Exotic Fern A Threat to Wetlands

Yet another potentially serious exotic weed is spreading throughout the southeastern U.S. Although cultivated for its attractive soft green foliage, the Japanese Climbing Fern (Lygodium japonicum) is beginning to be seen as a threat to the native vegetation of shady wetlands such as floodplain forests.

The threat may be most real in South Florida, where year-round temperatures enable the naturalized plant to keep on growing, and growing, and growing.

The resulting tangled canopy of six-to-one hundred-foot-long fronds of the fern can be so dense that plants underneath them die for lack of sunlight.

This Asian exotic first appeared in North Carolina around 1900, and since has become naturalized south to Florida and west to Texas.

Illustration by Raphael Chien Gottlieb
For an informative flyer, contact the APIRS office, address on page 16.

2 x CO₂ = X Aquatic Plants

Since the beginning of the industrial age, atmospheric carbon dioxide (CO₂) has increased by 25% to the current level of about 350 parts per million. Fuel combustion and deforestation are considered major contributors to this increase. Experts believe that CO₂ concentrations around the world will double by the end of the 21st century.

What will be the effects of increased carbon dioxide on plants? Will there be a "CO₂ fertilization effect" that makes plants grow larger and faster? Will increased CO₂ be a boon to agriculture? What will be the effects on unmanaged wild plants? Will certain plants make better use of the elevated CO₂ and replace other plants, thereby reducing biological diversity? How will animals react to the plant changes? Scientists are working to find answers to these questions, answers that might be used in predictive models that may help us plan for the coming changes.

The positive effects of increased CO₂ on plant growth have been known for the past two centuries. Photosynthesis is one of the most studied of natural phenomena. However, until the "greenhouse effect" controversy, little work had been devoted to the effects of elevated levels of CO₂ on plants. Now, many researchers are studying the effects of increased CO₂ on many parts of the environment, including aquatic plants.

One of the first major calls for work on elevated CO₂ and aquatic plants came in 1983 when R.G. Wetzel, J.B. Grace and a panel of other scientists reviewed the research and found it wanting. They recommended that programs be started to study the long-term effects of CO₂ enrichment; the mechanisms of C and O₂ supply and plant adaptations; nitrogen fixation; nutrient sequestration; noxious byproducts; and litter production and how it affects growth and plant population change.

A search of the APIRS aquatic plant database reveals that during the past ten years, a few dozen studies have been published about aquatic plant responses to elevated CO₂ levels. Listed below are some of them. (Many more studies about effects of elevated CO₂ on terrestrial plants have been published.) In addition, more than 500 studies are in the APIRS database about how aquatic plants actually use carbon sources (such as carbon dioxide) for photosynthesis.

Aquatic Plant Research

The following researchers have found a variety of responses of aquatic plants to elevated CO₂ levels in the air and water. It appears that, generally, a doubling of atmospheric CO₂ concentrations increases plant growth by approximately 30%. However, elevated CO₂ effects depend on a plant's photosynthetic pathway as well as on the interactive effects of light intensity, temperature, pH, oxygen concentration, nutrient availability, salinity and possibly other factors such as starch accumulation and plant shoot architecture. In the words of one researcher (Idso), "predicting the ultimate biospheric consequences of a doubling of the earth's atmospheric CO₂ concentration may prove to be much more complex than originally anticipated."

[See CO₂ on page 12]
Study This!


"Lakes in Florida are important resources and they often must be managed for a variety of purposes including flood control, water supply, fishing and general recreation. Lake usage, however, is a match between people's desires and the lake's capacity to satisfy these desires. Lake problems are defined in terms of the limits on desired uses. Many limitations can be prevented or corrected with proper lake management, but desired uses need to be clearly defined, limitations on the uses identified, and the causes understood."

The purpose of this study was to determine how aquatic plant management plans may affect water quality, fish populations and bird populations in Florida lakes. The five year study included 60 lakes of varying trophic states, size, depth and aquatic plant coverage.

Among the significant findings are:

- consistent with previous studies, total fish biomass increased as the lakes increased in trophic status; fish ranged from 6 kg/ha (5 pounds/acre) in an oligotrophic lake to 675 kg/ha (602 pounds/acre) in a hypereutrophic lake.
- fish populations are likely to be depressed when there are either too many or too few aquatic macrophytes.
- harvestable fish and sportfish populations in lakes having no aquatic macrophytes due to grass carp, showed no consistent trends. Thus long-term loss of macrophytes will not necessarily decrease the lake's fish populations.
- as in fish populations, bird abundance increased as the lake's trophic state increased.
- in a turbid nutrient-rich lake with no aquatic plant coverage, the cover must be raised to 30% to 50% before significant improvements in water clarity (chlorophyll a concentrations) will be observable. Conversely, significantly reducing macrophyte coverage of a lake, for example from 60% to 20% or from 40% to 0%, will cause significant and observable water quality (water clarity) changes.
- leaving a small fringe of vegetation around a lake for the purpose of water quality improvement will have little or no effect on the lake's trophic state values (total phosphorus, total nitrogen, chlorophyll a, algal levels and Secchi transparency).

With these findings in mind, the scientists suggest that a moderate amount of aquatic macrophytes would be beneficial to most Florida lakes. To preclude fisheries problems, a reasonable management objective for most Florida lakes may be a macrophyte coverage of at least 15% including emergent, floating-leaved and submersed vegetation.

Objectives such as this require a long-term commitment to some level of aquatic plant management. The authors also recommend "maintenance control" of non-native species such as hydrilla and water hyacinths so as not to allow these plants to completely take over lakes and replace native species.

The authors complete the study by recommending future research thrusts: develop better biocontrol techniques; develop species-specific aquatic plant management methods; find a method to remove grass carp after their work is done; find the environmental ranges of individual aquatic plant species; ascertain the relationships between water chemistry, lake morphology and macrophyte species composition; identify the management objectives for each lake; and develop better education for the general public about how lakes function, the values of macrophytes, and the risks and benefits of the various management methods.

