variance.

Table 13.--Size of Lake Communities Sampled (Number of Households)

Higher Performance Lake Associations	Lower Performance Lake Associations
900	1,750
500	1,250
450	450
300	147
227	80
200	45
180	42
160	30
155	18
100	?
?	-
3,173	3,812
mean = 317.2	mean = 423.56
variance = 58877.29	variance = 405741.03
standard deviation = 242.65	standard deviation = 636.98

Table 14.--Lake Association Memberships (Number of Households)

Higher Performance Lake Associations	Lower Performance Lake Associations
240	700
225	275
200	100
160	50
149	50
133	48
132	40
95	40
90	20
77	16
52	-
1,553	1,339
mean = 141.18	mean = 133.9
variance = 3764.16	variance = 45276.99
standard deviation = 61.35	standard deviation = 212.78

Active and Seasonal Lake Members

Lake association officers estimate that approximately 45 percent of their membership is actively engaged in the functions of the association (Table 15). "Active" is defined as those households regularly represented at association meetings and which can be relied upon to help in association projects. As was the case with community size and association membership, there is no significant distinction between the two groups with respect to active participation.

The seasonal component of association membership is about 55 percent of both the total and active members (Tables 16 and 17). This estimate applied equally to both categories. However, it should be noted that several respondents in the lower performance category were unable to estimate the seasonal fraction of their membership.

Organization

Age of Lake Associations

Of the associations interviewed (Table 18), the range of dates of incorporation or organization varied from 1975 to 1920 (or perhaps earlier as this is the date at least when that particular LA existed).

Since legislation for this purpose predates the turn of the century, it may be presumed that formal LA's could go back at least 80 years. However, two-thirds of the sample of LA's were organized since 1960. This suggests that while the idea has been around for some time, there has been a considerable expansion of growth in LA's just in the last decade. This may be a reflection of the economic and working age population expansions of the same period manifested in second (vacation) home purchases. Parents of the "baby boom" were

Table 15.--Active Membership (Those Who Regularly Attend Meeting and Participate in LA Projects) by Number of Households

Higher Performance Lake Associations	Lower Performance Lake Associations
100	350
90	75
87	65
75	40
59	30
56	28
50	20
40	12
35	10
30	10
12	-
634	640
mean = 57.64	mean = 64
variance = 773.86	variance = 10602
standard deviation = 27.82	standard deviation = 102.97

Table 16.--Percent of Lake Association Members Who Are Seasonal Residents (Those Who Do Not Live at Lake All Year-round)

Higher Performance Lake Associations	Lower Performance Lake Associations
88%	90%
80	75
75	75
70	50
66	50
65	50
60	50
50	10
30	?
10	?
3	-
597	450
mean = 54.27%	mean = 56.25%
variance = 795.82	variance = 591.07
standard deviation = 28.21	standard deviation = 24.31

Table 17.--Percent of Active Lake Association Members Who Are Seasonal Residents

Higher Performance Lake Associations	Lower Performance Lake Associations
80%	90%
75	80
70	75
60	50
60	50
50	50
50	50
50	?
10	?
10	?
4	-
519	445
mean = 47.18%	mean = 63.57%
variance = 735.36	variance = 305.95
standard deviation = 27.12	standard deviation = 17.49

getting out from under child rearing responsibilities at the same time that their rising levels of disposable income occurred, thus making luxury purchases attractive and feasible. Whatever the reason for their expansion, the inland lake associations are becoming social institutions significant to lake environments and their management.

Table 18.--Ages of Sampled Lake Associations (Year When First Formed, Not Necessarily the Year of Incorporation)

Higher Performance Lake Associations	Lower Performance Lake Associations
1926	1920
1945	1926
1960	1946
1961	1954
1965	1956
1966	1967
1970	1967
1971	1973
1973	1974
1974	1975
1974	-
mean = 1962	mean = 1956
variance = 216.818	variance = 390.622
standard deviation = 14.725	standard deviation = 19.764

Enabling Authority of the Lake Associations

Sixteen of the twenty-one LA's interviewed are either not incorporated or are organized under the Michigan General Corporation Acts (Table 19). Only three associations in the survey are incorporated under Act 137 of 1929, the Summer Resort Act. Of the organizational alternatives utilized by these associations, Act 137 conveys the most authority over member activities by granting the association quasi-municipal powers. In theory, LA's so organized may be expected to have the most potential for successful lake management since they would be most able to regulate the behavior of their members, particularly with respect to land use.

Table 19.--Type of Enabling Legislation Under Which the Associations Incorporate

LEGISLATION	FREQUENCY		
	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Michigan General Corporation Acts	9	5	4
Not Incorporated	7	4	3
Act 137, 1929 Summer Resort Act	3	2	1
Unknown	1	0	1
Deed Restriction	1	0	1

However, the constitutionality of the 1929 Summer Resort Act has twice been challenged in the Michigan Supreme Court without resolution (384 Mich. 42, 1970; 56 Mich. 162, 1974). The tenuous status of this law may, at least in part, account for the low incidence of its use as enabling legislation by the associations.

In any case, the data suggests that most of the associations have very little real authority and must rely on the voluntary cooperation of their members for any successful lake management programs.

Discussion with the interviewees indicated that most of the seventeen associations not organized by deed restriction or Act 137 either were unaware of the possibility of having greater authority over their members or, knowing of the option, did not want the authority. One officer stated he did not feel Act 137 was legally "safe," but if it is ever cleared in the courts he would like to see his lake organize under it.

On the contrary, another officer stated that his association's lawyer specifically advised against incorporation in any form to avoid potential law suits. The general impression received from the interviews was that many lake associations are not at all anxious to assume any authority over their community. It is suspected that this attitude originates from a strong concern by most LA members, including the officers, for the protection of their individual property rights. The desire to preserve their options to do what they like on their own property apparently extends even to control of their lake association.

A second motivation may result from a reluctance by some associations to be a recognized source of unpopular, albeit necessary, decisions

made with respect to the lake community, i.e., the butt of individual or sectional wrath when the LA moves to remedy a common tenant violation such as waste disposal ordinances or boating restrictions. While this second concern is by no means prevalent (Some officers, at least in these discussions, implied that they would take on anybody!), it does seem to bother the more sensitive individuals who would prefer to endure abuse of their standards than invite hard feelings.

Given the prevailing voluntary nature of the sampled associations, concern for maintaining harmony and cooperation is certainly a wise strategy. However, at least majority rule via peer pressure must eventually be imposed. If not, the community may suffer a dictatorship of the abusive minority.

Frequency of Association Meetings Per Year

Table 20 shows that the great majority (about 75 percent) of the sampled lake associations have only one or two general membership meetings per year. Fifty percent of the sample have just one annual meeting.

The enabling legislation pertinent to Michigan lake associations (General Corporation Acts and the Summer Resort Acts) requires at least one general membership meeting per year. The data and comments by interviewees suggests that most associations hold their meetings primarily to meet the minimum requirement of the laws.

Those associations meeting two or three times a year tend to hold these meetings during the summer months, i.e., beginning and end of the summer season or beginning, middle, and end of summer. The two remaining associations hold bi-monthly meetings with one holding an extra designated annual meeting.

Table 20.--Frequency of General Membership Meetings Per Year

Higher Performance Lake Associations	Lower Performance Lake Associations
7	3
6	3
2	3
2	2
2	1
2	1
1	1
1	1
1	1
1	1
1	-
26	17
mean = 2.36	mean = 1.7
variance = 4.45	variance = 0.9
standard deviation = 2.11	standard deviation = 0.95

Table 21.--Average Attendance (Number of Individuals) at General Membership Meetings

Higher Performance Lake Associations	Lower Performance Lake Associations
160	250
110	150
100	65
100	30
70	23
50	20
40	20
35	20
24	12
18	10
15	-
722	600
mean = 65.64	mean = 60
variance = 2166.05	variance = 6233.11
standard deviation = 46.54	standard deviation = 78.95

The average attendance at these meetings (Table 21) is about 60 people for both performance categories.

Other Associations on the Lake

Three-fourths of the associations polled constituted the only organization on their respective lakes (Table 22). Where more than one association exists on the lake, the incidence is slightly more frequent in the lower performance category. As might be expected, the multiple associations tend to occur (in both categories) on the larger lakes. In two of the five instances reported, the respondents stated that difficulty coordinating the activities of the two or more associations impairs their lake management potential.

Table 22.--The Incidence of More Than One Association on a Lake

	FREQUENCY		
	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Two or More Associations on the Lake	5	2	3
Only One Association on the Lake	16	9	7

However, several large HP lake associations indicated the satisfactory existence of an overall LA together with other independent neighborhood associations. Residents tend to belong to both, the one dealing with neighborhood roads and other localized problems, while

the large LA deals with overall lake issues (apparently the neighborhood units functioning like states in a federal government.

Association Relationships with Local Community and Government

The relationship between the LA and its host community also seems variable, but generally favorable (Table 23). From their perception, the LAs appear to get along fairly well with the local community. Both HP and LP associations are about evenly split between "very good" and "generally friendly" assessments of their relationships with their fellow local residents. There was an inverse relationship between these two degrees of positive attitude when the association officers described their relationships with local governments. The majority of the HP associations felt their relationship with government was "very good," while the majority of LP associations viewed this relationship as "generally friendly" or "distant." This perception appears to support the earlier impression that LP associations place less emphasis on political involvement than do the HP associations.

The possibility of improving lake management performance by inducing the associations to take a more active role in local government, is enhanced by the fact that none of them reported frequent conflicts or bad feelings with either local residents or government officials.

However, their favorable response toward local governments is somewhat surprising in light of frequently expressed complaints by the associations about services provided and high tax rates. Apparently the lake associations distinguish between what they wish would be provided them, and what they realistically expect township and county governments to provide. In fact, comments were twice made by LA

Table 23.--Lake Association Relationships with the Local Community and Government

A) INTERPERSONAL RELATIONSHIPS OF "LAKE PEOPLE" AND LOCAL "TOWN PEOPLE"	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Very Good	9	5	4
Generally Friendly, But Little Mutual Involvement	11	5	6
Distant Other Than Occasional Conflicts	1	1	0
Frequent Conflicts and Bad Feelings	0	0	0

B) THE RELATIONSHIP OF THE LAKE ASSOCIATION AS A POLITICAL BODY WITH EITHER THE TOWNSHIP OR COUNTY GOVERNMENTS	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Very Good	12	9	3
Generally Friendly, But Little Mutual Involvement	7	2	5
Distant Other Than Occasional Conflicts	2	0	2
Frequent Conflicts and Bad Feelings	0	0	0

officers to the effect that local authorities were sympathetic to their tax plight (i.e., often being the highest taxed property owners in rural, agricultural counties), but could do little about it because of state tax equalization policies. These officials often point out that while lake property taxes may be high compared to adjacent land, they are still a bargain compared to what they could be under state taxation laws.

Incidentally, a prevailing complaint remains that tax assessors don't carefully examine lake property and thus tend to tax plush, year-round homes at the same rate as "rustic," primitive summer cottages to the detriment of the owners of the less improved holdings.

Social Orientation of the Associations

Thirteen of the 21 associations interviewed (62 percent) reported that they did not sponsor social activities for their members, and only one of the thirteen expressed a desire to include such a function in future operations. Similarly, over 80 percent of the sample reported that issues and projects, rather than social events, are most effective in keeping association membership active (Table 24).

It is evident that the great majority of sampled associations view themselves as being primarily issue or service-oriented. This attitude is further supported by their responses above when asked to list the objectives of their associations. (The objective of providing social and recreational amenities by the HPs presented in Table 2 is qualified by this data, in Table 24, as an organizational function secondary to the issue oriented purpose of the associations.)

The data, therefore, suggest that LAs would be responsive to Cooperative Extension Service proposals oriented to problem solving on a localized, self-initiative basis.

Table 24.--Social Function of Lake Associations

A) SPONSORSHIP OF SOCIAL ACTIVITIES	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Association Sponsorship of at Least One Annual Social Function	8	4	4
No Sponsorship of Any Social Functions	13	7	6
B) APPROACH MOST EFFECTIVE IN KEEPING ASSOCIATION MEMBERSHIP ACTIVE	**Total Sample of Lake Assn's**	**Higher Perform. Lake Assn's**	**Lower Perform. Lake Assn's**
Issues and Projects	17	9	8
Social Events	2	1	1
Both	2	1	1

Lake Association Finances

Estimated Average Household Income Levels

Not surprisingly, the lower performance associations tend to represent lower income level residents as compared to the higher performance associations (Table 25). The average household income for the lower performance category is $17,500 per year, with 66 percent of these estimates in the $10,000 to $15,000 category. The higher performance lake associations sampled average $27,400 per year income per household, with 70 percent of their estimated annual incomes being greater than $15,000. A t-test analysis of this data revealed a distinction between the two categories significant at the 0.1 level.

Table 25.--Respondents' Estimated Average Annual Income for Members of His Lake Association (Two Respondents Refused to Estimate an Average Income Figure for Their Membership.)

A) ESTIMATED AVERAGE ANNUAL INCOME (WAGES OR EQUIVALENT)	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
$ 5,000 to $10,000	2	1	1
> $10,000 to $15,000	8	2	6
> $15,000 to $20,000	3	3	0
> $20,000 to $30,000	3	2	1
> $30,000 to $40,000	2	2	0
> $40,000	1	0	1
Average Estimated Household Income:		$27,400	$17,500

Note: Computations of the average income figures are based upon specific annual income estimates by LA officers or, if they were reluctant to estimate that closely, the mid-point of the estimated income range was used, i.e., > $15,000 to $20,000 estimate converts to $17,500.

B) RELATIONSHIP OF LA MEMBERS ANNUAL INCOME TO REST OF LAKE COMMUNITY AS ESTIMATED BY RESPONDENT	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Higher	11	7	4
Similar	10	4	6
Lower	0	0	0

The upper range of these individual incomes, extended to a few individuals making in excess of $100,000 per year. On one occasion a respondent (in the lower performance category) referred to a "millionaire" on the lake.

The estimates of average income levels are obviously crude, being dependent upon the opinion of one member of each association. However, even this estimate may be conservative. In one instance at least, it was strongly suspected that the lake association president interviewed was grossly underestimating the income levels of himself and his peers. His home was obviously plush, and all of the houses in the area were large and expensive looking. The gentleman's evasive responses when asked about income levels and his reference to not knowing what assets some of his retired neighbors have, even though they . . . "technically no longer have any income," suggested considerable wealth in the community and a shrewd concern not to provide any estimate of real worth.

In all instances the lake associations estimated themselves to equal or exceed the annual income status of the rest of their lake community.

However, there is an almost direct inverse relationship in their estimates of relative economic status. Most of the higher performance association interviewees perceived their membership as having a higher income level than non-member residents of the lake community (64 percent = higher, 36 percent = equivalent income levels). In the lower performance category, the estimates were reversed, with 60 percent of the respondents perceiving member income levels to be similar to the rest of the lake community, and 40 percent believing themselves to be wealthier.

These perceptions of relative wealth of the two categories of lake associations tend to support the differences in average income levels for members of each type lake association as noted earlier. The absence of any estimates by the interviewees of income status lower than the rest of the lake community may result from one or both of two factors. First, personal pride and self respect of the respondents may be such that they wouldn't consider viewing themselves as anything less than the economic equals of their neighbors. Second, association members may represent a generally higher personal achievement level within their lake community. Neither of these suppositions can be proven by the information collected in this study, but none of the interviews ever took place at a residence that was obviously inferior to the condition of its neighbors and in fact the reverse was usually true. It is evident that the average income levels estimated for either lake association category exceeds the statewide average family income of $12,296 per year as reported in the 1970 U.S. Census (U.S. Bureau of the Census, Census of Population: 1970 General Social and Economic Characteristics, Final Report PC(1)-C24 Michigan, U.S.G.P.O. 1972). A Department of Resource Development survey research project conducted last year indicated the average statewide income level to be $13,500 (Kimball and Thullen, Department of Resource Development, Michigan State University, Michigan Public Opinion Survey, Summary of Results, 1976). No matter which of these estimates of average Michigan income is closest to reality, it remains clear that the respondents estimate their communities to be wealthier than average.

