ABSTRACTS

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THE AQUATIC PLANT MANAGEMENT SOCIETY, INC.

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The Campaign for Aquatic Herbicide Registration: Lake Minnetonka - A Case History

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The US Army Corps of Engineers, DowElanco, the Minnesota Department of Natural Resources, the University of Florida Center for Aquatic Plants, and other cooperators recently completed the first phase of the most comprehensive aquatic herbicide field dissipation study ever undertaken. Information obtained from this study, conducted under USEPA guidelines for Good Laboratory Practices (GLP), will complement findings from dozens of other laboratory and field efforts to support the National aquatic registration of triclopyr (Garlon. 3a). Intensive planning and preliminary field activities initiated in the spring of 1993 resulted in successful treatment and data collection in three Eurasian watermilfoil-infested bays of Lake Minnetonka, MN, from June through August 1994. Analysis of herbicide residues in water, sediment, plants, fish, and shellfish, and final treatment efficacy evaluations will be completed by summer 1995. A summary of current regulatory guidelines and requirements for obtaining aquatic labels, recent interactions with the USEPA Office of Pesticide Programs, and a perspective on the future of aquatic registrations are discussed.

Ecological and Environmental Results of Eurasian Watermilfoil Infestations

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Eurasian watermilfoil (*Myriophyllum spicatum* L.) is a non-indigenous submersed aquatic plant that has been causing nuisance problems in U.S. waterways for over 40 years. However, the ecological and environmental effects of this exotic invader has only been recently quantified. Recent research on the decline of native plant species under canopies of this species will be reviewed, as well as effects on water column chemistry, dissolved oxygen, and temperature. In addition, the restoration of native plant communities after management of Eurasian watermilfoil by several techniques has been accomplished in management projects from Washington and New York. The negative impacts of this species are reversible if management occurs soon after invasions occur.

Fact or Perception: Do We Really Have an Aquatic Non-indigenous Plant Species Problem in the United States?

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In recent years, a great deal of attention has been generated concerning the spread and potential "biological pollution" caused by certain non-indigenous species. It has been estimated that in the United States there are over 4,500 species of plants, terrestrial vertebrates, insects and arachnids, fish, mollusks (non-marine) and plant pathogens with an origin outside of the United States.

Of these 4,500 species, there are at least 13 non-indigenous aquatic plants. Certain of these aquatic weeds are high-impact species which cause an inordinate amount of harmful effects. Examples include hydrilla (*Hydrilla verticillata*), Eurasian watermilfoil (*Myriophyllum spicatum*), waterhyacinth (*Eichhornia crassipes*) and purple loosestrife (*Lythrum salicaria*). While this ecological dilemma is real and well-known within the aquatic plant industry, the message generally is limited in scope by what is documented and able to be communicated. Lack of documentation on a national basis in a very real way affects the potential to help remediate these problems with Federal and State funds. It is strongly recommended that The Aquatic Plant Management Society critically evaluate a process to document the non-indigenous aquatic plant problem and help move the issue of the need to manage these plants from a perception to a reality.

Role of Aquatic Plants in Lake and Reservoir Water Quality

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Through uptake from the sediment, submersed aquatic macrophytes can transport nutrients to the overlying water column. Elevated pH, associated with macrophyte photosynthesis, further enhances nutrient (phosphorus) flux directly from littoral sediments. Water circulation affected by diel heating and cooling of surface water in the littoral zone facilitates littoral-pelagic nutrient exchanges. All of these processes potentially result in enhanced phytoplankton (chlorophyll) production and deteriorated water quality conditions. However, particularly in shallow-high energy environments, these negative effects appear to be overshadowed by the ability of aquatic macrophytes to reduce current and wave energies, thereby also reducing sediment resuspension turbidity, and concentrations of suspended particulate materials. Thus, effects (favorable versus unfavorable) of aquatic plants on water quality conditions in lakes and reservoirs must be considered within the context of basin morphometry, hydrology, and local climate.

