A Q U A P H Y T E

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Toxicity Testing and Biomonitoring Using Aquatic Plants

by Wuncheng Wang, Illinois State Water Survey, P.O. Box 697, Peoria, IL 61652, (309) 671-3196

Regulatory agencies, industries, and consulting laboratories routinely use three "base-set" tests for toxicity assessment in compliance with the Toxic Substances Control Act, the Clean Water Act (and its section on the National Pollutant Discharge Elimination System), and other environmental laws. These tests rely on species of fathead minnow (*Pimephales promelas*), algae (*Selenastrum capricornutum*), and cladoceran (*Daphnia magna* or *D. pulex*) (Peltier and Weber, 1985; Horning and Weber, 1985; Weber et al., 1988). The reasons for selecting these species are apparent. First, the principal route-of-exposure of effluents, industrial chemicals, and other toxicants is waterways, so that aquatic species are frequently the first to be exposed to toxicity. Second, these species represent three important trophic levels. Third, there are ample data bases pertaining to these species. Regulatory agencies have relied on these tests as their tools for environmental protection. However, although these tests are widely used, they are impractical in some cases.

For effluent biomonitoring, it is essential to use either the renewal or the flow-through methods because effluent samples (especially samples of municipal effluents) are unstable as a result of large microbial populations and high organic content. Algae are not appropriate for use in either of these tests. In addition, filtration of turbid samples or samples containing large algal populations is required if they are to be evaluated by means of the algal test; however, sample filtration is undesirable because the procedure destroys the integrity of the test samples. Faunal tests (fish and cladoceran) also have drawbacks for effluent toxicity assessment. Some samples may contain low levels of dissolved oxygen, thus necessitating sample aeration, but like filtration, aeration violates the integrity of the test samples.

All these difficulties, however, are non-existent when aquatic, vascular macrophytes are used as test organisms. In addition to the ease of using macrophyte tests, several features make them ecologically relevant. Along with algae, macrophytes are essential, primary producers in the ecosystem. They produce oxygen and organic matter, both of which are needed by almost all other life forms in order to survive. Macrophytes frequently provide food, habitat, and shelter for waterfowl, insects, mollusks, amphibians, and mammals. Some macrophytes have important roles in nutrient cycling and in stabilization of shores or sediments.

Among macrophytes, duckweed is generally considered the most promising toxicity test organism. The plant is a small angiosperm and is extremely fast-growing (Hillman, 1961; Hillman and Culley, 1978). A detailed literature review regarding the use of duckweed for toxicity testing is available

[See TOXICITY on page 14]

Work on the **aquatic plant identification videotapes** continues. The programs feature aquatic plant expert Dr. David Hall, University of Florida Extension Botanist. See story on page 12.

VIDEO PROGRAM IN USE

FLORIDA'S AQUATIC PLANT STORY is the most recent environmental education program produced by the UF/IFAS Center for Aquatic Plants. The program describes the benefits of aquatic plants, recounts problems caused by some exotic "aquatic weeds", and introduces the major methods of aquatic plant management, including mechanical, biological and herbicidal control. The program is intended especially for general audiences and school students who have little knowledge of Florida's aquatic plants and their management.

We are very pleased that the program is being used in a variety of ways:

- Eleven television and cable stations in Florida requested broadcast quality copies of the program. One cable station aired the program several times during August.
- Twenty-two Florida school systems have purchased or borrowed the program for student use. One science coordinator determined that the program is appropriate for elementary and secondary schools and consequently requested 36 copies, one for each school in his district.
- A vocational high school teacher has developed a natural resources teaching unit around the program.
- The Florida Department of Education Instructional Television Office has offered to duplicate the program free of charge for requesting teachers throughout the state.
- The program has been purchased by a variety of environmental groups, including several Florida LAKEWATCH groups.
- The program is being used in environmental education forums such as the recent ECO-FAIR '90, sponsored by the Army Corps and the Take Pride in Lake Okeechobee Committee. Nearly 2,000 students and 100 teachers (grades K-8) attended the one-day forum.
- The program has been used for Army Corps training purposes in Texas, Tennessee and Minnesota.
- The program is also shown during public education meetings held by the Cooperative Extension Service.

