THE AQUATIC PLANT MANAGEMENT SOCIETY, INC.

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A Watery Jungle – or Why There is an Aquatic Plant Management Society Today

Herbert J. Friedman
Retired, Chairman of the Board, Southern Mill Creek Division of the Crompton & Knowles Corporation
Tampa, Florida 33601

A review of the history and early activities of the Society, then known as the Hyacinth Control Society. It includes the original objectives, concepts and urgency for it, the impact of its early members, the struggles of the formative years, with its growth and changes. How the society's base was broadened and the development of its worldwide recognition and acceptance. What the future can hold in store for the organization.

Results of the Federal Working Group Survey

J. L. Decell
USAE Waterways Experiment Station
Vicksburg, Mississippi 39180

The Interagency Federal Working Group for Aquatic Plant Management has surveyed state agencies to determine the status and implementation of laws or regulations that govern the interstate transport of problem species of aquatic plants. Results of this survey will be used to decide on the nature of future needs in this area.

Exclusion of Aquatic Federal Noxious Weeds by USDA APHIS PPQ

Randy C. Westbrooks and Daniel Fleenlman
USDA APHIS PPQ
Whiteville, North Carolina 28472

Inspection of imported goods is conducted by USDA APHIS to prevent the entry of foreign pests. Currently, 16 foreign aquatic weed species are targeted for exclusion under the Federal Noxious Weed Act. Aquatic plants are imported by the aquarium industry and may also be found as contaminants of plant collections and herbarium specimens. Examination of such materials is usually carried out at one of several plant inspection stations around the country.

Prevention and Management of New Aquatic Plant Infestations in Florida

Larry E. Hall
Florida Department of Natural Resources
Tallahassee, Florida 32301

The State of Florida maintains regulatory and management programs to prevent the introduction of new aquatic plant pests and to control the spread of existing species. Rules establish a list of prohibited plants and require permits for any business use of aquatic plants and any use of prohibited plants. Permitted facilities are inspected for compliance.

The Wetland Classification System and the Associated Lists of Wetland Plants and Hydric Soils

Porter B. Reed, Jr.
Inland Freshwater Ecology Section, National Ecology Center
St. Petersburg, Florida 33702

The Fish and Wildlife Service published the Classification of Wetlands and Deepwater Habitats in 1979. Associated lists of wetland plants and hydric soils have been developed to aid in the field implementation of the wetland classification system. The lists are currently undergoing an intensive review by academic and Federal personnel. The lists are maintained on computer systems and data is available in both hard copy and digital format.

California Laws and Regulations as They Relate to Hydrilla

Leslie W. Sonder, Senior Agricultural Biologist
California Department of Food and Agriculture
Sacramento, California 95814

California's Hydrilla Exterior Quarantine regulation, Section 3281 of Title 3 of the California Administrative Code, prohibits entry of hydrilla plants or plant parts into California. The area of quarantine includes all States, Districts and Territories of the United States. Enforcement of these regulations is conducted by inspection at border stations and inspection of shipments at pet stores and wholesale and retail outlets dealing in fish and aquatic plants.

Wetland Identification under the "Swampbuster" Provision of the 1985 Food Security Act

Edward R. Smith
USDA - Soil Conservation Service
Fort Worth, Texas 76115

To carry out the obligations of the Swampbuster provisions of the 1985 Food Security Act, the USDA-SCS must determine if an area in question is or is not a wetland. For an area to be considered a wetland, it must have a substrate of hydric soil and must be capable of supporting hydrophytic vegetation. Wetlands are determined by three methods: in the office, visually in the field, or by vegetative transects.

Overview of the Corps of Engineers Wetlands Research Program

Russell F. Theriot
USAE Waterways Experiment Station, Program Managers Office
Environmental Lab
Vicksburg, Mississippi 39180-0631

Section 404 of the Clean Water Act is the authority through which the Corps of Engineers regulates dredge and fill activities in wetlands, the objective of which is to maintain or restore the integrity of the Nation's water quality. Executive Order 11990 recognizes the significant values provided by wetlands and establishes several major requirements with which Federal agencies must comply to minimize the impact on wetlands. To successfully conduct the regulatory program of the CE, the U.S. Army Engineer Waterways Experiment Station is involved in developing precise and technically defensible methods for delineating and evaluating wetlands.

Revegetation of a Southeastern U.S. Floodplain Following Disturbance by Thermal Pollution

Rebecca R. Sharitz and Christopher P. Dunn
University of Georgia, Savannah River Ecology Laboratory
Aiken, South Carolina 29801

Since 1954, the Savannah River floodplain has received, via tributary streams, thermal effluent from nuclear production reactors. This effluent killed most of the vegetation along the streams and in deep water areas of the river floodplain. One such stream has not received effluents since 1968, providing a chance to study natural revegetation in the floodplain. Deposition of alluvium, altered hydrology, dense herb cover, low seed availability, and lack of suitable germination sites have prevented a return to predisturbance composition and structure.

Lacustrine Vegetation Establishment Within a Cooling Reservoir

Gary R. Wein, Gary J. Pierce and Steven R. Kroeger
University of Georgia, Savannah River Ecology Laboratory
Aiken, South Carolina 29801

A 1000 acre once-through cooling lake was created as a mitigation alternative for thermal discharge from a reactivated production nuclear facility on the Savannah River Plant, South Carolina. Habitat improvements that favor establishment of a balanced biological community include creation of 25 acres of wetland/littoral vegetation along the lake shoreline. Planting, begun during January 1987, includes >18 submersed, floating leaved, emergent, and woody species. Planting techniques include transplants, seeding, and shrub wands. Experimental manipulations include alternative planting techniques, wave action abatement, and tailoring shoreline plant placement to mimic natural distributions. Establishment success is being monitored in planted areas. Wetland functions, including shoreline anchoring, fisheries habitat, and sediment trapping, are being investigated. Research into competition of species pairs along an elevational and fertility gradient is being initiated.