A limited number of copies of this report are available from M.V. Hoyer, Department of Fisheries and Aquaculture, Center for Aquatic Plants, University of Florida, 7922 N.W. 71st Street, Gainesville, FL 32606, (904) 392-9617.
Research Review Review

The Center’s annual aquatic plant research review on March 31 once again drew dozens of scientists of all disciplines to share their latest data.

Among them were USDA’s Dr. Ted Center who reported on hydrilla biocontrol efforts in Florida. According to Center, several ponds full of hydrilla have “dropped out” within months of introducing the aquatic fly Hydrellia pakestanae (right). Center says his group “can’t really say the insects did it” yet, but the coincidences are piling up, and so are their fly establishment and monitoring efforts.

In another talk, Dr. D.F. Martin (Univ. South Florida) reported having isolated a possible fungus (a “white filamentous material”) that may be preventing hydrilla from growing in a certain lake near Tampa. He hypothesizes that whatever is stifling the hydrilla is somehow connected to whatever decomposed the tons of cypress logging residues that were dumped into the same lake decades ago.

In their hydrilla physiology research, Drs. Mark Rattray and George Bowes (Univ. Florida) reported that for the first time, AHAS has been extracted from hydrilla. AHAS (acetohydroxy acid synthase) is a key enzyme in the biosynthesis of amino acids essential for growth. Their studies with “Mariner” herbicide indicate that the herbicide’s mode of action against hydrilla is to quickly and greatly inhibit AHAS activity.

Other researchers presented talks about aquatic plant clone culturing, surveys of invertebrates on aquatic plants, aquatic herbicide research, grass carp studies and the economics of aquatic plant management.

CENTER FOR AQUATIC PLANTS
Institute of Food and Agricultural Sciences
University of Florida
7922 N.W. 71st Street
Gainesville, Florida 32606
(904) 392-9613

Dr. Joseph Joyce, Director
Aquatic Plant Growers - Information Update

Those ubiquitous aquatic plants. If you are an aquatic plant manager, researcher, cultivator, extension agent or information specialist, you probably feel like you work in a rather remote field. But wherever you go, you see them in one form or another. Nelumbo seed pods in dried flower arrangements, talcum powders from wet-meadow plants, vitamin supplements from dried Lyngbya, lip balm from Metaleuca alterniflora oil, Sphagnum in 'feminine products', candles in the shape of Nymphaea, Nymphaea Eau de Parfum (at $30.00 per bottle, according to the ad 'a woman sprays it only where she wants to be kissed ...'), Ranunculus on tea towels, Trapa in Asian food markets, Typha everywhere, and of course, aquariums and ornamental ponds.

According to the Florida Department of Agriculture and Consumer Services (FDACS), Florida's aquatic plant industry sold $7 million worth of aquatic plants in 1989. To assist people in this industry, FDACS recently published the Florida Aquatic Plant Locator. The book lists retail and wholesale suppliers of plants for aquariums, ponds, food, and wetland restoration and mitigation. The book includes listings of exporters, installation and maintenance services, landscape architects, production and technical information, trade associations and regulatory agencies.

The Florida Aquatic Plant Locator is $3.50, payable to FDACS, FDACS, Aquaculture Program, Room 425, Mayo Building, Tallahassee, FL 32399-0800, (904) 488-4033.

Mags and Orgs

The Aquatic Gardener is the journal of the Aquatic Gardeners Association, whose stated purpose is to disseminate information about, to study and improve culture techniques for, and to increase interest in, aquatic plants. Mostly comprised of articles from members, the journal focuses on practical information about growing aquarium plants for the hobbyist. The Technical Advisory Committee of the association offers a question and answer section in the bi-monthly journal.

The Aquatic Gardeners Association, 83 Cathcart Street, London, Ontario, N6C 3L9, CANADA. Membership, $15.00 yearly in N. America, $28.00 overseas.

The National Pond Society is "dedicated to helping people to be successful pond keepers at home, in community groups and in institutions because we believe 'pondering' adds joy to living while improving the environment and encouraging an appreciation of the earth.

Pondscapes is the society's monthly magazine, and is written "for and by pond keepers". It is packed with information. A recent issue contained articles about pond fish, dissolved oxygen, building waterfalls, growing water lilies, drying water lilies, and tips for planning and building water gardens. The December issue contains a national directory of suppliers of pond products and services and lists volunteers in over twenty-five states who are willing to field questions on water gardening.

Upcoming events of the Society include the Atlanta Tour of Ponds and the American Pond and Garden Expo in June 1992. The group has many interesting ideas and projects, such as starting a pond keepers youth group, wildlife habitat pond projects for grammar schools, and volunteering labor for special groups such as the Atlanta Zoo and the Jewish Nursing Home's therapeutic gardening service.

The National Pond Society, P.O. Box 449, Acworth, GA 30101, (404) 973-0277. Membership, $18.00 yearly domestic, $36.00 foreign and commercial.
BOOKS/REPORTS


(OrderBy University of Wisconsin - Extension, Geological and Natural History Survey, Map and Publications Office, 3817 Mineral Point Road, Madison, Wisconsin 53705; 608/263-7389. Information Circular 73. $3.00 plus $.50 postage.)

Published for aquatic plant managers, this deceptively thin circular includes more practical information about aquatic plants than many publications 10 times its size. It is meant to help managers "to know which species are desirable and how to encourage them as well as which species are likely to be nuisances and how to discourage them."

This collection of five simple "attribute tables" of 149 aquatic plants lists the plants, their habitat preference, wildlife and environmental value, propagation method, and herbicide susceptibility.

The book is very easy to use and understand: managers, students and other users will be surprised by how much they can learn from simple tables.


(OrderBy Butterworth-Heinemann, 271-273 Lane Cove Road, P.O. Box 345, North Ryde, N.S.W. 2113, AUSTRALIA. Aus$39.95.)

