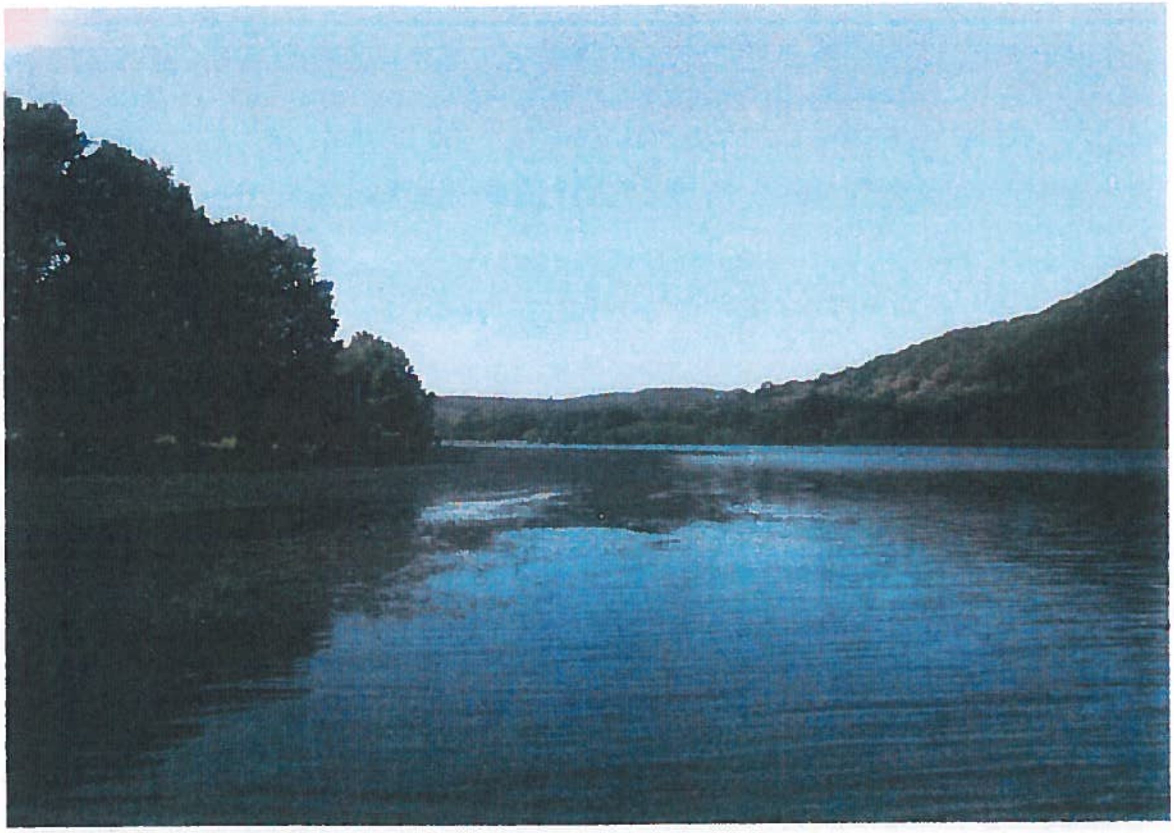
Agenda item 5c

Lake Austin Hydrilla Management Plan



Lake Austin Hydrilla Task Force:
Lower Colorado River Authority
Texas Parks and Wildlife Department
Travis County
City of Austin

Water Quality Report Series
COA-ERM 2000-1

December 2000

TABLE OF CONTENTS

List of Tables

List of Figures

APPENDICES

EXECUTIVE SUMMARY

This report summarizes recommendations for the management of hydrilla, an invasive, non-native aquatic plant in Lake Austin. These recommendations were produced by a task force comprised of staff from governmental entities with responsibilities for Lake Austin including Texas Parks and Wildlife (TPWD), Lower Colorado River Authority (LCRA), Travis County, and the City of Austin (Watershed Protection, Parks and Recreation, and Water and Wastewater Departments). Starting in March 2000, this group has investigated management options and followed the guidelines of the TPWD State Aquatic Vegetation Management Plan to determine a treatment proposal for the lake. The process for determining the appropriate treatments and implementation strategy contained in TPWD guidance included identification of species and level of concern, investigation of the treatment alternatives for the species, and development of a priority sequence of treatment options which considers the physical and biological constraints of the lake and its uses.

Lake Austin is an approximately 1,600 acre run-of-the-river reservoir whose uses include public and private water supply, flood and irrigation water conveyance from Lake Travis, contact recreation, and sport fishing. From investigation of the infestations at other Texas lakes, it was determined that the uncontrolled growth of hydrilla is likely to affect not only the many recreational activities but also lakefront property values, and drinking water intakes along Lake Austin. Water quality degradation , ecosystem impairment, and fisheries health are also concerns should hydrilla continue its present growth rate.

A rapid, easy to implement, and inexpensive solution for hydrilla control does not currently exist. Primary controls of hydrilla which have been applied with varying degrees of success in other Texas lakes include educational (brochures, signage and web pages targeting lake users and lakeside property owners), mechanical (harvesting, cutting, bottom barriers, lake lowering), biological (grass carp, revegetation), and chemical (herbicides) methods. The advantages and disadvantages of each of these methods were assessed and a selected subset was determined for Lake Austin application in a phased Integrated Pest Management (IPM) program.

The treatment originally recommended by this evaluation called for phased educational activities and mechanical harvesting in early summer 2000 followed by grass carp introduction in the late summer 2000. Chemical treatments were considered the control measure of last resort, and were to be undertaken only if grass carp were deemed ineffective. This was to be determined by 6-9 months of monitoring grass carp effectiveness through a tracking study of radio-tagged fish and comparison of seasonally paired surveys of hydrilla acreage. The treatment proposal was submitted to TPWD on May 12. (Appendix A)

In June, a letter from TPWD (Appendix B) indicated that a permit for carp would not be issued. The denial was based on the potential for the fish to consume plants other than hydrilla as well as the issue of whether hydrilla would continue to increase (TPWD stated that there was no certainty that it would). It also stated that vegetation coverage above

30% can be detrimental to a fishery. At that time, TPWD recommended a combination of mechanical harvesting and herbicides as the most effective control option. A July 2000 vegetation survey conducted by TPWD documented 32 % vegetative cover in Lake Austin, including 200 acres of hydrilla. These values can be compared with a July 1999 survey during which the hydrilla was measured to be 23 acres and the total vegetative coverage was at 16%. In August, the City and LCRA met with TPWD to discuss the feasibility of using only herbicides and harvesting in light of the increase in vegetative cover, and TPWD indicated a willingness to reconsider the grass carp issue. The task force then revised the treatment proposal to integrate a Spring 2001 application of an herbicide (EPA-approved for potable water reservoirs) with a lower stocking rate of grass carp. Water and Wastewater Department is considering conducting a pilot application of herbicide prior to full scale treatment. This current proposal, along with an application for a grass carp permit, was the main focus of a November 1 public hearing. The permit application was submitted to TPWD on October 25 and is provided in Appendix C.

The proposed course of action implements the best technology currently available with the highest successful case histories in a manner with the least potential for impact to the environment. Additional resources and monies for hydrilla management should be planned for the upcoming years for implementation of this plan. Regulatory approvals must also be sought and the revised treatment proposal must be approved by TPWD under the State Management Plan. Public input has been sought through briefings to City of Austin boards and commissions as well as presentations to neighborhood associations. Assuming this proposal is approved by TPWD and the City Council, and implemented in Spring 2001, hydrilla may be reduced below nuisance levels while allowing for the excellent sport fishery. Long term success would depend in part on maintaining carp in the lake over a period of several years.

1.0 INTRODUCTION

In 1999, 23 acres of the invasive, non-native aquatic plant hydrilla *(Hydrilla verticillata)* was discovered growing in Lake Austin. Because of the limited, controllable nature of the initial infestation, and the lake characteristics conducive to the spread of the plant, Texas Parks and Wildlife Department (TPWD) determined in March 2000 that Lake Austin was appropriate for an immediate response. The lake was designated as a Tier One infestation under the TPWD Statewide Aquatic Vegetation Management Plan. The appropriate response for a Tier One infestation entails immediate implementation of a management strategy aimed at eliminating the vegetation in a manner reducing or precluding chances of spread or reoccurrence. The Lake Austin Hydrilla Task Force (task force) was created to develop a treatment proposal according to the TPWD draft guidance document, Aquatic Vegetation Management in Texas.

Task force meetings began in March, with representatives from the City's Watershed Protection Department (WPD), Parks and Recreation Department (PARD), Water and Wastewater Utility (W&WW), Lower Colorado River Authority (LCRA), TPWD and Travis County Transportation and Natural Resources (Travis County).

As a first step in the process, the draft treatment proposal (Appendix A) was submitted to TPWD on May 12, 2000 for review and approval. By this time, hydrilla had increased to 150 acres. Presentations were made to the LCRA's Lake Austin Advisory Panel, whose members then drafted a resolution on May 16, 2000 to support the task force's management plan and efforts to control the infestation. Additional presentations were made to the City of Austin Parks Board (approved a recommendation of support on May 23, 2000) Water and Wastewater Commission and Environmental Board (also recommended support of the treatment proposal). In addition, presentations to local groups such as the Cuernavaca Conservation Association were conducted to educate the public about hydrilla and the city's approach to controlling it.

On June 1, 2000, TPWD responded to the treatment proposal with a letter (Appendix B) indicating that a permit for carp would not be issued. They felt the increase in hydrilla put the lake beyond a Tier One (eradication) response into Tier II, or management category. The denial was based on the potential for the fish to consume plants other than hydrilla as well as the lack of certainty that hydrilla would continue to increase. TPWD recommended a combination of mechanical harvesting and herbicides as the most effective control options. A July 2000 vegetation survey conducted by TPWD documented 32 % vegetative cover in Lake Austin, including 200 acres of hydrilla. In August, the City and LCRA met with TPWD to discuss the feasibility of using only herbicides and harvesting in light of the increase in vegetative cover, since TPWD's June letter stated that vegetation cover above 30 % can be detrimental to a fishery. TPWD indicated a willingness to reconsider the grass carp issue. The task force then revised the treatment proposal to integrate a Spring 2001 application of an herbicide (EPA approved for potable water reservoirs) with a lower stocking rate of grass carp. A presentation on the revised plan was made to the Environmental Board on August 2, 2000, and the resolution of their support for an aggressive control strategy is Appendix D.

The current proposal (including the grass carp stocking) was the main focus of a November 1 public hearing. Other items up for discussion included the possible pilot application of herbicide recommended by Water and Wastewater Department prior to a larger application in the spring 2001. The permit application for grass carp submitted to TPWD on Oct 25 is included in Appendix C.

