NUISANCE AQUATIC VEGETATION CONTROL IN 2005

by

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All personnel involved in aquatic vegetation control are to be commended for their efforts in what may be the most demanding yet least acknowledged aspect of fisheries management. Vegetation control efforts by District 3E in Bryan and District 1E in Mathis contribute significantly to the overall statewide program. We appreciate the efforts of all Inland Fisheries districts in their attention to annual vegetation surveys. Annual reports would not be possible without critical review by Inland Fisheries Region 3 personnel, technical contributions by Fred Janssen, and comments and suggestions by Bob Betsill. We remain in debt to our support staff in Region 3 and Austin headquarters.

ABSTRACT

Nuisance aquatic plant species can negatively affect resource use by restricting access, displacing native vegetation, and degrading water quality. Control efforts in 2005 utilized integrated pest management principles focusing on giant salvinia, (*Salvinia molesta* D.S. Mitchell), waterhyacinth, [*Eichhornia crassipes* (Mart) Solms], and hydrilla [*Hydrilla verticillata* (L.F.) Royle]. Control strategies included: direct efforts to increase public awareness, the application of approved aquatic herbicides, and the introduction of biological control agents. Containment of giant salvinia infestations and immediate action to control or eliminate new infestations of invasive aquatic vegetation species in public waters remains the first priority for 2006. Efforts to manage or control established problematic nuisance species continue.

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INTRODUCTION

The nutrient-rich inland waters of Texas possess diverse native aquatic plant communities essential to healthy aquatic ecosystems. Many public waters promote excessive growth of native plants as well as introduced exotic plant species. Many native and exotic aquatic plant species can become invasive, negatively affecting aquatic systems by restricting access to the resource, displacing beneficial native plants, and degrading aquatic habitat.

Nuisance aquatic vegetation species in the public waters of Texas continue to increase every year. The lack of severe winters and accompanying freezing temperatures encourage the expansion of tropical invasive species like waterhyacinth, giant salvinia, and common salvinia to the detriment of their adopted ecosystems. The primary directive of the TPWD aquatic vegetation control effort continues to emphasize the eradication, when possible, of new infestations of problematic non-native aquatic plant species as they are identified.

A list of "harmful or potentially harmful exotic plants" (Table 1) is maintained by the Texas Parks and Wildlife Department (TPWD). Species listed are considered the most likely to negatively affect the freshwater aquatic resources of Texas. Control of nuisance aquatic plant species is the responsibility of Inland Fisheries District 3F, Aquatic Habitat Enhancement (AHE), headquartered in Jasper, Texas. Control efforts are supplemented by District 3E in Bryan and District 1E in Mathis. Control strategies are guided by the philosophy of Integrated Pest Management (IPM). IPM is defined as the coordinated use of pest and environmental information and pest control methods to prevent unacceptable levels of pest damage using the most economical means and in a manner that will cause the least potential hazard to persons, property, and the environment (Chilton et al 2005). IPM methods may employ environmental manipulation, ecological intervention, mechanical or physical removal, introduction of biological control agents, and the application of herbicides to control, manage, or eradicate problem species. All herbicides and adjuvants used are approved for aquatic use by the U. S. Environmental Protection Agency. The sale and application of herbicides in Texas is regulated by the Texas Department of Agriculture. Herbicides are normally purchased by controlling authorities and applied by AHE or by private contractor.

This report presents control methods and strategies used to manage nuisance aquatic vegetation on public waters within Texas in 2005. Although the primary focus of control efforts are to manage exotic species such as waterhyacinth, [*Eichhornia crassipes* (Mart) Solms], hydrilla [*Hydrilla verticillata* (L.F.) Royle], and giant salvinia (*Salvinia molesta* D.S. Mitchell), efforts to manage problematic native species are included for documentation and reference. Historical occurrence of invasive aquatic species in Texas waters is detailed in Helton et al. (2004).

Reported distributions of waterhyacinth, hydrilla and giant salvinia within Texas are shown in Figures 1-3, respectively. Appendix I lists the known occurrence during 2005, within Texas, of those species listed in Table 1. A list of the aquatic herbicides and surfactants in use by TPWD, application rates, and target plants, is found in Table 2. A

summary of total acres treated by TPWD on public waters in 2005 is in Table 3. Locations of giant salvinia weevils (*Cyrtobagous salviniae* Calder and Sands) released since October 2001 are summarized in Figure 4. An example of the Daily Log of Herbicide Operations card, on which herbicide application operations are recorded, is in Appendix II.

Waterhyacinth

Anecdotal information suggests waterhyacinth, native to Brazil, was probably first introduced to the United States at the 1884 Cotton States Exposition in New Orleans, Louisiana (Sculthorpe 1967). This helps explain the presence of problematic infestations since the early 1900s (Wunderlich 1962; Zeiger 1962). While it is unknown when waterhyacinth was discovered in Texas, use of herbicides to control its spread began in the 1950s.

A Statewide Noxious Vegetation Control Program was formed within TPWD. Initially administered through Dingell-Johnson funds and supported by a 70% cost-share funding from the Aquatic Plant Control Program of the U.S. Army Corps of Engineers (USACE), the program continued until the early 1990s when it was discontinued due to lack of funding. A limited number of states, including Texas, are now part of an Aquatic Plant Control Program that receives 50% cost-share funding from USACE funds.

Waterhyacinth is now considered common in coastal Texas from the Louisiana border to Brownsville, as well as in many reservoirs up to 250 miles inland. Detriments of waterhyacinth infestations are detailed by Hitchcock et al. (1949) and Langeland (1987). Although the primary threat of waterhyacinth is to navigation, large thick mats eventually cause severe ecological stress within affected aquatic systems. Waterhyacinth infestations block sunlight and prevent oxygen exchange in surface waters. As populations senesce, decaying plant matter increases biological oxygen demand, reducing dissolved oxygen levels. Consequently, biological diversity declines and fisheries are negatively affected.

Although recent experimentation in control methods included reservoir drawdowns, mechanical and biological options have also been used (Helton and Hartmann 1995; Cofrancesco 1998). Foliar applications of approved aquatic herbicides have proven the quickest, most cost-effective method for controlling waterhyacinth infestations. Estimated costs of chemical treatments to control waterhyacinth in 2005 ranged from $48.00 to $62.00 per acre.

Waterhyacinth has now been confirmed on 36 public waters within the state (Fig. 1). The only new infestations of waterhyacinth reported in 2005 were on Cedar Creek Lake, Lake Tawakoni, and Lake Athens. Established infestations in Lake B.A. Steinhagen, Caddo Lake, Lake Fork, Lake Quitman, Sam Rayburn Reservoir, Toledo Bend Reservoir, and Armand Bayou continue to require annual herbicide treatments. The most severe waterhyacinth infestation requiring treatment in 2005 was on Caddo Lake. The lack of freezing temperatures during recent mild winters has resulted in increased survival of waterhyacinth.

Hydrilla

Hydrilla is believed to have been imported from the old world (Godfrey and Wooten 1979), probably for use as an ornamental aquarium plant (Langeland 1996). Subsequently, hydrilla is thought to have been introduced into Texas waters by aquarium hobbyists. Despite extensive control and management efforts during the past 29 years, hydrilla remains the dominant submersed weed problem in Texas. Although identified in the United States as early as 1960, hydrilla was first verified in Texas in 1969 near Houston (Klussman et al. 1988). By 1975, infestations were confirmed in Toledo Bend Reservoir, Sam Rayburn Reservoir, Lake Conroe, and Lake Livingston. Soon after, smaller power-plant reservoirs in the eastern portion of the state were plagued by serious problems related to hydrilla infestations. Hydrilla has been described as the "perfect aquatic weed" because of its highly specialized growth habit, physiological characteristics, and multiple modes of reproduction (Langeland 1996). Hydrilla reproduces through turions (compact dormant buds) and tubers. Tubers can remain quiescent in undisturbed sediments for years, their function very similar to a seed bank. For this reason, hydrilla often re-establishes several years after control techniques have been successful (Netherland 1997).