FLORIDA'S AQUATIC PLANT STORY is one of a series of environmental education programs about aquatic plants and the management of Florida's freshwater ecosystems. The series is sponsored by the Florida Department of Natural Resources, Bureau of Aquatic Plant Management, with funds from the Aquatic Plant Trust Fund.

VHS, S-VHS or PAL copies of the program may be purchased for $10.60 ($10.00 for non-Florida residents) payable to the University of Florida. Order from:

IFAS Publications Office
IFAS Building 664
University of Florida
Gainesville, Florida 32611-0001
(904) 392-1764.

COMING SOON...

The Center video team is currently working with **Dr. Ken Langeland,** IFAS Aquatic Weed Extension Specialist, on a second calibration program. This new calibration program emphasizes the mathematics required to pass the Florida Certified Pesticide Applicator examination. The program will be available in early 1991.

Other programs in production include aquatic plant identification videos, featuring U.F. Extension Botanist **Dr. David Hall,** who teaches the identifying characteristics of 100 common Florida aquatic plants. The program will be divided into four tapes:

I. Floating and Floating Leaved
II. Submersed
III. Emersed
IV. Grasses, Sedges and Rushes

Programs will be announced as soon as they are available.

More than 2,000 students and teachers (grades K-8) attended the **ECO-FAIR '90,** September 19, 1990 in Clewiston. The fair introduced students and teachers to the federal, state and local agencies and organizations that provide environmental awareness programs in the Lake Okeechobee area.

A T T H E C E N T E R

Continuing Studies On Torpedograss

Dr. Paul Thayer, in collaboration with Dr. Bill Haller, continues to investigate the troublesome Florida aquatic weed, torpedograss (*Panicum repens*).

In preliminary studies, Thayer has found that torpedograss will not resprout from the root system if it is cut or damaged when submerged more than one foot. Thayer believes disease organisms indigenous to Florida (the fungi *Phoma* and *Fusarium*) damage the plant stems in submerged conditions, and may serve as natural control agents in deeper waters where the plant cannot resprout. However, the fungi do not effectively control torpedograss in those situations where the weed grows best: shallow water or moist soil.

Torpedograss can survive in water depths up to four feet as long as the stems are not cut or damaged. This research may prove significant if Florida's water levels return to former heights and the torpedograss range extends out to four foot depths.

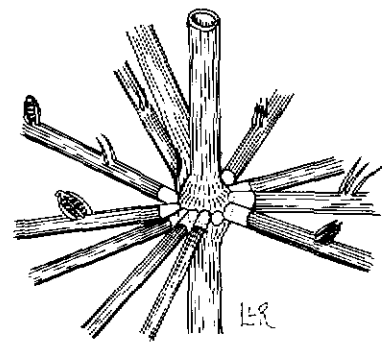
In other work, Thayer has been studying the effects of fluridone (Sonar) on torpedograss in drawdown situations. In a study initiated on West Lake Tohopekaliga in 1987, fluridone provided control through a two year evaluation period after the lake was drawn down, treated with the herbicide, and reflooded. Thayer is hoping to duplicate these results in studies on East Lake Tohopekaliga. Greenhouse tests have confirmed that greater weed control is achieved when the root system can be treated, instead of the foliar parts of the plants. Use of non-ionic surfactants with the herbicide further improved control.