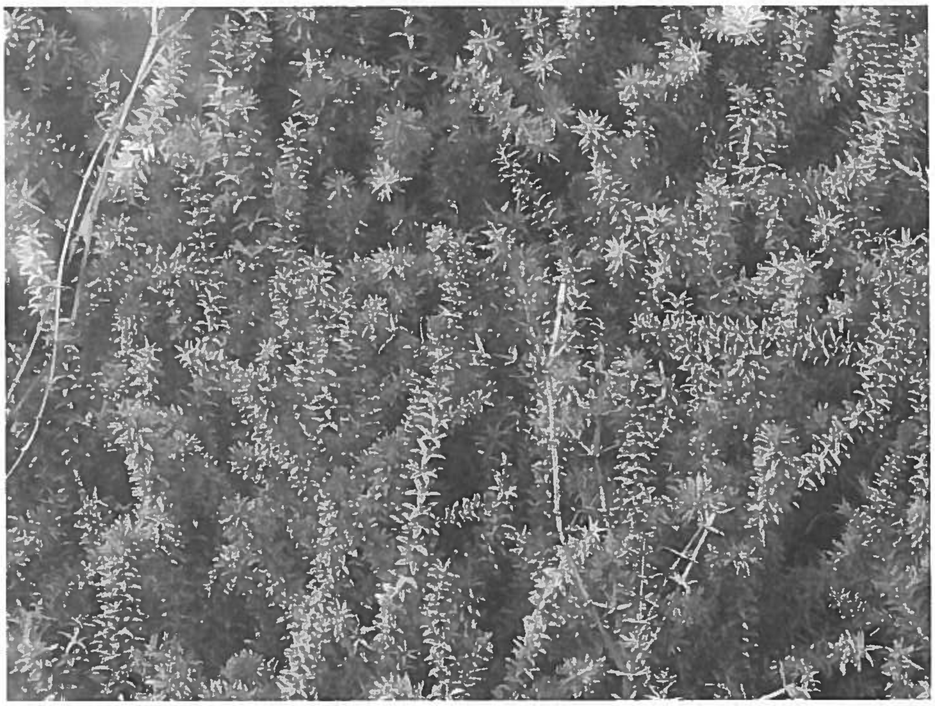
2.0 BACKGROUND ON HYDRILLA

Hydrilla is considered one of the most problematic aquatic plants in the United States. This plant is native to Africa, Australia, and parts of Asia but was introduced to Florida in 1960 via the aquarium trade. By the 1990s, hydrilla was well established in the southern states as well as California and some northern lakes.

2.1 Growth Habitat

As shown in Figure 1, hydrilla has small pointed leaves arranged in whorls around the stem. It grows rapidly (up to one inch per day) and forms dense surface mats of vegetation that restrict a wide variety of lake uses. Once hydrilla becomes established, it is readily spread by fragments carried by waterfowl, boating activities, harvesting operations and downstream flow.

Figure 1
Photograph of Hydrilla



Unlike native plants and many other non-native plants, hydrilla's growth is extremely rapid and aggressive. It will grow in a wider range of environmental conditions: less light, fewer nutrients, and deeper depth- up to 15m (45 ft) deep. It also has extremely effective methods of propagation. Besides making seeds (seedlings are actually rarely seen in nature), it can sprout new plants from root fragments or stem fragments containing a single whorl of leaves. Recreational users can easily spread these small fragments from waterbody to waterbody. However, hydrilla's real secret to success is its ability to produce structures called turions and tubers. Turions are compact " buds" produced along leafy stems. They break free of the parent plant and drift or settle to the bottom to start new plants. They are ¼ inch long, dark green, and appear spiny. A single turion can potentially produce over 2,800 additional turions per square meter. Tubers are underground and form at the ends of roots. They are small, potato-like, and are usually white or yellowish. Tubers may remain dormant for several years in the sediment. A single tuber can produce 6,000 new tubers per square meter. Hydrilla produces an abundance of tubers and turions in the fall, and they can both withstand ice cover, drying, herbicides, and ingestion and regurgitation by waterfowl.

2.2 Problems Caused By Hydrilla

If not controlled diligently, the presence of hydrilla in a lake can have negative impacts on a variety of uses. Recreation in particular could be limited, as motor boats, sailboats, canoes, water skiers and swimmers are all restricted by dense mats of the plant. Extremely thick plant growth often limits shoreline access and creates nuisance odors as it decomposes. Both drinking water and power plants can be affected by shut downs when hydrilla clogs the intake screens. Overabundant hydrilla may cause wide fluctuations in dissolved oxygen, pH and temperature, as well as a reduction in biological diversity, including stunting sport-fish populations (Colle and Shireman 1980). Finally, the potential of the plant to move downstream, as well as into other area lakes, is a major concern. Plants are spread by downstream flow, but also by fragments attached to boat trailers and propellers.

2.3 Case Studies Of Hydrilla Infestations in Texas

Several Texas reservoirs have experienced a variety of problems with hydrilla, as small infestations expand to monumental proportions in relatively little time.

Hydrilla was first discovered in Lake McQueeny in 1994, and coverage jumped to 50 % of the 400 acre lake by 1995. An aquatic herbicide was applied in both 1995 and 1996. In addition to the herbicide treatment, 5,000 grass carp were introduced to the lake in the spring of 1996; by the end of the summer 1996, the vegetation in the lake was gone. Beginning in 1997, a majority of the stocked grass carp left the lake, travelling over the spillway during a series of flood events. Hydrilla is still very limited in Lake McQueeny, probably due to extreme scouring of sediment during the historic flood of October 1998.

Caddo Lake's hydrilla coverage was consistently low for several years, until the late 1990s. In 1996, 500 acres of hydrilla were documented in the 26,800 acre lake, and the same amount was mapped in early summer 1997. In August 1997, the coverage had spread to 5,000 acres, with no apparent cause. The coverage has not expanded beyond that 5,000 acres, and no treatment measures have been implemented in Caddo Lake.

Lake Bastrop is a 900 acre power plant cooling lake operated by LCRA. In 1992, it had hydrilla coverage of approximately 4 acres; four years later, it had expanded to cover 400 acres, affecting all uses of the lake. Since then, coverage has fluctuated between 300 and 490 acres. In November 1999, the power plant on Lake Bastrop experienced a 6-hour shut down when hydrilla fragments completely clogged intake structures and had to be removed by hand. A mechanical harvester is currently the primary method of control. During 4 months of 1999, the harvester was able to manage 60 acres of hydrilla, at a cost of approximately $1,041/acre. (LCRA 2000a) During the summer of 2000, hydrilla demonstrated a marked decline in the lake, possibly either from high temperatures as a result of increased power generation or a prolonged phytoplankton bloom shading the plants.

Lake Long (surface area approx 400 acres) is used for cooling water in power generation by the City of Austin. Hydrilla became a severe infestation in Lake Long in the late 1980's and over 50% of the lake surface was impacted. Austin Energy has used an aquatic herbicide (fluoridone) periodically since 1990 to control the plant.

From the above case studies and literature review, it was determined that management of Lake Austin hydrilla would most likely require a continued commitment of resources for repeated treatments regardless of the approaches selected. None of the case studies resulted in complete eradication of hydrilla without concomitant losses in native vegetation. The most successful case studies included both herbicide and grass carp treatments. Mechanical harvesting was found to be adequate for maintenance of boat lanes if repeated constantly over the growing season; however, as a long term solution to ecosystem changes induced by hydrilla, it was not found to be successful.

3.0 LAKE AUSTIN HYDRILLA INFESTATION

3.1 Current Austin Hydrilla Coverage

During a routine survey in July 1999, TPWD discovered approximately 23 acres of hydrilla in Lake Austin. Never documented in the lake before, 12 acres of the plants were concentrated near the Loop 360 boat ramp, growing from the shoreline out to a depth of 25 feet. Other patches were found near City Park (9 acres) and farther upstream, in 10-20 feet of water, with milfoil growing in the near shore area. In mid-April 2000, a survey by LCRA and COA staff indicated that the plant coverage had increased considerably since July 1999, in particular in the upstream areas near City Park. Figure 2 shows the hydrilla coverage in Lake Austin, July 1999.

In May 2000, at the request of the task force, TPWD conducted a vegetation survey that documented a dramatic increase in hydrilla coverage. The survey indicated approximately 152 acres of dense coverage, with the sparse areas not included in the acreage. The total surface area of the lake was estimated by TPWD to be 1,609 acres; however a 1999 bathymetric survey documented a surface acreage of 1,599 acres (Texas Water Development Board, 1999). The major areas of coverage were 29 acres near the Loop 360 boat ramp (140% increase from the 12 acres in July 1999) and 90 acres near City Park (900 % increase from the 9 acres in July 1999). For much of these 90 acres, the plants were growing across the entire channel of the lake, with the most dense, "topped out" (surface matted) portions within 50 feet of shore. It is important to note that this large increase occurred outside of what is typically the peak seasonal growth period for the plant (May-August), and further increases were expected in the summer of 2000. Figure 3 shows hydrilla coverage in Lake Austin, May 2000.

In July 2000, TPWD conducted their routine annual survey of vegetation in Lake Austin, and hydrilla had increased to 196.4 acres, or approximately 12 % coverage. As in May, the major areas of growth were in the areas adjacent to the Loop 360 Boat Ramp and City Park, with changes mainly in increased density. But a substantial new patch of hydrilla was documented upstream of City Park, along the shore of Commons Ford Ranch. Although only topped out mats were found within 50 ft of shore, the plants were growing in deeper water nearly all the way across the channel. Another find of concern was a small patch of plants growing downstream of the Loop 360 bridge, confirming the potential for downstream spread. Figure 4 indicates coverage of all aquatic vegetation in Lake Austin, July 2000.

3.2 Lake Characteristics, And Potential For Hydrilla Spread

Lake Austin is the sixth lake in a chain of seven lakes on the Colorado River and tributaries commonly referred to as the Highland Lakes. The current impoundment has a conservation pool elevation of 492.8 feet National Geodetic Vertical Datum (NGVD), a design surface area of 1,830 acres, and volume of 21,000 acre-feet. The drainage area for the lake encompasses about 38,240 square miles, of which about 11,900 has been noted as impounded elsewhere or otherwise non-contributing. A 1999 Texas Water Development Board (TWDB) bathymetric survey indicates that the surface area currently is approximately 1,600 acres, and the lake's volume is approximately 21,725 acre-feet (TWDB, 1999).

Lake Austin's clarity and relatively shallow depth (< 30 feet upstream of Loop 360) provide prime growing conditions for hydrilla, while its river-like flow presents unique problems for effective control. Given the current growth habit in Lake Austin, dense topped-out mats of hydrilla could grow bank to bank in water up to 18 feet deep, with growth reaching within one or two feet of the surface for all of the lake upstream of Loop 360. It is uncertain to what extent the plant will colonize downstream of Loop 360, since its current growth there is fairly limited. Although growth projections assume a maximum depth of less 25 feet to predict potential locations, the plant has been documented in other water bodies in water as deep as 50 feet. If this potential is reached in Lake Austin, it is not inconceivable that the entire lake could have dense growth of the plant from Tom Miller dam to the headwaters. The potential for the plant to move downstream into Town Lake and the lower portions of the Colorado River, as well as into other area lakes, is a major concern.

3.2.2 Water Levels And Flows

Lake Austin is a riverine lake and is operated as a 'run of the river' or 'pass through' reservoir with an operating level held within 491.0 feet and 492.8 feet. The dam was not designed to provide flood storage above the conservation pool elevation. The absence of drastic changes in water elevation helps optimize hydrilla growth year round. The water level changes in Lake Travis have been referred to as the primary reason hydrilla has not proliferated in that lake. Water level manipulation is also a method used to control hydrilla through shading by holding water depths several feet above normal or through desiccation and freezing of shallow growths through lowering water levels to expose plants in the winter. Water levels on Lake Austin cannot be raised high enough to produce adequate shade for limiting hydrilla's growth, and lowering the lake is limited in effectiveness by the adaptability of hydrilla, its ability to out-compete other vegetation under induced stresses, and the depth of drinking water intakes.

Although lake levels are fairly constant, flows are highly variable in Lake Austin on a seasonal basis due to the irrigation releases mandated by downstream water rights on the Colorado River. Timed releases for rice farmers downstream usually begin in March and continue through October. Because of these conditions, the velocity regime of the lake changes drastically; however, vegetation has adapted to these seasonal changes. Average velocities in the lake can range from <0.05 fps to 0.59 fps depending on release rates and storm influences. Mean annual retention time in the lake varies from three to twelve days (Raines and Rast, 1998). Flows released from Mansfield Dam vary from a minimum required for instream uses of about 45-100 cfs to a maximum capacity of 121,080 cfs discharged through floodgates and turbines plus spillway flows during extreme events. Scouring of plant growth is not expected within the normal range of flows and with the exception of severe flood conditions is not anticipated to be a controlling factor in the spread of hydrilla in Lake Austin.

