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HYDROTHOL® 191 Aquatic Algicide and Herbicide
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All pesticides can be harmful. Read label carefully and use only as directed.
EDITORIAL
Florida has the undeniable distinction of having the greatest exotic aquatic plant problem of all the states. Fortunately, along with the evolution of the problem, a network of technology and expertise has also evolved which means that we can maintain the plants within reasonable bounds. Without full use of this network much of the state’s freshwater resources would be lost for use by boaters, fishermen and hunters. Flooding and pest insect populations would increase and agriculture would suffer from poor water flow through the intricate drainage and irrigation systems.

We have been blessed with general cooperation between the many governmental agencies that impact aquatic plant management programs. Of course we all know that this cooperative attitude has had its difficult times in the recent past. Philosophies between individuals and agencies are bound to differ from time to time. This is human nature and can serve as a healthy system of checks and balances to ensure that our programs are carried out in a manner that best serves the interest of everyone. It is part of the overall system that has helped us to develop our current safe methods of managing aquatic plants. The more recent episodes of philosophical differences, however, began to build walls between various sectors of the aquatic plant management community. A hostile environment developed that seemed to block all chances of arriving at workable compromises.

Through recent changes it appears we may now have the opportunity to shorten the walls and collectively work together under a more cooperative attitude. Various entities are beginning to show more understanding of others’ viewpoints. We are not out of the woods yet. Only through cooperation and cooperation have we been able to maintain control of a seemingly impossible problem. In order to maintain the high level of efficient vegetation management and provide the public with the best service we have to offer, we must-all strive to work together towards this common goal.

Jim McGehee

THE COVER
Hydrilla dominates an irrigation ditch in a central Florida citrus grove.

Photo by David L. Sutton
IDENTIFYING FLORIDA’S MOST COMMON AQUATIC GRASSES

by John A. Rodgers
Biologist, Department of Natural Resources

It's been said that taxonomic books on grasses are only as good as its pictures. Actually, anyone who has difficulty in identifying grasses is in good company. Hopefully this article will enable one to identify four of the most commonly found grasses in our waterways.

These four aquatic grasses are *Panicum hemitomon* Schult., *Panicum repens* L., *Paspalidium geminatum* (Forsk.) Stapf., and *Panicum purpurascens* Raddi. Their leaves, except at the basal portion of the stem, are made up of two parts. The lower portion which envelops the stem is the sheath and the upper flat or folded portion is the blade. The flowering stalk or inflorescence contains numerous spiklets on ascending branches. A spiklet consists of a flower or floret surrounded by up to 4 scales or bracts. These bracts are further defined as the first glume, second glume, lemma and palea.

*Panicum hemitomon* or maiden-cane is a native grass found throughout the state in lakes, ponds, ditches and rivers. The lower portion of the stems are erect, which is in contrast to the decumbent (reclining on the ground before ascending) stems of knotgrass and para grass. Maiden-cane's leaf blades are between 15-25 cm long and 8-15 cm wide. Its sheaths are usually glabrous (without pubescence), only occasionally covered with short hairs. The width of the inflorescence is very narrow; its branches suppressed against the central axis.

*Panicum repens* or torpedo grass is an exotic from the Old World (Africa, India and Australia). In Florida, it is more common in the southern and central regions of the state. The leaf blades of torpedo grass are usually less than 15 cm long and from 3-7 cm wide. They are folded at the midrib with the upper leaf surfaces rough to the touch. The sheaths of torpedo grass are always glabrous. Unlike maidencane or knotgrass, the inflorescence is opened with spreading floral branches 4-10 cm long.

*Paspalidium geminatum* (Panicum geminatum Forsk.) or knotgrass has a distribution range similar to torpedo grass. The thick decumbent stems of knotgrass have swollen nodes from which it derives its common name. Leaf blades are 15-35 cm long and only half as wide as the blades of maidencane. The surfaces of the blades have numerous raised longitudinal ridges. These pronounced ridges can be used to distinguish this species from maidencane. The sheaths of knotgrass are also glabrous. The narrow inflorescence is similar in width and length to maidencane but the floral branches are only 3-4 cm long.

*Panicum purpurascens* (Brachiaria purpurascens (Raddi) Henr.) or para grass is an African grass which often clogs and impedes water flow in canals in south and central Florida. Its decumbent stems have swollen nodes which are densely covered with long, soft hairs. In addition, the sheaths are also densely pubescent. The pubescent nodes and sheaths of para grass are characteristics which can be used to differentiate this species from maidencane when neither species is flowering.

Para grass leaf blades are 15-30 cm long and from 10-22 mm wide. The upper and lower surfaces of continued on page 9
At last there's a new generation aquatic herbicide that manages a host of undesirable vascular plants without mismanaging the good life. Sonar® from Elanco.

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---

**Fall**

- **Iknd weeds**
- **Torpedograss**
- **Paraggrass**

**Winter**

- **Iknd weeds**
- **Torpedograss**
- **Paraggrass**

<table>
<thead>
<tr>
<th>length (cm)</th>
<th>Iknd weeds</th>
<th>Torpedograss</th>
<th>Paraggrass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>15-25</td>
<td>&lt;15</td>
<td>15-35</td>
</tr>
<tr>
<td>Winter</td>
<td>15-30</td>
<td>15-35</td>
<td></td>
</tr>
</tbody>
</table>
Sonar® aqueous suspension can be applied to the water surface or under the water surface or placed along the bottom of the water just above the hydrosol. Any conventional application equipment can be used.

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the blades are smooth but the margins are rough to the touch. The inflorescence is open with floral branches 2.5-10 cm long.

In summary, the following simplified key can be written for the four species.

1. Surface of leaf blades with numerous raised longitudinal ridges ............ knotgrass.
2. Blade width 2-7 mm ........ torpedo grass.
3. Nodes of stems and leaf sheaths glabrous ........ maidencane
4. Nodes of stems and leaf sheaths very pubescent ............................. para grass.

