NON-NATIVE AQUATIC VEGETATION CONTROL IN 2002

by

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Confronted by an ever-increasing list of introduced exotic aquatic vegetation species, a small number of dedicated Texas Parks and Wildlife Department (TPWD) employees continue their campaign against new infestations of non-native species and the uncontrolled growth of those already established. A debt of gratitude is due those who helped develop current vegetation management techniques and those who continue in their footsteps. The Aquatic Habitat Enhancement staff at Jasper deserves special mention for their willingness to accept the primary responsibility of aquatic vegetation control efforts. Staff members of District III-E (Bryan) and District I-E (Mathis) are to be complimented for their technical support and quick response when occasion requires. Critical reviews by District III personnel and TPWD Research Director Dick Luebke were essential in completing this report. Technical support provided by Fred Janssen and moral support offered by Inland Fisheries Austin staff is always needed and sincerely appreciated.

ABSTRACT

Problematic aquatic vegetation in Texas has the potential to not only negatively impact aquatic habitat and degrade water quality, but interfere with resource access and navigation. Although native aquatic plant species often cause problems, invasive non-native aquatic plant species have proven to be a more serious threat to the freshwater resources of Texas. Texas Parks and Wildlife Department control strategies in 2002 employed the application of approved aquatic herbicides as well as the introduction of host-specific bio-control agents. Control efforts in 2002 targeted three non-native species -- waterhyacinth [*Eichhornia crassipes* (Mart) Solms], hydrilla [*Hydrilla verticillata* (L.F.) Royle], and giant salvinia [*Salvinia molesta* D.S. Mitchell).

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INTRODUCTION

Invasive aquatic vegetation, both non-native and native, continues to plague the freshwater resources of Texas. The Texas Parks and Wildlife Department (TPWD) maintains, within its proclamation, a list of "harmful or potentially harmful exotic plants" (Table 1). These species are considered the most likely to negatively impact freshwater aquatic resources where they occur. Non-native species have no natural control mechanisms and unchecked growth can contribute to habitat degradation, reduction in water quality, and restricted access and navigation. This report will discuss control strategies used in 2002 (Jan-Dec) on the three plant species of most concern: waterhyacinth [*Eichhornia crassipes* (Mart) Solms], hydrilla [*Hydrilla verticillata* (L.F.) Royle], and giant salvinia (*Salvinia molesta* D.S. Mitchell). Control efforts on problematic native aquatic plant species are included for documentation and reference.

TPWD encourages an Integrated Pest Management philosophy utilizing biological, chemical, mechanical, environmental manipulation, and ecological intervention methods to manage or eradicate problematic exotic species. Control methods implemented in 2002 will be discussed by water body. Known distribution of waterhyacinth, hydrilla and giant salvinia within Texas are shown in Figures 1-3, respectively. Appendix I lists the known occurrence during 2002, within Texas, of those species listed in Table 1. An example of the Daily Log of Herbicide Operations (DLO) card on which herbicide application operations are recorded is found in Appendix II. A list of the aquatic herbicides and surfactants employed by TPWD personnel, use rates, and target plants is found in Table 2. Release locations of salvinia weevils (*Cyrtobagous salviniae*) in 2002 are summarized in Figure 4.

Waterhyacinth

Problematic infestations of waterhyacinth have occurred in the United States since the early 1900's (Wunderlich 1962; Zeiger 1962). The exact year of introduction into Texas waters is unknown, but serious infestations in the 1950's led to the implementation of aggressive chemical control programs. These aquatic plant management activities led to the formation of a Statewide Noxious Vegetation Control Program within TPWD. Although initially administered through Dingell-Johnson funds, the U.S. Army Corps of Engineers (USACE) Aquatic Plant Control Program provided 70 % cost-share funding for many years, specifically for the control of waterhyacinth in Texas. Funding for the program was discontinued in the early 1990's.

Waterhyacinth is common along the Texas coastal bend and inland up to 250 miles. Caddo Lake, Lake Fork, and Lake Quitman form the northern-most range of waterhyacinth presence in Texas. The primary threat of waterhyacinth is to navigation, but the large, thick mats that eventually form cause severe ecological stress within aquatic systems (Hitchcock et al 1949; Langeland 1987). In Texas, control of waterhyacinth has mostly been achieved using aquatic herbicides (2,4-D Amine,

glyphosate, and diquat), but winter drawdowns and biological and mechanical control measures have also been utilized (Helton and Hartmann 1995; Cofrancesco 1998).

Waterhyacinth has been identified on 33 public water bodies within the state (Fig. 1). No new infestations of waterhyacinth were reported in 2002. The most severe infestations that required treatment in 2002 were on Lake B.A. Steinhagen and Caddo Lake. A mild winter in 2001 allowed increased survival of waterhyacinth on Caddo Lake, in sharp contrast to the reduction in plant biomass due to the severe winter in 2000.

Hydrilla

Hydrilla was first identified in the United States in 1960, but was not verified in Texas until 1969 near Houston (Klussmann et al. 1988). By 1975, infestations of this species were confirmed in Toledo Bend Reservoir, Sam Rayburn Reservoir, Lake Conroe, and Lake Livingston. By the late 1970's the plant began to create serious problems in a number of smaller heated reservoirs in the eastern half of the state. 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). Monotypic stands of hydrilla are common in many Texas reservoirs and, as a result, native plant diversity and coverage has declined (TPWD, unpublished data). Within the state, historical control methods for hydrilla have included herbicides and biological and mechanical means.

In 2002, 91 public water bodies within Texas had hydrilla (Fig. 2). TPWD Inland Fisheries (IF) staff surveys estimate that in years when most reservoirs are at capacity, there may be as many as 100,000 acres of hydrilla statewide (TPWD, unpublished data). Hydrilla declines were noted in 2001 on Caddo Lake, Lake Murvaul, Toledo Bend Reservoir and Lake Fork. The exact cause of these declines is not known.

