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RESTORING THE RECREATIONAL POTENTIAL OF SMALL IMPOUNDMENTS

The Marion Millpond Experience

UPPER GREAT LAKES REGIONAL COMMISSION

An Inland Lake Renewal and Management Demonstration Project Report

1973

Technical Bulletin No. 71
DEPARTMENT OF NATURAL RESOURCES
Madison, Wisconsin

A Cooperative Effort of the University of Wisconsin and the Department of Natural Resources

Sponsored by the Upper Great Lakes Regional Commission

ABSTRACT

There are many small water bodies in the upper midwest that are located in or near municipalities. These waters are, or potentially are, important local recreational resources. Silting, heavy growths of algae and rooted aquatic vegetation and declining fisheries have severely limited the recreational potential of many of these small lakes and flowages. This publication describes some of the methods of rehabilitating and managing these water resources.

Marion Millpond, a 110-acre impoundment in east central Wisconsin, was selected as the site for demonstrating lake improvement techniques. Demonstration work was divided into in-pond, shoreland and drainage basin activities. In-pond activities included dam modification, stump and log removal, sediment manipulation, application of various bottom treatments (plastic sheeting, sand blankets, etc.) and fish restocking. The shoreland program included grading and rip-rapping selected shoreland areas for erosion control, recontouring and revegetation of dredged "spoils" and enhancing recreational facilities (beaches, boat launching facilities, park areas) around the pond. Drainage basin efforts were limited to a demonstration of simple remedial measures for reducing nutrient and sediment runoff at three farms in the largely agricultural watershed.

The Marion Millpond restoration was completed in August, 1971, reestablishing the recreational value of the flowage. The project successfully developed efficient techniques for stump and log removal, and for the application of various bottom treatments to suppress rooted plant growth. After two years of monitoring, treated areas generally exhibited less plant growth than untreated areas; the application of plastic sheeting with a sand or gravel covering was most effective. The reduction in rooted aquatic plant problems was accompanied by the invasion of the algae, *Chara,* which will continue to pose some aquatic plant problems in the millpond. Because the impoundment was overfertile, and rehabilitation did not substantially decrease nutrient loading, continued aquatic plant problems are anticipated. Fairly intensive management procedures will be necessary to maintain the pond's recreational usability.

The major impetus for planning and implementation of this project came from local residents. The project has clearly shown how local interests, given the requisite technical advice and partial financial support, can undertake substantial environmental improvement programs. Without the strong local commitment, this renewal project could not have been accomplished.

RESTORING THE RECREATIONAL POTENTIAL OF SMALL IMPOUNDMENTS

By

Stephen M. Born
Thomas L. Wirth
Edmund M. Brick
and
James O. Peterson

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INTRODUCTION

There are hundreds of millponds, flowages and other impoundments in the Upper Great Lakes region. Many of these waterways were formed behind dams to provide power for milling operations. No longer used for power-generation, the dams and man-made lakes remain. Over the years, towns have grown up around these millponds and flowages which represent a potentially important scenic and recreational resource to the community. Eutrophication and sedimentation – resulting in heavy growths of aquatic vegetation, deteriorating fisheries and limited usable surface-water acreage – have severely limited the recreational opportunities afforded by these small impoundments. What could be a prime community asset has become, in many cases, a local liability.

The Inland Lake Demonstration Project, a joint venture of the University of Wisconsin and the Wisconsin Department of Natural Resources, has been concerned with demonstrating lake renewal and management techniques since its beginning in May 1968. Project personnel recognized that an example of how to rehabilitate and manage a lake or impoundment would be readily transferable to the many similar water bodies in the region. Although an impoundment offers certain advantages over a natural lake from the standpoint of demonstrating techniques of lake renewal (the ability to manipulate water levels facilitates the implementation of many "in-lake" management techniques), several elements of the rehabilitation activity would be directly applicable to natural lakes. A successful project would not only be a worthwhile investment in Wisconsin's resources, but would also function as a catalyst and guide for such environmental improvement programs elsewhere.

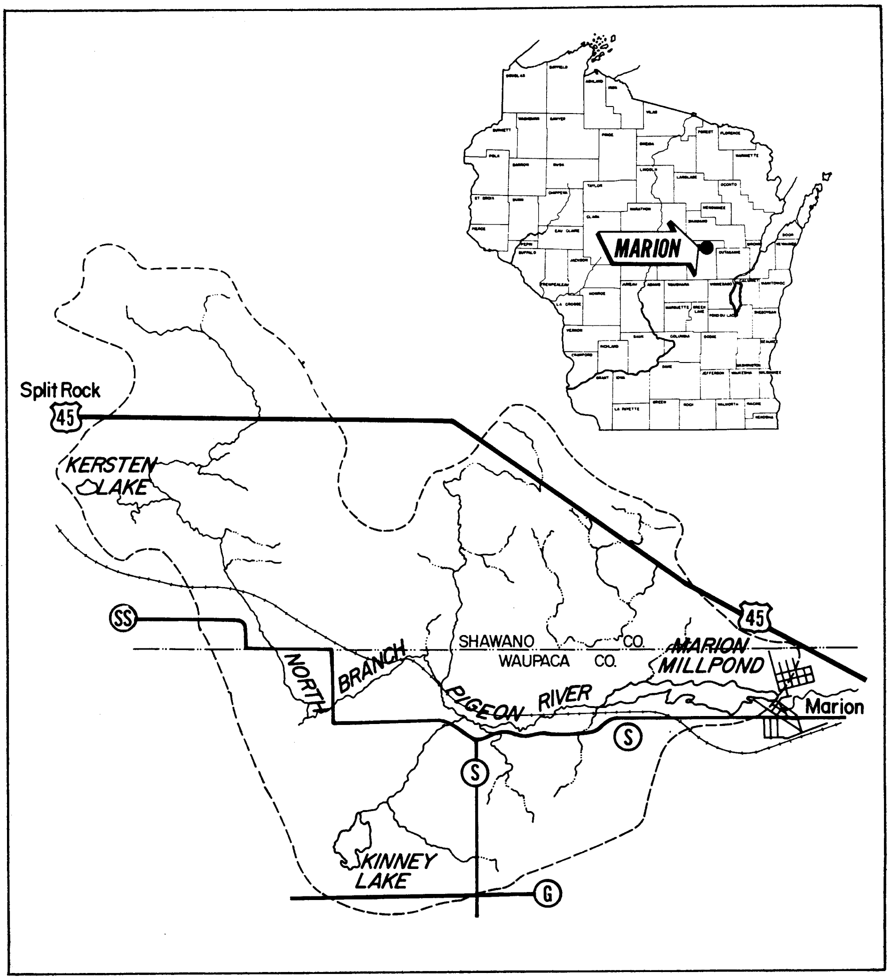


FIGURE 1
Location of the Marion Millpond watershed.

Two general considerations were of primary importance in selecting a site for this demonstration activity: (a) the condition of the water body should make improvement both necessary and attainable, and (b) the attitudes and interest of the local people toward a renewal project should be such that the major impetus for planning and implementation would come from the community. This latter factor was of special importance because a major objective of this undertaking was to assist and guide local groups so that they might better accomplish their goals. The Project would provide technical guidance and direct financial assistance, but an effort would be made to maximize the use of available local funds.

Specific criteria for site selection were that the site should be a millpond or flowage and should: (a) be 50-200 acres in area, (b) be readily drainable – physically and legally, (c) be both urban and rural in character, (d) have a watershed of manageable size and (e) have a visible, existing need for aquatic plant management. In early 1969, Marion Millpond, a 110-acre flowage in east central Wisconsin (Fig. 1), was formally selected as the demonstration site.

DESCRIPTION OF SITE

HISTORY

The physical and cultural setting of the millpond in the City of Marion (Waupaca County) satisfied demonstration project requirements. An organization capable of carrying out many facets of the renewal work was already actively engaged in improving the millpond. This group, the local Conservation Club, had worked for a number of years trying to rehabilitate the Marion Millpond. Beginning in 1950, the Club acquired a piece of land destined to become a shoreland park (Wallace Park). During the next decade, the Club spent about $4,000 and worked with Waupaca County officials in renovating this park so that it became an important use area and access point for fishermen and boaters. During the late 1950's, the Club acquired equipment and began pumping accumulated sediment from the pond. In 1961, the Club members purchased and rebuilt a used drag line. Over the next several years, at a cost of about $2,000 and hundreds of volunteer man hours, the Club removed silt, muck and debris from the pond. Additional expense and labor were devoted to stabilizing portions of the shoreline and cutting and removing tree stumps from the pond.

Even though hampered by lack of financial support and technical guidance, the Marion Conservation Club made considerable progress in "cleaning-up" their pond. In contrast to the short-term interests of most organizations of this type, this group had both a sincere interest in improving the millpond and perserverance. Their enthusiasm was contagious and the community responded by purchasing the water rights from the old milling company for $6,000, allowing the city to manipulate water levels for recreational rather than power purposes. This momentum carried through the course of the rehabilitation project. Local civic groups reacted by donating trucks, equipment and funds, and the community as a whole committed their energies to restoring their millpond. Marion, then, was selected not only because its millpond was afflicted with typical lake aging problems, but also because of the attitude and commitment of the citizens of the community.