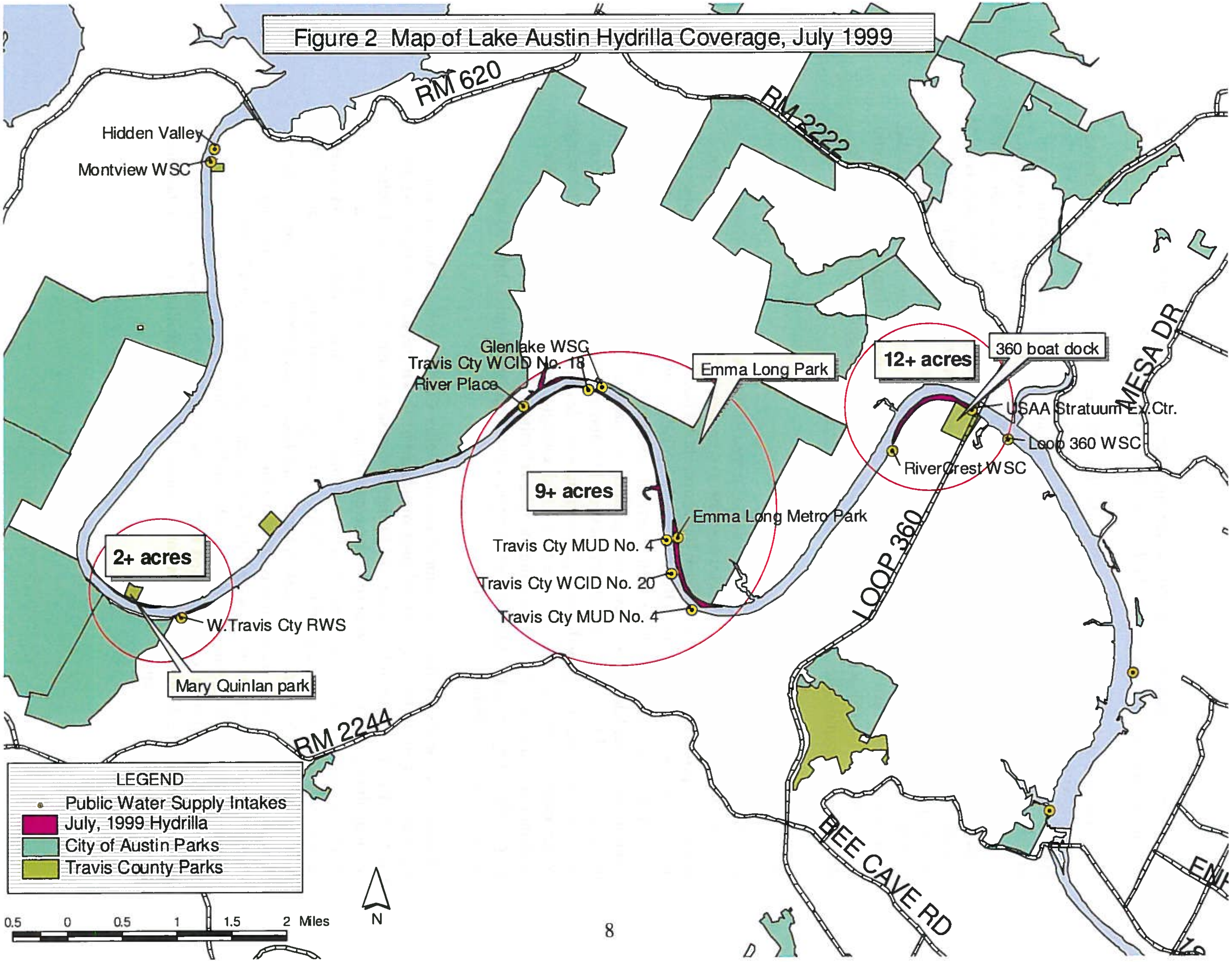
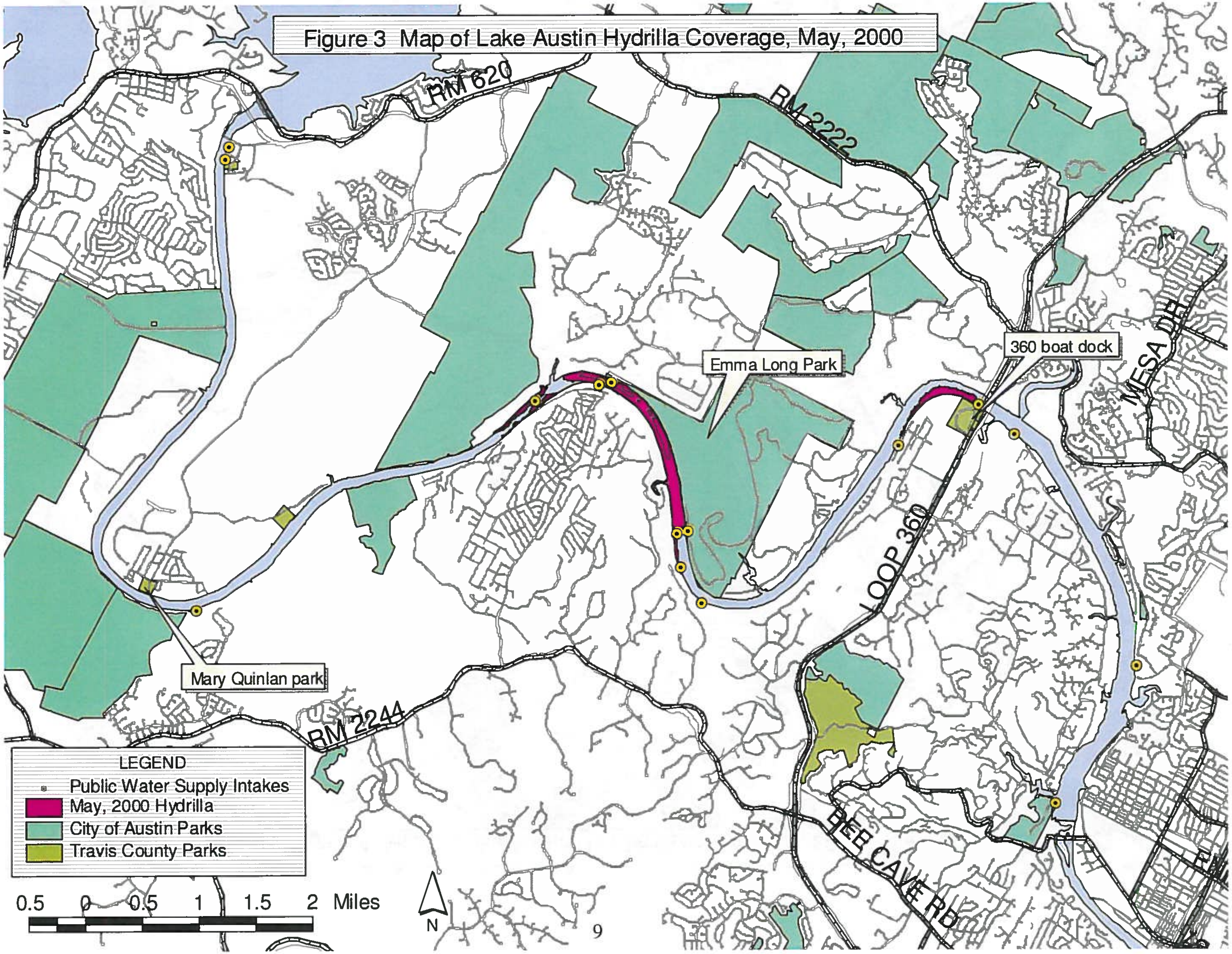


Figure 2 Map of Lake Austin Hydrilla Coverage, July 1999
RM 620
RM 2222
RM 2244
LOOP 360
MESA DR
BEE CAVE RD
Hidden Valley
Montview WSC
Glenlake WSC
Travis Cty WCID No. 18
River Place
Emma Long Park
Emma Long Metro Park
Travis Cty MUD No. 4
Travis Cty WCID No. 20
Travis Cty MUD No. 4
W.Travis Cty RWS
Mary Quinlan park
360 boat dock
USAA Stratuum Ex.Ctr.
Loop 360 WSC
RiverCrest WSC
2+ acres
9+ acres
12+ acres
LEGEND
Public Water Supply Intakes
July, 1999 Hydrilla
City of Austin Parks
Travis County Parks
0.5 0 0.5 1 1.5 2 Miles
N

Figure 3 Map of Lake Austin Hydrilla Coverage, May, 2000



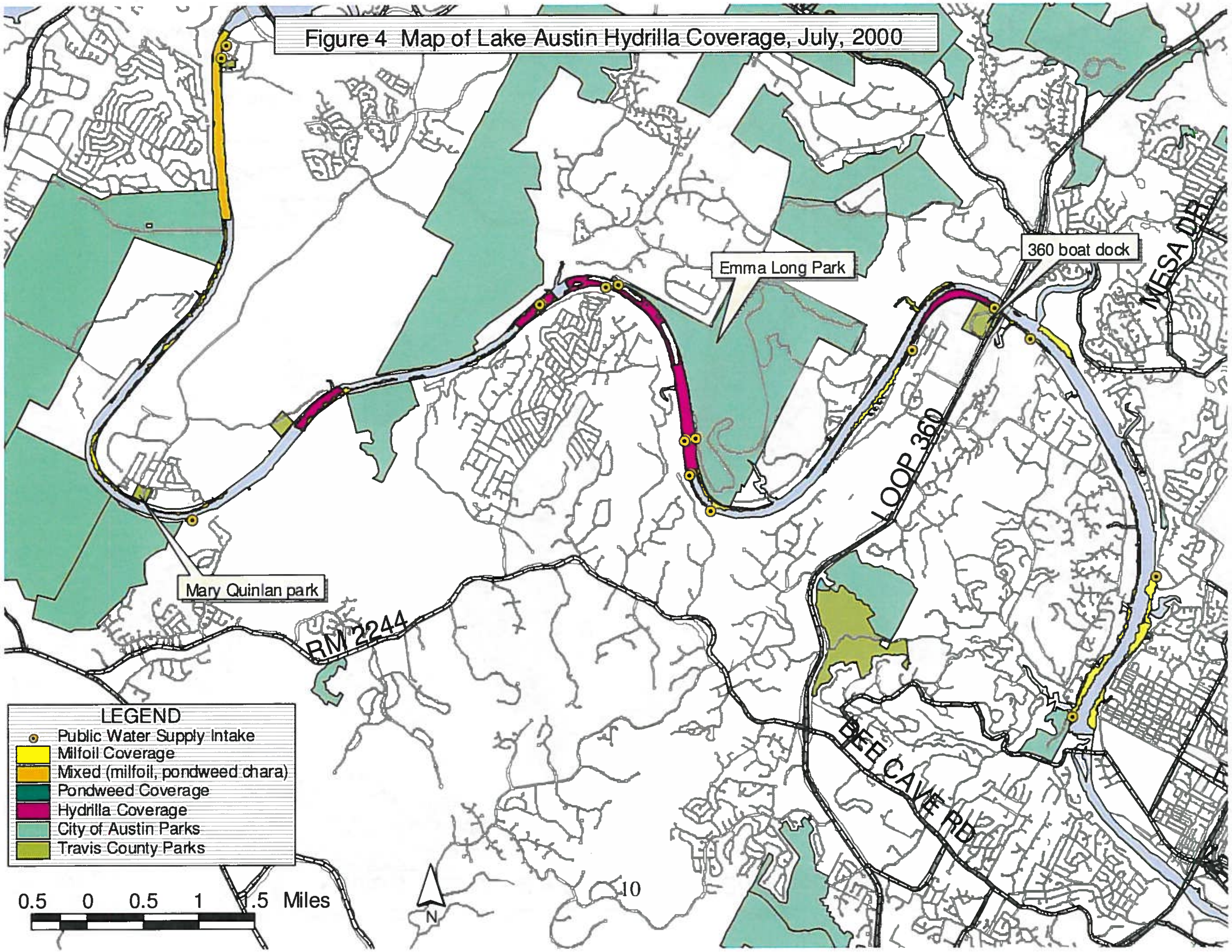


Figure 4 Map of Lake Austin Hydrilla Coverage, July, 2000
Emma Long Park
360 boat dock
Mary Quinlan park
MESA DR
LOOP 360
RM 2244
BEE CAVE RD
LEGEND
Public Water Supply Intake
Milfoil Coverage
Mixed (milfoil, pondweed chara)
Pondweed Coverage
Hydrilla Coverage
City of Austin Parks
Travis County Parks
0.5 0 0.5 1 1.5 Miles
N

3.2.3 Native Vegetation

Lake Austin has a somewhat diverse mix of aquatic plants, previously dominated by the non-native Eurasian milfoil (*Myriophyllum spicatum*) , commonly referred to as 'duckweed'. Native pondweeds, bulrush and cattails also are present. Although considered a problem by many lakeside property owners, milfoil has historically been controlled by lowering the lake on a two year basis. Although still an option, lowering the lake may not prove to be as effective on hydrilla as on milfoil. This option is discussed in more detail in section 4.2.3, Lake Drawdown.