Giant Salvinia

The highly invasive floating aquatic fern, giant salvinia, was first identified in the wild in the United States (South Carolina) in 1995. The second U.S. record, and the first for Texas, occurred with identification of the plant from a small wild population located in Houston during spring 1998 (Helton and Chilton 2001). Worldwide, where introductions of this species have occurred, severe human impacts resulted rapidly (Oliver 1993). 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).

Giant salvinia has now been identified in four public reservoirs and 41 private impoundments, which includes 10 commercial nurseries (Fig. 3). With the exception of four research sites, the plant has been eradicated in all private water bodies and nurseries where it has been found. Giant salvinia was found in Toledo Bend Reservoir in 1998 and Lake Texana in 1999. New infestations were documented at Lake Conroe and Sheldon Reservoir in 2000. No new infestations were documented on any public reservoir in 2001 or 2002. However, giant salvinia was confirmed in a 10-mile stretch of the Trinity River just above its entrance into the Galveston Bay system. As in 1999-2001, herbicide control programs continued on Toledo Bend Reservoir. A single day's treatment by the San Jacinto River Authority personnel was all that was necessary on Lake Conroe in 2001. Extensive surveys by TPWD personnel could locate no giant salvinia on Sheldon Reservoir in 2001. A total of 1,417 acres of waterhyacinth and giant salvinia were treated in 2002 on Lake Texana by a private contractor.

The U. S. Department of Agriculture (USDA), with TPWD support, continued research on the development and production of the salvinia weevil as a biological control agent for giant salvinia. Research efforts focused on the Australian strain of salvinia weevil. The success of this insect on infestations in other parts of the world has been thoroughly demonstrated (Room et al. 1981). Insect releases were initiated into Texas giant salvinia populations in October 2001. A total of 1,100 insects were released at four sites including Toledo Bend Reservoir, Lake Texana, and two private water sites in Southeast Texas. Toledo Bend Reservoir received 597 additional insects in 2002, while a private site in Chambers County (Nelson Pond) received 520 additional insects (Fig. 4).

Public education efforts were continued to inform Texas citizens about the threat that giant salvinia poses to aquatic resources. State media sources and widespread distribution of a giant salvinia fact sheet have no doubt contributed to the quick discovery of new infestations. 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 2002

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 located on the western shore of Galveston Bay and is one of only four Coastal Preserves in Texas. The preserve is considered an environmentally sensitive area with a wide diversity of native vegetation, both terrestrial and aquatic. Waterhyacinth continues to persist in the preserve, due primarily to temperate climate and fertile conditions. A total of 63 acres of waterhyacinth were treated in 2002 using Weedar 64® (2,4-D Amine at 1.0% v/v) and Aqua-King Plus®

surfactant (Table 2) by TPWD-IF personnel. In comparison, only 38 acres of waterhyacinth were treated in 2001.

Winter freezes and the flushing action on the bayou, created by high rainfall events, assists in managing the waterhyacinth population on the preserve. Although subsequent surveys confirmed the effectiveness of spray treatments, the inevitable re-growth of waterhyacinth will require continued monitoring and repeated annual treatments to maintain an acceptable level of control.

Lake Austin

Controlling Authorities: Lower Colorado River Authority (LCRA) and the City of Austin. Contact: Mary Gilroy (City of Austin), phone 512-974-2717, e-mail *mary.gilroy@ci.austin.tx.us*, John Wedig (LCRA), phone 512-473-3307. Prohibited plant: hydrilla.

Status: Hydrilla continued to expand despite a 6-week draw down in January-February. Hydrilla coverage reached a maximum of 320 acres before a nearly 30,000-cfs flood event washed out approximately 100 acres of the plant. A radio-tracking study conducted by Texas State University indicated the increased flow rate had not been enough to cause triploid grass carp to emigrate downstream and out of the lake. According to the LCRA, hydrilla had been responsible for backing water up enough to flood seven houses in the upper end of the lake. Additionally, when hydrilla clogged water intakes, it cost the LCRA about $300,000 in lost hydropower generation and repairs. As a result, the "Lake Austin Hydrilla Management Plan" was developed. The plan includes the use of triploid grass carp (*Ctenophayrngodon idella* Val.), herbicide, mechanical control, and water level manipulation. In addition, the USACE introduced 788,000 hydrilla flies (*Hydrellia* sp.) in Lake Austin in an effort to help control hydrilla in 2002.

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*), alligatorweed (*Alternanthera philoxeroides*).

Status: Waterhyacinth populations on Lake B.A. Steinhagen decreased substantially in 2002 from those seen in 2001. A total of 209 acres of waterhyacinth were treated by TPWD-IF crews in 2002 using Weedar 64® (2,4-D Amine at 1.0% v/v) with Aqua-King Plus® surfactant) (Table 2). Herbicide and surfactant was provided by the USACE. In comparison, 261 acres of water hyacinth were treated in 2001. Treatment efforts were focused primarily on boat ramps and public access points within the USACE recreation area, Angelina-Neches Wildlife Management Area, and Martin Dies, Jr. State Park. Post-

treatment surveys indicated 90-100% efficacy on waterhyacinth treatments in Lake B.A. Steinhagen in 2002.

Water level drawdown during the winter months has been an important tool in waterhyacinth management on Lake B.A. Steinhagen. Depending on the severity of the winter, some years have seen plant mortality of over 95% (Helton and Hartmann 1995). Drawdowns in mild-winter years have not proven as effective in managing noxious vegetation. Without periodic herbicide treatments, waterhyacinth continues to expand. Based on TPWD surveys in June 2001, waterhyacinth coverage was estimated at 2,750 acres. Another drawdown in the fall of 2001 extended through mid-summer of 2002 and reduced visible waterhyacinth coverage to 625 acres.