Successful Control of Hydrilla and Reestablishment of Native Species on Lake Okahumpka Despite Long Odds

Brian Nelson, Southwest Florida Water Management District, Brooksville, FL

Lake Okahumpka is a six-hundred acre, eutrophic lake in Central Florida. The abundant, native vegetation communities on the lake were replaced by the exotic species hydrilla in 1980. Since that time, hydrilla has dominated the lake despite herbicide treatments and the stocking of triploid grass carp. Due to the lack of success of the ongoing efforts, an interagency aquatic plant management plan was developed and implemented during 1990. By utilizing small applications of the aquatic herbicide Sonar over the past five years, hydrilla has all but been eliminated and native submerged plant species have flourished.

Aquatic Plant Action Plan for Lake Seminole, AL-FL-GA

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Lake Seminole is located at the confluence of the Chattahoochee and Flint Rivers, with portions of the project in Florida, Georgia, and Alabama. Since impoundment of this 37,500 acre Corps of Engineers lake in 1957, over 900 species of aquatic and wetland plants have become established and several species have reached problem levels. These plants have caused serious water resource problems. The majority of aquatic plant species creating problems on Lake Seminole are non-native species such as water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata*). Hydrilla, the major problem plant, has increased from 1 acre in 1967 to a peak of 24,000 acres in 1992. A number of aquatic plant management techniques have been utilized since project construction, including chemical (herbicides), biological, and mechanical. Herbicidal control applications have been the most effective technique demonstrated to date; however, these repetitive applications are costly (annual herbicidal program expenditures are approximately $750,000). Two potential aquatic plant management techniques which have not been utilized to date at Lake Seminole: water level fluctuation (drawdown) and stocking of the triploid grass carp (*Ctenopharyngodon idella*), have been discussed for many years by the Corps, federal and state agencies, and the public; however, a number of technical concerns about these methods remain unresolved. Therefore, no consensus has been reached regarding the viability of their use on Lake Seminole.

Public pressure and Congressional interest at Lake Seminole has increased proportionately with the expanding hydrilla growth. Based on the current status of the resource problems and public concerns at the lake, in mid-1994 the Corps initiated a special Congressionally-directed two-year study to develop a long-term strategy for management of hydrilla — termed the Lake Seminole Aquatic Plant Action Plan. Public and agency involvement is an integral part of the study. The Action Plan will include economic and environmental impact analyses. Consideration is being given to a variety of management options including those mentioned above, with special emphasis on; a) a detailed "paper" assessment of the impacts associated with a potential lake level drawdown; b) a herbicide drip delivery system evaluation; and c) a major field study — Confined Grass Carp Demonstration Test. This grass carp demonstration test is farther along than the other two, thus is the focus of this presentation.

The Fish Pond Drain (900 acres) and Cypress Pond (580 acres) areas of Lake Seminole have had two types of barrier systems constructed to allow for passage of recreational boats, with stocking of triploid grass carp (12 per surface acre) planned for November-December 1995. The Cypress Pond area is contained by boatable gates and barriers at the east and west ends of this open-end water body, while a tandem V-shaped funnel weir gate and barrier system has been constructed on Fish Pond Drain. The bulk of the structures consist of horizontally mounted PVC pipe barrier mounted and pressure treated timbers. The objective of the demonstration test is to evaluate and compare these barrier systems to contain triploid grass carp All 18,000 grass carp (12-inch minimum) to be stocked will be tagged with Binary Coded Wire Tags. and 125 five to ten pound triploids will be radio tagged and monitored from November 1995 through June 1997. In addition, submersed vegetation quantities in the confined areas will be monitored every other month using recording fathometer tracing and color aerial photographs.

The Use of Sonar™ as a Renovative Tool to Restore Aquatic Ecosystems

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Throughout North America many lakes have become infested with exotic plant species. While abundant plant growth is beneficial to a point, some plant species, such as Eurasian watermilfoil (EWM) have the potential to become a serious problem. Studies conducted in North America have shown that when EWM growth becomes extremely dense, it can negatively effect aquatic ecosystems. When such problems exist it might be necessary to take a renovative approach to restore the lake's ecosystem.

Since its registration in 1986, Sonar has demonstrated its superiority in controlling the invasive exotic plants of hydrilla, EWM and curlyleaf pondweed. These successes are due to the susceptibility of these species to fluridone, the active ingredient in Sonar. Contrastingly, important native plants have shown less sensitivity to Sonar, thereby, allowing restoration of native plants. The fact Sonar has an excellent toxicology profile makes it a valuable management tool.