Written by two of the foremost experts in the subject, this book is a concise treatment of the background and procedures involved in the use of the biological method of controlling weeds. It would be useful to anyone interested in the subject, from students to experienced scientists.

The book discusses all aspects of a biological control project including the selection of the target weed; finding effective control agents; ensuring that the agents are host-specific and free of diseases and parasites; and the rearing, distribution and monitoring of biological agents. It also contains chapters on the history of classical biological control. Also included is an appendix outlining the design and operation of insect reception and quarantine facilities.


(OrderBy Water Quality Centre, DSIR Division of Water Sciences, P.O. Box 11-115, Hamilton, NEW ZEALAND.)

According to the author, the concept of using New Zealand wetlands for disposal of wastewaters has become increasingly popular for two reasons: 1) "it is extremely cost-effective" and 2) "there is increasing understanding of the Maori perspective on waste disposal, which opposes direct discharge of sewage into natural waters because it is an affront to its wairua and therefore affects the mana of those who use it."

This report is for conservation officers who are responsible for evaluating applications to discharge wastewater into wetlands. It includes a review of the ecological impacts of wastewaters on wetlands and presents guidelines for assessing waste discharge proposals.


(OrderBy John Wiley & Sons, Inc, 1 Wiley Drive, Somerset, New Jersey 08875-1272, 201/469-4400. $84.95 cloth.)

This "self-contained textbook for students from tropical countries" explains all important concepts of aquatic ecology in the tropics. The book includes chapters about river and lake environments including water chemistry, drainage basins and morphology, hydrology, and stratification. Also included are chapters about the community structures and dynamics of plankton, benthic animals, and macrophytes, including text on primary productivity, nutrient cycling and secondary production. Seasons, phenology, and animal periodicity are discussed in one chapter; diversity and evolution are discussed in another.

The final chapter discusses aquaculture and fisheries management.

LIGHT CLIMATE AND ITS IMPACT ON POTAMOGETON PEC-TINATUS L. IN A SHALLOW EUTROPHIC LAKE by G.M. van Dijk. 1991. 125 pages.

The purpose of this book is to examine the effects of eutrophication and light on algal and vascular plant growth, abundance and success. One general hypothesis could be described: increased nutrients in a lake cause algal populations to increase, thereby reducing light to submersed plants. The submersed plants die off, thus making even more nutrients available to algal populations.

The final part of this book is a discussion of lake restoration projects in the Netherlands. It includes an assessment of the potential of biomanipulation (using fish, sediment-management and macrophyte re-establishment) as a method to restore eutrophic lakes. The author concludes that water quality managers should pay more attention to submersed vegetation, which has positive and negative impacts on the functioning of shallow aquatic ecosystems.


(OrderBy Dr. R. Clarysse, National Botanic Garden of Belgium, Domein van Bouchout, B-1860 Meise, BELGIUM. 1600 BEF, plus 300 BEF for foreign checks.)

An "isozyme" (= isoenzyme) is a molecular form of an enzyme. Electrophoretic analysis of isozymes enable researchers to identify species, clones, races and populations. Among other benefits, such analysis of aquatic plants ultimately helps in working out appropriate control and management programs, especially for plants deemed "weeds."

This book is a review of the electrophoretic studies in aquatic macrophytes and algae. It includes information on the molecular systematics and biogeography of Alisma, Baldellia, Hydria, Lagarosiphon, Potamogeton, Ruppius, Zannichellia, Najas and the seagrasses.
FROM THE DATABASE

Here is a sampling of the research articles, books and reports which have been entered into the aquatic plant database since November, 1991. The database has more than 33,000 items. To receive free bibliographies on specific plants and/or subjects, contact AIPRS at the address shown on the mail label on page 16.

To obtain articles, contact your nearest state or university library.


Austin, A.P.; Harris, G.E.; Lacey, W.P. Impact of an organophosphate herbicide (glyphosate) on periphyton communities developed in experimental streams.


Coutinho, M.E. Ecologia populacional de Eichhornia azurea (Kth.) e sua participacao na dinamica da vegetacao aquatica da Lagoa do Infernario - SP. DISERTACAO DE MESTRADO, UNIVERSIDADE FEDERAL DE SAO CARLOS, UFSCAR, BRASIL. 145 PP. (In Portuguese)


Dionne, M.; Folt, C.L.
An experimental analysis of macrophyte growth forms as fish foraging habitat.

Ewing, K.
Plant growth and productivity along complex gradients in a Pacific Northwest brackish intertidal marsh.

Fagerberg, W.R.; Eighmy, T.T.; Jahnke, L.S.
Studies of Elodea nuttallii grown under photorepirculatory conditions. III. Quantitative cytological characteristics.

Felle, H.H.
The role of the plasma membrane proton pump in short-term pH regulation in the aquatic liverwort Riccia fluitans L.

Friday, L.E.
The size and shape of traps of Urtilularia vulgaris L.

Gadzhiev, V.D.; Lyatifova, A.K.
Samples of wet-marsh vegetation of Kyzylagash (Kazakhstan) Soviet Preserves.
J. AZERBAYCAN ACAD. SCI. 2:3-9, 1988. (In Russian)

Gauthier, G.; Bedard, J.
Experimental tests of the palatability of forage plants in greater snow geese.

Bioconcentration of chlorinated aromatic hydrocarbons in aquatic macrophytes.

Haworth-Brockman, M.J.; Murkin, H.R.; Clay, R.T.; Armstrong, E.
Effects of underwater clipping of purple loosestrife in a southern Ontario wetland.

Horecka, M.
The significant role of Chara hispida - grown in a water regime of a gravel pit lake at Senec.

Husband, B.C.; Barrett, S.C.H.
Colonization history and population genetic structure of Eichhornia paniculata in Jamaica.

Kantrud, H.A.
Wigeongrass (Ruppiu maritima L.): a literature review.

Kouki, J.
Small-scale distributional dynamics of the yellow water-lily and its herbivore Galeruca nymphaeae (Coleoptera: Chrysomelidae).