Hydrilla has become common in many Texas reservoirs and, as a result, native plant diversity and coverage has declined (TPWD, unpublished data). Currently, 92 public waters within Texas have hydrilla populations (Fig. 2). TPWD surveys estimate that when most reservoirs are at capacity, there may be as many as 100,000 acres of hydrilla statewide (TPWD, unpublished data). Historical control methods for hydrilla have included planned drawdowns, mechanical removal, biological control agents, and approved aquatic herbicides. The most severe hydrilla infestation treated in 2005 was on Lake Sheldon. Estimated costs of herbicide to control hydrilla in 2005 ranged from $137.00 to $926.00 per acre.

Giant Salvinia

Giant salvinia is a highly invasive floating fern native to Brazil. Consequences of its establishment are well documented in several countries. Oliver (1993) believed introductions of this species, wherever they have occurred, have resulted in severe negative impacts on human populations. Giant salvinia was first identified growing wild in the United States (South Carolina) in 1995. The second confirmed sighting of giant salvinia occurred during spring of 1998 in Houston, Texas (Helton and Chilton 2001). Giant salvinia forms dense, thick, floating mats of vegetation which invariably conflict with all uses of an aquatic resource. Gradually, alteration in the natural nutrient dynamic flow results in total degradation of the ecosystem (Oliver 1993). Studies on growth of giant salvinia have found a leaf doubling time of 8.1 days under natural conditions (Mitchell and Tur 1975). In Texas, those rates may be reduced to 5-7 days due to climate and abundant nutrients (D.S. Mitchell, pers. comm. 1999). Public education efforts continue to inform Texas citizens about the threat giant salvinia poses to aquatic resources. Early detection of this plant species has proven instrumental in its control. This factor alone will be critical if eradication is ever possible (Allen 2000).

In 1998, giant salvinia was confirmed on Toledo Bend Reservoir on the Texas-Louisiana border. In 1999, TPWD personnel confirmed the presence of giant salvinia on Lake Texana in south-central Texas. New infestations were documented at Lake Conroe and Lake Sheldon in 2000. Although no new infestations of giant salvinia have been documented on public waters since 2000, the ability of the plant to escape detection until it reaches significant proportions is very common. One new infestation of a private pond in Montgomery County was estimated to have been in place a minimum of two years before being reported. It is likely many infestations are never reported. Every effort is being made to eradicate giant salvinia populations in private waters and commercial nurseries when reported. A total of 37.2 acres of giant salvinia in privately owned ponds were treated in 2005. Giant salvinia continues to persist in 10 public waters and has been reported in 50 private water bodies (Fig. 3).

Aerial surveys in spring 2005 estimated over 5,000 acres of giant salvinia on Toledo Bend Reservoir. In an effort to contain the infestation on Toledo Bend Reservoir and prevent transport to other water bodies, chemical treatment of boat ramps was a priority in 2005. Estimated costs of TPWD herbicide applications to treat giant salvinia in 2005 ranged from $100.00 to $112.00 per acre.

Efforts to establish the giant salvinia weevil (*Cyrtobagous salviniae*) as a bio-control for giant salvinia continued in 2005. Success of this insect on infestations in other parts of the world has been thoroughly demonstrated (Room et al. 1981). Supplemental releases of weevils were conducted on four reservoirs containing giant salvinia (Toledo Bend, Conroe, Sheldon, and Texana). Insects were provided by the Lewisville Aquatic Ecology Research Facility (LAERF). Costs of weevil releases remain minimal; expenses are limited to manpower, fuel, and related per diem. Estimated cost for 2005 weevil introductions was $400.00.

AQUATIC PLANT MANAGEMENT BY WATER BODY IN 2005

Armand Bayou Coastal Preserve

Controlling Authority: TPWD (Coastal Preserves). Contact: Mark Kramer, phone 281-474-2551, e-mail *mkramer@eu1.net*. Prohibited plant: waterhyacinth.

Status: Armand Bayou Coastal Preserve is one of four coastal preserves leased from the General Land Office by TPWD. The preserve is complemented by the Armand Bayou Nature Center, a non-profit environmental education facility. The 2,800-acre preserve is on the northwest shore of Clear Lake estuary in Harris County, Texas, southeast of Houston.

Waterhyacinth is a persistent problem within the preserve due to the presence of a large seed bank deposited over many years. No significant expansion of waterhyacinth over that of previous years was noted in 2005. The majority of the waterhyacinth population in Armand Bayou was killed by salt water intrusion during hurricane Rita in

September 2005. Prior to the hurricane, AHE personnel treated a total of 5 acres of waterhyacinth in 2005, compared to 114 acres in 2004, and 38 acres in 2003. Treatments were conducted using Weedar 64® (2, 4-D Amine) at 1.0% v/v and Aqua-King Plus® (surfactant) at 0.0625% v/v (Table 2). Post-treatment surveys of Armand Bayou were not possible due to hurricane Rita. The germination of seed will require periodic surveys and repeated herbicide treatments to keep waterhyacinth populations at a manageable level within the preserve.

Lake Athens

Controlling Authority: TPWD. Contact: Richard Ott, TPWD, phone 903-566-2161, e-mail *richard.ott@tpwd.state.tx.us*. Prohibited plants: hydrilla, waterhyacinth.

Status: Lake Athens is a small, 1,799-acre, oligotrophic reservoir located in Henderson County. One acre of hydrilla, found near the Lake Athens Boat Ramp and FM2495 road bridge in 2004, prompted a Tier I response using aquatic herbicide to prevent expansion of the invasive exotic. Surveys in 2005 indicated hydrilla had been reduced to 0.5 acres. The remaining hydrilla was treated by TPWD personnel in 2005 using Aquathol K® (endothall) at 4 ppm (Table 2). Chemical was supplied by the City of Athens. Although post-treatment surveys indicated high effectiveness, hydrilla often returns following endothall treatments.

A small population of waterhyacinth was discovered on Lake Athens in 2005 by District 3C personnel during routine habitat surveys. The plants presumably had germinated from seeds deposited by a dragline previously used to remove waterhyacinth from another lake. Physical removal of plants prevented any further expansion and the homeowner responsible was advised of the plant's prohibited status. Routine surveys and prompt removal of invasive species may help prevent other exotic species from becoming established in Lake Athens.

Lake B.A. Steinhagen

Controlling Authority: USACE. Contact: Ed Murtishaw, Project Manager, phone 409-429-3491, e-mail *ed.murtishaw@swfo2.usace.army.mil*. Prohibited plants: waterhyacinth, hydrilla, common salvinia (*S. minima*) and alligatorweed (*Alternanthera philoxeroides*).

Status: Lake B.A. Steinhagen is a 16,830-acre, eutrophic reservoir located in Jasper and Tyler Counties. The most problematic vegetation species on B.A. Steinhagen are waterhyacinth and common salvinia. TPWD surveys on B.A. Steinhagen in 2005 estimated the waterhyacinth coverage at 1,695 acres compared to 1,535 acres in 2004. Accurate estimates of common salvinia are complicated by its close association with waterhyacinth.

The relationship of common salvinia to waterhyacinth appears to be a commensal association, common salvinia benefiting from the shade and cover provided by waterhyacinth. This relationship has rendered treatment with herbicides of either species problematic. Herbicide treatments using 2, 4-D, effective on waterhyacinth, have little or no effect on common salvinia. Consequently, when both plants are in close proximity, removal of waterhyacinth results in the expansion of common salvinia. A combination of glyphosate and diquat-based herbicides has proven effective on both waterhyacinth and common salvinia and is now being used when both species occur in the same area. A second treatment is necessary since common salvinia is often protected from direct contact with herbicides by waterhyacinth leaves. Post-treatment surveys indicate excellent control of both species using this strategy.

TPWD personnel treated a total of 54 acres of waterhyacinth and common salvinia on B. A. Steinhagen in 2005. Boat ramps on USACE and Martin Dies State Park property accounted for 20 acres and were treated using the herbicide Aquamaster® (glyphosate) at 0.75% v/v in combination with Reward® at 0.25% v/v and surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2). An additional 16.25 acres were treated on Martin Dies State Park using Aquamaster® (glyphosate) at 0.75% v/v with surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2). Separate waterhyacinth treatments of 17.5 acres were conducted using Tenkoz® (2,4-D Amine at 1.0% v/v) with Aqua-King Plus® surfactant (0.0625% v/v) (Table 2).