A case study was established with the successful renovation of Long Lake, located in Thurston County, Washington. Results of this project were excellent. Follow up surveys indicate how well the aquatic native plant community is recovering. The diversity of species changed from 15 in 1981 to 10 in 1991 due to natives being displaced by EWM. The number of species decreased again from 10 in 1991 to 9 in 1992, due to Sonar removing EWM. In 1994 the number of species increased to 16, indicating the aquatic plant community is recovering without EWM.

Copper Treatments and Aquatic Sediments

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Formulations of copper have been used as algicides and vascular plant herbicides for many years. Some questions have recently arisen regarding the ecological and human health risks associated with the use of this metal for aquatic plant management. This presentation focuses on the critical elements that are central to resolution of this issue, such as: 1) transfers and transformations of copper in aquatic systems; 2) bioavailability and potential for acute effects in the column, and the margin of safety; 3) affinity of copper for sediment, and bioavailability; 4) use scenarios and projections for sediment accumulations; and 5) U.S. EPA plans for evaluation of copper as an aquatic herbicide.

Anodic Stripping Voltammetry as a Tool for Measuring Bioavailable Copper

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In aquatic plant management, analytical measures of copper are important for understanding the efficacy of herbicides, and the potential risks to non-target species. Since speciation can effect bioavailability and toxicity of copper in aquatic systems, accurate predictions of effects of bioavailable forms require detection and/or measurement of these forms. An approach for measurement of labile copper was developed using a modification of differential pulse anodic stripping voltammetry (DPASV) and applied in 10-d aqueous and sediment toxicity tests with *Hyalella azteca*. Water and sediments encompassing a range of characteristics were amended with a copper sulfate solution ($CuSO^4 \cdot 3Cu(OH)^2 \cdot H^2O$). Changes in copper speciation were measured and evaluated relative to amphipod survival. In sediment tests with total copper concentrations spanning an order of magnitude, *H. azteca* survival was explained by DPASV measurements varying by 24%.

Assessing the Effects of Copper in Freshwater Sediments - Lake Steilacoom, Washington

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Lake Steilacoom, located in western Washington State, is a shallow urban lake covering 320 acres. The 5.7-mile lake shoreline is completely developed with residential properties. The relatively large drainage basin (90 square miles) is comprised of residential, agricultural, and commercial land uses. Lake Steilacoom has been characterized as eutrophic, a condition accelerated by its shallow depth. The lake regularly develops wide scale algal blooms and wide spread extensive macrophyte growth. In order to control algal blooms, copper sulfate has been applied by the Lake Steilacoom residents annually since the late 1950's under Washington State Department of Ecology (Ecology) permit. Since 1989, the application of copper sulfate has been prohibited by state agencies over concerns that accumulated sediment copper concentrations (180 to 1100 mg/kg dry weight) pose an adverse effect on biological resources. As a result, current lake conditions restrict recreational activities and impair fish and wildlife habitat. In 1994, blue-green algae blooms reached dangerous levels, a concern to lake residents and local health departments. A Lake Steilacoom Phase 1 Restoration Project study is currently being performed to address lake eutrophication and related water quality issues, though a long-term solution is not expected for many years. This paper presents an assessment of Lake Steilacoom sediment quality which considers surface sediment copper data, bioassay data, and benthic macroinvertebrate population structure. This assessment concludes that copper in Lake Steilacoom sediment do not appear to be biologically available. Recent efforts by Ecology to develop chemical criteria under that State Sediment Management Standards (SMS:Chapter 173-204 WAC) by the Apparent Effects Threshold (AET) method also indicate that sediment copper concentrations as high as 840 mg/kg dry weight are not associated with adverse effects in the freshwater amphipod *Hyalella azteca*. The implications of future copper sulfate application as a cost effective, short-term treatment to control algal blooms needs to be further evaluated.