The common salvinia infestation in Lake B.A. Steinhagen is still the largest in Texas and has increased dramatically from the 250-325 acres observed in 2001. Successful waterhyacinth treatments in 2002 resulted in reduced competition and a dramatic expansion of common salvinia throughout the reservoir by fall. The plant, although still confined to protected backwaters, is found in large expanses protected by cypress trees and now dominates small stands of waterhyacinth and alligatorweed. Since this problem could not be foreseen, no treatments targeting common salvinia were conducted in 2002. Control efforts in 2003 will need to address this new threat and include appropriate control measures for common salvinia in management plans.

Repeated drawdowns appear to impact hydrilla and common salvinia as well as waterhyacinth on Lake B.A. Steinhagen. TPWD surveys indicate a gradual reduction in coverage of hydrilla from a high of almost 3,000 acres in the mid-1990's to just 425 acres in 2001. No treatments on hydrilla have been performed by TPWD since 1997.

Although an accepted method of biocontrol, the introduction of alligatorweed flea beetles (*Agasicles hygrophila* Selman and Vogt) has not proven very effective on Lake B.A. Steinhagen, in spite of relatively high population density. Alligatorweed has exhibited a marked increase in shallow areas and along shorelines, perhaps due to an extended drawdown in 2002. The expansion of alligatorweed in Lake B.A. Steinhagen may warrant large-scale herbicide treatments in the near future.

Caddo Lake

Controlling Authority: Cypress Valley Navigation District. Contact: 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 in 2002 were slightly higher in comparison to those recorded in 2001. Summer herbicide treatments totaled 317 acres in 2001. Surveys in the fall of 2001 estimated 350-400 acres of waterhyacinth remained on Caddo Lake. In 2002, a total of 350 acres of waterhyacinth were treated with Weedar

64® (2,4-D Amine at 1.0% v/v and Aqua King Plus® surfactant at 8 oz/acre)(Table 2). Target areas included the Caddo Lake Wildlife Management Area and Caddo Lake State Park, public-access locations, residential frontage, and boat roads to popular angling/waterfowl hunting areas. Post-treatment surveys indicated near 100% efficacy in the areas treated.

Fall surveys in 2001 estimated 150 acres of hydrilla on Caddo Lake. Spring surveys in 2002 confirmed this estimate. The dramatic decline of hydrilla from 5,500 acres in 1998 to 150 acres in 2001 and 2002, a loss of over 95%, may be linked to a lack of vital nutrients or trace elements in the lake hydrosoil, or a naturally occurring cyclic pattern in growth. Similar declines in hydrilla biomass have been documented in other reservoirs throughout the state. No treatments targeting hydrilla were conducted on Caddo Lake by TPWD in 2002.

Lake Fork

Controlling Authority: Sabine River Authority. Contact: David Parsons, phone 903-878-2262, e-mail *dparsons@sra.dst.tx.us*. Prohibited plants: waterhyacinth, hydrilla.

Status: Waterhyacinth populations in Lake Fork have decreased substantially since the last treatment of 47.6 acres in 2001. In 2002, a total of 25 acres of waterhyacinth was treated in Lake Fork by TPWD-IF personnel using Rodeo® (glyphosate) at 0.75%v/v and the surfactant Red River 90® at 0.25% v/v (Table 2). Although applications of glyphosate require relatively clean water to be effective, water quality in Lake Fork proved sufficient during spray operations.

The fertile nature of its watershed makes Lake Fork a prime target for waterhyacinth expansion. Routine surveys and decisive treatments should maintain waterhyacinth at manageable levels.

Although hydrilla was monitored in Lake Fork in 2002, no treatments targeting hydrilla were conducted by TPWD in 2002. Surveys suggest a slight increase in hydrilla biomass in 2002 from that documented in 2001.

Lake Quitman

Controlling Authority: Wood County. Contact: Roy Don Shipp, phone 903-878-2238. Prohibited plant: waterhyacinth.

Status: Lake Quitman historically supports small amounts of waterhyacinth normally controlled by physical removal by TPWD-IF personnel. The inevitable expansion of plants to different parts of the lake resulted in 1 acre of waterhyacinth discovered and treated in 2002 by TPWD-IF personnel using Weedar 64® (2,4-D Amine at 1.0% v/v) and Aqua-King Plus® surfactant (Table 2). Routine surveys and decisive action, such as

physical removal, when possible, may prevent waterhyacinth from becoming the costly problem seen in other public waters.

Lake Raven

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

Status: In 2001 the hydrilla infestation on Lake Raven had expanded to cover 80% of the lake (about 160 acres). A true integrated control program was initiated on Lake Raven through the cooperative efforts of TPWD-PL and IF staffs in 2000. Methods to control hydrilla around fishing piers and boat ramps included chemical treatments, a mechanical harvester and Weed Roller ™, and biological controls in the form of introducing the hydrilla fly in 2000 and 400 triploid grass carp in 2002. Due to low efficacy and associated costs, mechanical controls were not pursued in 2002.

In 2002, IF staff conducted chemical treatments during May and September treating a total of 42 acres of hydrilla. The May treatments represented the largest portion of effort at 39.7 acres. Treatments included the application of Aquathol K® (endothall), Sonar® (fluridone), and Aquathol Super-K® (Table 2). Herbicides were applied in areas heavily infested with hydrilla. A supplemental treatment of Aquathol K® was necessary to control a 2.3-acre area in September 2002.

The integration of chemical and biological controls employed in Lake Raven since 2001 hold a great deal of promise in providing both long-term and cost-effective control of hydrilla. Future surveys should help define additional needs and approaches to further improve control efforts.