Common salvinia weevils, released in small numbers as bio-control agents in 2004, apparently failed to establish a reproducing population on B.A. Steinhagen. No evidence of their presence has been documented since the initial release.

Hydrilla declined on B.A. Steinhagen in 2005 compared to that in 2004 (655 acres and 890 acres, respectively). Competition for space and high turbidity severely limits expansion of hydrilla on B.A. Steinhagen. Existing populations remain isolated and have not warranted extensive control efforts.

Alligatorweed continued to expand on B.A. Steinhagen, reaching 496 acres in 2005 compared to 463 acres in 2004. Although effective herbicides are available, significant reduction of alligatorweed using herbicides would require substantial funding to support focused aerial applications. Supplemental introductions of the alligatorweed flea beetle (*Agasicles hygrophila*) as part of an integrated approach may prove necessary in the future to provide at least some measure of control.

Periodic reservoir drawdowns during winter months have been used on Lake B.A. Steinhagen to control aquatic vegetation. The effectiveness of these drawdowns in vegetation management is directly related to the severity of winter, in some years resulting in plant mortality of 95% (Helton and Hartmann 1995). Prior to the construction of the power generation station on B.A. Steinhagen, summer drawdowns occurred on a regular basis. These periodic fluctuations helped maintain aquatic vegetation species at manageable levels. The USACE has planned an extended summer drawdown in summer, 2006 in an effort to reduce excessive aquatic vegetation.

Caddo Lake

Controlling Authority: Cypress Valley Navigation District. Contacts: Ken Shaw, President, phone 903-679-4657, e-mail *kens@shreve.net* and Tim Bister, TPWD, phone 903-938-1007, e-mail *Timothy.Bister@tpwd.state.tx.us.* Prohibited plants: waterhyacinth, hydrilla, alligatorweed, East Indian hygrophila.

Status: Caddo Lake is located in Harrison and Marion Counties and encompasses 26,800 acres. It is considered the only natural lake in Texas. Caddo Lake contains several non-native aquatic vegetation species that could potentially block access to the resource. Problematic invasive exotic species present on Caddo include waterhyacinth and hydrilla. Alligatorweed and East Indian hygrophila (*Hygrophila polysperma*), although present, have yet to cause any serious problems. In addition to the exotic species, a native species, American lotus, has reached problematic proportions in many areas.

Waterhyacinth continues to persist and expand on Caddo Lake. Fall surveys in 2005 estimated 1,700 acres of waterhyacinth on the Texas portion of the lake compared to 1,000 estimated acres in 2004. The complex nature of the area makes accurate estimates of waterhyacinth density difficult. The highest densities of waterhyacinth are in the Caddo Lake Wildlife Management Area (CLWMA). Due to an extensive seed bank, waterhyacinth can be expected to be problematic on Caddo Lake for many years.

Estimated cost of foliar applications to control waterhyacinth on Caddo Lake ranged from $48.00 to $62.00 per acre in 2005. A total of 308 acres of waterhyacinth were treated with herbicides on Caddo Lake in 2005 compared to 321 acres in 2004. Treatments using Weedar 64® (2, 4-D Amine) at 1.0% v/v and Aqua-King Plus® (surfactant) at 0.0625% v/v (Table 2) focused on the CLWMA, public access locations, residential frontage, and boat lanes to popular angling and hunting areas. All herbicide and surfactant was provided by TPWD Wildlife Division. An additional 30 acres of waterhyacinth was treated by private contractor in 2005 using herbicide supplied by the City of Uncertain.

Surveys in September 2005 estimated hydrilla had expanded to 2,500 acres on Caddo Lake. This is a dramatic increase from previous surveys, though previous surveys may have underestimated hydrilla. Hydrilla was closely associated with American lotus in most areas. An estimated 760,650 hydrilla flies (*Hydrellia pakistanae*) were released on Caddo Lake in 2005 by District 3A personnel in an effort to establish a viable bio-control for hydrilla.

Although widespread, the extent of alligatorweed on Caddo Lake has not been quantified. In an effort to initiate some control, a total of 3,000 alligatorweed flea beetles (*Agasicles hygrophila*) were released on Caddo Lake in 2005.

Lake Conroe

Controlling Authority: San Jacinto River Authority (SJRA). Contacts: Blake Kellum, phone 936-588-7102, e-mail *bkellum@sjra.net* and Mark Webb, TPWD, phone 979-822-5067, e-mail *mark.webb@tpwd.state.tx.us*. Prohibited plants: hydrilla, waterhyacinth, giant salvinia, Alligatorweed, torpedograss.

Status: Lake Conroe is a 21,000-acre impoundment in Walker and Montgomery counties. The most problematic aquatic vegetation species present on Lake Conroe are hydrilla and giant salvinia. In 2005, surveys showed 868 acres of hydrilla on Lake Conroe, prompting chemical treatments in the densely affected areas. District 3E personnel assisted the San Jacinto River Authority (SJRA) in conducting chemical treatments targeting hydrilla on Lake Conroe in 2005. Public meetings, scheduled for spring, 2006, will discuss the possible stocking of triploid grass carp as a bio-control for hydrilla.

Since the discovery of giant salvinia on Lake Conroe in spring of 2000, aggressive chemical applications and introduction of bio-control agents by SJRA have held the population in check. Only 1.4 acres of giant salvinia were reported in fall, 2005 compared to 25 acres in 2004. It is likely these surveys under-estimate total acres of giant salvinia due to low water levels and limited access to shallow backwater areas. Supplemental releases of giant salvinia weevils were conducted in 2005 by SJRA. Adult weevils released since 2004 on Lake Conroe number 750,000.

Lake Fairfield

Controlling Authority: TXU Corporation. Contact: Richard Ott, TPWD, phone 903-566-2161, e-mail *richard.ott@tpwd.state.tx.us*. Prohibited plant: hydrilla. Nuisance plant: American lotus.

Status: Lake Fairfield is a 2,034-acre impoundment in Freestone County, Texas. American lotus is abundant on Lake Fairfield and, in recent years, has established dense stands in the Fairfield State Park swimming area and boat ramp. American lotus grows from a persistent rhizome buried in the substrate, requiring repeated applications of herbicide to achieve acceptable control. At the request of Lake Fairfield State Park, a total of 6 acres of American lotus was treated in 2005 by AHE personnel. Plants within the State Park swimming area were treated with Aquamaster® (glyphosate) at 0.75% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v by TPWD personnel (Table 2). The State Park manager, reported treatments were 90-100% effective. Herbicide was provided by Lake Fairfield State Park and surfactant was provided by AHE. Estimated cost to treat American Lotus on Lake Fairfield in 2005 was $33.48 per acre.

Lake Fork

Controlling Authority: Sabine River Authority (SRA). Contacts: Bill Kirby, phone 903-878-2420, e-mail *bkirby@sra.dst.tx.us* and Kevin Storey, TPWD, phone 903-593-5077, e-mail *kevin.storey@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, hydrilla, alligatorweed.

Status: Lake Fork is a 27,690-acre reservoir in Hopkins, Rains and Wood Counties, Texas. Waterhyacinth populations persist on Lake Fork. Fall surveys in 2005 indicated 73 acres of waterhyacinth. A total of 54 acres of waterhyacinth were treated on Lake Fork in 2005, compared to 74 acres in 2004. Treatment of historical nursery areas was not possible in 2005 due to abnormally low water levels. Infestations were treated by AHE personnel using both Aquamaster® (glyphosate) and Aquastar® (glyphosate) at 0.75% v/v and Red River 90® (surfactant) at 0.25% v/v (Table 2). All herbicide and surfactant was supplied by SRA. Treatments were confined to Glade Creek and an area adjacent to the State Highway 515 Bridge. Estimated cost of treatment on Lake Fork in 2005 was $32.04 per acre. Although treatments were effective on areas treated, repopulation is almost certain due to the presence of substantial seed banks. Annual maintenance of the waterhyacinth population on Lake Fork will be required if acceptable control is to be maintained.