Sequential (Simulated-Tidal) and Continuous Exposures of *Egeria densa* to Sonar

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Egeria densa is causing increased interference with commercial, recreational and fishing activities in the tidally influenced Sacramento Delta. To determine the potential for utilizing tidal-driven herbicide exposure, rooted plants were exposed (in 4 replicates) in indoor tanks to either 1, 3, or 6 daily six-hour treatments of Sonar at 20, 60, and 100 ppbw. Though some chlorosis occurred within 7 to 10 posttreatment, plants in all treatments recovered fully within six weeks after treatments and no significant differences in dry weights were observed. Plants exposed at 20, 60, or 100 ppbw continuously for 21, 42 or 63 days exhibited chlorosis during exposure periods, ca. 50% reduced root production, ca. 75-85% reduction in shoot biomass and ca. 70 to 85% reduction in root biomass six weeks after the end of the exposure periods. However, plants in all treatments exhibited some degree of recovery upon termination of exposures, evidenced by newly formed green shoots and leaves. Results suggest that control of *E. densa* with Sonar will require long-duration exposures (> 21 days) at 60 ppb, possibly provided via daily injections timed to coincide with incoming tides to eliminate the need for applications by boat.

Phytotoxic Effects of Diquat and Fluridone on a Non-target Rooted Aquatic Macrophyte as Determined by a Static Laboratory Bioassay.

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Rooted aquatic macrophytes are an integral component of aquatic systems. When herbicides enter water bodies they can adversely affect growth and development of non-target aquatic vegetation. *Myriophyllum sibiricum* Komarov, a dicotyledonous species with a north temperate distribution, was selected as a representative aquatic macrophyte. A static, 14-day laboratory bioassay using sterile *M. sibiricum* was developed and utilized to determine the effects of technical grade diquat and fluridone upon morphological and physiological development of this species. When tested at the maximum label rate of 4.5 kg/ha (as if the herbicide were sprayed onto a 15 cm deep column of water), both herbicides were severely toxic to this aquatic plant species. After conducting a series of dilution steps for diquat, the EC50 for chlorophyll b content was 14.5g/L, the EC50 for disruption of membrane integrity was 19.5g/L and both total root length and plant area had EC50s of 28.5g/L. Fluridone concentrations

down to 47.5g/L severely inhibited chlorophyll a, chlorophyll b and carotenoid content. This bioassay appears to be one of the most sensitive at detecting the impact of these herbicides upon aquatic macrophytes.

Comparison of Six Media for Isolation of Microbes Associated with Hydrilla under Natural Conditions

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Six selective and nonselective culture media, namely, Sneh & Stack selective medium (SS), Komada's (K), PART Selective medium for *Pythium* and *Phytophthora spp.* (PART),chitin agar (CA), nutrient agar (NA), and hydrilla-half-strength potato dextrose agar (HPDA), were compared for effectiveness in isolating various types of microorganisms from four man-made ponds and two freshwater lakes infested with *Hydrilla verticillata.* The direct dilution-plating technique was used which involved plating of water, soil, and hydrilla plant samples with subsequent characterization of the recovered microbial types and frequencies. Three hundred and forty three different organisms (160 bacteria, 138 fungi, 44 actinomycetes, and 1 cyanobacterium) were recovered from 24 samples taken from the four ponds using the six media. Fifty eight (28 bacteria, 29 fungal isolates, and 1 cyanobacterium) were recovered from seven samples taken from Orange lake using the six media. Greater variety of fungi were recovered on K and SS agar media, respectively. Chitin agar (CA) and HPDA, in that order, were the best for isolating actinomycetes. NA and HPDA were the most effective for isolating bacteria. In general there was variation in the types or organisms isolated from the same samples depending on the isolation medium used. From pond samples, *Cercosporidium sp.*, *Cladosporium sp.*, *Chaetophoma sp.*, *Penicillium sp.*, and *Staphylotrichum sp.*, and cultures F1015 and F1009 were the most frequently isolated fungi; B2, B4, B502, B1003, B1006, and B1009 (Gram-positive), B2002 (Gram-variable), and B13, B34, B2001, B2004, B2006, B3025, and B3018 (not tested for Gram reaction) were the most frequently recovered bacteria; and A2001, A2004, A2006, A3001, and A3014 were the most frequent actinomycetes. *Penicillium sp.*, and cultures F802, F1502, F1503, and F2505 were the most dominant fungi recovered from Orange lake samples; B301 and B309 (Gram -positive) and B303 and B316 (Gram-variable) were the most frequent bacteria. Thus, the frequency and diversity of the microbial flora isolated confirmed the efficacy of the media and the dilution technique used.

