NUISANCE AQUATIC VEGETATION CONTROL IN 2003

by

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ABSTRACT

Many public waters within Texas harbor invasive, non-native aquatic plant species capable of restricting resource use, displacing native vegetation, and destroying aquatic habitats. Utilizing an integrated pest management philosophy, control and management efforts in 2003 primarily targeted the exotic species waterhyacinth [*Eichhornia crassipes* (Mart) Solms], hydrilla [*Hydrilla verticillata* (L.F.) Royle], and giant salvinia (*Salvinia molesta* D.S. Mitchell). Methods employed included the use of host-specific bio-control agents to combat giant salvinia and the application of approved granular and liquid aquatic herbicides. The first priority of the TPWD aquatic vegetation control effort in 2004 will remain to control or eradicate giant salvinia infestations in wildlife management areas, State Parks, public reservoirs, and private waters. Annual monitoring and maintenance of waterhyacinth, hydrilla, and other non-native populations are a secondary, but no less important concern.

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INTRODUCTION

Texas boasts some of the most fertile and productive freshwater habitats within the continental United States. Aquatic habitats in the more temperate regions of the State possess diverse native plant communities which make Texas' streams, lakes, and rivers some of the most unique in the nation. However, many public waters also harbor invasive, non-native aquatic plant species capable of restricting resource use, displacing native vegetation, and destroying aquatic habitat. Introduced exotic aquatic plant species lack the natural enemies and ecological controls present in their area of origin and rapidly fill any available niche with predictable negative consequences. Although the restriction of navigation and resource use are the most noticeable effects of the unchecked growth of invasive aquatic plant species, the impacts on valuable aquatic habitat, native aquatic plant species, and water quality are of highest concern.

A list of "harmful or potentially harmful exotic plants" (Table 1) is maintained by the Texas Parks and Wildlife Department (TPWD). The species listed are considered the most likely to negatively impact the freshwater aquatic resources. Where feasible, control and management efforts of nuisance aquatic plant species, both non-native and native, in Texas utilize 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 by the most economical means and in a manner that will cause the least possible hazard to persons, property, and the environment". IPM methods may employ environmental manipulation, ecological intervention, mechanical and/or physical removal, the introduction of biological control agents, and the application of herbicides to control, manage, or eradicate problem species. This report will discuss control methods and strategies employed to manage nuisance aquatic vegetation on public waters within Texas in 2003. Helton (2002) details statewide occurrence of noxious (listed) aquatic vegetation in Texas. Although the primary focus of control efforts are to manage exotic species like 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. Each will be discussed in turn by both plant species and water body.

The known distribution of waterhyacinth, hydrilla and giant salvinia within Texas are shown in Figures 1-3, respectively. Appendix I lists the known occurrence during 2003, within Texas, of those species listed in Table 1. A list of the aquatic herbicides and surfactants employed by TPWD personnel, application rates, target plants, and approximate cost/acre is found in Table 2. Locations of salvinia weevils (*Cyrtobagous salviniae*) released since October 2001 are summarized in Figure 4. An example of the Daily Log of Herbicide Operations (DLO) card on which herbicide application operations are recorded is found in Appendix II.

Waterhyacinth

Anecdotal information tells us waterhyacinth, a native of South America, 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 1900's (Wunderlich 1962; Zeiger 1962). Although waterhyacinth reproduces primarily by stolons which produce viable daughter plants that break free and quickly colonize new areas, significant numbers of drought-resistant seeds are produced every year.

Although it is unknown when exactly waterhyacinth found its way to Texas, aggressive chemical control programs to control the noxious intruder began in the 1950's. 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 by the U.S. Army Corps of Engineers (USACE), the program continued until the early 1990's when it was discontinued due to lack of funding. A limited number of states, including Texas, are now part of an Aquatic Plant Control (APC) 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 many reservoirs up to 250 miles inland. The detriments of waterhyacinth infestations were detailed by Hitchcock et al. (1949) and again by Langeland (1987) almost 40 years later. Although the primary threat of waterhyacinth is to navigation, large thick mats eventually cause severe ecological stress within affected aquatic systems. Although relatively recent experimentation in control methods included reservoir drawdowns, mechanical and biological options have also been utilized (Helton and Hartmann 1995; Cofrancesco 1998). At present, the most effective control method used on waterhyacinth is aquatic herbicides, specifically 2,4-D Amine, glyphosate, and diquat compounds.

Waterhyacinth has been identified on 33 public waters within the state (Fig. 1). The only new occurrence of waterhyacinth in 2003 was reported in Cedar Creek Lake. Established infestations in Lake B.A. Steinhagen, Caddo Lake, Toledo Bend Reservoir, Armand Bayou, and the lower Rio Grande continue to require annual chemical treatments. The most severe infestations that required treatment in 2003 were on Lake B.A. Steinhagen, and Caddo Lake. The lack of freezing temperatures during winter months has resulted in the increased survival of waterhyacinth throughout both water bodies. Small populations continue to persist in Lake Fork, Lake Quitman, and Sam Rayburn Reservoir, each requiring annual treatment to prevent expansion.

Hydrilla

Hydrilla is believed to have been imported from the old world (Godfrey and Wooten 1979), probably for use as an ornamental aquarium plant. Subsequently, hydrilla is thought to have been initially introduced into Texas waters by aquarium hobbyists.

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). 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 Texas were plagued by serious problems related to hydrilla infestations. Hydrilla has become common in many Texas reservoirs and, as a result, native plant diversity and coverage has declined (TPWD, unpublished data). Historical control methods for hydrilla have included planned drawdowns, mechanical removal, biological control agents, and approved aquatic herbicides.

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). Hydrilla declines in many reservoirs in 2001 have been followed by slight increases in coverage in 2003.

Giant Salvinia

Giant salvinia is a highly invasive floating fern native to Brazil, South America. The consequences of its establishment are well documented on several continents. Oliver (1993) believed introductions of this species have resulted in severe negative impacts on human populations wherever they have occurred. Giant salvinia was first identified in the wild in the United States (South Carolina) in 1995. The second confirmed sighting of giant salvinia within the United States occurred during the 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, the alteration in the natural nutrient dynamic flow results in total degradation of the ecosystem (Oliver 1993). Studies on the 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 the eutrophic nature of aquatic ecosystems (D.S. Mitchell, pers. comm. 1999).

In 1998, giant salvinia was confirmed on Toledo Bend Reservoir on the Texas-Louisiana border. In 1999, TPWD personnel confirmed giant salvinia on Lake Texana in south-central Texas. New infestations were documented at Lake Conroe and Sheldon Reservoir in 2000. Since then, no new infestations have been documented on public waters. However, in 2003, giant salvinia was reported and confirmed in five private ponds in Texas. Giant salvinia continues to persist in 10 public waters and has been reported in 47 private waters (Fig. 3). With the exception of four United States Department of Agriculture (USDA) research sites, the plant has been eradicated in all private waters and nurseries where it has been found. Officials from Louisiana reported treating 110 acres of giant salvinia on Toledo Bend in 2003. A total of 107 acres of giant salvinia on Toledo Bend were chemically treated by TPWD personnel in 2003.

