Proceedings of Conference on Inland Lake Renewal and Shoreland Management

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WATER RESOURCES RESEARCH CENTER
UNIVERSITY OF MINNESOTA
GRADUATE SCHOOL

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FOREWORD

The Water Resources Research Center of the University of Minnesota was established for the purposes of encouraging, supporting and coordinating research and education in all aspects of water resources. Among the more urgent water resources problems requiring additional research are those dealing with inland lake renewal and shoreland management in Minnesota. In view of the great public concern and the urgent need for information on this topic, this Bulletin is being published by the Water Resources Research Center as a public service. It is thus being made available to a wide variety of people concerned with the research, technical, educational and operational aspects of water resources. This Bulletin contains the proceedings of a Conference held in the North Star Ballroom, Student Center, University of Minnesota, St. Paul Campus on March 20, 1972. Readers are urged to obtain copies of the references listed below and to become more fully acquainted with the results of the Wisconsin Inland Lake Demonstration and Shoreland Management Project. Copies of the references are available through the University of Wisconsin - Extension, Environmental Resources Unit, 215 North Brooks Street, Madison, Wisconsin 53706.

Anon. 1972. Inland Lake Demonstration Project - Progress Report, May 1968-June 1972. University of Wisconsin - Extension.

Born, S.M. And D.A. Yanggen. Understanding Lakes and Lake Problems. University of Wisconsin - Extension.

Klessig, L.L. and D.A. Yanggen. 1972. Wisconsin Lakeshore Property Owners' Associations: Identification , Description, and Perception of Lake Problems. University of Wisconsin - Extension.

Kusler, J.A. 1972. Survey: Lake Protection and Rehabilitation Legislation in the United States. University of Wisconsin - Extension.

This Bulletin is related to OWRR Annual Allotment Agreement No.: 14-31-0001-3523 and the Center Director's Office program.

Publication Abstract:

The program of the Conference included an introduction and overview of the program of the Inland Lake Demonstration and Shoreland Management Project of Wisconsin. Reports were presented on selected lake renewal activities, selected shoreland management and development activities, and shoreland management educational programs. Projects were described involving chemical inactivation of nutrients, nutrient exclusion/dilutional pumping, rehabilitation of a small flowage, urban runoff, characterization private controls for recreational land development, shoreland development, and lake rehabilitation legislation and programs. The progress of Minnesota's shoreland program and activities in lake demonstration projects was described.

Alum was used successfully for chemical inactivation of nutrients in an overfertilized small lake in Wisconsin. Dilutional pumping resulted in some success in reducing the phosphorus content of another lake. Plastic sheeting, in combination with sand and gravel blankets on the bed of a millpond, was used to control aquatic plants. With regard to water-oriented

recreational developments, it was suggested that an automatic property owners association can provide a mechanism for maintaining and managing the common open space and facilities to which individual lake lot owners have common rights. A nation-wide survey disclosed that explicit statutes saying that a local unit of government or State agency is authorized to project, manage, or rehabilitate lakes are rare. The 1969 session of the Minnesota Legislature passed the Shoreland Management Act requiring each county to adopt a shoreland management ordinance to help combat lake problems. Considerable progress has been made in implementing the provisions of that Act.

Descriptors: *Lakes/ *Management/ *Shores/ Wisconsin/ Minnesota/ Eutrophication/ Agencies/ Ordinances/ Water quality/ Adequate eco-systems/ Nutrients/ Littoral zone/ Dredging/ Urban runoff/ Legislation

Identifiers: *Lake renewal/ *Shoreland management/ *Lake demonstration project/ Lake improvement associations/ Weed harvesting/ Winter kill/ Lakeshore properties

COWRR Field & Group: 05-F, 06-G

PROCEEDINGS OF
CONFERENCE ON INLAND LAKE RENEWAL
AND SHORELAND MANAGEMENT

INTRODUCTION

The objective of the Conference was to disseminate information concerning inland lake renewal and management programs in Minnesota and Wisconsin. The morning session included 1) an overview of Wisconsin's Inland Lake Renewal and Management Demonstration Project, 2) reports on selected lake renewal and related activities, and 3) a showing of a Project Documentary Film. The afternoon session focused on selected shoreland management and development activities.

The program of the Conference is given below:

Morning

9:00-9:30 a.m.	Registration
9:30-9:40	Welcome - Gene Hollenstein, Dir., Div. of Waters, Soils & Minerals, Minnesota Department of Natural Resources
9:40-10:15	1. An Introduction and Overview of the Program of the Inland Lake Demonstration and Shoreland Management Project of Wisconsin - S.M. Born, University of Wisconsin, Project Leader
10:15-10:30	Coffee
10:30-10:55	2. Reports on Selected Lake Renewal activities a. Chemical Inactivation of Nutrients - Tom Wirth
10:55-11:10	b. Nutrient Exclusion/Dilutional Pumping - Tom Wirth
11:10-11:35	c. Rehabilitation of a Small Flowage, People Part of Environmental Action Programs, Marion Millpond - Ed Brick
11:35-11:45	d. Waupaca Urban Runoff Study - J.O.Peterson
11:45-12:00	Questions and Answers
12:00-12:30 p.m.	3. Inland Lake Documentary Film
12:30-1:30	Lunch

Afternoon

	4. Reports on Selected Shoreland Management and Development Activities
1:30-2:20 p.m.	a. A Resource-Protective Approach to Shoreland Development, Including Innovative Private Controls for Recreational Land Development - Steve Born & Doug Yanggen
2:20-2:30	b. A Study of the Rate, Magnitude, and Nature of Shoreland Development in Northern Wisconsin - Doug Yanggen

2:30-2:50 c. Nation-wide Survey of Lake Rehabilitation Legislation and Programs - Jon Kusler

2:50-3:10 Coffee

3:10-3:40 5. Shoreland Management Educational Programming - Doug Yanggen & Steve Born

3:40-4:10 Progress of Minnesota's Shoreland Program and Activities in Lake Demonstration Projects - Mike Hambrock

The Conference was sponsored by Minnesota Department of Natural Resources; Division of Waters, Soils and Minerals and Water Resources Research Center, University of Minnesota. The following persons served as the program planning Committee for the Conference: Gene Hollenstein, Department of Natural Resources and William C. Walton, Water Resources Research Center. Eighty-two people attended the Conference; a list of Conference participants is given at the end of this Bulletin.

OPENING REMARKS

Gene Hollenstein, Minnesota Department of Natural Resources, Division of Waters, Soils and Minerals

We are very pleased to cooperate with the Water Resources Research Center, University of Minnesota in sponsoring this Conference on Inland Lake Renewal and Shoreland Management. The Conference is going to be primarily a presentation by people from the University of Wisconsin and the State of Wisconsin.

In recent years our lakes in Minnesota have been subjected to both increased and diverse uses. There is ample evidence to indicate that future years will bring greater and more diverse demands for use of this most valuable resource. Because of this, there have been many requests from lake management and lake improvement associations, municipalities, sportsmens organizations, other groups, legislators, and individuals for investigations of conditions in lakes and investigations that would lead to recommended solutions and action programs to prevent continued deterioration of problem lakes.

I want to introduce you to Steve Born,who is the project leader of the Inland Lake Demonstration Project in Wisconsin. Steve has a Ph.D. from the University of Wisconsin and he was formerly with the Shell Oil Company as an exploration geologist. The Inland Lake Lake Demonstration Project is a $1 million project funded by the Upper Great Lakes Regional Commission and I am sure that we will all be most interested in the information that Steve and his people have to present to you today.

AN INTRODUCTION AND OVERVIEW OF THE PROGRAM OF THE INLAND LAKE DEMONSTRATION AND SHORELAND MANAGEMENT PROJECT OF WISCONSIN

Steve Born, University of Wisconsin, Project Leader

It is a real pleasure for those of us associated with the Lake Demonstration Project to be here today, for a number of reasons. One is that in funding the Inland Lake Demonstration Project the Upper Great Lakes Regional Commission is concerned with regional natural resource problems, and not simply those that are germane to Wisconsin. We hope that the opportunity to bring you up-to-date on the results of our program today will be useful to you and we intend it to be a progress statement.

The Lake Demonstration project began in May 1968 and was originally conceived as an action program, not a research program. It is a joint venture of the Wisconsin Department of Natural Resources and the University of Wisconsin. The project is directed by a 7-man committee composed of representatives of both of those agencies. The idea was to bring together the capabilities of the regulatory and management agency with those of the educational agency, and thereby produce a greater than 1 plus 1 combination for this very difficult undertaking. We sometimes think we have a cast of thousands participating in this project; actually we are working with the field staff and the support people of both agencies and we are very thinly staffed back in our home office in Madison. Our funding from an economic development agency, the Upper Great Lakes Regional Commission in the Department of Commerce, simply acknowledges the importance of lakes and related shorelands to the tourist and recreational economy of the region.