No treatments targeting waterhyacinth were conducted in Lake Raven in 2002.

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: hydrilla, waterhyacinth.

Status: Combined with an extended drought throughout the western United States, unregulated pumping for irrigation and severe infestations of hydrilla and waterhyacinth have reduced flow in the lower Rio Grande to a mere trickle. In 2002, TPWD-IF personnel recommended aggressive chemical and mechanical treatments in combination with the introduction of triploid grass carp to help restore the historic river flow to acceptable levels. Plans to implement $100,000 of mechanical and chemical treatments in the fall of 2002 had to be postponed due to inclement weather. As a result, no treatments targeting waterhyacinth were conducted by TPWD personnel in the lower Rio

Grande in 2002. However, the USACE introduced 572,000 hydrilla flies in the lower Rio Grande in an effort to control hydrilla in 2002.

Lake Texana

Controlling Authority: Lavaca-Navidad River Authority (LNRA). Contact: Pat Brzozowski, phone 361-782-5229, e-mail *lnra@ykc.com*. Prohibited plants: giant salvinia, waterhyacinth, hydrilla.

Status: Giant salvinia was first identified in the Sandy Creek arm of Lake Texana in 2000. Initial control efforts involved the placement of oil retention booms to act as barriers, effectively containing the infestation until high water levels pushed significant amounts of giant salvinia into the main reservoir. Herbicide treatments have been complicated by excessive growth of waterhyacinth. Giant salvinia is now present along most of the lake shoreline. Although no treatments were conducted by TPWD in 2000 or 2001, extensive treatments targeting waterhyacinth were conducted in 2002 by LNRA. A total of 1,417 acres of vegetation were treated in 2002 on Lake Texana by a private contractor using aerial and foliar applications. The herbicides Rodeo® or Aquamaster® (glyphosate, at 0.75% v/v) and Weedar 64 ((2,4-D Amine at 1.0% v/v) combined with two surfactants, Aqua-King Plus® at 0.25% v/v (1 qt) and Thoroughbred® at 0.1% v/v (12 oz) were used as a foliar application. Although a reduction of the giant salvinia population associated with waterhyacinth in Lake Texana is assumed, the level of such a reduction is unknown.

Australian salvinia weevils were released at two different sites on Lake Texana in October 2001(Fig. 4). A total of 220 insects were released at each site, located in the upper end of the lake. Both sites are being monitored by the USDA and TPWD personnel for pre- and post-introduction biomass estimates. Results of insect releases on Lake Texana have been complicated by low water levels and repeated vandalism at release sites. Quantitative evaluations of the effectiveness of weevil releases on Lake Texana are unknown at this time.

No treatments targeting hydrilla were conducted on Lake Texana by TPWD in 2002.

Toledo Bend Reservoir

Controlling Authority: Sabine River Authority. Contact: Jim Washburn, phone 409-565-2273, e-mail *toledobend@datarecall.net*. Prohibited plants: waterhyacinth, giant salvinia, hydrilla.

Status: Surveys in the spring of 2002 indicated a slight increase of waterhyacinth in the North Toledo Bend Wildlife Management Area (NTBWMA). This area is jointly managed by TPWD Wildlife Division and Ducks Unlimited for migratory, over-

wintering waterfowl. The area covers approximately 600 acres and some years have seen almost total coverage by waterhyacinth (e.g., 1986). Since that time, annual herbicide treatments have been effective in maintaining waterhyacinth at low population levels within the NTBWMA. Surveys in the summer of 2001 did reveal an increase of waterhyacinth outside the NTBWMA in the Bayou Siepe and Tenaha Creek areas. A total of 73 acres of waterhyacinth were treated in the Williams Camp and Teneha Creek areas using Weedar 64® (2,4-D Amine at 1.0% v/v and Aqua King Plus® surfactant at 8 oz/acre) in 2002 (Table 2).

Although the waterhyacinth weevil (*Neochetina* sp.) has been found and identified on waterhyacinth in Toledo Bend Reservoir, total insect populations have always been low. No recent releases of the insect to augment the existing population have been made. Substantial areas of untreated waterhyacinth are present in the upper end of Toledo Bend Reservoir for the insect to populate.

Giant salvinia coverage has been greatly reduced since 1999-2000. Only 10 acres of giant salvinia were treated on the Texas side of the reservoir in 2001, while Louisiana Department of Wildlife and Fisheries (LDWF) sprayed 122 acres. In 2000, a total of 1,196 acres were sprayed lakewide. This 90% reduction can be attributed to three primary factors: (1) lakewide reduction of the plant as a result of aggressive spraying in 1999 and 2000, (2) reduction due to a winter freeze in December 2000 and (3) a prolonged and drastic drawdown in the fall of 2001 (9 ft below conservation pool, Sep-Dec) to perform maintenance on the dam. Although lower water levels made many infested sites inaccessible, they also helped to strand and desicate many giant salvinia infestations. Giant salvinia has not been confirmed in the NTBWMA, but was found a short distance south of the management area.

In 2001 TPWD-IF personnel began applying Rodeo® (glyphosate, at 0.75% v/v), instead of diquat to control giant salvinia. Two surfactants, Aqua-King Plus® at 0.25% v/v (1 qt) and Thoroughbred® at 0.1% v/v (12 oz) (Table 2), were used in combination with the glyphosate and then foliarly applied. Although diquat was still effective as a contact herbicide, the glyphosate formulation allowed better control of heavy infestations.