Retirees in the Lake Associations

The principle wage earner in 23 percent of the higher performance association households is retired. Similarly, 17 percent of the householders in the lower performance category are retirees (Table 26).

Table 26.--Respondents' Estimate of Percent of LA Membership Who Are Retired Individuals

Higher Performance Lake Associations	Lower Performance Lake Associations
65%	55%
50	25
50	19
25	15
15	13
15	12
10	8
10	5
9.5	0
5	?
1	-
255.5	152
mean = 23.23%	mean = 16.89%
variance = 468.17	variance = 258.86
standard deviation = 21.64	standard deviation = 16.09

Annual Dues of the Lake Associations

The range of annual dues charged by the sampled associations is considerable, varying from $1.00 to $75.00 per household. The average is about $15.00, with no significant difference between the two performance groups. However, the great majority of the associations charge only $5.00 or $10.00 per household per year. (Table 27).

Table 28 shows that slightly less than half of the associations augment their income with funds other than from dues, usually special assessments or donations as a particular need arises.

Lake Association Annual Income

The average income for the higher performance associations is about $2,400. The average income of the lower performance associations is about $800. A t-test analysis of the data indicated no significant difference between these income figures because of the great variance of the small sample involved (Table 29). However, it is evident that the higher performance associations have more funds available to work with.

Table 27.--Annual Dues of the Lake Associations (In Most Instances Dues Are Per Household or Property Owner)

Higher Performance Lake Associations	Lower Performance Lake Associations
$75/year	$40/year
67	35
10	10
10	10
10	5
5	5
5	5
5	4[1]
5	1.50[1]
5	1
4	-
201	116.5
mean = 18.27	mean = 11.65
variance = 688.22	variance = 195.78
standard deviation = 26.23	standard deviation = 13.99

[1] Indicates dues per adult.

Table 28.--Frequencies of Respondents Answering the Question: Does Your LA Have Any Other Source of Income Beyond Dues?

INCOME	FREQUENCY Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Lake Associations Having Income in Addition to Annual Dues	9	6	3
Lake Associations Whose Only Source of Income Is Annual Dues	12	5	7
	21		
ALTERNATIVE INCOME SOURCES			
Special Donations	5	4	1
Special Assessments	3	2	1
Social Events	1	0	1
	9		

Table 29.--Annual Budget of the Lake Associations, i.e., Estimated Amount of Funds Taken in Each Year, Before Expenses

Higher Performance Lake Associations	Lower Performance Lake Associations
$16,000	$3,525
2,300	1,400
2,000	700
1,200	600
1,200	450
1,200	300
750	200
700	150
600	28
450	?
240	-
$26,640	$7,353
mean = 2,421.82	mean = 817.00
variance = 20,676,536.36	variance = 1,198,001
standard deviation = 4,547.15	standard deviation = 1,094.53

Lake Characteristics

Lake Size

A t-test analysis of this data revealed no significant difference in average lake size between the two groups. This would indicate that the average size lake in the sample is about 1,200 acres (Table 30). However, the extremely high variance suggests an inordinate influence on the sample of the few very large lakes. This small sample size results in a considerably skewed estimate of the mean. Eighty-two percent of the sampled lakes are less than 500 hundred acres in size and fifty-four percent are less than 250 acres. If the mean value is recomputed without including the 16,700 acre lake, a value of about 730 acres is estimated.

This 730 acre estimate is about thirty times the average computed on the basis of Humphrys' index of nearly 35,000 Michigan lakes and ponds (1965). However, the Humphrys' data includes all recorded lakes and ponds in Michigan, many of which are no doubt too small to support a lake association.

In 1975, sixty-four LAs participated in the Department of Natural Resources Self-Help lake program sponsored by the Inland Lake Unit. The mean size of these lakes was 619 acres, with 56 percent of them in the 100 to 500 acre size group. This data compares favorably with the above reported lake sizes and suggests that one may estimate most lower peninsula inland lakes to be less than 500 acres in size.

Lake Depths and Bottom Characteristics

While these data are not as variable as lake size, elements of the same problem remain evident, and no significant distinctions emerged.

It was hoped that the acreage and depth estimates (Tables 30 and 31) might provide some clue to the trophic status of the lakes sampled which might then be compared to performance of their associations.

However, it is evident that without knowing more about the lake bottom configurations, maximum depth has little meaning beyond suggesting that all of the lakes sampled have at least a portion of their water column below the phototrophic zone and are probably subject to seasonal stratification and turnover.

The interview question regarding most frequently occurring lake depth (Table 32) was asked in an effort to gain some insight into aquatic weed growth potential in the lakes. The extent of shallow (littoral) areas where the lake bottom is within the phototrophic zone is some indication of the impact of nutrient influents. There was some difficulty conveying the essence of this question without indicating its purpose, and perhaps the matter should have been approached differently. Nonetheless, except for one lake, in the LP category, which drops off to a great depth, it appears that the lakes sampled all have rather extensive photic zones available to rooted vegetation.

The frequent identification of marl bottoms in the lakes is consistent with Michigan's "hard" groundwater resources. The similarly frequent reference to soft bottom conditions, commonly referred to as muck by the respondents (and qualified when questioned as meaning "silt" or organic "mud") suggests potential nutrient reservoirs in the accumulated bottom sediments of these lakes (Table 33).

The information about area, depth, and bottom conditions so far collected in no way establishes the trophic status of the lakes.

Table 30.--Lake Size, in Acres

Higher Performance Lake Associations	Lower Performance Lake Associations
16,700	4,865
4,000	3,000
2,400[1]	498[3]
1,068[1]	342
660	310
400	200
375	187[3]
287	179[3]
210	80
183	73
115	68
88[2]	40
54.5[2]	-
51[2]	-
45[2]	-
26[2]	
26,662.5 acres	9,842 acres
mean = 1,666.406 acres	mean = 820.167 acres
variance = 17,219,032.77	variance = 2,289,288.697
standard deviation = 4,149.582	standard deviation = 1,513.0395

1
2
3 } Indicates multiple lakes served, in each instance, by one LA.

Table 31.--Maximum Lake Depth in Feet, i.e., Deepest Point in Lake

Higher Performance Lake Associations	Lower Performance Lake Associations
90	120
86	110
80	100[3]
70[2]	90
70[1]	80
65[1]	80
55	60[3]
50	55
47[2]	50
42[2]	50
40	50
35	48
30	35[3]
22[2]	-
15[2]	-
797	878
mean = 53.133	mean = 73.167
variance = 536.125	variance = 755.787
standard deviation = 23.154	standard deviation = 27.492

[1]
[2] } Indicates multiple lakes served, in each instance, by one LA.
[3]

Table 32.--Most Frequently Occurring Lake Depth, i.e., Respondent's Estimate That, in His Experience, Most of the Lake Is the Below Reported Depth or Shallower

Higher Performance Lake Associations	Lower Performance Lake Associations
30 feet	100 feet
30	30
20	25
20	20
20	20
16	15
15	12
12	12
10	10
10	6
10	-
193	250
mean = 17.55 feet	mean = 25.00 feet
variance = 53.87	variance = 672.40
standard deviation = 7.34	standard deviation = 25.93

However, it does suggest that the combination of shallow silted bottom, seasonal overturn, and allochthonous nutrients from lawn fertilization and septic tanks are all present and could result in rapid cultural eutrophication.

Table 33.--Predominant Lake Bottom Types According to Respondent Assessments

LAKE BOTTOM TYPES	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Marl	7	4	3
Muck (soft, organic mud)	6	2	4
Sand and Marl	1	0	1
Mixed, but Mostly Soft	2	2	0
Muck and Marl	1	0	1
Silt and Mud	1	1	0
Sand	1	0	1
Unknown	1	1	0
Sand and Clay	1	1	0

Extent of Lake Development

The sampled lakes vary in the extent to which residential development of the riparian land has occurred. The least developed lake was estimated by the respondent to have about one-fourth the waterfront lots suitable for construction developed. The most developed lakes are in the lower performance category and involve more than two tiers of completely developed lots around the lake (Table 34).

The average lake development for this study is about 70 percent of the lake frontage (with lots averaging about 65 feet wide) and in most cases there is only slightly more than one tier of development (Table 35).

Table 34.--Extent of Lake Community Development That Includes Non-Riparian Lot Development, i.e., More Than One Lake Front Tier of Housing; Additional Rows of Houses Back from the Lake

Higher Performance Lake Associations		Lower Performance Lake Associations	
No. of Tiers of Housing on the Lake	% of Lake Housing in More Than One Tier	No. of Tiers of Housing on the Lake	% of Lake Housing in More Than One Tier
1	-	1	-
2	50	3	5-10% in third tier
2	5	2	50
2	4	3	"most of lake"
2	10	2	75
1	-	1	-
2	10	2	10
2	15	1	-
1	-	1	-
2	15	2	15
?	?	-	-

Note: This data does not correlate with percent development and density of housing because lake development does not proceed in a systematic manner. Second or third tier development may proceed in some areas before all lake shore lots are built upon.

Table 35.--Extent of Development; i.e., Percent of Available Lake Shore Lots Suitable for Construction That Have Been Built Upon

Higher Performance Lake Associations		Lower Performance Lake Associations	
% Developed	Average Front Footage of Lots	% Developed	Average Front Footage of Lots
150[1]	50'	250[1]	50'
97	60	200[1]	50
85	88	150[1]	50
80	55	100	50
80	100	90	60
75	100	85	100
75	50	80	100
60	75	50	70
60	75	30	60
50	60	30	45
25	45	-	-
837	750	1065	635
mean = 76.09	mean = 68.909	mean = 106.5	mean = 63.5
variance = 982.091	variance = 401.091	variance = 5289.166	variance = 422.5
standard deviation = 31.338	standard deviation = 20.027	standard deviation = 72.7266	standard deviation = 20.5548

[1]Represents rough estimate of extent of development of off-lake as well as riparian lots, where back lot development appeared extensive.

Political Boundaries Associated with the Lake Communities

Ninety percent of both categories of lake associations are located entirely within one county (Table 36). This suggests that the county as a political and administrative entity is a feasible regional deliniation for consideration in proposing local lake management programs.

Township boundaries don't appear to be sufficiently inclusive to function as a local political denominator of lake management efforts since about 60 percent of the lakes sampled lie within the jurisdiction of two or more townships. This data also suggests that lakes under the authority of more than one township are not particularly hindered in their relative management performance. Almost half of the higher performance associations are in this situation including the highest scoring lake association in the sample; while 70 percent of the lower scoring lakes were located within a single township.

Table 36.--Political Boundaries Associated with the Lakes

	FREQUENCY		
A) LAKE ENTIRELY WITHIN ONE COUNTY	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Yes	19	10	9
No (In Two or More Counties)	2	1	1
	21		
B) LAKE ENTIRELY WITHIN ONE TOWNSHIP	Total Sample of Lake Assn's	Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Yes	12	5	7
No (In Two or More Townships)	9	6	3
	21		

Political "horse sense" suggests that multiple township involvement would compromise lake management efficiency because the involved local bureaucracy would be larger. However, the data does not support this assumption. Apparently, if a lake association is adamant about its management objectives, township government constitutes either an insignificant obstacle or is compatible (even in the instance of overlapping authority) with the association's intent.

The primary indication of this portion of the study dealing with lake association characteristics is one of remarkable homogeneity between the higher performance and lower performance groups. With only a few exceptions, the differences in quantitatively measurable characteristics between the two categories of associations are statistically insignificant (Table 37, t-test results column three). This suggests that (with respect to those characteristics measured individually) there is little to distinguish in advance of an association's actual performance, its likelihood for self-help management success.

To further investigate this, the characteristics of the combined sample of 21 lake associations were tested for correlation with their performance scores. It is preferable to use the entire sample to test for correlation because the dependent variable (performance score) was used to establish the two categories, and because there was no demonstrated distinction between them otherwise. Table 37, last column, presents the results of this analysis.

There remained the possibility that significant correlations with performance could result from the interaction of two or more characteristics of a lake association, i.e., when measured discretely, the characteristics may fail to suggest a relationship with management

Table 37.--Summary of Quantitative Lake Community Characteristics

	Mean Characteristic of the HP Group	Mean Characteristic of the LP Group	Significant t-test of Difference Between the Two Groups	Correlation (r) of Total Sample (HP+LP) Characteristics with Performance Score
POPULATION CHARACTERISTICS				
Size of Lake Community (Households)	317.2 ± 242.65	423.56 ± 636.98	no	r = 0.7383, signif. at 0.01α
Number of Members in Lake Association (Households)	141.18 ± 61.35	133.9 ± 212.78	no	0.3415, no
Number of Active Households in Lake Association	57.64 ± 27.82	64.0 ± 47.8	no	0.1704, no
Percent of Member Households that are Seasonal	54.27 ± 28.21	56.25 ± 24.31	no	- 0.1407, no
Percent of Active Member Households that are Seasonal	47.18 ± 27.12	63.57 ± 17.49	no	- 0.4256, signif. at 0.1α
ORGANIZATIONAL CHARACTERISTICS				
Year Lake Association Was Organized	1962	1956	no	- 0.0215, no
Frequency of General Meetings Per Year	2.36 ± 2.11	1.7 ± 0.95	no	- , no
Average Attendance at General Meetings (Individuals)	65.64 ± 46.54	60.0 ± 78.95	no	0.2154, no
Percent of Associations in Each Group Belonging to MLSA	82	30	x^2 test signif. at 0.01α	- , -
Average Performance Score	87.45 ± 13.92	50.30 ± 12.93	t-test signif. at 0.001α	- , -
FINANCIAL CHARACTERISTICS				
Average Annual Household Income	27,400 ± 9,297.70	17,500 ± 13,028.82	t-test signif. at 0.1α	0.2047, no
Percent of Association Members Retired (Households)	23.23 ± 21.64	16.89 ± 16.09	no	- 0.0032, no
Annual Dues Per Household	18.27 ± 26.23	11.65 ± 13.99	no	0.0435, no
Annual Income of the Lake Associations	2,421.82 ± 4,547.15	894.13 ± 1,143.66	no	0.0245, no
LAKE SETTING CHARACTERISTICS				
Size of Lake (Acres)	1,666.4 ± 4,149.6[1]	820.2 ± 1,513.04[2]	no	0.1116, no
Maximum Depth of Lake (Feet)	53.13 ± 23.15	73.17 ± 27.49	t-test signif. at 0.1α	- 0.3467, no
Most Prevalent Lake Depth (Feet) or Shallower	17.55 ± 7.34	25.00 ± 25.93	no	- 0.2652, no
Percent of Residential Development of Suitable Shoreline	76.09 ± 31.34	106.5 ± 72.73	no	0.2367, no
Average Front Footage of Waterfront Lots	68.91 ± 20.03	63.5 ± 20.55	no	0.2742, no

[1]Seventy percent of the lakes in this group are less than 500 acres in size.

[2]Ninety percent of the lakes in this group are less than 500 acres in size.

performance, but together they could have a complimentary effect. To screen for this possibility, a series of multiple linear regression analyses were conducted. This procedure was described above in Chapter I under Analytical Methods and will not be repeated here save to report that no correlations significant at the 0.1 level were detected.

Lake Management Performance by the Lake Associations

Table 38 presents a summary of the various self-help management options available to the lake associations according to the literature, and of the frequency with which they avail themselves of the management opportunities.

The only management option actively pursued by 100 percent of the sample was the seeking of technical assistance by the lake associations. Table 39 presents a breakdown of the various sources of assistance sought by the associations and the interviewees' assessment of the quality of service derived from each source.