The goals of this project from its outset have been to demonstrate, that is to show, by example, various methods for protecting and maintaining lakes and shorelands and where necessary, to restore lakes and shorelands. More broadly stated, we are concerned with showing how resource management can achieve economic development and social welfare goals in concert with environmental quality objectives.

Gene Hollenstein has alluded to some of the lake problems in Minnesota; they are region wide. These problems break down roughly into three categories: water-quality deterioration and overfertilization; shoreland deterioration; and water-use conflicts, that is, recreational conflicts on the water surface proper. We have separated our activities into two major components; one component we call inland lake renewal and management, the after-the-fact renewal approach, and the other component we call shoreland management and development, which is a preventive approach undertaken before the problem arises.

The lake renewal and management activity is a somewhat optimistic effort for a number of reasons. There are a variety of difficulties in demonstrating lake renewal. The art is in a state of infancy at best. For those of you who work with aquatic eco-systems, you will surely agree with me that our understanding is less than complete and that our predictive capabilities concerning eco-systems is somewhat limited at this time. Furthermore the technology for renovation or restoration of lakes is also in its infancy. It will be some time before the hardware for undertaking lake renewal will be fully refined. There are some additional problems; time is

certainly one of the more important problems. It has taken a number of years for lakes to become degraded and they cannot be reparied overnight. In order to develop some kind of remedial strategy one needs background information. The scientific community will always desire one more season of data before it is forced to make a decision. On the other hand, those people in State planning agencies and those people who live around problem lakes would like the job done yesterday and generally, with the cost borne by somebody else. In many cases, the economics may make lake renewal impractical. Before-the-fact approaches, like Minnesota's shoreland regulations, are ways to solve problems before they occur and prevent the problem from occurring.

Our program has been funded on a year-to-year basis and it had to be predicated on a four or 5-year life. Of our early project efforts, one of the most promising has been chemical activation of nutrients using alum, an aluminum salt. This is simply an extrapolation of techniques used in advanced waste-water treatment plants. By applying alum to a natural lake setting we hoped to remove phosphorus from the lake involved. This has been accomplished in only one other place--in Sweden; ours was the first test of this concept in the United States. The test was conducted at Horseshoe lake in southeastern Wisconsin in May 1970. We have seen a number of results that suggest some improvement in water quality in Horseshoe lake. There has been a reduction in total phosphorus, and the nuisance algal problems which existed for years and years do not persist. There have been many suggestions of generally favorable short-term results. But, this technique is in an experimental stage and it needs long-term assessment of its effectiveness and environmental consequences. We have expanded this program to three other limnological settings and we will be conducting additional studies on this promising lake renewal approach.

A second activity which we began early in the program involved dilution and nutrient exclusion at Snake Lake, in northern Wisconsin. This is a lake which has received treated and partly treated sewage effluent from a now inoperative treatment plant for a period of some 20 years. The lake degraded from one which sustained a warm-water sport fishery to one in which oxygen was non-existent and the fishery was described as simply mud minnows and frogs. Nutrients were curbed by diverting wastes elsewhere and we were interested in seeing whether or not we could dilute that lake using high-quality (low in nutrients) groundwater from the adjacent groundwater aquifers and reduce the nutrient levels in the lake below those necessary for nuisance aquatic vegetation. It appears that we conducted a large-scale leaching test with the sediments in the lake and we have not seen the most opportunistic results.

Another early activity was a management demonstration project, which had a dual intent. On the one hand we were concerned with demonstrating various techniques for the rehabilitation and management of small flowages and mill ponds. Secondly, we were concerned with how to involve local interests in environmental improvement programs. At the Marion millpond in central Wisconsin, which had a typical suite of problems, we were trying to provide some supplemental funds, some seed dollars, along with inputs of interdisciplinary technical advice to guide local people in renovating the millpond which had been degraded over a period of many years. Generally, the project involved the littoral zone management activities made possible by fluctuations of water levels. There are hundreds and hundreds of

millponds and flowages, many of which are now detriments to the community but which can be readily converted into recreational assets. This then is the people part of environmental action programs. We have a corollary program going on at a lake in northeastern Wisconsin where we are attempting to implement the problem-solving process working with a property owners association on a 60-acre lake in Forest County. Here we are testing whether or not we can provide some short-term technical expertise in terms of problem definition, develop some remedial alternatives, get the people organized to conduct this management activity, and execute the program in conjunction with them.

Other activities we have been engaged in recently involve mec hanical aeration or circulation systems to aerate and oxygenate lakes. We are concerned with both hypolimnetic or lower-level mixing of lakes and total anatomy largely to achieve water quality improvement and for fish management purposes. There will be two of these aeration projects in progress in the future. The Department of Natural Resources in our State has been concerned with these kinds of activities for a number of years.

Another problem that affects many of our flowages and natural lakes in both Wisconsin and Minnesota is the excessive growth of littoral aquatic vegetation. At Mondeaux Flowage in the Chequamegon National Forest in central Wisconsin, we were concerned with managing littoral zone plants by drawing down the impoundment and attempting to limit plant growth by freezing and drying the littoral zone. This is an outgrowth of a program undertaken by our Department of Natural Resources earlier on the Murphy flowage. Unfortunately that facility washed out during a period of heavy storms. We are simply trying to pick up where they left off.

Another project we have been concerned with involves lake deepening by dewatering in an attempt to consolidate sediments. We recognized for some time, as I am sure you have, that the cost of dredging is prohibitive and consequently it would be desirable if we could devise a much cheaper and better way of deepening lakes. The idea of removing the water from the lake so that the sediments are allowed to compact has some viability, and we recently ran a small-scale field test of this activity on a bog lake in northern Wisconsin. One of our conclusions is that we should be looking for a lake which has more inorganic sediments. We should also point out that most of the activities I am talking about will be available in the form of technical reports in the not too distant future, in the next year or yearand a half, so there will be a much greater explanation of what is involved. I am simply trying to give you some overview of our project activities.

The technical studies that we conducted on each demonstration lake generally lack the longevity that most researchers would like to have before they arrive at conclusions. The studies we routinely conduct at each of our 10 or 11 lake sites include limnology and water chemistry, hydrology and hydrogeology, aquatic biology (macrophytes, the fishery, plankton, and benthos), sediment studies, and, where necessary, supporting laboratory investigations. For example, in the case of nutrient inactivation using alum salts we were concerned with determining what the most effective dosage of alum would be for maximum removal of phosphorus from the lake water, simultaneously minimizing the danger to various aquatic organisms. We conducted some toxicity tests to help us answer this question.

In our lake renewal activities we are also conducting topical studies related to lake problems. On the one hand we are concerned with problem sources. We are studying urban runoff in a small typical sands-plain town in central Wisconsin in cooperation with the U.S. Geological Survey. Urban runoff is a real emerging water quality problem, and we are trying to document the problem and to determine if there is some possibility of correcting the problem by altering the arrangement of storm drains. Communities elsewhere can then capitalize from the knowledge and experience gained in this demonstration.

We are also taking a look at nutrients and septic tank systems. As many of you are aware, some of the large-scale real-estate developments which are being dropped on the landscape have some very serious ecological ramifications. One of the questions which is continuously raised is the possibility of pollution from septic tanks, or nutrient additions from septic tanks. We are dealing with a problem that to some local governments might affect a $20 million increase in tax base; there is real concern for an improved factual basis on which to predicate decision making.

Early in our activities we undertook a dredging survey. This study is looking at corrective measures. The idea was that we had much information available on large-scale dredging experiences, like the Corps of Engineers activities on the Great Lakes and Upper Mississippi river. But, very little information was available on what happens to the person who is dredging 200 feet of lake frontage or the person who is attempting to renovate a 30-acre lake. After surveying many small-scale experiences, we have developed a hand book for dredging -- costs, equipment, planning, and potential problems.

We are initiating an aquatic plant management review which is not concerned with chemical treatments but rather with physical control mechanisms. We are trying to get an inventory of what has been done in the past, who has undertaken such activities, costs, and what has been the target species. We hope to prepare a cook-book of sorts on this subject.

One of the spin-offs from our demonstration activities has been to show the high degree of complementarity between the action-oriented demonstration work and basic research projects. We are able to identify new and very exciting avenues for basic research, and to continually integrate research results in our activities.

Now let me shift my remarks to the shoreland management and development phase of our activities. This phase incorporates an array of programs aimed at articulating lakeshoreland related problems and devising new approaches to reducing the environmentally destructive impacts of traditional usage and development. We are not necessarily promoting land development. We are simply saying that we feel that we should intelligently guide and channel land development on the landscape. This requires some policy decisions on whether or not we want to disperse or concentrate and cluster development and the recreational pressures in a given region.

We have conducted a variety of background studies, I will cite only a few examples. One of our earlier studies was a review of private institutions and controls for lake maintenance and management. What kinds of things have lake property owners been doing? What are the possibilities of using homeowners associations and some fairly novel deed restrictions to get resource

protection? We have also tried to get a little better understanding of what users are looking for through a variety of recreational user demand and land development preference surveys.