September 2005 surveys estimated 1,200 acres of hydrilla on Lake Fork in comparison to 3,701 acres in 2004.

An accurate estimate of alligatorweed on Lake Fork was not available. In an effort to initiate some level of control, 3,000 alligatorweed flea beetles (*Agasicles hygrophila*) were introduced to infestations located in Birch Creek in 2005.

Lake Joe Pool

Controlling Authority: USACE. Contacts: Bobby D. Faucett, Project Manager, phone 214-207-4412, e-mail *Bobby.D.Faucett@swfo2.usace.army.mil* and Raphael Brock, TPWD, phone 817-732-0761, e-mail *Raphael.Brock@tpwd.state.tx.us*. Prohibited plant: hydrilla.

Status: Lake Joe Pool is a 7,470-acre reservoir near Fort Worth, Texas in Tarrant and Dallas Counties. Surveys indicated 106 acres of hydrilla on Lake Joe Pool in 2005. Chemical treatments in 2004 of the Cedar Hill State Park boat ramps, USACE property, and Lynn Creek Park were 70-80% effective; areas treated with fluridone (Sonar®) in 2004 experienced much better and longer lasting control than those treated with endothall (Aquathol®) and chelated copper (Cutrine® Plus).

In 2005, the City of Grand Prairie requested treatment of the Lynn Creek Park boat ramps and swimming areas in advance of summer visitation. Under the direction of Inland Fisheries District 2D, AHE personnel treated 10 acres of hydrilla in Lynn Creek Park using a combination of Sonar PR®, and Sonar Q® to establish and maintain

concentration of the active ingredient fluridone at 90 ppb in specific areas (Table 2). Treatments were limited to boat ramps and swimming areas. Significant reduction of hydrilla was reported in the areas treated. Herbicide was provided by the City of Grand Prairie.

Lake Lyndon B. Johnson

Controlling Authority: Lower Colorado River Authority. Contact: Stephan Magnelia, TPWD, phone 512-353-0072, e-mail: *Stephan.magnelia@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, hydrilla, Eurasian watermilfoil (*Myriophyllum spicatum*).

Status: Lake Lyndon B. Johnson is a 6,534-acre reservoir in Llano County, Texas. The primary nuisance species on Lake Lyndon B. Johnson are hydrilla and Eurasian watermilfoil. Concerns regarding the expanding hydrilla population resulted in chemical treatments in 2005. In two separate treatments, 13.3 acres of hydrilla were treated with the herbicide Nautique® at a rate of 6 gallons per acre and an additional 25 acres of hydrilla were treated with Sonar PR® at a rate of 30 pounds per acre (Table 2). Treatments were conducted by TPWD personnel from District 1E. Herbicide was supplied by the Lower Colorado River Authority.

Abnormally low water levels during the fall and winter of 2005 resulted in a dramatic decline in the Eurasian watermilfoil population on Lake Lyndon B. Johnson. Fall 2005 surveys estimated only 0.5 acres of Eurasian watermilfoil compared to 83 acres in 2004.

A Tier I response to 2 acres of waterhyacinth on Lake Lyndon B. Johnson in 2004 proved extremely effective; 2005 surveys indicated only 0.2 acres of waterhyacinth present after chemical treatment. Physical removal of any plants found in the reservoir in 2006 may prevent future need for herbicide treatments.

Purtis Creek State Park Reservoir

Controlling Authority: TPWD. Contact: Rick Ott, phone 903-566-2161, e-mail *richard.ott@tpwd.state.tx.us*. Prohibited plant: hydrilla.

Status: Purtis Creek State Park Reservoir is a 349-acre impoundment owned by TPWD and specifically designed for recreational fishing. Hydrilla infestations have historically restricted access to the Purtis Creek State Park swimming area, boat ramp, bank fishing areas, and fishing piers. Surface coverage in these areas have been reported to reach 80% or greater by late summer. Spot treatment of the swimming area and one fishing pier with Sonar SRP® was done at a rate of 40 lb/acre, providing a prolonged concentration of the active ingredient fluridone at approximately 18-20 ppb (Table 2). A total of 2 acres were treated using 80 lb. of chemical supplied by Purtis Creek State Park. Post-treatment surveys indicated chemical treatments were less effective in reducing hydrilla compared to previous treatments. Poor results may be due to offsite drift of herbicide, often

occurring if treated areas are located on windblown shorelines. An integrated approach, using both chemical and biological means, is being considered for hydrilla control on Purtis Creek.

Lake Quitman

Controlling Authority: Wood County. Contacts: Roy Don Shipp, phone 903-878-2238 and Kevin Storey, TPWD, phone 903-593-5077, e-mail *kevin.storey@tpwd.state.tx.us*. Prohibited plant: waterhyacinth.

Status: Lake Quitman is an 814-acre reservoir in Wood County, Texas. Physical removal of some waterhyacinth from Lake Quitman was done by TPWD District 3B personnel, assisted by the Denton County Bassmasters, in 2005. District AHE personnel treated 1 acre of waterhyacinth on Lake Quitman in 2005 using Weedar 64® (2,4-D Amine) at 1.0% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v (Table 2). Fall surveys in 2005 estimated only 0.3 acres of waterhyacinth present after treatment. The participation of concerned volunteers in waterhyacinth removal on Lake Quitman establishes a precedent for future aquatic vegetation control on small community lakes.

Sheldon Lake

Controlling Authority: TPWD. Contacts: Rob Comstock, phone 281-456-2800, e-mail *rob.comstock@tpwd.state.tx.us* and Mark Webb, TPWD, phone 979-822-5067, e-mail *mark.webb@tpwd.state.tx.us*. Prohibited plants: hydrilla, giant salvinia.

Status: Sheldon Lake is a 1,200-acre reservoir located in Harris County, Texas. Giant salvinia was found on Sheldon Lake in July, 2000. After aggressive herbicide applications by TPWD Public Lands and Inland Fisheries personnel, the infestation was essentially eliminated, only to reappear in 2002. The majority of the infestation was in areas inaccessible to spray equipment. Personnel from District 3E were only able to treat 5.3 acres of giant salvinia in 2004. Two separate treatments of 75 acres of hydrilla and giant salvinia were conducted on Sheldon Lake in 2005 using Sonar AS® and Sonar SRP® (Table 2). Treatments were conducted by District 3E personnel. An estimated 65,300 adult giant salvinia weevils were released on Sheldon Lake in 2005 to supplement 56,000 giant salvinia weevils introduced in 2004. Insects were provided by LAERF and distributed by District 3E personnel.

Lake Tawakoni

Controlling Authority: Sabine River Authority (SRA). Contacts: Bill Kirby, phone 903-878-2420, e-mail *bkirby@sra.dst.tx.us* and Kevin Storey, TPWD, phone 903-593-5077, e-mail *kevin.storey@tpwd.state.tx.us*. Prohibited plants: waterhyacinth.

Status: Lake Tawakoni is in Van Zandt, Rains, and Hunt Counties, 15 miles southeast of Greenville, Texas. Impounded in 1960, the reservoir encompasses 37,879 acres. Historically, Lake Tawakoni has not had problems with aquatic vegetation. In 2005, a small infestation of waterhyacinth was reported in the Ash Cove area. Four acres of waterhyacinth were treated by AHE personnel using Aquamaster® (glyphosate) at 0.75% v/v and Red River 90® (surfactant) at 0.25% v/v (Table 2). Later in the season, low water levels stranded remaining waterhyacinth and it may have died from desiccation.

Lake Texana

Controlling Authority: Lavaca-Navidad River Authority. Contacts: Pat Brzozowski, phone 361-782-5229, e-mail *lnra@ykc.com* and John Findeisen, TPWD, phone 361-547-9712, e-mail *john.findeisen@tpwd.state.tx.us*. Prohibited plants: hydrilla, waterhyacinth, giant salvinia, alligatorweed.

Status: Lake Texana contains persistent populations of waterhyacinth, giant salvinia, and hydrilla; waterhyacinth has historically been the most problematic. The Lavaca-Navidad River Authority (LNRA) has assumed full responsibility for nuisance aquatic vegetation control efforts on Lake Texana with excellent results. A dramatic reduction in both waterhyacinth and giant salvinia is evident on Lake Texana since LNRA assumed full responsibility for control efforts in 2002.