In July 1999, the total coverage from all plants was 16%, and hydrilla only covered 1.4 % of the lake. By May 2000, hydrilla coverage had increased to 9%, showing a rapid and aggressive growth that is cause for major concern. A survey conducted approximately 3 months later (July 2000) showed hydrilla coverage increased to 12.2%, with acreage increasing from 150 to nearly 200 acres in this short period of time. With other native plants, the total vegetative cover on Lake Austin was 31.8 % as of July 2000. Figure 4 indicates coverage of all aquatic vegetation in Lake Austin, July 2000.

In addition to hydrilla, Eurasian milfoil had also increased to 218 acres from103 acres in July 1999. This increase in milfoil is possibly due to the two year schedule of lake lowering; on "off years" the lake is not lowered, and milfoil increases. In addition, recent lake lowerings have not been as effective as hoped, due to either lack of freezing weather, or flood releases bringing the lake back up before scheduled.

Table 1 compares the coverage of Lake Austin vegetation from July 1999 to July 2000 given a 1,600 acre surface area. None of the species listed have been found to out-compete hydrilla, and the current native vegetation does not appear to be a limiting factor for the spread of hydrilla in Lake Austin. Hydrilla coverage is in bold for easier reading.

Table 1
Vegetation Coverage of Lake Austin July 1999 and July 2000

Common Name	Scientific Name	July 1999 Acres	July 1999 % Cover	July 2000 Acres	July 2000 % Cover
Bulrush	*Scirpus spp.*	1.6	<1	1.6	<1
Cattails	*Typpha spp.*	0.004	<1	0.004	<1
Eurasian Milfoil	*Myriophyllum spicatum*	102.84	6.4	217.87	13.5
Hydrilla	***Hydrilla verticillata***	**22.72**	**1.4**	**196.41**	**12.2**
Pondweed	*Potomogeton spp.*	17.56	1.1	5.82	<1
Mixed *	*Varies*	112.49	6.9	90.91	5.7
	Total	257.21	16.0	512.61	31.8

* Mixed consists of Chara spp., Pondweed spp., Eurasian Milfoil. Pondweed spp. and Chara spp. were the dominant species present along with significant amounts of Eurasian Milfoil. Chara spp was found throughout the reservoir; however, it did not represent a significant aerial coverage.

3.2.3 Water Clarity

The depth range of hydrilla is dependent upon water clarity. Water clarity in Lake Austin resembles that found in Lake Travis more than the downstream more turbid Town Lake. Secchi disk data from Lake Austin reveals visible range water clarity up to 28 feet maximum with an average of 9.2 feet over the 132 measurements made by LCRA at City Park from 1993 to 1999 (LCRA 2000b). This can be compared to average secchi depths of 7.6 feet in Town Lake with significant periods of less than 4.5 feet and a maximum of only 12 feet.

Since hydrilla can grow and photosynthesize in less than 1% of full sunlight (Haller 1978) clarity does not appear to limit growth in Lake Austin at any depth. Although current stands of hydrilla have been observed up to 25 feet, water clarity does not appear to be the controlling factor or an impediment to further coverage in the lake.

3.2.4 Water Depth

The deepest point in the lake from the 1999 TWDB survey was 52.4 feet, at approximately 724 feet upstream from the center of Tom Miller Dam. Average depth of the lake is 11.5 feet. Approximately 1,000 acres of the lake is at ten feet or shallower in depth, and a further 500 acres is less than 20 feet.

Hydrilla has been found commonly in water depths up to nine feet and in situations of exceptional water clarity, growth up to 50 ft has been documented (McKinney and Durocher 2000). Since the water clarity in Lake Austin is relatively high, the horizontal spread in Lake Austin is not substantially depth limited. Also, since all inlet structures are well within hydrilla's range of depth, dense growths near the intake screens are likely to present a clogging problem for all the public and private drinking water intakes in the lake.

Anticipated growth may proceed along depth lines and according to light availability. It is anticipated that the decrease in clarity downstream of the Bull Creek confluence could provide some limitation in plant growth below Loop 360, although this is not a guaranteed limit. In Texas, hydrilla will form dense surface mats at the surface in water greater than 10-12 feet, but these "topped out" mats were identified on Lake Austin in 15 feet depth near Loop 360 bridge. Lewisville Aquatic Ecosystem Research Facility staff has documented other water bodies with topped out hydrilla mats in water as deep as 18 feet. (Owens 2000) In addition, boaters report difficulty navigating near City Park in hydrilla that is within 6-12 inches of the surface, even without dense mat formation. A map of the anticipated spread of hydrilla is provided as Figure 5. Also indicated in Figure 5 are depths less than 18 feet where matting would most likely occur, causing the greatest concern for navigation and safety.

3.2.5 Temperature

Lake Austin exhibits longitudinal zonation with respect to temperature. The upper one-third is riverine in nature, being very shallow and strongly influenced by deep water releases from

Lake Travis through Mansfield Dam. This zone extends to just above City Park on the north side of the lake; from this point downstream to the Loop 360 bridge, a transition zone exists, characterized by sinking of upstream cooler water beneath the warmer water downstream. Below the Loop 360 bridge, a third zone exists that is more typical of lacustrine conditions, with thermal stratification and turnovers. These three zones are most distinct during high releases from Lake Travis in summer months. In the absence of these releases, the lacustrine zone dominates throughout the lake during the winter. Although these temperature dynamics appear to indicate defined changes over season, the actual range of conditions is still rather small. Temperatures typically vary seasonally from 13 to 23 degrees C with local minimum and maximums from 6.5 to 31 degrees. Although seasonally lower temperatures can retard growth of hydrilla, none of the temperatures in the range observed in Lake Austin would significantly affect the spread of the plant.

3.2.6 Nutrients

The concentrations of nitrogen and phosphorous compounds in Lake Austin are monitored by the USGS and LCRA. Additional water quality parameters including plankton counts are also monitored at the COA water treatment plant intakes. Analysis of long term USGS monitoring from 1978 for nitrate-nitrite nitrogen and 1992 for orthophosphate phosphorous combined with LCRA and COA data does not indicate any significant long term increasing trend in nutrient parameters. The long term average values for nitrate-nitrate nitrogen in the lake varies seasonally from 0.11 mg/L in the fall to 0.20 mg/L as N in the spring and does not vary significantly by sites with depth. The long term average orthophosphate phosphorous concentration is 0.015 mg/L as P and does not vary seasonally or with depth between sites.

The trophic state of lakes and reservoirs is a commonly used measure indicating the level of nutrient enrichment of a water body. This measure ranges from oligotrophic (nutrient poor, low productivity) through mesotrophic (moderately or somewhat nutrient enriched) to eutrophic (nutrient rich, high productivity).

The trophic state of Lake Austin was evaluated previously using a variety of metrics combining nitrogen, phosphorous, chlorophyll-a, and secchi disk measurements (Armstrong et al. 1991). The conclusion was that Lake Austin was primarily oligotrophic by nitrogen and chlorophyll-a criteria and mesotrophic by phosphorous and transparency criteria. Because the lake was also found to be nitrogen limited and the transparency criteria is not as applicable in southern reservoirs as in northern temperate lakes where it was developed, the oligotrophic, or low productivity, characterization of Lake Austin is more appropriate.

Given the relatively low nutrient concentrations and oligotrophic status of the lake, nutrient enrichment does not appear to be a major causative factor in the hydrilla proliferation. However, the nutrient needs of the plant are very low, and increases in nutrient concentrations that have not been shown to be statistically significant through quarterly monitoring of the lake may still have contributed to the growth. In any case, the nutrient levels in the lake provide no current impediment to the further spread of the plant.

3.3 Lake Uses and Impacts from Hydrilla

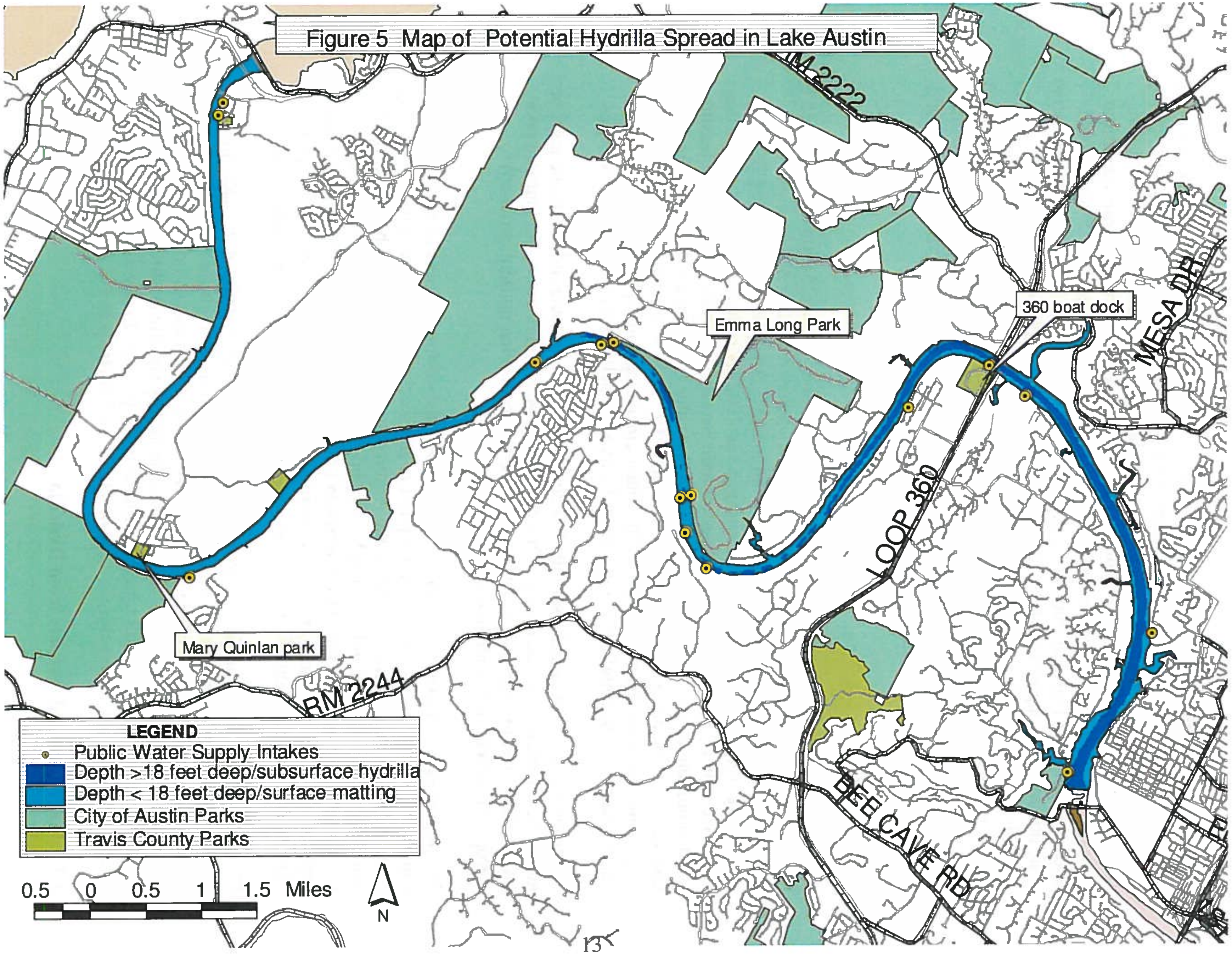


Figure 5 Map of Potential Hydrilla Spread in Lake Austin

3.3.1 Drinking water intakes

Lake Austin serves as a primary source of drinking water for the citizens of Austin, with at least thirteen intake structures located on the lake. Two intakes are for city water treatment plants; the Ulrich Water Treatment plant near Tom Miller Dam has an intake at approximately 26.8 ft depth (466.0 feet elevation) and the Davis Water Treatment Plant near Mount Bonnell intake is at approximately 17.8 ft depth (475.0 feet elevation). Emma Long Metropolitan Park also pulls water from the lake to treat for park use. Another treatment plant owned partially by the City of Austin serving the Davenport Ranch development has an intake on the southern side of the lake downstream from the Loop 360 bridge. LCRA also has an intake upstream of Emma Long Metropolitan Park, and there are many other private water providers with intakes on the lake. Two already report hydrilla growing around their intakes; Water District 20 serving Rob Roy on the Lake has become concerned enough to investigate herbicide use to limit the dense growth around their intake. All of the water intakes, public or private, could potentially be impacted by hydrilla, as they are located at depths where hydrilla is now growing in the lake.