As it relates to shoreland development, we have looked at the available recreational housing options. What kinds of pre-fab units are on the market today? What kinds of units will be available in the near future? What kinds of alternatives are there for waste disposal for recreational developments? We are involved in a number of shoreland development demonstration projects.

We are taking a look at the increasing number of large-scale developments, their effects on the landscape, and associated sociological and economic impacts. Because these developments are subject to a greater degree of regulatory control and because we feel they provide economies of scale in terms of planning and design, we have focused our energies in this area. Large-scale developments are going to be of growing importance in meeting the lakeland buyers demands. The business is highly competitive. If you can get one developer to put a show-case development on the ground one can hope to force competitors to emulate the action. With this in mind, we undertook cooperation with a single large land developer, a timber company with hundreds of thousands of acres of lands in the Upper Peninsula of Michigan, in an effort to show how development could be made with minimal environmental impact. For a 3,600-acre tract in northern Wisconsin we conducted site analysis and undertook design and planning activities which incorporated some new approaches and new concepts with regard to large-scale development around lakes. We concurrently performed a number of marketing surveys and some preliminary economic feasibility analyses and put together a legal framework so that these kinds of resource-protective developments can be perpetuated through time. One result of this kind of design is that you leave 75 percent of the land essentially untouched and come up with a 20-25 percent return on investment. The private corporation in this case has not exercised the option of developing yet because of the depressed economic situation and because of some internal corporate decisions. However, at the point in time when they decide to develop, they are going to move away from conventional gridding of lakeshores and instead go to something in line with our design.

At the present time a shoreland management educational program has been started which is aimed at reaching the public and building the kind of support and understanding for sound water resource programs which you must have if plans are to be effectively implemented. We anticipate reaching some 10,000 directly concerned individuals during the first year's work.

A number of our studies have dealt with some very controversial policy issues; one touched on shoreland development in northern Wisconsin where we are concerned about the rate, nature and magnitude of development. We would like to document the kinds and amounts of land parcelling that are taking place, to provide a factual basis for new policies and programs. There has also been a study conducted on artificial lake building and land subdividing which is a very sensitive political issues in Wisconsin, as well as elsewhere in the Upper Great Lakes region.

A multi-state waste disposal regulatory review has been completed with emphasis on the kinds of innovative systems which are available for disposing of wastes in the rural environment. We have also completed a nation-wide survey of various States' lake protection and rehabilitation legislation programs

which is preparatory to developing some draft materials or at least suggestions for lake improvement legislation.

I should point out that Senator Muskie's Senate Bill 2770 (concerning the 1971 amendments to the Water Pollution Control Act) incorporates the Clean Lakes Act, which was promoted by Senator Mondale of Minnesota. This Act will provide $300 million in funds for lake rehabilitation over the next 4 years on a 70-30 cost sharing basis with the States. There is no reason why the Upper Great Lake region, with its tremendous abundance of lakes, should't be in the forefront in terms of getting Federal funds to help them with the monumental job of lake reclamation where necessary.

Also the Inland Lake Demonstration project was chosen by the Upper Great Lakes Regional Commission to serve as a nucleus to provide a better factual basis for decision making on a precedent-setting Federal Power Commission relicensing controversy, the Chippewa Flowage. Our attempts here are basically to evaluate the environmental issues and policy alternatives in a non-advocacy information generating way. We hope to prepare a conceptual framework for making better resource management decisions which will have transfer value to comparable situations elsewhere. It has been important to us as we move along to disseminate information about our activities. We have tried to do this by Conferences such as our meeting today, by technical reports, by use of the news media, and by preparation of a number of films. What are the impacts of this kind of demonstration project?

On the one hand, there has been substantial enhanced public awareness and involvement as a result of our activities and the attendant publicity. We think we have aided lake rehabilitation programs elsewhere. Michigan has initiated a sister project. The National Eutrophication Research program people, the Federal activity in lake restoration, have expressed great interest in our work and use them as a lever to develop the additional funding which is necessary for a long-term more thorough investigation of some techniques. A number of agencies and Universities have launched comparable programs using our results as a stimulus. We think our work with developers, large and small, will substantially influence the nature of the rural landscape in the upper Midwest over the next several years. Several of us had the opportunity to meet with 50 small real-estate developers in a 3-county area in northern Wisconsin last year. We tried to provide some guidelines for land development around water bodies. At the end of the meeting we felt we had missed the target, but within a 3 or 4 week period we were surprised to see 2 or 3 of the developers incorporate the deed restrictions and other private controls we had talked about. Two developers changed their en tire land development schemes; in one case backing away from a meander in a river and creating some buffering shoreland and some commonly owned grounds; in another case moving far back from wetlands. In each case the developers realized a much greater economic return than if they had proceeded with their original design. We realized at that time that if we could only extrapolate this experience to other Wisconsin counties and to Minnesota and Michigan, it would have tremendous impact over the years.

Another subject which is closely related to water quality degradation is the kind of waste disposal facilities which exist close to lakes. We think that our early activities with waste disposal research and demonstration projects has stimulated a number of creative activities in this area. Hopefully, we have made some contribution to policy making in the area of lake shoreland and resource management.

Where do we go from here? Of course we expect to complete our treatment of different lakes and to continue to monitor and report the results to potential users. But unlike some programs which seek perpetual funding, we have a death wish targeted for June 1973. At that point in time, we feel that the project should be institutionalized because it has been shown to be successful; and if not successful, then it should be discontinued. If this kind of an approach, bringing together expertise from the Department of Natural Resources and Universities along with some seed monies, is a way of protecting our lakes and restoring the lakes and shorelands, we think it should be paid for by prime beneficiaries, that is the people of the benefited State rather than by a Federal agency which is attempting to get this kind of program initiated to protect the resource base of the Upper Great Lakes region.

REPORT ON SELECTED LAKE RENEWAL ACTIVITY - CHEMICAL INACTIVATION OF NUTRIENTS, NUTRIENT EXCLUSION/DILUTION PUMPING

Tom Wirth, Wisconsin Department of Natural Resources, Section Chief for Water Resources Research

One of the basic tenets of lakes is that they are nutrient traps. When you look at the runoff in a watershed that ends in a lake most of the nutrients stay in the lake going into plant growth that dies and settles to the bottom of the lake. Usually the overflow of water out of the lake is the best quality in the lake with regard to low nutrient concentrations. Considering ways to renew or manage lakes to prevent rapid aging, there are several possible ways of removing nutrients. One is harvesting aquatic plants and fish. Another possibility is using a bottom draw in lakes with an outlet stream so that when you move water out of that lake you are taking the water with the greatest concentration of nutrients. Another possibility is pumping which I will describe later. Still another possibility is nutrient exclusion either physically or chemically by tying nutrients up so they are not available for aquatic plant production. Any excessive nutrient input must be stopped first of course.

The choice of the chemical for chemical inactivation of nutrients takes into account the need for a safe chemical so we aren't harming the aquatic eco-system; the need for a practical chemical, one that isn't too expensive and can be handled safely; and one that has long-term effectiveness. We started with the use of an aluminum salt, alum to be exact, in Horseshoe Lake.

Horseshoe lake is located in Manitowa County Wisconsin. The lake is 22 acres in size, has a maximum depth of 55 feet, contains about 375 acre ft. of water, in a watershed of 1,700 acres. The watershed is poorly drained because of the glacial moraine and potholes in the region. The lake has an intermittent outlet and it received most of its nutrients over recent years from a cheese and butter factory located in the watershed. The factory closed in 1965 after several decades of operation. From 1963 to 1965 it operated with a tiled discharge field which enhanced effluent flow to Horseshoe lake. The lake was originally a bass pan fish lake that suffered fish kills in the winters of 1964, 1965 and 1966. The dissolved oxygen was essentially depleted in the winter of 1969-70. The lake suffered nuisance

algal blooms and copper sulfate was used from 1965 until the present to attempt to control algae. Blooms were common in the winter as evidenced by layering in the ice. Alum was choosen because of its widespread use in waste water treatment and drinking water purification.

Alum is a coagulant which is relatively harmless to aquatic organisms, especially at the concentrations we were using. Alum is relatively inexpensive, $60 a ton at dry weight and about $48 a ton for liquid alum. Transportation charges from Chicago to the lake were $17 a ton. Alum was applied at the rate of 1,000 pounds per acre in May 1970. It took about 4 hours to put the alum in the lake. The total cost for this lake was about $1,000. The alum removed phosphorus and particulates in the lake water and had low toxicity to most life forms.

Alum and sodium aluminate was first tried in the lab with jar tests. Several coagulant aids, including polyelectrolytes, bentonite, Fullers earth, and fly ash were also applied with alum but no increase in phosphorus removal was noted. Alum was tried in jars at levels of 75 to 300 parts per million which means 7-27 parts per million aluminum.

