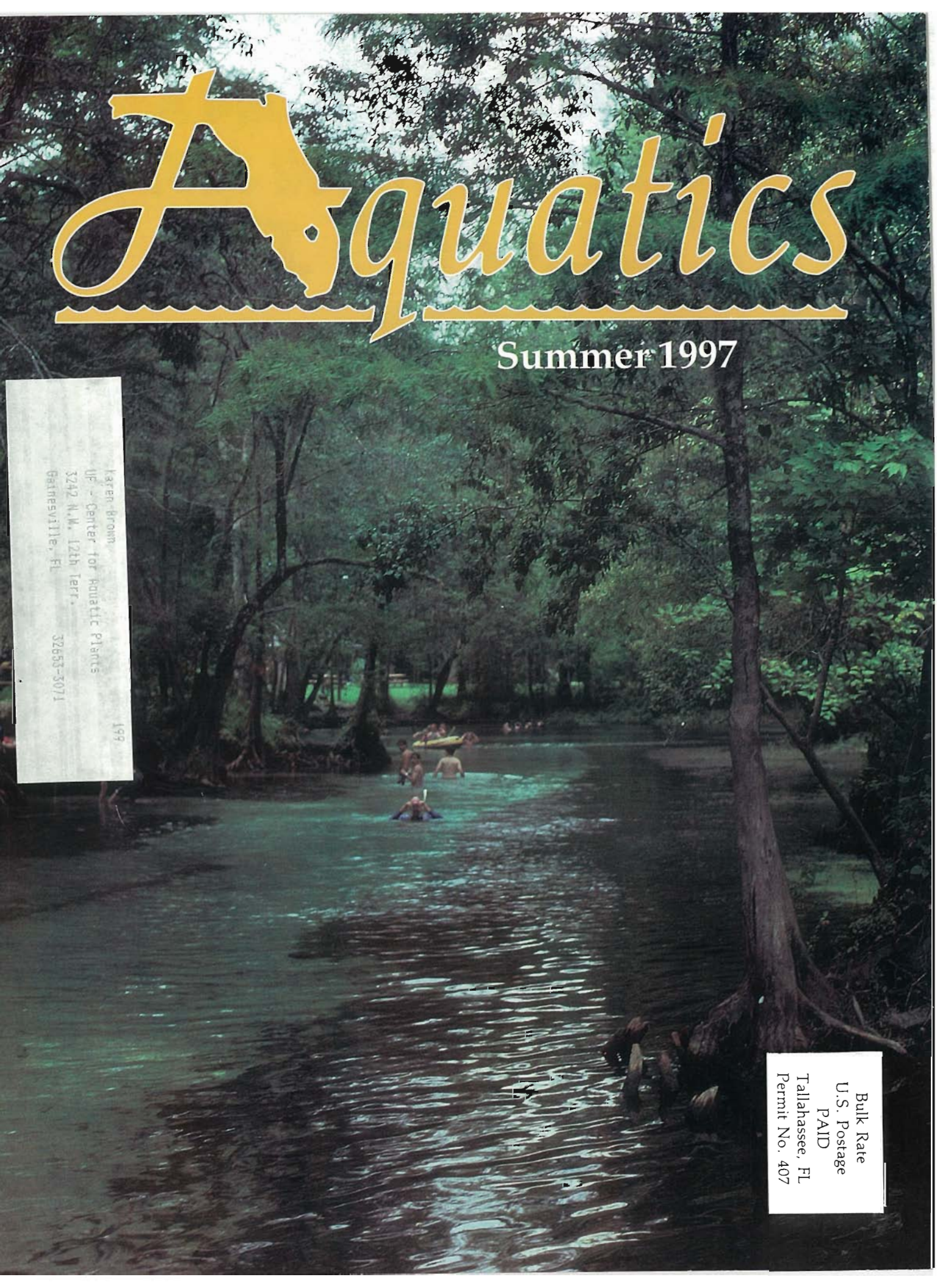

Aquatics

Summer 1997

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Letter to the Editor

Efforts to Move the Bureau Fail

During the 1997 Legislative session, an effort, primarily involving members of the Florida House of Representatives, was made to eliminate the Bureau of Aquatic Plant Management and to remove the Bureau Chief. It seems one of the members was angry because the bureau refused to change the department's rules to allow the growth and sale of water hyacinth back in 1993 when such activity would have been in violation of state law, and federal law, and after it had also been rejected in a vote by the governor and Cabinet. Another member was angry because a constituent was not allowed to do something that was illegal under the law. For refusing to change the rules or condone illegal activities, the bureau and its chief were charged with being "inflexible."

House members first devised a plan to transfer all of the responsibilities of the bureau to the Water Management Districts. Under this plan, all of the positions in the bureau would have been eliminated and all 32 members of the bureau's staff, including the Bureau Chief, would have been without jobs as of July 1, 1997. However, an agreement was reached that if the Bureau Chief resigned, which he had already offered to do, the effort to move the bureau's responsibilities would be dropped. In spite of this agreement, and a tendered resignation, efforts continued to dismantle the bureau until the Water Management Districts made it clear they did not want these responsibilities.

Not to be deterred, a change in plan was made - literally in mid-stream of the appropriations conference process - to move the entire program to the Department of Agriculture and Consumer Services. The reason given was that DACS was a "can do" agency and DACS had done a better job of removing melaleuca. Many wondered about this explanation. If the program belonged in DACS, why did they first try to dismantle the program and give the responsibilities to the Water Management Districts?

Once this effort became public knowledge, the reaction against it was instantaneous and extremely vocal with the effort to move the program being strongly criticized by citizens groups, environmental groups and by newspaper editorials around the state. The history of the bureau's efforts were such that people recognized that, when appropriately funded, the bureau was highly successful in its efforts to bring invasive exotics under maintenance control. This was also supported by the Annual Report to the Legislature, Governor, and Cabinet, as well as the performance audit done by the Auditor General's office.

In the end, because of the strong support given the program by the leadership of DEP, the Senate refused to go along with the House's efforts to move the program through proviso language in the Appropriations Bill, and insisted that if the House wanted to move the program, it should pass separate legislation. Such legislation did not pass.

The good news is, that in spite of the efforts to move the program which failed, the Legislature did fund the program at the highest level in history, thanks primarily to the efforts of Sen. Rick Dantzler, lobbyists for FAPMS, and lobbyists for SePRO.

Tom Brown, Chief
Bureau of Aquatic Plants

A cool place on a hot summer day, Santa Fe River, Florida.

Aquatics
Summer 1997/Vol. 19, No. 2

CONTENTS

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A Historical Look at Aquatic Plant Management on Lake Rousseau - Part 1

by
Nancy P. Allen, U.S. Army Corps of Engineers
and
Terry Sullivan, Department of Environmental Protection

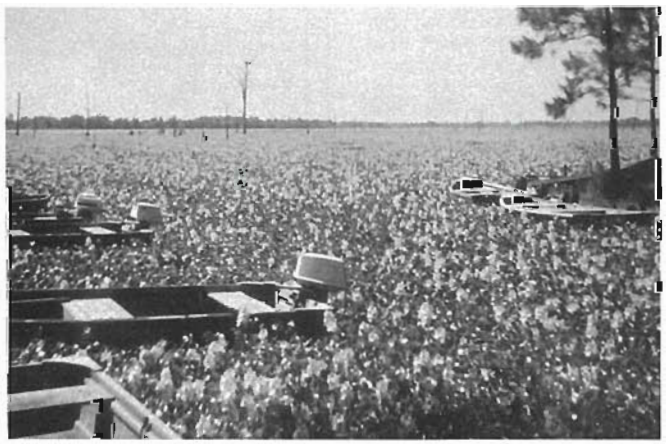
Introduction

The fast pace of our world today offers little time for reflection on the past. The following article is a summary of the highlights from almost 100 years of aquatic plant management on Lake Rousseau. By evaluating our successes and failures of the past we can gain valuable knowledge and direction for the future.