While there are other species of aquatic grasses, none are as commonly found growing in Florida’s lakes, canals and ditches according to recent floral surveys. Knowing the difference between maidencane, torpedo grass, knotgrass and para grass, one can accurately identify the aquatic grasses in the majority of the water bodies in Florida.

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**COMPARISON OF THE FOUR AQUATIC GRASSES**

<table>
<thead>
<tr>
<th></th>
<th>MAIDEN-CANE</th>
<th>TORPEDO GRASS</th>
<th>KNOT-GRASS</th>
<th>PARA GRASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stems</td>
<td>erect</td>
<td>erect</td>
<td>decumbent</td>
<td>decumbent</td>
</tr>
<tr>
<td>width (mm)</td>
<td>3-7</td>
<td>2-3</td>
<td>6-10</td>
<td>5-10</td>
</tr>
<tr>
<td>nodes</td>
<td>glabrous</td>
<td>glabrous</td>
<td>glabrous</td>
<td>densely pubescent</td>
</tr>
<tr>
<td>Leaf Blades</td>
<td>flat</td>
<td>folded</td>
<td>flat</td>
<td>flat</td>
</tr>
<tr>
<td>length (cm)</td>
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<td>&lt;15</td>
<td>15-35</td>
<td>15-30</td>
</tr>
<tr>
<td>width (mm)</td>
<td>8-15</td>
<td>3-7</td>
<td>4-8</td>
<td>10-22</td>
</tr>
<tr>
<td>Sheaths</td>
<td>usually glabrous, sometimes pubescent</td>
<td>glabrous</td>
<td>glabrous</td>
<td>densely pubescent</td>
</tr>
<tr>
<td>Inflorescence</td>
<td>panicle</td>
<td>panicle</td>
<td>panicle</td>
<td>panicle</td>
</tr>
<tr>
<td>(type)</td>
<td>15-30</td>
<td>6-15</td>
<td>15-35</td>
<td>15-30</td>
</tr>
<tr>
<td>width</td>
<td>narrow</td>
<td>open branching</td>
<td>very narrow</td>
<td>open</td>
</tr>
<tr>
<td>length of branches (cm)</td>
<td>2-10</td>
<td>4-10</td>
<td>3-4</td>
<td>2.5-10</td>
</tr>
<tr>
<td>Spiklets</td>
<td>green</td>
<td>green/purple tinge</td>
<td>green</td>
<td>green/purple tinge</td>
</tr>
<tr>
<td>length (mm)</td>
<td>2.5</td>
<td>2.2-2.5</td>
<td>2-3</td>
<td>2-3</td>
</tr>
</tbody>
</table>
Aquatic Plant Competition
by David L. Sutton
Professor
Agricultural Research and Education Center
University of Florida — IFAS
3205 S. W. College Avenue
Fort Lauderdale, FL 33314

I. INTRODUCTION
An aquatic plant, like all other organisms, competes with other species and with other individuals of its own species for space in which to develop and grow. Those that can most effectively exploit a particular aquatic habitat will dominate.

There is no simple answer that can readily explain why certain plants are ubiquitous and present in large numbers while others are rare. A number of factors are involved in the dispersal, colonization, growth, and development of plant populations and the invasion of new habitats. Some of these are well known, others are poorly understood.

Physical factors which influence growth of all aquatic plants include light, temperature, water depth, air and water currents, and substrates. Nutrients, pH, and gases are included in the chemical factors. Biological factors include herbivores, pathogenic organisms, and allelopathic stresses. The interaction of these factors plus the influence of human activities results in complex relationships which encourage or prevent growth of plants.

In an ecological sense based primarily on terrestrial systems there is an orderly progression in the sequence of plants growing in an area. Initially pioneer plants invade and colonize an area. As these develop and spread they gradually modify the habitat allowing other species adapted to this change to become established. This process continues until eventually a climax stage is reached where certain plants become dominant and resistant to invasion by other plants.

II. EXOTIC PLANTS
Throughout the world over 70 species of aquatic plants have been introduced into areas far from their native homes during the past 150 years (9). Some of these plants have readily exploited their new habitats and made a nuisance of themselves while others have barely managed to survive outside their native home.

Introductions of certain exotic plants change the plant community structure by bringing with them characteristics and adaptations developed for life in other aquatic ecosystems which allow them to take advantage of the physical, chemical, and biological factors present. In many cases the natural checks which keep the exotic plant under control in its native home are not present in the area where it is introduced. Freed of these natural controls the exotic plant grows luxuriantly.

The most famous of all these introduced species is water-hyacinth [Eichhornia crassipes (Mart.) Solms]. This plant can be found on every continent and is included in the top 10 of the most troublesome weed species in the world (4). Hydrilla [Hydrilla verticillata (L.f.) Royle] is another plant which has gained notoriety during the past several decades. This plant too is causing serious problems in many areas throughout the world. Furthermore, in Florida, hydrilla surpassed water-hyacinth as the most abundant species of those encountered during the 1982 survey by the Florida Department of Natural Resources (8).

Hydrilla appears to have the potential to become, if in fact it is not already, the most troublesome of all the submerged aquatic species. In time however, hydrilla may demand more attention because it will grow in areas with temperatures lower than water-hyacinth will tolerate.

What special characteristics or adaptations do water-hyacinth and hydrilla possess which enable them to grow at such prodigious rates in so many aquatic sites? An understanding of these characteristics and adaptations will be useful in formulating methods to manage growth of these weeds.

III. WATER-HYACINTH
Water-hyacinth is a good example of an exotic plant which effectively competes for space in which to grow. This floating plant, introduced to the United States almost 100 years ago, still grows despite herbicidal, biological, and mechanical control efforts. Why is water-hyacinth so productive?