Table 38.--Summary of Lake management Performance by the Interviewed Lake Associations

FEASIBLE MANAGEMENT OPTIONS	NUMBER OF ASSOCIATIONS OF TOTAL SAMPLE ENGAGED IN EACH PERFORMANCE, n=21
Nutrient and Effluent Abatement	
Septic tank system maintenance and use restrictions	2 (10%)
Septic tank system improvements	2 (10%)
Consideration of alternative to septic tank systems	4 (19%)
Program to prevent or reduce lawn fertilization	5 (24%)
Promotion of natural vegetation buffer strips along lake shore	0 (0%)
Erosion or sedimentation control	1 (5%)
Marsh protection	4 (19%)
Drainage (agricultural and/or road) diversions from lake	3 (14%)
Water Quality Investigation	
Lake water quality sampling program	7 (33%)
Septic tank system dye testing or inspections	2 (10%)
Symptomatic Management	
Fish management	13 (62%)
Algae control	1 (5%)
Aquatic weed control	4 (19%)
Winter lake level drawdown for weed control	0 (0%)
Sociopolitical Involvement	
Information and Education Function	
Information program (speakers)	55[1](76%)
Technical assistance sought	39[2](100%)
Persuasion Function	
Newsletter	13 (62%)
Media utilization (newspapers, radio, t.v. - editorials and features)	7 (33%)
Legal Function	
Active promotion of, and compliance with, laws and regulations	14 (66%)
Legal counsel available to the lake association	16 (76%)
Economic Function	
Awareness and utilization of the LA's economic status in the community	12 (57%)
Association members influential in local community and government	16 (76%)
Political Function	
Greater than 30% resident voters in the lake association	10 (48%)
Regular association representation at township or county meetings	13 (62%)
Letter or telephone campaigns on lake issues (including petitions)	5 (24%)
Communication with state legislators on lake issues	1 (5%)

Table 38.--Continued

FEASIBLE MANAGEMENT OPTIONS	BREAKDOWN OF PERFORMANCE BY ASSOCIATIONS IN THE "HIGHER PERFORMANCE" CATEGORY, n=11						
	Not Possible	Not a Problem	By LA	Other Sponsor	Some Attempt By LA	No Attempt By LA	% LA's Actively Involved
Nutrient and Effluent Abatement							
Septic tank system maintenance and use restrictions			2		2	7	18
Septic tank system improvements			1		2	8	9
Consideration of alternative to septic tank systems			3		3	5	27
Program to prevent or reduce lawn fertilization			5		1	5	45
Promotion of natural vegetation buffer strips along lake shore					3	8	0
Erosion or sedimentation control		8			2	1	0
Marsh protection		6	3			2	27
Drainage (agricultural and/or road) diversions from lake		3	3		1	4	27
Water Quality Investigation							
Lake water quality sampling program			5	2	2	2	45
Septic tank system dye testing or inspections			2	1	4	4	18
Symptomatic Management							
Fish management			8			3	72
Algae control		7	1		1	2	9
Aquatic weed control		5	3			3	27
Winter lake level drawdown for weed control	6				2	3	0
Sociopolitical Involvement							
Information and Education Function							
Information program (speakers)			37[1]			1	91
Technical assistance sought			63[2]				100
Persuasion Function							
Newsletter			9		1	1	82
Media utilization (newspapers, radio, t.v. - editorials and features)			6			5	55
Legal Function							
Active promotion of, and compliance with, laws and regulations			10			1	91
Legal counsel available to the lake association			11				100
Economic Function							
Awareness and utilization of the LA's economic status in the community			9			2	82
Association members influential in local community and government			10			1	91
Political Function							
Greater than 30% resident voters in the lake association			7			4	64
Regular association representation at township or county meetings			9		2		82
Letter or telephone campaigns on lake issues (including petitions)			3	1	1	6	27
Communication with state legislators on lake issues				1	2	8	0

Table 38.--Continued

FEASIBLE MANAGEMENT OPTIONS	Not Possible	BREAKDOWN OF PERFORMANCE BY ASSOCIATIONS IN THE "LOWER PERFORMANCE" CATEGORY, n=10 Not a Problem	By LA	Other Sponsor	Some Attempt By LA	No Attempt By LA	% LA's Actively Involved
Nutrient and Effluent Abatement							
Septic tank system maintenance and use restrictions					1	9	0
Septic tank system improvements			1		2	7	10
Consideration of alternative to septic tank systems		1	1	2	2	4	10
Program to prevent or reduce lawn fertilization					2	8	0
Promotion of natural vegetation buffer strips along lake shore		1			1	8	0
Erosion or sedimentation control		6	1	2		1	10
Marsh protection		2	1	3		4	10
Drainage (agricultural and/or road) diversions from lake		5			1	4	0
Water Quality Investigation							
Lake water quality sampling program			2	3		5	20
Septic tank system dye testing or inspections				2		8	0
Symptomatic Management							
Fish management			5	1		4	50
Algae control		7				3	0
Aquatic weed control		3	1		1	5	10
Winter lake level drawdown for weed control	6					4	0
Sociopolitical Involvement							
Information and education Function							
Information program (speakers)			18[1]			4	60
Technical assistance sought			26[2]				100
Persuasion Function							
Newsletter			4			6	40
Media utilization (newspapers, radio, t.v. - editorials and features)			1		2	6	10
Legal Function							
Active promotion of, and compliance with, laws and regulations			4		2	4	40
Legal counsel available to the lake association	(unknown) 2		5			3	50
Economic Function							
Awareness and utilization of the LA's economic status in the community			3		3	3	30
Association members influential in local community and government	(unknown) 1		6		2	1	60
Political Function							
Greater than 30% resident voters in the lake association			3			7	30
Regular association representation at township or county meetings	(unknown) 2		4		2	2	40
Letter or telephone campaigns on lake issues (including petitions)	(unknown) 1		2		1	7	20
Communication with state legislators on lake issues	(unknown) 2		1			7	10

[1]Number of speakers invited to lake association meetings within the preceding 5 years

[2]Number of times technical assistance was sought by lake associations within the preceding 5 years

Table 39.--Sources of Technical Assistance Utilized by the Sampled Lake Associations

Total Sample of Associations, n = 21

AGENCY OR OTHER SOURCE OF TECHNICAL ASSISTANCE[1]	FREQUENCY OF CONTACT				QUALITY OF ASSISTANCE PROVIDED			
	Often	Occasionally	Once	Unknown/ None	Good	Fair	Dissatisfied	Opinion Pending
USDA Soil Conservation Service	1	1	3	16	4	0	0	1
MSU Cooperative Extension Service	2	2	1	16	5	0	0	0
College or University Personnel	2	3	4	12	9	0	0	0
Drain Commissioner	1	4	1	15	3	1	1	1
Michigan Department of Natural Resources	7	10	0	4	4	5	6	3
County Public Health Department	6	7	0	8	5	1	4	3
Association Members	6	5	1	9	11	0	0	2
Commercial Firms	2	1	6	12	6	1	2	1
County Planning and Zoning Board	1							1
Local High School	1							1
Police, State or Local	1	1			2			0
County Tax Assessor			1		1			
County Road Commission	2	2			1		2	1
Township Government	1				1			
Other Lake Associations		1			1			
Private Attorney			1		1			

Table 39.--Continued

Higher Performance Category of Sampled Associations, n = 11

AGENCY OR OTHER SOURCE OF TECHNICAL ASSISTANCE[1]	FREQUENCY OF CONTACT				QUALITY OF ASSISTANCE PROVIDED			
	Often	Occasionally	Once	Unknown/ None	Good	Fair	Dissatisfied	Opinion Pending
USDA Soil Conservation Service	1	1	2	7	3			1
MSU Cooperative Extension Service	2	2		7	4			
College or University Personnel	2	3	3	3	8			
Drain Commissioner	1	3	1	6	2	1	1	1
Michigan Department of Natural Resources	6	5			2	3	4	2
County Public Health Department	3	5		3	2	1	4	1
Association Members	4	2	1	3	7			1
Commercial Firms	1	1	4	5	5			1
County Planning and Zoning Board	2							1
Local High School	1							1
Police, State or Local	1				1			
County Tax Assessor			1		1			
County Road Commission	2	2			1		2	1
Township Government	1				1			
Other Lake Associations								
Private Attorney								

Table 39.--Continued

Lower Performance Category of Sampled Associations, n = 10

AGENCY OR OTHER SOURCE OF TECHNICAL ASSISTANCE[1]	FREQUENCY OF CONTACT				QUALITY OF ASSISTANCE PROVIDED			
	Often	Occasionally	Once	Unknown/ None	Good	Fair	Dissatisfied	Opinion Pending
USDA Soil Conservation Service			1	9	1			
MSU Cooperative Extension Service			1	9	1			
College or University Personnel			1	9	1			
Drain Commissioner		1		9	1			
Michigan Department of Natural Resources	1	5		4	2		2	1
County Public Health Department	3	2		5	3			1
Association Members	2	3		5	4			1
Commercial Firms	1		2	7	1	1	1	
County Planning and Zoning Board								
Local High School								
Police, State or Local		1						
County Tax Assessor								
County Road Commission								
Township Government								
Other Lake Associations		1			1			
Private Attorney			1		1			

[1]Sources of assistance below the dashed line are those additions to the questionnaire format volunteered by interviewees when asked if they had sought other help not specifically mentioned.

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

Composite Lake Association Characteristics

The average inland lake community size appears to be about 370 households, possibly a convenient size for self-help management implementation. The tendency toward lower relative performance, within the sample, accompanied associations in communities of less than 100 or more than 1,000 households. It may be that smaller lake communities lack municipal and economic influence, while larger ones suffer from high communication costs (Schmid, 1976).

About 40 percent of the lake community or 135 households belong to the lake association. Forty-five percent of the member households are "active" members, in that they regularly attend meetings and participate in association projects. About 55 percent of association members are seasonal residents, and 20 percent are households in which the principal wage earner is retired. The average annual income for association member households is higher than either the state median income level or that of non-member neighbors. Higher performance category association member households averaged $27,400 per year; lower performance association households averaged $17,500 per year.

The average lake association was formed in that late 1950's or early 1960's, although some associations have existed since at least 1920. The tendency for the associations to be fairly young is probably

due in part to the relatively high disposable income levels of that period. This made lake property purchases attractive to many middle income families. Most of these lake associations are either not incorporated or are non-profit corporations organized under the Michigan General Corporation Acts. In either instance, they are essentially voluntary organizations with little actual or implied authority over the land use activities (such as waste disposal or other actions which could affect the lake) of their members. In particular, the Summer Resort Act of 1929, which provides quasi-municipal authority to the lake association, appears to have been avoided. This may be due to fears that it will eventually be ruled unconstitutional in the Michigan Supreme Court.

Most associations hold general membership meetings once or twice a year, but the officers meet monthly or bimonthly. Attendance at the general meetings runs about 60 people. The association is usually the only one on the lake (75 percent of sampled associations).

Of the 21 associations interviewed, 12 are formal members of MLSA. (Membership is available both to individual riparians or to LAs as a unit.) Nine of the 11 HP associations (82 percent) belong to MLSA, while only 3 of the 10 LP associations (30 percent) belong.

All of the associations are strongly issue-oriented. Social functions assume a distinctly minor role. Their emphasis on issues apparently does not prejudice the relationship between the associations and local residents or government, because in all instances favorable relationships were reported. However, there was a slight tendency for the higher performing associations to indicate a greater rapport. This may indicate more involvement and greater negotiating finesse on their part.

Annual dues are usually charged on a household basis. The rates are low and average $15.00 per year, with the majority charging only $5.00 or $10.00 per household per year. Collection of dues is not a problem, given the generally low rates and high income level of members.

When the associations need extra money for particular projects, they commonly request special contributions from their membership. All associations which have done this, reported that their appeals were highly successful. A few associations maintain special contingency funds for such projects, particularly law suits.

Given the low reported dues rates, most associations have surprisingly large budgets. The average is about $1,600, but the range of annual association incomes extends from $28.00 to $16,000.00.

Ninety-five percent of the sampled lake associations are within one county, and 57 percent are within one township. Most of the sampled lakes are less than 500 acres in size, and the average maximum lake depth (deepest point in the lake) for the sample is 63 feet. The average for the lower performance category is 73 feet. The higher performance group averaged 53 feet at the deepest point. While these depths are significantly different for the two categories, the more important characteristic of most frequent depth of water in the lake (regarding extent of littoral zone) was essentially the same. The indication is that the sampled lakes are relatively shallow and may have rather extensive littoral zones. Bottom type was most often marl and/or soft organic deposits.

The lakes varied in the extend of residential development, from only about a fourth of the available riparian lots built upon, to complete shoreline development plus two or more additional tiers of "back

lots" built upon (250 percent developed). The average extent of development is about 90 percent of the water front lots suitable and available for housing. There is very little back lot development. It was unusual to encounter a lake community in the study where back lot development approached or exceeded half the number of lake front houses. The average lake front lot is 65 feet wide.

Association Characteristics Compared to Performance Score

The only apparent correlation between overall performance and LA characteristics is with respect to community size, the extent of seasonal residents who are active in the association, and association membership in the MLSA.

It may be that an optimum community size exists which is appropriate to self-help lake management. Too small a community may not have a great enough degrading impact on lake quality to arouse attention and/or may lack the resources sufficient to accomplish management. The larger communities may have the greater need for management, but their size and diversity of concerns and priorities can impede organizational efforts.

The negative correlation of seasonal, active residents with performance score indicates the effect the absence of key members can have upon an association. These residents comprise about half the active membership and may be expected to be present in the community only 3 to 6 months of the year. Most seasonal residents arrive and depart the lake within weeks of each other and are usually at the lake only in summer. (Extended lake use due to the growing popularity of winter snowmobiling and progressive retirement "to the lake" of seasonal

residents may change this pattern.) The resultant impact of this residential migratory pattern is obviously an interruption of program continuity. Their absence also diminishes the effect of LA influence on and participation in local government or agency programs.

The strong positive correlation between management performance and MLSA membership is impressive but does not necessarily imply an influence by MLSA on association performance. While this may be the case, it may also be that the more dynamic LAs, particularly those with water quality concerns, are simply more inclined to gather under the rubric of the MLSA.

Summary of Lake Association Water Quality Management Performance

Nutrient and Effluent Abatement

Only 5 of the 21 sampled LAs, all in the HP category, have made any attempt at lawn fertilization abatement, even though this is the most easily implemented of the management options. Most of the associations are aware of the concept of lawn fertilizer impact through either Department of Natural Resources literature or MLSA sponsored material. But they tend to dismiss the effect of such applications as incidental. This is indicated by the observation in Table 3 of only one LA identifying lawn fertilization as a matter of concern, and this association had as yet taken no action itself. Twice LA presidents admitted fertilizing their own waterfront lawns. Apparently the "suburban syndrome" of manicured lawns is stronger than expected. This inclination, together with a prevailing reluctance on the part of most LAs to "interfere" in their members property uses, probably accounts for the negligence in this area.

Marsh protection and consideration of alternatives to septic tank systems has been attempted in each case by 4 LAs, mostly in the HP category. The activity is manifested in association complaints to Public Health, Zoning, and Department of Natural Resources authorities when they hear of sales or proposed fill and construction plans on marsh sites. This activity is expeditious since the LA can assume an environmentally responsible position, while also furthering its self-interests by restricting additional lake development. The limited diligence of LAs in this respect may reflect the success of the Inland Lakes and Streams Act of 1973 (Act 346, 1972), which requires a permit for any dredging or filling activities. However, enough reports of evasion of this law were reported by interviewees to suggest that community monitoring by more LAs is indicated.