The History

Far away and a long time ago, in the year 1900, reports indicated that waterhyacinths (*Eichhornia crassipes*) had become a problem on the Withlacoochee River. In 1909, the Camp Phosphate Company created an impoundment of the Withlacoochee River to provide power for the company and the city of Dunnellon. The impounded area, currently called Lake Rousseau, was called the "Backwaters" and is located along the Levy-Citrus and Marion-Citrus boundaries. Local residents enjoyed this 4,000 acre favored fishing area. In 1913, the first aquatic plant control contract was signed to clear waterhyacinths from the Withlacoochee River from Lake Istachatta to Lake Panasoffkee. A separate contract was made to control waterhyacinths between Lake Panasoffkee and the Backwaters Dam. By 1919, the Withlacoochee River still had several large blockages of waterhyacinths. In the 1920's, regular spray operations were conducted on the Withlacoochee to remove waterhyacinths. In 1926, the hydro-electric plant on the Backwaters was acquired by the Florida Power Corporation. The Backwaters came into the limelight again in 1935 when construction began on the Florida Ship Canal. Construction halted during the depression and W.W.II. In 1948, surveys reported waterhyacinths in most of the major waterways in Florida including the St. Johns, Withlacoochee, Ocklawaha, Kissimmee, and Caloosahatchee Rivers. Alligatorweed (*Alternanthera philoxeroides*) infestations were also reported in the St. Johns River. In March, U.S. Army Corps of Engineers (USACE) crews began spraying 2,4-D to control water hyacinths. During 1949, 557 acres of hyacinths were destroyed by cutter boats, 670 acres were pushed out to salt water and 299 acres were sprayed with 2,4-D. By 1952, the St. Johns River, Okeechobee Waterway, Hillsborough River, and Withlacoochee River were open and in good condition.

In 1963, the Florida Power Corporation gave the State of Florida the dam structure and surrounding property including the reservoir bottom. The Florida Power Corporation stipulated that the donated area be managed for recreation. The Governor named the recreation area, Lake Rousseau in memory of C.C. "Cliff" Rousseau, a Florida Power employee. Work began anew on the Cross Florida Barge Canal project in 1964. A barge canal, lock and bypass spillway were constructed at the western end of Lake Rousseau. The bypass spillway was constructed to maintain a stabilized lake level and to provide a continued flow to the lower Withlacoochee River. The Barge Canal project was stopped in 1971 due to environmental concerns and outdated design capabilities. State and Federal studies recommended in 1977 that the project be terminated. The Cross Florida Barge Canal was turned over to the State of Florida in 1992; consequently, changing the focus of the lands and waters from shipping, to recreation and conservation.



Waterhyacinth mats cover Lake Rousseau in 1965 preventing fishing and other recreational uses.

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Managing aquatic plants on Lake Rousseau is a difficult task. Prior to flooding, the forest was not logged and numerous stumps and snags were left. The Withlacoochee River Channel is a Federal Navigation Project, authorized by the River and Harbor Act of 1946. This Act requires that a navigable main channel be maintained. This translates into problems for the aquatic plant manager because water normally remains in the lake only 5-16 days (Downing, 1989).

GFC Manages Aquatic Plants On Lake Rousseau

The Florida Game and Fresh Water Fish Commission (GFC) was the first agency to manage aquatic plants on Lake Rousseau and the Withlacoochee River under a 1959 cooperative agreement with the USACE. Under that agreement, GFC managed Lake Rousseau from 1952-1977. Mr. P. W. (Phil) Phillips, a pilot from Little Rock, Arkansas was the first person hired by GFC to control hyacinths. Waterhyacinths were present in such large numbers that crop duster type spray planes had to be used. The very first spray pumps were run by a fan blade attachment, which turned the pump to create pressure. To prevent drift, low level flying of about 6 feet above the hyacinths was required. The phrase, "Coming In On A Wing And A Prayer", may have been coined by Phil, while negotiating the many snags protruding above the surface of the Backwaters. Shortly after Phil came to work, additional people were hired to spray by watercraft. The early airboats that were used did not have a prop cage as today's boats do. Phil told me that when they arrived into town to spray a lake, they were welcomed with open arms. This work was the beginning of the aquatic plant management program as we know it today.

The SWFWMD Takes Over Lake Rousseau Aquatic Plant Management

The Southwest Florida Water Management District (SWFWMD) assumed responsibility for the aquatic plant management on Lake Rousseau in October 1977 and continued until August 1987. During the District's ten year term, various methods of aquatic plant control were utilized. Mechanical methods such as a cookie cutter and harvester were used to control the waterhyacinths, water-lettuce, and a variety of minor nuisance plants. Both aerial and ground applications of herbicides occurred as well. In 1984, SWFWMD contracted to have a series of boat trails created to allow safe access through the "stump fields". Approximately three miles were cleared during this fiscal year. In December of 1986, the first Sonar treatment for hydrilla (*Hydrilla verticillata*) control was conducted on Lake Rousseau. Two hundred forty acres of hydrilla was treated using Sonar slow release pellets (SRP) at a rate of 60 lbs. per acre. Control plots were concentrated in the main body of the lake. The treatment was deemed successful in controlling the initial infestation of hydrilla. Eight months after treatment, little regrowth was evident. However, approximately 11 months after treatment, hydrilla regrowth was present and the biomass was nearing pretreatment levels in all plots.

Corps of Engineers Begin Lake Rousseau Aquatic Plant Management

See next issue.

Acknowledgments

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Robbie Lovestrand, DEP, Floral City
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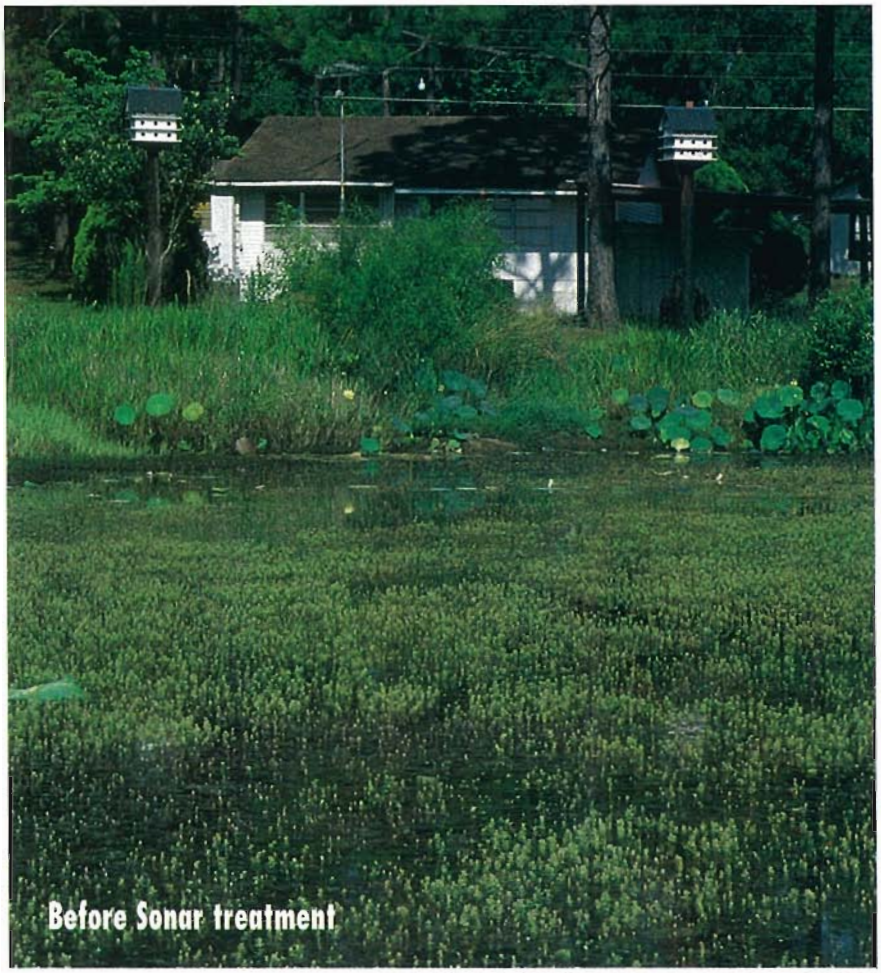