A total of 360 acres of nuisance vegetation consisting of waterhyacinth and giant salvinia were chemically treated on Lake Texana by LNRA in 2005 using aerial application. Direct foliar applications by airboat accounted for another 400 acres. Total costs for herbicide treatments in 2005 amounted to $14,421.25.

An estimated 700,000 hydrilla flies (*Hydrellia pakistanae*) were released in Lake Texana in 2005 by USDA to establish a viable bio-control for hydrilla. Personnel from District 1-E released approximately 105,000 giant salvinia weevils in a private pond adjacent to the Sandy Creek arm of Lake Texana in 2005. The pond was found to be a nursery site for giant salvinia and is thought to be the original site of infestation. The release supplemented a similar release in 2004 and is intended to help establish an insectary near Lake Texana. No chemical treatments were required of TPWD personnel on Lake Texana in 2005.

Toledo Bend Reservoir

Controlling Authority: Sabine River Authority (SRA). Contacts: Jim Washburn, phone 409-565-2273, e-mail *toledobend@datarecall.net* and Todd Driscoll, TPWD, phone 409-384-9572, e-mail *todd.driscoll@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, giant salvinia, hydrilla, Eurasian watermilfoil, torpedograss.

Status: Toledo Bend Reservoir is on the Texas-Louisiana border and encompasses 185,000 acres. Toledo Bend Reservoir supports significant populations of giant salvinia,

waterhyacinth, hydrilla, and Eurasian watermilfoil. The lack of freezing winter temperatures for the past several years has allowed survival and expansion of most invasive species on the reservoir. Fall surveys in recent years may have underestimated the extent of the giant salvinia infestation on Toledo Bend Reservoir due to the inability of survey crews to access shallow backwater areas.

Conventional vegetation surveys in fall, 2004 estimated 3,070 acres of giant salvinia on the Texas portion of Toledo Bend. An aerial survey in spring, 2005 estimated over 5,000 acres of giant salvinia reservoir-wide. Many areas included in the aerial survey were not surveyed in 2004. Control efforts in 2005 continued to emphasize the containment of giant salvinia, focusing most chemical treatments at boat ramps and high-use areas. Permanent signs at all public boat ramps, warning of the threat of giant salvinia, are considered effective and continued maintenance of these signs remains a priority. Press releases and distribution of informative flyers should help maintain public awareness of the problem.

A total of 173 acres of giant salvinia were treated with herbicides on Toledo Bend in 2005, compared to 228 acres in 2004. In an effort to contain the infestation, treatments focused on boat ramps and areas of dense concentrations. District AHE personnel conducted treatments using Aquamaster® (glyphosate) at 0.75% and Reward® (diquat) at 0.25% v/v with surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.09% v/v (Table 2). Chemicals were provided by SRA.

Introductions of the Australian strain of the salvinia weevil on Toledo Bend continued in 2005. An estimated 185,265 weevils, provided by LAERF, supplemented 140,075 insects released in 2004. Evidence of over-wintering and reproduction of the weevil has been documented at release sites that have been sampled. A visible reduction of giant salvinia has been noted in several release sites since introductions began in 2004. Introductions in smaller, more confined areas appear more successful than those exposed to open water. Numerous environmental factors, combined with the size of the reservoir, may delay successful establishment of the giant salvinia weevil reservoir-wide. More introductions of giant salvinia weevils are planned in 2006.

Environmental conditions may prove the limiting factor in giant salvinia growth and expansion. Although giant salvinia is susceptible to extreme cold (Oliver 1993), relatively mild winters have failed to provide the freezing temperatures required to eliminate giant salvinia in east Texas. In 2005, the SRA offered a 3-4 foot drawdown in the fall to combat giant salvinia infestations. The drawdown was designed to mimic normal reservoir operations in past years when fall drawdowns aided control efforts. In 2005, a drought resulted in record low water levels. Significant reductions in giant salvinia resulted in the lower portion of the reservoir, while low lying areas in Pendleton Creek, Bayou Siepe, and the Sabine River delta failed to completely dry and harbored many small nursery areas which continued to grow.

Low water levels and lack of rainfall in 2005 prevented extensive chemical treatment of waterhyacinth on Toledo Bend Reservoir. Fall surveys indicated over 400 acres of waterhyacinth present in 2005, most of which was located in the North Toledo

Bend Wildlife Management Area (NTBWMA). Only 33.5 acres of waterhyacinth were treated on Toledo Bend by AHE personnel in 2005, compared to 140 acres in 2004. Infestations were treated using Weedar 64® (2, 4-D Amine at 1.0% v/v) with Aqua-King Plus® surfactant (at 0.0625% v/v). Waterhyacinth treatments were limited to the NTBWMA and the William's Camp area. Herbicide and surfactant used in the wildlife management area was supplied by TPWD Wildlife Division. Chemicals used outside the wildlife management area were provided by SRA.

Hydrilla has never been problematic on Toledo Bend Reservoir and is considered by many to be beneficial fish habitat. Low water levels during the 2005 growing season may have contributed to a decrease in the hydrilla population on Toledo Bend. Fall surveys indicated 1,516 acres of hydrilla in Toledo Bend in 2005 compared to 2,109 acres in 2004. Stands of hydrilla in the lower portion of the reservoir seemed less affected by the water level fluctuation. Stands of hydrilla remain associated with stands of Eurasian watermilfoil and coontail. No treatments targeting hydrilla or Eurasian watermilfoil were conducted by TPWD on Toledo Bend Reservoir in 2005.

SUMMARY

Control and management of nuisance aquatic vegetation continues to challenge available manpower and fiscal resources. Integrated pest management techniques remain the most effective means to maintain relative control of most problematic species. Ultimate control, however, may be dependent on unpredictable environmental factors. Control efforts benefit greatly when accompanied by periodic low water levels and freezing winter temperatures. Without the largescale reductions provided by such environmental extremes, problematic aquatic vegetation species will likely continue to flourish, despite aggressive conventional control options.

The increasing trend in nuisance aquatic vegetation coupled with limited resources will require a different approach in the future if any measurable control is to be achieved. One approach would be to require the active participation of controlling authorities in control efforts. Precedents set by authorities that have assumed full responsibility for the control of nuisance aquatic vegetation offer strong evidence to the effectiveness of such a strategy and provide a model for responsible stewardship and commitment to our natural resources.

Future control efforts should continue to emphasize prevention through public awareness, long-term control options, and non-herbicide alternatives. Water level manipulations, bio-control agents, and the use of physical barriers should be implemented as part of an integrated approach whenever possible. Herbicide applications, as part of an applied integrated approach, should serve solely as support for long-term measures. Years of control efforts indicate reliance on repeated applications of herbicides alone is not only expensive but ineffective in long term control.

PRIORITIES FOR 2006

1a	Any state-controlled water (state park, WMA) with giant salvinia.
1a	Other public waters with giant salvinia.
1a	Any new infestation of giant salvinia in private waters.
1b	Any state-controlled water with a noxious (state-listed or prohibited) vegetation control problem (primarily waterhyacinth or hydrilla).
1b	Other public waters with noxious (state-listed or prohibited) vegetation problems.
2a	Other public waters with native vegetation problems.
2b	Technical assistance to private pond owners for vegetation management procedures other than giant salvinia eradication.

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Table 1. Harmful or potentially harmful exotic aquatic plants in Texas, 2005.

Scientific name	Common name
Landolita punctata	giant duckweed
Eichhornia crassipes	waterhyacinth
Hydrilla verticillata	hydrilla
Myriophyllum spicatum	Eurasian watermilfoil
Eichhornia azurea	rooted waterhyacinth
Panicum repens	torpedograss
Pistia stratiotes	waterlettuce
*Lagarosiphon major**	lagarosiphon
Alternanthera philoxeroides	alligatorweed
Melaleuca quinquenervia	paperbark
Ipomoea aquatica	water spinach
*Salvinia minima***	common salvinia
*Salvinia molesta***	giant salvinia

*Plant yet to be identified in Texas.
**Only two species of the genus *Salvinia* have been identified in Texas, but all are prohibited.