A Successful Wetland Restoration and Management Program

Robert D. Blackburn and Gerald E. Fensch
Joyce Environmental Consultants, Inc.
Lake Worth, Florida 33461

A system of man-made wetlands (36 ha) and a natural retention was designed, planted and placed under a management program in a residential/golf course development (947 ha). The wetland system was designed to improve water quality, restore destroyed wetlands, provide habitat for fish and wildlife and add natural aesthetics. Native wetland species could be used in the system. The success of the story is based on water quality enhancement, aesthetics and wildlife utilization.

Coastal Plain Wetlands for Wastewater Management

Robert L. Knight, Ph.D., CH2M Hill
Gainesville, Florida 32605

Over the past 15 years, increasing use has been made of coastal plain wetland ecosystems for wastewater management. Wetlands treatment has been incorporated as a component of full-scale wastewater management systems at a number of sites along the coastal plain. The Sea Pines Public Service District at Hilton Head Island, South Carolina has been conducting a full-scale pilot study of this alternative for four years in their 50 acre Boggy Gut wetland. This system has effectively assimilated up to 1.0 million gallons per day (mgd) of secondary effluent during this study period.

Grand Strand Water and Sewer Authority (GSWSA) provides wastewater treatment for the inland area west of Myrtle Beach, South Carolina. GSWSA has two innovative, full-scale natural land wastewater treatment projects presently in operation. Bear Bay is a 100 acre Carolina bay that is used for the land application of up to 0.43 mgd of treated wastewater. Central Slough is a 78 acre floodplain wetland contiguous with the Waccamaw River that receives a discharge of 0.4 mgd of secondarily-treated wastewater.

Data for the South Carolina systems as well as from several wetland projects in Florida, indicate that these natural land areas are very effective for assimilation of the remaining oxygen-demanding materials and nitrogen in treated wastewaters. As an alternative to direct discharge to rivers and estuaries, wetlands may provide a valuable buffering function for protection of coastal surface waters.

What's on Down Under

Kathleen H. Bowmer
CSIRO Centre for Irrigation and Freshwater Research
Griffith, New South Wales 2680, Australia

As water re-use increases there is increasing concern about deterioration in water quality. Emergent aquatic plants can filter out suspended particles, heavy metals and phosphorus, and stimulate the removal of gaseous nitrogen compounds. These rhizosphere processes have been utilized in artificial wetland systems for water purification. In rice floodwater some of these processes are controlled by green algae and cyanobacteria, with substantial effects of crop productivity and water quality.

Aquatic Weed Problems and Control Methods in Malaysia

Mashhor Mansor
Universiti Science Malaysia
School of Biological Sc., Universiti Sains Malaysia
Penang, 11800, Malaysia

Almost all freshwater ecosystems in a tropical country like Malaysia provide a suitable habitat for most aquatic plants. The exotic aquatic weeds, namely Eichhornia crassipes and Hydrilla verticillata are known to spread and flourish well in several aquatic habitats.

The infestation of these noxious weeds are generally pronounced in man-made canals and rice production areas where they have directly affected the economy of the country.

Total eradication of these unwanted weeds are difficult and sometimes virtually impossible because in Malaysia aquatic weeds are mainly controlled by human laborers. Herbicides are seldom used in Malaysian water, however, few herbicides like 2,4-D and Macheta (2 chloro 2, 6 diethyl N acetanilide 50%) are becoming increasingly popular.

To date, biological agents, such as grass carp (Ctenopharyngodon idella) and certain insects, are still in the experimental stage and not widely used in the field.

Aquatic Plant Management: The South Carolina Approach

Steven J. de Kozlowski
South Carolina Water Resources Commission
Columbia, South Carolina 29240

South Carolina has over 8,000 miles of rivers and 460,000 acres of public lakes. Nuisance aquatic vegetation severely impairs water use activities on many of these waters. The State established an aquatic plant management program in 1980 designating the Water Resources Commission as the lead agency and establishing the multiagency S.C. Aquatic Plant Management Council. Planning and management activities began in 1981 on one lake and have since expanded to 38 water bodies. Research and management activities have totaled over $1 million annually.

Aquatic Plant Management on the Santee Cooper Lakes

John R. Inabinet
South Carolina Public Service Authority (Santee Cooper)
Moncks Corner, South Carolina 29461

The South Carolina Public Service Authority (Santee Cooper) has been actively involved in aquatic plant management activities for nearly 45 years. The story of Santee Cooper's management program during this period represents a microcosm of the history of aquatic weed control efforts throughout the southeastern United States. Since 1943, management techniques and target species have continually evolved. In recent years, the control of submersed exotic species has become the Authority's primary management priority.

Aquatic Weed Control in North Carolina

David J. DeMont
North Carolina Department of Natural Resources and Community Development, Division of Water Resources
Raleigh, North Carolina 27611

Since 1983, the North Carolina/US Army Corps of Engineers Aquatic Plant Control Program has offered cost-sharing and other services to local governments with aquatic weed problems. Hydrilla and alligatorweed project costs are shared by the Corps (70%), State (15%), and local governments (15%). Triploid grass carp and Sonar control hydrilla in small impoundments but have not worked well in large impoundments. Rodeo™ controls alligatorweed where winter flows remove moribund mats. Case histories are reviewed.