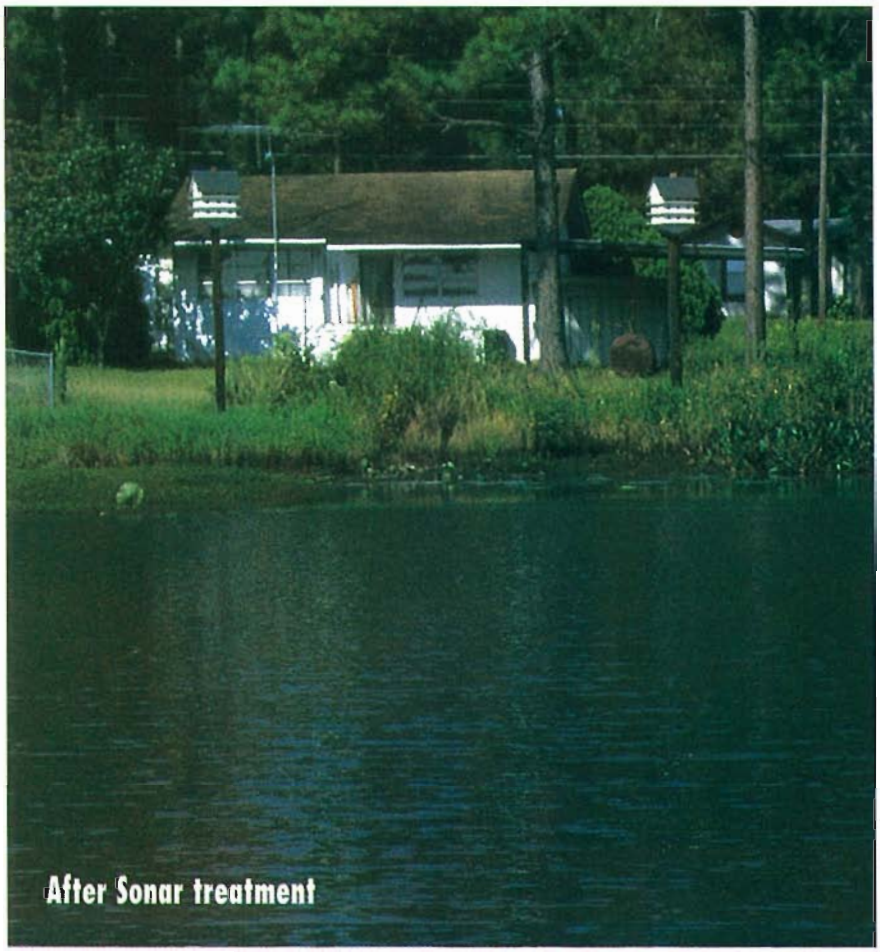

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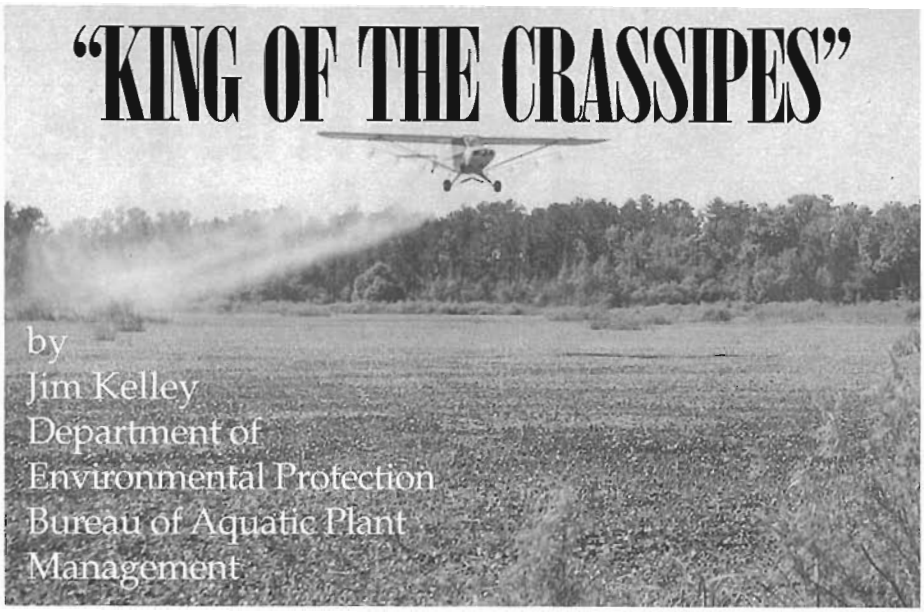

by
Jim Kelley
Department of
Environmental Protection
Bureau of Aquatic Plant
Management

Hamburger Lake, Lake City, Spring of 1953.

In the early 50's the exotic plant waterhyacinth(*Eichornia crassipes*) had become so prolific in Florida that many water bodies were 100% covered. The Florida Game and Fresh Water Fish Commission (GFC) decided it was time to do something about it. Their first step was to purchase a crop dusting plane and to hire a top gun pilot to fly it.

Mr. P.W.(Phil) Phillips from Little Rock Arkansas was hired by GFC in 1952 as the first person to spray waterhyacinths. Many lakes and rivers in the State had never been sprayed before and were so grown over with waterhyacinths that it was impossible to navigate them with conventional kicker boats or airboats. After 20 years of aerial spraying, Phil is most definitely the Red Baron of weed control with the most confirmed kills on "bull hyacinths" in the State, and probably on the planet.

Phil was watching the Movie the Yearling by Marjorie Kinnan Rawlings in a Little Rock movie theater when he got the uncontrollable urge to move to Florida. Ironically one of the first areas he was assigned to spray with his airplane was Orange Lake behind Marjorie Rawlings small farm. At that time there was a block of waterhyacinths one thousand acres strong drifting around the lake closing down fish camps, first on one side of the lake and then the other.

P.W. (Phil) Phillips

One fisherman and his wife were trapped on the lake for two days when the wind suddenly shifted, pinning them between two drifting mats. Phil was welcomed with open arms when he showed up with his spray plane ready to do battle with the noxious weeds. As Phil recalls it, "it took one to two days to spray the 1,000 acres."