PHYSICAL SETTING

The Marion Millpond is a relatively small impoundment – 108 acres with a maximum depth of 12 feet (Fig. 2). It was formed in the 1850's by the construction of a dam across the north branch of the Pigeon River (Doty Creek) which flooded a wooded valley. The rolling topography of the 18-square-mile drainage basin is developed on Pleistocene glacial deposits (till and glaciofluvial sediments – chiefly sand and gravel) that overlay crystalline rocks at relatively shallow depths within the area. The drainage basin is composed largely of agricultural lands, some of which are no longer in production. Woodlots comprise approximately 20 percent of the basin and marshlands, about 5 percent. Most of the millpond itself lies within the municipal limits of Marion. Although only the lower reaches of the pond were developed for residences at the beginning of the project, a trend toward additional frontage develop-

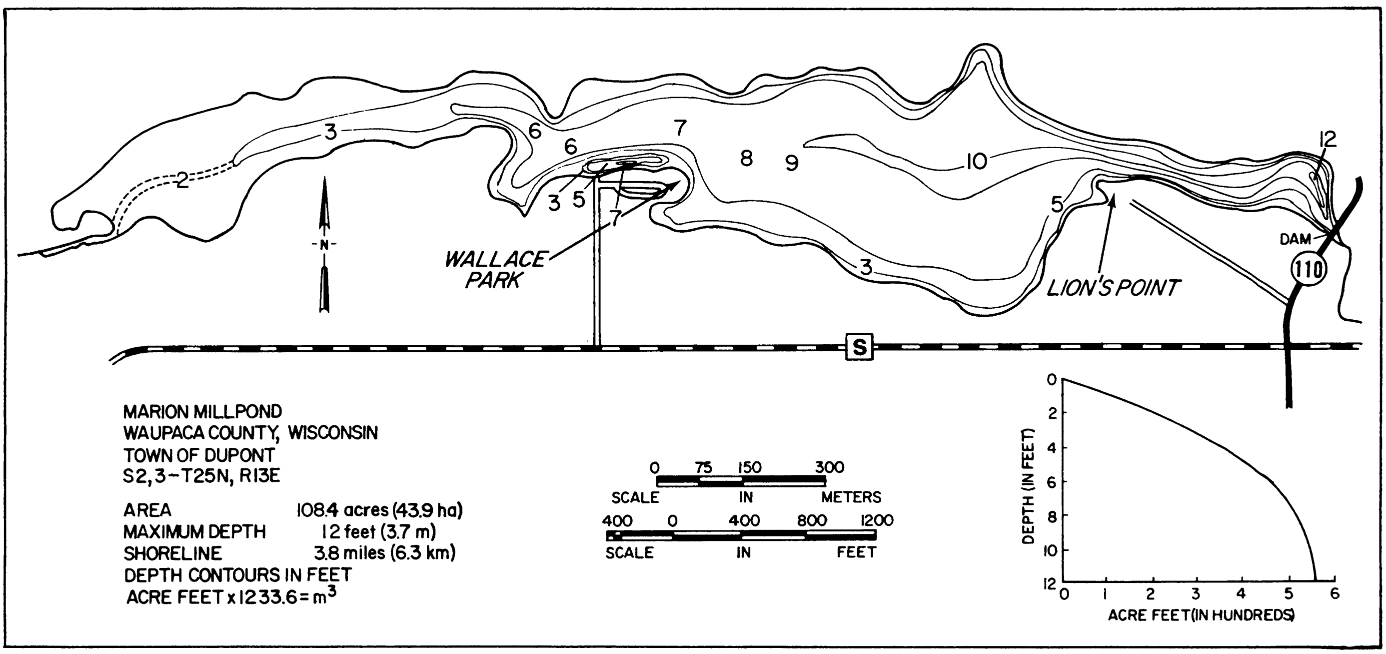


FIGURE 2
Pretreatment hydrographic map of Marion Millpond.

TABLE 1
Summary of Water Quality Data from Marion Millpond, August 1968–August 1972

Parameter*	**Inlet** (N. Br. Pigeon River) 7 sampling dates	**Outlet** (Dam Outflow) 8 sampling dates	**Pond** (East End)** 5 sampling dates
pH (units)	8.0–8.4	7.8–8.7	7.8–8.8
Total alkalinity (mg $CaCO_3$/1)	180–250	180–220	160–210
Inorganic nitrogen	0.3–3.0	0.3–1.8	0.1–1.5
Total nitrogen	1.0–3.9	1.1–3.4	0.5–2.8
Reactive phosphorus	0.01–0.11	< 0.01–0.13	< 0.01–0.09
Total phosphorus	0.04–0.23	0.03–0.16	0.02–0.20
Chloride	4–9	2–6	5–10
Potassium	1–7	1–3	1–2
Color (units)	--	--	60–80

*All parameters expressed as mg/l except as noted.
**Samples were taken at the surface, 3-foot and 4-foot depths.

ment has been evident.

Since its formation, conditions in the Marion Millpond have deteriorated markedly. When the pond was created, a wooded lowland was flooded but not cleared. Some years later, many of the dead trees were cut at water levels below normal pond level. These stumps, along with toppled trees, seriously impaired recreational use of the pond. The upper one-half mile of the impoundment had become badly silted in, with water depths commonly less than two feet over several feet of muck. During the summer, this upstream portion of the pond was filled with a dense mass of rooted vegetation; weeds were also a problem over much of the remainder of the pond, impeding recreational use as well as detracting from the aesthetics of the pond. The warm-water sport fishery present in the pond – northern pike, largemouth bass, bullheads, perch, bluegills, crappies and other panfish – had deteriorated to one in which small panfish predominated. The effects of excessive nutrient enrichment were also evident during winter months, when oxygen levels were greatly reduced, at times threatening fishkills. Chemical and mechanical weed control had been initiated, and an annual program of snow plowing on the ice was conducted to facilitate light penetration and thus stimulate oxygen production by aquatic plants.

GENERAL HYDROLOGY AND LIMNOLOGY

Measurements of surface water discharge into the Marion Millpond via the north branch of the Pigeon River (Doty Creek) during summer and spring 1968-69 indicate streamflows of 5 to 25 cubic feet per second (cfs). Surface water outflow from the millpond on the same dates was about 80 percent of the inflow. This difference was largely the result of groundwater flow into the pond; when drawn down, numerous springs and seeps are evident in and around the pond. Based on calculations by Barr Engineering (Minneapolis, Minnesota), a peak discharge of about 200 cfs has a recurrence interval of approximately two years.

Water quality data available for the pond are summarized in Table 1. The data indicate that Marion Millpond water is relatively fertile, colored and alkaline. Water sampling and analyses were not extensive enough to calculate a meaningful average for the parameters, nor to detect water quality changes before and after manipulation, partly because pond manipulation was started by local people before project involvement.

Excessive fertilization of the pond appears to be due to farming opera-

TABLE 2
*Average Nitrogen, Phosphorus and Potassium Content of Marion Millpond Sediment Samples**

Parameter	Amt. Present
Total N	1.4 percent
Available P	200 $\mu g/g$
Exchangeable K	800 $\mu g/g$

*Composites of samples taken at 4 sites, March 1969.

tions in the watershed. This may be largely due to fertilizers and manure spread on fields, but also is the result of pastureland and barnyard runoff directly into streams which flow into the pond. Table 4 in Appendix A shows water analyses from above and below barnyards located directly on streams flowing into the millpond; it indicates that detectable increases in nitrogen, phosphorus and potassium concentrations occur in short reaches of the stream which encompass several barnyards in the watershed. Some substantial water quality changes occur even during dry weather, partly the result of livestock being in the stream. Sampling was not intended to provide flow-composited monitoring of stream water quality, and consequently cannot be used for precipitation/runoff/water quality change correlations.

Surficial sediments in the millpond are predominantly black organic lake muck. Typically within a few feet of the surface, these sediments overlie woody peat and in some places, marl; these in turn overlie sandy glacial deposits at variable depths. The chemical character of surficial sediments is presented in Table 2. Based on these data and the criteria for relative fertility of agricultural soils (Walsh and Schulte, 1970), the Marion Millpond sediments would be considered excessively fertile.

METHODS

OBJECTIVES

Lake renewal involves not only in-lake improvements, but also includes management of lands within the watershed. The rehabilitation program at Marion had three main elements: (a) in-pond work, (b) shoreland work and (c) drainage basin activities.

The objectives of the in-pond work were to design, implement and demonstrate management techniques to improve conditions within the pond for recreational purposes and to minimize the undesirable effects of excessive fertilization, especially the growth of nuisance vegetation. Many of the techniques demonstrated also could be used in managing littoral zone problems in lakes, particularly lakes with outlet controls, where some water level manipulation is possible.