A total of 43 acres of giant salvinia were treated in 2002 on Toledo Bend Reservoir. Treatments for giant salvinia in 2002 also employed Rodeo® (glyphosate, at 0.75% v/v), again using the combination of Aqua-King Plus® at 0.25% v/v (1 qt) and Thoroughbred® at 0.1% v/v (12 oz) as surfactants. One application in October used Reward® (diquat) at 0.75% v/v with Aqua-King Plus® at 0.25% v/v (1 qt) and Thoroughbred® at 0.1% v/v (12 oz) to treat 13 acres of giant salvinia (Table 2).

A total of 1,625 acres of giant salvinia have been treated by TPWD and LDWF on Toledo Bend Reservoir since May 1999. Although efficacy estimates are near 95% with a single spraying, untreated plants have demonstrated a tendency to re-infest a previously treated area within a month during the peak growing season (water temperatures $\geq$ 80°F).

Treatment efforts in combination with environmental factors have provided a measure of control on the giant salvinia population at Toledo Bend Reservoir. Herbicide applications help confine the plant to shorelines in coves and creeks entering the lake. High priority locations for spraying will continue to be boat ramps and other public access areas to reduce the accidental transfer and introduction of this plant into other water bodies. In conjunction with this effort, signs have been posted at all boat ramps to inform the public. An accurate assessment of cold weather impacts on giant salvinia infestations is not available, but an impact appears to be occurring. Ice formation on surface waters containing giant salvinia has been reported to be a cause of plant mortality (Oliver 1993). However, thick mats of giant salvinia efficiently insulate themselves against freezing conditions. Water-level fluctuations may actually have the most impact, stranding plants either in bushes or on dry ground. Surveys in 2001 after the fall drawdown (Sep-Dec) confirmed significant plant mortality in some areas. 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.). In contrast, relatively stable water levels and mild winters may provide giant salvinia the necessary conditions to flourish and quickly expand to problematic proportions at any time. Future control efforts of giant salvinia infestations on Toledo Bend Reservoir must be not only flexible, but decisive to maintain the relative control achieved thus far.

Research with a biological control agent, the salvinia weevil, continues and Toledo Bend Reservoir was the focal point of field operations. Led by USDA personnel in Florida and Texas, TPWD personnel are actively involved in collecting pre- and post-release plant biomass data on Toledo Bend Reservoir, Lake Texana, and one private location in Chambers County. A total of 220 Australian salvinia weevils was released into a research site on Toledo Bend Reservoir in October of 2001. An additional 597 and 520 weevils were released into the Toledo Bend Reservoir and Chambers County sites in 2002, respectively (Fig. 4). Evaluations of all releases will continue into 2003.

Surveys indicated there were 2,561 acres of hydrilla on Toledo Bend Reservoir in 2002, a drastic decline from the 9,830 acres recorded in 2001. The decline appears to be related to the severe and prolonged drawdown in the fall of 2001. Hydrilla normally produces turions in the fall of the year, which provide the majority of re-growth for the following spring. The duration of the drawdown may have interfered with this process, effectively reducing hydrilla re-occurrence in many areas. The largest decline appears to be confined to the northern half of the reservoir. No chemical, mechanical, or biological treatments targeting hydrilla were conducted by TPWD on Toledo Bend Reservoir in 2002.

SUMMARY

The inland waters of Texas continue to support exotic species like waterhyacinth, hydrilla, and giant salvinia. A temperate climate and favorable latitude, combined with extremely fertile waters, makes Texas an ideal growing medium for many exotic aquatic

plant species. Dispersal mechanisms, like boat trailers, have historically contributed to the inadvertent spread of these species among public waters. Although the history of giant salvinia in Texas is relatively recent, this prohibited plant species may eventually re-define what is meant by "problematic". Past treatments and monitoring data suggest that in most years infestations of waterhyacinth, hydrilla, and giant salvinia will require intensive management efforts in waters where they are present (TPWD, unpublished data). All known infestations of giant salvinia, whether public or private and not used for research purposes, have been treated with resolve for eradication. The release of the salvinia weevil in Texas in October 2001 adds a potential long-term, cost-effective management tool to control efforts. New TPWD directives emphasize the need to eradicate new infestations of problematic non-native aquatic plant species as they are identified.

PRIORITIES FOR 2003

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 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

* 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)/ Aqua-King Plus® non-ionic surfactant	3 qt/acre (1ppm) 0.25-2 qt/acre
waterhyacinth	Weedar 64® (2,4-D Amine)/ Aqua-King Plus® non-ionic surfactant	1 gal/acre (1.7 ppm) 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)/ 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® 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, 2002.