TPWD personnel continue to assist the USDA with research on the development and propagation of the salvinia weevil as a biological control agent for giant salvinia. Although two species of weevil have been investigated, one from Brazil and one from Australia, research efforts have focused on the Australian salvinia weevil. The success of this insect on infestations in other parts of the world has been thoroughly demonstrated (Room et al. 1981). The Australian variety of the weevil was first released into Texas giant salvinia populations in October 2001. Since their initial introduction, a total of 1,430 insects have been released at four sites including Toledo Bend Reservoir, Lake Texana, and two private water sites in Southeast Texas. Although promising reductions in giant salvinia biomass were documented in the Toledo Bend Reservoir release site and one private site in July 2003, for unknown reasons the Toledo Bend Reservoir site experienced complete re-infestation in one month.

Public education efforts continue to inform Texas citizens about the threat giant salvinia poses to aquatic resources. For the third consecutive year actual reports of new infestations declined. Early detection of this plant species was instrumental in the control of giant salvinia on Lake Conroe. This factor alone will be critical if eradication is to be achieved, especially on reservoirs (Allen 2000).

AQUATIC PLANT MANAGEMENT BY WATER BODY IN 2003

Armand Bayou Coastal Preserve

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

Status: Armand Bayou Coastal Preserve is one of only four coastal preserves in Texas. Located on the western shore of Galveston Bay, the preserve is considered an environmentally sensitive area with a wide diversity of native vegetation, both terrestrial and aquatic. Waterhyacinth remains a problem within the preserve boundaries primarily due to the ideal growing conditions, inaccessibility of infestations to spray equipment, and a large seed bank deposited over many years. Waterhyacinth coverage declined 50% from 2002 to 2003. TPWD personnel treated a total of 38 acres of waterhyacinth in 2003 compared to 63 acres treated in 2002. Treatments were conducted using Weedar 64® (2,4-D Amine) at 1.0% v/v and the surfactant Aqua-King Plus® at 0.0625% v/v (Table 2).

Severe flooding, common to coastal areas, sometimes assists in transporting large amounts of waterhyacinth into more inhospitable saline areas where it ultimately dies. Although subsequent surveys confirmed the effectiveness of spray treatments, the inevitable re-sprouting of seed will require continued monitoring and repeated annual treatments to maintain an acceptable level of control within the coastal preserve.

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 supports a rich diversity of native and non-native aquatic vegetation. Waterhyacinth coverage in high use areas (boat ramps, public access points, the Angelina-Neches Wildlife Management Area, and Martin Dies, Jr. State Park) declined in 2003 to almost 50% of that seen in 2002. Using herbicide and surfactant supplied by USACE, TPWD personnel treated 113 acres of waterhyacinth on Lake B.A. Steinhagen in 2003, compared to 209 acres in 2002. Treatments were conducted using Weedar 64® (2,4-D Amine at 1.0% v/v) with Aqua-King Plus® surfactant (at 0.0625 % v/v) (Table 2). Post-treatment surveys indicated 90-100% efficacy on waterhyacinth treatments in Lake B.A. Steinhagen in 2003. The use of private contractors in 2003 by the USACE helped reduce the amount of chemical treatments required by TPWD personnel.

Hydrilla infestations in Lake B.A. Steinhagen have typically been isolated to specific areas and seldom require extensive control efforts. High turbidities and past drawdowns may help explain the suppression of hydrilla in Lake B.A. Steinhagen. TPWD personnel did not conduct any treatments targeting hydrilla on Lake B.A. Steinhagen in 2003.

Coverage of common salvinia continues to expand on Lake B.A. Steinhagen. The morphology of the reservoir prevents truly accurate estimates of the extent of the infestation. Once confined to protected backwaters and under the canopy of dense waterhyacinth, common salvinia now dominates the plant community wherever it is found. Treatments targeting common salvinia in 2003 focused on problematic areas within the USACE Magnolia Ridge campground area. A total of 18.5 acres of common salvinia were treated by TPWD personnel in 2003 using a combination of the herbicides Aquamaster® (glyphosate) at 1.0% v/v and Reward® (diquat) at 0.25% v/v with the surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2). This combination of chemicals allowed applicators to visibly see the effects of the previous day's treatment, thereby preventing duplication of efforts. Twelve acres of common salvinia was treated with Reward® (diquat) at 0.75% v/v with the surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2). Herbicides and surfactants were provided by USACE. Nuisance aquatic vegetation control efforts on B.A. Steinhagen in the future will require strategic planning and more specific efforts designed to address the expansion of common salvinia.

Alligatorweed has expanded on Lake B.A. Steinhagen, reaching a record 679 acres. Although the biological control agent, alligatorweed flea beetle (*Agasicles hygrophila*), is present in substantial numbers in Lake B.A. Steinhagen, visible suppression of alligatorweed is not evident. Ideal growing conditions may allow the

plant to establish sufficient biomass faster than the beetles can multiply and achieve numbers necessary for effective control. Alligatorweed is seldom targeted for chemical control efforts due primarily to its resistance to herbicides. An experimental study in 2003 conducted by the SePRO Corporation in cooperation with TPWD determined the active ingredient tryclopyr may hold promise as a chemical control for alligatorweed in the future. A total of 2.5 acres of alligatorweed were treated by TPWD personnel on Lake B.A. Steinhagen during the study in 2003 using variable rates of the herbicides Renovate® (tryclopyr), Aquamaster® (glyphosate), and Weedar 64® (2,4-D) and the surfactants Cidekick®, Aqua-King Plus®, and Thoroughbred®. All chemicals used in the study were provided by SePRO Corporation.

Periodic water level drawdowns during the winter months have proven a debatable tool in aquatic vegetation management on Lake B.A. Steinhagen. Effectiveness of drawdowns appears directly related to the severity of winter, severe cold in some years resulting in plant mortality of over 95% (Helton and Hartmann 1995). Drawdowns have proven, however, devastating to the sport fishery. In 2003, personnel from TPWD Inland Fisheries and Wildlife divisions coordinated with USACE and agreed not to conduct any major drawdowns for a minimum of 4 years on Lake B.A. Steinhagen to allow the sport fishery to recover. Increased chemical treatments may be required to maintain nuisance aquatic vegetation at manageable levels under this strategy.

Caddo Lake

Controlling Authority: Cypress Valley Navigation District. Contacts: Tom Wagner, President, phone 903-665-2794, e-mail *ASBasin@aol.co* and Mike Ryan, TPWD, phone 903-938-1007, e-mail *michael.ryan@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, hydrilla.