The existing waste disposal method for all of the communities studied is on-site septic tank systems with tile fields. In a few households, the distribution system was a dry well. Reported consideration of alternatives to this system by the associations, either actively or incidentally ("some attempt by LA," Table 38), is probably somewhat inflated. It is easy for a respondent to report that his association has "considered" alternatives in response to the interview question. Since the predominant alternative under consideration by the sampled LAs is a municipal sewer system, and since no construction had yet begun, the absence of any evidence of performance is justifiable. The positively responding association representatives all implied active involvement in local planning and requesting of federal funds. But it is suspected that the project often originated with regional or local planning agencies, and that the LAs are in many cases simply responding (both pro and con) to this initiative. Only

one respondent reported considering the self-contained options for waste disposal. Others felt such alternative considerations were contra-indicated until the issue of a municipal sewer was resolved. All LAs, where a sewer system was under consideration, were apprehensive about the property assessments required to pay for it. But, surprisingly, most accept it as worth the cost. Of greater concern seems to be the fear of a building boom following the installation of the sewer. In this respect, one involved association has successfully initiated local township land use planning and ordinances to control the anticipated development.

Diversion of road drains from the lake followed waste disposal alternatives in frequency of performance. Three HPs were actively involved in this area, but two of them were primarily motivated by the condition of eroded and flooded access roads caused by deficient drains, rather than by a paramount concern for lake sedimentation. No agricultural drains were known to enter the lakes investigated.

Only two LAs had an active program of any sort to inform residents and restrict their use of septic tank systems. In both instances, the process consisted only of the occasional circulating of informative literature and "word of mouth" at annual meetings. Interviewees often appeared ill informed with respect to the potential impact of septic tank systems on lake water quality.

Similarly, only two LAs (not coincident with the two LAs referred to immediately above) had made any attempt to upgrade the efficiency of on-site disposal systems. In both cases the procedure simply involved watching for and reporting suspected system malfunctions to the Public

Health Department. The bulk of the LAs indicated, however, that they felt the function of an individual's septic tank system was a private property matter and not their legitimate concern.

Water Quality Investigation

Thirteen of the 21 LAs reported that some form of lake water quality testing, at one time or another and to varying extent, had been conducted on their lakes. But only 7 of these LAs initiated and supported the investigation. The other 6 benefited from independent studies conducted by colleges, the Department of Natural Resources, the local public health department, or by local residents on their own initiative.

The nature of the various sampling approaches includes: unsupervised grab samples taken by householders and submitted to various laboratories for testing; participation in the Department of Natural Resources self-help testing program; contracted lake testing by consultant firms; and lake sampling by university or college personnel as part of ongoing teaching or research activities. The latter approach is the only one, so far, generating an extensive, multi-seasonal body of information about any of the lakes. Four of the 21 LAs interviewed have access to data which includes sampling of multiple areas of their lake over more than two occasions. Two of these associations contracted the research themselves; the other two enjoyed the windfall of being on lakes targeted for university research projects.

Dye testing of household septic tank systems was attempted by two LAs. In each case the association obtained the dye from the health

department and made it available to lake residents on a voluntary basis. No attempt was made to coordinate either program for optimum participation or effluent detection. In both instances few residents elected to test their system, and the sponsoring LA considered the attempt to be unsuccessful.

Symptomatic Lake Management

By far the greatest LA participation in any of the physical management options discussed (as opposed to sociopolitical involvement) is fish management. In most instances this is manifested in stocking of the lake with game fish or sampling of the fish population to determine stocking needs. The LA role is most often that of the petitioner for Department of Natural Resources assistance. However, in two instances the association has assumed the predominant role in stocking and managing the lake's fishery resource. In one case the association president is a department employee, and in the other, a member is a student of fishery biology. The personal contribution of each of these members no doubt enhances the association's performance.

It should be noted that 13 lake associations reported direct involvement in fish management at one time or another, but only 6 regarded this function as an "accomplishment" in the initial open question portion of the interview. This suggests that the respondents may view this as a "service" to their fishermen members (fishing is the most frequently reported lake use), rather than as a primary objective of the association.

Weed and algae control are actively pursued by fewer associations than expected. However, several respondents indicated that they expect to have to deal with vegetation problems in the near future as the weed beds have expanded noticeably in recent years. The same observation was reported with respect to algae blooms on the lakes. No association reported prolonged duration, but the regularity of noticeable algae growth for a few weeks each summer in recent years was a consistent comment.

Limited Department of Natural Resources data for nine lakes, represented by 5 of the LAs, indicates that all are mesotrophic (Mikula, et al, 1976, Annual Report of the Inland Lake Self-Help Program; unpublished data provided by the Inland Lake Management Unit, Michigan Department of Natural Resources). Mesotrophy, in this instance, is defined as lakes from which water samples indicate a Chlorophyll-a concentration of 4 to 10 µg/l and Secchi disc depth reading of 6.5 to 15 feet.

The observations of the respondents together with available water quality data suggest that the lakes sampled may be just now approaching a level of enrichment sufficient to generate physical symptoms graphic enough to stimulate riparian concern. Where weed controls have been attempted, the method used is evenly divided between chemical treatment (2 LAs) and mechanical cutting (2 LAs).

Lake level winter drawdown as a weed control technique has not been attempted by any of the LAs interviewed. In all instances the respondents were unaware of this recently developed approach to weed control. Most of the LAs also lacked the appropriate lake level control structures to accomplish such management.

Sociopolitical Involvement

Clearly the area of greatest activity by the associations, both HP and LP, is in the area of sociopolitical influence on behalf of association interests (Table 38).

This sociopolitical involvement is concentrated in the information and education, economic, and legal functions. These areas of emphasis by both categories of associations, albeit to different degrees, indicate a desire by the LAs to obtain more information pertinent to their resource and related issues and an attempt to utilize those services and institutions available to them.

All of the associations have sought technical assistance in the areas of resource management and/or law enforcement appropriate to the lake environment. Most of the associations regularly invite speakers to their meetings to address issues of concern to the members.

However, the LAs have not fully utilized some of the available services. Of 8 logical resource agencies locally available to the riparian public, only fellow members, the Department of Natural Resources, and Public Health Department have been called upon by as many as half the sampled associations. Particularly underutilized are the services of the Soil Conservation Service and the Michigan State University Cooperative Extension Service. Both agencies have local offices and resource personnel skilled in areas related to problems of lake associations. But, when asked why they had not contacted either, most association representatives expressed either ignorance of the existence of the agencies or the presumption that they did not serve the needs of

lake communities. There is a strong impression among respondents who knew of either agency, that their clientele are strictly limited to members of the agricultural community.

Low recourse to county drain commissioners, on the other hand, would appear to be based on political experience. While the opinion was not universal, many LAs were critical of the priorities and accomplishments of the county drain commissioner's office (or equivalent in the road commission) and indicated a disinclination to pursue this option for resolution of drainage problems.

The two highly involved resource agencies, the Department of Natural Resources and the local Public Health Department, received mixed assessments by the associations. In both cases comments extended from high praise to pointed criticism. Critical LAs were quick to exonerate local personalities and instead laid their blame on agency policy as they perceived it. A common refrain was in essence, "I don't blame so-and-so, he's just trying to do his job, but . . ."

The expressed policy perceptions were generally that the Department of Natural Resources takes an aloof approach to local resource management entirely independent of community concerns. Instead of providing a service to the local community in the management of natural resources, the regional office is seen by many interviewees as an enforcer of remote and inconsiderate state "mandates" inappropriate to their interests or needs.

In the case of public health department criticism, interviewee perceptions are slightly reversed. While they would like the local natural resources agent to be more independent of "state" pressures,

they want the local sanitarian to be more independent of "local" ones. Most critical LAs feel the health department does not adequately enforce the sanitation codes regarding on-site waste disposal. They blame this lack of enforcement on limited manpower and long standing local influence by land development and construction interests.

Closely related to their pursuit of additional information and management assistance, is the attempt by LAs to influence local institutions on their behalf. Most of the associations are very cognizant of the power structure in their community (as indicated by their comments regarding agency performance immediately above) and of their place in that structure. Where they have economic significance via property taxes paid or local purchasing power, they do not hesitate to impress the point on local government in their pursuit of services. They often contribute space, labor, or funds to civic causes and recognize the significance of such activities to the advancement of their interests in the local community. Most LAs reported having at least one member on the township board or similar governing body, and most make it a point to have representatives present at all such governmental meetings.

The major objectives of this civic involvement is the protection of their lake interests. To this end the LAs actively promote local ordinances and enforcement of existing laws, especially those relating to lake use, boating safety, and land use zoning regulations.

The persuasion, public exposure, and political functions (beyond the local setting) are only occasionally employed by the lake associations. This suggests that they are still in the process of establishing their influence within the immediate lake setting and have yet to expand their area of sociopolitical impact.

Objectives, Problems, and Accomplishments of the Associations

Water quality protection is the most frequently stated objective of the sampled lake associations. That they are having difficulty meeting that objective is indicated by their two most prevailing problems of pollution abatement and weed or algae control. Although they appear to recognize lake pollution and enrichment problems, there is a low incidence of any reported accomplishments in these areas of lake water quality management.

One factor related to this low level of reported accomplishment may be that the associations are not yet sufficiently organized to be an effective force for local management. That the lake associations are generally in the formative stages of organization is indicated by the frequency of reported "accomplishments" in organizing and maintaining an association, observed apathy problems reported by the respondents, and the often expressed desire for increased member and resident involvement to improve association performance.

A second implied factor of low water quality management effectiveness is lack of motivation. Most of the respondents appear to be at least vaguely aware of pollution potentials and land use impacts on their lakes but seem somewhat complacent about doing anything so long as the lakes still look good. Appearances, in most instances, are still quite pleasing, and the Department of Natural Resources data mentioned above parallels this observation. It may require massive and frequent algae blooms and extensive weed growth sufficient to impair boating, fishing, and swimming before the associations are motivated to implement water quality management on a serious basis.

Conclusions

1. Much of lake management involves the abatement of cultural eutrophication, and there is much that lake associations, on their own initiative, can do to improve lake water quality. A review of the technical literature documents many of these options which includes effluent abatement, water quality investigation, symptomatic management, and sociopolitical involvement by the LAs to accomplish institutional change.

2. The associations recognize the significance of lake water quality degradation as a present or potential problem and are basically inclined and organized, as issue-oriented bodies, toward self-initiated lake management.

3. However, as a group, the LAs have not approached their potential for self-help lake quality management. This is certainly true of the LPs, and the relatively higher performing associations are also functioning at a level short of that which is economically and physically feasible. This short fall is particularly true with respect to the investigation of lake water quality and the abatement of enriching and polluting influents.

4. Of the lake association characteristics measured, there was little distinction between the HP and the LP associations. In terms of geographic location, social characteristics, finances, population, organization, and physical setting, the HP and LP associations are remarkably homogeneous. This suggests that key elements pertinent to self-help management success either were not measured or are common to both association categories and have not yet been sufficiently exploited.

In particular it is interesting to note that there is no significant difference between HP and LP association budgets or dues rates, even though the average income level of HP members is considerably higher than that of LP members. The failure of these indicators of wealth to correlate with performance score may be because none of the associations have reached a level of management proficiency sufficiently complex or expensive to make the relative difference in individual wealth a significant factor.

5. The association characteristics that do correlate with performance are: size of lake community; percentage of active members who are seasonal residents; and whether or not the association belongs to MLSA. The element of "participation" is common to all three characteristics and suggests that this may be the key factor to emphasize in any program designed to assist lake associations.

6. There are two major elements related to the overall low management performance by the sampled lake associations. The first is a lack of sufficient information and technical assistance with respect to lake issues. The second is member apathy.

The associations are unaware of many management options available to them. This deficiency includes: the causative elements of eutrophication; lake management techniques feasible for local implementation; and awareness of resource services available to them to expedite their programs.

The member apathy problem may be, in part, a common symptom of the early developmental stages of the lake associations; reflecting community inertia to this relatively new institution. As such it

may be overcome by subsequent accomplishments, activities, and recruitment campaigns.

However, this sense of apathy may also result from a conflict between the personal objectives of the lake residents as property owners and their environmental concern for the lake resource. A particular resident may generally concede that his septic tank discharge and lawn fertilizer runoff are bad for the lake. But he may also know that septic tank repairs or sewer service assessments are expensive and that his beautiful lawn is the envy of his neighbors. Personal costs and vanity come up against wise resource management. The alternatives are to make an unpleasant decision or to do nothing. The decision to do nothing, apathy, can be rationalized by convincing one's self that the individual's contribution to the problem is minuscule, especially if residence is only for a few months of the year; that others are not cooperating either; or that little can be accomplished anyway. These presumptions are reinforced by the observed lack of performance on the part of the lake association and the public agencies involved.

Another element contributing to the appearance of apathy may be the temptation to be what Schmid (1976) refers to as a "free rider." Some residents may see lake management by the association as a situation whereby they can benefit from all the advantages of improved water quality resulting from the sacrifices of others, without being inconvenienced at all. The prevailing voluntary membership nature of most associations is conducive to this ploy, and if enough residents adapt the "free rider" attitude, member recruitment and participation by the association will be seriously impaired.

7. The problem of low management performance by the associations is primarily the result of the interaction of limited technical information and assistance with low resident participation in the association. The interchange of these two factors creates a self-perpetuating cycle of inefficient performance.

The presumption by riparians that little can be done by them to manage the lake (caused by insufficient knowledge and a lack of technical assistance on one hand, and a propensity to place self-interest above environmental concern on the other) generates a general sense of apathy in the lake community or association. This attitude in turn handicaps any projects association leaders attempt to implement because they cannot gain majority cooperation. Consequently the management attempt fails. This poor performance substantiates the initial apathetic attitude which becomes a self-fulfilling prophecy.

With the presentation of these conclusions, it is appropriate to review the objectives discussed in Chapter I at the opening of this paper. The first objective, to determine feasible management options for localized implementation, has been accomplished by the presentation in Chapter III and is summarized in conclusion number one above. The second objective, an assessment of the characteristics and performance of LAs, is satisfied by the results presented in Chapter IV and the assessment of those results in this chapter. Chapter VI will include a recommendation for an approach based on the conclusions presented above and is appropriate to the final objective of designing an assistance program for LA self-help management.

CHAPTER VI

RECOMMENDATIONS

The initial premise of this study is that (at least for the short term) lake water quality management is, by default, a community and/or lake association responsibility. It is not the purpose of this study to seek public policy changes to remedy the problem, if indeed there is one, but rather to propose corrective approaches given conditions as they are. Thus, the following recommendations are confined strictly to elements of the localized, self-help approach to lake management.

Further Research

This study constitutes the initial spade work in Michigan lake association research. The 21 interviews conducted have generated some interesting observations but have hardly exhausted the field.

A repetition of this study using a larger sample would help refine the presumptions offered here. Additional areas of inquiry might also be pursued, including the element of MLSA influence on LA performance; the educational background of association members and officers; community size characteristics; and the degree and nature of administrative organization adopted by the LAs, particularly with regard to the authority they assume. The Upper Peninsula of Michigan and the Detroit metropolitan area were excluded from this study and deserve investigation as geographic entities themselves.

By using this study as a base for further research, comparisons can be made between the characteristics of Michigan and Wisconsin LAs. Knowledge of the similarities and distinctions of lake communities in the two states could have a bearing on the extent to which research conducted in either state is applied locally. The information so far collected in this investigation is also pertinent as a benchmark against which future studies may be compared to assess changing attitudes or performance of Michigan associations.

Further investigation of the literature with regard to feasible management options available to the LAs is obviously indicated. The framework presented in this study demonstrates that self-help options are available. There is little question that these options, as research progresses, are also subject to change and are expandable.

In particular, the concept of using phreatophytic vegetation as a lake shore buffer zone is an intriguing management concept. The idea of preserving the natural shore line vegetation has long been espoused in Department of Natural Resources extension pamphlets, but a review of the literature indicated no clear cut proposals adapting the concept, as a form of lake management, to enhance the quality of drainage waters entering developed lakes. Inquiry of the sampled LAs revealed no utilization of the concept at all on a lake wide basis. Because the idea is believed to have merit and, if feasible, would be highly appropriate to self-help lake management, a description of the process and list of suggested plantings is included in Appendix E.