Large Scale Aquatic Plant Management at Lake Seminole

Joe Kight
U.S. Army Corps of Engineers
Chattahoochee, Florida 32324

Hydrilla was treated with SONAR™ 5P and SRP on 693 acres in 1985, 220 acres in 1986, and 1,000 acres in 1987. Giant cutgrass, Zizaniopsis miliacea, was treated with RODEO™ on 628 acres in 1986. Waterhyacinths received four treatments in 1986 with 0.5 lbs. A.I. of 2,4-DMA, totaling 1,330 acres. SONAR™ was effective on treated areas; increased treatment this year is due to spread from untreated areas. Hyacinths and cutgrass have been reduced to a maintenance level.

Aquatic Plant Management in TVA Reservoirs

Earl R. Burns, A. Leon Bates, and David H. Webb
Tennessee Valley Authority
Muscle Shoals, Alabama 35660

Water level fluctuations and herbicide applications are the primary operational strategies used to control undesirable vegetation in the TVA reservoir system. In 1986 submersed aquatic plants colonized approximately 35,000 acres in 11 reservoirs, an increase of 38 percent over the previous peak infestations in 1982. The significant increase was attributed to a record drought and resulting ideal growing conditions. Approximately 7,600 acre/treatments were made with herbicides. Hydrilla infestations expanded eight-fold within Guntersville Reservoir in northeast Alabama.

New herbicides, alternative application techniques, special drawdowns and biological controls are being evaluated for incorporation into the operational program.

Eradication of Hydrilla from Spring Lake, in Sonoma County, California

Leslie W. Sonder, Senior Agricultural Biologist
California Department of Food and Agriculture
Sacramento, California 95814

Hydrilla was discovered infesting Spring Lake on September 2, 1984. The infestation was light, although scattered through about half of the lake. The lake functions as a flood control regulating reservoir. Hydrilla has been eliminated from Spring Lake through the process of chemical treatment, draining, hydrosoil removal and fumigation. The lake was filled in November, restocked with fish and opened for public use in March 1986. Annual diving surveys will be utilized to determine final results.

Surface and Aquatic Weed Control Methods in the Salt River Project, Phoenix, Arizona

Winn Winkyaw
Salt River Project
Phoenix, Arizona 85001

The Aquatic and Surface Weed Control Program consists of waterways, office facilities and power generation sites. There are approximately 1300 miles of canals, laterals, drain ditches, 200 power generation stations, substations, 160 deep well pumps, 6 major dams and one diversion dam. The control methods are mainly chemical and mechanical. They are designed for domestic and irrigation water, safety of customers, employees, environmental conditions and urbanization needs.

Triploid Grass Carp Management and Sterility Evaluation in Imperial Valley, CA.

Randall K. Stocker and Neal T. Hagstrom, Imperial Irrigation District,
Imperial, California 92251
and
Richard G. Thiery, Coachella Valley Water District,
Coachella, California 92236

Over 95% of the hydrilla that infested the waterways of the Imperial Irrigation District has been removed by triploid grass carp. Triploid grass carp tend to move upstream initially after being stocked into flowing-water canals. In long sections of canal with abundant plant biomass, grass carp may remain in specific areas within the stocked section, not necessarily moving throughout the available space.

Low catch per unit effort (CPUE) during November 1985 to May 1986 indicates overall poor quality fishing in the largest canals of the Imperial Valley; however, peak CPUE values indicate periodic high quality fishing. Although catch is low, significant numbers of fishermen are utilizing the fishery habitat. No negative impacts of triploid grass carp on the sports fishery have been detected. Triploid grass carp are entering the creel of the local sports fishery.

Induced spawning of triploid grass carp during April 1987 resulted in production of sperm and eggs. While fry did result from diploid egg X triploid sperm crosses in 1986 and 1987, no fry resulted from triploid egg X triploid sperm crosses in 1987.

Control of Brazilian Elodea in a Piedmont North Carolina Reservoir Using a Winter Drawdown

Kenneth L. Manuel, Robert T. Barden, Tommy W. Bowen, Duke Power Company,
Environmental Services, Huntersville,
North Carolina 28078
and
Kenneth A. Langeland, University of Florida, IFAS
Center for Aquatic Weeds
Gainesville, Florida 32606

During January and February of 1986 the level of Lookout Shoals Reservoir was lowered 2.5 m. The drawdown exposed approximately 80 ha of shoreline fringing Brazilian elodea (Egeria densa) to freezing and drying. An October 1986 survey found less than 5% of the previously infested area of the reservoir subjected to drawdown had growing elodea. These plants grew from fragments drifting from upstream beds not effected by the drawdown.

Drawdowns and Hydrilla Control

W. T. Haller
University of Florida Center for Aquatic Weeds
Gainesville, Florida 32606

Drawdowns or water level fluctuation have long been one of the main components of physical control methods for aquatic plant management. Drawdowns are used extensively for fisheries management and purposes other than aquatic weed control. Drawdowns used solely for aquatic weed control have not always been successful and at best often provided only short term weed control, principally for targeted submersed species. Successful utilization of drawdown depends on time of year, target species and extent of drawdown among other factors. The results of drawdown for hydrilla control in Florida will be reviewed and data from drawdowns on Lake Ocklawaha will be presented.

Development of an Aquatic Plant Management Plan for Lake George, New York

Carol Desormeau Collins
Biological Survey, New York State Museum
Cultural Education Center, Albany, New York 12230

Beds of Myriophyllum spicatum L. were first identified in Lake George, New York in August of 1985. The plant was not observed during an extensive macrophyte survey performed in 1973-75. The current infestation covers approximately 52 acres with major beds in 4 separate areas. The potential for growth and spread of milfoil and suitable management strategies are currently being evaluated in effort to prepare a long term management plan.