Status: Waterhyacinth populations in Caddo Lake in 2003 decreased slightly in comparison to 2002. A total of 202 acres of waterhyacinth were treated on Caddo Lake in 2003 compared to 350 acres in 2002. TPWD personnel conducted treatments using Weedar 64® (2,4-D Amine) at 1.0% v/v and the surfactant Aqua-King Plus® at 0.0625 % v/v (Table 2). All herbicide and surfactant was provided by TPWD Wildlife Division. Post-treatment surveys indicated near 100% efficacy in the areas treated. A fall survey in 2003 estimated 350-400 acres of waterhyacinth remained on Caddo Lake, primarily in inaccessible areas. Target areas included the Caddo Lake Wildlife Management Area and State Park, public-access locations, residential frontage, and boat roads to popular angling/waterfowl hunting areas.

Spring surveys in 2003 indicated a possible increase in hydrilla coverage on Caddo Lake. In addition to its presence in historical locations, isolated patches of hydrilla were observed in more remote areas, less frequented by resource users. However, no treatments targeting hydrilla were conducted by TPWD personnel on Caddo Lake in 2003.

Fairfield Lake

Controlling Authority: TXU Corporation. Contact: Rick Ott, TPWD, phone 903-566-2161, e-mail *richard.ott@tpwd.state.tx.us*. Nuisance vegetation: American lotus (*Nelumbo lutea*).

Status: Fairfield Lake is a 2,353-acre impoundment in Freestone County. American lotus is abundant in Fairfield Lake and reports of its expansion into the State Park swimming area prompted a chemical treatment in 2003 to reclaim the affected area. A total of 3 acres of American lotus were treated with Aquamaster® (glyphosate) at 0.75% v/v and the surfactant AquaKing Plus at 0.25 % v/v by TPWD personnel (Table 2). Herbicide was provided by Fairfield State Park. Surfactant was provided by Jasper AHE. Owing to the large rootstock of American lotus, it is expected that repeated treatments will be required to effectively maintain control within the swimming area.

Lake Fork

Controlling Authority: Sabine River Authority (SRA). Contacts: David Parsons, phone 903-878-2262, e-mail *dparsons@sra.dst.tx.us* and Kevin Storey, TPWD, phone 903-593-5077, e-mail *kevin.storey@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, hydrilla.

Status: The waterhyacinth population present on Lake Fork showed an apparent decline from 47.6 acres in 2001 to 25 acres in 2002. However, 63 acres of waterhyacinth were treated on Lake Fork in 2003 by TPWD personnel using Rodeo® (glyphosate) at 0.75% v/v and the surfactant Aqua-King Plus® at 0.0625% v/v (Table 2). All herbicide and surfactant was supplied by SRA. Treatments were focused near the State Highways 154 and 515 bridges and portions of Glade Creek. Routine surveys and continued maintenance treatments should maintain waterhyacinth at manageable levels in Lake Fork.

Historically, hydrilla has never reached problematic proportions in Lake Fork. Fall surveys indicated there were 1,773 acres of hydrilla on Lake Fork in 2003. No treatments targeting hydrilla on Lake Fork were conducted by TPWD personnel in 2003.

Gibbons Creek Reservoir

Controlling Authority: Texas Municipal Power Agency. Contact: Mark Webb, TPWD, phone 979-822-5067, e-mail *mark.webb@tpwd.state.tx.us*. Prohibited plants: hydrilla, waterhyacinth, alligatorweed.

Status: Gibbons Creek Reservoir is a 2,500-acre impoundment located east of Bryan/College Station. Although present in the reservoir for many years, hydrilla infestations never reached problematic proportions and at present are in decline. Surveys in 2003 indicated there was only a trace of alligatorweed. No treatments targeting

hydrilla or alligatorweed were conducted by TPWD personnel in 2003. Isolated stands of waterhyacinth have been present in the reservoir for several years, requiring periodic treatment to prevent expansion. A total of 8 acres of waterhyacinth were treated on Gibbons Creek Reservoir by TPWD personnel using Rodeo® (glyphosate) at 0.75% v/v and the surfactant Aqua-King Plus® at 0.5% v/v (Table 2).

Gilmer Reservoir

Controlling Authority: City of Gilmer. Contact: Mike Ryan, TPWD, phone 903-938-1007, e-mail *michael.ryan@tpwd.state.tx.us*. Prohibited plant: hydrilla.

Status: Gilmer Reservoir is a relatively new 1,010-acre impoundment constructed by the City of Gilmer in 2001. In the spring of 2003, approximately 1 acre of hydrilla was documented at the boat ramp and an adjacent rip-rap area near the highway bridge by TPWD personnel. Several small isolated stands of hydrilla on the opposite side of the reservoir had been reported as well. One acre of hydrilla near the boat ramp on Gilmer Reservoir was treated by TPWD personnel in 2003 using Aquathol-K® liquid at 2.0% v/v (Table 2). Herbicide was provided by the City of Gilmer. At the time of treatment, close inspection revealed substantially more hydrilla than had been surveyed in the spring. The decision was made to cease treatment and reserve the remaining chemical for more efficient control efforts in the spring of 2004.

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 355-acre impoundment owned by TPWD and specifically designed for 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 affected areas with Sonar SRP® was conducted 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 13 acres were treated using 520 lb of chemical supplied by Purtis Creek State Park. Post-treatment surveys indicated hydrilla was effectively reduced in the treated areas, stands of native coontail (*Ceratophyllum demersum*) becoming established in its place. It is expected that effective maintenance of the areas mentioned may require chemical treatment on a biennial basis.

Lake Raven

Controlling Authority: TPWD. Contact: Mark Webb, phone 979-822-5067, e-mail *mark.webb@tpwd.state.tx.us*. Prohibited plants: hydrilla, waterhyacinth, alligatorweed.

Status: Lake Raven has a history of problems associated with invasive aquatic plant species. Intensive control efforts implemented in 2002 targeted dense stands of hydrilla. Surveys conducted in 2003 indicate the coverage of hydrilla in Lake Raven has been contained near 28% or 100 acres. Alligatorweed, although totaling 33 acres in 2003, did not pose any problems regarding access or resource use. No treatments targeting hydrilla or alligatorweed were conducted on Lake Raven in 2003 by TPWD personnel. Isolated stands of waterhyacinth required chemical treatment to prevent expansion. A total of one acre of waterhyacinth was treated by TPWD personnel using Rodeo® (glyphosate) at 0.75% v/v and the surfactant Aqua-King Plus® at 0.5% v/v (Table 2). Due to the proximity of the treatment area to an adjacent campground, the surfactant Thoroughbred® was mixed as a drift retardant at 0.1875% v/v.

