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# EWQOS

## ENVIRONMENTAL & WATER QUALITY OPERATIONAL STUDIES

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Nuisance algal blooms, caused by bloom-forming algae such as the blue-green algal genera shown above (*Anabaena, Microsystis,* and *Aphanizomenon*), occur in many Corps of Engineers impoundments. Algal-related problems are a source of considerable public concern related to the use of water resources throughout the country. The following article summarizes some of the most recent efforts under the Environmental and Water Quality Operational Studies (EWQOS) Task IIA to evaluate the major factors controlling algal growth rates and to develop appropriate control and management methods.

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# MANAGEMENT OF ALGAL BLOOMS IN RESERVOIRS

## PROBLEM IDENTIFICATION

Excessive algal production and the subsequent decay of algal biomass frequently result in localized oxygen depletion, fish kills, disagreeable taste and odor of water supplies, and unsightly shorelines and surface waters. Algal-related problems are a source of considerable public concern related to the use of water resources throughout the country.

Initially an attempt was made to identify CE reservoir projects experiencing algal bloom-related problems. Results of a survey of all CE District offices in the United States indicated that at least 78 impoundments fell into this category. Each of the affected impoundments appears to be annually subjected to excessive nutrient loadings and provides suitable environmental conditions conducive to the periodic formation of algal blooms.

## CONTROL AND MANAGEMENT PRACTICES

Simultaneous with the problem survey, existing algal control techniques and management policies were identified through a systematic literature survey and through communications with various State and Federal agencies. Most of the algae control methods identified during the survey can be categorized into one or more of the following generalized categories:

| Control Method | Example |
|---|---|
| Biological | Pathogens |
| Chemical | Algicides |
| Physical | Destratification |
| Ecological | Selective predation |

For the most part, these techniques afford limited algal control for relatively brief periods of time. Long-term algal management policies are essentially nonexistent. Most algal control methods are invoked only after a bloom has occurred and must be repeated on a regular basis in order to ensure continued success.

Many methods now used for algae control may be unacceptable for CE purposes. For example, algicides may have significant adverse ecological side effects. Furthermore, algicides, except for localized control, are difficult or impossible to use on large reservoir projects.

Controlling algal blooms by reducing growth-promoting factors or through alterations in project operation are attractive alternatives. Most previous algal control work has concentrated on natural lakes. Reservoirs in many cases present significantly different conditions, including greater potential for management by manipulation of water levels and discharge elevation. Considerable emphasis on understanding the constraints and limitations associated with the application of various algal control techniques is required to provide long-term, effective control programs, and most importantly, preventive methodologies.

## POTENTIAL INFLUENCE OF NUTRIENT RELEASE

Nutrients sedimented in reservoirs represent a potentially vast source of supply to the overlying water. Various mechanisms of nutrient release from sediments can contribute to the internal nutrient loading of aquatic systems. These mechanisms may become increasingly important in systems that have been subjected to high rates of nutrient input predominantly as suspended sediments. The occurrence of internal nutrient loading processes in reservoirs may lessen the effectiveness of algal management methods where success is dependent upon reductions in overall nutrient supply.

Phosphorus (P) is a particularly important nutrient because it has been identified as one of the major algal growth-controlling factors in aquatic systems. Recent experiences by the Environmental Protection Agency and others have indicated that internal P cycling between sediment and water needs to be considered in algal bloom management. Aquatic plants have been indicated as a major mechanism of P mobilization; however, definitive data on aquatic plant-mediated "phosphorus pumping" have been lacking, thus making it difficult to develop and evaluate management alternatives for many reservoirs.

## LABORATORY STUDY

The mobilization of sediment P by three submerged freshwater plant species was

investigated using sediments from five reservoirs:

| Reservoir | Location (CE District) |
|---|---|
| Ashtabula | North Dakota (St. Paul) |
| Branched Oak | Nebraska (Omaha) |
| DeGray | Arkansas (Vicksburg) |
| Papillion | Nebraska (Omaha) |
| West Thompson | Connecticut (New England) |

Purposes of the study were to provide quantitative information on the movement of P from sediment into the water via submersed plants and to determine variations in the rate of movement as a function of plant and sediment type. The experiment was conducted under controlled environmental conditions in Plexiglas columns that enabled the separation of sediment and plant roots from the overlying P-free complete nutrient solution (Figure 1).