Plant Growth Regulators for Aquatic Plant Control

Carole A. Lembi
Purdue University, Department Botany and Plant Pathology
W. Lafayette, Indiana 47907

A potential approach to maintaining functional submersed plant growth, but at "non-weedy" levels, is the use of plant growth regulators (PGRs). One group of PGRs, the antigibberellins, reduce stem length in terrestrial plants without altering plant viability. Our data indicate that at least one of these compounds, paclobutrazol, inhibits stem elongation in Eurasian watermilfoil and hydrilla. Milfoil is more sensitive than hydrilla. Data on the effect of paclobutrazol on oxygen evolution in both plants will be reported.

Influence of Natural and Synthetic Plant Growth Regulators on Hydrilla verticillata Royle

B. J. Knowles and S. J. Klaine
Department of Biology
Memphis State University
Memphis, Tennessee 38152

The synthetic cytokinin, thidiazuron (N-phenyl-N'-1,2,3-thidiazol-5-yl urea)(TDZ), has been shown to inhibit tuber and turion production in Hydrilla verticillata Royle (hydrilla). Tuber and turion production in hydrilla is characterized by an increase in endogenous abscisic acid (ABA) levels. It has been hypothesized that TDZ compensates for the high ABA levels by some antagonistic mechanism. Studies with TDZ treated plants supplemented with weekly doses of ABA showed no such antagonism. However, when ABA was supplied daily the TDZ effects on plant growth and vegetative propagule production were suppressed. After four weeks the daily ABA treatments were discontinued. Although new plant growth exhibited the cytokinin influence of TDZ, vegetative propagules were produced after four additional weeks.

While the half-life of TDZ in water is relatively short, it is not readily metabolized in the plant. Hence, once uptake by hydrilla occurs, the TDZ effects are long-term. Significant TDZ uptake by hydrilla occurs within 24h.

Allelopathy in Threesquare Burreed and American Eelgrass

Tai-Sheng Cheng and Donald N. Riemer
Soils and Crops, Rutgers University
New Brunswick, New Jersey 08903

Water extracts of dried threesquare burreed shoots, roots, and American eelgrass plants were shown to have allelopathic properties in a lettuce seed bioassay. A reduction in germination and in radicle growth were observed and it showed a concentration response. Osmotic potentials below 70 mOs/kg and the pH of the plant extracts had no effect on germination or growth. The extract of burreed roots caused the lettuce hypocotyls to be short and bulbous but the same phenomenon was not observed with the extract of burreed shoots.

Physical Characteristics of Waterhyacinth Mats

R. J. Petrell and L. O. Bagnall
Agricultural Engineering Department, University of Florida
Gainesville, Florida 32611

Various characteristics of different types of waterhyacinth mats were measured and functions were determined that related these various attributes to each other. The variables studied were areal and population density; vertical loading capacity; plant connectivity; average root, aerial and total plant length and average total plant and largest petiole weight. These characteristics are very useful when associated with design of specific machines or operations; or analysis of the behavior of plants while handling.

Environmental Fate and Persistence of the Herbicide Triclopyr (Garlon 3A) Applied to an Aquatic Environment: An EUP Field Study

H. E. Westerdahl and W. R. Green
USAE Waterways Experiment Station, Environmental Laboratory
Vicksburg, Mississippi 39180-0016
and
J. C. Joyce
Center for Aquatic Weeds, University of Florida
Gainesville, Florida 32606

A field study was initiated during summer 1986 using the herbicide triclopyr under an experimental use permit. Objectives of this study were to collect information on the dissipation characteristics, environmental fate and persistence of triclopyr residues, applied on an operational scale. Two of three 4 hectare (10 acre) plots, located in Lake Seminole, Georgia were treated aerially or by surface injection at a rate of 35 kg (AE) per hectare. Chemical residue concentrations were determined for sediment, water, plants, cray fish, shell fish and sport fish. Empirical herbicide efficacy evaluations were also conducted.

Use of Environmental Fate Information in Selection of Herbicides for Aquatic Plant Management

J. F. Hall* and J. R. Rodgers, Jr.
North Texas State University, Institute of Applied Sciences
Denton, Texas 76203

Only a few herbicides are currently registered for aquatic use by the U. S. Environmental Protection Agency. When more than one herbicide appears to be satisfactory for use in controlling an aquatic weed species, environmental fate information may prove useful in the final selection. For example, herbicides can be ranked based on their margin of protection for non-target species (e.g., fish). Herbicides can also be ranked according to their bioconcentration potential and overall persistence. This paper examines recent data on environmental fate of currently registered aquatic herbicides and provides examples using this information in decision making.

Application and Validation of the COE-WES HARVEST Model in Pat Mayse Lake, Texas

Philip A. Clifford and John H. Rodgers, Jr.
North Texas State University
Denton, Texas 76203

The COE-WES HARVEST computer model was used to simulate mechanical harvesting operations on Myriophyllum spicatum L. in Pat Mayse Lake, Texas. The utility of the model was evaluated relative to planning of management operations using measurements made under actual operational conditions. The option of in-lake disposal of harvested plant material and related impacts on water quality was investigated as a cost reduction alternative to conventional harvesting methods. The value of the harvest model was illustrated and several model design modification suggestions emerged from the study.

Persistence of the Aquatic Herbicide Dichlobenil in the Field: A Pilot Study

W. R. Green, H. E. Westerdahl, and K. D. Getsinger
Waterways Experiment Station, Environmental Laboratory
Vicksburg, Mississippi 39180

A small scale field study using the aquatic herbicide dichlobenil was conducted in Lake Seminole, Georgia during the summer of 1986. Objectives of this study were to determine residue persistence under operational conditions, in order to provide background information in determining procedures and protocol for a future study under an EUP. Two dichlobenil formulations, (10 and 20% granular), were applied to different 0.4 hectare (1 acre) plots at a rate of 17 kg (AI) per hectare. Duplicate tests included the application of dichlobenil to mature standing vegetative plots and plots vegetatively knocked down with an endothall treatment. Chemical residue concentrations were determined for both sediment and water for 104 days posttreatment. Empirical herbicide efficacy evaluations were also conducted.