Rio Grande

Controlling Authority: International Water and Boundary Commission. Contact: Earl Chilton, TPWD, phone 512-389-4652, e-mail *earl.chilton@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, hydrilla.

Status: Waterhyacinth continues to require control efforts on the Rio Grande below Anzalduas Dam. Both U.S. and Mexican funding sources were utilized to conduct vegetation control and management activities, each country financing 50% of the cost. Activities were coordinated and supervised by TPWD personnel. Mechanical shredding and herbicide applications were conducted by private contractors. A total of 275 acres of waterhyacinth were mechanically shredded in 2003 and 150 acres were treated with glyphosate-based herbicide at 0.75% v/v combined with the surfactant Aqua-King Plus® at 0.0625% v/v (Table 2).

Control efforts targeting hydrilla in the Rio Grande focused on the stocking of 26,595 sterile triploid grass carp (*Ctenopharyngodon idella*). Purchase of the grass carp was funded by the Lower Rio Grande Valley Development Council, the National Fish and Wildlife Foundation, and TPWD. In addition, the USACE introduced an additional 1,837,195 hydrilla flies (*Hydrellia* sp.) in the lower Rio Grande in an effort to help control hydrilla in 2003.

Sam Rayburn Reservoir

Controlling Authority: USACE. Contact: Todd Driscoll, TPWD, phone 409-384-9572, e-mail *todd.driscoll@tpwd.state.tx.us*. Prohibited plants: waterhyacinth, hydrilla, common salvinia, torpedograss (*Panicum repens*).

Status: Fall surveys estimated a combined total of 88 acres of waterhyacinth in Sam Rayburn Reservoir in 2003. The infestations were confined to Stanley and Harvey creeks in the Angelina River arm. The largest portion of waterhyacinth was either stranded and

desiccated by water level fluctuations or rendered inaccessible in the back of wooded creek arms by mid-summer. In 2003, TPWD personnel were able to treat 15 acres of waterhyacinth in Harvey Creek using Weedar 64® (2,4-D Amine at 1.0% v/v) and the surfactant Aqua-King Plus® (at 0.0.625% v/v) (Table 2). Required herbicide and surfactant was supplied by USACE.

Common salvinia is closely associated with waterhyacinth colonies in both locations on Sam Rayburn Reservoir. Water level fluctuations appear to maintain some level of control on common salvinia, stranding much of the exotic fern on dry land as water levels recede during the summer months. Fall surveys indicated there were 180 acres of common salvinia on Sam Rayburn Reservoir in 2003. No treatments targeting common salvinia were conducted by TPWD personnel in 2003 on Sam Rayburn Reservoir.

Hydrilla coverage appears to be increasing on Sam Rayburn Reservoir, although not at historic levels. Fall surveys indicated there were 8,026 acres of hydrilla on Sam Rayburn Reservoir in 2003. Hydrilla has never reached problematic proportions on Sam Rayburn Reservoir, owing primarily to its size, average depth, and annual water level fluctuations. No treatments targeting hydrilla were conducted by TPWD personnel on Sam Rayburn Reservoir in 2003.

Torpedograss is another exotic found on Sam Rayburn Reservoir and fall surveys indicated there were 1,124 acres in 2003. Torpedograss provides marginal fish habitat during periods of high water and may prove beneficial in reducing erosion when present. No treatments targeting torpedograss were conducted by TPWD personnel on Sam Rayburn Reservoir in 2003.

Sheldon Lake

Controlling Authority: TPWD. Contact: Mark Webb, TPWD, phone 979-822-5067, e-mail *mark.webb@tpwd.state.tx.us*. Prohibited plants: hydrilla, giant salvinia.

Status: Sheldon Lake is located east of Houston near the San Jacinto River. Impounded in 1943, the 1,200-acre reservoir has a history of invasive aquatic plant species. Surveys in 2003 indicated there were 800 acres of hydrilla and 3 acres of giant salvinia. Although hydrilla occupied nearly 67 % of the reservoir in 2003, it was not considered problematic. A total of 3 acres of giant salvinia were chemically treated by TPWD personnel using Reward® (diquat) at 0.75% v/v with the surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.09% v/v in 2003 (Table 2).

Toledo Bend Reservoir

Controlling 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 (*Myriophyllum spicatum*), torpedograss .

Status: Spring surveys in 2003 revealed an increase of waterhyacinth in the North Toledo Bend Wildlife Management Area (NTBWMA). In 1986, waterhyacinth covered 100% of the 600-acre management area. Coverage was estimated to be approaching 70% in 2003. Neighboring areas like William's Camp also suffer from annual problems with waterhyacinth, normally restricting access by mid-summer. A total of 156 acres of waterhyacinth were treated on Toledo Bend Reservoir by TPWD personnel in 2003 using Weedar 64® (2,4-D Amine at 1.0% v/v) with Aqua-King Plus® surfactant (at 0.0625% v/v) (Table 2). A total of 126 acres of waterhyacinth were treated in the NTBWMA and 30 acres in 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. Fall surveys estimated there were 1,025 acres of waterhyacinth present on Toledo Bend Reservoir.

Although the waterhyacinth weevil (*Neochetina* sp.) has been found and identified on Toledo Bend Reservoir, total insect populations have always been low. Under ideal conditions, waterhyacinth may reach sufficient biomass fast enough in the growing season to negate the effects of a slower growing weevil population. Although no supplemental releases of the insect have been made recently, such releases may provide some level of suppression in the future. A substantial untreated area is present in the upper end of Toledo Bend Reservoir for the insect to populate.

An estimated 150 acres of giant salvinia was reported on the Texas portion of Toledo Bend Reservoir in the spring of 2003, primarily confined to the backs of creek arms. A relatively mild winter made the potential expansion of giant salvinia during the spring and summer of 2003 inevitable. A total of 107 acres of giant salvinia were treated on the Texas portion of Toledo Bend Reservoir in 2003 in comparison to 43 acres in 2002. Infestations were treated by TPWD personnel using Reward® (diquat) at 0.75% v/v with the surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.09% v/v (Table 2). Chemicals were provided by SRA. Glyphosate-based herbicides have proven more efficient in the control of giant salvinia and will be incorporated to a greater degree in the future to control giant salvinia on Toledo Bend Reservoir.

Efficacy estimates of chemical treatments on giant salvinia are near 95% with a single spraying; however, water temperatures $\geq$ 80°F allow untreated plants to re-infest treated areas quickly. Numerous backwaters on Toledo Bend Reservoir provide ideal nursery areas that harbor giant salvinia colonies. High flows during flood events disperse plants throughout the reservoir every year. Plants that are not stranded above the water line as the water recedes quickly establish new infestations.

