Nuisance Aquatic Vegetation Control in 2004

by
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Management Data Series
No. 239
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INLAND FISHERIES DIVISION
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For over 50 years, personnel of the Inland Fisheries Division of Texas Parks and Wildlife Department (TPWD) have engaged in aquatic habitat improvement. Employees involved in these efforts, past and present, deserve recognition and appreciation for their contributions. Personnel of the Jasper Aquatic Habitat Enhancement office, District I-E in Mathis, and District III-E in Bryan deserve unique acknowledgment and respect for their committed effort in aquatic habitat improvement and the control/removal of invasive aquatic vegetation. We thank the field personnel of Inland Fisheries, Region III for their constructive review of this report. We thank Fred Janssen for contributing his GIS expertise and Dick Luebke for his editing proficiency. Lastly, we extend our personal gratitude to our support staff in Region III and Austin headquarters.

ABSTRACT

Many public waters within Texas harbor exotic aquatic plant species that impact resource use, displace native vegetation, and degrade aquatic ecosystems. Utilizing integrated pest management, control efforts in 2004 focused on giant salvinia, (*Salvinia molesta* D.S. Mitchell), waterhyacinth, [*Eichhornia crassipes* (Mart) Solms], and hydrilla [*Hydrilla verticillata* (L.F.) Royle]. Methods employed in 2004 included the use of liquid and granular aquatic herbicides, and the introduction of biological control agents. The first priority of TPWD aquatic vegetation control in 2005 will be to contain expansion of giant salvinia, preventing its spread into non-infested public reservoirs. Measures to be taken will include herbicide treatments at reservoir access points, wildlife management areas and state parks, augmentation of salvinia weevil (*Cyrtobagous salviniae* Calder and Sands) populations, and engagement in public education. Secondary priorities will include management and control of waterhyacinth, hydrilla, and other exotic species.

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INTRODUCTION

The nutrient-rich inland waters of Texas possess diverse native aquatic plant communities that are essential to healthy aquatic ecosystems. Unfortunately many public waters host exotic and invasive aquatic plant species which restrict resource access, displace native plants, and degrade aquatic habitat. Introduced exotic plant species lack natural controls present in their region of origin and rapidly fill ecological niches.

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 impact the freshwater aquatic resources of Texas. Control and management efforts of nuisance aquatic plant species by TPWD 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 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 or physical removal, 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 2004. 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).

Known distributions of waterhyacinth, hydrilla and giant salvinia within Texas are shown in Figures 1-3, respectively. Appendix I lists the known occurrence during 2004, 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 all herbicide treatments by TPWD on public waters in 2004 can be found in Table 3. Locations of salvinia weevils (*Cyrtobagous salviniae*) 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 found in Appendix II.

Waterhyacinth

Anecdotal information tells us 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 1900's (Wunderlich 1962; Zeiger 1962). While it is unknown when waterhyacinth was discovered in Texas, use of herbicides to control its spread 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 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. Detriments of water hyacinth 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 further reduces dissolved oxygen levels. Consequently, biological diversity declines and fisheries are negatively impacted.

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, use of aquatic herbicides is the most effective method for controlling waterhyacinth. Estimated costs of chemical treatments to control waterhyacinth ranged from $48 to $62 per acre.

Waterhyacinth has been identified on 34 public waters within the state (Fig. 1). The only new infestation of waterhyacinth reported in 2004 was on Lake Tawakoni. Established infestations in Lake B.A. Steinhagen, Lake Caddo, Lake Fork, Lake Quitman, Sam Rayburn Reservoir, Toledo Bend Reservoir, Armand Bayou, and the lower Rio Grande continue to require annual herbicide treatments. The most severe infestations that required treatment in 2004 were on Armand Bayou Coastal Preserve, Toledo Bend Reservoir, and Caddo Lake. The recent trend of mild winters has resulted in increased survival of waterhyacinth populations throughout these waters.

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 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 produces propagules called turions that can remain quiescent in undisturbed sediments for years. These persistent turions function

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. Lake Athens was the only reservoir to report a new (Tier I) infestation of hydrilla in 2004.

Giant Salvinia

Giant salvinia is a highly invasive floating fern native to Brazil, South America. 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 within the United States 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 the eutrophic nature of aquatic ecosystems (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. Since then, no new infestations have been documented on public waters. Giant salvinia continues to persist in 10 public waters and has been reported in 49 private waters (Fig. 3). Two new infestations of giant salvinia on private waters were reported in 2004, one in Montgomery County and one in Brazoria County.

With the exception of United States Department of Agriculture (USDA) research sites, every effort has been made to eradicate populations in private waters and nurseries where it has been found. A total of 228 acres of giant salvinia on Toledo Bend Reservoir were chemically treated by TPWD personnel in 2004. Estimated costs of herbicide applications to treat giant salvinia in 2004 range from $100 to $112 per acre.

TPWD personnel continued to assist the USDA with research on development and propagation of the salvinia weevil as a biological control agent for giant salvinia.

Success of this insect on infestations in other parts of the world has been thoroughly demonstrated (Room et al. 1981). Although salvinia weevils were initially released in Texas in October 2001 for research purposes, large-scale introductions began in July 2004. Insects provided by USDA/APHIS/MPPC in Mission, Texas were released on giant salvinia infestations on Toledo Bend Reservoir (140,075 insects), Sheldon Lake (56,000 insects), Lake Conroe (10,000 insects), and Lake Texana (104,440 insects). Costs associated with weevil introductions were minimal. Weevils were provided free-of-charge and expenditures included only manpower, fuel, and related per-diem.