In Figure 1 a group of water-hyacinth plants in a canal in south Florida are beginning to spread over a mat of water-lettuce plants (Pistia stratiotes L.). And in the same canal another group of water-hyacinth plants have almost taken over a mat of water-lettuce (Figure 2). A few months after these pictures were taken this canal was completely filled with water-hyacinth.

This example of water-hyacinth crowding out water-lettuce in a canal illustrates the intense competition which takes place between plants for space in which to grow.

What are some of the factors which allow this plant to be so successful in these systems? For one, water-hyacinth extends its leaves above many of the other floating plants and reduces the sunlight available to them. The leaf shapes of this exotic plant are such that they efficiently gather the light falling on them, thus enhancing their ability to grow.

continued on page 12
GOOD NEWS FOR AQUATIC WEED FIGHTERS:

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Water-hyacinth grows not only in full sunlight but also in shade and in areas with subdued light. In some Florida river systems these plants grow in the shaded cypress swamp areas adjacent to the rivers. During periods of high water the plants then float down river with the current. Or, the plants will form mats along the river bank and eventually break loose to move with the current to new areas.

Leaves of water-hyacinth can act as sails so that they are freely moved by air currents. Their large inflated petioles with gas-filled aerenchyma tissue provide buoyancy to help keep the leaves high in the water so that the plants can move easily with the wind.

Furthermore, these exotic plants grow as an entangled interlocking mat which resists destruction by wind and wave action that would destroy other smaller floating plants such as the duckweeds (Lemna spp.). These dense mats of plants also effectively prevent light from reaching submerged plants growing beneath them.

Water-hyacinth tolerates a wide range of nutrients. They grow well in areas high in nutrients such as sewage lagoons (7), but when in waters of low nutrient concentration they greatly extend the length of their roots to increase the surface area available for nutrient uptake. However they are quite sensitive to salinity and cannot tolerate concentrations greater than 2.5 parts per thousand (3).

With regard to temperature water-hyacinth grows best when the ambient air temperature is from 25 to 30 C (77 to 86 F) (5), typical daily temperatures for most of the year in Florida. However, it is quite sensitive to cold and cannot survive freezing temperatures for long periods of time. Near freezing temperatures may kill the leaves but the plants regrow quickly, if the entire plant has not been killed.

Water-hyacinth plants spread not only by seeds but vegetatively as well. The importance of seeds in the spread of this plant from site to site is probably minor in comparison to vegetative means. However, germination of seedlings in shallow water areas may be the major source of young plants for reinestation of an area.

Small floating plants such as duckweed, azolla (Azolla spp.), Wolffia (Wolffia spp.), and others enjoy the protection offered by mats of water-hyacinth but these small plants are generally never present in large amounts. In older mats it is not uncommon to see pigweeds (Amaranthus spp.), primrose willows (Ludwigia spp.), water-pennywort (Hydrocotyle sp.), and other emergents normally found in the shallow areas of a body of water or along the shore line growing intermingled with the water-hyacinth.

The eventual outcome of not controlling a mat of water-hyacinth is that it provides a base to support growth of other plants. The buildup of plants on top of the mat can continue until the entire column of water is filled.

Water-hyacinth also tolerates some drying which gives it an advantage over many other aquatic plants. In Figure 3 a plant is stranded on a sand bank but yet is producing a flower with the potential of producing seed which could germinate when the water level rises again.

In Florida it is not uncommon to control a water-hyacinth problem only to have hydrilla take over. A good example is Lake Trafford where the weed problem alternates between water-hyacinth and hydrilla depending on which species has been controlled.

IV. HYDRILLA

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spread of hydrilla. Its demand for use as an aquarium plant has resulted in it being sold throughout the United States. Hopefully recognition of problems caused by hydrilla will lead to a cessation of its transportation across the country.

Fragments of hydrilla which resist drying are easily transported on boats and trailers from one site to another and readily develop into new plants. Every single node, of which there are many on a single branch, has the potential of producing a new shoot, and the larger the fragment, the greater the chance a shoot will form (6).

Hydrilla has several characteristics which allows it to take advantage of the area in which it is growing. Of prime importance, this exotic submersed plant can photosynthesize under light conditions lower than most other submersed plants (12) which enables it to begin to use carbon dioxide early in the morning when the supply is at its maximum. By the time the other plants receive sufficient light to begin to photosynthesize the amount of carbon dioxide has been reduced by the hydrilla.

Hydrilla has an interesting feature of developing long internodes on single strands when the plant is in deep water, but upon reaching the upper layers of the surface it begins to branch profusely. This branching results in a mat that blocks light penetration (2). Plants under this mat become starved for light and eventually die.

Another important characteristic of hydrilla is its production of specialized reproductive buds. Buds formed under the hydrosol at the end of rhizomes are commonly termed “tubers” while those in the axis of the leaves are called “turons”. Tubers appear to be more numerous than turions but both are important sources for regrowth once the mature parent dies.

Hydrilla also forms root crowns which have the potential to produce new plants. The importance of these crowns have received little attention, and therefore little is known of their role in regrowth. Until recently there has been little concern about the spread of hydrilla by seeds since the plant populations consisted of only females. However, the recent discovery of male plants (10) raises new questions as to the importance of seeds in allowing this plant to invade new areas or serve as a source of reinestation.

And finally, hydrilla also competes with other individual hydrilla plants for space. For example, one shoot tip of this submersed plant was found to produce as much dry weight during a 16-week period as 16 similar tips planted under the same conditions (11). This study also showed that the dry weight of plant material after 16 weeks of growth was as high as 1,561 times that of the initial material planted. This helps to show why control methods must eliminate all hydrilla plants. Vegetative growth from even a small fragment, when given the opportunity, will rapidly fill in the area in which it can grow.