Environmental instability is a critical factor in decreasing the growth and expansion of giant salvinia (Peter Room, Commonwealth Scientific and Industrial Research Organisation, Australia, pers. comm.). Extreme cold has been attributed to plant mortality (Oliver 1993), although thick mats of giant salvinia can efficiently

insulate plants from freezing temperatures. Treatment priorities include boat ramps and other public access areas to reduce the potential for accidental transfer and introduction of this plant into other waters. In conjunction with this effort, posted signs are maintained annually at all boat ramps to maintain public awareness.

Introductions of the salvinia weevil have proven promising and continue on Toledo Bend Reservoir. USDA personnel in Florida and Texas, in partnership with TPWD, are currently collecting pre- and post-release plant biomass data on Toledo Bend Reservoir. After an initial introduction of 220 weevils in October 2001, a total of 597 weevils have been released at the Cypress Bend research site on Toledo Bend Reservoir in Louisiana (Fig. 4). In spite of a drastic reduction in giant salvinia coverage in July 2003 at the Cypress Bend release site, a complete re-colonization of the entire site was documented in August 2003. Augmenting and maintaining high numbers of weevils in backwater nursery areas may be the key to effective establishment and subsequent dispersal of weevils throughout the reservoir.

Fall surveys indicated a decline in hydrilla coverage on Toledo Bend Reservoir in 2003. Although primarily confined to major creek arms in the lower half of the reservoir, stands of hydrilla appeared healthy and expanding. Total coverage of hydrilla in the Texas portion of Toledo Bend Reservoir in 2003 was estimated to be approximately 1,631 acres in comparison to 9,830 acres in 2001 and 2,567 acres in 2002. Stands of hydrilla were often associated with Eurasian watermilfoil and coontail. No treatments targeting hydrilla were conducted by TPWD personnel on Toledo Bend Reservoir in 2003.

Eurasian watermilfoil is closely associated with hydrilla in Toledo Bend Reservoir, but has never posed a serious problem on the reservoir. No treatments targeting Eurasian watermilfoil were conducted by TPWD personnel on Toledo Bend Reservoir in 2003.

Torpedograss is another exotic found on Toledo Bend Reservoir. Although fall surveys did not indicate there was any torpedograss present in 2003, low water levels prevented accurate measurement of the extent of its presence. Torpedograss has never reached problematic proportions on Toledo Bend Reservoir and in addition to its value as fish habitat when inundated, it may prove beneficial in reducing erosion where it does occur. No treatments targeting torpedograss were conducted by TPWD personnel on Toledo Bend Reservoir in 2003.

Tyler Nature Center Pond

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

Status: Tyler Nature Center Pond is a small, 2-acre impoundment located on TPWD property that is used primarily for outreach fishing events and educational purposes. The

presence of hydrilla posed a significant risk to many of the native aquatic plant species present in the small pond. Effective chemical treatment demanded a minimum of impact on native species. The pond was treated with a low concentration (5-10 ppb) of Sonar SRP® requiring a rate of 10 lb/acre (Table 2). Post-treatment surveys indicated there was complete removal of hydrilla and minimal impact on native plant species.

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 historically supports a small population of waterhyacinth normally controlled by physical removal. In 2003, a small colony of waterhyacinth was found to be inaccessible to physical removal and required chemical treatment. TPWD personnel treated 0.25 acre of waterhyacinth on Lake Quitman in 2003 using Weedar 64® (2,4-D Amine) at 1.0% v/v and the surfactant Aqua-King Plus® at 0.0625% v/v (Table 2). In this particular instance, routine surveys combined with physical removal and chemical control may eventually eradicate waterhyacinth at Lake Quitman.

SUMMARY

The fertile waters of Texas continue to provide ideal habitat for both exotic and native species of aquatic vegetation. Non-native species are becoming more common in the nutrient-rich waters of the more temperate regions of the state. Although dispersal of seeds and vegetation can theoretically occur by a number of means, most new infestations of nuisance exotic aquatic vegetation are found near boat ramps and other public points of access. Boat trailers have historically contributed to the inadvertent spread of many species between public waters. Unintentional introductions by unwitting aquarium and water garden enthusiasts most likely contributed to the establishment and spread of giant and common salvinia species in the continental United States. Past experience and documented evidence from other countries indicate that, once established, infestations of waterhyacinth, hydrilla, and giant salvinia will require intensive management efforts in waters where they are present (TPWD, unpublished data). Fast, decisive action is paramount to possible eradication in the event of new infestations of any exotic aquatic vegetation. Although the most effective means of control remain aquatic herbicides, the release and establishment of promising biocontrol agents like the salvinia weevil hold great promise and may provide the key to long-term, cost-effective management of many invasive species. The primary directive of the TPWD aquatic vegetation control effort continues to emphasize the eradication, if at all possible, of new infestations of problematic non-native aquatic plant species as they are identified.

PRIORITIES FOR 2004

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 water owners for vegetation management procedures other than for giant salvinia.

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Table 1. Harmful or potentially harmful exotic aquatic plants in Texas, 2003.

Scientific name	Common name
*Spirodela polyrhiza**	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

* Plants 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 prohibited plant species in Texas.

Target plant	Herbicide (a.i.)/ surfactant	Rate (ppm or ppb)
waterhyacinth	Rodeo® (glyphosate)/	3 qt/acre (1ppm)
	Aqua-King Plus® non-ionic surfactant	0.25-2 qt/acre
waterhyacinth	Weedar 64® (2,4-D Amine)/	1 gal/acre (1.7 ppm)
	Aqua-King Plus® non-ionic surfactant	0.25-2 qt/acre
hydrilla	Aquathol Super K® (endothall granular)	8.8 - 17.6 lb/acre-ft (2-4 ppm)
hydrilla	Aquathol K® (endothall liquid)	1.3 - 2.6 gal/acre-ft (2-4 ppm)
hydrilla	Sonar®SRP (fluridone)	32-80 lb/acre (60-150 ppb)
hydrilla	Sonar® A.S. (fluridone liquid)	8-32 oz/acre* (10-150 ppb)
giant salvinia	Rodeo® (glyphosate)/	1-2 gal/acre (1.3-2.6 ppm)
	Aqua-King Plus® non-ionic surfactant	1-2 qt/acre
	Thoroughbred® organo-silicone surfactant	12 oz/acre
giant salvinia	Reward®(diquat)/	3 qt/acre(0.7 ppm)
	Aqua-King Plus® non-ionic surfactant	1-2 qt/acre
	Thoroughbred® organo-silicone surfactant	12 oz/acre
giant salvinia**	Sonar® A.S. (fluridone liquid)	1 qt /acre (80 ppb)

* Variables dictate optimum use rates (passive or flow-through).

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

Figure 1. Waterhyacinth distribution in Texas, 2003.