Kruger, L.; Kirst, G.O.
Field studies on the ecology of Bolboschoenus maritinmus (L.) Palla (Scirpus maritinmus L. S. L.).

Kulmi, G.S.
Associated weed flora and their susceptibility to herbicides in transplanted rice.

Lagarde, F.; Gauthier, M.
Heteranthera limosa (Sw.) Willld. (Pontederiaeae) en France.
(In French; English Summary)

Latham, P.J.; Pearlstine, L.G.; Kitchens, W.M.
Spatial distributions of the softstem bulrush, Scirpus validus, across a salinity gradient.

Leach, S.J.; McMullin, A.S.; Northridge, R.H.
Rhynchospora fusca (L.) Alt. F. in Co Fermanagh.

Lee, C.K.; Low, K.S.; Hew, N.S.
Accumulation of arsenic by aquatic plants.

Les, D.H.
Genetic diversity in the monococcous hydrophilus Ceratophyllum.

Lindau, C.W.; Delaune, R.D.; Jiraporncharoen, S.; Manajuti, D.
Nitrous oxide and dinitrogen emissions from Panicum hemitomon S. freshwater marsh soils following addition of N-15 labelled ammonium and nitrate.

Linz, G.M.; Davis, J.E.; Engeman, R.M.; et al.
Estimating survival of bird carcasses in cattail marshes.

Lopez, J.; Carballereira, A.; Barreiro, R.; Real, C.
Relation between pigmentary stress in Fontinalis antipyretica Hedw. and metal pollution in Galician (N.W. Spain) rivers.

Lund, M.; Davis, J.; Murray, F.
The fate of lead from duck shooting and road runoff in three western Australian wetlands.

Madamwar, D.; Patel, A.; Patel, V.
Effects of various surfactants on anaerobic digestion of water hyacinth-cattle dung.

Madsen, J.D.; Sutherland, J.W.; Bloomfield, J.A.; et al.
The decline of native vegetation under dense Eurasian watermilfoil canopies.

Madsen, T.V.
Inorganic carbon uptake kinetics of the stream macrophyte Callitriche cophocarpa Sendt.

Mandal, B.K.; Das, N.C.; Singh, Y.V.; Ghosh, R.K.
Effect of phosphorus on multiplication and nitrogen content of Azolla pinata.
Menapace, F.J.
A preliminary micromorphological analysis of Eleocharis (Cyperaceae) achene for systematic potential.

Merendino, M.T.; Smith, L.M.
Influence of drawdown date and reflood depth on wetland vegetation establishment.

Myttinger, L.; Williamson, G.B.
The invasion of Schinus into saline communities of Everglades National Park.

Newman, R.M.
Herbivory and detritivory on freshwater macrophytes by invertebrates: a review.

Nielsen, S.L.; Gacula, E.; Sand-Jensen, K.
Land plants of amphibious Littorella uniflora (L.) Aschers. maintain utilisation of CO2 from the sediment.

Niklas, K.J.
Bending stiffness of cylindrical plant organs with a 'core-rind' construction: evidence from Juncus effusus leaves.

Olsen, T.M.; Lodge, D.M.; Capelli, G.M.; Houlihan, R.J.
Mechanisms of impact of an introduced crayfish (Orconectes rusticus) on littoral congeners, snails, and macrophytes.

Osborn, J.M.; Taylor, T.N.; Schneider, E.L.
Pollen morphology and ultrastructure of the Cabombaceae: correlations with pollination biology.

Outridge, P.M.; Noller, B.N.
Accumulation of toxic trace elements by freshwater vascular plants.

Overath, R.B.; Titus, J.E.; Hoover, J.E.; Grise, D.J.
The influence of field site and natural sediments on the growth and tissue chemistry of Vallisneria americana Michx.

Ozimek, T.; Pieczynska, E.; Hankiewicz, A.
Effects of filamentous algae on submerged macrophyte growth: a laboratory experiment.

Pandey, V.N.; Srivastava, A.K.
Yield and nutritional quality of leaf protein concentrate from Eleocharis dulcis (Burm. F.) Hensch.

Peerally, A.
Cylindrocladium hawksworthii sp. nov. pathogenic on water-lilies in Mauritius.

Petrell, R.J.; Bagnaill, L.O.
Hydromechanical properties of water hyacinth mats.

Pezeshki, S.R.; DeLaune, R.D.
A comparative study of above-ground productivity of dominant U.S. gulf coast marsh species.

Fine, R.T.; Anderson, L.W.J.
Effect of triploid grass carp on submerged aquatic plants in northern California ponds.

Poddar, K.; Mandal, L.; Banerjee, G.C.
Evaluation of nutritive value of water hyacinth in wilted and silage forms.

Polar, E.; Bayulgen, N.
Differences in the availabilities of Cesium-134, 137 and Rutherium-106 from a Chernobyl-contaminated soil to a water plant, duckweed, and to the terrestrial plants, bean and lettuce.

Powell, G.V.N.; Fourquarean, J.W.; Kenworthy, W.J.; Zieman, J.C.
Bird colonies cause seagrass enrichment in a subtropical estuary: observational and experimental evidence.

Rattray, M.R.; Howard-Williams, C.; Brown, J.M.A.
Sediment and water as sources of nitrogen and phosphorus for submerged rooted aquatic macrophytes.

Reddy, K.R.; Agami, M.; D'Angelo, E.M.; Tucker, J.C.
Influence of potassium supply on growth and nutrient storage by water hyacinth.

Rohrlee, M.B.; Barber, T.R.; Carlson, P.R.; et al.
Mass mortality of the tropical seagrass Thalassia testudinum in Florida Bay.

Rodríguez, E.M.; Amin, O.A.
Acute toxicity of parathion and 2,4-D to larval and juvenile stages of Chamissoa granulata (Decapoda, Brachyura).

Sawidis, T.; Stratis, J.; Zachariadis, G.
Distribution of heavy metals in sediments and aquatic plants of the River Pinius (Central Greece).