Shoreland work objectives were to improve the immediate shorelands by erosion control, recontouring, etc., and to enhance the recreational facilities available around the pond. Additionally, surface-water use regulations were jointly prepared by Project personnel and local citizens to reduce user conflicts, and to help protect the recreational investments of the Marion community.

Because land use within the drainage basin has a direct effect upon conditions within the pond, especially with regard to sedimentation and eutrophication, a program was initiated within the watershed to show the relationship between the pond and the watershed and to demonstrate remedial techniques where possible. Given the extensive agricultural use pattern in the basin, it was realized that localized nutrient/sediment control efforts would have limited impact on the pond. However, such efforts were intended to: (a) identify and alleviate the most obvious nutrient/sediment sources, (b) show how such control measures could be used to alleviate other nutrient/sediment sources in the watershed, and (c) initiate, even on a limited scale, contact and cooperation between residents of the City of Marion and rural people in the drainage basin.

FIELD PROCEDURES

In-pond

Dam Modification. Access to the littoral zone to undertake work on the pond bottom was governed by the ability to manipulate water levels.* At Marion, drawdown of only 51 inches was possible; in order to drain the pond and expose the bottom, the dam had to be modified.

Three alternative methods to enable water levels to be lowered by 10-12 feet were considered: (a) cutting down the floor of the waste water tunnel, (b) installing a siphon to drain the pond or (c) jacking a pipe through the bottom of the dam. The relative feasibility of these methods depended greatly upon the interior of the dam. To investigate the interior of the dam, it was necessary to divert the entire flow from the Marion pond through the flume by bulkheading the upstream end of the emergency wasteway (Fig. 3). Prior to authorization of such work by the Wisconsin Department of Natural Resources, engineering studies were necessary to insure that the outlet flume could pass runoff from a 50-year frequency rainfall.

Estimated costs for each method were comparable – about $11,000. (Estimates were based on contractor's scale labor and material costs. Costs were to be considerably lower because volunteer labor and donated materials were available.) Based on data obtained from the investigation of the dam, the best of the three methods appeared to be lowering the floor of the waste water tunnel because it would

*The littoral zone is defined as those areas in which rooted aquatic plants can grow and includes the whole of the Marion Pond.

leave behind a permanent facility to drain the pond in the future (Fig. 4).* This work was performed by the citizens of Marion (for less than $5,000) during May and June 1969, and by late July 1969, the Marion Millpond was drained (Fig. 5).

Stump and Log Removal. With the pond filled, thousands of submerged and partially submerged stumps and toppled trees (left behind when the pond was originally flooded) hindered recreation and boating. With the pond drained, they were present almost everywhere and hampered work on the pond bottom (Fig. 6). Prior to drawdown, stump removal activities had been entirely directed at cutting off exposed stumps at the water line. After drawdown, cutting of stumps as close to the ground as possible was continued, but failed to permit adequate preparation of the pond bottom for subsequent treatments. Therefore, intensive work "bees" were organized by the community to mechanically and manually remove debris, logs and stumps embedded in the pond sediments. Although the work was facilitated by construction and farm machinery in part donated by local people and businesses, the work was tedious, back-breaking and slow.

During the 1969-1970 winter, roads were frozen-in on the pond bottom. This enabled contracted heavy equipment to work on the pond bottom proper. Deeply embedded logs and stumps were removed by a drag line, wind-rowed by a front-end loader, and moved off the pond bottom by truck. (Fig. 7). The large volumes of stumps and debris were trucked to a disposal area. (In spite of a great deal of thought, no salvage value was found for this wood – largely cedar and elm). This approach was more effective than working directly on the unfrozen pond bottom. The heavy equipment expedited the job, and about forty acres were cleared in this way. However, this work proved very expensive.

Early in the project, consideration had been given to trying to remove the wood debris by draining the pond, allowing the wood to dry, and refilling the pond, thereby causing the logs and stumps to float so that they could be towed to shore for removal. During the spring of 1970, an opportunity to test the idea inadvertently occurred. Heavy rains made it necessary to close the gates on the Marion Dam to

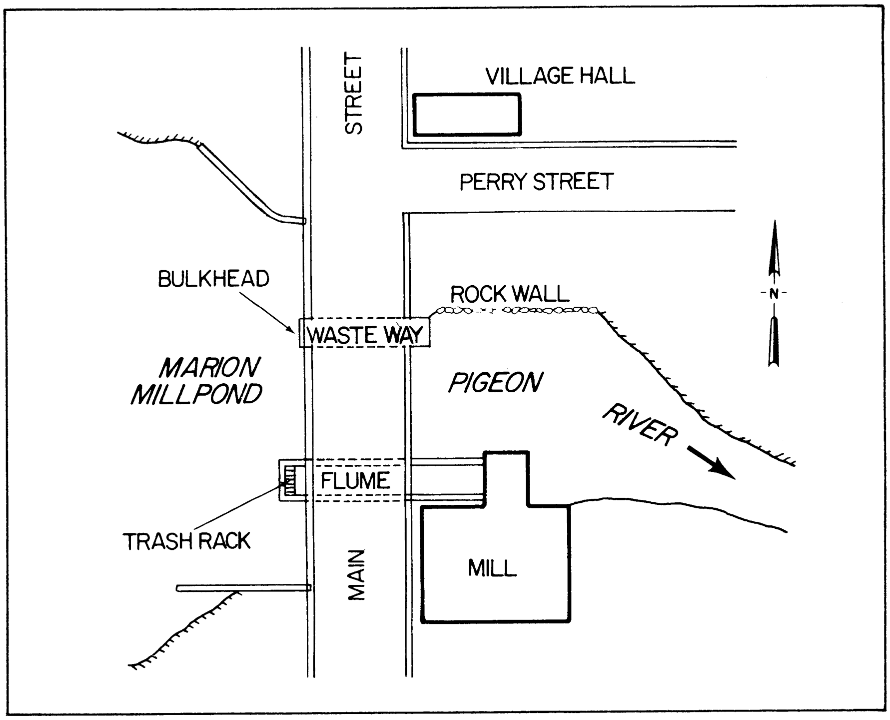


FIGURE 3
Plan view of Marion dam.

FIGURE 4
The Marion dam showing the emergency wasteway and flume (looking east).

*In some situations, the installation of a bottom-water discharge structure would be advantageous; it could be installed coincident with dam modification. A bottom draw can accelerate the flow of relatively nutrient-enriched deeper waters from an impoundment. Where appropriate, such a feature would be of great value for impoundments located on trout streams (dams often destroy downstream trout streams by passing warm water over their spillways during summer months). However, the persistence of thermal stratification and the volume of the cool hypolimnion must be considered in determining the feasibility and effectiveness of such a program (see Appendix B).

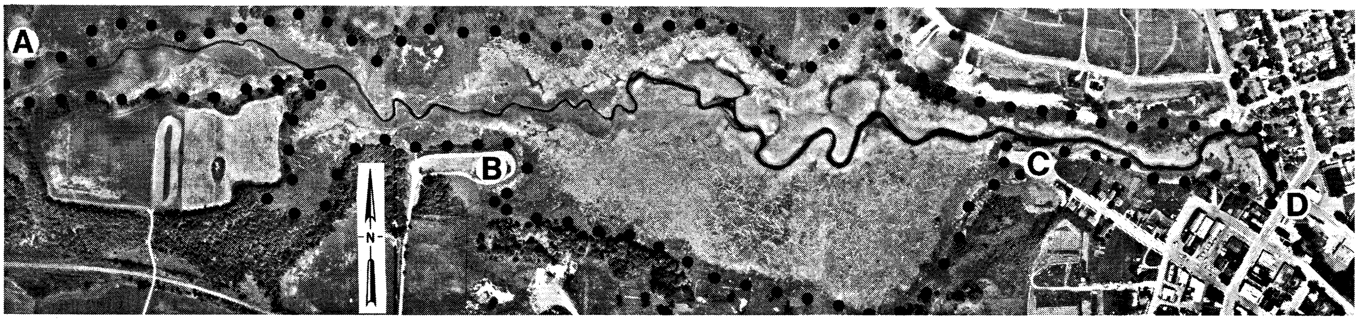


FIGURE 5
Aerial photograph of Marion Millpond after draining. (A=North Branch of the Pigeon River, B=Wallace Park, C=Lion's Point Beach, D=Marion Dam and....=pond shoreline). Note logs and stumps on pond bottom.