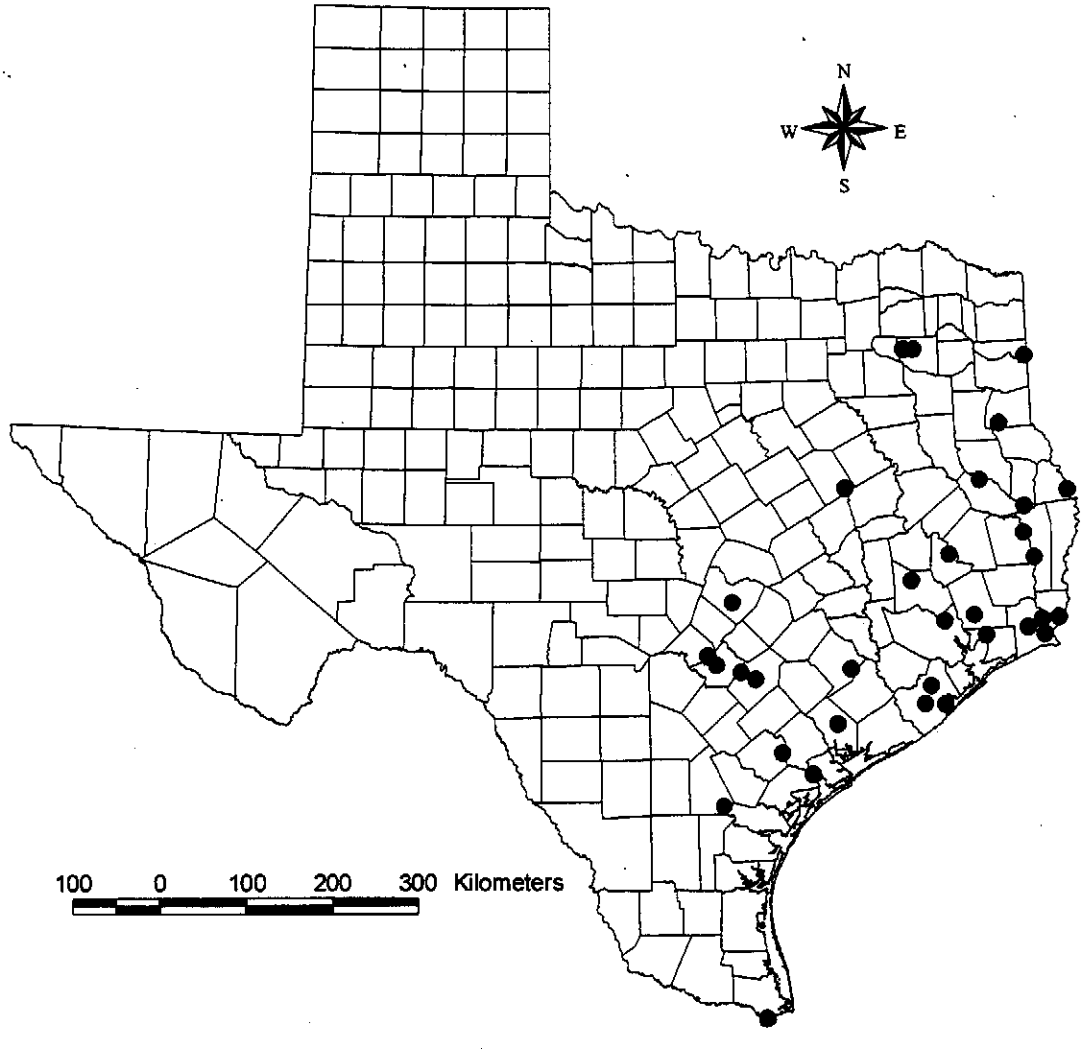


Figure 2. Hydrilla distribution in Texas, 2003.

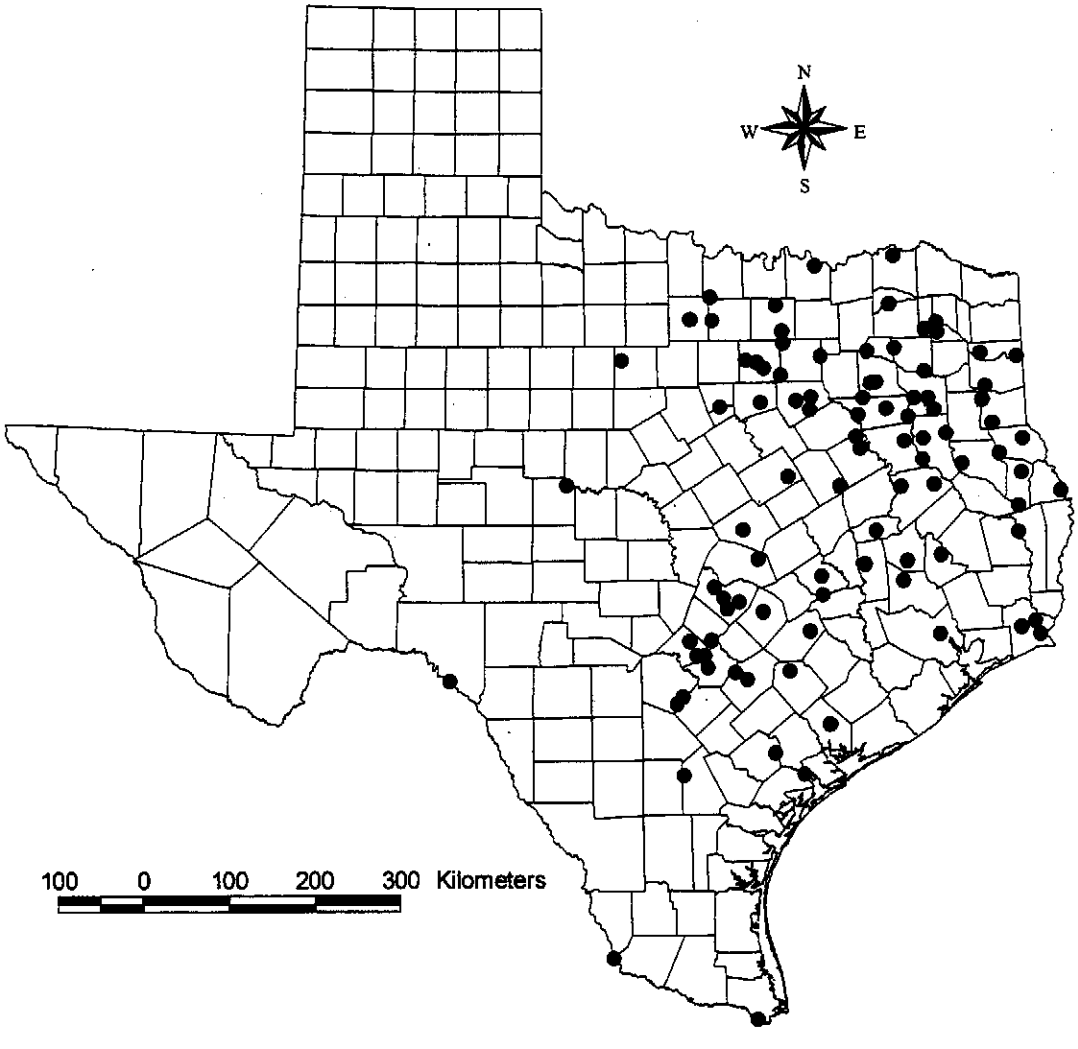


Figure 3. Giant salvinia distribution in Texas, 2003.