Schwegler, T.; Brandle, R.
Ethylene-dependent growth and development of cuttings of the water cress (Nasturtium officinale R. Br.).

Servin, L.C.; Gutierrez, J.V.
Plantas medicinales del Distrito de Ocotlan Oaxaca.
ANALES INST. BIOL. UNIV. NAC. AUTON. SER. BOT. 60(1):85-103, 1990. (In Spanish; English Summary)

Sharp, M.J.; Britton, D.M.
Isoetes tuckermanii, Tuckerman's Quillwort, an addition to the flora of Ontario.
Silvanima, J.V.C.; Strong, D.R.

Simkunaitie, E.
Herbs of wet sites in Lithuanian folk medicine.

Smith, A.G.; Goddard, I.C.
A 12500 year record of vegetational history at Sluggan Bog, Co. Antrim, N. Ireland (incorporating a pollen zone scheme for the non-specialist).

Speziale, B.J.; Turner, E.G.; Dyck, L.A.
Physiological characteristics of vertically-stratified Lyngbya wollei mats.

Stefani, A.; Arduini, I.; Onnis, A.
Juncus acutus: germination and initial growth in presence of heavy metals.

Struve, M.R.; Scott, J.H.; Bayne, D.R.
Effects of fluoride and terbutryn on phytoplankton and water chemistry in isolated columns of water.

Takagi, S.; Kamitsubo, E.; Nagai, R.
Light-induced changes in the behavior of chloroplasts under centrifugation in Vallisneria epidermal cells.

Tazawa, M.; Kurosawa, S.; Amino, S.; et al.
Induction of cytoplasmic streaming and movement of chloroplast induced by L-histidine and its derivatives in leaves of Egeria densa.

Tel-Or, E.; Rozen, A.; Ofir, Y.; et al.
Metabolic relations and intercellular signals in the Anabacna-Azolla association.

Thorsen, R.M.; Harris, S.L.
How "natural" are inland wetlands? An example from the Trail Wood Audubon Sanctuary in Connecticut.

Titus, J.E.; Hoover, D.T.
Toward predicting reproductive success in submerged freshwater angiosperms.

Tomaszewicz, H.; Klosowski, S.

Tripathi, R.D.; Chandra, P.
Chromium uptake by Spirodela polyrhiza (L.) Schiedein in relation to metal chelators and pH.

Tucker, G.C.
Scirpus polyphyllus (Cyperaceae) in New Hampshire.

Turner, R.K.
Valuation of wetland ecosystems.

Ulehlwala, B.
Release and uptake of metals during decomposition of plant litter in fishpond littoral.

Van der Merwe, G.C.; Schoonbee, H.J.; Pretorius, J.
Observations on concentrations of the heavy metals zinc, manganese, nickel and iron in the water, in the sediments and in two aquatic macrophytes, Typha capensis (Robhr.) N.E. Br. and Anurida donana, of a stream affected by goldmine and industrial effluents.

Van Strien, A.J.; Van der Burg, T.; Rip, W.J.; Strucker, R.C.W.
Effects of mechanical ditch management on the vegetation of ditch banks in Dutch peat areas.

Warne, T.R.; Hickok, L.G.
Control of sexual development in gametophytes of Ceratopteris richardii: antheridiogen and abscisic acid.

Watano, Y.; Masuyama, S.
Inbreeding in natural populations of the annual polyploid fern Ceratopteris thalictroides (Parkeriaceae).

Welling, C.H.; Becker, R.L.
Seed bank dynamics of Lythrum salicaria L.: implications for control of this species in North America.

Wilcox, D.A.; Meeker, J.E.
Disturbance effects on aquatic vegetation in regulated and unregulated lakes in northern Minnesota.

Wilson, S.D.; Keddy, P.A.
Competition, survivorship and growth in macrophyte communities.

Wolf, S.D.; Lassiter, R.R.; Wooten, S.E.
Predicting chemical accumulation in shoots of aquatic plants.

Zardini, E.M.; Peng, C.J.; Hoeh, P.C.

Zeifert, D.V.; Rudakov, K.M.; Petrov, S.S.
Effect of industrial and municipal wastes on the composition of higher aquatic plants in the middle channel of the Belaya River.
CUSTOMIZED IDENTIFICATION VIDEOTAPES AVAILABLE; 7-PART ID SERIES COMPLETE

The aquatic and wetland plant identification videotape series is complete. The seven-part series features 115 treatments of the most common and/or economically important aquatic and wetland plants. They are listed below.

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FLOATING AND FLOATING-LEAVED

1. Water hyacinth - Eichhornia crassipes
   Compare - Water hyacinth and Frog's-bit
2. Water lettuce - Pistia stratiotes
3. Frog's-bit - Limnobium spongiosa
4. Water fern - Salvinia minima
5. Mosquito fern - Azolla caroliniana
6. Small duckweed - Lemna valdiviana
   Compare - Small duckweed and Giant duckweed
7. Giant duckweed - Spirodela polyrhiza
8. Bog-mat - Wolffia gladiata
9. Banana lily - Nymphaoides aquaticus
10. Water shield - Brasenia schreberi
11. Spatterdock - Nuphar luteum
12. Fragrant water lily - Nymphaea odorata
   Compare - Water lily and Spatterdock
13. Yellow water lily - Nymphaea mexicana
14. American lotus - Nelumbo lutea

EMERSED - PART I

1. Alligator weed - Alternanthera philoxeroides
2. American lotus - Nelumbo lutea
3. Arrow arum - Peltandra virginica
   Compare - Arrow arum, Common arrowhead, Wild taro
   Arrowheads - Sagittaria spp.
4. Coastal arrowhead - Sagittaria graminea
5. Common arrowhead - Sagittaria latifolia
6. Duck potato - Sagittaria lancifolia
7. Baby's-tears - Micranthemum umbrosum
9. Blue flag - Iris virginica
10. Bur marigold - Bidens pilosa
11. Buttonbush - Cephalanthus occidentalis
   Compare - Southern cattail and Common cattail
13. Elderberry - Sambucus canadensis
14. Fire flag - Thalia geniculata
15. Frog's-bit - Limnobium spongiosa
   Compare - Frog's-bit and Water hyacinth
16. Golden canna - Canna flaccida

CUSTOMIZED IDENTIFICATION PROGRAMS

The aquatic and wetland plants of most interest in Florida are not necessarily the same as in Michigan or Iowa or Washington state. So, agencies in those states may wish to have ID videotapes that include only certain of the plants treated in the Florida 7-part ID series. In fact, several environmental agencies outside Florida have asked permission to make their own ID tapes by copying segments from our series onto a master of their own.