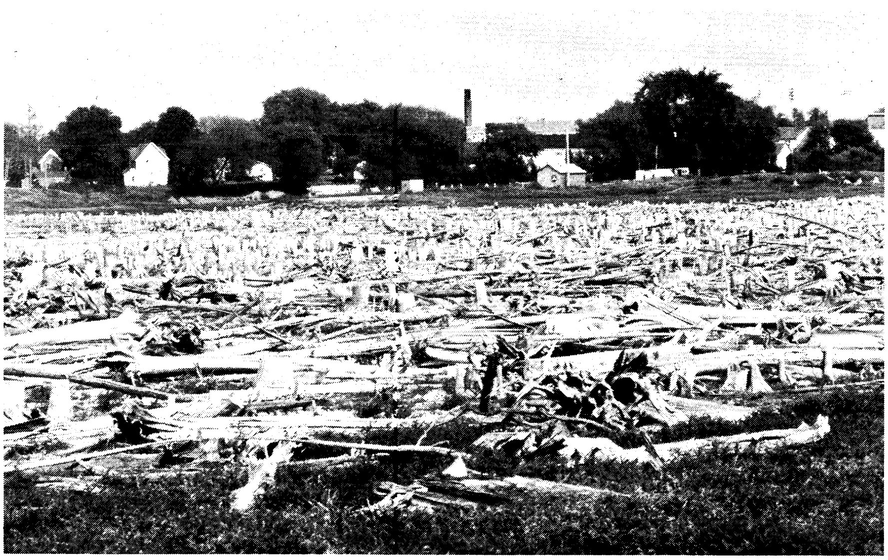


FIGURE 6
Stump field on millpond bottom.

FIGURE 7
Winter stump removal.

prevent flood dangers at the downstream City of Clintonville. Runoff filled the pond over a weekend, and an immense volume of logs, stumps and other wood debris – having dried out sufficiently over a two-year period – floated to the surface. Log jams were pulled apart with a barge-mounted winch, and a fleet of small boats towed the logs to shore for removal.

Sediment Manipulation. After the bottom had been largely cleared of wood debris, the sediments and pond bottom were accessible to manipulation. Some areas were simply leveled and graded as preparation for bottom treatments. In other areas, sediments were removed and the bottom recontoured. The excavation of sediments was undertaken to provide a greater amount of usable water surface for recreation, to deepen some near-shore areas in an effort to limit plant growth, to remove nutrient-rich sediments which had accumulated in the pond over the years, and to expose sand mineral soil, where possible.

In an attempt to expedite drainage and drying of bottom sediments, some ditches were dug. These conventional agricultural drainage techniques, however, did not markedly accelerate the drying process; this was particularly true where the sediments consisted of low permeability marls and marly mucks.

Materials removed from the bed of the pond were deposited in designated spoils areas along the perimeter of the pond. Substantial additional new land area was developed near Wallace Park (see Figure 5) in this manner.

Bottom Treatments. A number of bottom treatments were tested in order to evaluate their relative value as management techniques. The prime objective of these treatments was to retard the growth of aquatic plants; secondary objectives were to impede the transfer of nutrients from organic sediments into the water and, in some places, to provide swimming and wading areas. Some data on sediment-covering effects were available from laboratory studies (Hynes and Grieb, 1967; Hynes and Grieb, 1970; and Sylvester and Seabloom, 1965), but well-documented field data were sparse. Where possible, accumulated organic sediments were removed to expose the underlying sand – in general, a less-suitable substrate for rooted aquatic plants.

Approximately 25 acres of the pond bottom were covered with 4-mil (0.1 mm) black polyethylene sheeting which was subsequently covered with anchoring materials.* Test plots were located so as to obtain a wide variety and distribution of treated areas for comparison and evaluation. Special emphasis was given to the lower reaches of the pond and areas adjacent to parks, which were subject to intensive use and maximum visibility and which were, therefore, of prime local concern. About 10 acres of sheeting were placed in the lower neck of the pond, about 5 acres off-shore from the Lion's Point beach, about 5 acres along Wallace Park, and several strips and patches along the north shore and in the center of the pond.

The plastic sheeting was applied in the winter, when frozen ground and ice cover allowed machinery to be used for transporting and spreading sheeting and anchoring materials. Sheeting was laid down by a team of workers, and anchored temporarily with rocks (Fig. 8). The sheeting was perforated to permit gases from the underlying sediments to escape. From 3-6 inches of sand, gravel or "pit-run" sand and gravel was then spread over the sheeting by means of a front-end

*The opaque quality of the sheeting prevents the growth of plants under the sheeting. The selection of a 4-mil thickness represented a trade off between cost, ease of application and durability.

FIGURE 8
Plastic sheeting anchored in place prior to covering.

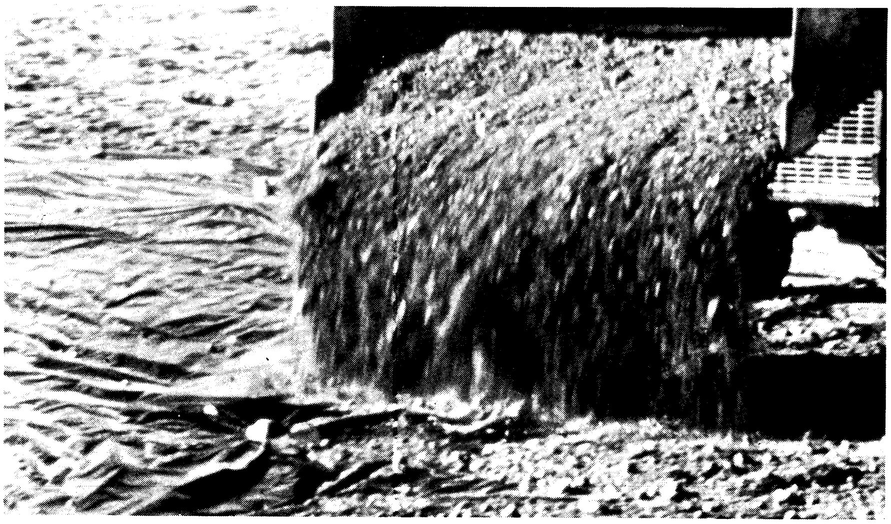


FIGURE 9
Sand blanketing of plastic sheeting with front-end loader.

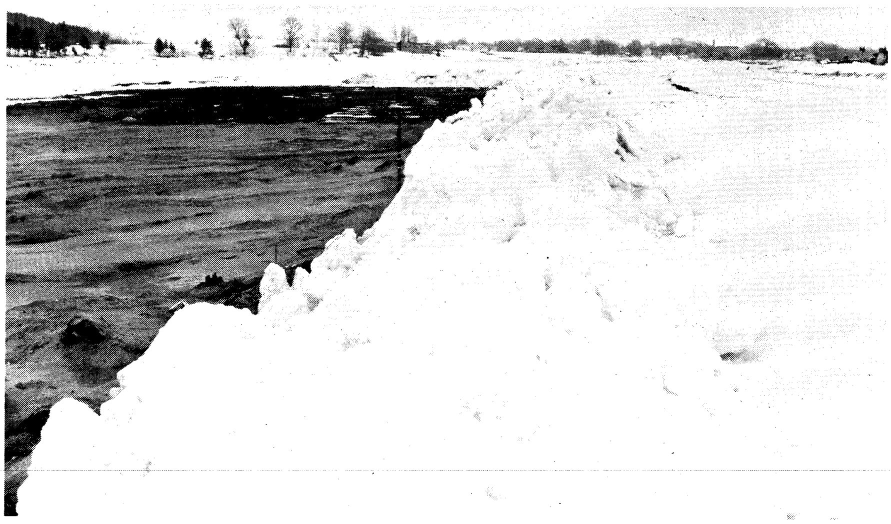


FIGURE 10
Winter treatments at Wallace Park.

FIGURE 11
Gravel and sand covering over cleared areas.

loading vehicle (Fig. 9).

Although some sheeting was placed directly on frozen ground, residual debris and uneven topography impeded application. It proved far more efficient to apply the sheeting on ice, in the following manner: Water levels were controlled to govern the extent of ice cover on the pond; the objective was to have ice cover formed over all areas to be treated, with a minimal depth of water under the ice. Snow was cleared from the portion of the ice to be covered, and the sheeting and covering material were placed on the ice (Fig. 10). Then water levels were lowered to collapse the treatment "package" onto the pond bottom.