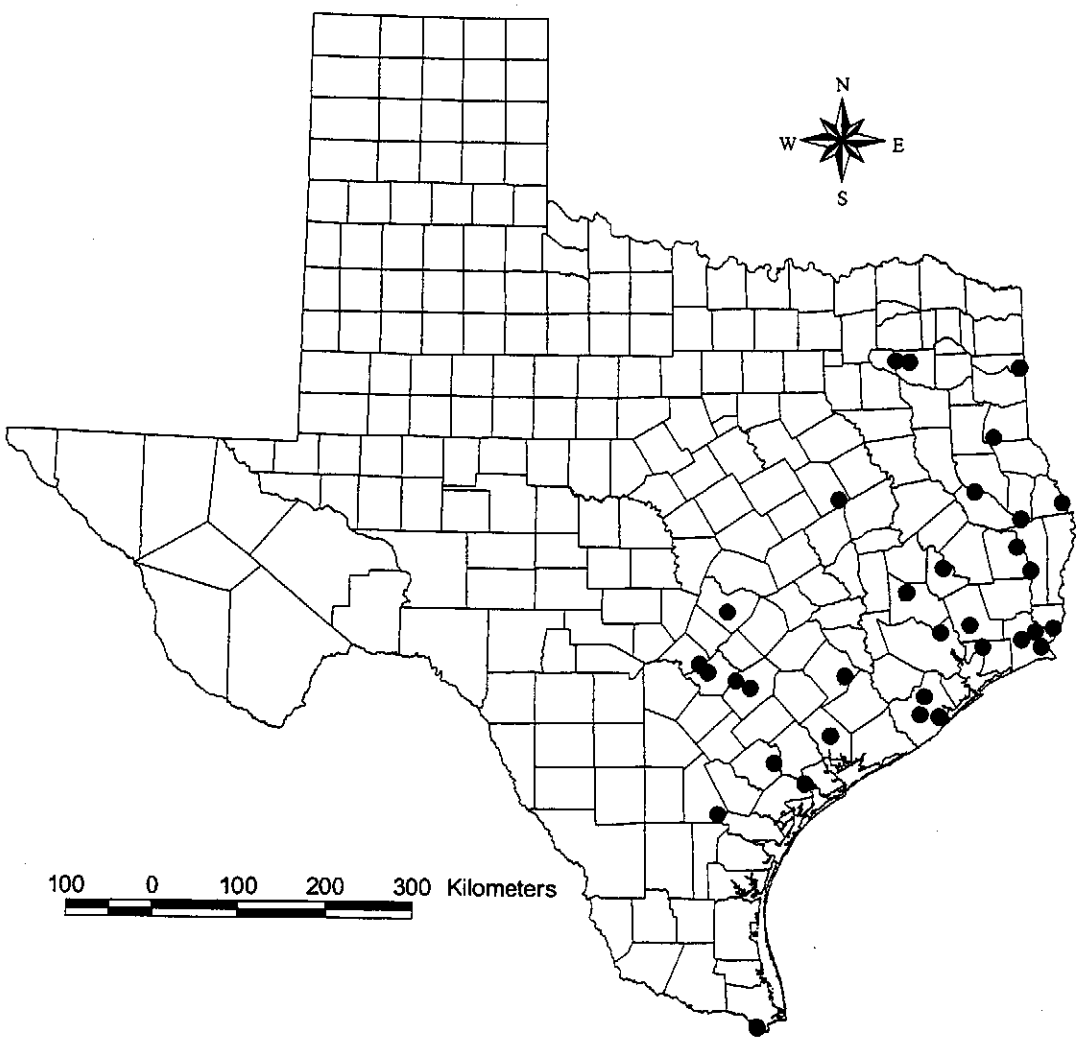


Figure 2. Hydrilla distribution in Texas, 2002.

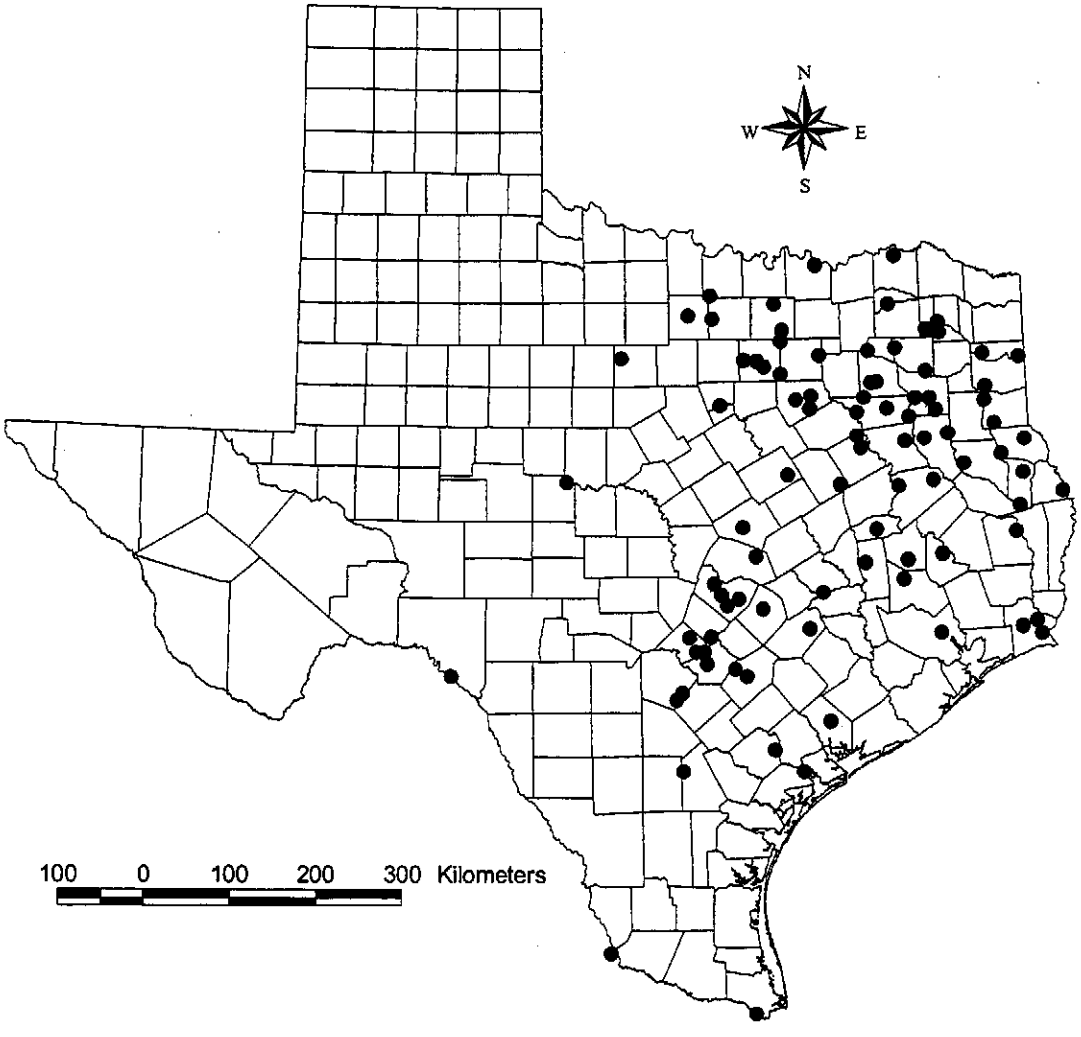


Figure 3. Giant salvinia distribution in Texas, 2002.