V. OTHER PLANT RELATIONSHIPS

There are other factors which contribute to the ability of a plant to dominate the area in which it grows. Location of the growing point helps determine the ability of a plant to compete with its neighbors. For example, eel-grass (Vallisneria americana Michx.) has a difficult time competing with hydrilla because its growing point is just above the surface of the hydrosol whereas most of hydrilla's is from the tips of branches well above that point in the water column. Hydrilla can easily grow above the eel-grass and reduce the amount of available light necessary for its growth.

Biological factors other than the aquatic plants themselves will also determine their ability to survive in a given area. Herbivores, and pathogenic organisms can stress a plant to such an extent that it can no longer compete with its neighbors.

Certain herbivores combined with appropriate control methods can effectively reduce the competitive advantage of water-hyacinth and hydrilla. For example, herbivorous fish can be combined with herbicides to control hydrilla and at the same time encourage growth of plants that are more desirable for the body of water in question (10).

Wave action, silt, and currents can disrupt plant growth. If a
plant cannot resist these forces, no matter how efficient it is in utilizing light, carbon dioxide, and nutrients, it will not survive. Likewise, a plant with a strong anchoring system and tough connective tissue, such as the submerged forms of Sagittaria spp. found in some of Florida’s rivers, may resist these forces although they are not considered highly competitive with other plants.

Little information is available on allelopathy, the release of small amounts of material from a plant which adversely affects another plant, in aquatic systems. The best example of an apparent allelopathic response is from studies in California (1, 14) with slender spikerush [Eleocharis acicularis (L.) R. & S.] and dwarf spikerush [Eleocharis coloradoensis (Britt.) Gilly]. These spikerushes, although their growing points are near the hydrosol, have been found to replace elodea (Elodea canadensis Michx.), American pondweed (Potamogeton nodosus Poir.), and sago pondweed (Potamogeton pectinatus L.) even though those weeds tower over them. However, no chemical compounds have yet been isolated from these spikerushes to substantiate this allelopathic interaction.

VI. CONCLUSIONS

The old saying that “nature abhors a vacuum” is certainly true for eutrophic aquatic environments such as many bodies of water in Florida. Water does not sit long before something is growing in it. In many cases those plants growing in it interfere with water use, and therefore, some action must be taken to limit their growth.

One way to help reduce problems associated with excessive weed growth would be to grow those plants which interfere least with water use for a particular site. These plants would occupy some of the space that nature will fill, thus making it difficult for other plants to invade the area. For example, growth of plants short in stature in a canal would allow water movement but at the same time they occupy some of the space where a submerged weed would grow.

Maintaining the correct balance of plants in a body of water will require an understanding of plant competition as well as judicious use of control methods to enhance growth of desirable plants while, at the same time, retarding growth of the weed species. A goal of aquatic plant management is to maintain this balance of plants concomitant with minimal impact on various other components of the aquatic ecosystem. The complexity of the various factors involved with plant growth will make this a difficult and challenging job.

Toxicity of Adjuvants to Bluegill

Curtis E. Watkins II*, D.D. Thayer**, and W.T. Haller**

The use of adjuvants, various surfactants, drift control, weighting agents and inverting oils in aquatic weed control operations has increased dramatically in the past decade. Primarily, this is due to the relatively high cost of aquatic herbicides and the desire to reduce the amount of herbicides in the aquatic environment. Consequently, applicators are trying to optimize herbicide effectiveness by adding various adjuvants to their tank mixes.

Several confusing names have been employed to group spray tank additives. As a method of classification, adjuvants are grouped into three categories: (1) utility modifiers, which encompass those adjuvants that are emulsifiers, dispersants, stabilizing agents, and antifoaming agents. (2) spray modifier adjuvants which include stickers, spreaders, thickening and weighting agents and foams and, (3) activator adjuvants, which include surfactants, wetting agents, penetrants and oils (McWhorter et al. 1982).

Utility modifiers, as the name suggests, aid in modifying the compatibility between herbicides as well as their solubility in water. Spray modifying adjuvants mechanically enhance spray applica-

Literature Cited


*Center for Aquatic Weeds, 7922 N.W. 71st Street, Gainesville, FL 32606
**Florida Department of Natural Resources, 8233-22 Gator Lane, West Palm Beach, Florida
A static bioassay as the name implies, is a "biological assay" or test to assess the biological response of an organism to a substance. The measured response can range from a change in behavior to death. As changes in behavior are determined at the discretion of the investigator, and therefore may be prone to bias, we chose mortality as the response of our test organism. The term static refers to the fact that water was not replaced through the duration of each test.

A static bioassay was conducted to examine the toxicity of nine adjuvants: Spra-Mate, Cide-Kick, X-77, Formula 403, IVOD, Big Sur (F-239), Naquatic, Polysar, and Herbex, over a 96 hour period on bluegill sunfish. Bluegill sunfish were chosen because they are a major component of the freshwater fish community throughout the United States and also because their popular use as a bioassay organism has made them a valuable reference for comparing toxicities between substances. Fish were obtained from the Fish and Wildlife Service Welaka Fish Hatchery in Welaka, Florida, and were transported live to the Center for Aquatic Wildlife Gainesville Florida where the toxicity tests were conducted. The fish ranged in weight from 0.2 to 2.1 grams and from 26 to 61 mm total length.

Eighteen containers representing three replicates of five concentrations and three controls were used to test each surfactant. After a minimum four day acclimation period, ten fish were placed into each 50 liter tank containing various concentrations of the adjuvants. The acute toxicity of each adjuvant was determined by calculating the lethal concentration and the 95.0% confidence interval. This procedure determines acute toxicity, which is defined as that concentration which induces direct mortality. A common means of quantifying acute toxicity is by calculating the median lethal dose (LD) where 50 percent mortality is observed. Mortality, defined as evidence of no respiratory movement, was examined immediately after placing fish into the containers and every 24 hours up to 96 hours when each test was terminated. As the surfactants Herbex and Polysar made the solution opaque, fish were examined only after 96 hours, at the time when the containers were drained and the experiment was terminated.