AQUATIC PLANT MANAGEMENT BY WATER BODY IN 2004

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 maintained by TPWD. The preserve, located on the northwest shore of Clear Lake estuary, is an environmentally sensitive area that supports a unique assemblage of coastal wetland plants and animals. Waterhyacinth is a persistent problem within the preserve due to the presence of a large seed bank deposited over many years. Waterhyacinth expanded significantly in spring 2004 due to favorable environmental conditions. TPWD personnel treated a total of 114 acres of waterhyacinth in 2004, compared to 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 indicate herbicides were effective in treated areas. Some areas were inaccessible due to tidal fluctuations. Seasonal flooding events transport large quantities of waterhyacinth downstream into saline areas every year, killing plants. The inevitable yearly germination of seed will require continued assessment 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 plant: hydrilla.

Status: Lake Athens is a small, 1,500-acre, oligotrophic reservoir with no recent history of noxious vegetation. In 2004, 1 acre of hydrilla was found growing at the Lake Athens Marina Boat Ramp and in waters near the shoreline adjacent to the FM 2495 bridge. Due to the potential of hydrilla to become a severe aquatic nuisance, a Tier I response prompted TPWD to treat the stands with Aquathol K® (endothall) at 4 ppm (Table 2). The chemical was supplied by the City of Athens. Although post-treatment surveys indicate high efficacy, endothall typically provides a maximum of 3-4 months of control.

Future surveys will be needed to ensure hydrilla and other exotic species do not become 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: Waterhyacinth continued to persist and grow to problematic infestations on Lake B.A. Steinhagen in spring and summer months. Heavy infestations in 2004 caused serious access problems to USACE and TPWD boat ramps. TPWD personnel treated 90 acres of waterhyacinth on Lake B.A. Steinhagen in 2004, focusing primarily on boating access. Treatments were conducted using Weedar 64® (2,4-D Amine at 1.0% v/v) with Aqua-King Plus® surfactant (0.0625% v/v) (Table 2). Herbicide was supplied by Martin Dies State Park.

Fall 2004 surveys by TPWD personnel revealed 890 acres of hydrilla were present on Lake B.A. Steinhagen. Infestations continued to be isolated and seldom required extensive control efforts. Lake B. A. Steinhagen is highly turbid and habitat suitable for hydrilla is limited. Predictably, hydrilla expansion should be minimal in 2005. TPWD personnel conducted no treatments of hydrilla in 2004.

Common salvinia continued to expand on Lake B.A. Steinhagen; fall 2004 surveys indicated there were 1,271 acres. Populations were found in close association with waterhyacinth colonies where both plants formed extensive mats of vegetation. Herbicide treatments were focused within the USACE Magnolia Ridge Unit. A total of 6 acres of common salvinia and waterhyacinth were treated by TPWD personnel in 2004 using the herbicide Aquamaster® (glyphosate) at 0.75% v/v and surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2). The treatment targeted waterhyacinth. Herbicide and surfactant were provided by the USACE.

Biological control of common salvinia using the salvinia weevil is being researched by the USDA. In 2004, USDA personnel supplied TPWD with 183 weevils that were released at two different sites in the USACE Magnolia Ridge Unit.

Alligatorweed continued to expand on Lake B.A. Steinhagen due to favorable growing conditions. Because of its resistance to approved aquatic herbicides, alligatorweed is seldom treated by TPWD. An experiment conducted by SePRO Corporation and TPWD in 2003 found that the chemical tryclopyr may be effective for controlling alligator weed in the future. The alligatorweed flea beetle (*Agasicles hygrophila*) is present on the reservoir but suppression of alligatorweed is not evident. Alligatorweed may be outgrowing any damaging impact the flea beetles have at present population numbers. Future augmentation of alligatorweed flea beetle populations should be considered.

Because Lake B.A. Steinhagen is shallow, eutrophic, and host to several exotic species, vegetation management will require more strategic planning in the future. Periodic reservoir drawdowns during winter months have been used on Lake B.A. Steinhagen to control aquatic vegetation. The effectiveness of these drawdowns as vegetation management tools is directly related to the severity of winter, in some years resulting in plant mortality of 95% (Helton and Hartmann 1995). The USACE has planned a drawdown for summer 2006. If weather is predictably hot and sufficiently dry, acceptable reduction of aquatic weeds should result.

Brazos Bend State Park

Controlling Authority: TPWD. Contact: Steve Killian, Park Manager, phone 979-553-5101, e-mail *steve.killian@tpwd.state.tx.us*. Prohibited plant: waterhyacinth. Nuisance plants: coontail (*Ceratophyllum demersum*), American lotus (*Nelumbo lutea*).

Status: Surveys conducted by Brazos Bend State Park personnel reported overgrowth of several aquatic plant species, both native and exotic, within the park. The park lake management program was cancelled in 1995 as a result of budget cutbacks. After several years without vegetation management, the lakes required a Tier I response. Surveys indicated Elm Lake, Forty Acre Lake, and Pilant Lake were completely covered with aquatic vegetation. TPWD treated 26 acres of American lotus and waterhyacinth using the herbicide Aquamaster® (glyphosate) at 0.75% v/v and ChemSurf® (surfactant) at 0.25% v/v to open access to fishing and other recreational use. The treatment targeted American lotus. Herbicide was provided by Brazos Bend State Park. Adherence to a management program will be essential in preventing overgrowth of aquatic vegetation and maintaining recreational value of the fishing lakes at Brazos Bend State Park.

Caddo Lake

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

Status: Waterhyacinth populations in Caddo Lake continued to persist. A total of 321 acres of waterhyacinth were treated in 2004, compared to 202 acres in 2003. TPWD personnel conducted 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). Treatments focused on the Caddo Lake Wildlife Management Area (CLWMA), public-access locations, residential frontage, and boat lanes to popular angling/waterfowl hunting areas. All herbicide and surfactant was provided by TPWD Wildlife Division. A fall survey in 2004 estimated 1,000 acres of waterhyacinth remained on Caddo Lake, with highest concentrations in the CLWMA. Due to the existence of a well established seed bank, waterhyacinth can be expected to be problematic on Caddo Lake for many years.