"Input" Wanted: Wetlands, Wildlife And Stormwater

Dr. Chuck Cichra, Fisheries Extension Specialist, is beginning work on a three year project that will result in an Extension publication entitled, "Designing Storm Water Control Ponds to Mitigate Wetland Habitat Losses," and an accompanying 30 minute video program. Since it is believed that storm water control ponds can serve many of the same functions as natural wetlands, the focus of the project is to relate how to design and manage ponds to retain water, be aesthetically pleasing, enhance fish and wildlife habitat, and provide recreational opportunities such as fishing, bird watching, and nature photography in developed areas. The publication and video program will contain information and species lists applicable at least to the southeastern portion of the U.S.

Topics to be covered in the project include regulations, site selection, liability, pond construction, fish and wildlife habitat and management, and pond landscaping and aquascaping. The investigators plan to consult with representatives from the water management districts and other regulatory agencies, environmental engineers, developers, landscape architects and other groups. Knowledge gained will be combined with that of the urban wildlife and fisheries specialists to produce these "how to" guides for future development activities, thus integrating fish and wildlife needs into the design, construction and management of storm water control ponds.

Input is solicited and anyone with information to offer may contact any of the investigators: Dr. Chuck Cichra (904/392-9617); Dr. Joe Schaefer (904/392-4851), Dr. Craig Huegel (813/586-5477) or Dr. Frank Mazzotti, (305/370-3725) of the U.F. Department of Wildlife and Range Sciences.



"Stem" of muskgrass (**Chara** spp.)
Drawing by Laura Line, 1990

Canadian Studies Florida's Wild Rice

Canadian U.F. graduate student, **Jan Miller,** has begun studying the general biology and ecology of wild rice (*Zizania aquatica*) in Florida. An honor's biology student from Lakehead University, Miller is working on her master's project with Dr. Bill Haller.

The only cereal grain native to North America, wild rice is a cash crop in Canada and is considered a delicacy in many countries. In the U.S., California and Minnesota corner the market in wild rice paddy cultivation. However, very little biological information is available on the southern variety of wild rice. Besides adding to the existing body of knowledge on *Zizania aquatica*, learning about the growth characteristics may help scientists interested in developing hybrids.

Miller travels the state in search of wild rice plants, collecting seeds and data such as water temperature, salinity, and distribution. So far, the species has only been found in spring-fed or tidally influenced rivers. Plants are now being established in growth vaults for future studies.

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UNIVERSITY OF FLORIDA
7922 N.W. 71ST STREET
GAINESVILLE, FLORIDA 32606
(904) 392-9613

Dr. Joseph Joyce, Director

WATER QUALITY AND AQUATIC PLANT MANAGEMENT IN WAYNE COUNTY, NEW YORK (Sodus Bay, Lake Ontario)

by Robert K. Williams, Aquatic Program Coordinator, Wayne County Soil & Water Conservation District, 8340 Ridge Road, Sodus, New York 14551. (315) 483-6958

Within the Finger Lakes region of New York State there has been growing concern for the water quality of the area's freshwater resources. This concern was triggered mainly by the increasing abundance of aquatic macrophytes. In some cases over 500 grams (dry weight) per square meter have been recorded. Dominant aquatic plants include *Potamogeton crispus, Potamogeton pectinatus, Myriophyllum spicatum, Vallisneria americana,* and algae.

The Wayne County Soil and Water Conservation District (SWCD) has developed a comprehensive program to address both water quality and excessive aquatic plant growth. Three cooperating agencies provide the backbone for the program: the Finger Lakes Water Resources Board (WRB) which facilitates the exchange of information and maintains the integrity of similar programs in the region; the State Department of Environmental Conservation, Division of Water, which provides technical support; and the Cooperative Extension Service which supports the educational component.

The overall goal of the program is to manage aquatic plant growth on a long term basis and to restore water quality to a more acceptable level. Early in the program, the SWCD identified Sodus Bay as their primary waterbody to work with. Sodus Bay is the largest freshwater embayment along Lake Ontario's shoreline. The surface area of the bay encompasses over 3000 acres (1248 hectares) and has a watershed of just over 30,000 acres. The watershed is separated into five subwatersheds.