Comparative Study of the Fate and Effects of Diquat and 2,4-D

Patricia M. Rocchio and John H. Rodgers, Jr.
North Texas State University
Denton, Texas 76203

A study was conducted to determine the fate of diquat and 2,4-D in experimental systems. In addition, the effects of diquat and 2,4-D on Myriophyllum spicatum were also evaluated. Diquat and 2,4-D concentrations were measured through time in the water column, plant tissue and sediment. Effects were evaluated in terms of: viability of plant tissue through the use of 2,3,5-triphenyl tetrazolium chloride (TTC), chlorophyll a to pheophytin ratios, and diurnal dissolved oxygen concentrations. Dose-response relationships between herbicide concentration in water, plant tissue, and sediment and effects on M. spicatum were determined.

Relationship between Tissue Burden and Response of Hydrilla to Diquat

Kelly Michela Cassidy and John H. Rodgers, Jr.
Institute of Applied Sciences, North Texas State University
Denton, Texas 76203

Hydrilla (Hydrilla verticillata Royle) grown in 10 gal aquaria was dosed with 0, 0.2, 0.5, 0.75, and 1.0 ppm diquat. Concentration of diquat in water was below minimum detectable level (0.05 ppm) by day 5 after introduction, while diquat concentration in hydrilla tissue peaked on day 4 or 5. Hydrilla response was measured by dissolved oxygen, chlorophyll a, and cell membrane leakage. Dissolved oxygen appeared to be the most sensitive measure of response, followed by cell membrane leakage. Chlorophyll a responded slowly and showed minimal correlation with diquat dose.

The Use of Diquat-Alginate in Flowing Water

Alison Fox and Kevin Murphy
Department of Botany, University of Glasgow
Glasgow G12800 United Kingdom

Midstream is a formulation of diquat with sodium-alginate which allows the herbicide to be placed onto specific weed beds and to be used in flowing water. This makes it a particularly useful product for use in British rivers which are managed as sports fisheries.

Trials with Midstream in a series of rivers throughout the U.K. and in large-scale, artificial recirculating channels did not produce any evidence that the herbicide had direct effects upon the water chemistry or macroinvertebrate communities. However, it was apparent that certain environmental factors, especially the calcium concentration and turbidity of the water, could influence the efficacy of the herbicide.

Species Abundance and Distribution in Seasonal Grass-Sedge Marshes in West-Central Florida

Pamela S. Botts
University of South Florida
Tampa, Florida 33620

Cluster analysis, reciprocal averaging, and a biotic boundary technique were employed for ecological description of grass-sedge marshes in west-central Florida. The marshes showed marked seasonal differences in community composition, but shallow areas of different marshes were more similar to each other than to deep areas of the same marsh. Deep areas were markedly different between marshes. Depth, distance from the margin, drainage patterns, and groundwater fluctuations are important regulators of plant communities.

Aquatic Macrophyte Change Detection: A Remote Sensing Methodology

Bruce A. Davis and John R. Jensen
Department of Geography, University of South Carolina
Columbia, South Carolina 29208

This study investigates the utility of the Landsat Thematic Mapper sensor system (TM) as a source of information on aquatic macrophytes. Analysis of data acquired on May 14 and July 17, 1984 discriminated predominately submersed and emersed aquatic macrophytes from other land cover classes. Innovative extension of spectral clusters resulted in a land cover classification of 41,000 acres in the upper reaches of Lake Marion. Comparison of May and July classifications resulted in a map showing new vegetation growth.

Investigation into the Disappearance of Milfoil in the Kawartha Lakes, Ontario

D. S. Painter
Environment Canada, NWRI
Burlington, Ontario, Canada

Over the past 6 years, Environment Canada has been attempting to isolate the causative factors behind the disappearance of Eurasian watermilfoil in the Kawartha Lakes in Ontario. Sediments were ruled out and insect grazing by the aquatic larva of the moth Acentria appears to be responsible.

The Characteristics of an Ideal Benthic Barrier

G. Douglas Pullman
Aquatic Ecosystems Management Research Program
The Dow Gardens, Midland, Michigan 48640

The ideal benthic barrier is opaque, durable, appropriately priced, and easy to install. It should be a barrier to vegetal and root penetration and impose minimal impacts on non-target organisms. An ideal benthic barrier should be aesthetically transparent. It should also be characterized by a low buoyant potential. Benthic barrier buoyant potential is the sum effect of the gas and ion permeability of the device and the nature and quantity of the periphyton that colonize its upper surface. Operational investigations, field studies, and laboratory experiments were initiated to evaluate several benthic barrier devices. A new silicone benthic barrier satisfied most of the characteristics inherent to an ideal benthic barrier.

The Hi-Line Sprayer for Rodeo® Herbicide

Nelroy E. Jackson
Monsanto Company, El Toro, California 92630

The Hi-Line sprayer was developed for application of Rodeo® herbicide to aquatic weeds in drainage channels where aerial application is not feasible. The flexible boom is supported by Kevlar cable suspended and controlled from 2 trucks driven on either side of a channel. The unit allows spraying of any swath width. Use of the unit instead of handguns allowed much quicker completion of the aquatic spray program in Contra Costa County, California and saved $50,000 annually.

Purple Loosestrife Control with Rodeo® Herbicide

Domingo C. Riego
Product Development Department, Monsanto Industrial and Residential Products
Indianapolis, Indiana 46032

Purple loosestrife (Lythrum salicaria) is a hardy perennial that infests shallow water marshes of the North Central, Midwest, and Northeast United States. The species is very aggressive and rapidly spreading across the Northern United States.