Besides public drinking water providers, many lakeside property owners draw water from the lake for a variety of purposes, including household use. Although no specific numbers are available, conversations with property owners indicate that a majority of lakeside homeowners use Lake Austin as their potable water source. Most have some type of in-house treatment, mainly carbon filtration. Some homeowners report using SCUBA divers clean out their intakes as they become clogged with dense growths of hydrilla.

3.3.2 Recreational uses and impacts

Lake Austin provides a resource for a wide variety of recreational activities, including skiing, swimming, pleasure boating, jet skiing and sportfishing. Although the main season is from Memorial Day to Labor Day, the area's mild climate provides opportunity for lake use practically year-round. Low water levels on Lake Travis increased recreational traffic on Lake Austin dramatically in the summer 2000, but it remains to be seen whether this trend will continue in the future.

The lake also supports a healthy sport fish population and is the location for major bass tournaments, with a 13.25 lb bass caught in March 2000. The lake was highlighted in the June 1999 issue of Texas Parks and Wildlife Magazine as one of the best places in the state to catch a trophy bass. A TPWD report in June 1998 (Magnelia, 1998) indicates that the lake supports a moderate density, high quality largemouth bass fishery , with the population much improved since 1994. This is attributed in part to the voluntary catch-and-release ethic among most anglers. It is important to note that this high quality fishery existed well prior to the introduction of hydrilla to the lake; in fact, the June 1998 report indicates that vegetation cover was only 8 %.

Hydrilla has the potential to impact each of these lake uses. Clogged water intakes and limited shoreline access are certainly issues, but dense mats of hydrilla create a serious safety concern for all recreational users. As hydrilla density increased over the summer of 2000, Austin Parks Police report that they have had to assist boaters and jet skiers whose crafts have become trapped in these thick mats at least 3-4 times/day from May to September (peak boating season). They also express concern about the ever-narrowing navigation channel on this lake where boaters are required by law to "stay to the right" as on a highway. In many places, as boaters come around a bend where the hydrilla surfaces well off shore, they must move towards the center of the lake (often towards oncoming traffic) to avoid the dense growth. This is of particular concern at the Loop 360 Boat Ramp, where the large acreage of dense hydrilla has substantially narrowed ramp access, increasing the chances for a collision.

Swimmer Safety Concerns

Swimmers are also at risk; even in water that is less than 5 feet deep, becoming tangled in hydrilla over 2-3 feet thick often causes panic and puts a swimmer at a risk of drowning. Two drownings on Lake Walter E. Long in September of 1993 were attributed to being tangled in hydrilla after individuals jumped off their boats into mats of the plant. This year at Lake Raven in Huntsville State Park, an adult male drowned over the July 4th weekend while swimming in a designated swimming area that had a dense infestation of hydrilla. Although the death was not directly attributed to hydrilla, observers indicate that the individual was having trouble once he entered water over his head where the hydrilla was topped out. According to the Huntsville Item, it took divers over two hours to find the body because the growth was so dense. (Huntsville Item, July 2000)

On Lake Austin, property owners report having to keep their family, especially younger children, out of the water (even with lifejackets) due to dense hydrilla growth. Other citizens express concern about the possibility of youngsters falling from inner tubes or rafts into the plants and being unable to swim out.

4.0 CONTROL OPTIONS

A wide variety of treatment options was examined for controlling hydrilla, and those options are described in this section. All potential control methods have some degree of environmental impact associated with their use, and are listed in order starting with the lowest impact. Advantages and disadvantages of each method are discussed, along with applicability to the situation in Lake Austin. Alternatives investigated fell into the categories listed below, with the first category aimed at indirectly reducing the spread of hydrilla, rather than the actual removal of plants.

1. Educational/cultural
2. Mechanical/physical
3. Biological
4. Herbicides
5. Innovative Techniques

It is important to keep in mind that no one single method will effectively control growth of hydrilla in Lake Austin. Instead, integrating all appropriate controls is considered the best approach. This integration is described in more detail in the Recommendations section (5.0) of this document.

4.1 Educational/cultural

Although not an actual control method, education about hydrilla can be an effective way to slow or prevent the spread of the plant. Informing the public regarding the problems associated with non-native aquatic plants could also help develop support for management strategies. Signs at public boat ramps, information on agency web sites, presentations to water resource user groups and brochures are all examples of possible avenues for public education. This information should include the methods by which hydrilla is spread and the measures which the users of the lake can take to prevent spread. Measures include cleaning boats of hydrilla fragments before leaving boat docks and avoiding surface mats of hydrilla while on the lake as much as possible. Dock or waterfront property owners should be provided with information on methods of hydrilla control for small near-shore shallow areas which can be implemented in a manner to cause the least fragmentation and spread of the plant.

4.2 Mechanical/physical

4.2.1 Harvesting

Harvesting requires specialized machines to cut and remove aquatic plants from the lake. It is not a widespread management tool because of high cost, fragmentation, and logistical constraints on large water bodies. Additionally, fish mortality resulting from harvester use may be high. Juvenile sport fish and smaller species are most susceptible. Currently, there are limited uses for the harvested material due to the high water content, low nutritive value and low fiber content. The harvested material is very bulky when wet, causing difficulties in disposal and transport. It dries to 10 % of its wet weight, making land tilling or composting possible.

Mechanical harvesters are large machines which cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. A barge can be stationed near the harvesting site for temporary plant storage; alternatively the harvester itself carries cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester or barge and lifts the cut plants into a dump truck. Harvested weeds are disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites. Harvesting is usually performed in late spring, summer, and early fall when aquatic plants have reached or are close to the water's surface. The rate of harvesting (acres per day) is variable depending on weed type, density, and storage capacity of the equipment. Depending on the equipment used, the plants are cut from five to ten feet below the water's surface in a swath 6 to 20 feet wide. Because of machine size and high costs, harvesting is most efficient in lakes larger than a few acres.

Mechanical harvesting may actually compound the weed problem since the primary mode of reproduction for aquatic weeds is fragmentation. Harvester operators report that 10 % of cut material or fragments fall back into the lake during operations. Nearly 50 percent of fragments with a single leaf whorl can sprout a new plant and subsequently a new population.

PROS	CONS
➢ Non-chemical	➢ Not a true control method, "mowing"
➢ Site specific	➢ Frequent harvesting required (every 60 days)
➢ Lake can remain open during harvest	➢ Spreads hydrilla by fragmentation
➢ Effective for small localized area control (private shoreline)	➢ Disposal - large volumes of wet material; high nitrate concentration
	➢ High costs ($1000-2500/acre)
	➢ Mortality of fish (1300/acre)

Case Studies of Harvesting

During 4 months of 1999, the Lower Colorado River Authority used a harvester for hydrilla control on Lake Bastrop, a power plant lake with approximately 35 % hydrilla cover at that time. 100 acres were targeted for harvesting, but with rapid re-growth and subsequent re-cutting, only 60 acres were actually managed with the harvester. Total cost for this operation was $1041 per acre, and rates ranged from 2 to 10 acres per week, with an average of 7 acres harvested per week. Factors influencing efficiency included density of hydrilla, distance to shore for disposal, weather and maintenance and repairs.

Lake Raven, at Huntsville State Park, had 100 acres of hydrilla in a 204 acre lake. In 2000, 25 acres were harvested to provide access in public areas, and these areas had to be cut three times that year because of re-growth rates. The cost of this operation was $250/acre.

Collateral Catch

One concern with mechanically harvesting aquatic vegetation is the potential to adversely affect fish populations. During normal harvesting operations, small fish are incidentally caught and removed by the harvester. On three occasions during the 1999 summer season at Lake Bastrop, LCRA biologists quantified the size, number and species of fish caught in the harvested hydrilla (see Figure 1). The average collateral catch for the three samples was 189 fish per load of harvested hydrilla, or less than 2 percent of the calculated fish population at Lake Bastrop. At an average of 7 loads per acre, these data indicate that harvesting has the potential to kill 1300 fish per harvested acre.

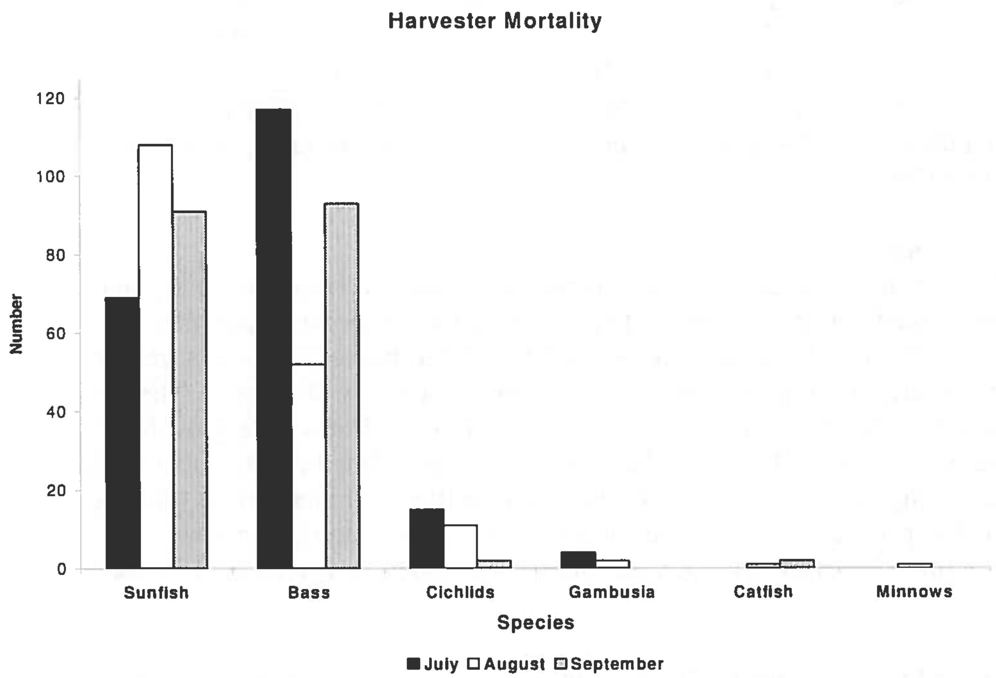


Figure 6. Fish mortality from Lake Bastrop harvester, 1999

The Lake Bastrop fish mortality numbers generally correspond to those in scientific literature. Mechanical harvesting removed between 2 and 8 percent of the juvenile fish from harvested areas in Saratoga Lake, New York (Mikol 1985) and 32 percent of the fish population in harvested areas in Orange Lake, Florida (Haller et al. 1980). Harvesting removed 21,000 to 31,000 fish per year, representing 25 percent of the fry from Lake Halverson, Wisconsin (Engel 1990). Harvesting removed about 39,000 fish, predominantly bluegill, from Lake Keesus, Wisconsin (Booms 1999). In the Wisconsin study, largemouth bass, unidentified fry and black crappie comprised 24 percent, 16 percent, and 8 percent of the total removed.