There are two reasons why UF/IFAS does not allow illegal dubbing. First, the tapes are sold for the cost of reproduction and handling only. The funds received are then used to maintain stock for future sales, so that the video programs can be self-sustaining. Second, illegal dubbing technically degrades the program quality to unacceptably low levels; dubbing segments of our VHS releases to a master to re-make more copies produces final copies that are all but unrecognizable, even using professional equipment. Unrecognizability does not lend itself to identification programs.

THERE IS AN ALTERNATIVE to the dilemma: let us customize identification programs for you. This office will produce a custom ID tape that will include any of the aquatic and wetland plants listed on these two pages. Rates would be determined by the number of plants included and production details. For an additional amount, we will make any number of copies of the new program.

If your agency is interested in having a customized ID tape about aquatic and wetland plants, simply photocopy these two pages, mark the plants you want included, and send the list and a letter to us explaining how you want the program structured. We'll send you a quote. Or call the APIRS number, (904) 392-1799.

17 Golden club - Oronium aquaticum
18 Hygrophila - Hygrophila spp.
   Compare - Lake hygrophila and East Indian hygrophila
19 Knotweeds - Polygonum spp.
EMERSED - PART II

20 Lizard's-tail - *Sauntrus cernus*
21 Mermaid weed - *Proserpinaca pectinata*
22 Parrot feather - *Myriophyllum aquaticum*
23 Pickerelweed - *Pontederia cordata*
    Compare - Pickerelweed and Common arrowhead
24 Red Ludwigia - *Ludwigia repens*
25 Redroot - *Lachnanthes caroliniana*
26 St. John's-wort - *Hypericum spp.*
27 St. John's-wort - *Triandrum virginicum*
28 Spatterdock - *Nuphar luteum*
29 Swamp lily - *Crinum americanum*
    Compare - Swamp lily and Spider lily
30 Swamp loosestrife - *Decodon verticillatus*
31 Water hemlock - *Conium maculatum*
32 Water born fern - *Ceratopteris thalictroides*
33 Water pennywort - *Hydrocotyle spp.*
34 Water primroses - *Ludwigia spp.*
35 Water spider orchid - *Habenaria repens*
36 Water spinach - *Ipomeoa aquatica*
37 Wild taro - *Colocasia esculenta*

GRASSES, SEDGES AND RUSHES - PART I

1 American cupscalegrass - *Sacchiopis striata*
    Compare - American cupscalegrass and Maidencane
2 Bald-rush - *Psilocarya nitens*
3 Barnyardgrass - *Echinochloa spp.*
    Beak-rushes - *Rhynchospora spp.*
4 Inundated beak-rush - *Rhynchospora inundata*
5 Small-headed beak-rush - *Rhynchospora microcephala*
6 Tracy's beak-rush - *Rhynchospora tracyi*
7 Bog buttons - *Lachnocaulon spp.*
    Compare - Bog buttons and Hat-pins
8 Bog rushes - *Juncus spp.*
9 Soft rush - *Juncus effusus*
10 Needle rush - *Juncus roemerianus*
11 Shore rush - *Juncus marginatus*
    Bulrushes - *Scirpus spp.*
12 Common three-square - *Scirpus pungens*
13 Soft-stem bulrush - *Scirpus validus*
14 Burhead sedge - *Scirpus cubsens*
    Compare - Burhead sedge and *Cyperus spp.*
15 Salt-marsh bulrush - *Scirpus robustus*
16 Bur-reed - *Sparganium americanum*
17 Bushy beargrass - *Andropogon glomeratus*
18 Common reed - *Phragmites australis*
    Cordgrasses - *Spartina spp.*
19 Sand cordgrass - *Spartina bakeri*
20 Salt-marsh cordgrass - *Spartina alterniflora*
21 Giant cutgrass - *Zizaniopsis miliacea*
    Compare - Giant cutgrass and Wild rice

GRASSES, SEDGES AND RUSHES - PART II

21 Hurricane-grass - *Fimbristylis spathacea*
22 Napiergrass - *Pennisetum purpureum*
    Panicgrasses - *Panicum spp.*
23 Maidencane - *Panicum hemitomon*
24 Torpedograss - *Panicum repens*
    Compare - Torpedograss and Maidencane
25 Guineagrass - *Panicum maximum*
26 Paragrass - *Brachytrichium nutica*
27 Saw-grass - *Cladium jamaicense*
28 Southern cutgrass - *Leersia spp.*
    Spikerushes - *Eleocharis spp.*
29 Road-grass - *Eleocharis baldwinii*
30 Club-rush - *Eleocharis cellulosa*
31 Giant spikerush - *Eleocharis interstincta*
32 Star-rush - *Dichromena spp.*
    Umbrella-grass - *Fuirena spp.*
33 Rush *Fuirena - *Fuirena spicoides*
34 Lake-rush - *Fuirena squarrosa*
    Umbrella sedges - *Cyperus spp.*
35 Flat sedge - *Cyperus odoratus*
36 Distinct sedge - *Cyperus distinctus*
37 Watergrass - *Luziola fluitans*
38 Water paspalum - *Paspalum repens*
39 Wild-rice - *Zizania aquatica*
40 Yellow-eyed-grasses - *Xyris spp.*
[From CO2 on page 1]

One of the first researchers to study CO2 exchange in aquatic plants in situ is B.G. Drake, who has studied salt marsh plants since the 1970s. More recently he has collaborated with Curtis, Long, Rozema and Ziska (below) in studies of the effects of elevated CO2 on salt marsh plant communities.