An Investigation of The Allelopathic Properties of Cattails, *Typha domingensis*, in Hillsborough County Florida

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One species of cattails, *Typha domingensis*, was studied in order to investigate any possible allelopathic behavior towards other plants in south Florida environment. Cattail plants differing in stages of maturation were collected from two locations. Portions of the plants (leaves, stem base, roots and the surrounding detritus) were separated, and then either extracted with deionized water at room temperature or using an autoclave for 25 min. at 1210 C and 15 psi.. Bioassays were performed using the extracts with test lettuce and radish seeds. Abnormal growth behavior was observed for all seed varieties and a delay in germination using radish seeds. Seedling growth using autoclaved extracts showed irregular development as well. EC50 values for lettuce seeds were calculated using both standard phenol solutions and leaf extracts. Simple dialysis, and then further ultrafiltration, provided fractions of the cattail extract containing compounds of differing molecular weights. These fractions were used to imbibe test lettuce seeds to help provide additional allelopathic characterization. *Lyngbya majuscul*a was used to study any effects to growth rates, and an inhibition of oxygen production was found to occur after adding the extracts. To help characterize compounds in the sample liquids, total carbon and inorganic carbon analyses were done.

Environmental Influences on the Early Phenology of Monoecious Hydrilla in Lake Gaston

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Quantitative measurements and field observations during 1994 and 1995 at Lake Gaston suggest that water temperature is the most important factor regulating tuber and turion sprouting and subsequent early plant development. Water temperature during the early spring vary as much as 7 C in various areas of the lake. For management efforts to be effective, intimate knowledge of the life cycle of hydrilla is needed. Tubers and turions collected from the 1 M depth were examined in the laboratory and field and found to remain dormant up to 12 C. Turion dormancy was broken at 13 C, and tuber dormancy was broken at 15 C.

Aquatic Plant Management in Oregon

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Invasive, submersed aquatic plants commonly go unnoticed until populations are well established and beyond control. Massive infestation of Oregon's water resources by non-native plants causes severe disruption of native aquatic plant communities, habitat structure, and water chemistry. *Egeria densa* (Brazilian elodea) has invaded most of the lakes on the Oregon coast and in the Willamette Valley. *Myriophyllum aquaticum* (Parrotfeather) occupies many shallow water habitats on the coast. *Myriophyllum spicatum* (Eurasian watermilfoil) occupies scattered waterbodies in Oregon. *Cabomba caroliniana* (Fanwort) appears to be restricted to the Cullaby Lake watershed in Clatsop County. Management options for most of these non-native species are limited by the size of the infestation.

Oregon has no defined program for aquatic vegetation management. The few aquatic weed management activities that have been conducted have met with limited success. Grass carp stocking in Devils Lake for *Myriophyllum spicatum* control has eliminated all plants from the lake, which has altered phytoplankton and fish populations. A more thoughtful approach to aquatic vegetation management in Oregon was initiated when the Oregon Department of Agriculture began to develop a prevention, detection, and contingency management program for *Hydrilla verticillata.* Results of a recent workshop held to begin development of a contingency plan for managing an *H. verticillata* invasion of Oregon will be discussed.

Effects of Short-term Summer Drawdown on Monoecious Hydrilla and Non-target Aquatic Plants

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Mesocosm studies were conducted during the 1993 and 1994 growing seasons to determine the potential of a short-term summer drawdown for management of monoecious hydrilla. In 1993, hydrilla was grown on two different hydrosoils and exposed to dewatering for period of one to four weeks. Substantial regrowth and tuber production occurred following a one-week drawdown. A longer drawdown almost completely suppressed regrowth. In 1994, hydrilla and four native species were exposed to different drawdown scenarios to determine effects on non-target vegetation. There was no regrowth of hydrilla or fanwort (*Cabomba caroliniana*). Watershield (*Brasenia schreberi*) was temporarily suppressed, but exhibited regrowth. Plants of soft rush (*Juncus effusus*) and waterwillow (*Justicia americana*) exposed to dewatering grew better than the controls.