Over the years the Red Carpet was always rolled out when Phil and his plane came to town. "We were treated like Royalty. More often than not we were invited to stay overnight in peoples' homes and fed elegant home cooked meals." To Phil, southern cooking was as good as a pay check any day, and in the early years of the GFC those pay checks weren't too regular. "Some months all we got was a promise. They would call us and say boys there's no money this month but just hang in there for a few weeks and we'll get some (money) to ya." I guess that's why all the old timers were such good hunters and fishermen, they had to be if they wanted to eat regular.

Spraying hyacinths with a plane was hazardous work and Phil carries the scars to prove it. He had nearly been killed earlier while crop dusting when his tail wheel caught a fence line. He pulled up about a mile of fence before the plane stalled and crashed to the ground. When spraying hyacinths he would usually fly about six feet off the ground. In some areas, like Lake Rousseau, he had to fly between the dead trees.

On one occasion, Phil reported, "I told my boss that the area was too dangerous to fly because of the obstructions, and I couldn't get down close enough to the water to get good coverage." His boss (Earl Fry, then director of GFC) said, "that's O.K. I'll get you a boat or a back-pack sprayer and you can spray them with that." Phil thought for a minute and said, "let me try it one more time and that time came back with water-hyacinths hanging from the wheels of the plane.

Phil has hundreds of stories to tell about his 20 years in a spray plane over Florida waters, and on one occasion, in the water. He was spraying on Lake Tsala Apopka one morning when, due to a faulty gas gauge, he ran out of gas. He crashed the plane into the lake near an old man fishing in a rowboat. Phil was trapped in the plane hanging upside down under water. Others rushed to rescue him but the old man just kept fishing. Later he was asked why he didn't try to help. "I thought that was one of them planes that's supposed to land on the water," he replied (yea but upside-down?).

When he wore out the first plane

Right to left, Don Luethy, Willie Lee Gieger, Phil Phillips, and John Gregory Carpenter Orange Lake, Florida.

they gave him, he contacted Tallahassee requesting a new one. When informed that there was no money for a new plane, he sent word back for them to send him the crate that the old one came in and he'd fly that for a few years.

Phil had what most people considered to be the most dangerous job in the entire GFC for 20 years and never received high hazard retirement. When he inquired about it late in his career he was told that he did not qualify for high hazard because he was not full time law enforcement.

Later, around 1972, Phil decided to give up his pilots job to accept the position of supervisor of the spray crews in the Southwest Region. It was my pleasure to work under him until the hyacinth spray program was transferred to the Department of Natural Resources in 1981, when Phil retired.

One of my first assignments after being hired by the GFC, as an aquatic plant control specialist in 1972, was to go out and buy a pistol. At that time all aquatic plant control personnel were required to carry a badge and a gun for the first nine days of the hunting season each year. Ask D. Wayne Corbin about his chrome plated 357 magnum Colt Python with white pearl grips and a black quick draw tie down holster. Phil had his hands full those last 10 years.

Phil retired after 30 years with GFC and later became president of the Citrus County Lakes Improvement Association and ran their fish-hatchery in Hernando until recently. Currently he is a full time Turkey Hunter, and teller of tall tales.

Love at First Bite–Introducing the Australian Melaleuca Weevil

by
Susan Wineriter
UF/IFAS/Entomology-USDA/ARS,
and
Gary Buckingham,
USDA/ARS
Florida Biological Control Laboratory

That *Melaleuca quinquenervia*, the paperbark tree, is an exotic plant pest in all ten central and south Florida counties has been well established (Ferriter 1995). The establishment of the Exotic Pest Plant Council (EPPC) in 1985 provided a forum for discussion of melaleuca as a regional problem (Langeland 1990), and the formation of The Melaleuca Task Force in 1990 provided a means to develop and implement a coordinated plan to control melaleuca (Bodle 1990). The long-term control strategy has included the use of biological control agents (Balciunas 1990). However, biologists realized that finding, evaluating, and establishing biocontrol agents would be a lengthy but necessary process. At last, the first biocontrol candidate for melaleuca, *Oxyops vitiosa*, has met the necessary criteria enabling it to be safely released in south Florida. Dr. Ted Center at USDA/ARS Aquatic Weed Research in Ft. Lauderdale will be leading a team of scientists who will evaluate the establishment, spread, and effectiveness of the weevil as a biocontrol agent. Studies conducted by J.K. Balciunas in Australia and by us in quarantine in Gainesville, Florida, provide a framework for what to expect from the weevil.

Melaleuca is in the family Myrtaceae. This includes 8 species native to Florida: 6 "stoppers" in the genera *Eugenia*, *Psidium*, and *Myrcianthes*, and two species of *Calyptranthes*. Many imported species are cultivated in Florida for their fruit (*Eugenia*, *Myrciaria*, *Psidium*, and *Syzygium*) and for landscaping (*Eucalyptus* and the bottlebrushes, *Callistemon*). Extensive field and laboratory studies of the weevil's host range were conducted by Dr. Balciunas and colleagues before any weevils were sent to quarantine in 1992 (Balciunas et al., 1994). No more than 7 individuals, including all stages, were found in the field on a non-host species (bottlebrush, eucalyptus, and other melaleucas) compared with more than 1000 on melaleuca. In laboratory tests, adults were produced only on melaleuca. Although his tests demonstrated the host specificity of *O. vitiosa* in Australia, no native Florida Myrtaceae nor many Myrtaceae cultivated in Florida were present in the field or available for testing by him. Thus, additional host range tests were required to demonstrate the safety for release in Florida.

Figure 2. A grayish-brown melaleuca weevil resting on a melaleuca stem. Note the short, blunt snout and four bumps on the wing covers (2 fore and 2 aft). When viewed from above, the bumps arise near the corners of a conspicuous dark rectangle on the weevil's back (photo by Rob Lowen).

Over 100 plant species were tested in quarantine for weevil feeding in initial adult screening tests. Thirty species, including all native Florida Myrtaceae, were tested with larvae and/or ovipositing females. These tests demonstrated that *O. vitiosa* will establish populations only on melaleuca. Wandering adults and larvae might

Figure 1. Colonel Terry Rice of the U.S. Army Corps of Engineers and others look on as Representative Clay Shaw (lower left) releases melaleuca weevils, April 26,1997 at Everglades Holiday Park, Broward County, Florida.

Figure 3. A yellow uncovered egg , two eggs covered with a brown to black secretion, and adult feeding damage (left of the eggs) on young melaleuca leaves.

occasionally feed on young leaves of the native wax myrtle, *Myrica cerifera*, and of some Myrtaceae (mostly imported bottlebrushes and eucalyptus), but feeding would be transitory. The proposal for release was approved by the federal interagency Technical Advisory Group for biological control of weeds and the Florida Arthropod Introduction Committee. The Florida Department of Agriculture and Consumer Services, Division of Plant Industry, and the USDA, Animal and Plant Health Inspection Services, issued the permit for release on March 24, 1997. A release ceremony was held in Broward County on April 26 (Figure 1).

Adult melaleuca weevils are small, 6-9 mm (<7/16 in) long, and brown (Figure 2). They will most likely be found inconspicuously on the leaves and stems of young seedlings, and the young growth of saplings and older trees. There they feed, mate, and lay eggs. Eggs usually will be layed singly or in small groups on the tips of young leaves (Figure 3). Sometimes eggs will be also found on the upper or lower surface of leaves, on leaf buds, and on tender stems. When layed, eggs are covered with a secretion that dries chocolate to black in color and gives them a teardrop shape. Without the secretion, eggs look like a yellow, 1 mm (<1/16) long, gelatin capsule. Rarely are eggs found uncovered. Scouting for adult feeding damage is probably the best way to locate eggs as oviposition is almost always associated with adult feeding (Figure 3).