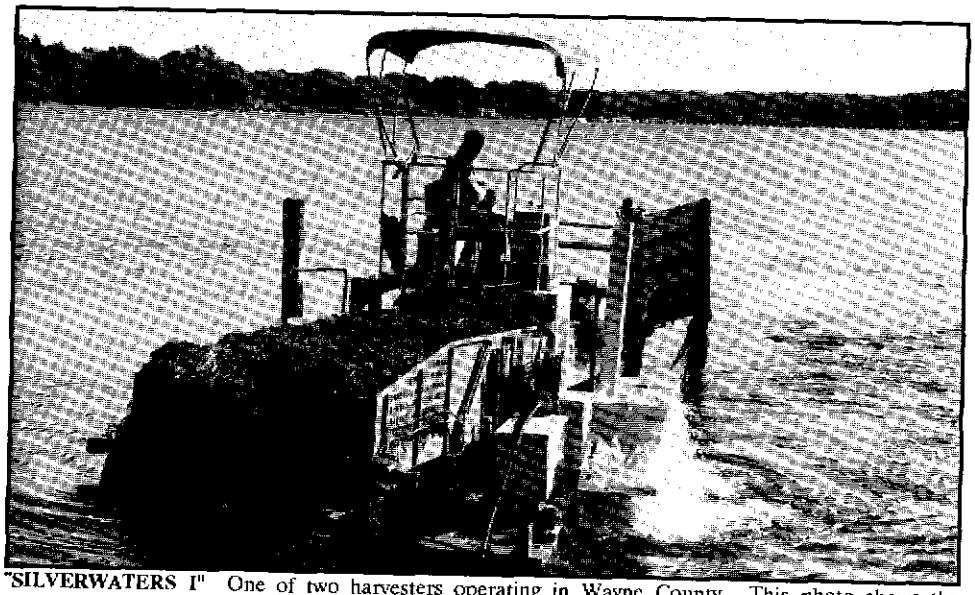
Through observation and review of limited historical data it appears that aquatic plant growth in the bay is accelerating. We believe the increased growth is a result of non-point sources of nutrients (NPS), and we have thus shaped our program efforts.

To effectively deal with the situation the SWCD has incorporated three key elements into the program: mechanical aquatic plant harvesting; non-point watershed research; and public education.

Mechanical harvesting provides the county with the means for immediate relief of aquatic plant infestations. To a limited extent, harvesting also removes some of the system nutrients (bound in the harvested plants). Two harvestors, each with ten foot cutting heads, are operated from June through September. An average of 1500 tons of vegetation are removed annually from three waterbodies. Results from 1989 are shown in Table 1 below.

The long term benefits of removing excess vegetation, as related to nutrient removal, are currently being investigated. Each year the District evaluates nutrient removal via aquatic plants by multiplying the dry weight of harvested material by nitrogen and phosphorus values calculated from vegetation analysis. These values represent the average amounts of Kjeldahl nitrogen (N) and total phosphorus (P) contained in the Sodus Bay plants.

Table 2 represents nutrient removal in 1989.



"SILVERWATERS I" One of two harvesters operating in Wayne County. This photo shows the machine preparing to unload.

Table 1. Harvest results from 1989.

AREA	TONS REMOVED	ACRES HARVESTED
SODUS BAY	1075	248
PORT BAY	56	21
GANADA LAKE	4	2
TOTALS	1135	271

Table 2. Nutrients removed, via harvesting in 1989.