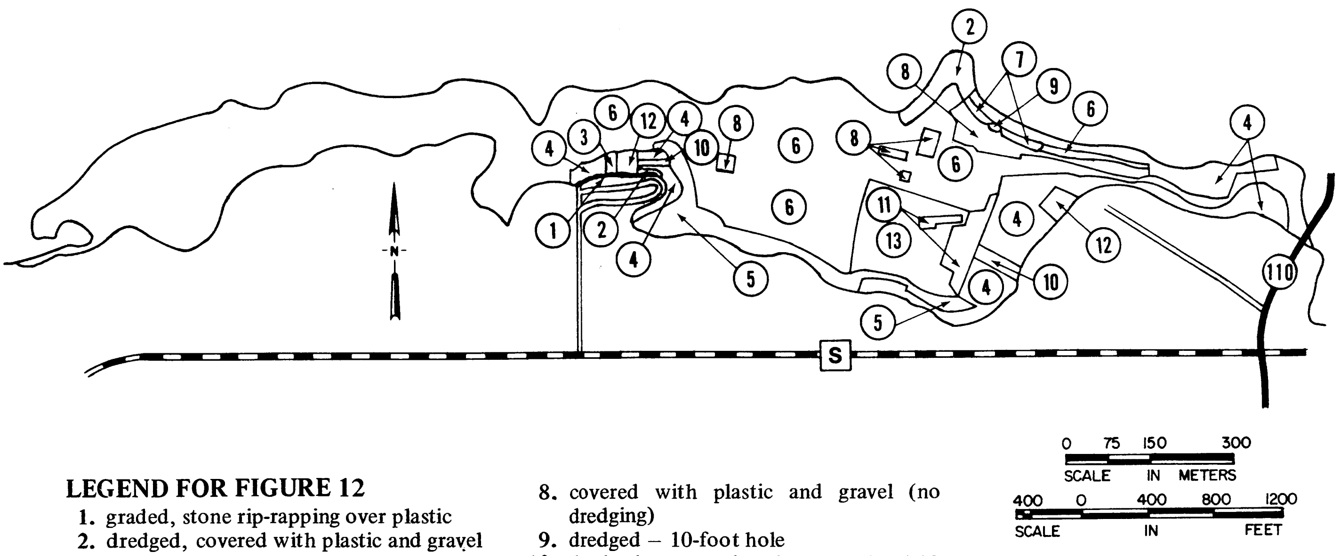
Other areas of the pond were covered only with sand or gravel for comparative purposes (Fig. 11). The location, description and evaluation of the treated areas are reported in Appendix C and Figure 12.

Fish Restocking. Fish populations were greatly reduced as a result of draining the pond. This was beneficial because fish growth and production had declined over the years, and restocking and subsequent fish management could reverse this trend. When the pond was refilled in 1971, it was restocked with walleye *(Stizostedion vitreum)*, northern pike *(Esox lucius)*, yellow perch *(Perca flavescens)*, largemouth bass *(Micropterus salmoides)* and bluegills *(Lepomis macrochirus)*.

Shoreland

The shoreland program associated with the rehabilitation project involved: (a) grading and rip-rapping selected shoreline areas for bank stabilization and erosion control, (b) recontouring and revegetating spoils disposal areas and (c) enhancing recreational facilities (beaches, boat launching facilities, park areas) around the pond. Much of this work was centered in the Wallace Park area, which had traditionally received a great deal of recreational use – particularly fishing and picnicking – by members of the community, especially the elderly.

Lion's Point (see Figure 5) was selected for construction of a public swimming beach and boat dock. This area had been acquired in 1968 by the Marion Lion's Club for this purpose. A beach area was chosen that would be swept clean by waves generated by prevailing westerly winds. Plastic sheeting was distributed over the bot-



LEGEND FOR FIGURE 12

1. graded, stone rip-rapping over plastic
2. dredged, covered with plastic and gravel
3. dredged, covered with sand (6-10 inches deep)
4. dredged, covered with plastic, "pit-run" sand and gravel (water 6 feet deep)
5. dredged
6. not treated – control area
7. dredged to sand
8. covered with plastic and gravel (no dredging)
9. dredged – 10-foot hole
10. dredged, covered with gravel (6-10 inches deep)
11. dredged, covered with plastic, "pit-run" sand and gravel (water 6 feet deep)
12. dredged, covered with plastic and sand
13. cleared of stumps and logs during winter

FIGURE 12
Location and description of treated areas in Marion Millpond.

tom, and covered with sand, which was then spread to a 1:8 grade (Figs. 13 and 14). A boat dock was built north of the new beach and picnic tables and other facilities were installed.*

To protect their recreational investment, members of the community worked with Demonstration Project personnel to draft surface-water use regulations (see Appendix D). These regulations, when adopted by the towns, provide for public safety, minimal user conflicts (e.g., conflicts between swimmers and boaters) and ecologic protection through establishment of a wildlife sanctuary zone.

Drainage Basin

As noted earlier, in the largely agricultural Marion Pond watershed, it was unrealistic and beyond the scope of the Project to abate the inflow of nutrients and sediments from such diffuse sources as cultivated lands, pasture lands, etc. Instead, working closely with Marion Conservation Club members, Project personnel identified and inventoried prominent nutrient sources within the drainage basin, and sought to use these more obvious sources to dramatize the interrelationship of the entire drainage basin, as well as to demonstrate some simple remedial measures.

The main sources of rural nutrient input into the water courses were barnyard and piglot runoff; two sources of urban nutrient contributions were identified in Marion itself – a stockyard along the southeast shore, and urban runoff from an area north of the pond. The City of Marion was persuaded to work towards altering drainage patterns to preclude the introduction of pollutants from these urban sources into the pond.

With the aid of the Soil Conservation Service, University Extension and local DNR personnel, meetings were arranged between townspeople and rural residents from throughout the basin to discuss problems in the millpond, the efforts to improve conditions therein, the rehabilitation project specifically and the possibility of cooperation with selected farmers to abate or reduce obvious pollution by livestock upstream from the pond. These meetings, which were conducted by the local citizenry, were successful in enlisting basin-wide support for the pond renewal, as well as identifying land-owning farmers who were willing to participate in drainage basin demon-

*A comprehensive outdoor recreation plan for Marion is presently being completed. Such a plan establishes the eligibility of Marion for state cost-sharing and for development of recreational facilities. In August 1971, the Marion Lions Club donated the Lion's Point property to the City of Marion for $1, and indicated a willingness to make substantial contributions for recreational improvements on this land. It appears likely that a multi-season facility (bathhouse-snowmibiling hut-ice fishing shelter) will soon be located adjacent to the Marion Pond.

FIGURE 13
Construction of the Lion's Point Beach.

FIGURE 14
Lion's Point Beach – after construction.

strations.

Work was undertaken at two farms. Although federal cost-sharing schemes for pollution abatement and water/soil conservation purposes were explored, the Inland Lake Demonstration Project elected to cost-share remedial measures with the farmers to expedite the work plan. Marion Conservation Club members volunteered labor, where needed. Basically, the program involved diverting roof runoff around the barnyards by installing eaves troughs, restricting cattle usage of the streambed with limited fencing and construction, and improving streambed conditions at watering areas by spreading gravel.

RESULTS AND DISCUSSION

COSTS

Figure 12 presents a graphic summary of physical work in the Marion Pond and in particular shows the location of different bottom treatments for retarding aquatic plant growth. It is difficult to fully and accurately assess the costs and cost-effectiveness of this kind of demonstration project because: (a) various techniques to accomplish a particular objective were tried, (b) it is almost impossible to separate out equipment and labor costs for individual activities, when in fact they were in progress by the available work force concurrently (e.g., stump removal, sediment excavation, pond-bottom grading, spoils disposal and recontouring, sand blanketing and sediment drainage), and (c) volunteer labor, donated equipment and inexpensive sources of materials invariably skewed the real costs. Table 3 is a generalized breakdown of costs associated with the Marion Pond project. Although costs for such a program will vary from community to community, expenditures at Marion provide some indication of the financial dimensions of such an activity.

The following conclusions merit consideration before undertaking similar programs elsewhere:

1. The costs of modifying the dam to permit drainage of the impoundment were cut by more than half due to volunteer community involvement (labor and equipment).

2. It is difficult to compare costs of stump removal, in that manual and mechanical techniques focused on specific areas, while flotation affected the entire pond. Based on volumes of

TABLE 3
Budget for Marion Millpond Rehabilitation

Expenditures and Sources of Funds	Amount
Expenditures	
Modification of dam	$ 4,800
Stump removal	
Labor, mechanical (summer)	2,000
Stump cutting (year round)	1,200
Removal by heavy equipment and hauling (winter)	14,000
Flotation, removal by boat and disposal	5,600
Sediment manipulation	
Draglining–shore and pond bottom	20,000
Draglining–sediment drainage program	3,000
Bulldozing–sediment removal and grading	14,000
Spoils removal, shoreline "trimming"	5,000
Bottom treatments	
Plastic sheeting (approximately 25 acres)	4,600
Placement on pond bottom (winter)	1,200*
Placement on cleared ice (winter)	8,000*
Placement, including rip-rapping, along shore	6,700*
TOTAL EXPENDITURES	90,100
Sources of Funds	
Inland Lake Demonstration Project	82,000
Community of Marion (cash disbursements)	8,100
Community of Marion (donated equipment and labor)	11,000
APPROXIMATE TOTAL COSTS	101,000

*Includes cost of materials, equipment and labor.

removed stumps and logs, flotation is the most economical method of removal. It has the further advantage of requiring far less strenuous work than direct methods – a real advantage where volunteer labor is asked to perform the work. Where flotation will not work, heavy-equipment operations during the winter – when the pond bottom can be made accessible – are best, based on cost/unit removed.