Fall surveys in 2004 indicated an increase in hydrilla coverage to an estimated 250 acres, compared to 100 acres in 2003. In addition to its presence in historical locations, isolated stands of hydrilla were observed in remote areas, less frequented by resource users. No treatments targeting hydrilla were conducted by TPWD personnel on Caddo Lake in 2004.

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.

Status: Lake Conroe is a 21,000-acre impoundment located in Walker and Montgomery counties. Giant salvinia was discovered in Lake Conroe in spring 2000. Since then, despite aggressive chemical applications, giant salvinia persists. Twenty five acres of giant salvinia were reported in fall 2004 surveys, compared to 40 acres in 2003. An estimated 10,000 salvinia weevils, supplied by the USDA, were released into Lake Conroe in 2004 as a biological control.

Hydrilla populations on Lake Conroe rebounded in 2004. Chemical treatment of 140 acres of hydrilla on Lake Conroe was conducted by SJRA in 2004 with the assistance of personnel from TPWD Inland Fisheries Districts III-E and Aquatic Habitat Enhancement (AHE).

Cow Bayou

Controlling Authority: Orange County Drainage District. Contact: Wilbert Duhon, phone 409-745-3225. Prohibited plant: common salvinia.

Status: Cow Bayou is a tidal stream that converges with the Sabine River above the Sabine Lake estuary. Common salvinia was reported to impede recreational access to the bayou in 2004. Once onsite, TPWD crews did not find the infestation as severe as indicated, however, herbicide was applied to all common salvinia mats found. Thirteen acres of common salvinia were treated with Reward® (diquat) at 0.75% v/v with surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2) to open access in the bayou system. Common salvinia is saltwater intolerant and tidal influx into Cow Bayou will predictably stunt populations within the system and prevent its expansion into Sabine Lake.

Lake Fairfield

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

Status: Lake Fairfield is a 2,353-acre impoundment in Freestone County. American lotus has been abundant on Lake Fairfield and in recent years has established thick growing stands in the Fairfield State Park swimming area. American lotus grows from a persistent rhizome buried in the hydrosoil. For this reason, repeated applications of herbicide will be required to achieve desirable results. Impeded access to the swimming area prompted an herbicide treatment. Three acres of American lotus 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). Herbicide was provided by Fairfield State Park and surfactant was provided by TPWD District AHE. Heavy rains resulted in road damage leading to the boat ramp in 2004, preventing additional treatment.

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, alligatorweed.

Status: Waterhyacinth appeared to be slowly increasing on Lake Fork in spite of annual herbicide treatments. Inaccessible pockets of plants combined with significant seed banks in historically infested areas promise future repopulation of treated areas. A total of 74 acres of waterhyacinth was treated on Lake Fork in 2004, compared to 63 acres in 2003. Infestations were treated by TPWD personnel using both Aquaneat® (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. Although small infestations near fishing piers and docks were treated, the majority of treatments were confined to Glade Creek. Annual maintenance of the waterhyacinth population on Lake Fork will be required to maintain acceptable control.

Alligatorweed has become more prevalent on Lake Fork, primarily in Birch Creek. Although not at problematic levels in 2004, its invasive nature demands close monitoring in the future.

Surveys suggest hydrilla increased to 3,701 acres in 2004 on Lake Fork from the 1,773 acres documented in 2003. No hydrilla treatments were conducted by TPWD personnel in 2004.

Gibbons Creek Reservoir

Controlling Authority: Texas Municipal Power Agency (TMPA). 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 experienced a slight increase of waterhyacinth in 2004. A private contractor treated 5.5 acres of waterhyacinth on the reservoir using Rodeo® (glyphosate) at 0.75% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v (Table 2). Herbicides were provided by TMPA.

Hydrilla and alligatorweed remained at very low levels on Gibbons Creek. No chemical treatments were conducted by TPWD personnel on Gibbons Creek Reservoir in 2004.

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: Hydrilla was first reported in Lake Joe Pool in the late 1990's. No control measures were initiated after its initial discovery since small isolated populations posed no immediate threat to the fishery or recreational access. In fall of 2003, an expansion of hydrilla was documented in the Cedar Hill State Park marina cove, swimming area, and adjacent boat ramps. On the opposite shoreline, Lynn Creek Park (owned by the City of Grand Prairie) experienced a similar expansion of hydrilla near the main swimming area and adjacent boat ramps. An unexpected release of raw effluent from the Cedar Hill water treatment facility is believed to have contributed to the dramatic expansion of hydrilla in Cedar Hill State Park.

The USACE formally requested herbicide treatment to prevent excessive growth of hydrilla on the eastern portion of the reservoir. TPWD personnel from District AHE treated 16 acres of hydrilla using a combination of granular Sonar SRP®, Sonar PR®, and Sonar Q®. Herbicide provided by USACE was applied at Cedar Hill State Park boat ramps and USACE property. Mixtures of Sonar® formulations were used to establish and maintain concentration of the active ingredient fluridone at 90 ppb. The Cedar Hill State Park swimming area was treated with Sonar SRP®, provided by TPWD District AHE. All Sonar® treatments were 70-80% effective, reducing hydrilla to non-problematic proportions where applied. The potential for off-site drift of herbicide in large reservoir applications prevent 100% efficacy of most herbicides designed for submersed vegetation. Under normal conditions, control in areas treated with fluridone is expected to last 1 year or more.

The City of Grand Prairie requested additional treatment of park boat ramps and swimming areas in advance of summer visitation. TPWD personnel from District AHE

treated an additional 10 acres of hydrilla near Lynn Creek Park swimming areas and boat ramps using a combination of the aquatic herbicide Aquathol K® (endothall) at 4 ppm and the algaecide Cutrine Plus® (chelated copper) at 0.7 ppm. The addition of an algaecide was deemed necessary due to the presence of algae, which can interfere with herbicide uptake by hydrilla. Chemicals were provided by the City of Grand Prairie. All treatments were 70-80% effective in treated areas. Endothall provides relatively short-term control, re-growth occurring in as little as 3 months.