It was found necessary to mix the dry alum with water to form a slurry and apply it just under the water surface. We decided to use 200 parts per million of alum which would give us 18 parts per million of aluminum. We choose to treat the top 2 feet of water in the lake. This means we used about 1000 pounds per acres. In the laboratory this quantity resulted in the removal of 88 and 30 percent respectively of dissolved and total phosphours in 6 hours. After several days, 80 percent of the total phosphorus was removed. In addition, alum also removed color, decreased total alkanitity and lowered the pH.

Rainbow trout fingerlings were subjected to dosages of alum and sodium aluminate to check on the toxicity of several levels. They were not harmed at the rate we intended to apply. At 300 parts per million they were bothered mechanically with the floc in the water. However, the water was decanted and trout were reintroduced into the decanted water with no harmful effect. Of course in the lake we were only applying alum to the surface and fish would have the opportunity of moving out of the surface and away from high concentrations. In addition, in the laboratory jar tests, it was noted that the two crustaceans brought in with the lake water lived through the tests. Green algae settled on the floc and maintained life indicating no acute toxicity to algae.

The lake was treated with 3 different craft including an army duck with three 55-gallon drums in which powdered alum and water are mixed into a slurry and pumped under the lake surface. In addition, a 20-foot long barge with two 200-gallon stock tanks for mixing and a 16-foot work boat with one 55 gallon drum were used. With the work boat and one 55 gallon drum and 2 pumps we were able to apply about 700 pounds per hour; with the barge 2,500 pounds per hour; and with the army duck 3,000 pounds per hour. The slurry was pumped into the lake through a 10-foot plastic pipe perforated with holes.

The lake was divided into nine 2 1/2-acre sections which were marked with bouys so that alum was applied evenly in each section. One day after treatment water clarity doubled. However, a week later we received 5 to 7 inches of rainfall and water clarity diminished to where it started and then slowly improved.

What happened to phosphorus? In the fall 1966 before treatment when the lake was completely mixed there was about .3 parts per million of phosphorus. After treatment the phosphorus concentration was down to about .04 parts per million. This is the weighted average total phosphorus in Horseshoe lake. The average was computed by dividing the lake into vertical sections. There was about a 110-pound decrease in phosphorus in the first summer of treatment. The color went down immediately after treatment but subsequently returned to what it was before treatment. There was no decrease in nitrogen; we got a temporary decrease in alkalinity and pH but both subsequently recovered. There was no increase in sulfates, the only real change we noted was in phosphorus. As far as the physical condition of the lake is concerned, during the winter of 1970 and 1971 the oxygen content were good for fish down to 25-50 feet from the surface of the lake. Previous to treatment the oxygen was out to the bottom of the ice. There have been no severe algal blooms since treatment; there have been some minor blooms. The vegetation along the shoreline which drops off steeply increased considerably so that this area required treatment near docks. The benthic fauna collected in April 1971 was typical of that found in a eutrophic lake.

Some of our future plans are to treat 2 or 3 more lakes of different types with aluminum. One type is a hard-water, nonstratified lake and the other type is a soft-water stratified lake.

Our other project involved 12.5 acre Snake Lake and dilutional pumping. This lake, located in northern Wisconsin, received sewage from the village of Woodruff from 1942 to 1964.

The lake has an outlet at the north end which empties into a system of three lakes and into a river system. The outlet channel was blocked with gravel to prevent water from enriching Arrowhead lake immediately downstream Snake Lake levels rose and water continued to seep into Arrowhead lake. When we started this project we installed a pump on the outlet of Snake Lake to pump about 17 gallons per minute into an adjacent wooded area to stop outflow. Then 22 wells were installed to monitor groundwater quality and to measure groundwater levels to get some idea of what effect pumping water out of Snake Lake has on the groundwater regime in the area.

The lake was at one time a bass, panfish, muskie lake. Many winter kills reduced it to a mud minnow, fathead minnow, stickleback lake. To begin with, the wells were installed, water samples were taken for water quality determinations, and infiltration tests were run to determine how fast we could put water back into the soil. In 1968 we began monthly monitoring of the lake itself. The soil is typically sandy. The lake is basically an expression of the groundwater table and the infiltration tests indicated that permeabilities were between 225 and 1125 gallons per day per square foot. In addition, bottom sediments were sampled to measure nutrient leaching potential.

The phosphorus content of the lake water averaged about .5 parts per million and the phosphorus content of groundwaters was between .01 and .03 parts per million. Chlorides in lake waters averaged about 35 parts per million; chlorides in groundwaters averaged about 2 parts per million.

A 4-acre disposal field was prepared in 1969 about 1500 feet east of the lake. The lake was pumped at that time for 2 weeks, 12 hours a day at 2,400 gallons per minute. During the two-week period we pumped about 65

acre-ft. of lake water. The lake had a total volume of 90 acre ft., so we pumped out about 2/3 of the lake volume and dropped the lake level 3 1/2 feet. From the pump to the disposal field fabric tubing was used.

In 1970, we enlarged the field to 17 acres; 1.7 miles of shallow ditches were installed in the field with a road grader. These ditches were contoured so that water stayed fairly level in all of them. We pumped from 2,250 gallons per minute to 1,150 gallons per minutes during a 6-week pumping period against a head of 42 to 45 feet. The lake level dropped 11 feet. We had quite a bit of sludge from the lake in the field which settled into the ditches. At the end of the pumping period we had about a foot of wet sludge; upon drying the sludge was 1 inch thick. Some compaction along the shoreline occurred as the result of lowering the lake water level. At the end of the pumping period a groundwater mound had built up under the disposal field.

Before pumping the average lake chloride content was 35 parts per million. During and shortly after pumping the lake chloride content was 17 parts per million. Eventually the lake chloride content rose to 35 parts per million probably because of leaching from the bottom sediments. The lake finally filled in the spring of 1971. Nitrogen levels before pumping were about the same as those measured after the lake had refilled. Since pumping, the phosphorus content has been about 1/2 of what it was prior to pumping indicating that we did leach bottom sediments enough and dilute the water enough to remove a considerable amount of phosphorus.

In general the conclusion on the Snake Lake project is that whereas we were not able to remove nutrients to low enough levels to prevent nuisance blooms or to bring oxygen levels back in the winter we did remove considerable amounts of phosphorus. Flushing operations for 5 or more years would be probably required to bring phosphorus levels to non-nuisance levels. Duck weed growths were almost eliminated.

The total cost of the pumping operation was about $5,000 not including the cost of monitoring. Future plans for Snake Lake are to utilize it to try out nutrient precipitation with aluminum.

REHABILITATION OF THE MARION MILLPOND

Ed Brick, Wisconsin Department of Natural Resources, Chief of Water Regulation Section

The Marion Millpond is located in northern Waupaca County in a part of Wisconsin which is hilly and has a sand-clay soils complex. It is a dairy farming area where many of the farms are going out of operation and properties are being acquired for recreational activities. The stream in question is the north fork of the Pigeon river. It is a trout stream. The site of the Marion Millpond dam is on a rapids that supported a naturally occurring wetlands adjacent to the river. The dam holds a pond about 100 acres in area with a maximum depth of approximately 12 feet. The dam was built in 1856 and has been rebuild several times.

Before we arrived on the scene, the local folks in Marion had acquired the dam from the mill owners and were trying to manage the pond. They were removing tree stumps which were abundant in the bottom of the pond. They were mechanically harvesting aquatic plants. In the winter time, to solve

the winter kill problem, they plowed the frozen surface of the lake to enhance light penetration to keep the aquatic plants actively producing oxygen. They also had accomplished some dredging at the head end of the pond in an effort to concentrate the high quality waters entering the pond.

The problems at the Marion Millpond were winter kill, excessive plant growth, and stumps. When we arrived at the pond, the City of Marion had already lowered the pond level somewhat so we were aware of the large number of stumps. Another problem that we discovered as we went along was that there were many point sources of nutrients that tended to enrich the waters and support the growth of aquatic nuisance plants in the water. Our initial objectives were to demonstrate ways to manage the littoral zone by employing the techniques of dredging to remove the organic soil down to mineral soil which we knew was a poor substrate for aquatic plant growth. In addition to dredging we desired to demonstrate placing gravel blankets over the millpond bottom. We intended to use plastic sheeting in combination with the sand and gravel blankets on the bed of the millpond. We desired to demonstrate how to get at the point nutrient sources in the watershed to try to slow down the rate of enrichment of the water.

A Marion Special Millpond Committee had been formed. It was composed of members of various sportsmen clubs, civic organizations like the Lions Club, and also members of the City Council.

What we really demonstrated in Marion was how to bring technical assistance and some dollars together with a very active local group to accomplish a goal of millpond renewal.

We conducted a bottom sampling program so we could understand more about the soils and the contours of the bottom. This information is extremely important to drainability. We also examined the dam and surveyed the aquatic plant community. We established a program that included dam modification, millpond draining, removal of stumps, bottom treatment, park development, watershed point sources for nutrient treatment, and monitoring. We lowered the bottom of an existing masonry arch opening in the dam, and enhanced the drainability of the dam so that the lake could be drained. Some sediment did move downstream as the result of the drainage. Because the sediments were underlain by marl we were never able to completely dry the sediments and we had to wait until winter when the millpond froze before moving equipment. Black plastic sheeting was laid and gravel was placed on it. The gravel blanket was found to be desirable for fish. Few aquatic plants have grown on the treated portion of the millpond bottom since the millpond was refilled.