Table 2. Summary of information regarding aquatic herbicides and surfactants used to treat problematic aquatic plants in Texas.

Target plant	Herbicide (a.i.)/ surfactant	Rate (ppm or ppb)
waterhyacinth	Reward® (diquat)/ Aqua-King Plus® non-ionic surfactant	3 qt/acre (0.7 ppm) 1-2 qt/acre
waterhyacinth	Rodeo® or Aquamaster® (glyphosate)/ Aqua-King Plus® non-ionic surfactant	3 qt/acre (1 ppm) 0.25-2.0 qt/acre
waterhyacinth	Weedar 64® (2,4-D Amine)/ Aqua-King Plus® non-ionic surfactant	1 gal/acre (1.7 ppm) 0.25-2.0 qt/acre
waterhyacinth	Aquaneat® or Aquastar® (glyphosate)/ Red River 90® surfactant	3 qt/acre (1 ppm) 0.25-2.0 qt/acre
hydrilla	Aquathol K®* (endothall liquid)	1.3 - 2.6 gal/acre-ft (2-4 ppm)
hydrilla	Nautique ® (Copper carbonate)	1.5-3.0 gal/acre-ft (0.5-1.0 ppm)
hydrilla	Sonar SRP® or Sonar PR® or Sonar Q® (fluridone granules)	32- 80 lb/acre (60-150 ppb)
giant salvinia	Rodeo® or Aquamaster® (glyphosate)/ Aqua-King Plus® non-ionic surfactant Thoroughbred® organo-silicone surfactant	3 qt/acre (1 ppm) 1-2 qt/acre 12 oz/acre
giant salvinia	Reward® (diquat)/ Aqua-King Plus® non-ionic surfactant Thoroughbred® organo-silicone surfactant	3 qt/acre (0.7 ppm) 1-2 qt/acre 12 oz/acre
giant salvinia	Rodeo® or Aquamaster® (glyphosate)/ Reward® (diquat)/ Aqua-King Plus® non-ionic surfactant Thoroughbred® organo-silicone surfactant	3 qt/acre (1.0 ppm) 1qt/acre (0.23 ppm) 1-2 qt/acre 12 oz/acre
giant salvinia**	Sonar AS® (fluridone liquid)	1 qt/acre (80 ppb)
common salvinia	Renovate 3® (triclopyr) or Reward® (diquat)/ Aqua-King Plus® non-ionic surfactant Thoroughbred®organo-silicone surfactant	2-8 qt/acre (0.75-2.5 ppm) 1-2 qt/acre 12 oz/acre
American lotus	Aquamaster® (glyphosate)/ ChemSurf® or Aqua-King Plus® non-ionic surfactant	3 qt/acre (1 ppm) 0.25-2.0 qt/acre

* The algaecide Cutrine Plus® (chelated copper) may be added at 0.7 ppm if filamentous algae is present.

** Preferred use for salvinia is in small ponds or lakes where total lake treatment is possible.

Table 3. Summary of TPWD aquatic herbicide applications (acres treated) for invasive aquatic plants in public waters, 2005.

Water body	Waterhyacinth	Common salvinia	Giant salvinia	Hydrilla	American lotus
Armand Bayou	5				
Lake Athens				0.5	
B.A. Steinhagen	34	20			
Caddo Lake	308				
Lake Fairfield					6
Lake Fork	54				
Lake Joe Pool				10	
Lake LBJ	2			38.3	
Purtis Creek State Park				2	
Lake Quitman	1				
Sheldon Lake			75	75	
Tawakoni	4				
Toledo Bend	34		173		
Lake Quitman	1				
Total	439	20	173	49	6

Figure 1. Waterhyacinth distribution in Texas, 2005.

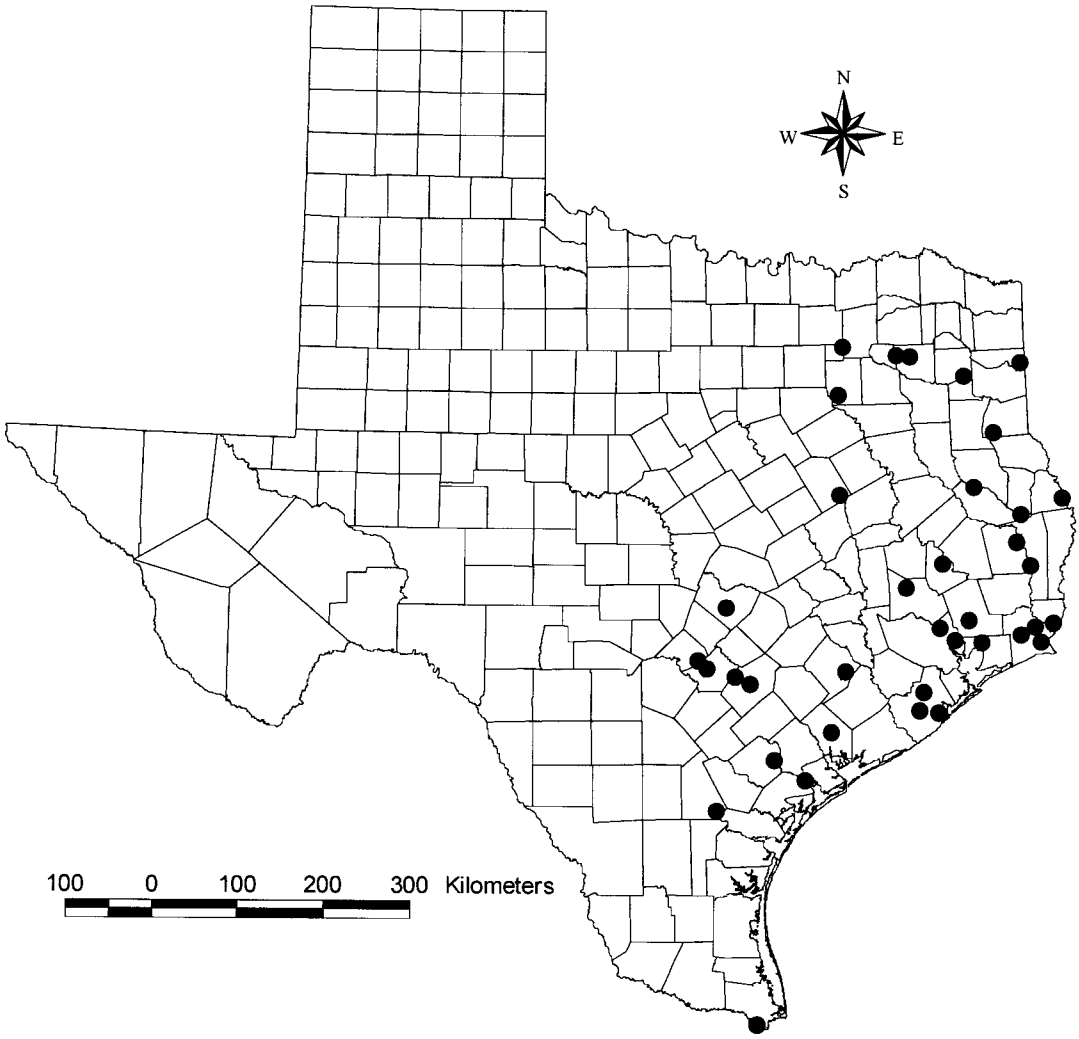


Figure 2. Hydrilla distribution in Texas, 2005.