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: Historically, Lake Lyndon B. Johnson has not experienced any major aquatic vegetation problems. Fall surveys indicated 83 acres of Eurasian watermilfoil were present. Although its presence represents a growing concern, no measures to control Eurasian watermilfoil were conducted by TPWD personnel in 2004.

A small waterhyacinth population was found in Lake Lyndon B. Johnson in 2004 and immediately classified as a Tier I priority. In an effort to eliminate the plant from the reservoir, TPWD personnel from District I-E treated 2 acres of waterhyacinth using Rodeo® (glyphosate) at 0.75% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v (Table 2). Close monitoring and physical removal of individual plants from the reservoir in 2005 may prevent future need for herbicide treatments.

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: Waterhyacinth continued to persist in Lake Quitman in spite of repeated herbicide treatments and physical removal. In 2004, a group of anglers, the Denton County Bassmasters, assisted TPWD personnel from District III-B with physical removal of a substantial amount of waterhyacinth from Lake Quitman. The unprecedented effort resulted in a significant reduction in vegetation requiring herbicide treatment. District AHE personnel treated 1 acre of waterhyacinth on Lake Quitman in 2004 using Weedar 64® (2,4-D Amine) at 1.0% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v (Table 2). Continued physical removal of waterhyacinth combined with herbicide treatments when necessary may eventually eradicate waterhyacinth from Lake Quitman.

Lake Raven

Controlling Authority: TPWD. Contact: Dennis Smith, phone 936-295-5644, e-mail *dennisedd.smith@tpwd.state.tx.us*. Prohibited plants: hydrilla, waterhyacinth, alligatorweed.

Status: Control measures initiated in 2000 on Lake Raven have proven highly successful in controlling hydrilla. As a result, no chemical treatments for hydrilla were required in 2004.

Alligator weed persisted at previous levels, in spite of the introduction of the alligatorweed flea beetles as a bio-control in 2003. The extent of the alligatorweed infestation did not warrant chemical treatment in 2004.

Waterhyacinth reached a level requiring chemical treatment in 2004. TPWD personnel from District III-E treated 16 acres of waterhyacinth using both Rodeo® (glyphosate) at 0.75% v/v and Reward® (diquat) at 0.75% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v (Table 2). Herbicides were provided by Huntsville State Park.

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: Vegetation control measures initiated on the Rio Grande in 2003 have proven highly successful on hydrilla and waterhyacinth populations, although small populations of waterhyacinth continued to persist in some areas. In 2004, TPWD personnel from District I-E treated 4 acres of waterhyacinth in water connecting to the Rio Grande using Weedar 64® (2,4-D Amine) at 1.0% v/v and Aqua-King Plus® (surfactant) at 0.25% v/v (Table 2).

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: Infestations of waterhyacinth on Sam Rayburn Reservoir remained relatively isolated to two small creeks (Stanley Creek and Harvey Creek) in the Angelina River arm. Seasonal water level fluctuations and dense brush have prevented problematic spread of waterhyacinth to other areas. Low water levels in the summer of 2004 prevented any herbicide treatment of waterhyacinth.

Common salvinia populations increased from 180 acres in 2003 to 365 acres in 2004. Although seldom found in problematic proportions, small colonies of common salvinia are becoming more common in creek arms throughout the reservoir. In 2004, TPWD personnel from District AHE treated 7 acres of common salvinia in Harvey Creek using Renovate 3® (triclopyr) at 0.375% v/v and surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.09% v/v. (Table 2). Herbicide and surfactant were donated by SePRO Corporation.

Torpedograss continued to slowly increase on Sam Rayburn Reservoir. In 2004, 293 acres of torpedograss were documented, compared to 270 acres in 2003. Although a non-native species, torpedograss has never caused any major access problems on Sam Rayburn Reservoir. It has some merit for erosion control and fish habitat where found.

Fall surveys indicate hydrilla coverage decreased from 8,026 acres in 2003 to 2,944 acres in 2004. Hydrilla has never proven problematic on Sam Rayburn Reservoir. No chemical, physical, or mechanical treatments targeting hydrilla were conducted by TPWD personnel in 2004.

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: Giant salvinia was found on Sheldon Lake in July 2000. Herbicides were applied to infestations by TPWD Public Lands and Inland Fisheries personnel. In 2001 no giant salvinia could be located on the reservoir. Giant salvinia reappeared in 2002 and has since re-established. In 2004, TPWD personnel from District III-E treated 5.3 acres of giant salvinia using Reward® (diquat) at 0.75% v/v with surfactants Aqua-King Plus® at 0.25% v/v and Thoroughbred® at 0.1% v/v (Table 2). In efforts to establish biological control, an estimated 56,000 salvinia weevils, supplied by the USDA, were released on the reservoir.

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: Giant salvinia was identified in Lake Texana in 2000. Herbicide treatments of giant salvinia have been complicated by excessive growth of waterhyacinth. A total of 220 salvinia weevils were released by USDA and TPWD personnel in 2001 to evaluate biological control potential of the insects. This research was compromised by low water

levels in the reservoir and vandalism at study sites. In 2004, 104,440 salvinia weevils, supplied by the USDA, were released in efforts to establish biological control of giant salvinia within the reservoir.

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: Rainfall during 2004 maintained water levels on Toledo Bend Reservoir at $\geq$ 168 msl throughout the growing season. Giant salvinia and waterhyacinth populations in backwater areas, normally reduced by low water levels in the fall, increased dramatically in response to relatively stable conditions.

Fall surveys revealed there were an estimated 3,070 acres of giant salvinia in 2004 compared to 124 acres in 2003, in spite of on-going herbicide treatments in Texas and Louisiana. Chemical treatments of giant salvinia proved ineffective in 2004 owing to the plants rapid growth rate and extent of the infestation. By mid-summer of 2004, chemical treatments were limited to boat ramps and access points to maximize available manpower and herbicides and help prevent spread of giant salvinia to neighboring waters. Press releases were distributed to alert the public of the potential danger giant salvinia represents and plans were made to post permanent signs at all boat ramps to enlist public aid in preventing the spread of giant salvinia to other public waters.

