SOME CONSIDERATIONS FOR MANAGING URBAN LAKES

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REFERENCE: Proceedings of the 1991 Georgia Water Resources Conference, held March 19 and 20, 1991, at The University of Georgia, Kathryn J. Hatcher, Editor, Institute of Natural Resources, The University of Georgia, Athens, Georgia.

INTRODUCTION

Water quality in a lake, or any other water body, is determined largely by the watershed which drains into it. The effects of soil characteristics, land use patterns, and topography form a continuous process which is driven by each rainfall event. Soil erosion is an on-going process which over time will gradually transform a lake into shallow marsh. The rate of a lake's aging process through sedimentation is a direct function of the amount of soil loss from the watershed. Urban development in a lake's watershed accelerates the aging process which reduces the useable life of the lake. The lake functionally acts as a settling basin for the watershed. In an urban setting lakes provide vital roles as stormwater retention areas. However, despite the on-going sedimentation from a developing watershed, many urban lakes are used for recreation and aesthetic purposes. Many subdivisions, office parks, apartments, and private residences will typically use a lake as an amenity to the overall project. This conflict of use – retention vs. recreation – creates a management challenge for the lake owners and users.

With the recent development (post 1970) around the Atlanta area, many lakes and ponds have been impacted by watershed changes and disturbances. The objectives of this paper are:
(1) to examine two problem areas common to many small impoundments in the piedmont region of Georgia: low biological productivity and sedimentation; and
(2) to present practical management strategies and available in-lake management technologies for developing effective plans for addressing these problems.

LOW PRODUCTIVITY

The soil type of the watershed greatly influences the water quality of the lake. Many lakes in the piedmont region of Georgia have low primary productivity due to low soil fertility and nutrient levels. Total alkalinity (TA), a measure of carbonate anion, and total hardness (TH), a measure of calcium cation, are often the water quality parameters measured and used as indicators of a lake's buffering capacity. For example, much of the piedmont region of Georgia has a high clay content in the soil which tends to make the soil slightly acidic and the lakes poorly buffered (low TH and TA levels, often < 20 mg/l). In the limestone region of north Georgia, the lakes are well buffered and show improved water chemistry (TA and TH often >50 mg/l). Boyd (1979) discusses in detail the relationship between water chemistry as a function of soil type found in the watershed and productivity in a lake. Ponds which are poorly buffered lack needed calcium for photosynthesis and are unproductive in terms of biomass supported within the lake system. Lakes that are newly limed are able to better utilize nutrients that may have been stored in acidic bottom muds.

In-Lake Management Strategy

(A) Water Quality Monitoring.

Total hardness and total alkalinity should be monitored annually. If a lake has TA or TH levels <15 mg/l, plans should be made to add agricultural limestone to the lake and possibly even the immediate watershed. Once a lake is limed, it should continue to be monitored on an annual basis.

(B) Application of Limestone.

A fine grade of limestone with respect to particle size should be obtained and ideally applied to the entire water surface. The goal of liming a lake is to neutralize the acidic bottom muds by spreading a thin layer of limestone across the lake bottom. New lakes should be limed before they are filled with water. Generally, two tons (4,000 lbs.) per acre will adequately meet the liming requirement in a lake for several years. Techniques (in order of decreasing effectiveness) for application of limestone to a lake include: (1) barge-slurry application, (2) dry applications from boat, (3) truck mounted spreader application (requires road around shoreline), (4) dumping lime directly into lake.

(C) Increasing Primary Productivity.

Phytoplankton forms the base of the food web in a lake. Increased phytoplankton production ultimately yields an increase in sport fish production. The addition of limestone can often stimulate an increase in primary production without adding additional nutrients. The needed calcium allows phytoplankton to utilize nutrients that might have been tied up in bottom sediments or released from control of macrophytes.

The addition of lake fertilizer is often used in fishing lakes to stimulate plankton blooms which in turn produce larger sport fish populations. Proper fertilization is the controlled input of nutrients (primarily phosphorous) into a lake system in order to establish and maintain a phytoplankton bloom throughout the warmer months (approximately March - October) for the purpose of enhancing sport fish populations. Caution must be exercised when attempting to fertilize an urban lake as there often exists conditions which make the addition of nutrients potentially detrimental to the overall health of the lake.

Prior to initiating a fertilization program for an urban lake, the lake manager should address the following concerns. (1) Excessive water flows through the lake can flush fertilizer downstream prior to it being utilized by the phytoplankton. (2) Drain systems which release surface water allow the most productive water to be removed from the lake, thus causing fertilization to be inefficient. (3) Irregular fertilizer applications are ineffective in maintaining a plankton bloom and can possibly stimulate a plant or algae problem by the sporadic addition of nutrients. (4) Established macrophytes, if not controlled, can respond to the fertilizer by invading extensive shallow water areas. (5) Soft water lakes often do not respond to the fertilizer which adds more nutrients to the bottom sediments possibly increasing the potential for aquatic plant problems.

SEDIMENTATION

Erosion in the watershed causes sedimentation in water bodies. The ultimate control of sedimentation is complete erosion control in the watershed. However, this is unrealistic, if not impossible. Many erosion control techniques implemented on construction sites are designed cost-effectively to accommodate a given rain event frequency. If a larger rain event occurs than for what was originally designed, sedimentation is inevitable. Despite present erosion control efforts and more stringent regulations, soil loss and sedimentation continue to occur and will eventually render the lake unusable as a water resource.