Hydrilla verticillata in New Zealand

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Hydrilla verticillata (L.f.) Royle is an introduced macrophyte in New Zealand waterways. Currently its distribution is limited to four lakes in the Hawkes Bay region. In two of these, Lakes Tutira and Waikapiro, hydrilla has an extensive distribution, whilst in Lake Opouahi it is less abundant. In Elands Lake, which has been a grass carp trial site for six years, there are no longer any weed beds of hydrilla, but a few stunted plants have been located.

Ongoing survey results in Elands Lake have yielded viable tubers as recently as April 1995. Preliminary studies on the distribution of tubers and turions in Elands Lake, Lake Tutira and Lake Waikapiro indicate that tubers only occur in the 1-2m water depth zone. Propagule distribution has implications for the future monitoring of Elands lake and any other New Zealand lakes in which control/eradication of hydrilla may be attempted.

Fishery and Lake Management Considerations for Aquatic Plant Control Programs

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Aquatic plant control programs occasionally fail to protect the environmental needs of impacted fish life and the ecological requirements of a viable aquatic ecosystem. A balanced oversight planning effort is mandated.

Assignment of prioritized beneficial uses for each particular water system permits the establishment of acceptable chemical, physical, and biological standards in order for management to pragmatically function. A lake monitoring program provides the analytical basis to apply corrective procedures to the ecosystem. Aquatic plant surveys are an important part of a monitoring effort.

We appreciate the detrimental consequences of growth excesses of aquatic plants in lakes and ponds, especially on a wide variety of recreational uses and visual aesthetics. Fish populations can quickly reach out-of-balance status due to overprotective habitat for prey species. However, an absence of plant life is equally undesirable. The issue is what constitutes an acceptable presence and distribution of emergent and submergent vascular plants in a fishery oriented body of water.

Submersed species provide escape habitat for young fish and insures an adequate annual recruitment of successive year classes. Plant masses harbor an abundance of invertebrate food organisms. Predator sport fish are also found near aquatic plant sanctuaries and thus serve as attractor habitat for anglers. Many submergent species provide a food source for migratory waterfowl.

Emergent plant species generally offer less habitat and food production attributes along shallow shoreline areas. Spawning areas for fish may be significantly reduced. Bird life utilize cattail and bulrush for nesting and shelter. Shoreline plants offer erosion protection from wind driven wave action.

The ecological balance between nutrient dependent vascular plants and phytoplankton - filamentous algae favors aquatic plants from a lake management perspective. The use of cultivated species in lieu of natural plant production adds an aesthetic value to lakes and ponds.

A conceptual approach to the formulation of a balanced aquatic plant control plan is suggested. Moreover, innovative methodology to achieve such plans is offered.

The essence of aquatic plant control programs is a blend of common sense, ecological awareness, economics, and philosophical moderation.

The Effect of Recreational Use on the Aquatic Plant Community of The Rainbow River, Dunnellon, Florida

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The Rainbow River, a high volume, spring-fed river with substantial ecological significance and scenic beauty, has received increasing amounts of recreational activity in recent years. A year-long study was conducted in order to determine the effects of various forms of recreational activity on the submersed plant community and to monitor the spread of the exotic plant *Hydrilla verticillata*.

A portion of this study specifically examined the relationship between the amount and type of recreational use and damage to the aquatic plant community. The biomass of drifting uprooted and cut plants was highly correlated (r 0.943) with recreational activity. The composition of drifting (damaged) plants was comparable to the composition of the upstream plant community. However, few areas throughout the river were devoid of vegetation due to recreation. In this river, aquatic plant community dynamics appear to be influenced more by factors such as water depth, substrate, and light availability rather than by recreational activity.

Biology, Ecology, and Impacts of Monoecious Hydrilla in Lake Gaston

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Lake Gaston is a 20,000 acre river run impoundment in the North Carolina and Virginia piedmont. Monoecious hydrilla first appeared in Lake Gaston in the mid-1980's, but was a minor component of the plant community until the winter drawdown of 1987-88. Hydrilla has spread from 25 acres in 1988 to more than 3000 acres in 1995. Turbidity, temperature, hydrosoil quality, and exposure determine its growth and distribution within the lake. Tuber and turion sprouting occurs from April through June. New tubers form in late June through mat senescence in October. Maximum biomass occurs in late July to mid-August, and turions are produced from October until early December. Monoecious hydrilla does not overwinter in the vegetative state.