AREA	N (lbs)	P (lbs)
SODUS BAY	1505	273
PORT BAY	78.4	12.3
GANADA LAKE	5.6	0.9
TOTALS	1589	286.2

In an effort to find a beneficial use for the harvested material the District is working closely with local organic farmers to study the feasibility of using the material in compost. Preliminary studies demonstrate that by mixing a 1:1 ratio of aquatic vegetation with a mixture of apple pumice, chicken manure and wood chips, soil organic matter is increased. Analysis of "aquatic compost" on a dry basis shows the following:

Organic matter	**.25%**
Total nitrogen	**1.43%**
T. Phosphorus	**.04%**
Potassium (K20)	**1.01%**
Calcium	**7.59%**
Sodium	**.07%**
Magnesium	**.26%**

An interesting observation made over the past two harvesting seasons is a shift in species dominance over the summer. We have found that in the first part of the season, late May through June, *Potamogeton crispus* dominates the harvest. By mid July, however, *P. crispus* was rarely observed. On the other hand *Potamogeton pectinatus* was relatively unnoticed throughout the summer but dominated the harvest in September. Future observations such as this may lead to information on changes in local plant community structure.

The second major element of the District program is monitoring water quality and managing non-point source pollution. We believe understanding our water quality is the key to controlling advanced eutrophication and excessive aquatic plant growth. In order to address our non-point sources of nutrients it is critical to gather scientific data on our waterbodies.

Currently two methods of collecting and assessing water quality are used: Fixed Frequency Sampling (FFS) and event-based monitoring/stream gauging. By regularly sampling watershed runoff we are able to assess water quality, develop historical and trend data, and compare each of the subwatersheds. With this baseline data, we will be better able to evaluate the effectiveness of future best management practices (BMPs). Currently all five tributaries entering Sodus Bay are sampled at a fixed frequency of once per week.

Event-based monitoring takes in-depth looks at the relationship between storm events (rain and snow) and nutrient runoff into the Bay. This system consists of a stream gauging station equipped with an automatic sampler and other advanced instrumentation. In response to changes in water depth, the system takes water samples and records all relevant physical data. Measurements include stream height and discharge, total phosphorus, soluble reactive phosphorus, total Kjeldahl nitrogen, nitrates/nitrites, suspended solids and dissolved oxygen.

Data from various other in-lake studies allow us to compare the lake (bay) water to watershed runoff and better understand how water chemistry relates to water quality and weed growth. Water sampling also enables researchers to study trends in water quality and to track program success.

To help assemble our data into a realistic picture, the District will use a computer imaging system running the "GRASS" software developed by the U.S. Soil Conservation Service. This imagery system will allow researchers to view and study real and hypothetical land-uses and their potential impacts on our water quality.

Public education is the third key element of the District's program. In the program's first two years, we made more than twenty public presentations, keeping the public informed on local water quality issues as well as encouraging them to participate in program efforts. Any public service program must contain a public education effort in order to balance a program's implementation with public concerns. In Wayne County, a variety of educational strategies are incorporated into the program: video tapes, brochures, newsletters, and technical reports.

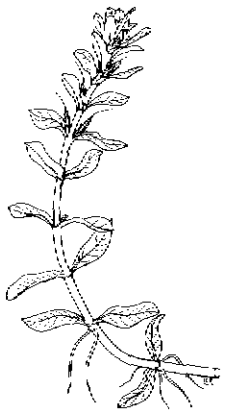
The three key elements, mechanical harvesting, non-point research and public education, combine to form a comprehensive program to manage aquatic plants and water quality on a long term basis in Sodus Bay, Lake Ontario. Harvesting provides a means of immediate control of aquatic plants while non-point research looks to long term control. By taking a closer look at the Bay's watershed and incorporating best managment practices on the surrounding land, lake trophic state succession can be better understood and controlled.

AQUARIUM PLANTS

It is commonly reported that hydrilla, the worst aquatic weed in Florida, was introduced into the state by people emptying their aquariums into canals in Crystal River and Miami. In the 1960s, hydrilla was sold for aquarium use as the "oxygen plant". The rest is history.