A Proposed General Assistance Plan for Lake Association Self-Help Management

Some suggestions for additional research into self-help LA management have been indicated above, but the information thus far obtained is sufficient to justify a pilot project intended to remedy the impediment to better management created by the information-apathy problem.

The conclusions of this research suggest that self-help options do exist permitting lake residents to accomplish management of their own initiative. It is also evident that they recognize water quality degradation as a significant problem and have not yet approached their potential for self-help management in this regard. The means for localized management exist and a need for assistance is evident. The correlations between relative performance and association characteristics suggests that a key factor of self-help management performance is resident participation. Another element of LA management inefficiency is apparently the problem of the interrelated effect of insufficient information on one hand and member apathy on the other. The key to solving this problem is, therefore, increased participation in a significant way by lake residents and the provision of more technical information demonstrating that they can accomplish localized management. Sufficient information and technical assistance from regional agencies should enhance the potential for localized management success. This project success together with demonstrated meaningful resident participation in the decision-making process should do much to break the information-apathy cycle.

If lake quality is to be efficiently managed, the local residents must be actively involved in that management. They must fully cooperate

in the financial support of management programs (the lack of funds is one reason why publicly administered lake management has not progressed further) and in the changing of individual land use practices contributing to cultural eutrophication and pollution. Recognition of this prerequisite of local involvement is inherent in Wisconsin's management program administered on a regional "lake district" basis (Klessig, 1976), and in Michigan's Inland Lake Improvement Act (Act 345, 1966 as amended, 1975) which authorizes individual lake management boards.

While the idea of local citizen involvement should be recognized as essential to Michigan inland lake management, the instrument selected by the state to achieve this has not accomplished adequate results. Since 1966, only 22 lake boards have formed in Michigan, of these at least nine are no longer active (Department of Natural Resources mimeo by L. A. Cook), and a member of the Department of Natural Resources Inland Lake Unit reported that he believed only 5 lake boards were still active as of December 1976. Consequently, the Department is now considering legislation intended to replace Act 345.

The primary deficiency of Act 345, in this writer's opinion, is that it does not allow sufficient local resident involvement. It creates an administrative body to manage a given lake resource, including the authority to levy property assessments to pay for that management, but the only authorized riparian involvement is to petition for the initial creation of the Lake Board. Board membership, the decision-making body, excludes local lake residents unless they happen to be affiliated with local government. Its authorized composition is: a representative of the county board of commissioners, a representative of each unit of local government, the drain commissioner

or his equivalent, and a representative of the Department of Natural Resources.

Given the expressed resentment of centralized authority observed in the course of this research, it is not surprising that lake community residents have failed to support a management program in which their participation is essentially restricted to paying the bills.

A program more conducive to success is one in which much of the decision-making authority starts with, and remains with, the lake community. Under such a program, the role of governmental and resource agencies would be more advisory than administrative.

The charge of riparian responsibility to participate in lake management can be justified on the basis of Aldo Leopold's stewardship philosophy alone. There is, however, a very pragmatic reason for pursuing this premise. As mentioned earlier, most lake degradation and eutrophication is the direct result of man's influence on that environment. Lake problems develop and management becomes necessary because of the strain and abuse imposed upon the lake setting by man's use of it. Most management, therefore, is essentially the changing of human behavior and the treatment of the natural environment to correct damages caused by that behavior. Thus, the people with the greatest responsibility to change their behavior and do something about its impact are those who use and benefit from the lake the most. Lake community residents are certainly among those people.

While the paramount concern of this paper is water quality management, this proposed assistance plan is designed to accommodate the necessary response to any problem area identified by the participating residents. This generalized paradigm is thus applicable to

the variety of objectives and problems identified by lake associations (Tables 2 and 3). However, it is still pertinent to lake water quality management, since sooner or later and to one degree or another, all lake communities will have to deal with this problem.

The essence of this self-help management concept then is for the lake community, via the lake association, to assume the initiative in the recognition, evaluation, and solution of their problems. To this end they have a right and responsibility to enlist the assistance of local public agencies. By initiating this process at the local level and keeping it there, the lake community enhances its potential to retain control over its own affairs. This is important if local citizen involvement, essential to any self-help program's success, is to remain viable.

The vehicle proposed for implementing this self-help process is a regularly meeting committee or consortium consisting of: 1) local lake association representatives responsible for presenting the problems of their community; 2) representatives of local government and public agencies recognized as pertinent to the given problem and invited to cooperate in its solution; 3) the County Cooperative Extension Service Director or Agent as coordinator; and 4) appropriate university specialists available to the group through the Michigan State University Cooperative Extension Service (CES).

The extension service director or agent is a logical choice for the function of coordinator since the CES is an agency charged with the responsibility of informing and assisting the local public. The apolitical nature of the CES and its recognized experience in community relations further recommends it to this function.

Through introduction by the county agent or director, the concept of assuming local lake management responsibility can be presented to a given, concerned lake association. The procedure for such managerial self-help follows the traditional cyclic format of: 1) research; 2) plan; 3) program implementation; and 4) assessment, with a return full cycle to research. The proposed steps for implementation are as follows:

1. Consultation between the CES agent or director and a trained lake management specialist to ascertain whether the procedure is feasible for the given lake community. If either of these two key individuals (the one knowledgeable about the community, the other about the lake resource) is reluctant to initiate a self-help program, the matter should be resolved before broaching the idea with the lake association. This is necessary to avoid raising false expectations or inviting defeat if the probability of accomplishment is low.

The major elements these two functionaries should consider in their deliberations are the subject lake associations' sense of commitment and its determination to see a task through. Does it appear capable of inducing its members to active participation in projects? Does it demonstrate the determination to confront and persuade recalcitrant local government or agency heads to provide the necessary services and regulatory enforcement?

In the course of their consultation both men may conclude that sufficient information doesn't exist to make this decision about feasibility. In this case stratified random interviews in the community and lake association may be indicated. An interview framework incorporating elements of Appendix A would provide adequate information

to assess existing and potential promise of community participation. Included in the course of such conversations should be the direct questioning of individuals as to their feelings about such a project. Subjects interviewed should include not only local householders but officers of the lake association and heads of local government. In keeping with the earlier admonition, some degree of evasiveness may be required in order to gain the initial information without implying the promise of starting a self-help program.

2. Consultation between the CES agent, lake specialists, and officers of the lake association. If the decision in step one is positive, a meeting with the officers of the lake association should be held at which time the technique of the program and its feasibility is discussed with them. Again, the two key factors of commitment and determination should be discussed. The two specialists may or may not reveal their prior determinations, but these points should be addressed by the association officers, their obligations fully recognized, and a firm decision made by them.

3. If the association officers conclude that the self-help management approach is viable for their lake, the matter should be presented to the general membership for a referendum.

This emphasis at three different points on a commitment by those involved is imperative because the key to success or failure of the self-help approach lies in the willingness of the majority to become involved.

It should be clearly explained before the referendum that the members are designating their representatives to work out a series of management plans which, if adopted by the association, will commit

them all to participation, which could involve personal financial expenditure and restrictions on private property uses. Further, the association's engagement of local government and agencies in the management program is a two-edged sword. While services and assistance may be obtained from these institutions, previously lax enforcement of regulations, laws, or assessments (advantageous to lake residents) might also change.

4. If the referendum supports the self-help proposal, the next step is information gathering. Since the whole idea of the self-help management concept is problem solving, the first order of business is to determine what problems are paramount in the minds of lake residents.

To this end a questionnaire should be prepared and circulated by the lake association to as many residents as possible. (A highly successful application of this technique has been conducted at Long Lake, Grand Traverse County by Dr. C. R. Humphrys of the Michigan State University Department of Resource Development, East Lansing.) The questionnaire used could be as simple as: 1) What do you think are the major problems on this lake? and 2) What do you think could be done to solve these problems?

5. Problem identification and assignment of priorities are then possible based on the information collected in step four. The lake association should consider three questions in determining project priorities. First, what problem is most frequently recognized by the residents? Presumably those problems commanding majority recognition, all other things considered equal, will also receive majority support for solution. Second, what problem(s) can be most easily solved? There is something to be said for starting off with

the easier tasks first and building up experience before taking on the hard ones. Also, initial successes provide confidence and incentive to the program. Third, what problem(s), if solved, will have the greatest beneficial effect upon the lake resource and community?

6. Based on the problems chosen, the lake association should select members for the management committee. These individuals (designated to at least an annual term for performance continuity), in consultation with the CES agent and appropriate university specialists for that set of problems, will then determine what other local government or agency members to invite to join the committee.

Likely candidates under most circumstances would be township and city or village officials, at least one representative from the county government, and, if possible, a member of the county or regional planning staff.

Other agencies which are likely to become involved at one time or another are: the County Drain Commission, Road Commission, and Public Health Department; Regional or field offices of the Michigan Department of Natural Resources, and Department of Public Health; and the District Conservationist of the USDA Soil Conservation Service.

It may also be advisable to establish a permanent lake quality component of the committee dealing with water quality management since this problem by nature requires continuous attention in the form of water quality monitoring, effluent investigation, and discharge abatement programs.

The process of determining committee composition may become a recurrent challenge to the lake association. Some regional agency

heads, for political or personal reasons, may be reluctant to participate. If their office is significant to the particular management program, they may have to be coerced into the operation. This being accomplished, these reluctant participants may still resist proposals offered or provide minimal cooperation if they perceive the project in a negative light with respect to their personal, political, or professional objectives. Under these circumstances, the association's original sense of commitment and determination may be sorely tested.

An appropriate response, should such difficulties evolve, is the careful investigation of that agency's professed and documented mandate. If a case can be built for cooperation with the project, the recalcitrant executive can be challenged to perform his duty. Further resistance may be combated by public exposure of the issue. In fact, all operations of the committee should, from the start, be open and well publicized in the community.

7. Discussion of options and development of a management plan. Once the committee composition is determined with respect to the current objectives, the members can begin discussion of the management options available to them; the merits and consequences of each; and the resources available to bring to bear on the problem(s). They may then weigh their alternatives, select the most promising approach, and develop a plan of action.

8. The lake community should then be informed of the particular management plan proposed and be given the opportunity to respond at a public hearing. This step is the essential "feedback loop" in the decision-making process and may result in revision or modification of the plan depending upon the community response.

An appropriate mechanism for the public hearing might be a general meeting of the lake association. At this meeting, the committee or its designated representatives should be present to explain the plan and respond to questions. By combining the hearing and lake association meeting, the opportunity is also provided to expand the association's membership. The more residents the association can gain, the stronger the community sense of commitment may become and the greater the individual rates of participation in the management projects may be.

9. Implementation of the program may now proceed according to the proposed or possibly revised management plan.

10. The final step is a subsequent assessment of the management program and its modification as logistics dictate, or termination when the original problem has been remedied. (Note: Reference throughout has been to "problems," obviously this same approach can be used to implement "improvements," "objectives," or "innovations" not necessarily involving a remedial approach.)

The management cycle has now been completed. Attention may now be directed to other issues and the process repeated by starting again at either step one or step five depending on the nature of the issue.

It may be noted by the reader that this proposed approach implies a conflict between some Michigan public agencies and lake residents. "Conflict" is perhaps too strong a term, but a disparity in objectives and priorities does appear to exist as indicated by the interview data and observations. It is this relative gap between public agencies and lake residents which distinguishes the institutional environment of Wisconsin and Michigan inland lake management programs.

Personal experience and Klessig's 1976 paper both suggest a condition of relative mutual cooperation arrived at by the Wisconsin Department of Natural Resources, Cooperative Extension Service, and lake community. In particular, the two agencies seem to have made considerable progress toward joint cooperation, as indicated by their many co-sponsored projects especially the Inland Lakes Demonstration Project of 1974. This cooperation between the primarily technical (DNR) and primarily social (CES) ramifications of lake management has permitted the broad institutionalization of lake management adopted by Wisconsin's "Lake District" framework. Confidence in this bureaucratic cooperation may be an element which permits Wisconsin to readily admit lake residents as a third party to the decision-making process.

Michigan, in this writer's opinion, has yet to approximate Wisconsin's level of cooperation or accomplishment with respect to lake management. The development of the Inland Lake Unit indicates progress, but a broad disparity still exists between CES and DNR information projects.

Given this distinction in evolved cooperation for lake management between the two states, the above proposal has been offered as a stimulus toward more complete lake management in Michigan. Where Wisconsin appears to have approached full involvement in inland lake management via bureaucratic inducement of lake community involvement, it may be that Michigan will have to approach it by lake community inducement of the bureaucracy.

APPENDICES

APPENDIX A

THE STANDARDIZED QUESTIONNAIRE USED IN THE PERSONAL INTERVIEWS WITH LAKE ASSOCIATIONS

TELEPHONE INTERVIEW REQUEST

Name of Lake Association: _____

Lake: _____ County: _____

Name of Association President: _____

Address (home): _____

_____

_____

Phone: _____

Address (lake): _____

_____

_____

Phone: _____

Corrections: _____

_____

_____

_____

Interview date & time: _____

Interview address: _____

_____

_____

Materials Requested:

Articles of Incorporation _____

Bylaws & Regulations _____

Annual Reports _____

Notes or Comments:

INTERVIEW FORM, LAKE ASSOCIATION WATER QUALITY MANAGEMENT

Date: _____ Time begin _____ Time end _____

Location of Interview: _____

_____

_____

Name of Lake: _____

Name of Association: _____

Interviewee: _____

Materials:

Articles of Incorporation _____

Bylaws & Regulations _____

Annual Reports _____

Interviewer(s): _____

_____

INTERVIEW FRAMEWORK

I. OPEN QUESTIONS

1. a) Please list five (or less) objectives of your lake association.

_____

_____

_____

_____

_____

b) Please rank these objectives in order of importance.

2. a) Please list five (or less) problems currently facing your association.

_____

_____

_____

_____

_____

b) Please rank these problems in order of importance.

3. a) Do you have any water quality problems? What are they? Causes?

_____

_____

_____

_____

_____

b) Please rank these in order of importance. How do they rank re: the problems you mentioned above?

4. a) Please list the accomplishments of your association.

_____

_____

_____

_____

_____

b) Please rank these accomplishments in order of importance.

5. Do you feel your association is necessary and meaningful? i.e., that it is beneficial to the lake and residents and that without the association things would be worse for both.

_____

_____

_____

_____

6. What, if anything, do you think would help improve your association's performance?

_____

_____

_____

_____

II. ORGANIZATION AND PARTICIPATION

1. When was your lake association formed?

   Unofficially _____ Incorporated _____

   Any interruptions in the existence of the association since first formed? _____

2. Type of enabling legislation _____

3. Membership:

   a) Size of the lake community, i.e., households directly associated with the lake by riparian or access right, or within 1/4 mile of the lake shore.

      Individuals _____ Households _____

   b) Total number of members in the association.

      Individuals _____ Households _____

   c) Number of active members in the association.

      Individuals _____ Households _____

   d) What percent of the total association membership are seasonal lake residents? _____ What percent of the active membership are seasonal residents? _____

4. How often are general membership meetings held? _____

   Average attendance? _____

5. Are there any other associations on the lake? _____

   If so:

   a) How many? _____

   b) Why? _____

c) Can you estimate their membership? _____

_____

d) Are they very active? _____

_____

e) Is there a system of cooperation (unity) among the associations on the lake? _____

_____

6. What is your association's relationship with the local community; residents and officials?

	Residents	Officials
Very good, much cooperation & common activities	☐	☐
Generally friendly, but separate interests & little involvement with each other	☐	☐
Distant, other than occasional conflicts on issues	☐	☐
Frequent conflicts & bad feelings	☐	☐

7. Does your association sponsor social activities attractive to the members? _____ Examples & frequency _____

_____

8. What is most effective in keeping your membership active?

Issues & projects ☐

Social events ☐

III. MEMBERS

1. Would you please estimate the average income of your association's members.

Less than $2,000 per year	☐	> $15,000 - $20,000	☐
$2,000 - $5,000	☐	> $20,000 - $30,000	☐
> $5,000 - $10,000	☐	> $30,000 - $40,000	☐
> $10,000 - $15,000	☐	Greater than $40,000	☐

How does this income compare with the rest of the lake community?