3. Sediment manipulation by any means is expensive. At Marion, costs of excavating and moving sediments were estimated at about $0.50/cubic yard. Such costs are highly variable from place to place, depending on the given site conditions. The costs at Marion are in line with costs of inland lake dredging elsewhere in the Midwest (Pierce, 1970).

4. The costs of bottom treatment applications are highly dependent upon the costs for labor and covering materials. Where inexpensive sources of these commodities are available, application costs can be dramatically reduced. The cost of 4-mil black polyethylene sheeting like that used at Marion is about $200/acre. The most efficient application technique (where water level manipulation is possible) is to: (a) attain a water level that provides for ice formation over the proposed treatment area, (b) await satisfactory ice formation, (c) clear snow from the ice and use machinery to apply plastic sheeting and to cover it with an anchoring blanket and (d) lower water levels in order to collapse ice-sheeting-covering onto the pond bottom. This approach is considerably more effective than working on frozen ground. Application of sheeting during the summer is hampered by lack of adequate drying of sediments to permit equipment access. Experience elsewhere indicates that where water levels cannot be manipulated, black polyethylene sheeting can be laid on winter ice; it will then melt the ice and break through relatively intact (although some touch-up work may be necessary).

It should also be noted in retrospect that costs could have been reduced measurably had there been previous experiences to draw upon. We estimate that a rehabilitation activity comparable to Marion could now be undertaken over a 2- to 3-year period at a cost of $50,000-60,000, assuming strong community support – expressed as volunteer labor and donated equipment and materials.

RESULTS

Aquatic Plant Control

The major problem impairing recreational use on the Marion Millpond was nuisance aquatic vegetation. Control measures consisting of dredging, and blanketing with sand, gravel and polyethylene sheeting – in various combinations – were initiated and were monitored in 1971 and 1972. Sampling procedures were established to test the various treatment methods against untreated areas. Using SCUBA techniques, 10 quadrats were randomly sampled in each treatment area. Density of plant stems, and biomass (oven dry weight) of *Chara* and filamentous algae were recorded.*

Based upon this two-year comparison, treated areas generally exhibited less plant growth than untreated areas (Fig. 15). Data for 1972 indicate that the areas that were blanketed with sheeting and sand or gravel had substantially less growth than those areas which were only dredged or dredged and sandblanketed; an exception to this occurred where dredging was done to a depth exceeding the photic zone (Treatment 9, see Appendix C). Treated areas have a different vegetation than the control areas. Macrophytic algae of the genus *Chara* form the majority of the plant growth in the treated areas. In contrast, rooted angiosperm macrophytes constitute most of the plant growth in control areas. The shallow-water treated areas had a high biomass of filamentous algae in 1971. Production of this algae dropped off markedly from 1971 to 1972, although small amounts were present clinging to plant tops and shoreline areas. The decrease in filamentous algae was expected, in view of competition from the higher biomasses of other plants in 1972.

*See Tables 5 and 6 in Appendix C and refer to Figure 12 for detailed analyses of individual treatment areas.

FIGURE 15
Plant growth in treated areas (foreground) vs. untreated areas during the second year after treatment.

In untreated areas, macrophytes are commonly large enough to reach the water surface and impede motorboating and fishing. This, coupled with the increasing invasion of *Chara,* will continue to pose some aquatic plant problems in Marion Millpond. In short, damming a stream in an agricultural basin has resulted in an overfertile impoundment. Nutrient loading has not been substantially decreased, and continued aquatic plant problems can be anticipated.

To maintain the recreational usability of the pond, fairly intensive management procedures (periodic drawdown to freeze out littoral zone vegetation and provide access to the pond bottom, repair of bottom treatment areas, etc.) will be necessary. During especially troublesome summers, chemical treatments may be needed as a last resort to control aquatic vegetation. In this way, the pond can be maintained as a valuable community asset.

Fish Population Response

Of the 5 species of fish stocked in Marion Pond in 1971, northern pike, largemouth bass and bluegills quickly reestablished themselves in the pond and provided some angling the winter after the pond was refilled. Initial fish growth was good. Survival of the remaining species - walleye and yellow perch – appeared poor.

Nutrient Control in the Drainage Basin

Because efforts to divert barnyard runoff and control cattle usage of the streambed were carried out on only 2 farms, they represent no "cure-all" for the problem of nutrients entering Marion Pond from its largely agricultural watershed. However, these remedial measures were very practical and fit in well with ongoing farming programs. They did not require extensive amounts of labor and finances to be put into operation. Finally, they provided examples of simple, but direct methods of reducing agricultural contributions to lake eutrophication, which if coupled with good farming practices and extended throughout an entire basin, could measurably reduce lake problems - in Marion Millpond as well as other lakes with large agricultural watersheds.

Community Attitudes and Response

Lessened aquatic plant problems, improved fisheries and elimination of stump and log obstructions are not the only ways to measure the results of a citizen-initiated environmental improvement program like the Marion Pond project. Enhanced user satisfaction and intensified recreational use (including a very popular, newly organized swimming program) are also indications of the success of the Marion project.

Heightened community pride is another index of the impact of the pond rehabilitation. Mr. Francis Byers, a lifelong resident of Marion and a Wisconsin state legislator, concisely summed up the community's reaction:

> *"Almost without exception the residents of Marion are very enthusiastic about the results of the project. In fact, realizing that we have no single asset in our community which even approaches the value of that water in terms of human enjoyment for so many people, I suspect that the people in Marion would be very willing to go into bonded indebtedness in order to achieve these results, had they not had the good fortune to be subjects of a test project."*

On 13 August 1971, the community of Marion dedicated their renovated millpond.

IMPLICATIONS

The Marion activity has clearly demonstrated how local interests, given the requisite technical advice and partial financial support, can undertake substantial environmental improvement programs. Of course, without the strong degree of local commitment found in Marion, the renewal project could not have been accomplished.

The Marion experience can be extrapolated readily to communities with similar problems. Perhaps the most difficult aspect of executing such action programs is the "people dimension," i.e., mobilizing and sustaining the support and cooperation of affected parties. This report and a 16-mm, color-sound film describing the Marion project* hopefully provide information that will help initiate and guide similar community-based projects in the future.

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*"Restoring the Recreational Potential of Small Flowages: the Marion Millpond Experience" may be rented for $2 from University of Wisconsin-Extension, Bureau of Audio-Visual Instruction, P. O. Box 2093, Madison, Wisconsin 53701 (order by title and BAVI number 8394). Copies may be purchased for $92 from Byron Motion Pictures, Inc., 65 K Street Northeast, Washington, D.C. 20002.

TABLE 4
Summary of Water Quality Data Collected in the Pigeon River Above and Below 4 Barnyards in the Marion Millpond Drainage Basin

Parameter*	Barnyard I: 24 March 1969 Above	Barnyard I: 24 March 1969 Below	Barnyard I: 27 May 1969 Above	Barnyard I: 27 May 1969 Below	Barnyard II: 24 March 1969 Above	Barnyard II: 24 March 1969 Below	Barnyard II: 27 May 1969 Above	Barnyard II: 27 May 1969 Below	Barnyard III: 9 August 1970 Above	Barnyard III: 9 August 1970 Below	Barnyard III: 20 August 1970 Above	Barnyard III: 20 August 1970 Below N. Farm	Barnyard III: 20 August 1970 Below N.&S. Farm
Precipitation during previous 24 hours (inches)	0.05	0.05	2.66	2.66	0.05	0.05	2.66	2.66	0	0	0	0	0
Inorganic nitrogen	1.5	2.5	1.3	1.8	1.1	2.6	0.3	2.6	1.3	1.7	2.2	2.4	3.0
Organic nitrogen	1.8	2.3	1.0	1.2	1.2	1.6	0.6	2.5	0.4	0.4	0.4	0.4	0.9
Total nitrogen	3.3	4.8	2.3	3.0	2.3	4.2	0.9	5.1	1.7	2.1	2.6	2.8	3.9
Reactive phosphorus	0.16	0.29	0.01	0.01	0.14	0.41	< 0.01	0.03	<0.01	<0.01	0.02	0.02	0.11
Total phosphorus	0.30	0.50	0.07	0.07	0.23	0.60	0.03	0.1	0.03	0.03	0.03	0.04	0.23
Sodium	2	3	–	–	1	3	4	4	–	–	–	–	–
Potassium	5	10	–	–	3	5	2	6	–	–	–	–	–
Chloride	7	9	6	6	3	7	10	9	2	2	8	5	9
Spec. cond. (micro-mhos/cm^3 at 25 C)	365	410	–	–	234	375	–	–	510	505	510	515	515