We learned that you need to organize to a considerable extent at the local level. The ability to organize is a good indicator of the sincerity of the local interest and it takes a great amount of local interest to see one of these projects through to successful completion. You should organize in a manner that includes fund raising potential. Thereafter there must be a great deal of discussion between the local organization and all of the experts you can put together. There must be a review of all the information you can put your hands on regarding the resource you are concerned with followed by a listing of the problems and of the options that may be employed to solve these problems. The people of Marion are very happy with

the results of the millpond renewal. The total cost of the project was $86,000 Federal and $30,000 local.

WAUPACA URBAN RUNOFF

Jim Peterson, Water Chemist With the
Inland Lake Demonstration Project

Another phase of the Inland Lake Demonstration Project is a study of urban runoff at Waupaca. Several studies in the nation, including ones in the Twin Cities area, have shown that large concentrations of nutrients, suspended solids, oxygen demand materials, and coliforms in urban runoff attain levels near those which are present in raw sewage. In addition, fair amounts of chlorides, pesticides, hydrocarbons, and heavy metals are incorporated in urban runoff washed from the streets. The substantial concentrations of nutrients, oxygen demand and other materials, coupled with the large volumes of runoff has led to the recognition that urban runoff has a very high potential for pollution and degradation of surface water quality.

Studies at Cincinnati, Ohio, among other places, have indicated that even rain water in urban areas is sufficiently degraded that it contains nutrient concentrations which are sufficient, in theory at least, to produce algal blooms. The studies have also indicated that suspended solids in urban runoff would come close to that in raw sewage. Chemical oxygen demand of runoff is often on the order of 1/3 that in raw sewage. Inorganic nutrients and coliforms runoff often are roughly in the order of 1/10 those found in raw sewage. Available data for nitrogen and phosphorus inputs from a watershed study on Lake Mendota showed that urban runoff came close to having the same phosphorus output characteristics in pounds per acre as the output characteristics from manured lands. About 17 percent of the phosphorus was contributed by urban runoff.

We note two facts from available studies: 1) Phosphorus content of waters is of prime interest because it has been indicated as possibly a commonly limiting nutrient. This is fortunate, because techniques are available for control of phosphorus whereas techniques for the control of carbon or nitrogen or some of the other nutrients are not so readily available. 2) Most of the studies have been conducted in large cities and to extrapolate studies to small cities may be difficult.

Our study is aimed at protection of water quality. We plan to characterize the urban runoff of a smaller Wisconsin city which we hope would be typical of the Upper Great Lakes region. We will compare our study with information from other cities in order to strengthen the general data which is available so that the observed effects of urban runoff can be extrapolated.

For the specific site we are working at we will be comparing urban runoff inputs of nutrients and other components with the groundwater and rainfall, and then go on to determine the relative importance of the urban runoff to water quality characteristics observed in lakes and to determine what controls might be expected and what these controls will achieve. The transport of nutrients, oxygen demand materials, suspended solids, and chlorides via urban runoff is of prime interest, but other components also

will be measured. The specific sites that we are considering are Mirror and Shadow lake basins which are 10 and 35 acre lakes within the city limits of Waupaca. The urban runoff constitutes the bulk of the surface water flow into these lakes. A single basin drains into Shadow Lake and 2 smaller basins drain into Mirror Lake. These are primarily residential areas of varying population densities. The 2 lakes are showing signs of creeping eutrophication; nuisance algal blooms, serious DO depletions, and fish kills. If the urban runoff can be shown to be the likely cause of the deterioration, control measures such as diversion or whole or partial treatment for the runoff can be implemented.

Because of the extreme variations in the composition of the urban runoff, it takes a fairly detailed study to adequately characterize runoff. We have gaging stations that the U.S.G.S. is operating on all 3 storm water basins, and are taking water samples at intervals varying from 10 to 30 minutes throughout the periods of runoff.

Shadow Lake is 35 acres in area and 35 feet deep. It is a hard water lake which has had a trout fishery. There is a single storm water outflow from a 100 acre drainage basin. The drainage basin is mostly low land with low population density. There is a 30-inch sewer pipe which empties into a ditch which apparently was a trout stream.

Mirror Lake is a 10-acre, 40 foot deep, seepage, hard-water lake which is adjacent to Shadow Lake. There are two storm-water basins, the first is about 40 acres with primarily residential development of roughly 10 persons per acre population density. On this basin there is a bubble gage in the storm sewer which was calibrated by running fire hydrant water down the street in the middle of the night in order to get good data. This basin will be sampled on 10-minute intervals. The second basin is about 5-acres in area with residential development. The U.S.G.S. has a V-notch weir and a continous recording gage in this basin. On this site there will be continuous flow data and sampling. Along with the urban runoff study itself we are collecting information on precipitation, groundwater movement, and dry fallout additions of nutrients in the basin.

This project started in January 1, 1972. The end result will be a study which can be used to direct action to solve this particular runoff problem and will provide a basis for making decisions concerning water quality in other small urban settings in the Upper Great Lakes region.

A RESOURCE-PROTECTIVE APPROACH TO SHORELAND DEVELOPMENT, INCLUDING INNOVATIVE PRIVATE CONTROLS FOR RECREATIONAL LAND DEVELOPMENT

Steve Born, University of Wisconsin, Project Leader

It is natural that we be concerned about shorelands because shoreland use has a direct impact on water quality. Shorelands are important as a rexource in their own right because they are unique ecologic habitats and moreover because they impart special scenic quality to a lake shoreline. The way we use a shoreline and the way we develop a shoreline relates to subsequent recreational water surface use conflicts.

Our major lake problems are water quality degradation, shoreland deterioration, and surface water use conflicts. These are inseperable by-products of shoreland use and development patterns. In Wisconsin, where we have almost 1 million acres of inland lakes, we have come to realize that our lake and shoreland resources are not inexhaustible. These resources are severly taxed in many areas, particularly close to the urban environment, and lake use (at least in Wisconsin) is expected to quadruple by the year 2000. We have demand for lake frontage and lake useage sky rocketing and a relatively fixed resource base -- the classic Malthusian dilemma. This poses some tremendous challenges and problems to natural resource managers both now and in the future.

We are especially concerned, as part of the Inland Lake Demonstration Project, with shoreland real estate development. We are funded by an economic development agency and many areas in the Upper Great Lakes Region have little potential economic base except for their recreational resources. Its inevitable in many situations that development is going to take place. We should certainly identify those areas where we wish development not to take place. We should be concerned with guiding the nature and location of development so that the result is good development. There are people of a preservation persuasion who would object and say there is no such thing as good development. But I think there is.

Past development of shorelands has largely involved simple parceling of lakeshore properties. This kind of perimeter development sometimes expands outward concentrically from the lake but seldom allows human pressures to be focused on the back lands. Instead pressures are directed to the immediate shoreland which are the most sensitive part of the eco-system and the most prone to problems. What we are supporting is a new kind of development that integrates back land resources that are not intimately associated with lake frontage to the water.

Other results of traditional and conventional shoreland development have included the destruction by man of shoreline vegetation, topography, and other natural values in his rush to occupy the lakeshore. We are all familiar with the lake which has been so completely developed by rings of civilization that piers stick out like tooth picks minimizing water surface for recreational purposes. Many of yesterday's lakeshore developments have become today's rural slums. Many of the values that attracted people to the lakes have been destroyed

In Wisconsin, we have had difficulties getting a handle on these problems! We recently undertook a study in the Upper Great Lakes region area to find out what has been the rate, mangitude and nature of shoreland development in northern Wisconsin. We used tax assessors records and records in the register of deeds office. A statistical survey is being made county by county of the rate at which development is taking place on different kinds of lakes, of what the nature of that development has been, and of what is the parcelling procedure. The objective is a factual accounting of where we are today. Hopefully, this will serve as the basis for formulating intelligent public policies. These could take several forms. They could include more stringent parceling or subdivision requirements, strengthening shoreland development controls, etc. We would like to document where the problems are most serious today in Wisconsin and get comparable information from region to region as a basis for programming. Furthermore we are interested in evaluating the kind

of information which is available locally so they might be incorporated in a shoreland development data bank. A dynamic inventory which keeps pace from year to year with the kind of land development taking place is what is needed in order to make strong well-documented decisions regarding the disposition and use of shorelands. Also, as we gather this information we are concerned with providing some guidelines for land developers regarding new tastes and new markets to afford a realization of the economic potential of shorelands. A by-product of our study is a comprehensive list of shoreland property owners who can then be surveyed and you gather information regarding what their roles have been in both development control and lake management.