Higher ☐ Similar ☐ Lower ☐

2. What percent of your membership would you estimate are living on a retirement income? _____

_____

3. Does your association have problems with membership apathy ____

_____ Why? _____

_____

4. Do the members get along well with each other personally? _____

_____ Why? _____

_____

5. Do they get along well with respect to lake association issues and business? _____ Why? _____

_____

IV. LAKE ASSOCIATION FINANCES

1. What are your association's annual dues? _____

   Are members prompt in payment? _____

2. Do you have other sources of income? _____

   Fund-raising projects, special assessments? (List.) _____

   _____

   _____

   _____

   _____

   How often? _____

   _____

   Successful? _____

   _____

   _____

   _____

3. Would you mind telling me your annual budget? (If object, perhaps a rough figure?) _____

   _____

   Has it recently changed? Up or down? _____

   Why? _____

V. LAKE CHARACTERISTICS

1. Size of lake _____ acres; maximum depth _____ feet

   Most of the lake is _____ feet deep (phototrophic zone)

2. Bottom type is mostly _____ (siltation)

3. a) Extent of development on lake: To what extent would you estimate your lake shore to be developed?

≤ 25% _____

26 - 50% _____

51 - 75% _____

76 - 100% _____

> 100% _____; number of tiers of housing back from the lake _____

b) What is the average front footage per lot? _____

c) Comments: _____

_____

_____

_____

4. Is your lake entirely within one county? _____

_____ One township? _____

_____

5. What is the most popular use on your lake? _____

_____

_____

6. What types of fish are most often caught from your lake?

	Game fish?	Pan fish?
Species:	_____	_____
	_____	_____
Size:	_____	_____
	_____	_____
Abundance:	_____	_____
	_____	_____
	_____	_____
Comments:	_____	_____
	_____	_____
	_____	_____
	_____	_____

VI. WATER QUALITY PERFORMANCE

A. Symptomatic Management:

1. Have any fish management programs been initiated on your lake? _____

_____

Association role in fish management efforts. _____

_____

2. Do you have algae problems on the lake? _____

If yes:

a) Algae blooms have been occurring since _____(year)

b) Extent (% of lake involved) and location in the lake: _____

_____

c) Type of algae, if known _____

3. Does your association have an algae control program? _____

Other sponsor? _____

If yes:

a) What method of control is used (chemicals)? _____

_____

b) How many years has the program been in effect? ____

_____

c) Is treatment necessary every year? _____

_____

d) How often per season? _____

_____

e) Cost per treatment? _____

4. Do you have weed problems on the lake? _____

If yes:

a) Has been a problem since _____

b) Extent (% of lake involved) and location _____

_____

_____

5. Does your association have a weed control program? _____

_____ Other sponsor? _____

If yes:

a) What method(s)? _____

_____

b) How many years has the program been in effect? ____

c) Is treatment necessary every year? _____

d) How often per season? _____

e) Cost per treatment? _____

f) Effectiveness? _____

6. Has winter drawdown of the lake level been considered or practiced as a means of weed control? (How much?) _____

If not, why? (can lake be lowered, riparian objections)

If drawdown, any ancillary projects with it? _____

7. Any other management procedures attempted on the lake? i.e., dredging, shading, sand blankets, etc. _____

B. Investigation:

1. Does your lake have a water quality testing program? Sponsored by the association? Encouraged by the association? _____

What tests are run? _____

Who conducts the tests? _____

How many samples each time? _____

Where are they taken? (Sampling methodology?, G/W?) _____

_____

_____

_____

How often? _____

_____

_____

2. Do you have a septic tank dye testing program and/or inspections? Sponsored by the association? Encouraged by the association? _____

_____

_____

Who conducts the tests or inspections? _____

_____

_____

How often? _____

_____

_____

When? (Best in summer) _____

_____

Results? (Successful detections and corrections) _____

_____

_____

3. Are there any other testing or investigative procedures conducted on the lake? _____

_____

_____

_____

Who does the testing or investigating? _____

_____

_____

Comments: _____

_____

_____

_____

C. Action Programs for Nutrient and Influent Abatement:

1. Is the waste disposal system on your lake sewers or septic tanks? _____

   Other? _____

   If sewer system, what was the association's role in initiation? _____

   _____

   Why? _____

   _____

2. If septic tanks; ask questions 2-4.

   Do you actively promote regular pumping and maintenance?

   (Pumped how often?) _____

   _____

   How do you promote this? _____

   _____

   Do you encourage improvements? _____

   a) Dosage chambers? _____

   b) Expansion or relocation of drain fields _____

   _____

   Success? _____

   _____

3. Are residents informed or regulated in any way with respect to septic tank system operational restraints? _____

   a) Diversion of roof and footing drains to dry wells or surface discharge away from septic system _____

   b) No garbage disposals, dishwashers, or washing machines or curtailed use _____

   _____

   c) General water conserving methods? _____

   _____

4. Have you discussed or implemented proposals to switch to alternative waste disposal methods?

   a) Holding tanks _____

   _____

   b) Incinerator toilets _____

   c) Self contained units _____

   d) Sewage system _____

   _____

e) Other _____

Why? _____

_____

5. Is there a program to reduce or prevent all-together the use of fertilizers on lake residents' lawns and gardens?

Awareness? _____

_____

a) Any encouragement of resident waterfowl on lake? ____

_____

6. Do you encourage the preservation of natural vegetation along the shore as opposed to lawns right down to the water's edge? _____

_____

Why? _____

How? _____

7. Do you have any erosion or sediment problems? _____

_____

If so, who is working on it? _____

_____

_____

_____

8. Are there any marshes on or draining into the lake? _____

If so, who is working to protect and preserve them or is attitude for drain/fill because of mosquitoes, or other reasons? _____

_____

_____

9. Are there any agricultural or road drains entering the lake or its tributaries? _____

_____

Any attempt to correct or improve them? _____

_____

By whom? _____

_____

VII. ENFORCEMENT AND TECHNICAL ASSISTANCE

1. With respect to your association bylaws, regulations, or programs, is there any problem with compliance? _____

   If yes, please specify which regulations or programs _____

   _____

   _____

   _____

   Why? _____

   _____

2. Are there any state or municipal laws or codes applying to your lake that are not generally complied with? _____

   If yes, please specify _____

   _____

   _____

   _____

   Why? _____

   _____

   _____

3. Has your association sought technical assistance from any of the following sources?

Agency	Frequency of Contact				Comments (Reasons, Satisfaction)
	Often	Occas.	Once	None	
S.C.S.					
Ext. Ser.					
Univ. Pers.					
Drain Comm.					
D.N.R.					
Public Health					
L.A. Members					
Comm. Firms.					
_____					
_____					

4. Does your association have legal counsel? _____

VIII. SOCIOPOLITICAL MOBILIZATION

(Extension of the association's impact outside of its immediate sphere of influence, i.e., pressing for legislation in its interests, persuasion, etc.)

1. Information, Education, and Persuasion

   a) Does your association sponsor public speakers on issues of interest or importance to your members? _____

   _____

   What topics? _____

   _____

   How often in the last 5 years? _____

   _____

   b) Do you have your own newsletter? _____

   If so, how often does it come out? _____

   _____

   When started _____ Continuous? _____

   _____

   What topics does it cover? _____

   _____

   Circulation? (Just members? Others in community, etc.)

   _____

   _____

2. Public Exposure Function

   a) Does your association express its position on local issues involving the lake in the editorial section of local papers? _____

   _____

   If yes, how often in how many years? _____

   _____

   b) Have you promoted local newspaper feature articles on your lake or association? _____

   _____

   c) "Spots" or features on local TV or radio? _____

   _____

3. Economic Function

   a) Do you feel your association contributes significantly to the local economy? _____

   What percent of retail sales and service? _____

   _____

What percent of the local tax revenue do you provide?

Have you considered the significance of this to your dealings with the local government?

b) Are any of your members or associates influential in the local community, i.e., businessmen, church members, etc.?

If so, is this of any assistance to you as an organization?

4. Legal Function

a) Does your association actively push for enforcement of municipal laws and regulations in your interests, i.e., housing and development ordinances, public health laws, Inland Lakes and Streams Act (Act 346, 1972) or the Sedimentation Control Law (Act 347, 1972)? Please give examples.

b) Has your association been engaged in any court suits or threatened legal action? Please explain.

5. Political Function

a) To what extent do your members claim a voting residence at the lake in order to participate in local decision making and elections?

b) Do any members belong to the local government as elected or appointed officials?

c) Do association representatives regularly attend local meetings and hearings on behalf of the association?

d) Does your association, as an official body or its members as constituents, maintain regular communications with state legislators?

e) Has your association ever engaged in letter writing campaigns to politicians or other decision makers over issues pertinent to your interests? Comments:

f) What is your opinion of the Michigan Lake and Stream Associations, Inc.? (Recognized as a real or potential lobbying instrument? Source of information?)

Does your association belong to MLSA?

IX. REASSESSMENT BY INTERVIEWEE

1. In reflecting on our discussion, are there any additions or changes you would make in your association's objectives, problems, or accomplishments listed at the start?

APPENDIX B

ASSESSMENT FORM USED TO EVALUATE LAKE ASSOCIATION MANAGEMENT PERFORMANCE.
The Performance Score is Based on Accumulated Points.
Possible Points for Each Aspect of Performance Are Indicated in Parentheses.

PERFORMANCE ASSESSMENT

Lake Association _____ Region _____ County _____

I. Investigation and Symptomatic Management	No Problem	Other Program	Lake Association Involved	Lake Association Program Completed	Attempted	In Effect	None	Points
1. Fish Management (5)								
2. Algae (5)								
3. Weeds (5)								
4. Winter Drawdown (5)								
5. Water Quality Testing								
- Nutrients (5)								
- Bacteria (5)								
- Groundwater (5)								
6. Dye Test (10)								
7. Other Investigations								
II. Influent Abatement								
1. Sewage Treatment Plant (10)								
2. Septic Tank Servicing (10)								
3. Septic Tank Information and Regulation (5)								
4. Alternative Disposal Methods (2)								
5. Lawn Fertilization Prohibition (20)								
6. Vegetative Buffer Zone (5)								
7. Marsh Protection (5)								
8. Agricultural Drain Abatement (2)								
9. Road Drain Abatement (2)								
III. Technical Assistance								
1. Resources Consulted (14 or 2 each)								
2. Legal Council (2)								
IV. Socio-Political Mobilization								
Information Function								
1. Speakers (2)								
2. Newsletter (2)								

PERFORMANCE ASSESSMENT (Continued)

Lake Association _____ Region _____ County _____

IV. (Continued)	No Problem	Other Program	Lake Association Involved	Lake Association Program				Points
Exposure Function				Completed	Attempted	In Effect	None	
1. Editorials (2)								
2. Feature Articles (2)								
3. Radio-Television (2)								
Economic Function								
1. Knowledge of sales contribution (2)								
2. Knowledge of tax contribution (2)								
3. Application regarding township government (2)								
Legal Function								
1. Enforcement of regulations or laws (5)								
2. Court action or threat of (2)								
Political Function								
1. Voting residence (2)								
2. Elected or appointed officials (2)								
3. Attendance at township meetings (10)								
4. Communication with state legislators (2)								
5. Letter or phone campaigns (2)								

APPENDIX C

HERBICIDES REGISTERED WITH THE MICHIGAN DEPARTMENT OF AGRICULTURE, AND THE ENVIRONMENTAL PROTECTION AGENCY FOR USE IN THE AQUATIC ENVIRONMENT

Herbicides registered with the Michigan Department of Agriculture, and the Environmental Protection Agency for use in the aquatic environment.

Brand Name	Manufacturer	Percent Active Ingredient	Liquid or Granular
COPPER SULFATE PRODUCTS			
Cito Copper Sulfate	Cities Service Co.	99.0%	G
E-Z Flo MO Copper Sulfate	E-Z Flo Chemical Co.	99.0%	G
Haviland Copper Sulfate	Haviland Agricultural Chemical Co.	99.0%	G
Rootex	Relance Chemicals Corp.	86.2%	G
Envirocap - C	3 - M Co.	5.3%	G
Diamond Copper Sulfate	United Co-operatives Inc.	99.0%	G
CHELATED COPPER PRODUCTS			
A & V - 70	A and V Inc.	1.8%	G
A & V - 70	A and V Inc.	7.0%	L
Cutrine	Applied Biochemists Inc.	1.1%	G
Cutrine	Applied Biochemists Inc.	7.1%	L
Cutrine - Plus	Applied Biochemists Inc.	9.0%	L
Cutrine - Plus	Applied Biochemists Inc.	3.7%	G
KS - 9	Aqualar	7.0%	L
Sequestrine Copper	Geigy Agricultural Chemicals	13.0%	G
Mogul 7431	Mogul Corporation	7.1%	L
Purina Algae Check	Ralston Purina Co.	5.0%	L
Herbicide System M	3 - M Co.	55.8%	G
Moriner System A	3 - M Co.	7.0%	L
Algae - Rhap Cu-7	Transvaal Inc.	7.0%	L

Brand Name	Manufacturer	Percent Active Ingredient	Liquid or Granular
ENDOTHALL PRODUCTS			
Mogul AG - 434	Mogul Corp.	66.7%	L
Mogul AG - 432	Mogul Corp.	40.3%	L
Mogul A - 433	Mogul Corp.	10.1%	G
Mogul A - 435	Mogul Corp.	17.5%	G
Aquathol Granular	Pennwalt Corp.	10.1%	G
Aquathol K	Pennwalt Corp.	40.3%	L
Potassium Endothall	Pennwalt Corp.	40.3%	L
Hydrothol 47 Granular	Pennwalt Corp.	17.5%	G
Hydrothol 47	Pennwalt Corp.	66.7%	L
3-M Brand System E	3 - M Co.	22.1%	G
ENDOTHALL & SILVER PRODUCTS*			
Mogul AG-436	Mogul Corp.	22.1% Endothall 25.3% Silvex	L
Mogul A-437	Mogul Corp.	5.1 Endothall 5.6% Silvex	G
Aquathol Plus	Pennwalt Corp.	22.1% Endothall 25.3% ilvex	L
Aquathol Plus Granular	Pennsalt Chemicals Corp. (Pennwalt Corp.)	5.1% Endothall 5.6% Silvex	G
SILVEX PRODUCTS*			
Kuron Low Volatile Brush and Weed Herbicide	Dow Chemical Co.	69.2%	L
Aquavex	Pennwalt Corp.	60.0%	L

Brand Name	Manufacturer	Percent Active Ingredient	Liquid or Granular
Aquavex Granular	Pennwalt Corp.	22.8%	G
Visko-Rhap Low Volatile Ester 2TP	Rhodia Inc.	34.7%	L
Ded - Weed Silvex LV	Thompson-Hayward Chemical Co.	64.0%	L
DIQUAT PRODUCTS			
Aqua - Kleen	Abbott Supply Co.	1.85%	L
Agro - Chem Aqua - Kill #101	Agro-Chem Inc.	1.85%	L
Diquat	Allied Chemical Co.	35.3%	L
A.R.C. DR-AC	American Research Corp.	1.85%	L
Ortho - Diquat Water Weed Killer	Chevron Chemical Co.	35.3%	L
Aquatate	Certified Laboratories Inc.	1.85%	L
Del Aquatic Weed Killer	DEA Chemical Corp.	4.35%	L
Globe Eradicate	Globe Chemicals Inc.	1.85%	L
Liquid Vegetation Control	Lad Chemicals	1.85%	L
Le Bro Liquid Vegetation Control	Le Bro Chemical Co.	1.85%	L
ConKill	Lion Industrial Chemical Corp.	1.85%	L
Aqua - Kill M	Modern Research Corporation	1.85%	L
Aqua - Kill	Muni Chem Corp.	4.35%	L
Watrol Herbicide	National Chemsearch Corp.	1.85%	L
Di - Kill	Precision Laboratories Inc.	1.85%	L
Veg - Go	Scientific International Research Inc.	1.85%	L
Super Aquatic Weed Control	Shore Corp.	1.85%	L
Statebrand Formula 268 Aqua-Guat	State Chemical Mfg. Co.	2.36%	L