Parameter*	Barnyard III, Cont.: 24 September 1970 Above	Barnyard III, Cont.: 24 September 1970 Below	Barnyard III, Cont.: 24 October 1970 Above	Barnyard III, Cont.: 24 October 1970 Below N.&S. Farm	Barnyard III, Cont.: 19 May 1971** Above	Barnyard III, Cont.: 19 May 1971** Below	Barnyard IV: 24 September 1970 Above	Barnyard IV: 24 September 1970 Below	Barnyard IV: 24 October 1970 Above	Barnyard IV: 24 October 1970 Below	Barnyard IV: 19 May 1971** Above	Barnyard IV: 19 May 1971** Below
Precipitation during previous 24 hours (inches)	1.2	1.2	0.55	0.55	1.4	1.4	1.2	1.2	0.55	0.55	1.4	1.4
Inorganic nitrogen	0.9	0.8	0.8	0.9	1.0	1.1	0.2	0.3	0.4	0.7	0.3	0.4
Organic nitrogen	0.7	0.9	0.7	1.3	0.6	1.0	1.0	1.2	0.8	1.7	0.9	1.2
Total nitrogen	1.6	1.7	1.5	2.2	1.6	2.1	1.2	1.5	1.2	2.4	1.2	1.6
Reactive phosphorus	0.04	0.05	0.03	0.08	<0.01	0.01	0.07	0.04	0.01	0.03	0.06	0.02
Total phosphorus	0.04	0.06	0.04	0.13	<0.02	0.04	0.07	0.09	0.06	0.08	0.08	0.02
Sodium	–	–	3	3	2	3	–	–	3	3	2	2
Potassium	–	–	3	7	1	3	–	–	3	5	2	3
Chloride	5	7	3	5	3	5	5	6	3	4	4	5
Spec. cond. (micro-mhos/cm^3 at 25 C)	390	–	400	–	390	395	335	350	–	390	370	375

*All parameters expressed as mg/l except as noted.
**Sampled after major runoff had occurred; 1.9 inches of precipitation were recorded during the day of sampling.

APPENDIX B: Downstream Temperature Studies

The pond at Marion is similar to many millponds with respect to impounding a trout stream. Good base flow of ground water provides ideal habitat for trout. The stream above Marion Pond remains a good brook trout stream, but below the Pond, the dam destroyed trout water for several miles downstream. Such loss of trout habitat is due to the fact that water releases from shallow impoundments are warm in summer, and will not support a cold water fishery (White and Brynildson, 1967). In deeper impoundments, drawing surplus water continuously from the bottom reduces downstream temperatures and provides suitable habitat to sustain trout throughout the year (Wirth et al., 1970; Uttormark, 1970).

The shallow nature of millponds suggests that thermal stratification does not occur and that a continuous bottom draw would do little to furnish stable flows of cold water. However, when Marion Pond was drained, the old stream channel was still visible along with several spring-flow tributaries.

To test the hypothesis that these channels might be conducting denser and colder water to the base of the dam, a comparison of pond vs. downstream temperatures was made. Two recording thermometers were suspended in a perforated aluminum pipe in the channel upstream from the dam – one just below the water surface and one above the bottom, ten feet below the surface. In addition, a recording thermometer was placed in the stream channel below the pond. The thermometers were monitored from 1 July to 15 October 1971. Daily temperature ranges obtained from the thermographs are shown on Figure 16, along with local air temperature ranges.

During the summer period, water from the pond bottom was occasionally passed through the wasteway. Unfortunately, no record of the dates or volumes is available. From the temperature records, it appears that deep water withdrawal took place around 15 and 26 July 1971.

Temperatures that inhibit trout are in the high 70's (77-80 F). Bottom temperatures in Marion Pond never reached these levels, but surface temperatures exceeded 80 F on at least three days and would have likely been lethal to trout. Bottom temperatures were generally about 10 F cooler than surface temperatures and exhibited less variation in range. Based on the Marion data, the continuous bottom draw of water from some millponds may be beneficial to trout in downstream waters.

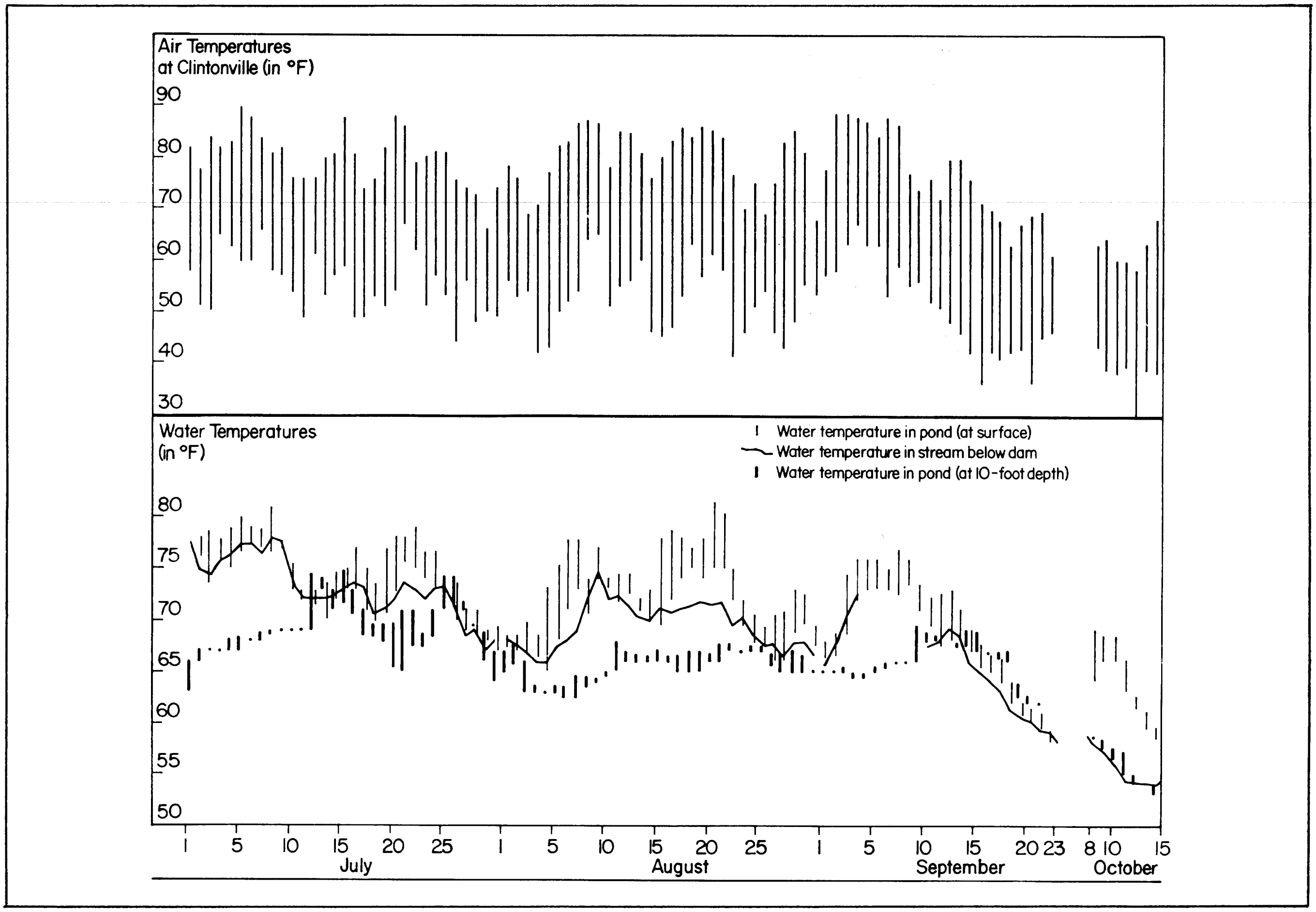

FIGURE 16
Water temperatures above and below the Marion dam and air temperatures, 1 July–15 October 1971.

APPENDIX C: Aquatic Plants

TABLE 5
*Aquatic Plants Present in Marion Millpond**

Scientific Name	Common Name
Callitriche palustris	water-starwort
Ceratophyllum demersum	coontail
Chara spp.	muskgrasses
Eleocharis robbinsii	trianglestem spikerush
Elodea canadensis	common elodea
Glyceria canadensis	manna grass
Lemna minor	duckweed
Lemna trisulca	duckweed
Mimmulus ringens	monkey flower
Myriophyllum exalbescens	northern watermilfoil
Najas flexilis	naiad
Penthorum sedoides	ditch stonecrop
Potamogeton americanus	American pondweed
Potamogeton foliosus	leafy pondweed
Potamogeton gramineus	variable pondweed
Potamogeton natans	floating pondweed
Potamogeton pectinatus	sago pondweed
Potamogeton praelongus	whitestem pondweed
Potamogeton pusillus	slender pondweed
Potamogeton zosteriformis	flatstem pondweed
Ranunculus trichophyllus	water crowfoot
Rorippa islandica	--
Sagittaria cuneata	northern arrowhead
Sagittaria latifolia	broadleaf arrowhead
Utricularia vulgaris	common bladderwort
Vallisneria americana	wild celery
Zannichellia palustris	horned-pondweed

*Nomenclature taken mainly from Underwater and Floating-leaved Plants of the United States and Canada, 1967, Bur. Sport Fish. and Wildl., Resour. Publ. 44, 124 p. and Common Marsh Plants of the United States and Canada, 1970, Bur. Sport Fish. and Wildl., Resour. Publ. 93, 99 p.