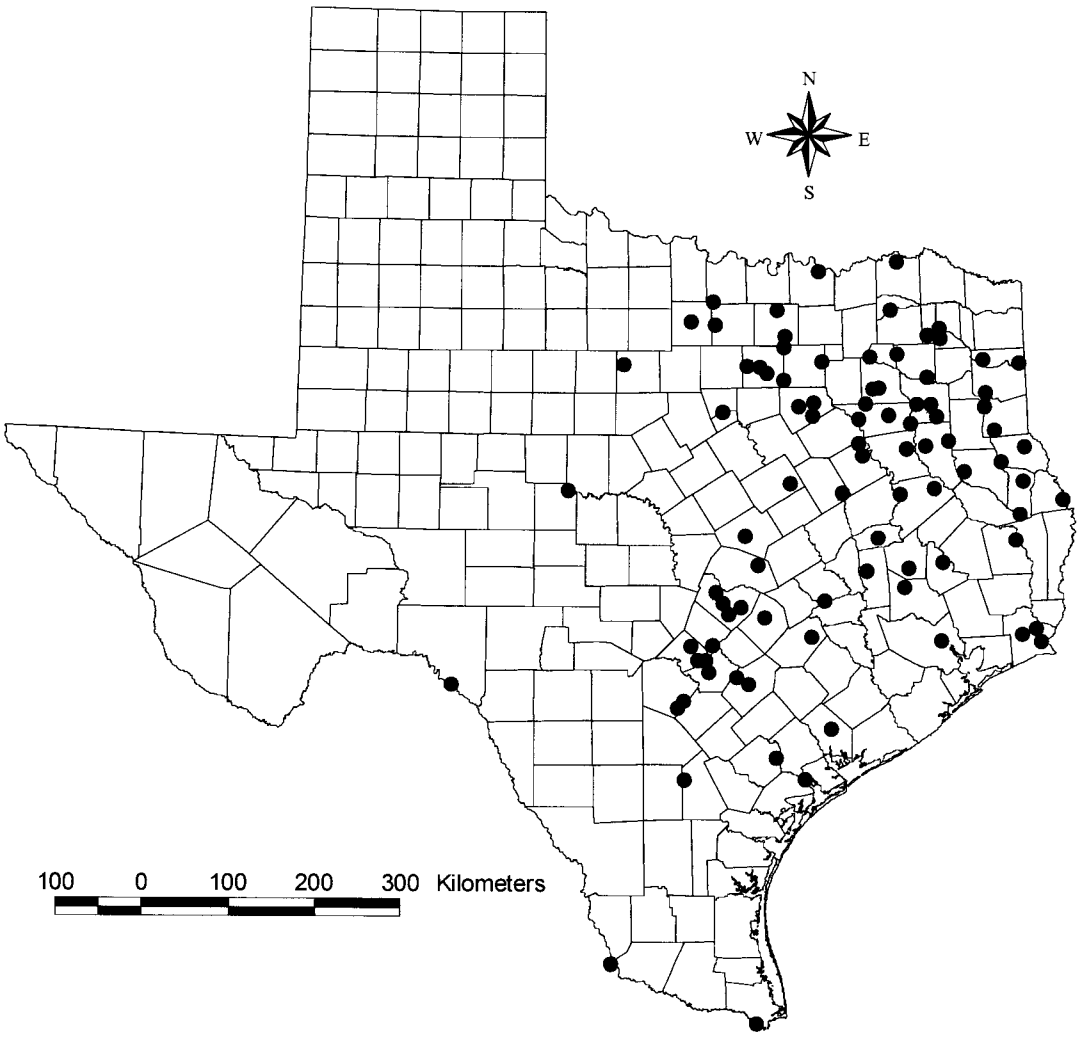


Figure 3. Giant salvinia distribution in Texas, 2005.

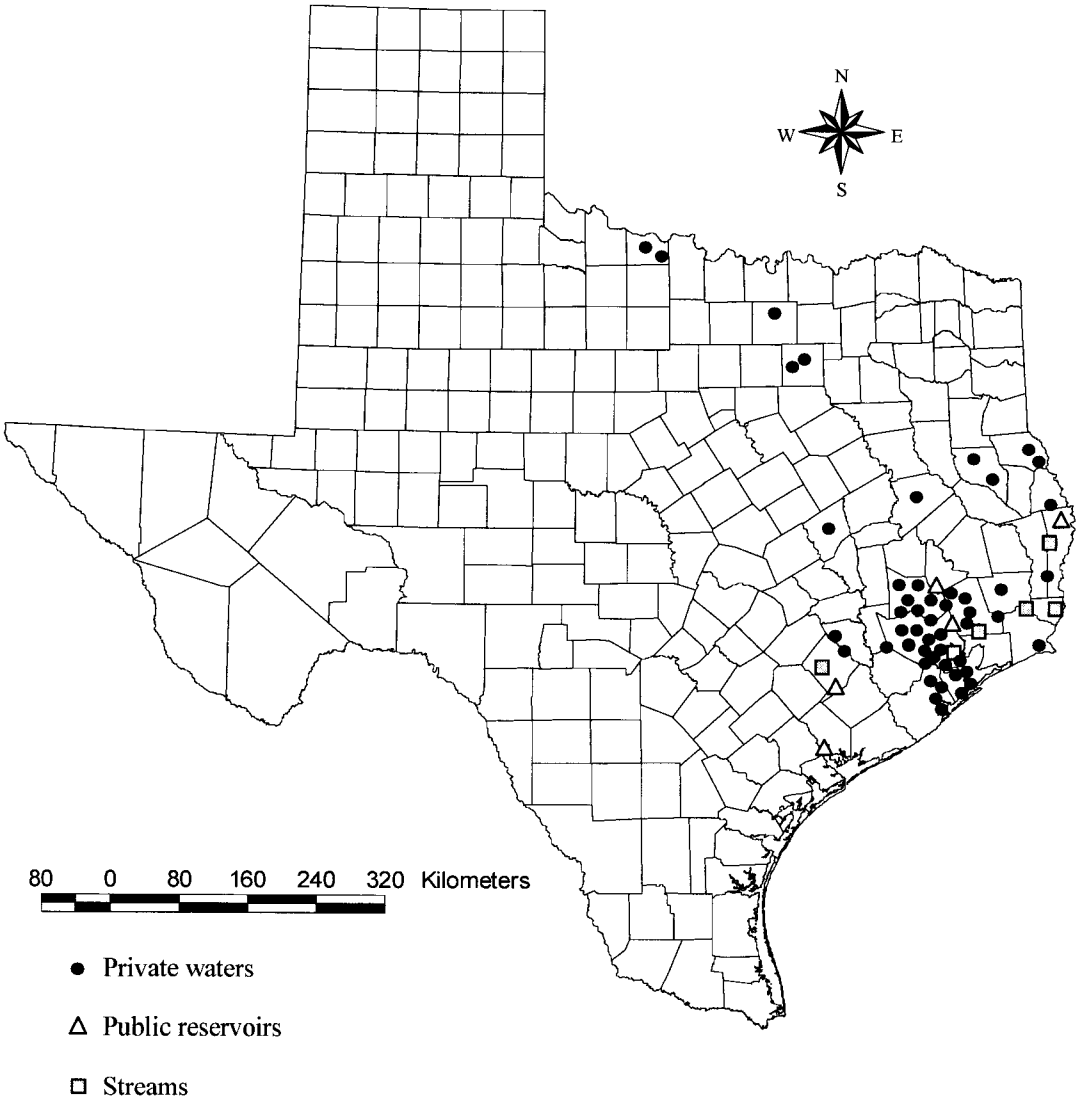
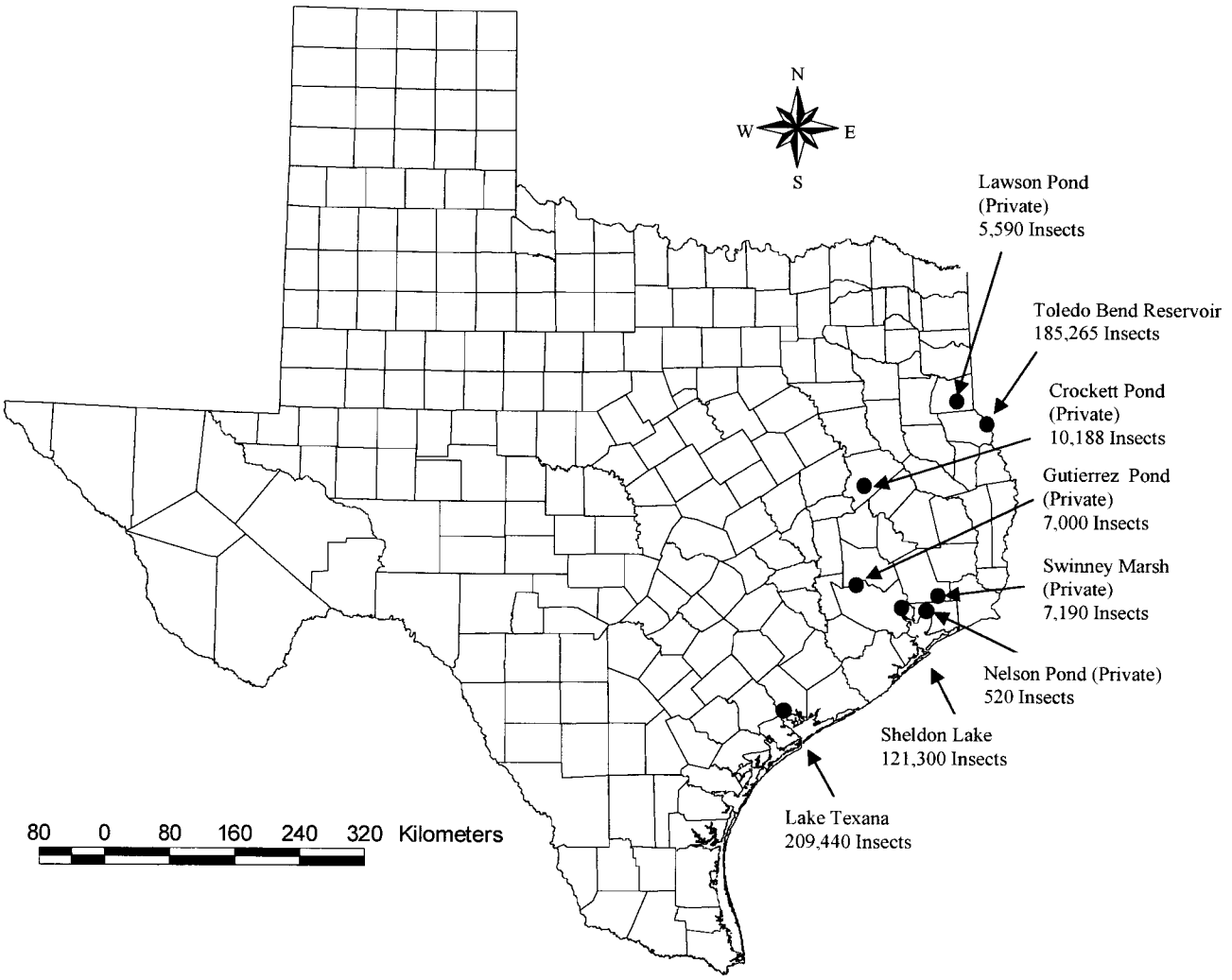


