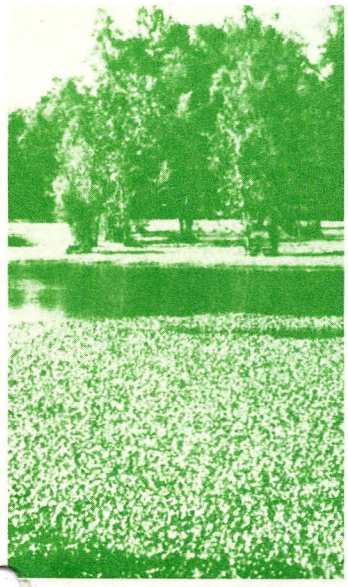
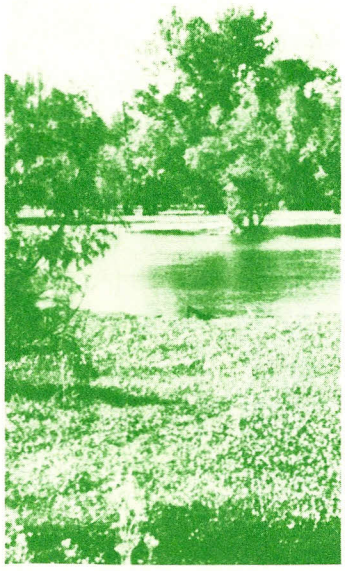
US Army Corps of Engineers
Waterways Experiment Station





ENVIRONMENTAL LABORATORY

AQUATIC PLANT CONTROL RESEARCH PROGRAM

VOL A-85-1 INFORMATION EXCHANGE BULLETIN MAY 1985

NUTRITION AND GROWTH OF SUBMERSED MACROPHYTES: THE ROLE OF BOTTOM SEDIMENTS

John W. Barko
Ecosystem Research and Simulation Division, EL

A variety of environmental factors influence the growth of submersed macrophytes. The strengths and weaknesses of different species in relation to environmental conditions affect specific growth rates and ultimately regulate macrophyte community composition. It is desirable to further our understanding of the ecology of these plants in order to better predict and/or manage their growth.

This article considers in a general way the role of bottom sediments in connection with the nutrition and growth of submersed macrophytes, and highlights ongoing related research in the author's laboratory. A large volume of literature and data support the major points made herein, but citations were excluded from the article to achieve brevity.

SEDIMENT AS A NUTRIENT SOURCE

It was once widely held that submersed macrophytes were exclusively dependent upon nutrient absorption by shoots (foliage) and that roots functioned merely as anchoring devices. Considerable recent evidence, obtained primarily during the past decade, suggests that these plants may actually be more dependent upon nutrient uptake from sediments by roots than on foliar absorption of nutrients from the overlying water. Indeed, the roots of submersed macrophytes appear to possess many (if not all) of the functional characteristics of terrestrial plant roots. Moreover, the availability of many potentially growth-limiting nutrients (e.g., phosphorus, nitrogen, and iron) appears to be much greater in most sediments than in the overlying water.

While sediments clearly represent a potentially important source of some nutrients to submersed macrophytes, the role of sediments in the overall nutrition of these plants remains a subject of continuing debate. For a variety of nutrients, rates of uptake by leaf and stem tissues are equal to or greater than uptake by roots when nutrient concentration and availability in the water column and sediment are equal. The extent to which nutrients mobilized by roots from sediments augment uptake from the water column or vice versa undoubtedly varies among specific nutrients as well as among aquatic systems. Perhaps the least ambiguous generalization regarding the nutrition of submersed macrophytes is that nutrient absorption occurs from regions of greatest availability relative to the distribution of macrophyte tissues having an absorptive capacity.

SEDIMENT AS A GROWTH REGULATOR

Since nearly the turn of this century, it has been recognized that the nature of bottom sediments somehow affects the growth of submersed macrophytes. Associated mechanisms, however, have not been clearly established. The influence of sediments on the growth of these plants may be due to physical properties

rather than chemical composition. Texture is apparently important in relation to the rooting depth of species with different abilities to penetrate sediment and may determine rooting success in particular conditions of water flow.

Site-related differences in the growth of submersed vascular plants may involve nutrition. However, this possibility currently lacks direct substantiation. On infertile sediments, freshwater macrophytes tend to concentrate biomass in belowground structures (i.e., increase root-to-shoot ratio), which may facilitate more effective absorption by roots and translocation to shoots of sediment nutrients. Submersed macrophytes are capable of maintaining adequate tissue nutrient levels through seasonal conservation of biomass and nutrients. Some species with a characteristically high root-to-shoot ratio appear particularly well adapted to infertile environments.