Despite the public education efforts warning of the dangers of exotic (non-native) aquatic plants, books and aquarium supply houses continue to promote the use of exotics in aquaria. One recently published aquarium book promotes the use of half a dozen exotic plants, plants that are listed on the Florida prohibited aquatic plant list including water hyacinth and *Limnophila*. Another aquarium book emphasizes the desirability of *Hygrophila polysperma* as an aquarium plant that can be easily propagated by cuttings, and also describes the pleasing green color of *Myriophyllum spicatum* (Eurasian watermilfoil). All these plants are prohibited exotics, some with the potential to be as much an ecological nuisance as hydrilla.

Some of these plants create only regional problems due mainly to climatic limitations. However, the aquarium industry, through its publications and catalogs, should take care in promoting known weed species.



Hygrophila polysperma

BOOKS/REPORTS

AQUATIC WEEDS - The Ecology and Management of Nuisance Aquatic Vegetation by A.H. Pieterse and K.J. Murphy, Oxford University Press. 1990. 593 pages.
(Order from Oxford University Press, 2001 Evans Road, Cary, North Carolina 27513, (919) 677-0977. $135.00 plus $2.00 shipping.)

This is a comprehensive and very readable new textbook on aquatic weeds. It is the result of an initiative of the Working Group on Aquatic Weeds of the European Weed Research Society (EWRS).

Thirty internationally recognized authors wrote the book's 20 chapters, which are divided into three main parts. "The first part is concerned with concepts, ecology, and characteristics of aquatic weeds and also includes chapters on flow resistance and the relation between aquatic weeds and public health. The second part covers the management of aquatic weeds, with chapters on various control methods, surveying and modelling of aquatic weed vegetation, utilization of aquatic weeds, and the relation between plant survival strategies and control measures. The third part deals with the present status of aquatic weed problems in the various continents."

AQUATIC PLANT BOOK by C.D.K. Cook. 1990. 228 pages.
(Order from SPB Academic Publishing, P.O. Box 97747, 2509 GC The Hague, THE NETHERLANDS. $55.00.)

The world's preeminent aquatic botanist has written a new book to replace his well-known *Water Plants of the World*. The large-format *Aquatic Plant Book* describes and illustrates 407 genera of vascular aquatic plants - "including all ferns and flowering plants that are likely to be found in or floating on permanent or semi-permanent, fresh or salt water anywhere in the world."

The identification keys are based on easily seen vegetative characters. Descriptions include information on juvenile forms, distribution, like forms, ecology, pollination mechanisms, uses, economic importance and references to the literature.

It is expected that the *Aquatic Plant Book* will be of use to all people concerned with aquatic ecosystems, from professional botanists to aquatic plant managers to water gardeners.

THE CONTROL OF EUTROPHICATION OF LAKES AND RESERVOIRS edited by S.-O. Ryding and W. Rast, UNESCO. 1989. 314 pages.
(Order from The Parthenon Publishing Group Inc., 120 Mill Road, Park Ridge, New Jersey 07656. $49.00.)

The goal of the editors was to develop a simplified handbook that "focuses on the practical control of eutrophication, as contrasted with a strictly academic treatment of the subject." The book includes everything the layman would want to know about eutrophication: characteristics, "limiting nutrients", factors and processes affecting the degree of eutrophication, the use of models, estimating nutrient loads, methods for sampling, techniques for treating eutrophication, reusing nutrients, and effective management strategies. Two annexes are included: a comprehensive and useful classification system for waterbodies in relation to their desired uses, and a list of case studies of eutrophication control from around the world.

More than 50 scientists, engineers and water managers reviewed and revised this book. In doing so, they have created a tool that meets the needs of many water managers and other water professionals.

AQUATIC AND WETLAND PLANTS OF SOUTH CAROLINA by C.A. Aulbach-Smith, S.J. de Kozlowski, and L.A. Dyck, with illustrations by V.C. Hollowell, South Carolina Water Resources Commission. 1990. 123 pages.
(Order from Publications Coordinator, S.C. Water Resources Commission, 1201 Main Street, Suite 1100, Columbia, South Carolina 29201, (803) 737-0800. $8.00 plus postage.)