Giant salvinia infestations on the Texas portion of Toledo Bend Reservoir (228.3 acres) were treated by TPWD District AHE personnel using both Aquamaster® (glyphosate) and Reward® (diquat) at 0.75% 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 the SRA.

In addition to herbicide applications, large scale introductions of the Australian strain of the salvinia weevil began in 2004. The USDA, in partnership with TPWD, distributed 140,075 insects on the Texas portion of Toledo Bend Reservoir in 2004. Establishment of significant numbers of weevils on a reservoir of this size may take 2-3 years or more.

Environmental instability may prove a critical factor in controlling the growth and expansion of giant salvinia. Giant salvinia has proven susceptible to extreme cold (Oliver 1993), however, a series of relatively mild winters have failed to provide sufficiently low temperatures to reduce giant salvinia in East Texas. A dramatic reservoir-wide reduction in giant salvinia populations was documented after an extended drawdown on Toledo Bend Reservoir in 2001. Prior to 2004, normal reservoir operations provided a fall drawdown which may have contributed significantly in preventing the expansion of giant salvinia on Toledo Bend Reservoir for many years. The absence of such a drawdown in

2004 may be directly related to the dramatic expansion of giant salvinia witnessed in 2004.

Large mats of giant salvinia, flushed from backwaters by heavy rains, pushed south into the main portion of Toledo Bend Reservoir in the fall of 2004. The result was an effective seeding of the reservoir with small viable colonies of giant salvinia. These seedling colonies represent the most severe ecological threat to Toledo Bend Reservoir and neighboring waters like Sam Rayburn Reservoir since the discovery of giant salvinia in 1998.

A total of 140 acres of waterhyacinth was treated on Toledo Bend Reservoir by TPWD District AHE personnel in 2004, compared to 156 acres in 2003. 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 North Toledo Bend Wildlife Management Area and the William's Camp area. Herbicide and surfactant used in the wildlife management area was supplied by TPWD. Chemicals used outside the wildlife management area were provided by SRA.

Fall surveys indicated there was an increase in hydrilla, from 1,631 acres in 2003 to 2,109 acres in 2004. 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 2004.

SUMMARY

In spite of annual vegetation control efforts, non-native aquatic vegetation species persist in public waters of Texas. While some species have proven non-problematic and even beneficial, most, if not all, exotic species present in Texas are increasing every year. Annual control efforts are continually challenged by insufficient fiscal and physical commitments. Budgetary constraints continue to prevent TPWD from assuming extensive aquatic vegetation control responsibilities. Future statewide control efforts will demand the active participation of controlling authorities as well as state personnel and resources. Controlling authorities in Texas that have assumed the responsibility of vegetation control in recent years have proven very effective and deserve recognition.

Integrated pest management techniques remain our foremost weapon in control and management of exotic aquatic plants. Future control efforts should emphasize long-term, non-herbicide options such as water level manipulation, bio-control agents, and physical barriers. 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.

PRIORITIES FOR 2005

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, 2004.

Scientific name	Common name
Spirodela oligorhiza	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 Thoroughbred® organo-silicone surfactant	3 qt/acre (1 ppm) 0.25-2.0 qt/acre 12 oz/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	Sonar SRP® or Sonar PR® or Sonar Q® (fluridone)	32- 80 lb/acre (60-150 ppb)
hydrilla	Sonar AS® (fluridone liquid)	8-32 oz/acre** (10-150 ppb)
giant salvinia	Rodeo® or Aquamaster® (glyphosate)/ Aqua-King Plus® non-ionic surfactant Thoroughbred®organo-silicone surfactant	1-2 gal/acre (1.3-2.6 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***	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.

** 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.

Table 3. Summary of TPWD aquatic herbicide applications (acres treated) for invasive aquatic plants in public waters, 2004.

Water body	Waterhyacinth	Common salvinia	Giant salvinia	Hydrilla	American lotus
Armand Bayou	114				
Lake Athens				1	
B.A. Steinhagen	96				
Brazos Bend State Park					26
Caddo Lake	321				
Cow Bayou		13			
Lake Fairfield					3
Lake Fork	74				
Lake Joe Pool				26	
Lake LBJ	2				
Lake Quitman	1				
Lake Raven	16				
Rio Grande River	4				
Sam Rayburn		7			
Sheldon Lake		5.3			
Toledo Bend	140		228.3		
Lake Quitman	1				
Total	768	25.3	228.3	27	29

Figure 1. Waterhyacinth distribution in Texas, 2004.