Brand Name	Manufacturer	Percent Active Ingredient	Liquid or Granular
Thoroughbred Liquid Vegetation Control	Thoroughbred Chemical Corp.	1.85%	L
Envirocop - D	3 - M Co.	17.4%	G
2,4 - D PRODUCTS			
Aqua - Kleen 20	Amchem Products Inc.	20.0%	G
Amoco 2,4 - D Granules	American Oil Co.	31.1%	G
Amoco 2,4 - D LV Ester	American Oil Co.	69.7%	L
Aquacide	Aquacide Co.	20.0%	G
Crop Rider 20% Aqua Granular	Diamond Shamrock Chemical Co.	30.2%	G
Hercules Weed - Rhap Amine A-4D	Hercules Inc.	49.5%	L
Hercules Weed - Rhap LV Ester 4D	Hercules Inc.	69.9%	L
Hercules Weed - Rhap Amine A-60	Hercules Inc.	69.1%	L
Hercules Weed - Rhap LV Granular D	Hercules Inc.	30.2%	G
Hercules Weed - Rhap LV Ester 6D	Hercules Inc.	94.2%	L
Hercules Visko Rhap LV Ester 2D	Hercules Inc.	36.6%	L
Parsons 2,4 - D Granules	Parsons Chemical Works	30.1%	G
Chipman 2,4 - D Gran. 20	Rhodia Inc.	30.2%	G
Rhodia Visko - Rhap LV Ester 2D	Rhodia Inc.	37.1%	L
Weed - Rhap 2,4 - D Amine A-4D	Transvaal Inc.	49.5%	L
Weed - Rhap LV - 4D	Transvaal Inc.	69.9%	L
Weed Rhap A - 6 D	Transvaal Inc.	69.1%	L
Weed Rhap Low Volatile Granular D	Transvaal Inc.	30.2%	G

Brand Name	Manufacturer	Percent Active Ingredient	Liquid or Granular
SIMAZINE PRODUCTS**			
Aquazine	Ciba - Geigy Corp.	80.0%	G

* Even though these products are registered for use in the aquatic environment, the Inland Lakes Management Section, DNR will not issue permits for their use.

** For use only in small private ponds without an outlet.

This listing has been prepared by the Inland Lakes Management Unit as a public service based on information currently available. Listing or omission should not be construed as an endorsement or disapproval of services offered.

APPENDIX D

RECOGNIZED PROBLEMS OF MICHIGAN LAKE ASSOCIATIONS

Separate research which correlates with this study was also conducted in the summer of 1976. The Michigan Lake and Stream Associations, Inc. circulated a questionnaire among its member lake associations asking them to list the problems they each face. Forty questionnaires were returned of 150 mailed.

At the same time, the Department of Resource Development, Michigan State University circulated a mail questionnaire to regional resource managers in 23 inland lake counties throughout the state. Forty-nine questionnaires were returned of the 83 mailed. In neither the MLSA or resource manager surveys was a follow-up conducted.

Results of the two studies are presented on the following pages for comparison to the data collected by this project. The final page of this appendix presents a comparison of the frequencies of observed lake problems from the three information sources.

LAKE PROBLEMS RECOGNIZED BY REPRESENTATIVES OF 21 LAKE ASSOCIATIONS INTERVIEWED, SUMMER 1976

PROBLEMS	Total Sample of Lake Assn's	FREQUENCY Higher Perform. Lake Assn's	Lower Perform. Lake Assn's
Pollution Abatement (including bacteria contamination, septic tank problems, tributary pollution, and difficulty implementing sewage projects)	10	7	3
Weed and/or Algae Control	6	2	4
Membership Apathy	6	3	3
Boating Safety (including user conflicts)	6	3	3
Public Access Concerns (including "abuses" and condition of access site)	5	4	1
Nuisance and Disturbing Peace	3	2	1
Vandalism	3	1	2
Development Control	3	3	0
Taxation	2	2	0
Road Maintenance	2	0	2
No Problems	2	1	1
Aesthetics	1	0	1
Lawn Fertilizers	1	0	1
Low Dues	1	0	1
Erosion	1	0	1
Creeping Sand Dune	1	0	1
Lack of Public Agency Cooperation	1	1	0
Conflict Potential over Possibility of Dredging Lake	1	1	0
Fish Management	1	1	0

LAKE PROBLEMS RECOGNIZED BY 65% OR MORE OF MLSA ASSOCIATIONS RESPONDING TO A MAILED QUESTIONNAIRE, SUMMER 1976

1. Water quality problem, excess nutrients causing plant growth (80%)
2. Algae problems (77.5%)
3. Aquatic plant problems (77.5%)
4. Fertilization of lawns (75%)
5. Fish management
   - Need for desirable species (72%)
   - Excessive small fish (70%)
   - Few large game fish (70%)
   - Need for a stocking program (65%)
6. Need for improved law enforcement pertaining to the lake community (70%). Note: Trespass problems (62.5%)
7. Shoreline erosion (67.5%)
8. Legal lake level determination (65%)
9. Power boats (65%)
10. Fishermen - skier lake use conflicts (65%)

NOTE: 40 respondents out of 150 mailings, no follow-up was conducted.

LAKE PROBLEMS RECOGNIZED BY 75% OR MORE OF RESPONDING REGIONAL RESOURCE MANAGERS MAILED QUESTIONNAIRE, SUMMER 1976

1. Overdevelopment - SCS, PHD, CES, DNR, DC's
2. Septic tank effluent to lake and/or problems getting sewage treatment plants or other alternatives to septic tanks implemented - SCS, CES, DNR, DC's, PHD
3. Lake level control - PHD, CES, DNR, DC's
4. Aquatic weed control - SCS, CES, DNR
5. Fertilizer runoff - PHD, DNR, DC's
6. Vandalism, trespass, theft, etc. - SCS, DC's
7. Agricultural and road drainage to lakes - DNR, DC's
8. Shoreline erosion - SCS
9. Algae control - CES
10. Litter - CES
11. Fish management - DNR
12. Protection of marshland - DNR
13. Overuse and user conflicts - DNR

QUESTIONNAIRE KEY

Code	Agency	Number Mailed	Number Returned
PHD	County Public Health Department	19	13
DC's	County Drain Commission (or Road Commission	22	8
DNR	Department of Natural Resources, Regional Fishery Biologist	9	8
CES	Cooperative Extension Service, County Extension Director	23	15
SCS	Soil Conservation Service, Regional Office (District Conservationist)	10	5
		83	49

COUNTIES POLLED BY MAIL QUESTIONNAIRE TO REGIONAL RESOURCE MANAGERS

I. Upper Peninsula

- Gogebic
- Marquette
- Schoolcraft
- Luce

II. Northern Lower Peninsula

- Emmet
- Charlevoix
- Cheboygan
- Antrim
- Grand Traverse
- Alcona
- Wexford
- Roscommon

III. Southern Lower Peninsula

- Montcalm
- Kent
- Barry
- Livingston
- Oakland
- Kalamazoo
- Jackson
- Washtenaw
- Cass
- St. Joseph
- Branch

Table D1.--Summary Comparison of the Frequencies of Reported Lake Problems for the Three Surveys

Personal Interviews of 21 Lake Associations	MLSA Mailed Questionnaire	Mailed Questionnaire to Resource Managers
1. Pollution Abatement	1. Water Quality	1. Overdevelopment
2. Weed and/or Algae Control	2. Weed and/or Algae Control	2. Pollution Abatement
3. Boating Safety	3. Lawn Fertilization	3. Lake Level
4. Member Apathy	4. Fish Management	4. Weed and/or Algae Control
5. Nuisance, Disturbing the Peace, Vandalism	5. Law Enforcement	5. Lawn Fertilization
6. Public Access Concerns	6. Shoreline Erosion	6. Vandalism, etc.
7. Development Control	7. Lake Level	7. Agriculture and Road Drainage
	8. Boating Conflicts	

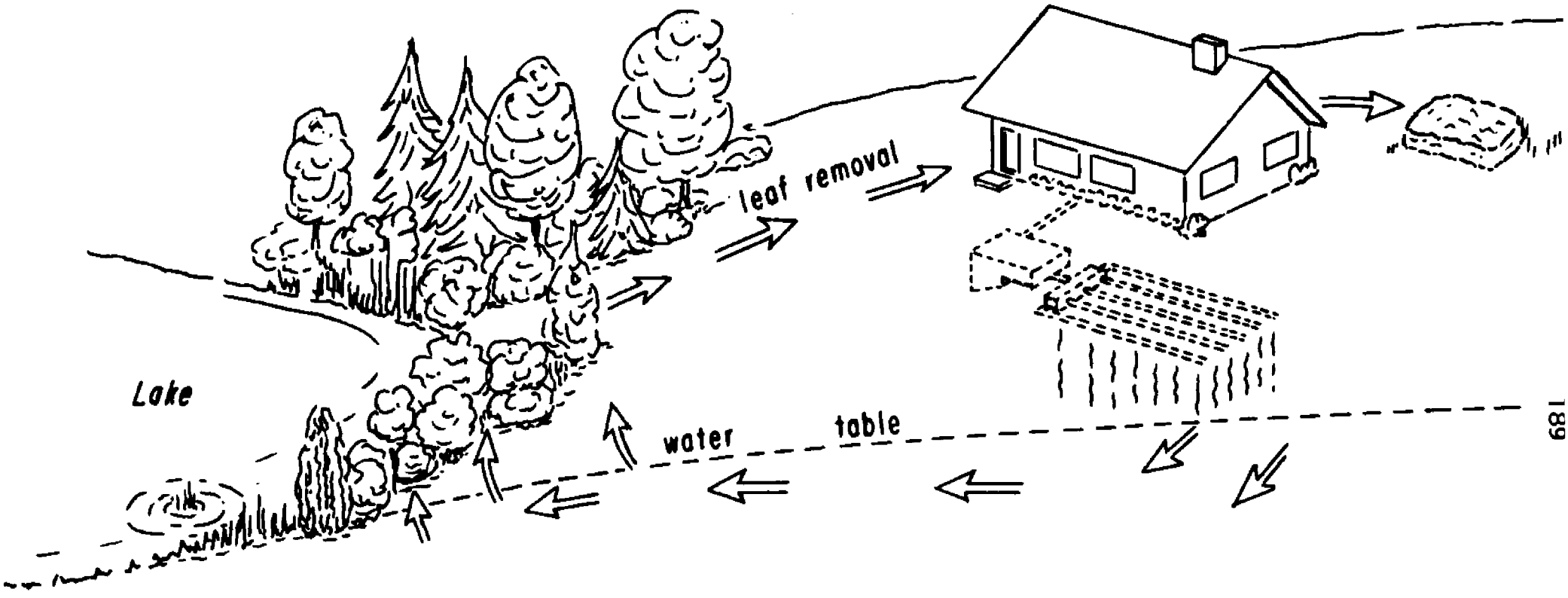
APPENDIX E

THE USE OF VEGETATIVE BUFFER STRIPS TO MITIGATE THE IMPACT OF SEPTIC TANK EFFLUENTS ON LAKE WATER QUALITY

THE USE OF VEGETATIVE BUFFER STRIPS TO MITIGATE THE IMPACT OF SEPTIC TANK EFFLUENTS ON LAKE WATER QUALITY

Irrespective of on-site sewage disposal method, an additional way to limit nutrient input to the lake is to preserve a natural strip of phreatophitic ("moisture loving plants") woody vegetation along the water's edge. This buffer zone of indigenous plants will help stabilize the lake shore as a precaution against erosion. It also intercepts some of the nutrients which would otherwise enter the lake by either surface runoff or subsurface drainage such as from household drain fields. This interception is accomplished by nutrient uptake via the root systems, with subsequent conversion of at least part of these nutrients to the relatively permanent biomass of the trees or shrubs' woody tissues. This interruption and partial retention of effluent nutrients in shoreside trees and shrubs is a preferable alternative to the direct entrance of these nutrients to the lake where they may contribute to aquatic weed and algal growth. While much of the nutrient uptake by the vegetative buffer strip may be expected to return in leaf fall at the onset of winter, any interruption of the flow of effluent nutrients to algae and weeds during the spring and summer growing seasons helps. Raking of the fallen leaves for decomposition in a compost pile set well back from the shore (preferably on the reverse slope) will further help reduce the nutrient loading of the lake.

If the lake lot is just being developed, the owner should leave as wide a strip of undisturbed vegetation as possible, particularly if a relatively steep slope is involved. In addition to heightened water quality protection, this practice also increases the aesthetics of the



The concept of the vegetative buffer zone, showing uptake of septic tank effluent from the ground water system. The nutrients are theoretically intercepted by the root system of the shrubs, trees and other plants, and retained in their structure and leaves. Leaves should be raked and composted away from the lake shore to prevent release of phosphates to the lake upon their decomposition.

lake by preserving its natural appearance, and provides the resident with more leisure time since less yard maintenance is required. In fact, the less the natural vegetation of the home site is disturbed, the better, so long as the initial cover is natural and thriving.

Where the property has already been extensively developed, the sculptured, manicured lawns right down to water's edge should be modified by the reintroduction of locally common phreatophytic vegetation. This can be accomplished by the selective planting of terrestrial species observed growing in this zone at other sites around the lake where development has not yet occurred. In inventorying the surrounding habitats for selection of the species to be incorporated, attention should be paid to the comparison and contrast of the two areas with respect to soil type, moisture content, depth to watertable, and slope. In selecting species for reintroduction, the assistance of the Department of Natural Resources regional forester can be invaluable. The accompanying guide to typical phreatophitic trees and shrubs found in Michigan may also be helpful.

In selecting species for incorporation in the buffer zone, a combination of deep rooted and shallow rooted plants should be considered for optimal drainage interception as well as inclusion of a suitable mixture of ground cover species. This will ideally, result in a three storied complex of tall trees, shorter trees and shrubs, and ground level vegetation, such as ferns, creeper, or grasses. When selecting the species to be used their relative compatibility to one another must be considered. (In the following table, an effort has been made to present compatible tree and shrub species with each reference tree, so the appropriate combination of canopy and understory species can be planted.) This may entail planting some species at different seasons or time

intervals to allow for differing growth rates. Similarly, the ultimate size of the plantings should be considered with respect to their potential for screening unsightly structures on the property or the possibility that they would obstruct a preferred view. Cooperating personnel of the Michigan State University Extension Service in the Department of Horticulture, and School of Urban Planning and Landscape Architecture may be approached for assistance in planning the best positioning of the species selected.

Once the choice of species is made, appropriate seedlings or larger individuals must be acquired. Some of the species included in the accompanying list of suggestions may be obtained from the Michigan Department of Natural Resources, Forestry Department under their Wildlife plantings program, and once again the regional forester should be of assistance in this respect. (An additional benefit associated with the buffer zone plantings is that most of the species listed are of direct benefit to wildlife and may enhance the natural aesthetics of the setting.) Stock obtained from the Department of Natural Resources will be of seedling size; if larger specimens are desired they may in many cases be purchased from local nurseries. Care should be taken to avoid the introduction of exotic species which may disrupt the local ecology. Similarly, individuals should be cautioned not to attempt to remove any wild species from public land, as this is a violation of state law.

The American homeowner would appear to take considerable pride in his lawn, as indicated by the large market in home gardening supplies. This same pride and industriousness can be applied to the lake property setting, with the resident deriving similar satisfaction. However, the effort expended must be redirected toward the more environmentally beneficial ramifications of vegetative buffer strip landscaping.