This colorful and distinctive "user friendly" identification manual helps identify 88 aquatic plants (including algae) that occur in South Carolina (and southeastern U.S.) waters. Exceptional photographs include habitat, medium and close-up shots of plants. Color coded chapters include 1) submersed, 2) floating, 3) shoreline and wetland, 4) grasses, sedges and rushes, and 5) algae. An illustrated glossary is included.

All proceeds from the book will go into a special account to develop additional public education projects related to aquatic plant management.

FIELD GUIDE TO THE SUBMERGED AQUATIC VEGETATION OF CHESAPEAKE BAY by L.M. Hurley, US Fish and Wildlife Service. 1990. 51 pages.
(Order from US Fish and Wildlife Service, Chesapeake Bay Estuary Program, 180 Admiral Cochrane Drive, Suite 535, Annapolis, Maryland 21401, (301) 224-2735.)

This field guide is a comprehensive look at 14 species of submersed aquatic plants of the Chesapeake Bay. Each plant is well illustrated with color photographs and line drawings. The guide features an easy-to-use key and a glossary. A special feature of the guide is its excellent summary of the general ecology and values of submersed aquatic plants.

PROCEEDINGS, 8TH INTERNATIONAL SYMPOSIUM ON AQUATIC WEEDS, 13-17 August 1990, Uppsala, Sweden, edited by P.R.F. Barrett, M.P. Greaves, K.J. Murphy, A.H. Pieterse, P.M. Wade and M. Wallsten, European Weed Research Society. 1990. 255 pages.
(Order from E.W.R.S. Symposia Proceedings, Post Box 14, NL-6700 AA Wageningen, THE NETHERLANDS.)

This is a collection of 50 papers presented at the EWRS 8th Symposium, including papers on aquatic weed ecology, biology, and management.

SAGO PONDWEED (POTAMOGETON PECTINATUS L.): A LITERATURE REVIEW by H.A. Kantrud, US Fish and Wildlife Service, Resource Publication 176. 1990. 89 pages.
(Order from Publications Unit, US Fish and Wildlife Service, 18th and C Streets, N.W., Arlington Square Building, Mail Stop 1111, Room 130, Washington, D.C. 20240.)

Sago pondweed is an important aquatic food plant for waterfowl. This comprehensive literature review (several hundred sources) compiles what is known of the plant's physiol-

ogy, morphology, ecology, propagation, economics and control.

THE ESTUARY AS A FILTER edited by V.S. Kennedy, Academic Press. 1984. 511 pages.
(Order from Academic Press, P.O. Box 96448, Chicago, Illinois 60693. $49.00.)

Estuaries "tie together terrestrial, freshwater, and marine biomes, weave a web of complexity far greater than that of their three contributor systems and far out of proportion to their occupation of less than 1% of the planet's surface." Barbara L. Welsh.

This collection of 23 papers describes the "filtering" processes of estuaries. Physical, geological, chemical-geochemical, and biological processes are described, and management implications are discussed.

One paper (Kemp, Boynton, Twilley) describes the physical, chemical and biological influences of the aquatic plants *Potamogeton perfoliatus* and *Ruppia maritima*. The paper also presents data on the reasons for reduced water turbidity over plant beds.

EFFECTS OF SALINITY AND IRRADIANCE CONDITIONS ON THE GROWTH, MORPHOLOGY AND CHEMICAL COMPOSITION OF SUBMERSED AQUATIC MACROPHYTES by R.R. Twilley and J.W. Barko, US Army Engineer Waterways Experiment Station. Technical Report A-90-5. 1990. 29 pages.
(Order from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650.)

The growth, morphology and chemical composition of *Hydrilla verticillata, Myriophyllum spicatum, Potamogeton perfoliatus* and *Vallisneria americana* were compared among different salinity and light conditions. Except for hydrilla, the plants were able to adapt to salinities one-third the strength of seawater.