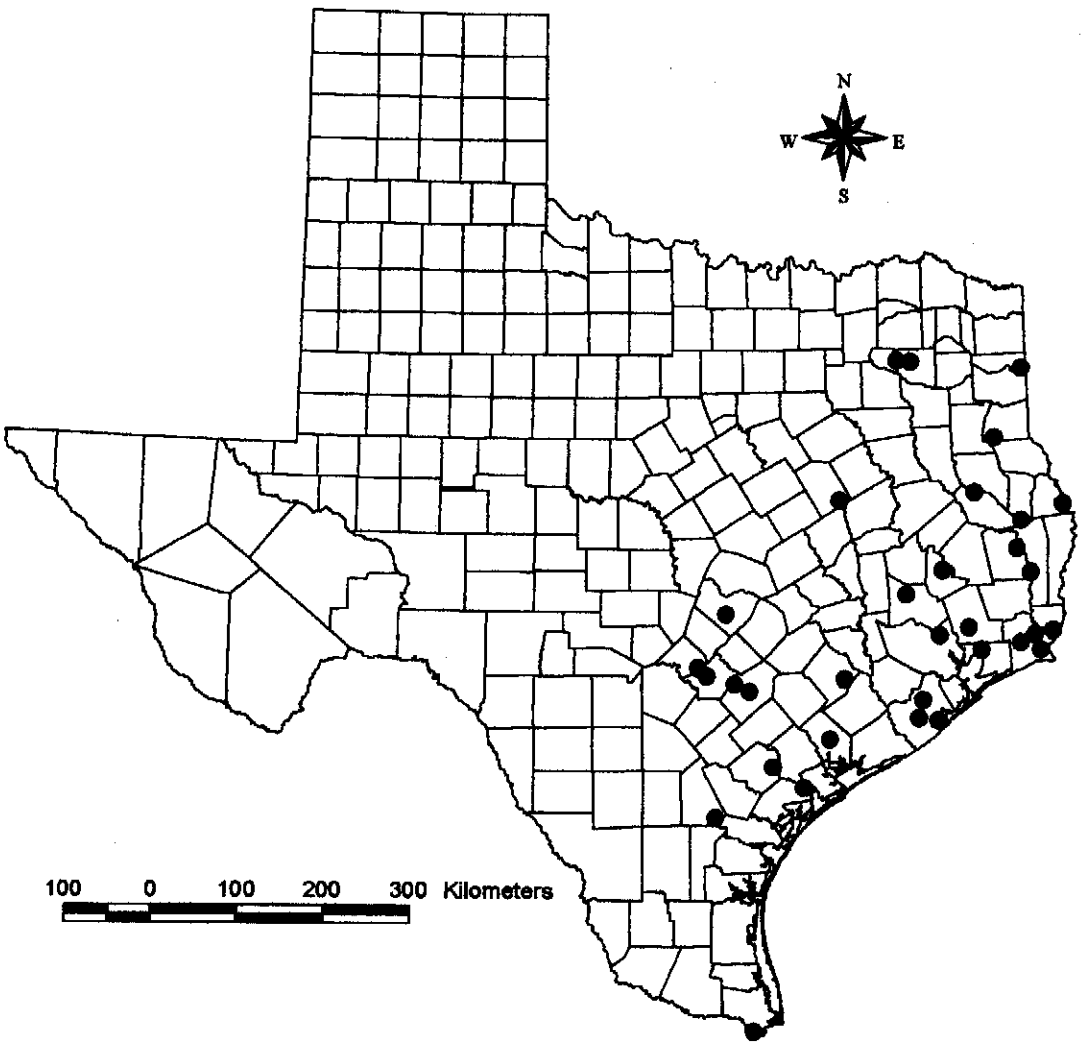


Figure 2. Hydrilla distribution in Texas, 2004.

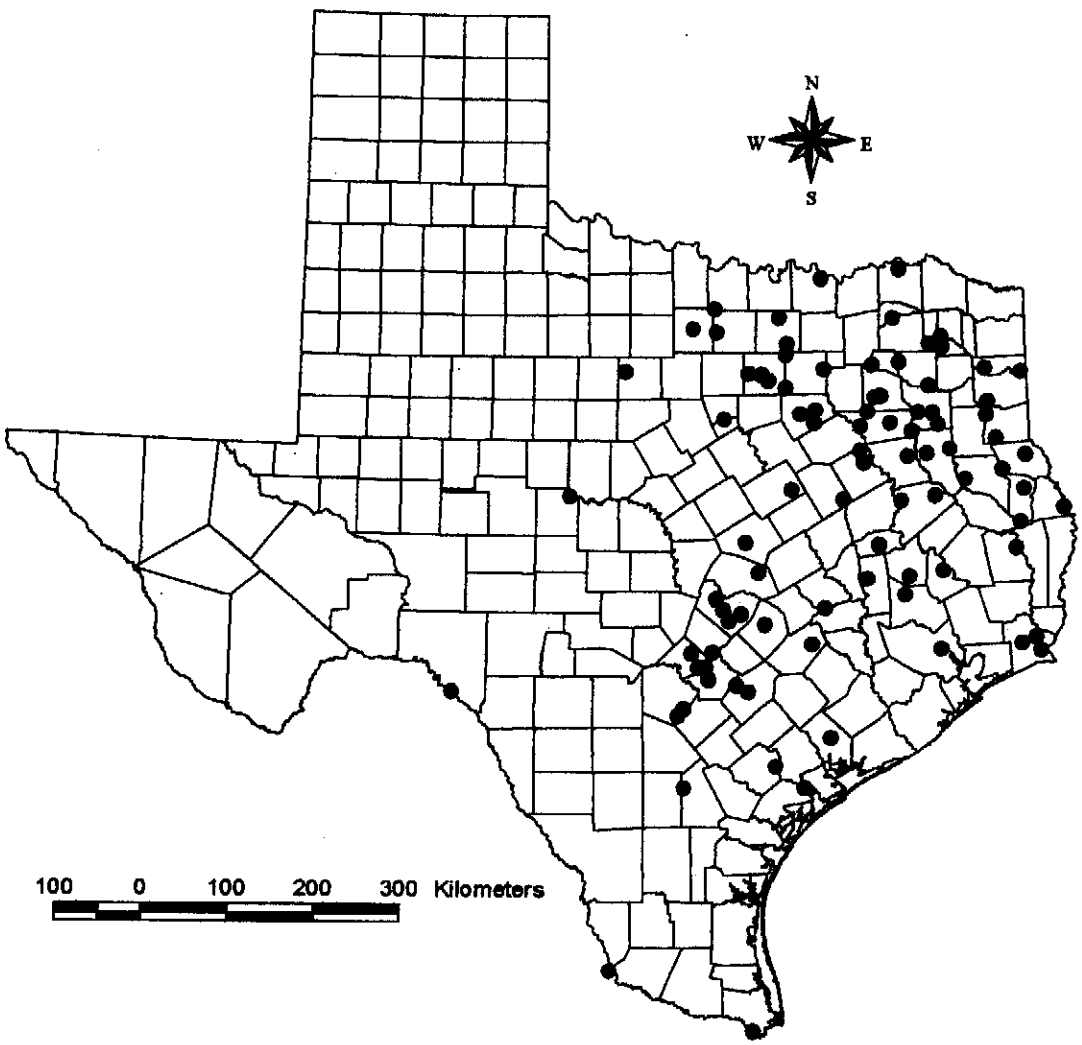


Figure 3. Giant salvinia distribution in Texas, 2004.