Adults feed on young leaves, succulent stems, and on leaf and flower buds. Feeding damage on leaves frequently appears as holes, 1-2 mm (<1/8 in) diameter, to elongate holes, 2-3mm (<1/8 in) wide x 5-20 mm (13/16 in) long. Occasionally feeding is superficial on leaves, and trenches rather than holes are evident. On stems, feeding damage consists of trenches, short or long, and usually along one side. Sometimes when stem feeding occurs on very young growth, the stem is nearly excised causing the upper portion to fall over and hang down. Adults may feed superficially on buds leaving holes in the outer portion or feed deeply leaving pits behind. When eggs are present, they are likely to be near or next to the feeding damage.

The life cycle of *Oxyops* includes 4 larval instars. When eggs hatch, newly hatched larvae begin feeding just outside the eggs. As larvae grow, they disperse downward on plants, feeding as they go. Their feeding damage is different than

that of adults. Larvae do not chew holes in leaves, they eat through all layers of the leaf except the cuticle on the opposite side. Their feeding produces paper-thin trenches in the leaves, about the width of their bodies (Figure 4). Larvae range in size from less than 1 mm, newly emerged, to 14 mm (9/19 in), 4th or last instar. Development takes about 4 weeks. New 1st instar larvae are yellow; once feeding begins they appear brown to black. Larvae usually are covered with a sticky secretion or exudate, and a long thin coil of feces is prominent on older larvae (Figure 5). Older larvae consume 10x as much as adults (Balciunas 1994). As many as 200 larvae have been found on one melaleuca tree in Australia (Balciunas 1990), a good omen for Florida.

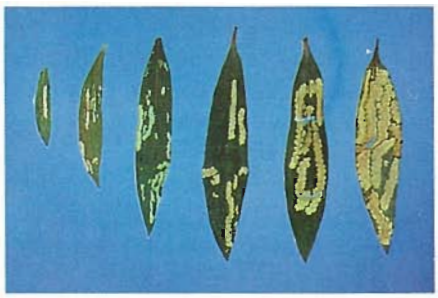

Figure 4. Young larval feeding damage (left) to older larval damage (right) on melaleuca leaves (photo by Jeff Lotz)

Figure 5. A large larva covered with a layer of sticky secretion on the body. Note the coil of dried feces at the posterior end, a characteristic often observed (photo by Rob Lowen).

The last stage of the life cycle or pupal stage is likely to go unnoticed by most people. When 4th instar larvae are finished feeding, they wander or drop to the ground where they locate a suitable site to go underground, form a pupal capsule from the surrounding soil, and pupate. Laboratory studies indicate they prefer drier areas with a high relative humidity. The time spent as a pupa can be as short as 11 days or as long as 6 weeks (Balciunas 1990), but was usually about 4 weeks at 25C (77F) in our studies.

Both adult and larval feeding interfere with normal plant processes. This will slow plant growth and make plants more susceptible to other control measures. Fewer seeds may be produced as well.

Acknowledgments

This article is a contribution of the USDA/ARS Aquatic Weed Research, Ft. Lauderdale, FL (Gainesville location), in cooperation with the University of Florida/IFAS/Department of Entomology and Nematology, Specific Cooperative Agreement 5866292006. It has been approved for publication by both agencies as Florida Agricultural Experiment Station Journal Series No. N-01408.

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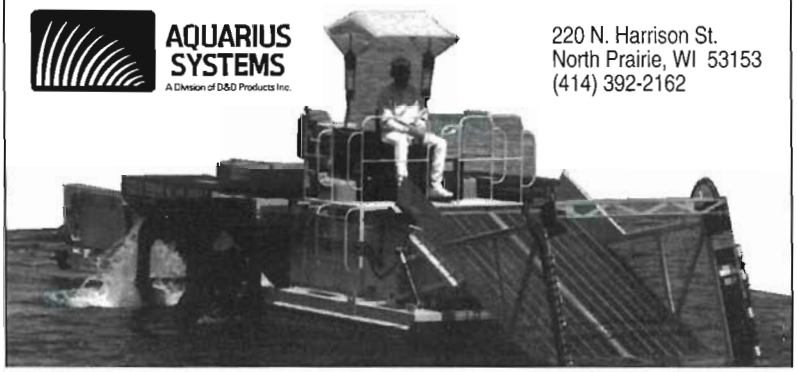

Germination of Lotus Seeds

by
David L. Sutton
Fort Lauderdale Research and Education Center
University of Florida - IFAS

Introduction

Prolonged dormancy of seeds is common for many aquatic plants. No where is this more evident than for seeds of *Nelumbo lutea* (Willd) Pers., commonly known as American lotus, and for Asian lotus (*Nelumbo nucifera* Gaertn.). In fact, lotus seeds are thought to be the longest-lived of all flowering plants. Dr. Jane Shen-Miller, a plant physiologist at the University of California at Los Angeles, obtained seven lotus seeds from the Beijing Institute of Botany (Allen 1995). The seeds were collected originally from a dry lake bed in China that had once been the site of lotus plants cultivated by Buddhists for use in religious ceremonies. Dr. Shen-Miller sprouted four of the seeds, and then determined their age by radiocarbon dating. The oldest seed was estimated to be 1,288 years old, the second at 755 years, the third at 684 years, but the fourth one could not be dated. These seeds may be the oldest seeds ever germinated. The three other seeds that did not germinate were estimated to be 416, 332, and 95 year's old.

Besides the thick, hard coat that helps prevent drying of the embryo, lotus seeds contain an enzyme, L-isoaspartyl methyltransferase. This enzyme is a protein-repair enzyme that delays aging, but to what extent this enzyme delays germination of lotus seeds is unknown.

Importance of Lotuses

Lotus plants have been cultured for thousands of years for their ornamental, food, and religious value (Sculthorpe 1967). They have been introduced into many countries. For example, Asian lotuses, a native of southern Asia, were introduced into Egypt about 2,500 years ago but they are no longer found there.

Lotuses are one of the most popular aquatic ornamental plants. Several hybrids have been produced, and are available through aquatic nurseries. Seed pods are used in dried flower arrangements. In Asia, lotuses are cultivated primarily for human consumption of seeds, stems, and rhizomes.

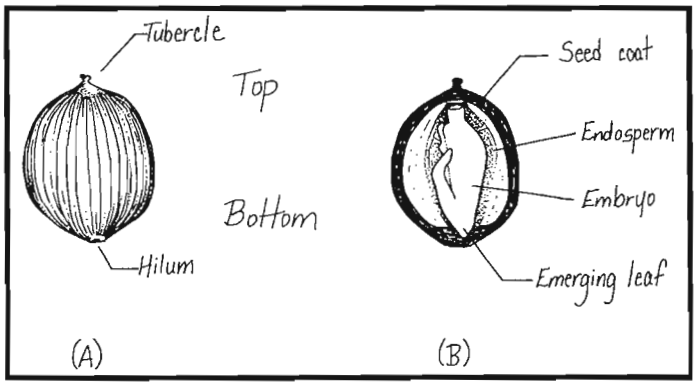

Figure 1. Schematic of a lotus seed showing (A) hilum, designated as the bottom of the seed, and tubercle, top, and (B) location of the embryo in the seed. Drawn by Ms. Ann Murray.