TABLE 6
Plant Abundance at Marion Millpond

Type of Treatment (See Fig. 12 for Location of Areas)*	*Chara* (g/m² dry weight)			Filamentous Algae (g/m²)			Macrophytes (stems/m²)		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
2. Dredged, covered with plastic and gravel									
1971	–	0.2	5.5	–	0	0	–	0.1	2.6
1972	48.9	65.2	9.8	0	0	0	0	6.4	9.6
3. Dredged, covered with sand (6-10 inches deep)									
1971	–	0	0	–	242.5	3.9	–	0.1	3.2
1972	17.7	29.9	0.1	0	0	0.1	0.4	2.9	3.4
4. Dredged, covered with plastic, "pit-run" sand and gravel (water <6 feet deep)									
1971	–	0.3	0	–	49.7	4.9	–	0.3	0.4
1972	22.7	17.6	9.1	0	0	0	0.4	0.7	2.6
5. Dredged									
1971	–	108.6	300.9	–	0	0	–	310	575
1972	845.8	1,317.7	725.4	0	0	0	3	2	31
6. Not treated–control area									
1971	–	0	10.0	–	0	0	0	175	47
1972	0	0	107.5	0	0	0	102	80	87
7. Dredged to sand									
1971	–	39.9	116.7	–	4.2	1.9	–	37.0	619.0
1972	1,753.9	888.4	500.6	0	0	0	8	55.0	145.0
8. Covered with plastic and gravel (no dredging)									
1971	–	0.8	4.3	–	0.6	3.9	–	3.7	30.7
1972	17.5	104.5	100.6	4.1	0	0	0.2	8.7	1.4
9. Dredged–10-foot hole									
1971	–	0	0.7	–	0.1	0	–	1.2	1.4
1972	13.6	6.4	19.2	1.2	0	0	0	1.1	0.7
10. Dredged, covered with gravel (6-10 inches deep)									
1971	–	3.2	34.8	–	0	0	0	2.8	3.3
1972	67.3	53.5	6.6	–	0	0	3.3	1.7	2.1
11. Dredged, covered with plastic, "pit-run" sand and gravel (water >6 feet deep)									
1971	–	0	0	–	0	0.8	–	1.1	0.4
1972	10.2	20.2	6.4	0	0	0	0	0.1	1.2
12. Dredged, covered with plastic and sand									
1971	–	0	5.4	–	38.3	0	–	0	0.9
1972	0	0	0.1	13.2	0.1	0	1.6	0.6	7.2

*No data are given for two other treatment areas: **1.** rip-rapping (no rooted vegetation was found on this area in 1971 and the area was largely above water level in 1972), and **13.** stump and log removal during winter (no data were gathered in either year).

APPENDIX D: Boating Safety And Water Use Regulations

Section 1.0 Authority

Pursuant to the authority granted by Section 30.77 (3) Wisconsin Statutes and amendments thereto, the City Council of the City of Marion, Wisconsin and the Town Board of the Town of Marion, Wisconsin do ordain as follows:

Section 2.0 Purpose

The purpose of this ordinance is to promote the public health, safety and general welfare in the enjoyment of aquatic recreation.

Section 3.0 Watercraft Operation and Speed

3.1 Operation – No watercraft shall be operated in a manner so as to endanger safety or property.

3.2 Speed – No watercraft shall be operated at a speed greater than is reasonable and prudent under existing conditions and in no case shall be operated at a speed in excess of six (6) miles per hour. No watercraft shall be operated so as to show a wake within 50 feet of any shoreline or bathing area.

3.3 Restricted Areas

3.31 No watercraft shall be operated within a water area which has been clearly marked by buoys or other means as a bathing area.

3.32 No motorized watercraft shall be operated upstream from the public landing.

Section 4.0 Water Skiing

Water skiing is prohibited due to the small size of the millpond.

Section 5.0 Piers

Piers and other mooring places for watercraft shall be located so as not to interfere with safe navigation. A permit to erect a pier shall be obtained from the city council or town board within whose respective jurisdiction the proposed location lies. Conditions, such as that the longest dimension of the pier shall be parallel to the shoreline, may be attached to the issuance of a permit.

Section 6.0 Penalties

Any person who violates this ordinance shall upon conviction thereof forfeit not less than ten dollars ($10) nor more than fifty dollars ($50) and costs of prosecution for each violation and in default of payment for such forfeiture shall be imprisoned until payment thereof but not to exceed thirty (30) days. Violations of State Boating Laws – Sections 30.50 through 30.71 – shall be as provided in Section 30.80 Wisconsin Statutes.

Section 7.0 Severability

If any portion of this ordinance is judged unconstitutional or invalid by a court of competent jurisdiction the remainder of this ordinance shall not be affected thereby.

Section 8.0 Effective Date

This ordinance shall be effective upon passage by both the City of Marion and Town of Marion. A copy of this ordinance shall be posted at any public access point and shall also be filed with the Department of Natural Resources.

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Weeds, Stumps Gone, Marion Millpond Sparkles Again

By Richard C. Kienitz
of The Journal Staff

Marion, Wis. – The clear, sparkling water in the 100 acre Marion millpond was a pleasant surprise for a lot of the people who returned this weekend for the city's annual homecoming.

Many remembered the millpond clogged with weeds and algae and nearly half forested with unsightly stumps of dead trees.

Now, after 4,000 hours of volunteer labor, there is not a stump in sight.

A brand new fishing dock and swimming beach are on a tract of land deeded to the city by the Lions Club. Along with it, the Lions committed $10,000 to make it an even finer area.

Richard Harris, Oshkosh, district fish manager, said the first 16,000 bluegills planted were hand sized and ready to catch, along with 400,000 young northern pike that were coming along fine. (A couple of youngsters at pondside verified that.)

It is hard to find someone in this Waupaca County community who did not participate in what was probably the most concentrated environmental self-help project in the state over the last year or so.

One of those who rolled up his sleeves was State Rep. Francis Byers (R-Marion). And he plans to keep his sleeves rolled up with this example to encourage other communities to get to work on the 32 similar ponds in the county, many of them also deteriorating.

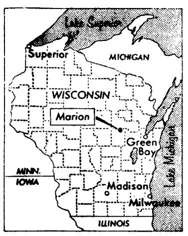
"Something like Johnny Appleseed, after it's done, I'd like to be known as Dam Byers," Byers said.

He is working to get state and federal outdoor recreation aids for similar endeavors.

Townspeople, 15 years ago began trying to do something about the pond they had used for recreation long before.

"They are the fishingest and boatingest people you ever saw" and they wanted to be able to enjoy it, said Stephen Born, a University of Wisconsin resource specialist who headed the state-UW technical team that helped guide the final thrust.

But there was not much success until mid-1968, when the pond was selected for a DNR-UW Extension inland lake re-



newal demonstration project financed by the Upper Great Lakes Regional Commission.

First the pond was drawn down to a trickle in the Pigeon River. Bulldozers and derricks went out the first winter to begin pulling out the stumps.

But when a flood threat arose downstream at Clintonville, the dam had to be closed again to help hold back what water it could. And then something like a small miracle happened as the water rose. Dried out stumps and hulks of dead trees up to 70 feet long popped to the surface where they could be towed out with draglines and a fleet of small boats. It made a pile of debris 15 feet high over an entire acre.

A dedication program was planned Friday night at pondside as the first big event of the homecoming, whose theme was "Conservation. Now and for the Future." But a rainstorm blackened the sky and drenched the earth and squeezed the truncated program into the City Council rooms.

At the program, Mayor William Bertram read his reckoning of the project: 4,000 donated hours of work, $12,000 in local money to acquire water rights and repair the dam, $82,000 from state and federal coffers, and 2,500 hours of donated bulldozer and equipment time.

It was not forgotten that the real sparkplug of the project was Martin (Ozzie) Lutzewitz. For his efforts he was honored as marshal of the Saturday homecoming parade.

The townspeople also chipped in and gave Lutzewitz a brand new 14 foot boat with a 20 horsepower motor.

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Dr. Born was project leader for the Inland Lakes Demonstration Project and is chairman of the Environmental Resources Unit, University of Wisconsin-Extension. Mr. Wirth is chief of the Water Resources Research Section in the Bureau of Research, Department of Natural Resources. Mr. Brick is also with the Department of Natural Resources as chief of the Water Regulation Section for the Bureau of Water and Shoreland Management. Mr. Peterson is a water chemist and project associate with the Inland Lakes Demonstration Project, University of Wisconsin-Extension.
Edited by Lois Harris and Susan Nehls.

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