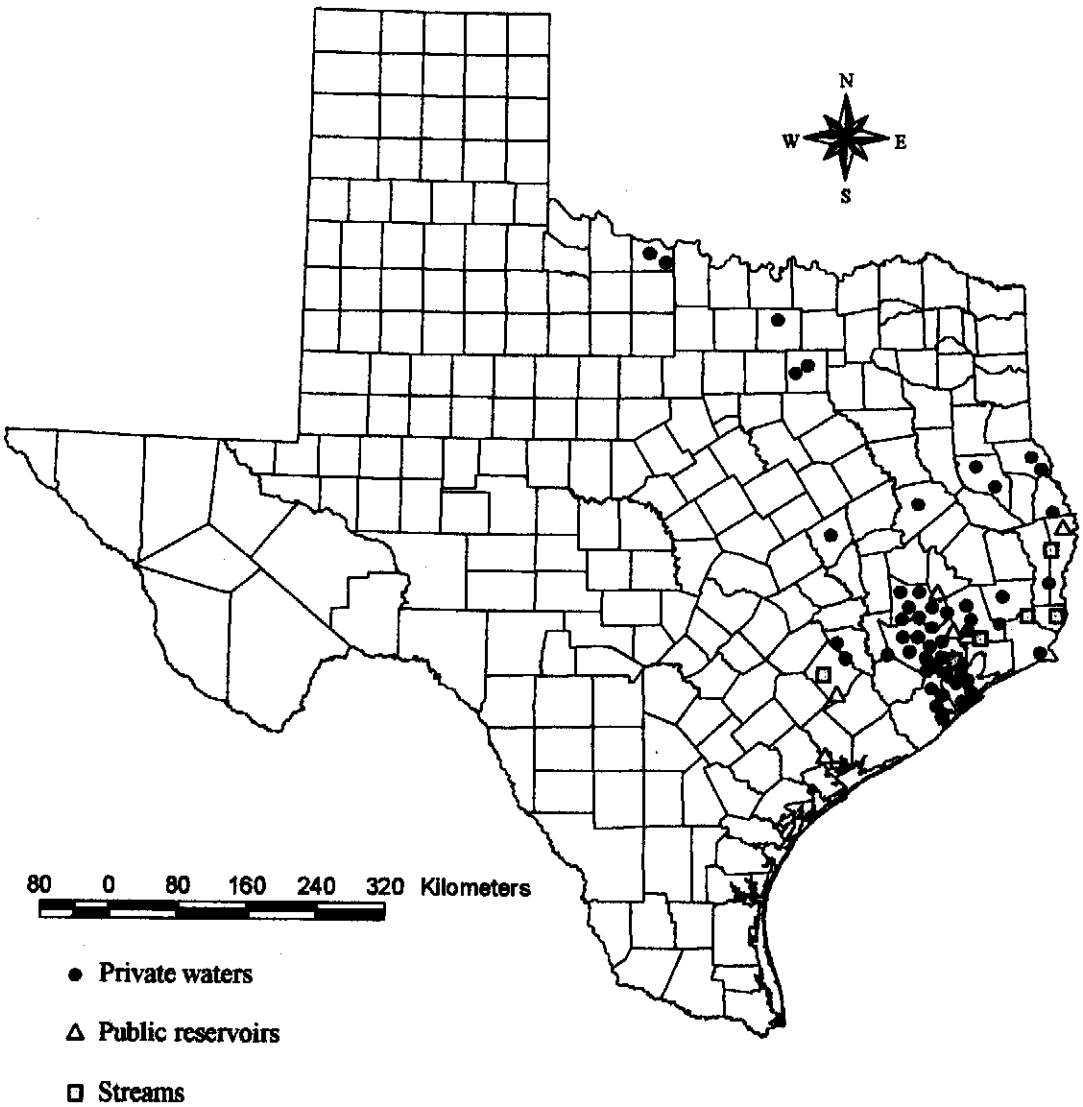
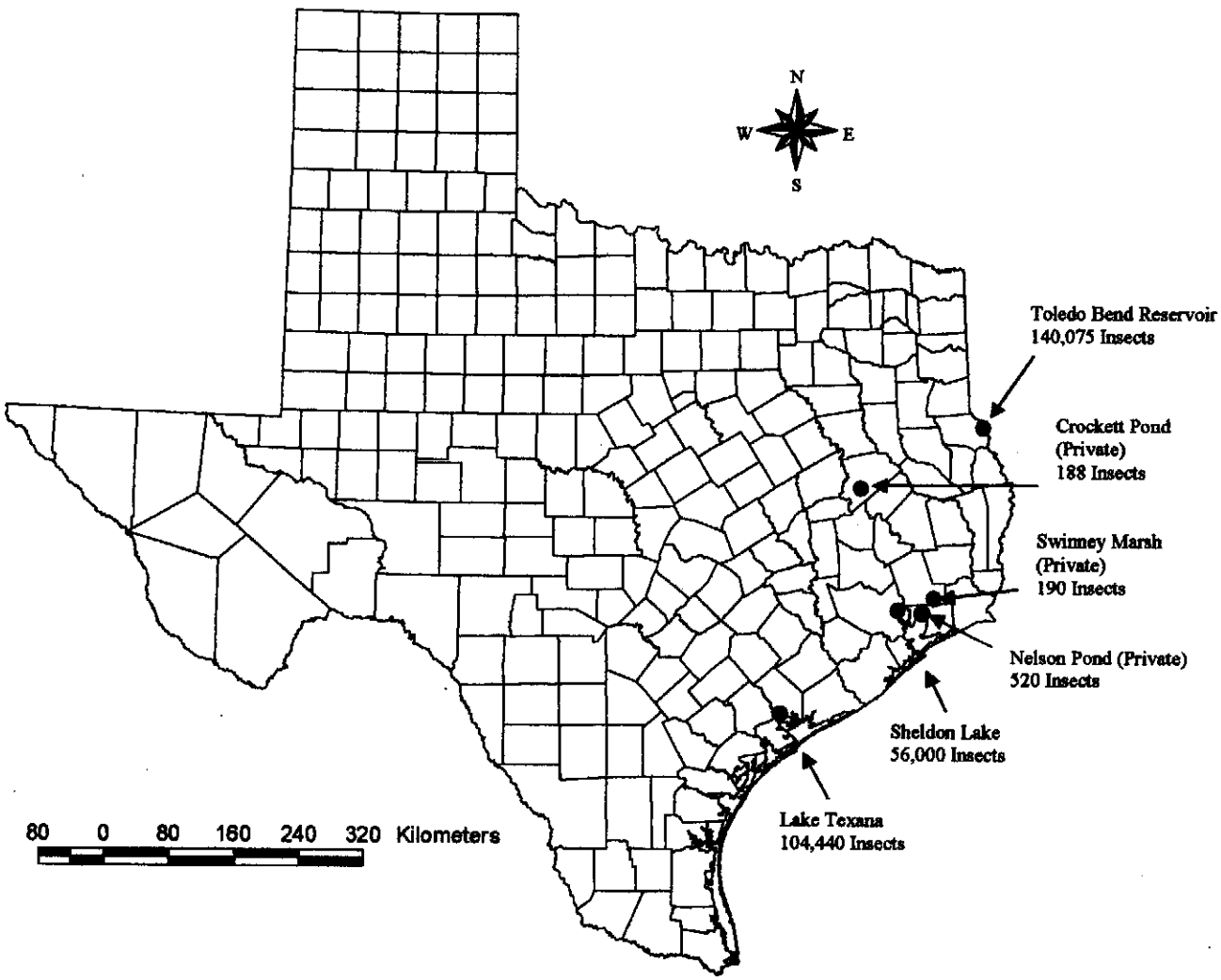