Lotuses are also an important component of many aquatic ecosystems. They provide food, shelter, and nesting sites for a myriad of aquatic organisms. Although lotuses grow primarily in protected areas, they help reduce erosion caused by wind and wave action. Since lotuses are large plants that grow in monospecific stands, when they are planted for restoration of aquatic habitats, sufficient space needs to be allowed to prevent them from crowding out other native aquatic plants.

Seed Anatomy

Lotus seeds are large compared with many other aquatic plants. They are enclosed by a large, fleshy, obconical, flat topped receptacle (Godfrey and Wooten 1981). The receptacle as it matures becomes hard with circular openings that form on its surface. A single seed is contained within each of these openings. The seeds are retained within the receptacle or they may eventually fall from it. The receptacle detaches from the peduncle and floats upside down on the surface, pushed by wind and wave action, which helps distribute the seeds.

Lotuses are dicotyledonous plants. As is characteristic of all dicotyledonous plants, each lotus seed contains two large, thick, fleshy cotyledons. Enclosed within the cotyledons is a plumule of one or two well-formed, green leaves (Fernald 1991). During sprouting, the leaves emerge through the hilum. The hilum is the bottom portion of the seed that was originally attached to the receptacle (Figure 1). Located on top of the seed is a tubercle, the function of which is unknown.

Germination of Lotus Seeds

It is well known that lotus seeds will not germinate unless the seed coat is scarified. One way to scarify the seed is to use any mechanical device such as a metal file to cut through the tough seed coat. This cut, or nick as it is commonly known, allows water to enter through the seed coat. The embryo then imbibes water to initiate germination. Seeds may be also scarified by soaking them in a strong acid. Proper safety precautions need

to be used when using a strong acid for scarification of seeds. Little information is available on germination rates and time required for sprouting of lotus seeds to occur after mechanical or acid scarification.

The processes involved in the natural scarification of lotus seeds is unknown. However, bacteria and fungi would provide natural processes to break down the seed coat over a long period of time. Information is lacking on natural scarification of lotus seeds.

In a study to evaluate whether freeze-thaw conditions provided a natural mechanical scarification of the seed coat, DeGroft and Francko (1996) subjected lotus seeds for 7 days to temperatures of 4° C and -20° C. These temperatures however did not scarify the lotus seeds.

A study was conducted with seeds collected from populations of lotuses growing on Lake Okeechobee, Florida to provide information on germination rates and time required for sprouting to occur after mechanically scarification. Seeds weighing 1.0 to 1.2 g were selected for use because seeds less than 1.0 g in weight have a high percentage of aborted or no embryos.

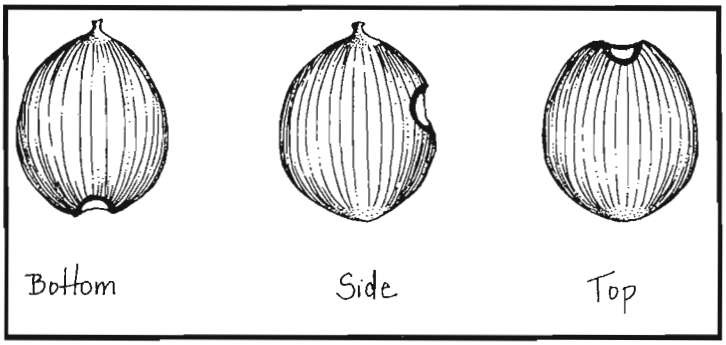

Figure 2. Schematic showing locations of nicks in the seed coat for mechanical scarification of lotus seeds. Drawn by Ms. Ann Murray.

The selected lotus seeds were used in two experiments. The first experiment consisted of two groups of lotus seeds, 150 in the first group and 180 in the second. The second experiment was conducted with 56 lotus seeds.

Experiment 1. Lotus seeds were scarified by making a small nick through the seed coat with an electrical grinder. Nicks were made on the top, middle, and bottom of the seed coat (Figure 2) to one-third of each of the total number of seeds in each group. The seeds were then placed in tap water and allowed to germinate at room temperature for 2 weeks. The seeds were rinsed and the tap water exchanged every couple days to prevent build up of fungus. A lotus seed was counted as sprouted once a green stem had emerged through the seed coat.

Experiment 2. Seeds were scarified by making a small nick in the seed coat using a band saw. These nicks were not made at any specific location on the seed. The seeds were placed in tap water and measurements for weights and diameters

around the middle of the seed were made on a daily basis for 2 weeks. Weights were determined after the seeds were blotted with paper towels to remove excess surface water, and diameters measured with a caliper. The seeds were allowed to germinate at room temperature and the water exchanged daily.

Discussion of Results

The green leaves of an unsprouted lotus seed embryo are clearly shown in an opened cotyledon in Figure 3 along with sprouted seeds nicked at three different locations on the seed coat. The base of the leaves of an unsprouted embryo is pointed toward the top of the seed. The leaves are folded with their tips, which eventually become the flat, circular portion of the leaf blade, pointed toward the top of the seed. As the stem portion, or petiole, of the leaf emerges through the hilum, the flat blade of the leaf remains folded back but then it eventually turns to an upright position as the petiole continues to develop and elongate.

Lotus seeds nicked in the middle of the seed coat appear to have a slightly lower percentage of germination, 87%, than for those nicked at the top or bottom of the seed coat, 92 to 96% (Figure 4). No other apparent differences were observed for the two different groups of seeds.

In the second experiment, sprouting began 5 days after the lotus seeds were placed in tap water

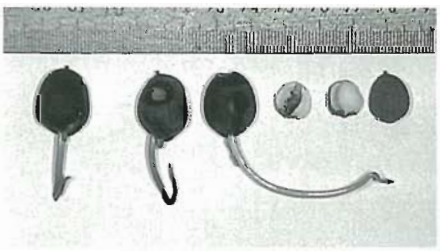

Figure 3. Close-ups of lotus seeds oriented with their tops down showing various stages of germination. The photograph shows, beginning at the left, an ungerminated seed, cotyledons split in half showing the location of a green, unsprouted embryo, and sprouted seeds nicked on the top, side and bottom. The scale at the bottom is in mm.

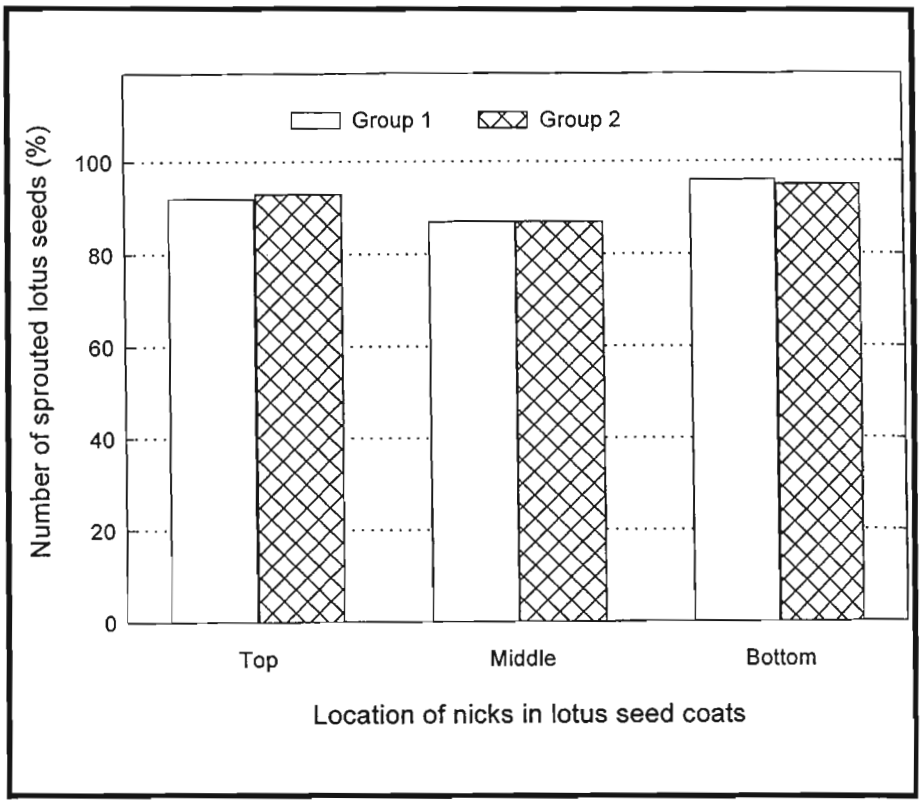

Figure 4. Percentage of sprouted lotus seeds after nicks were made in the top, middle, and bottom of the seed coat.