Negative Effects

Sedimentation negatively impacts a water body in many ways. Some effects of sedimentation on lakes include: (1) shoaling of the lake basin which decreases lake volume and creates more shallow water; (2) adding nutrients from eroded soils; (3) increasing turbidity which limits light and plankton production; (4) silting fish spawning habitat; (5) irritating fish gills with suspended silt (Moore, 1987).

Many lakes have aquatic macrophyte infestations at excessive levels. Sedimentation is the often the cause of the plant problem because of newly formed areas of shallow water are fueled by the nutrients from nonpoint sources and by sun light able to reach the shallow lake bottom. Aquatic plant problems are usually symptoms of a sedimentation problem.

Excessive growth of aquatic macrophytes further increase sedimentation rates by filtering incoming sediment and contributing organic matter as the plants die and decay. Indirect effects of excessive weed growth include: (1) increasing light penetration which can stimulate further infestations of macrophytes into deeper water; (2) creating stunted panfish populations by reducing predator effectiveness; and (3) reducing aesthetic values.

In-Lake Management Strategies

(A) <u>Monitoring.</u>

Monitor the lake at least annually to assess the rate of sedimentation. Annual surveys provide valuable baseline data for assessment of future sedimentation. With the current erosion control regulations, many projects are being forced to comply with the codes or face possible litigation for damaged water resources. If active sedimentation areas are found on a lake, the following steps are recommended. (1) Document impacted area of lake with surveys, maps, and photographs so that the amount of newly deposited sediment can be quantified from previous baseline information. (2) Locate possible erosion source in watershed and attempt to initiate control. (3) Notify appropriate regulatory agency. (4) Initiate planning of lake restoration project.

If no active areas of sedimentation are located in the lake, development of a watershed map can assist in identifying potential areas of erosion.

(B) <u>Lake Restoration.</u>

Restoration is an inclusive concept of using sound ecologic principles to bring about long-term improvement in water resources (Cooke, 1986). There are many factors involved in initiating and carrying out a successful restoration project on an urban lake and professional guidance is recommended. There are also sources available for assisting lake owners in designing and implementing lake restoration projects (NALMS, 1988).

For the purpose of this paper our discussion will include only a comparison of sediment removal methods (Table 1). The available technologies for sediment removal can be divided into two main groups: (1) those requiring the lake to be drained, and (2) those that can be implemented with the lake at normal water level. With present water demands increasing and supplies becoming more critical, draining a lake for restoration purposes should be avoided if at all possible.

Possible methods for sediment removal with the lake at full pool can further be broken down into land-based equipment and water-based equipment. If the shoaling is near shore, then the land-based equipment will be the most cost-effective method. However, most sedimentation in a lake is not accessible with land-based equipment.

There are two main groups of water-based dredges for use on inland lakes: hydraulic pumping and mechanical removal. The limiting factor of hydraulic dredging in urban lakes is most often the location and available size of the spoil area. Pumping a slurry of water and sediment requires a spoil area of sufficient size located in close proximity to the lake. This is often difficult in developed areas. Discharging of dredge spoil requires a section 404 permit from the U.S. Army Corps of Engineers (ACOE) for the protection of any wetland areas.

Mechanical removal of sediment can be accomplished using a self-propelled barge with a hydraulic operated clamshell bucket. Material is excavated from the lake bottom and either placed on a hopper barge or directly in a dump truck for transportation to a suitable upland spoil area. This methodology does not require section 404 permitting since there is no fill or return water into a wetland area. Table 1 summarizes the sediment removal methods. In dealing with urban lakes mechanical removal with a self-propelled clamshell barge has some distinct advantages over more traditional methodologies. More research and development of specialized equipment will be needed in order to deal with the magnitude of the sedimentation problems that will have to be dealt with during the 1990's.

TABLE 1. Review of Sediment Removal Metfiods for Lakes and Reservoirs.

Lake Level	Removal Method	Comments
Empty	Drain, Dry, Excavate	• dependent on weather drying lake • loss of lake use for indefinite time • aesthetically unpleasing; fish ? • possible low $ (unspecialized work) • possible siltation downstream • good for muck bottom (if dries) • spoil removal vs. reshaping basin • draining lake affects hydrologic cycle
Full	Excavation • dragline • backhoe	• limited to shoreline area (access) • shoreline disturbance • good for near shore shoaling • open bucket causes turbidity • disposal storage (permitting)
	Dredging (hydraulic)	• effective on large volume in one area • involved set-up & mobilization • requires constructed spoil area • requires section 404 permit • can dewater small lake
	Dredging (clamshell)	• self-propelled barge • hydraulic operated clamshell bucket • spoil can be trucked to optimum site • minimal mobilization & set-up • excellent for dispersed areas • no section 404 permit required • uses barges for material transport • requires one access point to lake

CONCLUSIONS

(1) Lakes in developed watersheds are subject to sedimentation at a rate which can potentially eliminate the effective use of the lake within a lake users lifetime.

(2) With the growing concern of having enough useable water in sufficient quantity and quality to meet future water demands, planning of lake and reservoir restoration projects must begin immediately and be on-going in order to formulate practical, cost-effective solutions.

SUMMARY

Urban lakes are complex systems driven by their watersheds and influenced by disturbances within the watershed. The original design of the lake dictates how the lake responds to the impacts placed upon it by the watershed. Management of an urban lake consists of manipulating the major components (physical structures, water, fish, plants, etc.) of a lake to adjust to the influences of the dynamic watershed. Sound management of an urban lake is tightly coupled with management of the lake's watershed.

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