Figure 4. Australian salvinia weevil release locations in Texas, 2001- 2004.



Appendix I. Statewide occurrence of non-native (listed) aquatic vegetation in Texas, 2004. 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	Trace
Armand Bayou Coastal Preserve	300	1945	waterhyacinth	114*
Austin	1,830	0033	hydrilla	26
			Eurasian watermilfoil	29
Athens	1,500	0031	hydrilla	1*
B.A. Steinhagen	16,830	0694	alligatorweed	463
			hydrilla	890
			common salvinia	1,271*
			waterhyacinth	1,535*
			torpedograss	Trace
Bastrop	906	0046	hydrilla	183
			Eurasian watermilfoil	15
Bridgeport	13,000	0109	hydrilla	5
Caddo	26,800	0128	Eurasian watermilfoil	300
			hydrilla	250
			waterhyacinth	1,000*
Corpus Christi	18,256	0201	waterhyacinth	1,200
Lake Fairfield	2,353	0073	giant reed	42
			hydrilla	13
Lake Fork	27,690	0433	hydrilla	3,701
			waterhyacinth	49
Fayette	2,400	0282	Hydrilla	1
			Eurasian watermilfoil	1
Gilmer	1,010	1778	hydrilla	25
Granger	4,064	0319	waterhyacinth	Trace
Houston County	1,523	0369	hydrilla	Trace
			waterhyacinth	1.5
Jacksonville	1,352	0389	alligatorweed	0.07
			giant reed	1.2
			hydrilla	122.5
Joe Pool	7,470	0582	hydrilla	116*
Kurth	800	0420	hydrilla	170
Lake Lyndon B. Johnson	6,534	0466	Eurasian watermilfoil	83
			waterhyacinth	0.5
Lake Moss	1,140	0511	hydrilla	6.1
Mill Creek	237	0503	hydrilla	8.2
Lake Murvaul	3,820	0519	hydrilla	2

Appendix I. Continued.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Nacogdoches	2,200	0521	hydrilla	37
			torpedograss	Trace
Lake Nocona	1,470	0536	Eurasian watermilfoil	Trace
Navarro Mills	4,336	0525	hydrilla	0.4
Pat Mayse	5,993	0573	hydrilla	6.1
Pinkston	580	0658	hydrilla	133
			Eurasian watermilfoil	Trace
Purtis Creek	354	0593	hydrilla	22
Lake Ray Roberts	29,350	0622	hydrilla	300
			Eurasian watermilfoil	752.7
Rio Grande		1492	waterhyacinth	4*
San Augustine City Lake	200	0644	hydrilla	112
Sam Rayburn	114,500	0640	hydrilla	2,944
			torpedograss	293
			waterhyacinth	Trace
			common salvinia	365*
Lake Sheldon	1,200	0667	alligatorweed	8
			hydrilla	817
			giant salvinia	120
Lake Somerville	11,460	0680	hydrilla	307
			alligatorweed	Trace
Tawakoni	36,700	0714	waterhyacinth	1.5
Timpson	237	0731	hydrilla	60
Toledo Bend	185,000	0734	alligatorweed	1,260
			Eurasian watermilfoil	2,124
			hydrilla	2,109
			giant salvinia	3,070*
			waterhyacinth	2,016*
			torpedograss	29
Town Lake	525	0737	Eurasian watermilfoil	9
Walter Long	1,210	0235	hydrilla	158
			Eurasian watermilfoil	0.5
Lake Wright Patman	20,300	0722	hydrilla	5
			giant duckweed	Trace

* Infestation treated during 2004. 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

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:** _____

PWD RP T3200-1200 (5/06)

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