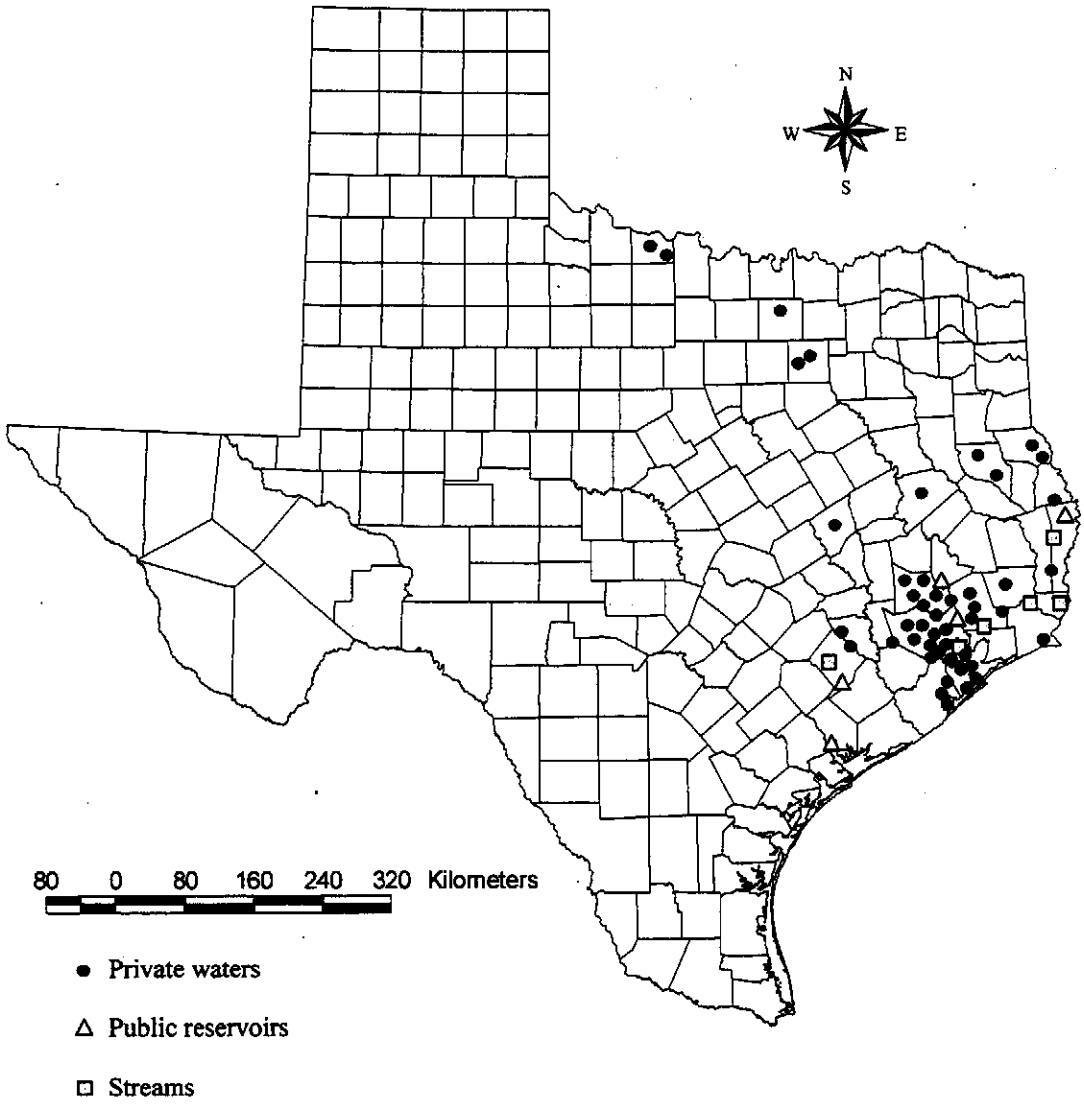
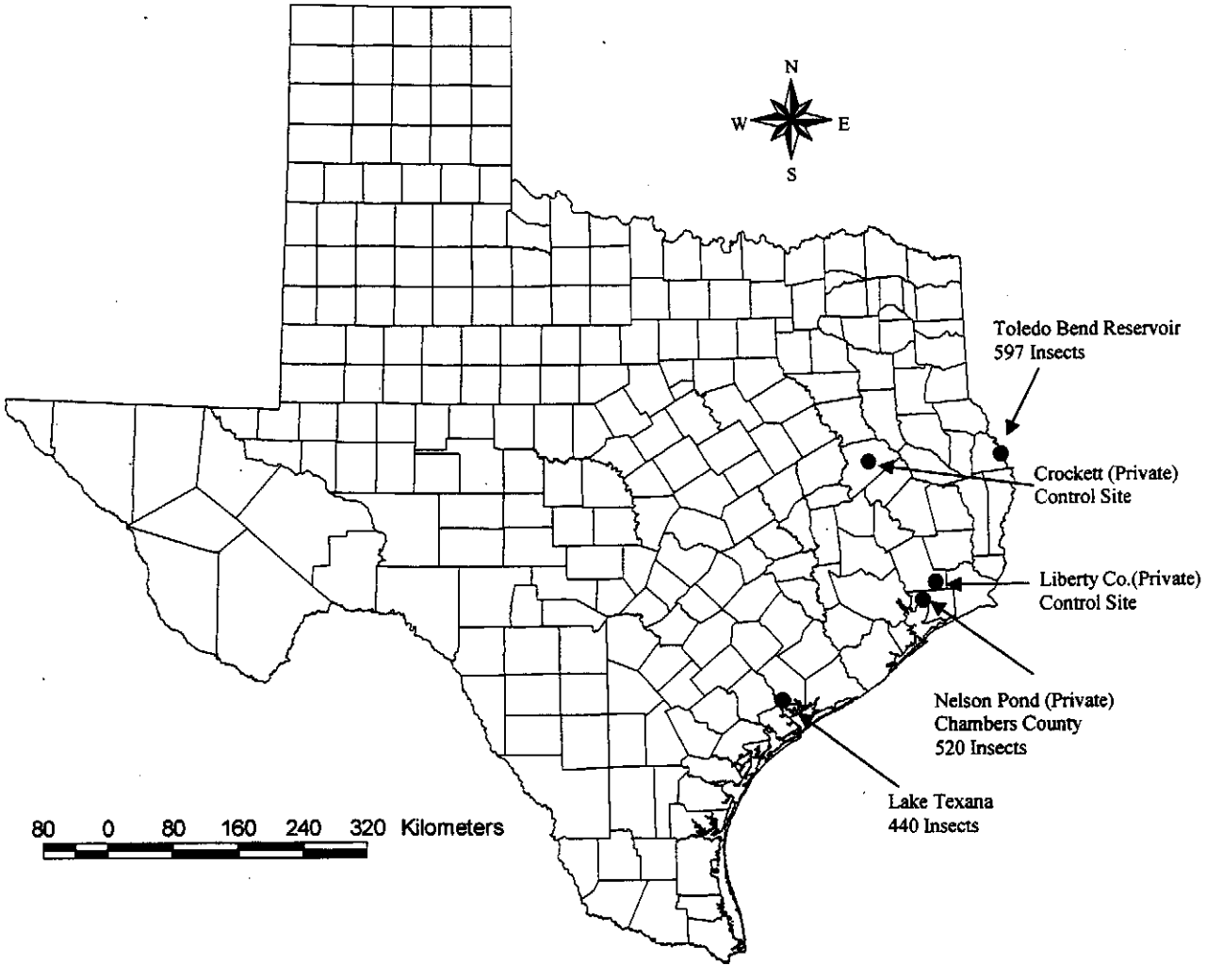