Another early researcher is S.B. Idso who has studied carbon dioxide effects on azolla, water lily, and water hyacinth. In 1984, he and Kimball found that elevated CO2 levels reduced the evaporative water loss of water hyacinths. In 1986, he and Clawson concluded that higher CO2 induces partial stomatal closure, reducing transpiration and significantly increasing foliar temperatures (from 1.5° to 4.5° C). Some believe that transpiration reduction and foliar temperature increases could change global rainfall and temperature patterns, and greatly influence groundwater recharge and surface water hydrology.

In 1987, Idso and his group found that in water hyacinth, carrots, radishes and azolla, enriched CO2 and a 3° C rise in temperature can increase growth by almost 60% above normal levels. They also found that enhanced CO2 tends to reduce plant growth at relatively cold temperatures of about 18.5° C.

In 1988, Idso enunciated generalities about plant response to atmospheric CO2 enrichment: under optimum growth conditions (best nutrients, light, temperature) a 300 ppm increase in CO2 increases plant productivity by about 30%; and increased CO2 levels enable water-stressed plants to survive drought conditions much better than today’s CO2 levels.

In 1989, Idso et al reported that elevated CO2 conditions allow azolla plants to grow at higher air temperatures than they are capable of withstanding under current atmospheric CO2 concentrations. In 1990, they reported that of 25 plant properties of a water lily cultivar, all were "stimulated or enhanced" by a doubling of atmospheric CO2, including a 49% increase in net photosynthesis, an 18% increase in leaf size and a total biomass enhancement of 270%.

Researchers have found that sometimes plants become "acclimated" to high CO2 levels. At the beginning of the studies, the plants may respond positively to high carbon dioxide, but later cease to respond positively. In arctic grass plants, Oechel et al in 1984 found that photosynthesis increased at high CO2 levels, but the plants acclimated after a year, and after the fourth year there was no detectable difference between elevated and control plant photosynthesis rates.

In a study of water hyacinth grown at very high levels of CO2 (up to 10,000 ppm), Larigauderie et al found that photosynthesis increased to a maximum at 800 ppm and declined after that; at 2800 ppm, photosynthesis was back down to ambient CO2 rates. These researchers believe the response depended on the interaction between light intensity and CO2 levels.

Spencer and Bowes (1986) studied water hyacinth at twice the atmospheric CO2 level and found the dry weight of ramets grown in enriched CO2 was increased by 39%. The plants also showed an increased number of leaves and flowers. However the scientists reported the rate of increase was not maintained due to acclimation to CO2.

Some researchers, such as Dons (1988) hypothesize that CO2...

Other researchers have found differences in plant responses to elevated CO2 depending on plant photosynthetic pathways. Curtis et al (1989) found that C3 plants such as Scirpus olneyi respond to elevated CO2 concentrations, whereas C4 plants such as Spartina patens were not affected. Curtis wondered if C3 plants could gain competitive advantage over C4 species.

Rozema et al (1991) also found that the relative growth rates of C3 plants were enhanced under elevated CO2 conditions, but that C4 species showed no increase. They also found that water use efficiency of all species was increased with elevated CO2.

Other researchers also study how conditions such as light intensity and temperature affect high CO2 effects on plants. For example, Guy (1990) found that Lemna gibba grown in ponds with higher temperatures and increased CO2 levels grew much better than those in control ponds with ambient temperature and CO2. Allen et al (1988) found that high light, temperature and CO2 increased net photosynthesis of Azolla pinnata by as much as 70% above control plants. Allen et al (1990) found that Nymphaea marilae also grew much better in increased light intensity, temperature and CO2.
acclimation results from a starch buildup in the plant which reduces the relative growth rate (RGR). Dons found that duckweed (Lemna gibba) rapidly built up starch in elevated CO₂.

Others, such as Poorter et al. (1988) believe acclimation to CO₂ may have to do more with the architecture of the plant than with its physiology. In a study of Plantago major, they found that the relative growth rate declined as the aerial parts of the plant grew, and concluded that "CO₂ enriched plants are larger and larger plants have a lower RGR due to self-shading."

In contrast, Long and Drake (1991) found no evidence of acclimation and photosynthesis decline in Scirpus olneyi, even after three years of growth in elevated (2X) CO₂ concentrations, under light-limited conditions.

And in a long-term study, Ziska (1990) also found no acclimation effect caused by increased CO₂ levels in C₃ plants.

Larigauderie et al. (1986) found that the effects of oxygen concentrations (O₂) negatively affects photosynthesis became less pronounced as CO₂ increased.

For the first time, other researchers are studying the effects of elevated-CO₂-grown plants on the animals that eat them. Lincoln and Couvet (1989) reported that peppermint (Mentha piperita) increased in leaf size and weight as CO₂ increased. Allelochemicals increased as well. They also found that duckweeds consumed a greater quantity of elevated CO₂ leaf material. Presumably this was because the nitrogen-to-tissue ratio was lower in high CO₂ plants, so the duckweeds had to eat more to gain the necessary nutrition from them.

Other researchers study submersed plants for their responses to increased CO₂ availability in the water. (The increased atmospheric CO₂ will result in increased free CO₂ in water.)Titus’ (1990) study shows that Vallisneria americana growth was greatly stimulated by free CO₂ enrichment, even in low pH (pH 5) water where the plant would normally show significantly depressed growth. In another study, Svedang (1990) shows that Juncus bulbosus is invading acidified lakes of Northern Europe because of elevated free CO₂ levels in the water.