EFFECTS OF WATER CHEMISTRY ON SUBMERSED AQUATIC PLANTS: A SYNTHESIS, by R.M. Smart, US Army Engineer Waterways Experiment Station. Miscellaneous Paper A-90-4. 1990. 22 pages.
(Order from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650.)

This is a review of the literature on the effects of water chemistry on the growth and distribution of submersed aquatic plants. Emphasis is on the factors that control the supply of inorganic carbon to the plants. These factors include alkalinity, dissolved inorganic carbon and pH.

USE OF VEGETATION IN CIVIL ENGINEERING, edited by N.J. Coppin and I.G. Richards, Construction Industry Research and Information Association, Butterworths. 1990. 292 pp.
(Order from Butterworths, 80 Montvale Avenue, Stoneham, MA 02180 (617) 438-8464. $65.00.)

Written for the practicing civil engineer, this comprehensive guidebook concerns the use of vegetation "as a way of reducing the visual impact of civil engineering works and enhancing the quality of the landscape."

The book includes sections on basic aspects of vegetation; physical effects of vegetation; vegetation selection, establishment and management; method of approach and implementation; and applications.

The book also includes a section about the use of plants for watercourse and shoreline protection. As engineers, the editors recognize the water-flow problems caused by some aquatic weeds; however, they still promote the use of shoreline plants and trees to enhance the visual and ecological appeal of canals and rivers.

MICROBIOLOGICAL CONTROL OF EURASIAN WATERMILFOIL - Final Report, by H.B. Gunner, Y. Limpa-amara, B.S. Bouchard, P.J. Weilerstein and M.E. Taylor, University of Massachusetts. US Army Engineer Waterways Experiment Station. Technical Report A-90-2. 1990. 125 pp.
(Order from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650.)

Two pathogens (the fungus, *Mycoleptodiscus terrestris* and a bacteria, *Bacillus* sp. strain P8) were isolated from *Myriophyllum spicatum* and cultured. The pathogens were applied to watermilfoil in laboratory and natural lake settings. Field applications "ultimately resulted in the virtual elimination of *M. spicatum* from a treated plot within 10 weeks."

PROCEEDINGS OF THE CALIFORNIA EELGRASS SYMPOSIUM, May 27 and 28, 1988, Chula Vista, California, edited by K.W. Merkel, R.S. Hoffman and J.L. Stuckrath, Sweetwater River Press. 1990. 78 pages.
(Order from Pacific Southwest Biological Services, P.O. Box 985, National City, California 92050, (619) 477-5333.)

Eelgrass (*Zostera marina*) meadows provide nurseries for a diversity of marine plants and animals. These ten scientific papers discuss management practices for eelgrass, with special emphasis on transplantation projects to restore eelgrass meadows in the Pacific.

DISTRIBUTION OF SUBMERGED AQUATIC VEGETATION IN THE CHESAPEAKE BAY, by R.J. Orth and J.F. Nowak, Virginia Institute of Marine Sciences. 1990. 249 pages.
(Order from U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, Maryland 21403.)

This report contains numerous maps showing areas having submersed aquatic plants in the Bay. Twenty-one species were mapped.

TIDAL MARSH PLANTS by L.N. Eleuterius, Gulf Coast Research Laboratory, Pelican Publishing Company. 1990. 160 pp.
(Order from Pelican Publishing Company, 1101 Monroe Street, P.O. Box 189, Gretna, Louisiana 70053 (504) 368-1175. $24.95.)

This is a field guide to the 200 most common vascular plants found in salt marshes of the U.S. Atlantic and Gulf coasts.

Rather than use a taxonomic key, the user scans line drawings to identify plants. Simple field descriptions and distribution information accompany each drawing. Many plants are further illustrated in color plates. A glossary of botanical terms, and a section of labelled illustrations of plant parts enhance the usefulness of this field guide.