Temperature was recorded initially and every 24 hours through the end of the experiment from each container using a mercury thermometer (data not show).

The results of our investigation indicate median lethal concentrations (LD-50's) for all nine adjuvants ranged 0.96 ppm to 8100.0 ppm (Table 1). Polysar and Herbex, the two spray additives which produced opaque solutions were the least toxic. Their 96 hour lethal concentrations were 3600.0 and 8100.0 ppm respectively (Table 1). The toxicity of the seven other surfactants increased during the 96 hour lethal period (Table 1). The most toxic surfactants, Spra-Mate, X-77, and Cide-Kick, had LD-50's at concentrations of 10.0 ppm or less.

Currently, spray additives are applied according to recommended surface area rates or as a percentage of the tank mix; therefore, final concentrations in the water column are dependent upon depth. Based upon our results, final concentrations were calculated over several depths according to the manufacturers recommended rates of application (Table 1). These calculations assume additives are mixed thoroughly throughout the water column. Considering the highest recommended use rate it appears there is a large margin of safety for all of the adjuvants tested except for Spra-Mate, X-77, and Cide-Kick. Precautions should be used with these three adjuvants at depths of less than 1.5 feet, 0.3 feet, and 3 feet, respectively.

Unlike laboratory conditions, where physical, mechanical, and biological actions are minimized, the toxicities of these additives may be affected by external factors in natural waters. Differences in physico-chemical parameters (i.e. temperature, pH, and especially alkalinity) may also affect adjuvant toxicity. Generally, toxicities of compounds increases (lower LD-50) as water hardness increases.

Other important considerations include our experimental design and the biological test organisms. The purpose of our test was to examine the static effect of these adjuvants. Application of these adjuvants within streams, rivers, or lakes which are subject to constant or extreme wind-wave action may reduce their toxicity to bluegills. It should be noted this experiment was designed to assess...
Table 1. Expected ppm for the ten surfactants in relation to various water depths and recommended use rate.

<table>
<thead>
<tr>
<th>Surfactant</th>
<th>Use Rate (qt/acre)</th>
<th>Expected ppm at Various Depths (feet)</th>
<th>96-hour LD-50 (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spra-Mate</td>
<td>6</td>
<td>2.3</td>
<td>0.96</td>
</tr>
<tr>
<td>Cide-Kick</td>
<td>3</td>
<td>1.1</td>
<td>5.2</td>
</tr>
<tr>
<td>X-77</td>
<td>2</td>
<td>0.8</td>
<td>5.5</td>
</tr>
<tr>
<td>&quot;403&quot;</td>
<td>8</td>
<td>3.1</td>
<td>37.0</td>
</tr>
<tr>
<td>IVOD</td>
<td>8</td>
<td>3.1</td>
<td>172.0</td>
</tr>
<tr>
<td>Big Sur</td>
<td>2</td>
<td>1.1</td>
<td>122.0</td>
</tr>
<tr>
<td>Nalquatic</td>
<td>4</td>
<td>1.5</td>
<td>200.0</td>
</tr>
<tr>
<td>Latex Paint1</td>
<td>2</td>
<td>0.8</td>
<td>560.0</td>
</tr>
<tr>
<td>Polysar Latex</td>
<td>2</td>
<td>0.8</td>
<td>3600.0</td>
</tr>
<tr>
<td>Herbex</td>
<td>1</td>
<td>0.4</td>
<td>8100.0</td>
</tr>
<tr>
<td>#4 Fuel Oil2</td>
<td>8</td>
<td>3.1</td>
<td>91.0</td>
</tr>
</tbody>
</table>

1Sherwin Williams White semi-gloss house paint
3Recommended use rates on adjuvant labels often show a range of values or suggest a percentage of tank mix. i.e. X-77 at 0.8% of tank mix. Tank mix volume vary from applicator to applicator so the recommended use rate will vary considerably.

the response of juvenile bluegill sunfish. The median lethal concentrations (LD-50) of each adjuvant may vary according to age and size of bluegill or other test organism. Also other native fish species as well as invertebrate organisms which may serve as food, could respond differently to each adjuvant.

The effectiveness of any adjuvant as well as any pesticide program, rests in the hands of the applicator. With the acquired skill and experience, an applicator can often insure the pesticide being applied will affect only the target species and is applied such that it is both economically sound and environmentally safe. Presently, there is no standard guidelines to insure safe application of any potentially toxic substance based upon the results of bioassay tests (Hart et al. 1945, Henderson and Tarzwell 1947, Mount and Stephan 1967, Cairns 1981). Hopefully, the results of our investigation will provide a useful guideline to applicators and assure them that when properly used these products are not toxic to fish.

Acknowledgments

We wish to thank Margaret Glenn and Don Driggers for their assistance, Bill Maier for reviewing the manuscript and the following companies for supplying materials used in these studies: Spra-Mate is an inverting oil manufactured by KDM Company, San Antonio, Texas; Cide-Kick is a surfactant manufactured for J.L.B. International Chemical Co., Vero Beach, Florida; X-77 is a surfactant manufactured by Chevron Chemical Co., San Francisco, California; Formula 403 is an inverting oil manufactured by Asgrow Florida Co., Plant City, Florida; IVOD is an inverting oil manufactured for J.L.B. International Co., Vero Beach, Florida; Big Sur (Big Wet) F-238 is a wetting agent manufactured by J.L.B. International Co., Vero Beach, Florida; Nalquatic is a sinking agent-Polymer manufactured by Nalco Chemical Co., Chicago, Illinois; Polysar Latex is a stabilizing agent manufactured by Polysar Inc., Chattanooga, Tennessee, and Herbex is an activator-adjuvant manufactured by the American Colloid Co., Skokie, Illinois.