We still don't know what the relative magnitude of piece-meal small-scale land subdivision is in contrast to large-scale land developments around lakes. As I indicated this morning, our concern has been focused to date on larger recreational developments because there has been a great acceleration in their number and more and more companies who own large tracts of land are looking for new profit centers and opportunities to diversify. This is a trend of the future. This kind of development requires carefully planning and designing and a well organized management device, perhaps a homeowners association.

We are trying to introduce new shoreland development concepts. These include a variety of design ideas. One concept involves substantial set-back distances around lakeshores to preserve the natural areas around the lakes. Another concept involves the clustering of development around the lake to minimize the amount of land which is disturbed. By going to cluster subdivisions you get more open space for back-land recreation activities such as hiking, horseback riding, nature walks, etc. This tends to relieve the pressure on the lakeshore property and disperses development to the back-lands.

The design and planning process includes several steps. The first step is a site inventory, an evaluation of the soils, water regime, vegetation, topography, geology, scenic assets and ecological or scientific qualities of an area. The second step is a suitability analysis, i.e., how can what's there be best used, matching the landscape characteristics with the requirements for a particular use. For example, to use septic systems, we need to know how deep the water table is, how deep it is to bedrock, percolation rates of the soils involved, and the slopes of the land. We need to determine the kinds and amounts of planned recreational facilities and their locations and interrelationships. We are concerned with the recreational carrying-capacity concept in an effort to reduce land and water use conflict.

Design aspects are constrained by economic considerations. There are a variety of cash-flow models which allow developers to test the outcomes of various development alternatives. We can get a fix on what kinds of financial trade-offs are involved for different designs.

Doug Yanggen, University of Wisconsin,
Extension Service

The past few decades have witnessed a rapid growth in the demand for recreational land, and the natural beauty of lakes and their water-oriented recreational opportunities have resulted in increased subdivision of

lakeshores into buildin g lots. The conventional pattern of developing a tier of lots on the immediate shoreland continues. But, new concepts in recreational development are appearing. These planned recreational complexes have both individually owned building sites and common open space and facilities.

Lakes can be buffered by not developing the shoreline. Individually owned lots can be grouped into attractively located off-shore clusters. This allows the shoreland to act as a buffer between the water and land absorbing some of the pressures of use. Shorelands as natural preservers of water quality trap nutrients and retard erosion. Preservation of the shoreline buffer in its natural state also conserves the unique scenic values of the lakeshore. Another feature, particularly of the large-scale developments is that in addition to the traditional water oriented activities we may find such things as golf courses, horseback trails, play fields, and other recreational facilities. Typically these facilities are linked by commonly owned greenways. The residential clusters in turn can be linked with each other with shared recreational facilities as well by a network of commonly owned greenways providing access to all parts of the property. This then is the general kind of development we are talking about.

The automatic property owners association can provide a mechanism for maintaining and managing the common open space and facilities to which individual lot owners have common rights. It can also administer architectural and environmental controls in the form of private zoning through deed restrictions that are designed to preserve the amenity values of the development. And finally, if necessary, the association can be a mechanism to provide services to the individual lot owners and to the development as a whole. The automatic property owners association, an incorporated non-profit organization, operates under recorded land agreements. These agreements provide each lot owner is automatically a member of the association and subject to his share of the expenses of the association's activities. The advantages of an association are sharing of property rights and expenses making possible maintenance and management of diverse facilities.

Open space can be used to protect the scenic values of woods, hillsides, waters and wetlands. Preservation of the undeveloped strip along the shoreline preserves the appearance of the shoreline and helps maintain water quality. The profit the subdivider foregoes by not developing the high value shoreline property can be more than compensated for by the increased value of more numerous off-shore lots. Clustering lots on suitable terrain reduces land improvement costs and converts wetlands, steep hillsides, and other difficult to develop features into scenic assets. Thoughtful planning and design which consider the resource values of the larger landscape preserve the character of the environment while enhancing property values.

What are some of the problems which are associated with this kind of development? Planned recreational development with both individually owned lots and commonly owned open-spaces requires several things. First of all maintenance and management of common properties. Secondly control of individual lot development and finally special provisions may be required for needed services. The extensive common properties will obviously require maintenance and management. Open spaces will require mowing and cleaning up. Some of the recreational facilities will have to be operated and supervised. Individual lot development would have to be supervised to insure compliance with the general plan of development. Control over the type of

structures to be erected would be necessary to insure the correct setting and architectural harmony. Proper installation and maintenance of private sewer and water supply systems, measures for interior drainage, and erosion control, etc. may also be necessary. The basic point is that plans for the physical layout and development of the recreational complex should be related to the consideration of the means for providing services, maintaining and managing the common property, and controlling private lot development.

In analyzing the role of a property owners association in these matters alternative and supplementary mechanisms for dealing with potential problems should also be considered. There are 2 principal types of collective action mechanisms which exist each capable of performing several of these functions. The first is public action based upon the police and taxing powers of either general purpose units of government or special-purpose districts. The second, is private action through a property owners association based upon covenants and restrictions applicable to the land within the development. No single agency, whether the property owners association or any one of the various governmental units, can deal with all problems. Some functions like the need for surface water regulations where you have an overloaded lake and you have conflicts between the various water users can be adequately met only by public action. Others, such as maintenance of commonly owned private property, can be performed only the the property owners association. A number of functions such as provision of services and control of individual lot development can be performed either by the property owners association, special-purpose units of government, or general purpose governmental units.

The authority of the property owners association to perform the various required functions and charge for their costs derives from the declaration of covenants and restriction. Prior to selling any lots the developer records this document which applies to all the lands in the development. The declaration announces the intention to create a general scheme of private regulation that integrates the residential clusters with commonly owned open-space recreational facilities. Each parcel or tract is thereby subjected to certain covenants, restrictions, easements, and assessments. The same declaration assigns to the property owners association affirmative powers that pertain to common properties, to enforce the negative covenants and collect the assessments provided for. The association, in administering the provision of the declaration, acts as the representative of each lot owner and exercises, his right to enforce them against every other lot owner. The recorded declaration is also referred in the deed of conveyance to each lot.

The amenities of a well designed complex can be imparied if individual lot development does not conform to the general plan. Some kind of private zoning through restrictive convenants is, I think, an important part of development. Approval of building plans by an architectural committee of the property owners association is typically required. The Committee can withhold approval if the exterior design materials or color of the building are not in harmony with the general surroundings. There are other kinds of environmental controls that can be imposed through private restrictions. Many of these same items are covered by public regulations or could be. The advantage of private restrictions is that they can include controls not covered by public regulation.

NATION-WIDE SURVEY OF LAKE REHABILITATION LEGISLATION AND PROGRAMS

Jon Kusler, Resource Consultant,
University of Wisconsin

Explicit statutes authorizing local units of government or State agencies to protect, manage, or rehabilitate lakes are rare. Existing State programs are often undertaken pursuant to broad powers such as those authorizing an agency to manage State waters or wildlife. Some agencies acting under broad mandates have dredged lakes, made duck ponds, etc.

There are many programs underway that affect the use of lakes, but they are often fragmented among many agencies. Communication between agencies is limited. This lack of explicit powers and fragmentation has discouraged comprehensive lake protection, management and rehabilitation efforts.

States will probably need new legislation to qualify for Federal participation under the pending Clean Lakes Act. Needed legislation might include regulations for indirect non-point sources of pollution such as agricultural runoff, urban runoff, septic tanks, road building, etc. There is often legislation on the books pertaining to point sources. Other legislation is needed expressly authorizing lake protection and rehabilitation efforts by local general purpose units of government, special-purpose units of government or State agencies. Increased control of shoreland uses is needed to protect water quality and wildlife. New methods for financing lake rehabilitation must be provided. Financing formulas should recognize both the benefits of lake management to private shoreland owners and to the general public. Costs should be charged to benefited individuals.

Both States and local units of government have programs related in some manner to lake protection. State activities are often concerned with water uses that directly affect the water. Local activities are usually concerned with shoreland activities.

All States have some kind of pollution control agency, although most programs are not concerned only with point discharges. Some States like Iowa, explicitly prohibit discharges of wastes into lakes; others prohibit discharges of wastes into special lakes. Agencies in some states have begun to adopt specific pollution regulations.

Forty-eight States require permits for dredging and filling and other alterations of navigable waters. A few States, like Nebraska and North Dakota, prohibit or regulate the draining of lakes. Thirty-five States authorize State agencies to investigate and make recommendations concerning lake water levels. Forty-nine States regulate the construction of dams. Forty-three States require permits for application of pesticides or chemicals for weed control.

There is very little specific legislation authorizing local units of government to regulate land use for the protection of lakes, but most cities, counties, and towns have broad zoning and subdivision control powers. A number of States have adopted legislation authorizing local units of government to adopt special shoreland regulations. All 71 Wisconsin, and a number of Minnesota counties have adopted shoreland regulations.

There is a fair amount of lake management legislation but little restoration legislation. Forty-two States permit State agencies to construct dams. Forty-eight States authorize agencies to stock fish and maintain habitat. Thirty-three States authorize agencies to stabilize lake banks and erosion areas. Forty States permit agencies to treat waters for week and algae control. Twenty-eight States authorize agencies to dredge or otherwise reclaim lakes.