Figure 4. Australian salvinia weevil release locations in Texas, October 2001 - October 2003.



Appendix I. Statewide occurrence of non-native (listed) aquatic vegetation in Texas, 2003. 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
Amon G. Carter	2,126	0015	hydrilla	0.1
Aquilla	2,366	0021	hydrilla	4
Armand Bayou Coastal Preserve	300	1945	waterhyacinth	50*
Austin	1,830	0033	hydrilla	197
			Eurasian watermilfoil	42.8
Athens	1,500	0031	hydrilla	1
B.A. Steinhagen	16,830	0694	alligatorweed	679*
			hydrilla	945
			common salvinia	1,096*
			waterhyacinth	160*
Bastrop	906	0046	hydrilla	122
			Eurasian watermilfoil	7
Bob Sandlin	9,460	0646	hydrilla	404
Bridgeport	13,000	0109	hydrilla	5
Brandy Branch	1,242	0110	hydrilla	155
Big Creek	520	0074	Eurasian watermilfoil	39.8
Choke Canyon	25,969	0164	hydrilla	3,130
Caddo	26,800	0128	Eurasian watermilfoil	300
			hydrilla	100
			waterhyacinth	400*
Cedar Creek	34,300	0152	hydrilla	<0.1
Conroe	21,000	0192	alligatorweed	200
			hydrilla	20
			giant salvinia	40
			waterhyacinth	200
Fayette	2,400	0282	hydrilla	1
Lake Fork	27,690	0433	alligatorweed	3.3
			Eurasian watermilfoil	9.9
			hydrilla	1,773
			waterhyacinth	3.3*
Gibbons Creek	2,500	0304	hydrilla	1
			waterhyacinth	8*
			alligatorweed	1

Appendix I. Continued.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Gilmer	1,010	1778	hydrilla	7*
Hawkins	800	0347	Eurasian watermilfoil	29.5
Houston	12,240	0368	alligatorweed	5
Houston County	1,523	0369	hydrilla	1
			waterhyacinth	15
Jacksonville	1,352	0389	hydrilla	185
Joe Pool	7,470	0582	hydrilla	116
Kurth	800	0420	hydrilla	144
Limestone	11,785	0447	hydrilla	Trace
			waterhyacinth	3
Livingston	90,000	0451	hydrilla	5
			waterlettuce	300
			waterhyacinth	300
Madisonville	75	0469	hydrilla	39
Monticello	2,000	0090	hydrilla	3.6
Moss	1,125	0511	hydrilla	6
			torpedo grass	2
Nacogdoches	2,200	0521	hydrilla	256
Pinkston	580	0658	Eurasian watermilfoil	1
Purtis Creek	354	0593	alligatorweed	0.5
			hydrilla	6*
Quitman	814	0596	waterhyacinth	1
Raven	354	0599	alligatorweed	33
			hydrilla	100
			waterhyacinth	1*
Ray Hubbard	22,745	0600	hydrilla	134
Ray Roberts	29,350	0622	hydrilla	1,000
Rio Grande		1492	waterhyacinth	700*
			hydrilla	3,150*
San Augustine City Lake	200	0644	hydrilla	88
Sam Rayburn	114,500	0640	hydrilla	8,026
			torpedo grass	1,124
			waterhyacinth	88*
			common salvinia	180
Sheldon	1,200	0667	hydrilla	800
			giant salvinia	3*

Appendix I. Continued.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Somerville	11,460	0680	alligatorweed	1.5
			hydrilla	1,368
Stillhouse Hollow	6,429	0696	hydrilla	30
Striker	1,920	0701	hydrilla	Trace
Timpson	237	0731	hydrilla	90
Toledo Bend	185,000	0734	alligatorweed	26
			Eurasian watermilfoil	342
			hydrilla	1,631
			giant salvinia	124*
			waterhyacinth	1,025*
Town	525	0737	Eurasian watermilfoil	2
Tyler Nature Center	2	1831	hydrilla	1*
Waco	7,173	0763	hydrilla	Trace
Walter Long	1,214	0235	hydrilla	70.6

* Infestation treated during 2003. 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.

Daily Log of Herbicide Operations

Date: ____/___/_____
Project: _____ Task: ____

Operation Data:

Work Detail

☐ - Survey only

☐ - Application

Time

Start _____

Stop _____

Equipment

☐ - Airboat

☐ - Outboard

☐ - Truck

☐ - Aerial

Water body Name: _____

County Name: _____

Specific Area: _____

Weather Data:

	Time	Air Temp (°F)	Water Temp (°F)	Wind Direction	Wind Speed (MPH)
Begin:	_____	_____	____	___	_____
End:	_____	_____	____	___	_____

Application Data:

Additive 1: ____Rate _____ _____
Additive 2: ____Rate _____ _____
Additive 3: ____Rate _____ _____

Herbicide 1: _____
Herbicide 2: _____
Herbicide 3: _____

Cost Additive/Acre: _____per_____
_____per_____
_____per_____

Cost of Herbicide : _____per _____
_____per_____
_____per_____

Total Additive(s) Used: _____
_____
_____

Rate of Herbicide/Acre: _____per_____

Target Plant(s): _____

Total Amount Herbicide Used: _____

Acres Treated: _____

Mix Volume/Acre: _____

Aerial Data:

FAA# N-_____

Decal # _____

Reg #_____

Reg #_____

Date: _____

Certified Applicator

Crew Member