Mention of a trademark or a proprietary product does not constitute a guarantee or warranty of the product by the University of Florida or the U.S. Department of Agriculture, and does not imply its approval to the exclusion of other products that may also be suitable. Project was funded in part through the University of Florida, USDA-ARS Cooperative Agreement No. 58-7830-0-177.
Planning for your Aquatic Weed Control Operation

by Vernon V. Vandiver, Jr.
Associate Professor, Agronomy
IFAS, University of Florida
AREC, Fort Lauderdale
Fort Lauderdale, Florida

The property manager, in developing an aquatic weed control program, faces a series of decisions which will determine the control measures which must be taken to resolve some problem or problems associated with excessive weed growth.

The information that the manager uses to make decisions and the way in which his decisions are made can lead to the following: the degree of success of the control program; the relative costs; the effect on non-target aquatic organisms in the area; the limitations placed on water use during control operations; and whether any desirable vegetation in the area sustains damage.

Prior to planning an aquatic weed control program, some individual or group will have identified one or more weed species that are perceived as limiting the use of a body of water. Water use, the ownership of the water and surrounding land, the resources available, and the desires of the controlling interests largely determine if some type of control program will be initiated to deal with the perceived problem.

Once a decision has been reached to proceed with a control program, proper identification of the weeds causing the problem is essential. Correct identification of the weed plays a very important part in a successful aquatic weed control program; mis-identification of a weed in many cases results in less-than-optimum results following the control operations.

If assistance is required in identifying a plant, the Plant Identification Service of the University of Florida Herbarium is available at no cost to the user. The Herbarium staff can assist by providing information on vascular plants such as scientific names and authors, common names, locations where the plant is known to occur, dates of flowering, and possible human or animal toxicity. The Herbarium facilities include an extensive taxonomic and general botanical library and a collection of over 200,000 preserved plant specimens which are used to aid in the identification of plant specimens sent to the Herbarium. For additional information or to use the Plant Identification Service, you may contact your local county Cooperative Extension Service, listed in the telephone directory under the county government section.

During the planning phase of the control program, the manager must also decide if he or his staff will conduct the operation or if the work will be delegated to another individual or firm. Factors that should be considered here include: the experience of the manager and his staff; the size of the proposed operation; the amount of funds available; the availability of equipment and personnel; the ownership of the proposed treatment area; the relative difficulty of the proposed treatment program; and the desires of the property owner and the responsible manager.

The individual who will be responsible for the control operation is continued on page 20.
INTRODUCING THE FIRST TRULY BROAD-SPECTRUM HERBICIDE FOR AQUATIC SITES.
NEW RODEO IS LABELED FOR YOUR TOUGHEST GRASSES AND BROADLEAF WEEDS, INCLUDING:

<table>
<thead>
<tr>
<th>ALLIGATORWEED</th>
<th>JOHNSONGRASS</th>
<th>REED CANARYGRASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT TAIL</td>
<td>MAIDENHAIR</td>
<td>SPATTERDOCK</td>
</tr>
<tr>
<td>GIANT CUTGRASS</td>
<td>PARAGRASS</td>
<td>TORPEDOGRASS</td>
</tr>
</tbody>
</table>
| GUINEA GRASS  | PHRAGMITES   | "Partial Control"

Now there's one aquatic herbicide that can handle a broad spectrum of obstructive emerged weeds. New Rodeo® herbicide keeps the constant spread of even your toughest weeds within manageable limits, from perennial grasses like torpedograss and paragrass, to broadleaf weeds like alligatorweed, to brush species like willows. In fact, Rodeo does the job of many aquatic herbicides, controlling more than 90 kinds of weeds, roots and all.

When applied with surfactant to the foliage of emerged, labeled weeds, Rodeo translocates to the root system, destroying the entire plant.

RODEO KEEPS WEEDS IN CHECK, LEAVES NATURE IN BALANCE.
Rodeo is compatible with your environmental standards. When applied according to label directions it is virtually non-toxic to mammals, birds and fish. Rodeo breaks down into natural products and does not bioaccumulate in the food chain. What's more, Rodeo has no residual soil activity so it won't leach into non-target areas.

RODEO CLEARS THE WAY IN FLOWING OR STANDING WATER.
You can use Rodeo in most aquatic sites, in recreation or utility areas, in flowing or standing water. This includes canals, ditches, lakes, rivers, streams and ponds.

<table>
<thead>
<tr>
<th>FLORIDA IRRIGATION DITCH</th>
</tr>
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<tbody>
<tr>
<td>Treated 10/21/82</td>
</tr>
<tr>
<td>Results 11/23/82</td>
</tr>
</tbody>
</table>

Label approval pending in California.

I. X-77 at 0.5% v/v
II. Rodeo cannot be applied within a half mile upstream of domestic water intake points, in tide-water areas, or rice levees when flood water is present.

RODEO. BROAD-SPECTRUM CONTROL FOR AQUATICS.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS FOR RODEO.
Rodeo® is a registered trademark of Monsanto Company.
© Monsanto Company 1983  FLIP-5553-111
tion must decide on the type program that will be employed. The choices available will be one or a combination of chemical, biological, mechanical, or physical treatments.

For chemical control operations, herbicide selection is one of the critical points in the planning process. First, the herbicide or plant growth regulator should be effective in controlling the target weed and also be registered for that use. In addition, the chemical control program selected should be the most cost effective that is available. Also, the chemical control program, as with other types of control programs, must be consistent with water use in the area of the treatment. One important consideration is whether the water is used for irrigation of crops or ornamentals and turf in residential areas. Water that is essential for livestock watering or potable water supplies for humans imposes other restrictions on the type of chemical application that can be made.