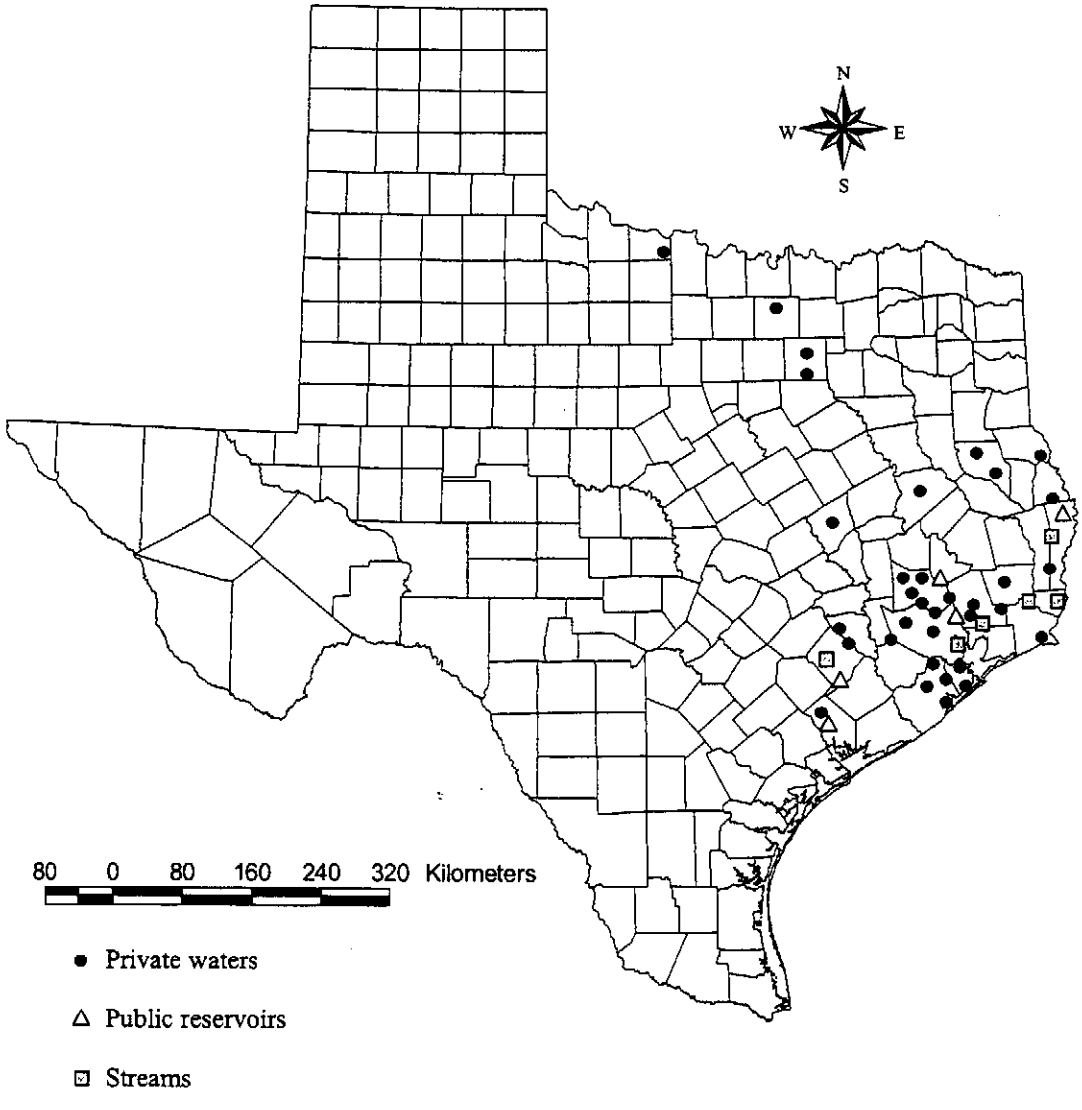
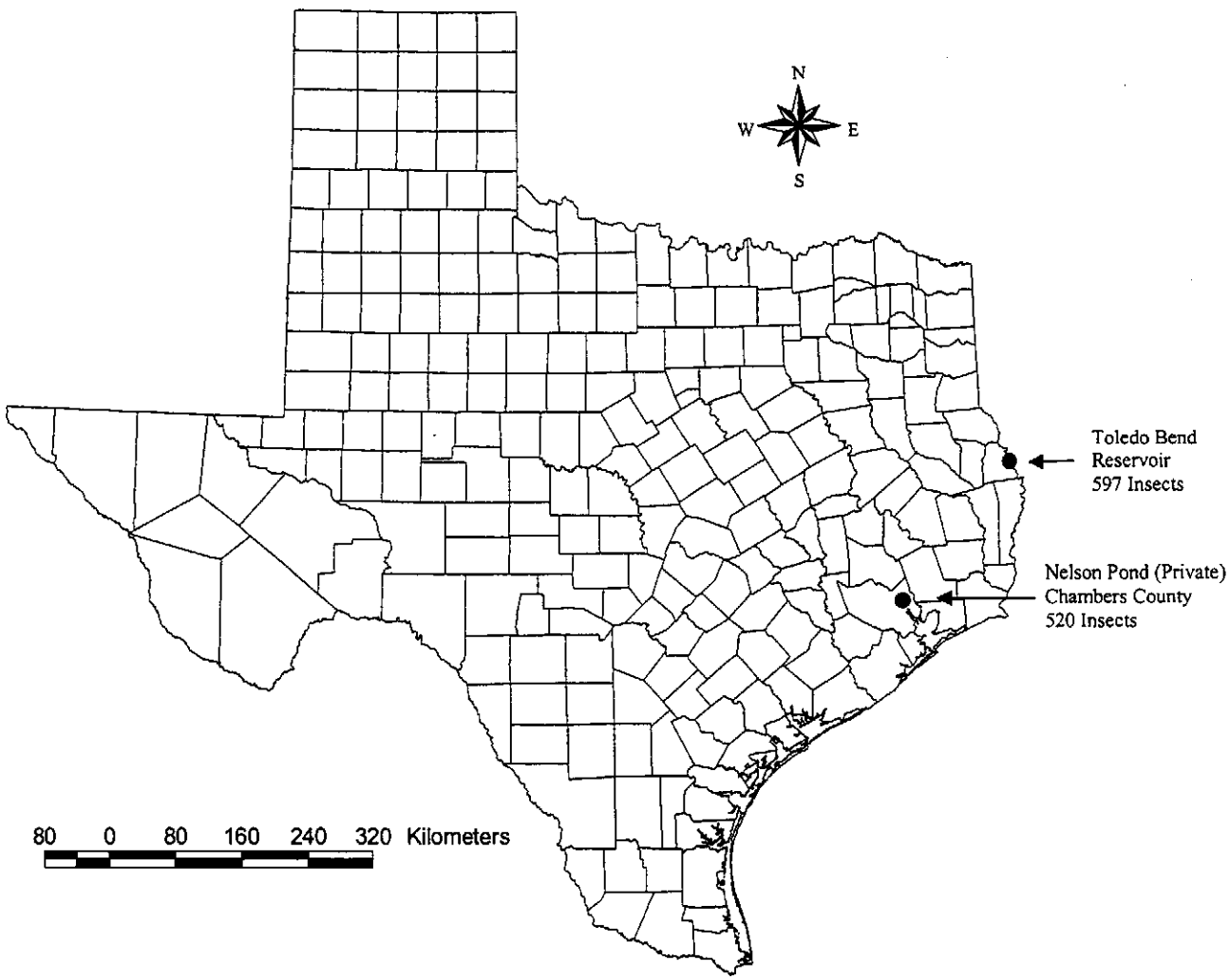