In Lake Bastrop, sunfish (47 percent) and juvenile bass (46 percent) represented 93 percent of the fish removed as collateral catch (see Table 2). Of the estimated 130,640 fish removed by the harvester, about 61,640 were bluegill, 60,260 were juvenile bass, 6,440 were Cichlids, and 1,380 were Gambusia. TPWD estimated the replacement value for these fish at $62,700.

TABLE 2. FISH REMOVED BY LAKE BASTROP HARVESTING OPERATIONS

	July	August	September	Subtotal	Average	Total*	Percent
Sunfish	69	108	91	268	89	61,640	47
Bass	117	52	93	262	87	60,260	46
Cichlids	15	11	2	28	9	6,440	5
Gambusia	4	2	0	6	2	1,380	1
Catfish	0	1	2	3	1	690	<1
Minnows	0	1	0	1	0	230	<1
	205	175	188	568	189	130,640	100

*Totals were calculated by multiplying the average number of fish per load times the number of loads cut in 1999 (690).

Applicability to Lake Austin:
Since June 2000, a privately owned harvester has been operating on Lake Austin through contract with private landowners. Information provided by the owners indicates that approximately 4.7 acres have been harvested since May. Their harvesting rate is similar to LCRA's, at approximately 6-10 hours per acre, depending on density of growth. The cost to private landowners is higher because they are operating for profit. Rates of re-growth are quite rapid; in many cases, hydrilla has reached the surface and formed dense mats (resulting in requests for re-cutting) within six weeks of initial harvesting. All landowners on Lake Austin are required to provide an area for dewatering of the plant material, and most individuals use the dried material as landscape mulch.(See Appendix E for City Disposal Guidelines)

An important consideration with harvesting is disposal; there is limited land adjacent to Loop 360 available for dewatering of plant material or landscape disposal. Concern for downstream spread through fragmentation, mortality of juvenile fish and high cost from frequent re-cutting needed during rapid growth periods are also considerations.

4.2.2 Cutting

Mechanical weed cutters cut aquatic plants several feet below the water's surface. Unlike harvesting, cut plants are not collected while the machinery operates. There are several versions of underwater weed cutters commercially available, including:

Hand-held, battery- powered cutters
Portable, boat-mounted cutting units

Specialized barge-like cutting machines

Cutting is generally performed during the summer when plants are near the surface.

Applicability to Lake Austin:

Although ease of operation makes this an attractive alternative for individuals, the spread of hydrilla through dispersal of the plant fragments rules this out as an option for Lake Austin. unless the city's disposal guidelines (Appendix E) are incorporated into the operation. It may also apply in small areas where booms and netting are employed to capture cuttings.

4.2.3 Lake Drawdown

Lake drawdown is a management practice that can be effective in ponds and small lakes where the water level can be easily regulated. When the water level is lowered, aquatic weeds along the shoreline are exposed to drying or freezing conditions. It also provides lakeside residents the opportunity to deploy other management techniques such as bottom barriers. However, lake drawdown can have an adverse impact on fish and desirable native aquatic vegetation.

Because of hydrilla's adaptability, drawdown could give it a survival advantage over desirable native plants as well as other exotics (like Eurasian milfoil). Lowering the water level in winter may kill the upper, vegetative portions of all aquatic plants, but because of hydrilla's numerous reproductive tubers unaffected by drying out, hydrilla will likely return when the water level rises, but other plants may not.

PROS	**CONS**
➢ Non-chemical	➢ Hydrilla tubers not killed
➢ Increases effectiveness of further measures	➢ Potential impacts on other aquatic and lakeside habitats
➢ Provides opportunity for dock maintenance and installation of bottom barriers	➢ Interferes with recreational use
	➢ Freezing weather conditions rarely occur
	➢ Cost/availability of water to refill lake

Case Studies of Drawdown Impacts on Hydrilla:

A study in Florida showed that re-flooding after a drawdown acts as a stimulus to increase sprouting rates of tubers. In addition, short drawdowns can stimulate sprouting in excess of 80%. (Netherland, 1999) Hydrilla tubers in Lake Ray Roberts, a reservoir in North Texas, showed no decline in number or viability after a 12 month continuous drawdown. After six cycles of drawdown and reflooding over a four year period in an experimental pond, 10 % of the original tuber bank was still present. (Doyle, et al, 2001).

Applicability to Lake Austin:
This control technique has been utilized for over 30 years on Lake Austin to control Eurasian watermilfoil. Normally, the lake is lowered 10-12 feet every other year for approximately six weeks in the winter. This past practice may not prove sensible now that hydrilla has been discovered in the lake. Drawdowns may actually give hydrilla a competitive advantage and promote its proliferation as tubers can be stimulated to sprout more by repeated drying out. Additionally, hydrilla is already growing at a depth of 25 feet and Lake Austin is usually lowered only 10-12 feet to keep water intakes submerged. However, drawdowns are not used exclusively for vegetation control, as the practice allows lakeside property owners an opportunity to perform dock maintenance and install bottom barriers.

4.2.4 Bottom Barriers

Bottom screens or barriers cover the sediment like a blanket, compressing aquatic plants while reducing or blocking light, preventing plant growth. They are usually used in swimming areas or boat access lanes. These barriers need to be gas permeable and carefully secured to the lake bottom to prevent them from breaking up and posing a problem to swimmers, wildlife and boat propellers.

Applicability to Lake Austin:
The City of Austin's Parks and Recreation Department utilizes this control technique for Eurasian watermilfoil at the Emma Long (City) Park swim area. Bottom covers are not practical for large-scale control endeavors, but could be an important tool for clearing areas around private docks. The city has provided private landowners with information (Appendix F) on these and other small scale techniques, and more details will be provided on the city's web page. Cost is prohibitive for large areas, as the material estimate alone is $10,000 per acre.

Shading

Shading is an artificial means of controlling unwanted submerged vegetation. Chemical dyes are employed to inhibit light penetration and thus shade out the problem plant. Shading is most often used in small lakes and ponds with little or no water flow or in urban areas such as landscape ponds.

Applicability to Lake Austin:
Due to Lake Austin's relatively high flows and the depth of growth of hydrilla, this is not an appropriate control option.

4.3 Biological Controls

4.3.1 Grass Carp

Biological controls are often less expensive than mechanical or chemical controls because a one-time investment may continue to pay dividends for years. Biological control agents include fish, insects and diseases that naturally suppress hydrilla in their native habitats. The most effective biological control to date is the grass carp or white Amur (*Ctenopharyngodon idella*). Triploid (sterile) fish are introduced and they actively feed on the hydrilla. Hydrilla is the preferred plant for consumption, but grass carp will eat desirable, native aquatic plants as well. Economic factors, reduced chemical use, the fish's preference for hydrilla and their longevity (at least 10 years) are strong incentives for grass carp use.

While biological control appears attractive due to length of control and relatively lower cost, there are some disadvantages that must be considered before pursuing this option. Negative public relations with local fishermen, the impact on vegetation besides hydrilla, and chance of downstream escape are all additional factors to include in the decision-making process.

Other concerns associated with using grass carp are:

- This fish is not native to the area. Introducing an exotic to control an exotic may disrupt the balance of the ecosystem beyond the damage done by hydrilla.
- Unpredictability of the fish and chance for escape.
- The grass carp will not provide immediate control of the aquatic weeds.
- There is a chance that the fish will over-eat the aquatic vegetation.
- Stocking requires a permit from TPWD and a public hearing.
- The fish are not site specific. Once released into the lake, they roam freely, feeding at will but not necessarily where the hydrilla needs control.

PROS	**CONS**
➢ Non-chemical	➢ Difficult to remove once introduced
➢ Offers long-term control (fish live > 10 years)	➢ Could eliminate other native vegetation
➢ Triploid fish do not reproduce	➢ Stocking rates are imprecise
➢ Use will not deplete dissolved oxygen	➢ Potential for downstream escape
➢ Prefer hydrilla	➢ Makes re-vegetation efforts more difficult
	➢ Does not promote improved fishery or balanced vegetative community

Stocking grass carp in Lake Austin presents certain challenges, primarily the issue of the fish impacting game fish habitat and water quality by eating more than the targeted vegetation (hydrilla). To address these, case studies of grass carp stockings were examined.

Case Studies of Grass Carp

Lake Conway in Florida is a 1,840 acre lake that was stocked in 1977 with all female grass carp, at a stocking rate of 8 fish/acre of submersed vegetation. No major changes were noted until the second summer after stocking, but two years after stocking, hydrilla was greatly reduced with no noticeable effect on other species. Tapegrass (*Vallisneria americana*), a non-preferred plant for grass carp, increased dramatically. In 1986 and 1988, in response to increasing hydrilla, additional fish were stocked at 1 and .6 fish per acre, reducing hydrilla by 1989 and keeping it low until the research was published in 1994. In this lake, grass carp have been able to maintain hydrilla at a low level for over 15 years with minimal impact on other aquatic plant species. Although this is a favorable example of what can be obtained with grass carp, Lake Conway has a much more diverse native plant community than Lake Austin, where the presence of the native, less palatable species tapegrass was particularly advantageous, as it expanded to replace hydrilla. (Leslie et al, 1994)

Another lake that has shown success with grass carp is Lake Jacksonville in Texas. This 1,208 acre lake has been the subject of a pilot study by TPWD, involving an integrated approach using minimal herbicide treatment, a low stocking rate of carp and introduction of native plants. In 1997, prior to stocking, there were 80 acres of hydrilla in the lake. 100 grass carp were stocked in conjunction with application of a contact herbicide Aquathol (not appropriate for use in Lake Austin due to drinking water restrictions). This same treatment (100 carp, Aquathol) was repeated in 1998, and following each treatment, native plants were introduced in protective cages. Preliminary results indicated good success, with native plants expanding beyond cages and hydrilla being selectively grazed. However, by Spring 2000, TPWD indicated that additional herbicide treatments were used, and hydrilla acreage has increased to 150 acres.

Lake Cypress Springs (3216 acres) also shows success with grass carp; in 1996 there were 434 acres of hydrilla or 13.5 % cover. 2170 carp (5 fish per acre hydrilla) were stocked in 1997, and in 1998 hydrilla coverage was only 3.6 %.

Pinkston Lake (560 acres) with 322 acres of hydrilla (60% cover). In 1997, 2100 grass carp (6.5 fish per acre hydrilla) were stocked and coverage has steadily declined to 40% in 1999 and 20% in 2000.

Some lakes show inconclusive results, Lake Raven (204 acres) had 100 acres of hydrilla, and one year after stocking 200 fish (.5 per acre of hydrilla), there is no change in coverage. Harvesting has been ongoing on this lake as well.

However, there are documented cases of grass carp removing all the vegetation in a lake: in the early 1980s, Lake Conroe lost all vegetation after the stocking of 20,000 diploid (or breeding) grass carp were stocked. Since that time, TPWD has restricted permitting of carp to only triploid, or sterile fish. Lake McQueeny (364 acres) and Lake Dunlap (335 acres), each with 200 acres of hydrilla, were both stocked in spring 1996 with 5,000 fish in conjunction with herbicide treatments (both Aquathol and Sonar). Later that same year, there was no vegetation in either lake. A majority of the grass carp left the lake during a series of flood events in 1997. Martin Creek (5434 acres) was stocked with a total of 11,857 fish over a four year period, and now has no hydrilla left.