Hydrilla Eradication in California: 1976-1995

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Since 1976, hydrilla has been detected in 17 different California counties. Some counties have had multiple infestations. Hydrilla has been eradicated from nine of these counties; Los Angles, Monterey, Riverside, San Bernardino, San Francisco, Santa Barbara, Sonoma, Sutter and most recently San Diego County.

On August 1, 1994 during the course of a routine detection survey, state and county biologists found monoecious hydrilla in Clear Lake. Clear Lake is one of the largest natural bodies of water in California, with a surface area of 4,300 acres. The initial survey indicated approximately 200 acres of the lake were infested, subsequent surveys brought the total to 425 acres by the end of the season. Chemical treatments using Komeen, a copper based herbicide, were made two weeks after finding the infestation, and continued on a regular basis through the growing season.

Clear Lake is one of the most popular bass fishing lakes in California. Tournaments are held periodically, attracting fishermen from around the country. The high use of this lake would allow hydrilla, if left uncontrolled, to spread throughout the state by movement of boats to other bodies of water. In addition, Cache Creek empties from the lake and plants could eventually infest this creek and move further downstream to the Sacramento-San Joaquin Delta.

Field Evaluation of a Concentrated Polymeric Granule of Endothall

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It takes a major cooperative effort to conduct field trails in the mid-1990's. In the old days you go to the pond (no permits), treat (no QA/QC), pick up dead fish (if necessary) and visually evaluate the plot (no recording fathometers). On March 21st we treated 4 - 4 acre hydrilla plots in Lake Walk in the Water. Two plots were treated with 2.0 ppm endothall; one with 1,283 lbs of standard 10.1% granules and the other with 299 lbs of 65% a.i. potassium polyacrylate polyacrylamide copolymer. The plots were 6 and 9 feet deep respectively. Two other 4 acre plots were treated at 3 ppm. These 6 foot deep plots required 1,921 lbs of 10.1% granules, but only 299 lbs of 6% polymer concentrated granules. Water samples were collected at 3, 6, 12, 24 hours, 2, 3, 5, and 7 days after treatment. Fathometer tracings of all plots were run on April 21st, 4 weeks post-treatment and indicated the polymer formulation is at least as effective for hydrilla control, if not more so (in this study). One obvious advantage of the supersorb polymer formulation is that much less product is required for treatment when compared to the standard 10.1% granules.

Low Dose/Long Term Hydrilla Control Using Sonar™

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Selective hydrilla control using low doses of fluridone has been documented to provide multi-year control in numerous lakes and ponds. An early spring treatment regime consisting of three split treatments in King Lake, Eatonville, Florida successfully reduced hydrilla coverage from 85% to 0%. Treatments of 10, 5, and 5 ppb fluridone were applied to the 22.5 acre lake. No subsequent treatments have been made as of June, 1995. Additionally, three Polk County, Florida lakes were placed under a similar protocol which began February, 1995. Early results indicate excellent hydrilla control and selectivity on native grasses.

Seeing Red in Lake Minnetonka

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In June 1994, a large-scale residue dissipation study was conducted in Lake Minnetonka, Minnesota, as a part of the EPA-registration requirements for obtaining an aquatic-use label for triclopyr. Rhodamine WT dye was applied with the herbicide to both test plots, under the QA/QC protocol. Dye concentrations were recorded each time water samples were collected for residue analysis. Dye

half-lives in both plots were > 90 hours, indicating that there was little water exchange. This allows considerable confidence in the interpretation of herbicide residue distributions, knowing that treated water was not rapidly dispersed from the plots and sampled organisms. A limited amount of dye was detected outside the plots within 12 hours of treatment. At only one sampling station, 100 m from the Phelps Bay plot, did dye concentrations indicate that the proposed drinking water tolerance for triclopyr (0.5 mg l^{-1}) might have been exceeded.