The range of water-use restrictions is wide, depending upon the herbicide used. For most copper-containing herbicides and algacides, the treated water may be used immediately for irrigation. With diquat, using water for animal consumption, swimming, or spraying must be delayed for 10 days after treatment or until the residue of the diquat ion falls to a level of 0.01 ppm. Also, for water treated with diquat, there must be a 14-day delay before the water is used for drinking or overhead irrigation or until the concentration of the diquat ion again falls to the 0.01 ppm level. For endothall, the treated water should not be used for irrigation of crops, with the restriction on livestock watering and domestic use ranging from 14 days to 25 days following treatment, depending on the herbicide treatment rate. Using fluridone under the current EPA Experimental Use Permit (EUP), when treating up to 10 percent of the total surface area of a lake, there is a 7-day restriction on using the treated water for such things as drinking, livestock watering, and irrigation. Under that same EUP, when an entire pond is treated, the restriction on drinking, livestock watering, and irrigation is 150 days.

With the use of simazine, there is no restriction on swimming or catching fish for food; however, there is a 12-month restriction on using treated water for irrigation or spraying of crops, ornamentals, and turf; human consumption; and livestock watering. The above restrictions are not all-inclusive for the herbicides discussed, nor are all of the herbicides which can be applied to water mentioned. The examples are given only to illustrate the wide variation in water-use restrictions among the various available herbicides.

Another area of concern when planning an aquatic weed control operation is to ensure compliance with all Federal, State, and local regulations. For example, an aquatic plant control permit may be required from the Florida Department of Natural Resources, or a dredge and fill permit from the Florida Department of Environmental Regulation may be required.

It is also very important to read carefully the label and labeling for any herbicide you plan to use and to follow all instructions and precautions. It makes good sense and it is also required by law. The Federal Insecticide, Fungicide, and Rodenticide Act as Amended (FIFRA) states that, "It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling". This includes following the application directions and carefully calibrating the application equipment to ensure correct application rates.

There are several active programs in the area of biological control. The U.S. Department of Agriculture, Agricultural Research Service and the U.S. Army Corps of Engineers have released three insects for the biological control of water-hyacinth, Eichhornia.
The impact of these introductions is still being evaluated. These insects have spread throughout Florida and thus do not generally require any further manipulation to develop an infestation in a water-hyacinth population.

The use of plant pathogens as a biological control for aquatic weeds is another area that is being actively pursued. Dr. R. Charudattan, Plant Pathology Department, University of Florida is currently evaluating Cercospora rodmani Conway under an Experimental Use Permit (EUP) for control of water-hyacinth. The commercial formulation has not been marketed yet as the product is still undergoing field testing.

Another approach to biological control has involved the effort in Florida and elsewhere to develop biological control programs using herbivorous fish which consume aquatic weeds. At this time, in Florida only one exotic fish, a triploid hybrid from a cross of grass carp and bighead carp, is available to the public for biological control of aquatic weeds under a permit program administered by the Florida Game and Fresh Water Fish Commission.

No individual or organization may purchase, possess, or stock this triploid hybrid carp without first obtaining a permit from the Florida Game and Fresh Water Fish Commission. Additional information about the Hybrid Grass Carp Permit Program can be obtained from the Florida Game and Fresh Water Fish Commission.

A variety of equipment is available for mechanical control of aquatic weeds. Equipment such as draglines, backhoes, dredges, cutters, mowers, and harvesters can be contracted, rented, or purchased, depending upon the individual situation. Mechanical control costs may tend to be somewhat higher than some other control techniques because of the nature of the operation; however, this possible higher cost can sometimes be offset by some other factor. For example, silt removal may be accomplished during removal of aquatic weed infestations or the vegetation removed may be utilized in some manner. Also, water use may preclude other types of treatments, making mechanical removal the only alternative.

Physical control measures also can play a somewhat limited, but important role in aquatic weed control. This would include such techniques as proper pond construction and water level manipulation in a lake. These can be especially effective when integrated with other control techniques such as a herbicide application following a drawdown.

With proper planning and preparation, the herbicides, equipment, and biological agents should perform as expected to give an acceptable level of control for the aquatic weed problem, without any compromise of safety or excessive use of resources.

From the Citrus County Aquatic Services crews

You know it’s gonna be a bad day when...

1) You go over your favorite jump only to find a ranger bass boat parked on the over side
2) That noise you heard at the prop was your bail bucket
3) You spray cattails and have a duck hunter stand up
4) O.S.H.A. asks to see your safety equipment
5) You take a shortcut across the swamp and find out it’s been drained
6) You step off the boat, onto dry land and find out it has no bottom to it.
Aquatics

AQUA-VINE

IPPC SPONSORED TOUR
by Bill Maier — Fla. Dept. of Natural Resources

The University of Florida, International Plant Protection Center's Aquatic Weed Program sponsored a tour on various aspects of aquatic plant management. The tour included several overseas scientists who attended the Aquatic Plant Management Society's Annual meeting in Lake Buena Vista. Dr. Haller arranged this trip which included visits to:

- The City of Lakeland's treatment plant which utilizes aquatic plants for nutrient removal
- Polk County Environmental Services Equipment Demonstration
- Florida Power & Light Company Martin County Power Plant reservoir — torpedo grass research
- Lake Okeechobee — Hydrilla and waterhyacinth control program
- Congen Properties — Hydrilla control with grass carp in agricultural canals.
- Lehigh Acres — Mechanical control of hydrilla and sea grass
- Corkscrew Swamp Sanctuary and Fairchild Tropical Gardens.

Over twenty-five persons participated in all or parts of this tour which covered many aspects of management and research. Needless to say, the trip was a great success and allowed for a tremendous exchange of knowledge and created personal contacts with scientists from around the world.

DR. BRUNER JOINS JEC

Dr. Marc Bruner has joined the staff of Joyce Environmental Consultants. He will serve in a position as Aquatic Ecologist at the firm's Lake Worth office. His main concerns will be environmental impact analysis and research. Marc came to JEC from the USDA Aquatic Weed lab in Ft. Lauderdale.