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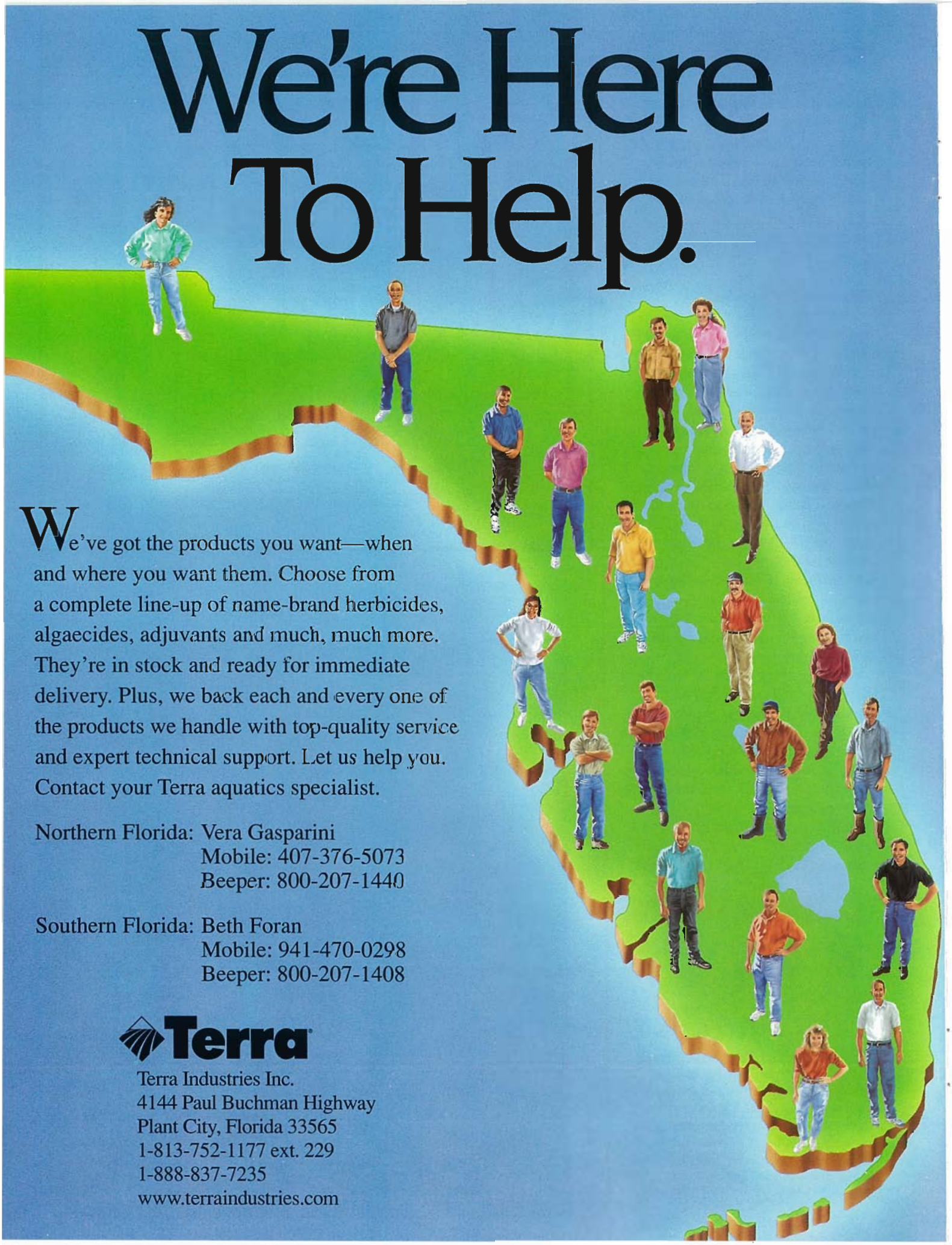

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(Figure 5). More than a third of the seeds sprouted after 6 days followed by a reduction in the number sprouted. No lotus seeds sprouted after 12 days. Of the 56 seeds used in this experiment, 45 sprouted resulting in a germination rate of 80%.

Average weights of the lotus seeds increased 74% within 24 hours after they were placed in water (Figure 6). The weight continued to increase until the 7th day after which it remained constant. The seeds after 7 days weighed more than two times their initial weights.

Measurements for circumferences of unsprouted lotus seeds showed an average minimum diameter of 10.6 mm and a maximum of 11.1 mm which indicates that they are oval (Figure 7). Diameters increased to a minimum of 14.5 mm and a maximum of 15.2 mm after 3 days in the water. After 3 days, diameters of the lotus seeds remained the same for the remainder of the time they were in the water.

This study shows the ease with which lotus seeds can be germinated using simple mechanical scarification techniques of nicking the seed coat. Germination rates of 80% or greater may be achieved in tap water held at room temperature within 2 weeks after scarifying seeds in this manner. Making nicks at the top or bottom of the seed may provide for a higher percentage of germination than nicking on the seed's side. The sprouted seeds can then be planted for use as ornamentals or to enhance aquatic habitats.

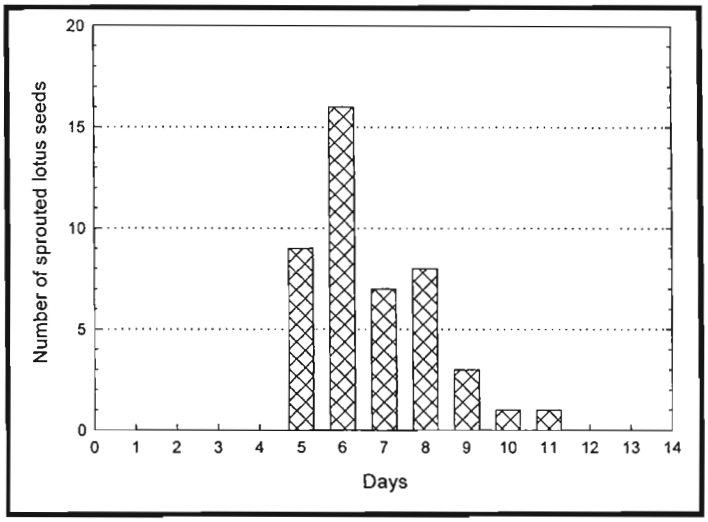

Figure 5. Number of germinated lotus seeds per day after they were nicked and placed in water. Fifty-six seeds were initially placed in the water.