A Florida study on grass carp in large lakes (Leslie, et.al. 1993) recommends integrating a low stocking rate of carp with other plant control methods, such as reducing the density with herbicides. It also states that it is better to underestimate stocking rates and use supplemental control methods, than to depend solely on carp for control. This, along with the control seen in reservoirs such as Lake Cypress Springs in Texas and Lake Conway in Florida provides support for the task force's integrated plan.

Applicability to Lake Austin:

Grass carp are an attractive, non-toxic option. These fish prefer hydrilla to other aquatic vegetation and provide passive control throughout the year. A low stocking of grass carp will provide long term control and will control areas the mechanical harvester can not reach (deeper than 5 ft, near obstructions, etc.) and in areas of hydrilla infestation not yet discovered. In many of the cases where fish consumed all vegetation, the stocking rate was extremely high. The impact on the fishery from this total vegetation removal has not been clearly documented, in fact, fishery biologists indicate that Lake McQueeny still has a strong bass fishery in spite of the loss of vegetation. There is reportedly a decline in water quality (increased turbidity and algae blooms) as would be expected with such a severe loss of vegetation.

If carp were able to remove most of the hydrilla in Lake Austin, milfoil may expand into areas once dominated by hydrilla. Milfoil is a relatively unpalatable plant, as is tapegrass. With 20 plants listed by approximate order of grass carp preference, hydrilla is #1, as the most preferred, while milfoil is 14 and tapegrass is 15 out of 20 (Sutton and Vandiver, 1986), Although milfoil is not a desirable plant and can be a nuisance, it is at least more easily controlled through lake drawdowns and harvesting than hydrilla has proven to be.

Although the selection of a stocking rate is not a precise science, using a low rate is preferable to what happened in lakes such as McQueeny or Dunlap. In those cases, the coverage of hydrilla reached near epidemic proportions while user groups and agencies discussed control options. With over 50 % cover, there was such a high level of frustration with the infestation that extremely high numbers of fish (25 fish per vegetated acre) were stocked, and vegetative cover was lost.

Impacts from downstream escapement into rivers and estuaries (such as the Guadalupe River downstream of Lake McQueeny and Lake Dunlap) have not been well documented. There is potential for downstream movement of the fish out of Lake Austin. Hydrogeneration could provide an avenue for escape, although this is unlikely due to the deep water nature of these releases. Opening surface-level gates during a major flood event would provide the primary route for movement downstream. A low stocking rate will minimize the number of fish in downstream areas in the event of such movement, while a radio tracking study could provide information on fish location.

4.3.2 Enhancing Native Vegetation Populations

Although not a control method for established beds of exotic plants, native plants can help limit new growth and re-establishment of exotics after control. Native aquatic vegetation provides the same benefits as exotic species (habitat, nutrient sinks, water quality, etc.), with few of the associated problems. Promoting non-nuisance aquatic plants such as tapegrass (*Vallisneria*), coontail, pond weed and water lilies will slow the spread of exotic species. Recent studies by Lewisville Aquatic Ecosystem Research Facility indicate that *Vallisneria* shows promise in actually outcompeting hydrilla as long as it is established prior to the introduction of hydrilla. (Doyle, 2000) Local populations of existing native vegetation can be identified and encouraged within specific coves. Efforts often involve planting native vegetation following other control endeavors.

Applicability to Lake Austin:

Lake Austin presently enjoys a somewhat diverse community of aquatic plants, but hydrilla has increased from 9 % to 43 % of this community in the past year. The main obstacle to using native plants as competition for hydrilla is the depths at which hydrilla is presently found. Native plants will not thrive in those deeper waters, but this remains an option for shallow coves and near shore areas

In addition to depth limitations, the logistics of getting native plants established are complicated by the high boat traffic on the lake, especially close to shore. Native plants are usually placed inside wire cages to limit grazing by turtles, etc., and these would have to be carefully placed and well marked to not create navigation hazards.

In spite of these obstacles, the establishment of native plants is still well worth investigating. Although they would only provide a fringe of growth along the shore, with hydrilla still occupying the deeper water, natives could prove to be more acceptable to all lake users than hydrilla.

4.4 Aquatic Herbicides

Human health and safety are always a concern when aquatic herbicides are applied to vegetation in water supplies, particularly in drinking water sources. Before labeling herbicides for use in aquatic systems, the United States Environmental Protection Agency (EPA) evaluates appropriate data and determines that at the approved rate, these chemicals should not adversely affect human or ecosystem health.

Two factors should be recognized when considering the safety of aquatic herbicides;

1) Products that have been granted an aquatic use label are registered by EPA to be used in and around water; and
2) Pesticides that are potentially harmful to humans and other non-target animals when used in and around water (or are carried by rainfall runoff from surrounding area into the water) do not have aquatic labels.

Herbicides are often the most effective and targeted means of hydrilla control. Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or pellet form. Only a few herbicides are available for the control of hydrilla. These include copper complexes, diquat, endothall and fluoridone. They fall into two categories: contact herbicides that are quick acting and show results within a matter of days, and systemic herbicides that kill plants over longer periods of time. Contact herbicides are most appropriate in infestations less than 5 acres or in moderately flowing water. Systemic herbicides are better suited for continuous infestations greater than 5 acres, with little or no water flow.

Many herbicides have some type of label restriction associated with drinking water. Some impose a time restraint such as 7 days, while others have a distance limitation such as "not within 1,320 feet of a functioning potable water intake." Chelated copper compounds (a class of contact herbicides) have no such use restrictions.

There are strong societal perceptions associated with the use of chemicals in the environment, even for aquatic herbicides with no use restrictions. Additionally, hydrilla management with herbicides can be expensive. The cost of herbicides alone range from $250 to $1,000 per acre and multiple applications of contact herbicides during each growing season are required for effective control.

PROS	CONS
➢ Site specific	➢ Strong societal concerns regarding use of chemicals in the environment
➢ Can be species selective	➢ High cost of herbicide ($200 - 1,000 per acre)
➢ Reaches deeper than harvesting, control can last up to one year or more	➢ Some types limit contact recreation and fishing for certain periods of time
➢ Lower labor costs	➢ Control typically partial due to dilution problems
➢ Some types are very effective in treating hydrilla (kills tubers and leaves)	➢ Several repeat applications necessary
	➢ Decomposing plant material may cause short-term dissolved oxygen (DO) reduction

Case Study of Impacts from Chelated Copper Application
Data from Florida lakes (Leslie, 1992) treated repeatedly with chelated copper for macrophyte control show average sediment levels of copper from 3 to 30 times higher in treated compared to untreated areas. Sediment accumulation of copper in three reservoirs treated with chelated copper range from 34 to 71 mg/kg, while untreated areas ranged from 2 to 10 mg/kg. In examining this data, it is important to remember that treatments were repeated over several years, and that this accumulation is not the result of a single treatment.

Although these data are of concern, the amount of copper herbicide input in these Florida lakes was large and long-term. The Florida Department of Natural Resources estimates between 51,800 lbs and 96,000 lbs of copper per year being used in lakes statewide between the years 1981 to 1991. These use figures include copper sulfate for algae control as well as chelated copper for macrophyte control. Sediment accumulation and potential for bioaccumulation by the threatened Florida Manatee was a consideration when the use of copper herbicides in Florida was phased out beginning 1985, and the state switched primarily to the use of the systemic herbicide fluoridone. However, copper is still used in the state on a private basis.

In addition to the field data, the same study provided calculations for potential copper accumulation in sediment from application of chelated copper. Using an herbicide containing 0.9 lbs elemental copper per gallon at a rate of 3.6 gallons per acre, there is the potential to deposit 14.0 mg/Kg Cu in the top 5 cm of sediment for each treatment. This herbicide formula and rate is similar to the chelated copper being considered by for Lake Austin.

Applicability to Lake Austin:
Lake Austin's relatively high flows limit the effectiveness of systemic herbicides (which kill the roots and leaves) because they require at least 30 days contact time to be effective. In addition, these often have limitations for use in drinking water reservoirs. However, copper complexes requiring 12- 24 hours contact time could be effective under the flow regimes present in Lake Austin and there are **no** use restrictions associated with their application, so water may be used immediately after treatment for drinking, swimming, fishing, and irrigation. The City Water and Wastewater Department has determined that chelated copper compounds are the only class of herbicides appropriate for use on Lake Austin. Background levels of copper in Lake Austin are low in both water (<0.006) and sediment (7.58 mg/kg) (City of Austin, 2000). Any herbicide application would involve notification of all drinking water providers, and would be done in conjunction with both water column and sediment monitoring for copper. Public input regarding this option will be an important part of the decision making process.

4.5 Innovative Techniques

Many control techniques are used in other states or countries but are not well-tested in Texas reservoirs. These options hold potential for effective control, but will require additional research before becoming part of a treatment proposal.

<u>Scuba diver- hand removal and dredging</u>

Scuba divers have been used on Lake Austin to hand pull hydrilla and remove it from the lake. This can be effective, as divers can pull more of the plant than the five feet removed by harvesting. However, it is a very expensive option, as evidenced by a private landowner on the lake who paid $2500 to clear less than one acre of shoreline cleared. The hydrilla re-grew to the surface within 60 days of removal.

Diver dredging is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to vacuum plant material out of the sediment. The purpose of diver dredging is to remove all parts of the plant including the roots. A good operator can accurately remove target plants, like Eurasian watermilfoil, while leaving native species untouched. The suction hose pumps the plant material and the sediments to the surface where they are deposited into a screened basket. The water and sediment are returned back to the water column and the plant material is retained. The turbid water is generally discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are disposed of on shore. Removal rates vary from approximately 0.25 to 1.0 acre per day.

Diver dredging has been used in British Columbia and Washington to remove early infestations of Eurasian watermilfoil. In a large-scale operation in western Washington, two years of diver dredging reduced the population of milfoil by 80 percent (Web Page www.ecy.wa.gov). Diver dredging is less effective on plants like hydrilla where seeds, turions, or tubers remain in the sediments to sprout the next growing season. More research is needed before this option becomes a recommended one.

4.5.2 Rotovation

Rotovators use underwater rototiller-like blades to uproot aquatic plants. The rotating blades churn seven to nine inches deep into the lake or river bottom to dislodge plant roots. Plants and roots may then be removed from the water using a weed rake attachment to the rototiller head or by harvester or manual collection.

In some waterbodies, rotovation can be used year-round to control aquatic plant growth. However, it is most effective in the winter and spring when plants have died back. Summer and fall rotovation usually requires the plants to be cut first, since longer plants wrap around the rototiller head, slowing the rotovation process.

Depending on plant density and sediment type, two to three acres per day can be rotovated. Because of the size of the equipment and high costs, rotovation is most suitable for use in larger lakes or in rivers. Concerns include discharge of silt into the water and effectiveness on hydrilla tubers.

5.0 TASK FORCE TREATMENT RECOMMENDATIONS

5.1 Integrated Pest Management

The principles of integrated pest management (IPM) were used to design the treatment proposal. IPM is generally thought of as a decision-making process for determining if a pest control action is needed and if so, then which to use, and when. IPM employs the use of an array of preventive and control strategies that include: cultural practices, maintenance measures, physical and mechanical removal, biological agents, natural chemical controls and as a last resort, synthetic chemical controls, beginning with the selection of the least hazardous choice.

The use of any toxic chemical is done judiciously, targeting the pest specifically and at the stage of development for the most effective control. The process strives for realistic and effective control of the nuisance weed, not complete eradication of the vegetation community.

In keeping with IPM strategies, all control methods were evaluated by the task force based on effectiveness, environmental impact, site characteristics, public health and safety, and economic factors. A predetermined calendar schedule will not be used to trigger each control method; instead, triggers will be defined when and where monitoring has indicated that previous methods have not provided reasonable control.