The Society is in the process of putting together some bound volumes of past issues of "Aquatics". One slight problem — we are short on the following issues: March 1979, December 1979, June 1981 and December 1981. If you have any of these, please send them to Dr. Bill Haller and they will be put to good use.

Thank you,
Editor

Jim Harrison has joined St. John's Water Management District as an aquatic supervisor. He is occupying the position presently held by John Lager. Jim's previous experience includes 8 years as maintenance supervisor with South West Fla. Water Management District under Bob Gates.

Changes — Bureau of Aquatic Plant Research & Control

Position changes include Judy Locke as the Bureau's new Administrative Assistant. Her former Grants Coordinator position has been filled by Greg Bracko a new bureau employee. Greg's experience with grant-in-aid programs will insure the continued smooth operation of the aquatic plant control programs. Greg Jubinsky formerly a senior biologist in the Grants Administration section where he was involved in the state's matching fund program is now that section's new supervisor.

Two vacant positions have been deleted from the bureau. The cut positions include one of the two regional biologists positions in West Palm and a research section biologist in Tallahassee.

This year's proposed research grant fund of approximately $400,000 was cut by the legislature to $60,000. Only existing research grants will be continued during the next fiscal year. In-house research conducted by the Bureau was not affected by the drastic reduction in funds. It remains unclear as to the legislative reasoning behind this action.

FLORIDA WELCOMES POLISH GRASS CARP EXPERT

Noted fish scientist and aquaculture expert, Dr. Karol Opuszynski, from the Inland Fisheries Institute, Zabieniec, Poland, has begun a six month sabbatical at the Center for Aquatic Weeds, University of Florida, Gainesville, Dr. Opuszynski, author of over 70 scientific papers on reproduction and rearing of Cyprinid fish and a textbook on basic fish biology, was invited to Florida to cooperate with Dr. Jerome Shireman on various grass carp projects. Opuszynski conducted some of the original studies on grass carp. He has traveled extensively in the People's Republic of China, the Soviet Union and in Eastern Europe. Florida scientists have long been seeking feasible methods for sterilizing grass carp and raising young fry to stocking size large enough to escape predation by other fishes. Dr. Opuszynski will be working with the IPPC literature retrieval system also and requests other scientists to contribute any recent information on grass carp that may not yet be in the database.

Reprinted from "Aquaphyte"

SPECIAL TO AQUATIC MAGAZINE

TO: David Tarver, Editor

By Doyle Conner
Commissioner of Agriculture

Recent changes in the Florida statutes regarding pesticides left intact the authority of the Florida Department of Agriculture and Consumer Services regarding the registration process for pesticides.

In fact, the 1983 Legislature strengthened the department's capability to manage the pesticides which protect Florida's crops and livestock from insects and diseases by authorizing the employment of specialists to hold assess the effects these products will have on the state's environment.

A new bureau will be set up within the Division of Inspection to analyze and evaluate data on pesticides submitted by companies which want to register them for use in Florida, as well as to review the uses and effects of products already in use.

This new bureau provides the scientific expertise to make sound judgments on environmental effects.
as a part of the overall water quality assurance act. This act also abolished the Pesticide Technical Council and in its place, established a new Pesticide Review Council.

The new Bureau of Product Data Evaluation created to help make decisions on new registrations and to evaluate current usage will have a toxicologist, a hydrologist and a biologist to bring those disciplines into the assessment process. The new Pesticide Review Council, while retaining experts from the environmental agencies, will have members trained in hydrology and toxicology and an expert scientific research consultant with experience in government and industry.

The new Pesticide Review Council will have the authority to review all U.S. Environmental Protection Agency data on newly-registered restricted-use-pesticides, advise the EPA of specific environmental conditions in counties where restricted pesticides are used extensively, and initiate scientific study of any such product when there is enough evidence that the product poses an unreasonable adverse effect on the environment or on human health, or when the product does not conform with the manufacturer's claims.

The new council is directed to employ the services of state agencies or the universities to make the investigations.

In addition, the council may ask the EPA to require pesticide manufacturers to provide environmental data generated in Florida or from simulated Florida environmental conditions.

The council also shall evaluate the feasibility of biological control methods as a substitute for chemicals to control insects or diseases.

And, the council may determine that field testing of products applying for registration in Florida is necessary before it makes any recommendation on whether the pesticide should be registered, under rules and conditions to be set by the department of agriculture.

The objective of the legislation obviously is to safeguard our water supply from accidental or unexpected contamination by harmful chemicals.

The department has a continuing obligation to regulate pesticide applicators, especially those purchasing and using Restricted Use Pesticides (RUP). Pesticides are classified as Restricted if it is determined they are highly toxic to man or the environment. Applicators who wish to use a RUP must have a license issued by the department to purchase and use the products.

The South Carolina Aquatic Plant Management Society would like to invite all interested individuals to join their Society. Write Dr. Harold Ornes, Biology Dept. University of South Carolina, Aiken, South Carolina 29801 for membership information.

Bob Lazor has left the Bureau of Aquatic Plant Research and Control, DNR to assume a position with the U.S. Army Corps of Engineers. Bob will be working with the Dredging Operation and Technical Support section at WES in Vicksburg, Miss.
DIQUAT CLEARS OUT WATER WEEDS FROM TOP...

Water weeds that clog Florida's waterways are sunk when treated with ORTHO DIQUAT Herbicide-H/A. DIQUAT is a broad spectrum herbicide that kills both floating and submerged weeds—even the tough ones like hydrilla, water lettuce and water hyacinth. And DIQUAT works fast—in just a few days after application you can see dramatic results.

DIQUAT interrupts photosynthesis in plants. And DIQUAT is economical to use. It can be used to spot-treat small areas, or control larger infestations. When surface spraying, apply with ORTHO X-77® Spreader for best results.

Licensed applicators: see supplemental label for complete details.

ORTHO DIQUAT. It sends water weeds straight to the bottom.