Smart (1990) has studied the submersed plants, egeria, hydrilla and Eurasian watermilfoil and found that these plants, even with four times the free CO₂ in the water than controls, did not grow significantly better, probably because of nitrogen limitation. It is evident that this is only the beginning of the research necessary to answer questions raised by the probable doubling of atmospheric CO₂ by the end of the next century. - V.R.

The following is a list of some citations from the AIPRS aquatic plant database about the effects of elevated levels of carbon dioxide on aquatic plant growth.


[Continued on page 14]
MEETINGS

32ND ANNUAL MEETING, AQUATIC PLANT MANAGEMENT SOCIETY and THE INTERNATIONAL SYMPOSIUM ON THE BIOLOGY AND MANAGEMENT OF AQUATIC PLANTS. July 12-16, 1992, Marriott Hotel, Daytona Beach, Florida.

Topics for this international symposium will include the ecology and photosynthesis of aquatic plants, the use of plant biology to develop better control methods, and environmental impacts of various management options. Post-meeting field trips to the Central Florida and Everglades areas are planned.

For more information, contact Bill Rushing, Secretary-Treasurer, APMS, Inc., PO Box 2695, Washington DC 20013-2695.

INTERNATIONAL SYMPOSIUM ON THE BIOLOGICAL CONTROL AND INTEGRATED MANAGEMENT OF PADDY AND AQUATIC WEEDS IN ASIA. October 12-18, 1992, Tsukuba Science City, Ibaraki, Japan.

The sponsoring agencies are the Food and Fertilizer Technology Center for the Asian and Pacific Region (FFTC/ASPAC) and the National Agriculture Research Center (NARC), MAFF, Japan.

Symposium goals are to identify the significance of paddy and other aquatic weeds in Asian countries; to review the biological control work on these weeds throughout the world; to discuss the development of biological control, and to identify the socio-economic constraints to the adoption of biological control.

For more information, contact Dr. H. Shibayama, National Agriculture Research Center (NARC), MAFF Yatabe, Tsukuba 305, JAPAN.

[From page 13]


Aquatic Plants Go To School

Aquatic plants and their role in the eutrophication process in north central Florida lakes and streams is the topic of a small nine-month grant to produce a curriculum for middle school science teachers and students. Botanist Seth Bigelow and environmental engineer Bill Davis recently received the grant from the Bingham Environmental Education Foundation. An interest in natural history, school children and Florida's unique aquatic plant situation prompted them to devise the program.

Bigelow hopes to encourage student interest in plant biology by bringing plants into the classroom and discussing the reasons for their weed growth potentials. The curriculum will include experiments for students to perform such as rooting certain aquatic plants, hydrilla tuber production and measuring growth rates of duckweed and algae in water of different nutrient, CO2 and light levels.

Davis is working on the water chemistry portion of the curriculum and will address the topic of phosphorus in Florida lakes. He is developing a simple classroom method to measure phosphorus levels in water and will analyse water samples from local lakes, rivers and springs. Phosphorus additions to water from different detergents will be demonstrated, and experiments will be conducted using aquatic plants to remove nutrients from water and to see if phosphorus diminishes as plant biomass increases.

At the end of the 4-5 week experiment session, students will evaluate and discuss the results. Topics such as eutrophication, aquatic plant growth, wastewater treatment using aquatic plants and others can be addressed based on results of the experiments.

Bigelow and Davis are working with Ms. Elaine Taylor's sixth grade class at Lincoln Middle School in Gainesville. After the new curriculum is evaluated and refined, they hope to distribute it to other middle school teachers in Alachua County. Bigelow and Davis also hope to obtain funding to distribute the new curriculum in other counties.

Bigelow and Davis are doctoral candidates at the University of Florida, Department of Botany and Department of Environmental Engineering, respectively. This independent project is sponsored by Dr. Kimberlyn Williams of the Department of Botany.

WaterWays Education in Public Schools

Wouldn't it be great if children could learn the basics of water cycling and water management while they were still young and interested in things? Well, lucky elementary school students in the Florida panhandle are doing just that, thanks to the Northwest Florida Water Management District.

The district has developed WaterWays, an environmental education program that provides free teaching materials to teachers and students in all sixteen counties of the district. So well has the program been received that at least two other water management districts are adapting the materials for use in their own counties.

WaterWays "uses a local perspective to give students a broad, general understanding of the need for, and methods of, water management and to lay the groundwork that will enable these future decision-makers to properly manage and protect our water resources."

The program consists of five lessons that range from the broad -- basic facts about water and the water cycle, to the specific -- issues and problems unique to each school district in northwest Florida. Slide/tape presentations give overviews of the contents of each lesson. In addition, the students receive a textbook/workbook that is competently written and well-illustrated. Students get to keep the textbooks, which also describe hands-on activities and experiments suitable for elementary and middle school children. WaterWays also provides teachers with a comprehensive guide to help them introduce important terms, provide background information, answer questions, and test students on the material.

To learn more about WaterWays, contact: Office of Public Information, Northwest Florida Water Management District, Route 1, Box 3100, Havana, Florida 32333-9700, (904) 539-5999, ext. 272.
Not long ago, it was "a new aquarium plant"

In 1945 the editor of The Aquarium magazine was asked to identify a luxuriant plant growth in a tank in a sunny store window in Chicago. His friend said somebody called it "Oriental Ludwigia." After a year, it finally flowered and was identified by the University of Pennsylvania as Hygrophila polysperma.

The Chicago aquarium dealer thought he had a winner and grew a large stock of the plant for sale. Said the editor in the February 1947 issue of The Aquarium: "Now that we can correctly name it and it has had trials under various conditions, he is prepared to broadcast it in a big way. It is our prediction that within two years it will be widely-known and accepted as one of our leading aquarium plants... It now appears to be from India, and to be the only species of the genus that is aquatic -- Hygrophila polysperma."

Forty-five years later, it is now known that the genus Hygrophila actually contains about 40 aquatic species. And because Hygrophila polysperma is such a prolific exotic, its sale and possession is banned in Florida where it already is becoming a common aquatic weed of the state.