Field experiments were conducted to evaluate the efficacy of Rodeo on purple loosestrife. Rodeo at 4 pints per acre of 1.0% v/v spray-to-wet provided better than 90% long term control of purple loosestrife. Addition of surfactant is recommended.

Rodeo is a non-selective, translocated herbicide that can solve more than 90 vegetation problems in and around aquatic sites. Rodeo contains 5.4 pounds per gallon of the active ingredient isopropylamine salt of glyphosate. The product can be used in all bodies of fresh and brackish water which maybe flowing, non-flowing, or transient. There is no restriction on the use of water after application for irrigation, recreation, or domestic purposes.

Effect of Water Hardness on Use of Glyphosate for Control of Torpedograss

Donn Shilling, W. T. Haller and D. D. Thayer
University of Florida and Florida Department of Natural Resources
Gainesville, Florida 32606

Torpedograss (Panicum repens) was introduced into Florida in the early 1900's for use as forage for cattle and now grows extensively along irrigation and flood control canals as well as along lake margins in Central and South Florida. Historically, torpedograss control has been difficult to achieve and more recently glyphosate has become widely used for its control. Still, high rates of glyphosate and multiple applications are often required to maintain control of this species. Studies conducted in growth chambers and in the field have shown that water hardness (Ca^{++}) of 100 to 200 ppm in the tank make-up water reduces activity of glyphosate. Preliminary field trials will be reported as well as results of controlled studies on the influence of water hardness and pH on glyphosate activity.

The Physiology and Development of Lyngbya Mats

B. J. Speziale, E. G. Turner and L. A. Dyck
Department of Biological Sciences, Clemson University
Clemson, South Carolina 29634-1903

The filamentous blue-green alga, Lyngbya magnifica, forms extensive benthic and floating mats in areas of Lake Marion, South Carolina. Preliminary to the recommendation of control procedures, we investigated the organism's physiological and developmental characteristics. Our studies focused on aspects of:

1. pigment composition, under low and high light conditions;
2. photosynthesis, in varied light and temperature regimes;
3. developmental features of growing and senescing cells;
4. mat formation; and
5. herbicide susceptibility.

These studies identified some environmental and physiological characteristics of importance in the derivation of management strategies.

A Simple Method for Estimating the Biomass of Filamentous Algae

James Evans
Department of Natural Resources, Game and Fish Division
Fort Valley, Georgia 31030

The widespread occurrence and persistence of Lyngbya in Lake Blackshear, Georgia has necessitated the development of a simple method for estimating its biomass. Random bottom grab samples are made pre- and post-treatment in affected areas. The material is washed in a mesh-bottomed bucket, allowed a standard air-drying time, and weighed. The resultant data may provide an adequate indication of the effectiveness of various treatment methods.

Effect of Selected Dyes on Short-Term Growth of the Filamentous Blue-Green Alga, Lyngbya majescula

Barbara B. Martin, Dean F. Martin, and M. J. Perez-Cruet
CHEMS Center, Department of Chemistry, University of South Florida
Tampa, Florida 33620

The effect of four representative dyes on the short-term growth of the filamentous alga Lyngbya majescula is described. The results of sunlight studies and measurements of photosynthetic rates, as well as continuous-flow studies of the most effective dye studied, rose bengal, are described. Studies of the photodegradation rates and description of the believed mode of action of the dyes are reported.

Sonar - One Year After EPA Registration

David P. Tarver
Eli Lilly (Elanco)
Tallahassee, Florida 32312

Sonar (fluridone) the newest EPA approved aquatic herbicide has now been marketed for slightly over one year in the U.S. Numerous ponds, canals and large public water systems have received a treatment of this selective systemic product with excellent efficacy. This report discusses how Sonar is being used in aquatic plant management operations designed to control noxious aquatic weeds yet minimizing impact on non-target aquatic vegetation. A label and revision and update is also provided.

Responses of Five Aquatic Plant Species to Combinations of Fluridone and Copper

Lars W. J. Anderson and Nathan Dechoretz
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

American pondweed, sago pondweed, dioecious and monoecious hydrilla, eurasian watermilfoil and elodea were exposed to various concentrations of ethylenediamine-Cu and fluridone from 0.05 to 1.0 ppmw for various durations in outdoor cultures. Subsequent analysis of dry weights showed that enhanced activity of fluridone occurred in the presence of copper in some species and that plant age greatly affected herbicide activity. Growth of young eurasian watermilfoil and hydrilla was greatly inhibited by combination exposures of 4 to 7 days. Sago pondweed was primarily affected by fluridone and combinations with EDA-Cu had little or no additional effect. Generally, effective concentrations for 4 to 7 day exposures to young plants were 0.1 fluridone plus .25-1.0 ppmw Cu, although elodea was very susceptible to copper alone.

Does External Iron Influence Recovery from Fluridone Treatment?

David Spencer, Greg Ksander, Nate Dechoretz
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

Fluridone inhibits carotenoid synthesis. Carotenoid synthesis is stimulated by iron. Dissolved iron levels in lake water varies seasonally within a lake and geographically among lakes. We tested the hypothesis that the level of externally available iron experienced by hydrilla following treatment with fluridone influenced recovery from the fluridone treatment. Experimental results confirmed this hypothesis. Recovery from fluridone treatment (as measured by pigment composition and biomass) was directly related to the level of externally available iron and was also influenced by plant age (7 vs. 19 days at treatment).