The species investigated (*Egeria densa, Hydrilla verticillata,* and *Myriophyllum spicatum*) were demonstrated to be fully capable of deriving their P nutrition exclusively from the sediments. Phosphorus absorption and translocation into shoots (i.e., mobilization) was substantial and, in some cases, indicated a greater than 1000-fold turnover of interstitial water $PO_4$-P over a 3-month period. Phosphorus release from the species investigated appears to be primarily dependent upon tissue decay rather than excretory processes. Since losses of biomass from submersed plants and subsequent tissue decay are continuous in aquatic systems, these plants potentially provide a persistent and significant source of sediment-derived P to other ecosystem components.

In reservoirs, or in localized portions of reservoirs such as coves and embayments, that are shallow and subjected to relatively minor areal water loads, P mobilization by aquatic plants is likely to play an important role in P cycling, possibly enhancing algal productivity. Even in deep impoundments, there are frequently numerous shallow coves in which rooted plants may significantly affect local nutrient conditions.

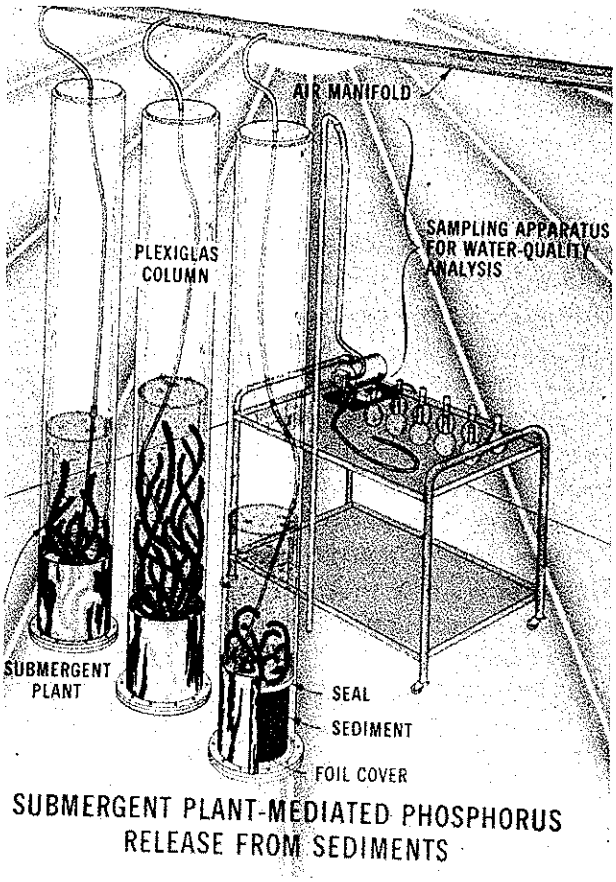


**Figure 1. Artist's conception of column apparatus**

## RECOMMENDATIONS

Generalized recommendations made on the basis of the results of this investigation are presented below.

- Aquatic plants should be considered as a potentially important source of P supply to other components (including algae) of aquatic systems.
- Sediment P mobilization by aquatic plants could negate the effectiveness of algal control techniques that rely on reduced P loadings.
- The role of plant-mediated sediment P cycling in regulating algal blooms should be considered along with other internal mechanisms of P supply (such as thermocline migration) in selecting and applying lake restoration techniques to reservoirs. This will be possible as internal nutrient cycling processes become better understood as a result of EWQOS studies and related work by others.

## CONTINUED WORK

Future direction in the development of algal management and control techniques for Corps implementation will be determined from consideration of key factors controlling algal biomass and productivity. A thorough understanding of these factors is paramount in evaluating the effectiveness of existing methods of algal control. For example, aquatic plant species, in addition to those investigated earlier, are currently being evaluated in regard to their ability to mobilize sediment nutrients. A workshop is being planned for 1980 to scrutinize various algal control methods for future application to CE impoundments in the program and to identify any additional critical information gaps that should be addressed to help solve this high-priority field problem.

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