Only a few States expressly authorize lake management by local units of goverment. Several States, like Washington and Indiana, authorize local units of government to construct dams and control water levels, and permit the beautification of waterways by counties and municipalities. Several States have granted soil and water conservation districts broad powers that could include dredging of lakes and powers to rehabilitate water bodies. Connecticut has adopted legislation authorizing special lake authorities to control and abate algae.

Only Michigan has explicit legislation authorizing the creation of lake improvement districts. Their statute has interesting elements that might be incorporated into statutes of other States. The statute places the burden of action on the local units of government or lakeshore owners and gives them a formal mechanism for undertaking lake rehabilitation activities. The statute permits 2/3 of the freeholders owning land abutting a lake to petition a local unit of government to form a lake improvement district or a local unit of government may, on its own initiate, create a lake improvement district. The Department of Conservation may also petition to create such a district. Lake improvement districts have very broad powers: they may improve the lake including taking necessary steps to remove and dispose accumulated materials from dredging, etc.

Michigan lake improvement districts are controlled by a board composed of a local county board member, a local governmental unit member (other than from the county board), a county drainage commissioner, and a representative from the Department of Conservation. The steps involved in a lake improvement program are as follows: First the board determines the scope of the project and defines a special assessment district to include all benefitted property owners. Then the board retains a professional engineer to prepare a feasibility report and make economic studies. The board holds a public hearing on the proposed project and notice is given to all affected land owners. If they decide, after the hearing the project is desirable, the board approves it. Local assessors of these affected units of government prepare an assessment role for the board. Hearings are held and an assessment role is adopted. Payments may be scheduled in one to thirty installments. These special assessments constitute a lien which is collected much like taxes. The board is empowered to issue bonds and to receive gifts for restoration projects. The board takes bids to raise immediate operating funds. The Department of Conservation has the power to intervene at any time in a project to protect the public interest.

SHORELAND MANAGEMENT EDUCATION PROGRAMMING

Doug Yanggen, University of Wisconsin,
Extension Service

The basic purpose of our Inland Lake Domonstration-Project's management educational program is to provide a better understanding by the public so that they can cope with lake problem solving efforts. The audience we have in mind is lakeshore property owners, local governmental officials, and the general public.

There will be two kinds of products associated with the educational package under preparation. The first is a primer on lakes and lake problems and the second is a slide-type presentation for use by local resource technicians. The narrative for the slide presentation will duplicate at a less detailed level the primer. An initial series of programs over the educational telephone network, which is a party line connecting all counties in Wisconsin to the Madison campus, will be used to familiarize local resource technicians with the program and then individual slide sets and copies of the primer will be sent to each one of the 50 listening locations. We hope to have a dry run with the technicians and local governmental officials and a substantial program this summer while the people are on the lakes is scheduled for about mid-August.

Basically the primer is in 4 parts. The first part describes the features of a typical lake and gives some general insight into the complex, ecologic processes which occur in lakes. The watershed, water cycle, origin of lakes, water movement in lakes, food web and other concepts are discussed. The second part describes lakes problems and corrective measures. A major concern deals with the processes that impair water quality, mainly sedimentation and eutrophication. In-lake management techniques test by the Inland Lake Demonstration Project and other agencies are discussed. The second part also describes how the shoreland can be protected to preserve water quality and the landscape environment and further suggests how boating controls and surface water regulations can reduce water conflicts that arise with increasing lake use. The third part describes lake related problems and presents a variety of ways to deal with lake problems. The fourth part suggests sources of information and where local units of government and interested citizens can go for assistance.

We hope through our combination of education techniques we will be able to raise the interest of the people in the State for managing lakes and to improve the decision-making process as far as lake problem solving is concerned.

PROGRESS OF MINNESOTA'S SHORELAND PROGRAM AND ACTIVITIES IN LAKE DEMONSTRATION PROJECTS

Michael J. Hambrock, Division of Waters, Soils and Minerals, Minnesota Department of Natural Resources

Lakes and streams are two of Minnesota's most valuable natural resources. Rapidly expanding recreational needs, as well as increased agricultural, domestic, and industrial demands for water, must be satisfied from a fixed natural supply. The economy of many areas is dependent upon the fate of water bodies and their shorelands. As man is drawn to shoreland areas, he often creates problems, such as water pollution, over-crowding, unwise development, destruction of fish and wildlife habitat, and the impairment of natural beauty. Scattered cabins and resorts are built to form continuous ribbons of buildings along lakes and streams. When prime lands immediately adjacent to the shore are in use, a second tier of cabins is often built behind the first. As land values rise, lots with water frontage are subdivided into smaller parcels. Frontage lands with steep slopes, high groundwater, and flooding conditions are platted and put to use in spite of their unsuitability for development. Uncontrolled lake and stream development may ultimately result in blighted recreational areas. Action is being taken now to meet these problems and preserve our waters and shorelands for future generations.

The 1969 session of the Minnesota Legislature passed the Shoreland Management Act amending Minnesota Statutes 1967, Chapter 105. It requires each county to adopt a shoreland management ordinance to help combat these growing problems.

Because of the importance of shoreland management to all the citizens of the State, the legislature also directed the Commissioner of Natural Resources to establish standards and criteria for shoreland development. These standards will serve as minimum guidelines for county shoreland management ordinances which must be adopted no later than July 1, 1972. The Commissioner is authorized to enact the statewide standards into ordinance form for the counties which do not meet this deadline.

The shoreland management standards pertain to the shorelands of public waters located in unincorporated areas.

"Shoreland", by statutory definition, includes lands within 1,000 feet of a lake or 300 feet from a river or stream. In certain cases, the limit may be defined as the watershed divide wherever this divide occurs at lesser distances than the statutory limits of shorelands.

"Public water" is defined by statute as any body of water capable of substantial beneficial public use. For the purposes of this program this can be interpreted as any body of water which has the potential to support any type of recreational pursuit or water supply purpose. Many of the state's lakes and streams are so small that they probably will never be developed for recreational uses. For this reason, and to simplify the administrative load, a lower size limit of 25 acres for public waters was established. Only streams draining an area greater than two square miles need be included in the program.

No single solution will solve all the problems associated with shoreland development. A variety of land use controls are needed to deal with the major causes of the problems. The goals of the shoreland management program are to coordinate land uses, to encourage development which is compatible with the shoreland resources, and to discourage development

which is not. The approach, then, is to establish a set of land use controls which will guide shoreland development for the benefit of both the counties and the residents of the State as a whole. These controls include:

1. Regulations governing the type and placement of sanitary and waste disposal facilities;

2. Regulations governing the size and length of water frontage of lots suitable for building sites;

3. Regulations governing the placement of structures in relation to shorelines and roads;

4. Regulations governing alteration and preservation of the natural landscape; and

5. Regulations governing the subdivision of shoreland areas.

As required, on July 1, 1970, the Commissioner of Natural Resources promulgated the Statewide Standards and Criteria for Management of Shoreland Areas of Minnesota.

The Division of Waters, Soils and Minerals worked closely with several State agencies in formulating a preliminary discussion draft during the first quarter of 1970. These agencies included the Minnesota Department of Health, the Pollution Control Agency, the State Planning Agency, the Department of Economic Development, the Department of Agriculture, the Soil and Water Conservation Commission, other divisions of the Department of Natural Resources, and representatives of the University of Minnesota. Legal advice was obtained from the Attorney General's office and representatives of the State of Wisconsin.

A series of 18 regional information meetings were held at 9 locations in the state in April 1970 to acquaint public officials and the general public with the proposals for the shoreland standards. The Division prepared a slide presentation to illustrate the new proposals, and several staff members attended each meeting to answer questions.

As required by law, a public hearing was held on April 29, 1970. Testimony presented at the hearing and a testimony received in the mail up to May 13, 1970 were considered in the evaluation of the final draft of the standards.

The standards were designed to provide adequate protection for the state's waters, but still be flexible in their application to various regions of the state and to various local physiographic conditions. For these reasons a public waters classification was incorporated into the program, as well as several variances and exceptions to allow for unique problem areas. The public waters classification consists of three classes: Natural Environment Lakes and Streams, Recreational Development Lakes, and General Development Lakes and Streams. A temporary designation of "critical lake" was assigned to any lake which did not clearly fall into one of the three classes under the criteria used for the classification.

Basically, these standards summarized by lake classification are as follows:

Land Use Control	Natural Environment	Recreational Development	General Development
Sanitary Facilities	(Dept. of Health specifications for construction)		
Setback from water	150 ft.	75 ft.	50 ft.
Zoning Provisions			
Lot Size	80,000 sq. ft.	40,000 sq. ft.	20,000 sq. ft.
Water Frontage	200 ft. wide	150 ft. side	100 ft. wide
Building setback	200 ft.	100 ft.	75 ft.