Figure 4. Australian salvinia weevil release locations in Texas, 2001- 2005 (numbers represent adult insects).



Appendix I. Statewide occurrence of non-native (listed) aquatic vegetation in Texas, 2005. Information represents only what was reported by district management crews during routine habitat surveys and vegetation was not treated unless so noted.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Armand Bayou Coastal Preserve	300	1945	waterhyacinth	5*
Austin	1,830	0033	hydrilla	13
			Eurasian watermilfoil	162
Athens	1,500	0031	hydrilla	0.18*
			waterhyacinth	0.16
			alligatorweed	0.17
Aquilla	3,020	0021	hydrilla	6
B.A. Steinhagen	16,830	0694	hydrilla	655
			waterhyacinth	1,695*
			common salvinia	1,064*
			alligatorweed	496
			torpedograss	Trace
Bastrop	906	0046	hydrilla	49
Bob Sandlin	9,004	0646	hydrilla	893
Bridgeport	13,000	0109	hydrilla	7
Caddo	26,800	0128	hydrilla	2,500
			waterhyacinth	1,700*
Coleto Creek	2554	0186	hydrilla	69
			Eurasian watermilfoil	65
			waterhyacinth	0.3
Conroe	20,118	0192	hydrilla	868
			waterhyacinth	9
			giant salvinia	1.4
			alligatorweed	Trace
			water lettuce	3.7
Corpus Christi	18,256	0201	waterhyacinth	2,374
Cypress Springs	3,461	0223	hydrilla	415
Lake Fork	27,690	0433	hydrilla	1,200
			waterhyacinth	74*
Fayette	2,400	0282	hydrilla	18
Gladewater	481	0307	waterhyacinth	5
Gibbons Creek	2,770	0304	hydrilla	6
			waterhyacinth	34
			alligatorweed	Trace
Hawkins	776	0347	hydrilla	160
Lake Houston	10,459	0368	waterhyacinth	Trace
			water lettuce	Trace

Appendix I. Continued.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Houston County	1,330	0369	hydrilla	Trace
			waterhyacinth	9
Jacksonville	1,352	0389	hydrilla	166
Joe Pool	7,470	0582	hydrilla	106*
Kurth	800	0420	hydrilla	170
Lake Lyndon B. Johnson	6,534	0466	hydrilla	13*
			Eurasian watermilfoil	0.5
			waterhyacinth	0.2
Limestone	12,553	0447	hydrilla	36
Navarro Mills	4,336	0525	hydrilla	0.4
O.H. Ivie	19,149	0688	hydrilla	2468
Palestine	25,560	0566	hydrilla	147
			waterhyacinth	1
			alligatorweed	0.6
Pinkston	580	0658	hydrilla	133
			Eurasian watermilfoil	0.6
Purtis Creek	354	0593	hydrilla	22*
Lake Quitman	814	0596	waterhyacinth	0.3
Raven	203.5	0599	hydrilla	1.2
			waterhyacinth	67
			alligatorweed	67
Lake Ray Hubbard	22,745	0600	hydrilla	9
Rio Grande		1492	hydrilla	100
Sam Rayburn	114,500	0640	hydrilla	4,876
			waterhyacinth	14
Lake Sheldon	1,200	0667	hydrilla	904*
			waterhyacinth	10
			giant salvinia	75*
			alligatorweed	8
Somerville	11,456	0680	hydrilla	570
			alligatorweed	2
Stillhouse Hollow	6,429	0696	hydrilla	887
Toledo Bend	185,000	0734	hydrilla	1,516
			Eurasian watermilfoil	390
			waterhyacinth	408*
			giant salvinia	281*
			torpedograss	Trace
Town Lake	525	0737	Eurasian watermilfoil	0.9

Appendix I. Continued.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Tradinghouse Creek	2,010	0740	hydrilla	113
Tyler	2,276	0874	hydrilla	824
Waco	7,194	0763	hydrilla	9
Walter Long	1,210	0235	hydrilla	36

* Infestation treated during 2005. The area actually treated may be different than the number appearing in the column.

Appendix II. TPWD Daily Log of Herbicide Operations card for herbicide applications.

Date: _____

Daily Log of Herbicide Operations **Project:** **Task:**

Operation Data:

Work Detail

☐ Survey only

☐ Application

Equipment

☐ Airboat

☐ Outboard

☐ Truck

☐ Aerial

Time

Start: _____

Stop: _____

Waterbody (Code): _____

County (Code): _____

Specific Area: _____

Weather Data:

	Time	Air Temp(F)	Water Temp(F)	Wind Direction	Wind Speed
Begin:	_____	_____	_____	_____	_____
End:	_____	_____	_____	_____	_____

Application Data:

Additive 1:_____ Rate:_____ Herbicide 1:_____ EPA#_____
Additive 2:_____ Rate:_____ Herbicide 2:_____ EPA#_____

Cost Additive/Acre 1: _____ per gallon
Cost Additive/Acre 2: _____ per gallon

Cost of Herbicide 1: _____per gallon
Cost of Herbicide 2: _____per gallon

Total Additive used:_____

Rate of Herbicide/Acre:_____
Rate of Herbicide/Acre:_____

Target Plant(s):_____

Total Amount Herbicide Used:_____

Acres Treated: _____

Mix Volume/Acre:_____

Aerial Data:

FAA # N-_____ Decal # _____

Lic # _____ Lic # _____

Certified Applicator **Crew Member** **Date**

***Chemical (if used) supplied by:** _____