Different submersed macrophyte species appear to vary in the magnitude of their response to sediment conditions. For example, in an earlier investigation of sediment-phosphorus mobilization by submersed macrophytes, the growth of *Myriophyllum spicatum* varied over a broad range, whereas the growth of *Egeria densa* on the same array of sediments did not vary (Figure 1). In nature, such differences in responsiveness to sediment conditions may influence through competition the species composition of submersed macrophyte communities.

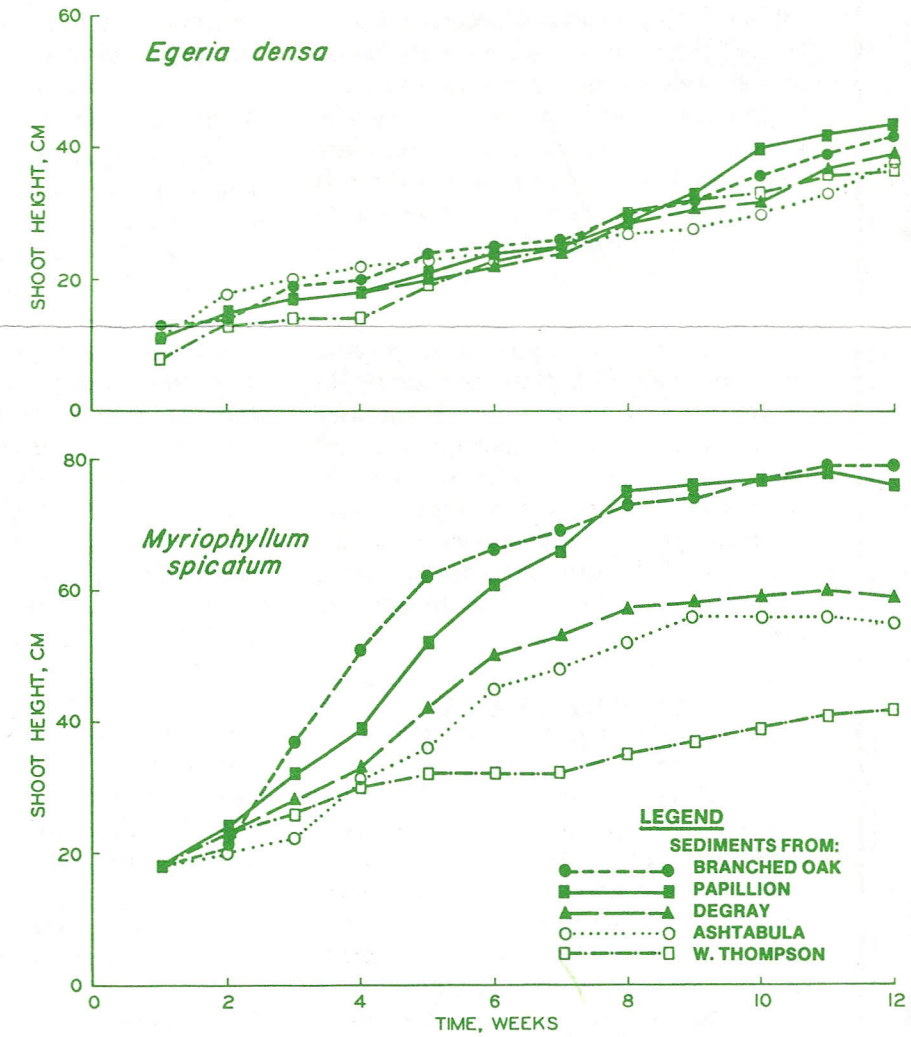
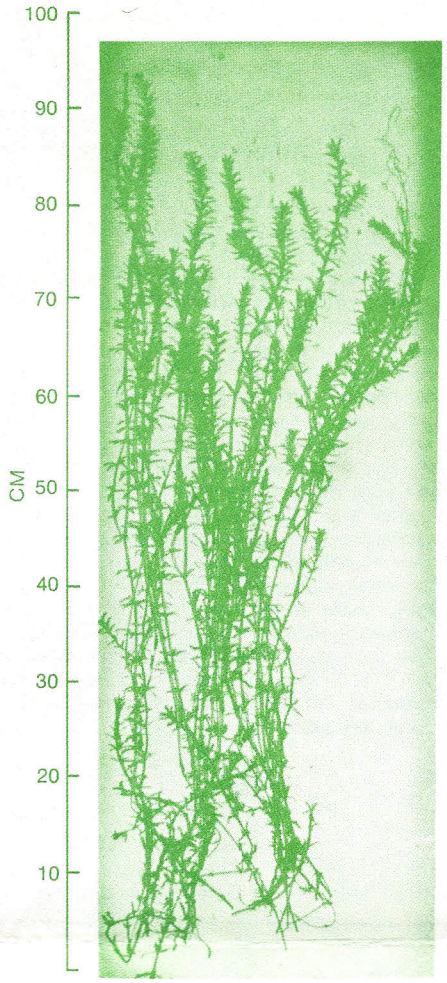
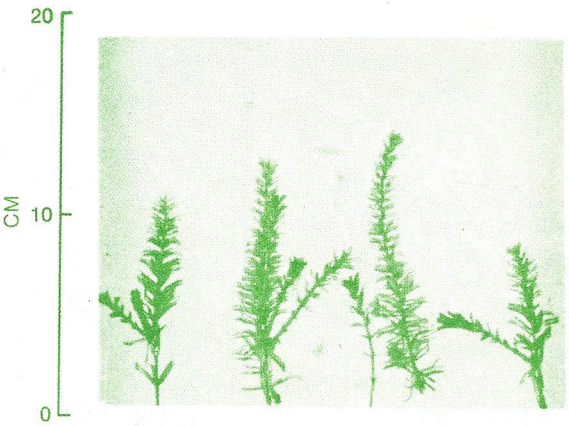