SUGGESTED WOODY PLANT SPECIES WHICH MAY BE APPROPRIATE TO LAKE FRONT BUFFER ZONE PLANTING

Reference: Fowell, H. A., 1965. Silvic of forest trees of the United States, Agriculture Handbook #271. USFS, Dept. Agri., USGPO, Wash., D.C., 762 pp.

Tamarack - All of Michigan.

Soil: Variety of soils, high moisture tolerance, common on lake shores. Found throughout Michigan.

Associated Trees and Shrubs:
Trees - N. white cedar, red maple, balck ash, aspen, black and white spruce.
Shrubs- Alder, red-osier dogwood, cranberry, birurnum.

Growth Conditions: Seedlings need abundant light and constant water level--should not be shaded in early growth stages. Relative slow growth 3 feet in 5 years; 16 feet in 15 years; 60+ feet in 45 years.

Roots: Shallow, compact system, usually 1-2 feet deep. Grows well if water table is 18 inches deep.

Cedar, White-Central and Northern Michigan.

Soil: Best in neutral or alkaline soils especially of limestone origin, well drained, but also grows in swamps.

Associated Trees and Shrubs:
Trees - White and black spruce, red spruce, yellow birch, balsam fir, white pine, Tamarack, red maple, American elm, aspen, sugar maple, basswood.
Shrubs- Red-ozier dogwood, willows, chokecherry, cranberry, alder.

Growth Conditions: Seedlings require constant summer moisture. Medium size tree commonly 40-50 feet tall, 2-3 feet diameter, 28 feet tall in 40 years on good site.

Roots: Shallow, subject to windthrow.

Cedar, Red-Southern Michigan (Eastern red cedar).

Soil: Neutral to slightly acid soils; pH 4.7 - 7.8, but not very tolerant of upper pH.

Associated Trees: Pines, oaks.

Growth Conditions: 40-50 feet tall, slow growth; rate of growth closely associated with water supply.

Roots: Seedlings have deep tap root, apparently maintained with maturity.

Aspen, Quaking-All of Michigan.

Soil: Wide variety, but least successful in coarse sands. Usually poor in sands because of low moisture and nutrient level (may do very well at lake sides with effluent).

Associated Trees and Shrubs:
Trees - Birch, white and black spruce, jack pine.
Shrubs- Hazel, alder, raspberry.

Roots: 39-60 inches deep.

Willow, Black-Southern and Central Michigan.

Soil: Flourishes in very wet areas. Needs abundant and continuous supply of moisture during growing season. Grows in almost any soil.

Associated Trees and Shrubs:
Trees - Black spruce, river birch, sycamore, red maple, locust, red mulberry.
Shrubs- Buttonbush, swamp privit.

Growth Conditions: Very rapid, reach 30-60 feet tall in north but short lived.

Roots: Tend to have relative shallow, extensive root systems.

Paper Birch-North and Central Michigan.

Soil: Glacial soils especially tills and outwash generally requires well drained soil. Grows best in stands.

Associated Trees: Jack pine, balsam fir, black spruce, yellow birch, aspen, sugar maple, white or red spruce, white ash.

Growth Conditions: Sensitive seedlings. Mature trees 70 feet tall, short lived 70-75 years. Heavy mortality.

Yellow Birch-All of Michigan.

Soil: Grows well on loams from good to poorly drained.

Associated Trees and Shrubs:
Trees - Hemlock, sugar maple, beech, red spruce, white cedar, basswood, black ash, white ash, aspen, white birch.
Shrubs- Mountain maple, dogwood (alternate leafed), ground hemlock.

Growth Conditions: Rapid with moderate overhead sunlight. 8-10 feet in 6 years. About 50 feet high when mature.

American Sycamore-Central and Southern Michigan.

Soil: Excellent along lakes. Tolerant of groundwater fluctuations.

Associated Trees: Black elm, red maple, silver maple, black willow (moderately intolerant).

Growth Conditions: Fast growing throughout its life, only black willow is faster. 70 feet in 17 years.

Roots: Wide spread, strongly branched roots.

Red Maple-A-1 of Michigan.

Soil: Wide variety of soils. Common along small sluggish streams.

Associated Trees: Black ash, American elm, aspen, paper birch, yellow birch, black spruce, sugar maple, beech, basswood.

Growth Conditions: Rapid up in early life 3-3.5 inches dbh in 10 years. Mature trees are 60-90 feet high.

Roots: Shallow or deep tap root depending on weight. Shade tolerant.

Silver Maple-Central and Southern Michigan.

Soil: Variety of soils, common on low, well drained river bottom land. Sometimes along low lake shores.

Associated Trees: American elm, red maple, basswood, sycamore, river birch, cottonwood, black ash.

Growth Conditions: Rapid especially in first 50 years, 70-120 feet high. Moderately intolerant.

Sugar Maple-All of Michigan.

Soil: All types, thrives on fertile, well drained sites, especially loams. pH range 3.7-7.3, best is 5.5-7.3.

Associated Trees and Shrubs:
Trees - Beech, yellow, basswood, red spruce, red maple, hemlock, white spruce.
Shrubs- Beaked hazel, atlantic leatherwood, scarlet elder, American elder, pagoda dogwood, dwarf honeysuckle, raspberry, blackberry.

Growth Conditions: About 1 foot/year. At age 30 may reach 35-40 feet. Very tolerant of shade.

Roots: Deep and branching.

Basswood-All of Michigan.

Soil: Loams, sandy loam, silt loam with clay subsoil. Should have minimum silt plus clay content of 35% and 3% organic matter in upper 7 inches of soil profile-pH 5.5-7.3. Fairly sensitive to microclimate.

[Apparently not "wet soil" tolerant, but leaves have high phosphorus and nitrogen content suggesting that it would take up effluent.]

Associated Trees: Paper birch, white pine, northern red oak, white ash, white pine, hemlock, yellow birch, sugar maple, beech, black cherry, white oak.

Growth Conditions: About 5 to 12 or 18 inches per year. Fastest growth in first 20 years. Reach 140+ feet tall.

Roots: Deep, wide spread system of strong lateral roots.

Black Locust-Not natural to Michigan, but has been introduced.

Soil: Does well on poor soils. But is a legume and with litter it produces significant nitrogen to the soil and environment (soluble nitrate occurs with rapid decomposition of locust litter).

Associated Trees: Hardwoods and yellow poplar, maples.

Growth Conditions: Very rapid 75 feet in 50 years. Maximum height is 40-100 feet.

Roots: Extensive shallow root system.

American Beech-All of Michigan.

Soil: Preference is loamy soil with a high humus content. Requires considerable water- 10 inches/year for growth andtranspiration. Will grow where water table within 6-10 inches of surface, but is less tolerant than red maple or sweetgum. Has shallower root system on poorly drained soils.

Associated Trees: Sugar maple, yellow birch, basswood, black cherry, red spruce, hickory, oaks.

Growth Conditions: About 1 foot/year for first 40 years, mature height 60-80 feet, maximum 120 feet. Very tolerant, similar to sugar maple.

Roots: Large expanse of surface roots. Thin bark makes it subject to fungal infection.

Black Ash-All of Michigan.

Soil: Most common in peat, but also clays and sands or clay till. Prefers high water table or standing water.

Associated Trees and Shrubs:
Trees - American elm, red maple, white cedar also birches, spruces, hemlock and tamarack.
Shrubs- Alder, dogwood, sumac, blueberry, holly.

Growth Conditions: Tallest of record is 79 feet in Wisconsin.

White Ash-All of Michigan except western Upper Peninsula.

Soil: Most common on fertile soils with high nitrogen content and moderate to high calcium content. Grows best on moderately well drained soils. Rarely found in swamps, but tolerant of temporary flooding.-- Rarely found in bottom lands where poor air drainage.

Associated Trees and Shrubs:
Trees - White pine, northern red oak, basswood, red and sugar maples, hemlock, beech, birch, black cherry, elm.
Shrubs- Downy serviceberry, paw paw, American hornbeam, flowering dogwood, witch-hazel, E. hophornbeam, dockmackie.

Growth Conditions: 3-5 years to reach breast height. About 35-40 feet tall in 20 years. Shade tolerant when young but with maturity becomes intolerant.
--Pioneer species but can survive in climax canopy.

Green Ash-All of Michigan.

Soil: Common on bottom-lands, loams with neutral pH to slightly alkaline. Successful plantings on spoil banks of strip mines. Common in alluvial soils of river and stream banks.

Associated Trees: Sugarberry, American elm, aspen, sugarmaple, basswood, black willow, sycamore, boxelder, red maple.

Growth Conditions: 1-3 feet per year in first 6 or 7 years.

Roots: "Fourth most extensive root system of all species studied" (Agri. Handbook #271 p. 188). Trees 38 feet tall had roots 48 feet laterally and 3.6 feet downward. About equally distributed within top 3 feet of soil. Highly resistant to wind damage.
--Intolerant to moderately tolerant.

Dogwood, Flowering -Central and Southern Michigan.

Soil: Upland to deep moist soils, common along streambanks. Do better on light soils than heavy ones. Foliage high in mineral nutrients, hence significant in soil improvement. Litter decomposes rapidly especially good source of calcium.
--Leaves concentrate flourine range 40 to 100 ppm with site and season.

Associated Trees: Oak-Hickory forests, also red maple, yellow-poplar, white ash, beech, blackgum.

Growth Conditions: Maximum size 40 feet tall, in northern range is a many branched shrub. Very shade tolerant.

Yellow Poplar-Lower Central and Southern Michigan.

Soil: Well drained, loose textured soils. Requires high nitrogen content and consequently often found with black locust.

Associated Trees: Beech, sugar maple, blackgum, dogwood, hickories.

Growth: 120 feet tall in 50-60 years with dbh 18-24". Very fast growth, but intolerant.

Roots: Rapidly growing, deeply penetrating top root plus many strongly developed wide spreading lateral roots.

White Pine-All of Michigan.

Soil: Grows on variety of soils but most commonly associated with well-drained sandy soils.

Associated Trees and Shrubs:
Trees - Northern red oak, white ash, hemlock, paper birch, red maple, pin cherry, sugar maple, beech, yellow birch, balsam fir, white spruce, white cedar.

Shrubs- Oxalis, Mitchella, Aralia, Arisaema, Dennstaedtia, Cornus, Maianthemum, Pteridium.

Growth Conditions: Rapid, 20 inches annually. Long lived, up to 200 years and old trees may be 200 feet tall. Tolerance: May be shaded out by aspens, oaks, maples and eventually die. But can dominate birches (thin leaf cover).

Roots: Form and distribution varies with soil characteristics. Normally only vestige of a tap root with 3-5 large roots spread laterally outward and downward. Gives tree firm anchor in soil. Mass of smaller lateral roots spread from the major laterals. High concentrations of nitrogen, organic matter and exchangeable bases stimulates formation of a concentration of fine roots.

Red Pine-Central and Northern Michigan including Upper Peninsula

Soil: Grows well in poorer soils. Studies of litter in lake states show it to be high in Phosporus and Nitrogen.

Associated Trees and Shrubs:
Trees - Jack pine, eastern white pine, quaking aspen, bigtooth aspen, scrub oaks, maples, black cherry, balsam fir, black spruce.

Shrubs- Canada blueberry (Vaccinium canadense), lowbush blueberry (Arctostaph-ylos uva-ursi), prairie willow (Salix humilis), Amer. hazel (Corylus americana) beaked hazel (C. cornuta), striped maple (Acer pensylanicum), dwarf bush honeysuckle (Diervilla lonicera), Jerseytea ceanothus (Ceanothus americanus), American fly honeysuckle (Lonicera conadensis).

Growth Conditions: About 1 foot per year for first 60 years. Live 100+ years.

Roots: Like white pine, very extensive root system, in some cases tap root may go down 9 feet or more.

Balsam Poplar-All of Michigan.

Soil: Common along lake borders. Excellent growth on sandy, gravelly soils. Needs much moisture.

Associated Trees and Shrubs:
Trees - Balsam fir, aspen, white spruce, balsam fir, paper birch, black ash, red maple, occasional tamarack.

Shrubs- Speckled alder (Alnus rugosa), American green alder (A. crispa), red-osier dogwood (Cornus stolinfera), bunchberry dogwood (C. canadensis), mountain maple (Acer spicatum), bearberry honeysuckle (Lonicera involucrate), beaked hazel (Corylus cornuta), American cranberry bush (Viburnum trilobum)...

Growth Conditions: Rapid during first 40-50 years-up to 70 feet tall. Short lived. Less shade tolerant than common associates: white spruce, balsam fir, northern white cedar, black ash, red maple, but equally intolerant as quaking aspen and paper birch. Will not grow well in competition with other speices unless is dominant.

Bigtoothed Aspen-All of Michigan

Soil: Well drained sandy soils. Needs water table lower than 18 inches from surface for adequate aeration. Found along streams and lakes.

Associated Trees and Shrubs:
Trees - Quaking aspen, balsam poplar, paper birch, red maple (these most common).

Shrubs- Choke berry (Prunus virginiana), downey serviceberry (Amelanchier arborea), sweetfern (Comptonia peregrina), prairie willow (Salix humilus).

Groundcover- Blueberries (Vaccinium spp), checkerberry wintergreen (Eaultheria procumbens), dwarf bushhoneysuckle (Diervilla lonicera) eastern bracken (Pteridium latiusculum) and blackberry (Rubus spp).

Growth Conditions: Medium size tree usually not more than 30-40 feet tall. Rapid growth until 40 years old. Short lived only about 60-70 years. Highly intolerant.

Roots: Very shallow, good effluent interception probably, but subject to windthrow and topping. Popular wildlife food-white tail deer, beaver, grouse, procupine.

Black Cherry-Michigan Lower Peninsula

Soil: Loamy to gravelly soils with silty to clayey subsoils, well drained.

Associated Trees: Sugar maple, white pine, northern red oak, white ash, hemlock, beech, yellow birch.

Growth Conditions: Very rapid first 45-50 years. Maximum height may reach 100 feet but usually 80 feet or less.

Roots: Predominantly spreading and shallow, usually restricted to upper 2 feet of soil. Easily windthrown. Intolerant, common in canopy openings.

Northern Red Oak-All of Michigan

Soil: Soils range from clay to loamy sands, and from deep stone free to rocky, shallow soils. Needs moist substratum within 4 to 1 foot of surface. Best sites are fine textured soils with high water table.

Associated Trees and Shrubs:

Trees - Many associates including ashes, aspens, birches, cherries, elm, firs, hickory, maples, other oaks, pines, spruces, basswood, sycamore, northern white cedar, black locusts, etc.

Small Trees- Flowering dogwood, holly, hornbeam, hophornbeam, redbud, pawpaw, sassafras, serviceberry, percimmon.

Shrubs- Greenbrier (Smilax spp.), Hydrangia, mountain laurel (Kalmia latifola), rhododendran, and witchhazel (Hamamelis virginiana).

Growth Conditions: Maximum 70-90 feet tall with 2-3 feet dbh. Slow growth rate intermediate tolerance.

Roots: Deep tap root.

Swamp White Oak-Lower Michigan (Southern)

Soil: Commonly found in wet lowlands.

Associated Trees: All trees common to wet or moist sites; basswood, black ash, hickories, pin oak, red maple, northern red oak, silver maple, sweetgun, sycamore, yellow poplar, white ash, willow.

Growth Conditions: 60-70 feet high, fairly rapid growth, 2-3 feet dbh. Intermediate intolerance with seedlings able to start in shade.

Roots: Shallow root system.

Eastern Hemlock-Central to Upper Peninsula of Michigan

Soil: Grows well in peat and muck soils, but also on sandy loams in lake states.

Associated Trees: White pine, yellow birch, yellow poplar, aspen, white spruce, paper birch, tamarack, sycamore.

Growth Conditions: 16 feet in 40 years in Michigan. Maximum 60 feet in 140 years. Highly tolerant of shading, but causes stunted growth.

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