Use of Insect Biological Control Agents for the Management of *Hydrilla verticillata*

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Hydrilla verticillata is a submerged, aquatic plant that has become widespread in the United States causing severe detriment to waterways and wetlands by blocking navigational routes and displacing native vegetation. The use of insect agents offers a viable, and practical option in the control of noxious aquatic vegetation. Establishment in Florida, Alabama, and Texas of two species of leaf mining ephydrid flies, *Hydrellia pakistanae*, and *Hydrellia balciunasi*, have shown substantial levels of damage on hydrilla infestations. Developing larvae cause damage to hydrilla by feeding on internal leaf tissue, thus causing a clearing of the leaf. The leaf clearing effect caused by the developing larvae reduce the photosynthetic rate of the plant which results in mat sinkage, and distinct holes found throughout the hydrilla infestation. Recent establishment (1994-1995) in Florida and Texas of a stem feeding weevil, *Bagous hydrillae*, has also shown much promise toward the control of this nuisance aquatic macrophyte. Damage by *B. hydrillae* adult appears as small puncture holes through leaves, stem fragmentation, and internal stem damage due to feeding action of larvae. Hydrilla mats damaged by this weevil appear to have a "mowed" appearance. Efforts to establish *Bagous affinis*, a tuber feeding weevil, continue in Texas and Florida. *B. affinis* larvae impact the reproductive potential of hydrilla by feeding on the subterranean tuber.

Aquathol Label Improvement Program

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Two years ago Atochem began a comprehensive program to remove or reduce certain restrictions on the AQUATHOL product labels..

Amendments to remove fishing, swimming, and livestock watering restrictions; remove the Skull and Crossbones/Signalword; change the precautionary statement; and add treatment sites have been submitted to the USEPA. Amendments to address potable water and to reduce or eliminate irrigation restrictions are planned for late 1995-96.

A Comparative Study of Emergence from the Sediment by Aquatic Plants from Vegetative Propagules.

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Many species of rooted aquatic plants persist in an area because they produce underground vegetative propagules. In temperate populations, propagules typically overwinter and resume growth the following spring. Studies using constant temperatures indicated that propagule sprouting was regulated by temperature, however such results are of limited value in predicting emergence in the field because temperature fluctuate. We established artificial propagule banks in August, 1993 by growing monoecious and dioecious *Hydrilla verticillata*, *Potamogeton pectinatus*, and *Potamogeton nodosus* in outdoor cultures at Davis, CA. We monitored emergence at 2 to 3 day intervals, and sediment temperature at 30 minute intervals using a data logger. We calculated degree days using the single triangle method with 5 C as the threshold temperature. Propagules began to emerge from the sediment in early March, 1994. We analyzed the data by logistic regression of cumulative propagule emergence versus accumulated degree days. Ten percent emergence was associated with accumulation of the following number of degree days: *P. pectinatus* tubers 94 (75 to 111, 95% C.I.), *P. nodosus* winter buds 142 (129 to 154), monoecious hydrilla turions 133 (124 to 139), monoecious tubers 293 (281 to 304), dioecious hydrilla tubers 1253 (1244 to 1262). These results should enhance management capabilities for these important aquatic plants.

Effects of Plant Quality on the Growth and Development of Aquatic Weed Biological Control Agents.

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Two biological control agents are established for hydrilla, a submersed aquatic weed. These include a weevil *Bagous hydrillae* and an ephydrid fly *Hydrellia pakistanae*. The nitrogen content and the toughness of hydrilla foliage and stems have a significant effect upon the growth and development of these two species. Identification of these factors should prove useful for better management of these beneficial insects.

The Effects of Herbicide Atrazine on *Ruppia maritima* L. Growing in Autotrophic versus Heterotrophic Cultures

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Bioassay experiments were performed to determine the effects of atrazine on *Ruppia maritima* L. (Potamogetonaceae) cultures grown in an inorganic seawater medium where bicarbonate provided the sole carbon source and in a sucrose augmented seawater medium. The bioassays were run for 35 days and growth (measured as the development of new nodes) was monitored on a weekly basis.

The calculated EC50 value for growth of cultures augmented with sucrose was 44.7 mg/L, compared to 2.5 mg/L where bicarbonate was the only carbon source. Photosynthetic experiments were also run to compare rates of photosynthesis among cultures exposed to various atrazine concentrations in bicarbonate versus sucrose-based media. Results from the bioassays and the photosynthesis study showed that atrazine decreased growth of *R. maritima*, but that those cultures grown in sucrose-based media were not as strongly affected as those cultures growing on a totally inorganic carbon source. These results suggest that the availability of an alternative carbon source may help *R. maritima* to withstand the inhibitory effects of atrazine.

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