Figure 1. Growth, as shoot height, of *Egeria densa* and *Myriophyllum spicatum* grown on sediments from five different reservoirs



a. Control sediment



b. Cattail-amended sediment

Figure 2. Growth of *Hydrilla verticillata* on an inorganic control sediment and on the same sediment amended by addition of dried cattail litter, representing a 5% increase in total sediment organic content

There is an apparent association during lake aging between increasing sediment organic matter and the decline of submersed macrophytes. Moreover, the species composition of aquatic plant communities and the spatial distribution of individual species seem to vary with sediment organic matter content. These observations, considered collectively, suggest that the effect of sediments on submersed macrophytes may in some way be related to sediment organic matter content.

Additions of vegetative organic matter to sediment can substantially reduce the growth of submersed aquatic plants. For example, in an investigation conducted in the author's laboratory, the addition of dried cattail litter to an inorganic control sediment resulted in a 90% reduction in the growth of *Hydrilla verticillata* (Figure 2). Since little is known about organic loading processes in natural aquatic systems, the applicability of these results obtained on artificially loaded sediments to nature has been open to question.

ONGOING RESEARCH

The growth of two invasive submersed macrophytes, *Hydrilla verticillata* and *Myriophyllum spicatum*, on 40 natural sediments from 17 geographically-widespread North American lakes has recently been examined in the author's laboratory. Macrophyte growth on these sediments varied over a broad range, but was rather uniformly diminished on highly organic sediments and on sands. Several possible mechanisms are being examined in connection with these results. This line of research is of fundamental importance in better understanding the ecology of submersed macrophytes and should also be useful in evaluating the site-specific growth potential of particular submersed macrophyte species.

AQUATIC PLANT CONTROL RESEARCH PROGRAM

This bulletin is published in accordance with Army Regulations 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Aquatic Plant Control Research Program (APCRP) can be rapidly and widely disseminated to Corps District and Division offices as well as other Federal agencies, State agencies, universities, research institutes, corporations, and individuals. Contributions are solicited and will be considered for publication so long as they are relevant to the management of aquatic plants as set forth in the objectives of the APCRP, which are, in general, to provide tools and techniques for the control of problem aquatic plant infestations in the Nation's waterways. These management methods must be effective, economical, and environmentally compatible. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: J.L. Decell, US Army Engineer Waterways Experiment Station, PO Box 631, Vicksburg, MS 39180-0631, or call AC 601/634-3494.

Robert C Lee

ROBERT C. LEE
Colonel, Corps of Engineers
Commander and Director

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
PO BOX 631
VICKSBURG, MISSISSIPPI 39180-0631

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

WESEP-A

BULK RATE
POSTAGE & FEES PAID
DEPARTMENT OF THE ARMY
PERMIT NO. G-5