Figure 4. Australian salvinia weevil release locations in Texas, October, 2002.



Appendix I. Statewide occurrence of non-native (listed) aquatic vegetation in Texas, 2002. Information represents only what was reported by district management crews during routine habitat surveys and vegetation was not treated unless so noted.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Armand Bayou Coastal Preserve	300	1945	waterhyacinth	63*
Aquilla	3,280	0021	hydrilla	Trace
Austin	1,830	0033	hydrilla	320*
Bardwell	3,570	0041	hydrilla	15
B.A. Steinhagen	16,830	0694	hydrilla	Trace
			common salvinia	625
			waterhyacinth	625*
			alligatorweed	1,139
Bastrop	906	0046	hydrilla	35
Caddo	25,400	0128	hydrilla	150
			waterhyacinth	710*
			Eurasian watermilfoil	90
Cypress Springs	3,450	0223	hydrilla	Trace
Fork	27,690	0433	hydrilla	873
			waterhyacinth	6*
Gibbons Creek	2,500	0305	hydrilla	Trace
			waterhyacinth	Trace
			alligatorweed	5
Houston	12,240	0368	waterhyacinth	20
			water lettuce	20
			alligatorweed	10
Lake O'the Pines	18,700	0428	hydrilla	700
Quitman	814	0596	waterhyacinth	1*
Raven	0599	239	hydrilla	160*
			waterhyacinth	Trace
Richland-Chambers	44,000	0615	hydrilla	125
Rio Grande	?	1492	hydrilla	3000
			waterhyacinth	700
Sam Rayburn	114,500	0640	hydrilla	6,582
			waterhyacinth	15
			common salvinia	15
San Augustine	200	0644	hydrilla	151

Appendix I. Continued.

Water body	Size (acres)	Waterbody code	Listed species	Acres infested
Texana	10,134	0720	waterhyacinth	1,417**
			giant salvinia	>800
Toledo Bend	185,000	0734	hydrilla	2,561
			waterhyacinth	345*
			giant salvinia	68*
			Eurasian watermilfoil	115
Walter E. Long	1,210	0235	hydrilla	27
Winnsboro	1,100	0791	alligatorweed	0.21

* Infestation treated during 2002.
** Multiple treatments on Lake Texana conducted by private contractor.

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

DATE:___/___/____
PPJ: - - /

2002 Daily Log of Herbicide Operations

OPERATION DATA:

Work Detail	Time	Circle One:
____-Survey	Start____:____	AM PM
____-Application	Stop____:____	AM PM

Equipment	Location	
____-Airboat	Waterbody_____	Code#_____
____-Outboard	County_____	Code#_____
____-Truck	Specific Area_____	
____-Aerial		

Weather Data:

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

Application Data:

Target Plant:_____ Acres Treated:_____

Herbicide: _____ Additive:_____

EPA Reg. # _____ Rate Add/Acre:_____

Cost of Herb: $_____per_____ Cost of Add: $_____per_____

Rate Herb/Acre:_____ Total Add Used:_____

Total Herb Used:_____ Mix Volume/Acre:_____

Aerial Data: FAA# N-_____ Decal #_____

Notes:

_____ _____

Certified Applicator/ TDA License # Crew Member/ TDA License #