Greenhouse and Field Efficacy Studies on a New Aquatic Herbicide, Bensulfuron-methyl (Londax®)

Lars W. J. Anderson, Nathan Dechoretz and Doreen Gee
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

The sulfonylurea herbicide Londax® has been widely tested for use in controlling weeds in rice. We now report on effects of this compound on other aquatic weeds including hydrilla, Potamogeton spp., and Eurasian watermilfoil. Londax effectively curtailed elongation in newly sprouting plants at concentrations of 5 to 15 ppb and also reduced growth of American pondweed in a spring, drawdown canal application of 0.2 kg/ha. Dissipation studies indicate that this herbicide is short-lived in rice paddies and is effective when applied to soil or the water. Initial studies in American pondweed on movement of ^{14}C-Londax® indicate that it can enter rhizomes and ramets following a single-leaf application.

Laboratory Evaluations of the Relationships Between Herbicide Concentration and Exposure Time for the Control of Aquatic Plants

W. R. Green and H. E. Westerdahl
Waterways Experiment Station, Environmental Laboratory
Vicksburg, Mississippi 39180

A laboratory system was used to determine the effective ranges of herbicide concentrations and exposure times to control submersed plants. Recent evaluations included fluridone applied to Hydrilla verticillata and Myriophyllum spicatum, and 2,4-D applied to M. spicatum. Optimum concentration/exposure time relationships differed between plants treated with the same chemical and between the different chemicals. These results will be taken to the field to be verified under operational conditions and procedures.

Rice Floodwater Ecology and Safe Acrolein Reuse

Kathleen H. Bowmer and Warren A. Muirhead
CSIRO Centre for Irrigation and Freshwater Research
Griffith, New South Wales, 2680 Australia

Water is treated with acrolein for weed control in irrigation systems. It could be reused in rice to avoid waste if crop safety were adequate. The response of rice seedlings reflected indirect changes in flood water ecology, some being beneficial, as well as direct tissue damage. Acrolein loss from the floodwater was rapid so a short delay between flooding and seeding could facilitate the safe use of treated water.

Melaleuca Control in Aquatic Sites-Loxahatchee National Wildlife Refuge, Florida

Donald P. Schultz
U.S. Fish and Wildlife Service
75 Spring St. S.W., Atlanta, Georgia 30303

The exotic tree, Melaleuca quinquenervia, is altering native plant communities at Loxahatchee National Wildlife Refuge, Florida. Melaleuca readily invades disturbed sites and can withstand intermittent periods of flooding and drying. Most melaleuca at Loxahatchee NWR exists in sites which are wet most of the year. Present control techniques are labor-intensive and costly. Aquatic labels and different application methodologies are needed for a cost-effective control program.

Triploid Grass Carp Movements in a Large, Hydrilla Infested, Open System Lake in Central Florida

K. W. Phippen, B. Z. Thompson, and R. S. Hestand, III
Florida Game and Fresh Water Fish Commission
Eustis, Florida 32727-1903

Triploid grass carp were introduced into Lake Harris (6,611 hectares) to determine their movements in a large open lake system infested with hydrilla. Initially, 11 triploid grass carp were implanted with radio transmitters and stocked in 3 different locations within the lake. The fish stocked in the area devoid of hydrilla exhibited diverse movement patterns. Those stocked in the area infested with hydrilla remained in that area for the life of the transmitter. Three fish that were stocked in another area close to hydrilla exhibited divergent behavior. All of the fish remained within the lake.

Evaluations of Efficacy, Growth, Movement, and Survival of Grass Carp in a Colorado Irrigation Canal

Fred L. Nibling, Jr. and Joan S. Thullen
U.S. Bureau of Reclamation
Denver, Colorado 80225-0007
and
Dan Beyers
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

Grass carp were evaluated for aquatic weed control during a 3-year study in a northern Colorado irrigation canal where water temperatures ranged from 0°C to 25°C. Stocking densities ranged from 63 kg/ha to 363 kg/ha. Over the study period, the grass carp increased in weight by 343% and in length by 55%. Movements of 50 radio-tagged grass carp were monitored, and experimental stockings showed that development of the aquatic plant community was the most important factor in preventing immediate, post-stocking, long-distance migration. Stocking at slow, deep-water locations also reduced downstream movement of recently stocked grass carp. Fish were kept in a frozen canal over winter in 1985 and 1986 with minimal mortality (3%).

Efficacy of Triploid Grass Carp in Central Florida Lakes

Rue S. Hestand III, Boyd Z. Thompson, and Ken W. Phippen
Florida Game and Fresh Water Fish Commission
Eustis, Florida 32727-1903

Nineteen lakes ranging from 0.6 hectares to 42.1 hectares were stocked with triploid grass carp (Ctenopharyngodon idella) at rates of eight fish per hectare to 370 per hectare. In the majority of lakes the target plant was hydrilla (Hydrilla verticillata). However, two lakes were primarily southern naiad (Najas guadalupensis) and two others were Brazilian elodea (Egeria densa). The higher stocking rates were successful while the lower rates gave mixed results. Several areas were stocked in conjunction with herbicide treatments in which all stocking rates used were successful.

Enhancing Biological Control of Waterhyacinth Using Limited Herbicide Application

Kim H. Haag
University of Florida, Department of Entomology and Nematology
University of Florida, Gainesville, Florida 32611

Seventy-five percent of a 15 acre pond covered with waterhyacinth was sprayed with herbicide in the autumn of 1985. The remaining unsprayed plants were confined with a floating barrier. The condition and density of plants and waterhyacinth weevils were monitored monthly from August 1985 to the present. Weevil density and feeding damage have increased and plant quality has progressively declined at the site.