Approximately 1,600 copies of the Statewide Standards have been distributed to public officials. Copies for the general public are distributed through the Documents Section, which is now in its second printing of the standards.

The process of classification was begun on a county by county basis immediately after the standards were promulgated. Priority was given to counties which requested it. The entire State was completed by October 15, 1970. Data for the classification were obtained from the Minnesota Lakeshore Development Study and Department of Natural Resources records. The classification was based upon physical characteristics (size, shape, depth, soils, vegetation, etc.) and developmental characteristics (seasonal homes, permanent homes and resorts). Existing development was weighted quite heavily in the classification, since legal constraints dictate that newly enacted zoning standards must be reasonably consistent with the established pattern of development.

A total of 9,667 lakes were classified. These consisted of lakes over 25 acres in size and not completely within municipal areas or the BWCA. A percentage breakdown by class of the initial classification follows:

Natural Environment	85%
Recreational Development	12%
General Development	3%

The Natural Environment category is inflated because all lakes under 150 acres were initially placed in this category due to a general lack of information regarding there suitability for development.

Many of these smaller lakes have been subsequently reclassified as counties have proceeded to review their preliminary classifications. Many of these smaller lakes have also been identified as being mostly or completely dry and have been dropped from the scope of the program.

At present the approximate percentage breakdowns for each class are as follows:

Natural Environment	55%
Recreational Development	30%
General Development	15%

If lakes under 150 acres are excluded from these totals the percentage breakdown is:

Natural Environment	40%
Recreational Development	37%
General Development	23%

To date 45 counties have finalized their preliminary classifications. Approximately one-third of the requested classification change requests from these counties have been for more restrictive controls. Most of these changes were from General Development to Recreational Development.

Twenty-five additional counties are in the process of reviewing their preliminary classifications and we expect to have them finalized by July 1.

An interesting by-product of this classification review process has been an expansion of the classification system. In Itasca County, for example, there were numerous Natural Environment lakes between 50 and 150 acres in size that were generally suitable for development and would qualify for Recreational Development status. Also, the county felt that the required 200 foot setback on these lakes would result in mass variance requests because along most of their shorelines the 200 foot setback would not allow for reasonable use. However, the county as well as the DNR felt that these lakes were quite fragile and could quickly become overdeveloped. Because of these factors, two subclassifications were developed requiring in one case the same lot area and frontage standards as the Natural Environment classification but with a reduced setback of 100 feet, and in another case, the frontage requirement was expanded to 300 feet, the setback was reduced to 100 feet and all other standards remained the same as for Natural Environment lakes.

This approach is very encouraging to see because it is leading us in precisely the direction we want to go. That is, setting a special set of land use controls tailored to the unique characteristics of an individual lake.

In the past two years the efforts of the Shoreland Unit have centered on contacts with county officials and in the preparation of shoreland information materials. Our staff has attended over 120 meetings with county officials in over fifty counties. The informational materials include a guide for prospective buyers of lakeshore property, an explanation of the classification system, explanation and background information on the rules and regulations, and a guide outlining implementation procedures for county shoreland controls.

To date sixteen counties have enacted shoreland controls in compliance with the statewide shoreland standards. Several of these ordinances have instituted more rigid controls than were required. These more stringent controls are usually found within the sanitary provisions of the ordinance and are composed of improved inspection and enforcement mechanics and increased soil absorption setbacks.

Although only about 20% of all Minnesota counties presently have acceptable shoreland ordinances, approximately 50% of the total number of lakes classified in the State are covered by these ordinances.

The staff of the Shoreland Unit is now in the process of reviewing eleven additional ordinances. If these ordinances meet the shoreland requirements the total percentage of lakes covered by shoreland controls will be raised to 65%. Our present projection is that by July 1, 50 counties containing over 75% of the state's classified lakes will have acceptable shoreland controls.

As mentioned previously, there is sufficient evidence that the increased pressure on our public waters is creating a variety of social, economic and environmental problems.

One readily definable ramification of this increased pressure is a great influx in the number of requests from lake improvement associations, municipalities, sportsman's organizations, other groups and from legislators and individuals for investigations of conditions in lakes and factors affecting them; investigations that would lead to recommended solutions and action programs that would prevent continued deterioration of problem lakes.

It is evident that there is a need to deal with increasing demands for action to study, recommend and implement programs for lake improvement through rehabilitation and restoration projects.

Most of the requests are referable to one or more of five general types of situations.

1. Problems related to excessive growths of water plants and algae. Such growths occur normally in many lakes but are enhanced by increasing the fertility of the water and compounded by activities of man. Domestic pollution and agricultural runoff are often important factors. Another aspect of this problem is development of best methods for controlling growth of such plants where this is due to natural fertility or where added fertility is not controllable.

2. Other water quality problems associated with human activities, such as private waste disposal by cess pools and industrial pollution.

3. Problems of water levels and fluctuation of levels. These are related to the size and topography of the watershed, nature of lake inlets and outlets, abundance and flow of underground waters, land drainage and other types of human use and development of the watershed.

4. Problems of sedimentation and filling of lake basins. This may occur as a result of soil erosion from the watershed and from natural filling of lake basins by deposition of remains of plant and animal life on the bottom.

5. Problems arising from alteration of shorelines and bottom contours, especially by improvement of shorelines for human use. Development for one type of use -- such as swimming -- may be at the expense of other kinds of values -- such as production of fish and wildlife.

It is obvious that there are no general and universal answers that will apply to these problems in all of Minnesota's lakes but there are certain general typical situations on which more information should be gathered so it can be applied elsewhere.

Lakes on which there are known or reported problems have been identified primarily from Department files. Major classes of these problems are as follows:

1. Eighty-eight lakes have had blue-green algal blooms that have been severe enough so that shoreline property owners have paid for control of algae with copper sulfate in at least two years. In recent years permits have been issued for the control of larger aquatic weeds with herbicides or by cutting on about 200 lakes. In addition, records of the Division of Waters, Soils and Minerals indicate that there are at least five lakes with severe weed problems and 31 lakes with associated water quality problems.

2. Seventy-one lakes have been noted in Division of Waters, Soils and Minerals files to indicate they presently have or have previously had specific problems related to water levels. Some of the water level problems are associated with excessive drainage, some with deficient inflow to lakes and some to outlet problems.

3. There are also 23 lakes which Division of Waters, Soils and Minerals files indicate as having sedimentation and siltation problems. These problems may result from shoreline erosion and subsequent deposition of materials in lakes and from silt and sediment carried into the lake by surface runoff, watercourses, or by artificial systems such as storm sewers and drainage ditch systems.

4. A 1968 report on Sewage Disposal Facilities in Minnesota prepared by the PCA indicated there were 72 lakes that were so situated that they could be fertilized by wastes (mostly partly treated effluent) from municipal sewage treatment systems. In many instances these lakes are known to have weed and algae problems.

The legislature in 1969 and again in 1971 recognized that there is a need to deal with problem lakes.

In Chapter 1139, Sec. 38, Subd. 7, 1969 Laws, the legislature provided funds for locally sponsored lake improvement projects by governmental units and non-profit organizations and associations eligible under guidelines established jointly by the State Planning Agency and the Department of Natural Resources.

In Chapter 3, Extra Session Laws 1971, funds were reallocated for the continuance of the 1969 authorized program.

Attention has been given to the development of guidelines for administering and directing the program on problem lakes. Generally these guidelines include the following:

1. Selected projects will be funded by the state at 50% of the local share of the project cost.

2. Other governmental grant programs should be included whenever possible.

3. Award of lake improvement grants will in many cases, be contingent on the ability and willingness of the local unit of government to institute land use controls for the watershed.

4. Eligible applicants include

   a. established regional authorities
   b. local units of government

5. Projects will be documented and results evaluated to determine the degree of improvement. These results will be useful in evaluating similar lake improvement proposals.

However, it is obvious that more is needed than just guidelines to a program of projects. It will be very difficult to establish accurate guidance without some forthought and planning. The types of goals and objectives to be achieved under a program of problem lake projects must be developed. These goals should determine desirable levels of lake character use and management. Goals are needed to draw attention to the range of lake problems and to the range of possible methods of solution. This effort must also draw attention to programs of preventative measures as well as corrective measures. Consideration must be given to how this program can and will be coordinated with existing management responsibilities of the State agencies involved. It is very difficult to establish meaningful guidelines for administering such a program and establishing eligibility of parties to participate unless there is comprehensive information regarding the nature and definition of lake problems, the number of lakes with problems and the possible solutions to the problems. One recommendation has been for a State "team" that would define, survey and analyze problems on various lakes in varying environments throughout the State.

This team would then report on the analysis of problems relating to various physical factors, i.e. water levels, quality, over development, etc. The reports would contain a factual account of all aspects on the problems and when possible include suggested alternatives to solve the problems. The primary purpose, however, would be to delineate the problems and analyze the causes and effects.

A program to solve identified lake problems would be developed consistent with state policy and management programs. Such an approach should lead to an established program of resource management, perhaps similar to those of the state shoreland and flood plain management programs.

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