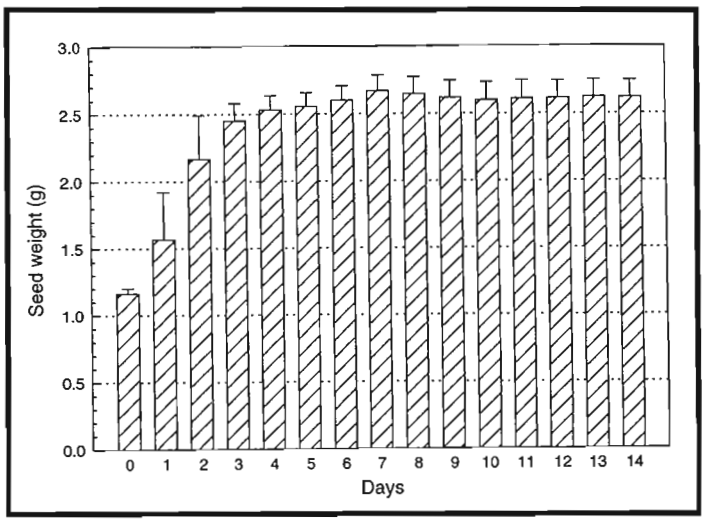

Figure 6. Weights of lotus seeds after they were nicked and placed in water. Error bars are 1 standard deviation of the mean. Fifty-six seeds were initially placed in the water.

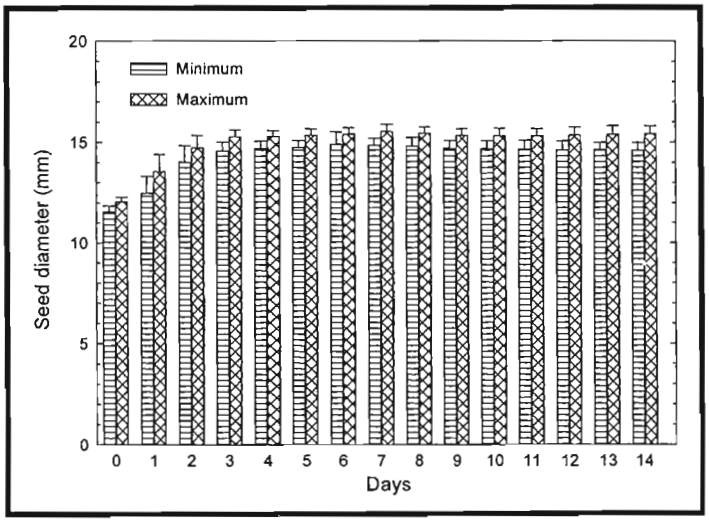

Figure 7. Measurements for diameters of lotus seeds after they were nicked and placed in water. Error bars are 1 standard deviation of the mean. Fifty-six seeds were initially placed in the water.

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MSAPMS 16th Annual Meeting

The Mid South Aquatic Plant Management Society will hold their 16th Annual Meeting October 22-24 at the Holiday Inn in Vicksburg. The meeting will start at 1:00pm on Wednesday and adjourn at 11:00 - 11:30am Friday. Thursday afternoon plans are for a Scholarship Golf Tournament at the Vicksburg Country Club, a tour of some of the high-tech facilities at the Waterways Experiment Station, a luncheon and tour of an antebellum home, and for those that don't golf or "tour" — you will have plenty of time to make your fortune at any on of the four riverboat gambling casinos in Vicksburg!

Make your plans to attend and mark you calendars! It should be a memorable time. Look for the final details in the September newsletter. If you have any questions, call Lewis Decell at 601-638-7150.

AQUAVINE

MEETINGS

Aquatic Plant Management Society 37th Annual Meeting, Sanibel Harbor Resort and Spa, Fort Myers, FL July 13-16, 1997.

South Carolina Aquatic Plant Management Society Annual Meeting, Duke Power World of Energy, Seneca, SC, August 13-15, 1997.

Florida Aquatic Plant Management Society 1997 Annual Meeting, Sheriton West Palm Beach, October 7-9, 1997.

Mid South Aquatic Plant Management Society 16th Annual Meeting, Holiday Inn, Vicksburg, Mississippi, October 22-24, 1997.

10th International Symposium on Aquatic Weeds, "towards an integrated aquatic plant management", Lisben, Portugal, September 22-25, 1998.

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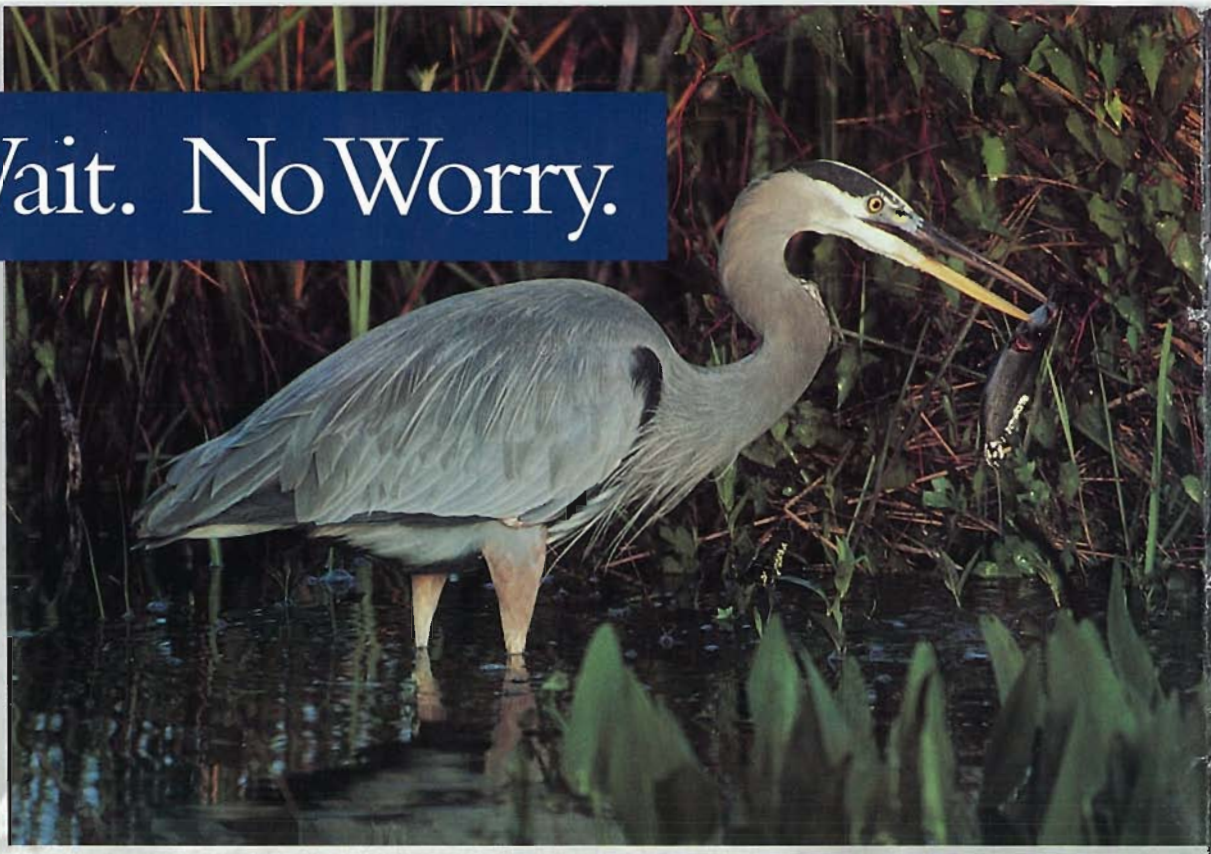

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