Growth and Survivorship for Sago Pondweed Grown from Different Sized Tubers

David Spencer
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

Sago pondweed tubers from natural or greenhouse grown plants vary considerably in fresh weight. Experimental results indicate that initial tuber fresh weight is directly related to the growth rate and survivorship characteristics of the subsequent plant. Plants from large tubers emerge from the substrate sooner and at a higher rate, elongate faster, produce leaves and ramets at a greater rate, and are stronger competitors than those from small tubers. These differences are more striking in plants grown in deeper water or from tubers planted deeper in the substrate. These results suggest that management practices which result in the formation of smaller tubers may have long term impacts on sago pondweed populations.

Winter Bud Germination in Response to Moisture and Its Implications for Aquatic Plant Management in Western Irrigation Canals

David Spencer and Greg Ksander
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

Pondweeds growing in many western irrigation canals pass the "dry" season as underground winter buds. Experimental results indicate that winter buds germinate only in saturated sediment. Winter buds collected on several dates during the "dry" period germinated within 7-10 days when placed under standard conditions, mitigating against the possibility of innate dormancy. Observations of sediment moisture levels and germination for winter buds in the Byrnes canal confirm that germination is in response to water saturation of the sediment. These results suggest that the plant's life cycle may be disrupted by short-term (30 days) flooding of canals during the "dry" season.

Use of Antibodies to Distinguish Biotypes of Hydrilla verticillata

Frederick J. Ryan
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

Antibodies have been produced for the principal soluble protein family of tubers of the dioecious biotype of Hydrilla verticillata. The dioecious biotype (Imperial Valley, CA) can be distinguished from the monoecious (Washington, D.C.) by the pattern of proteins which react with these antibodies after electrophoresis. An extract from H. verticillata from Australia gave a pattern which was quite distinct from the other biotypes. This approach may prove a useful adjunct to isoenzyme studies in distinguishing the strains of this plant.

Can Native Aquatic Plants Coexist With Monoecious Hydrilla?

David Spencer
USDA/ARS Aquatic Weed Control Laboratory
Botany Department, University of California
Davis, California 95616

Previous studies indicate that monoecious hydrilla has life history and growth characteristics which allow it the potential for spreading throughout much of North America. This report presents information on monoecious hydrilla's competitive ability relative to the widely distributed, sago pondweed (Potamogeton pectinatus). Results of multiple replacement series experiments indicate that sago pondweed competes well with monoecious hydrilla in cool water. Propagule type and size also affect the competitive abilities of these plants. While sago pondweed may be able to coexist with hydrilla during the initial stages of an invasion, hydrilla will become an increasingly stronger competitor as the tuber bank becomes a significant source of new plants.

Growth of Hydrilla from a Single Tuber

Davis L. Sutton and Thai K. Van
University of Florida & USDA
Fort Lauderdale, Florida 33314

Hydrilla is a major submersed aquatic weed and can rapidly colonize a body of water. This study determined shoot and root dry weight following 4 months of growth after a single sprouted tuber was planted in the center of a 1.0 m^2 container filled with sand and controlled release fertilizers. Results will be presented for summer and winter growth periods.

Effects of Temperature and Sediment Type on Growth and Morphology of Monoecious and Dioecious Hydrilla

D. G. McFarland and J. W. Barko
Environmental Laboratory, USAE Waterways Experiment Station
Vicksburg, Mississippi 39180-0631

Variations in growth and morphology of monoecious and dioecious hydrilla (Hydrilla verticillata (L. f.) Royle) were compared over a range of temperatures, 12 to 32 C, on a nutritionally favorable inorganic sediment and an unfavorable organic sediment. For both biotypes, biomass production was severely restricted at 16 C and below, with thermal optima within the range of 29 to 32 C. Total biomass, shoot number, and shoot length were significantly diminished for each biotype on the organic sediment as compared with the inorganic sediment. With increasing temperature, dioecious hydrilla lengthened more extensively than monoecious hydrilla, particularly on the inorganic sediment. The latter, however, produced higher shoot densities and greater numbers of tubers than dioecious hydrilla under nearly all experimental conditions. Overall, monoecious hydrilla appears to be better adapted to moderately low temperatures than dioecious hydrilla.

N O T E S

Growth Response to pH's 5, 7 and 9 of 16 Separate Races of Hydrilla (*Hydrilla verticillata*)

K. K. Steward and P. T. Madeira
USDA-ARS, Fort Lauderdale, Florida

The literature on hydrilla indicates that there are numerous races of this plant widely distributed through the world which could become established in the U.S. and become problems. The recent establishment of the monoecious type in the Potomac River illustrates the reality of this hazard. It is important to understand the biology of the various races of hydrilla to determine if significant differences exist in order to be prepared to cope with new introductions should they occur. This paper reports on part of a continuing study to meet these objectives. Hydrilla races have been collected from several U.S. and foreign sites ranging from 6 S to 40 N latitudes. These plants were exposed for 8 weeks to natural water in outside aquaria that was adjusted to pH's 5, 7 or 9. There were significant differences between races of hydrilla in growth responses to individual pH. There was a 720% difference in biomass at pH 7 between the most and least productive races. Growth of 7 of 16 races was not effected by pH. Results indicate that certain foreign races if introduced could likely adapt to local environments and have potential for being greater pests than those already established.

Vegetative Regeneration of *Azolla pinnata* R. Br. From Lateral Shoots

Dinesh Kumar Saxena and Sushil Kumar
Department of Botany
Bareilly College, Bareilly, U.P., India

Vegetative regeneration of *Azolla pinnata* R. Br. from lateral shoots has been studied under controlled as well as field conditions. Ten lateral shoots of the same size were selected for each set of experiments i.e. (i) in pond water (ii) in Knop's culture media (iii) in turbulence (iv) with *Eichhornia* and (v) with *Lemna*. Regeneration of lateral shoots into new plants was observed 90% and 92% in field conditions and culture media. The lowest regeneration was observed in turbulence and with *Eichhornia*.

N O T E S