5.2 Management Goals

An important component of IPM involves evaluation of treatment results and determination of the need for additional treatment. This evaluation is based on monitoring of the target population, with additional treatments being made only when and where monitoring has indicated that the pest will cause unacceptable damage. Using this integrated approach, "unacceptable damage" from hydrilla must be defined in order to evaluate effectiveness of management techniques. Although the many users of the lake would define this level of damage differently, the controlling factors to be considered in making this determination must be the protection of human health and the environment. At the current level of vegetation coverage, indications from Park Police and recreational users are that public safety is already adversely affected. Therefore, reduction in hydrilla coverage to a level below the current acreage is necessary as the management goal. The objective of the plan is to reach and maintain an appropriate level of native aquatic vegetation for a healthy ecosystem adequate for all users of the lake.

Specifying an actual target surface coverage of hydrilla for planning treatment is difficult as consensus does not exist on the level of aquatic vegetation that is acceptable for all users. Some fisheries biologists believe that a total vegetative cover of roughly 30% is optimal for sport fishing with between 10 and 40% beneficial (Mallison, 1994). There is conflicting information on this level, as other biologists state that values over 30% are detrimental to a fishery (Durocher, 2000). A published survey of 60 lakes determined that 15% macrophyte coverage precludes the probability of any adverse fisheries problems, but found "no relation between the standing crop of harvestable largemouth bass and the percentage area covered by aquatic macrophytes" (Wrenn, 1994). Recognizing that eradication is an unrealistic expectation, control should be maintained at a level that is achievable with the best applicable technology available and the least potential environmental impacts.

Herbicide manufacturers and applicators have stated that effectiveness decreases in waters greater than 10 ft. deep. Achievable herbicide treatment of all hydrilla present in the 2000 survey in 10 ft of water would reduce the coverage by 29.8 acres resulting in a total vegetative cover of 30.2%. In total, there are 641 acres of lake with less than 10 ft of water where hydrilla could colonize before treatment is made in spring (TWDB 1999). Control in the open public access areas at City Park (61.2 acres) and the Loop 360 boat ramp (41.5 acres) would require removal of an additional 102.7 acres. However, much of the removal in these patches would depend on herbicide effectiveness in deep water and the local activity of stocked grass carp. The resulting post treatment maintenance target would then be 93.7 acres of hydrilla in mostly deep water resulting in a 23.7% total vegetative cover.

In summary, target reductions are to bring hydrilla coverage down by approximately 50 % (from 200 to 94 acres) and to keep spreading of the plants to a minimum through education and disposal guidelines.

This would provide improved vegetative cover over pre-hydrilla infestation levels for sport fishing and improved public access and safety over the current situation. The target numbers assume that hydrilla will be the primary preference for the grass carp and other vegetation will remain at the same coverage as long as additional hydrilla is available. This target also assumes that the grass carp remain in the lake. It should also be recognized that the multitude of environmental variables in aquatic plant management and complications due to Lake Austin morphological and hydrological characteristics could intervene and prevent this goal from being reached. However, this target is needed for future evaluation in comparison to monitoring data.

5.3 Summary of Recommendations

The primary use of Lake Austin is in providing drinking water to the citizens of Austin. It also serves to pass flood and irrigation waters downstream from Lake Travis and provides numerous recreational opportunities. However, the uncontrolled growth of hydrilla is likely to affect not only the many recreational activities but also property values and drinking water intakes along Lake Austin.

An integrated process using several different control techniques will enable targeted control of hydrilla. There is not a quick, easy and inexpensive solution to aquatic vegetation control. Resources and monies for hydrilla management should be planned for the upcoming years. It is hoped that if a successful vegetation control plan is implemented in the spring of 2001 and continued for an additional three years, hydrilla can be brought under control. The following describes an approach that integrates several control practices to meet the goals set for hydrilla in Lake Austin.

The task force plan involves a one-time herbicide application in conjunction with stocking of a low number of carp. The herbicide will decrease the biomass of hydrilla so that carp can maintain effective control at a lower stocking rate. Having carp in the lake should minimize additional need for spot treatment with herbicide. These recommendations are compared to single treatment options in Table 3.

TABLE 3
COMPARISON OF "STAND ALONE" CONTROL OPTIONS WITH INTEGRATED PLAN

Control Option	Effectiveness/Description	Impacts	Cost
No Action	Potential for tenfold increase Over 50% cover by 2001	Clog drinking water intakes Water Quality degradation Navigation and public safety incidents Fishery decline Environmental concerns from unregulated herbicide application	Water treatment costs Property values decline Fish kills Lower recreation revenues Downstream costs to irrigators
Harvester	7 acres per week Cut every six weeks (at least 3 times/year) 50 acres per harvester Four harvesters to manage 200 acres	No reduction in hydrilla coverage No relief for water intakes 65,000 fish killed/50 acres Fragments sent downstream Disposal costs at Loop 360	$1000/acre + $500/acre disposal 50 acres, 3 times/yr, $150,000/yr 200 acres, 3 times/yr, $600,000
Carp	7 fish per acre x 1600 11,200 fish	Increased chance of -downstream impacts -total vegetation removal -fishery impacts	$134,000 cost of fish and fee $ 25,000 tracking study $ 159,000 total
Herbicides	Contact, copper based only Re-treatment every 3-5 weeks, at least 4 x yr Not effective in water > 10-12 feet	30 mg Cu/kg added to sediment with each 7.8 gall/acre treatment; 120 mg Cu/kg sediment accumulation with four treatments	$ 500-1000/acre for one treatment 100 acres, $100,000 4 x yr, $400,000
Recommended Control	Copper-based herbicide to reduce hydrilla, stock low numbers of carp. Introduce natives after initial hydrilla control	Minimize copper in sediment with fewer treatments Decrease potential for total vegetation removal and downstream impacts	Herbicide $100,000/ treatment Carp $35,000 (includes tracking study)

5.3.1 Educational Efforts

Signs have been posted at four public access parks on Lake Austin; Loop 360 boat ramp, Quinlan Park, Emma Long (City) Park, and Walsh Boat Landing. These signs are designed to limit the spread of hydrilla to other area lakes by requesting that boaters remove hydrilla fragments from trailers and boat propellers prior to leaving the area. Information regarding potential fines for transport of hydrilla (maximum $2000 per plant) is also on the signs. Boaters who fail to remove the plant fragments from their boat trailers are currently being ticketed by Parks Police. Disposal guidelines (Appendix E) for individuals removing hydrilla along private shoreline were also developed by the City Parks and Recreation Department and are being enforced by Parks Police, who report overall compliance by landowners.

In partnership with LCRA, an educational brochure was developed to provide information on hydrilla and control techniques. It has been distributed to lakeside businesses (restaurants and marinas) and local boat sales and repair shops. Copies are available at Watershed Protection Department and LCRA offices and on request by interested citizens. It is also on the city's web page. A letter was sent with the brochure to all property owners along Lake Austin, describing the task force's work in developing a management plan for the lake, and providing a chart with appropriate management options for privately owned lakeshore and docks.

As additional public outreach, presentations of this management plan have been made to appropriate neighborhood groups throughout the summer and fall of 2000. Web pages linked from the LCRA, and City of Austin Web sites currently provide general information on the plant, as well as control methods and updates on the task force efforts to manage hydrilla on Lake Austin. The public hearing on November 1 was an important opportunity for citizens to not only learn about hydrilla but also provide input on the management plan.

Lake Austin Advisory Panel, a citizen group appointed by LCRA board has been kept appraised of task force progress at their monthly meetings. Members of the group SMART (Sensible Management of Aquatic Resources Team) were invited to participate in each of these meetings.

5.3.2 Mechanical

Harvesting

Initially, the City considered using harvesting to provide temporary relief at public access areas, and to decrease biomass prior to grass carp stocking. When carp were not approved and concerns surfaced about downstream spread caused by fragmentation from large scale harvesting, this option was re-examined.

Private harvesting has been occurring on the lake since June 2000 and conversations with the harvester operator indicate that re-cutting is necessary in many places as often as 6-8 weeks after initial cutting.

This frequent cutting results in high management cost. As an example, if 50 acres of hydrilla were to be harvested, using LCRA estimates (7 acres/week, $1000/acre) it would take just about 7 weeks to harvest, and cost $50,000. These numbers are probably low, as the hydrilla in many parts of Lake Austin is extremely dense. Using documented rates of re-growth for Lake Austin, the original acre cut would already have reached the surface as the last acre was being harvested. The process would have to be repeated three times each year, at a cost of approximately $150,000 per year to cut only 50 acres.

Another factor in harvesting Lake Austin hydrilla is disposal; material adjacent to Emma Long Metropolitan Park can be disposed of on that shoreline and used by park staff for landscape purposes (mulched, tilled into open areas). There are no disposal sites at Loop 360, as both sides of the boat ramp park are privately owned. There is some limited space on the Texas Department of Transportation (TxDOT) right of way, but the material could only be stockpiled there for de-watering, and would still have to be hauled to a landfill. TxDOT has expressed reservations about odor and dewatering time. Without this option, the material would have to be put in plastic lined dumpsters to prevent transporting a wet load and hauled to a landfill at an additional cost of $500/acre.

Because adequate management of hydrilla through harvesting requires frequent cutting and results in extremely high cost, and because disposal is such an issue at Loop 360, the City of Austin does not consider harvesting feasible as a primary control technique. In addition, LCRA raised concerns regarding downstream spread during large scale operations. However, it is a more appropriate option for private landowners, and it continues to be used on Lake Austin for that purpose. Any use of harvesting by the City of Austin will be confined to clearing areas for navigation and safety purposes.

Lake Drawdowns

A routine lake drawdown is scheduled to occur this winter (2000-2001). The process of lake lowering typically begins with a request from the Lake Austin Advisory Panel. To help the panel in their decision with the request this year, the Lake Austin Hydrilla Task Force provided them with a letter (Appendix G) outlining the possibility that a drawdown might increase hydrilla coverage because it could survive (and even be stimulated by) drying and freezing while milfoil would not. The letter also stated that a drawdown should not be used with hydrilla control as the primary objective. TPWD staff also believes that lowering the lake could contribute to increased hydrilla coverage and suggest lowering the lake only 6 feet instead of the usual 12, to leave a fringe of milfoil as a buffer against encroaching hydrilla. Otherwise, if milfoil is removed to a depth of 12 feet, there is a possibility that large amounts of unvegetated shoreline could be available for hydrilla to colonize.

The panel's concern focused on the increase in hydrilla growth seen during the winter of 1999- 2000 (when the lake was not lowered) as well as the need for dock maintenance. The panel submitted a request for lake lowering, and it is scheduled for January through mid-February.

Prior to the lake lowering, the city developed and distributed a brochure of removal techniques appropriate for landowners to use during the drawdown. Suggestions included hand removal, tilling and removal of tubers and roots, as well as placement of bottom barriers of either burlap or weed barrier material.

Bottom Barriers

These are not appropriate for large areas, but could prove to be a reasonable control for lakeside property owners. Information on this technique (Appendix F) was distributed by a mail out to these individuals and is available on the City's Watershed Protection Department's web page. Details on their design, construction and deployment (including photographs) are provided through a link to Washington State's home page, and local sources for materials will be posted on the city's page as well. The City's brochure on Lake Austin drawdown also included directions for constructing and deploying bottom barriers.

Several nursery and landscaping companies are providing hydrilla removal services during the drawdown. These include hand or mechanical removal of the plants, double digging or tilling to expose or remove the tubers, and placement of weed barrier fabric on the lake bottom.

The City will be conducting a study comparing various physical control methods at City Park. Some of the exposed shoreline will be covered with weed barrier, other sections with burlap, while others will be tilled or disked by tractor. These areas will be evaluated throughout the next two years to determine if it is effective in hydrilla control.

5.3.3 Biological Control

Grass Carp

A low stocking of grass carp (15 fish/vegetated acre) was part of the treatment proposal sent to TPWD in mid May. This low rate was recommended because it would limit the potential for the fish to remove too much vegetation while still providing long term control of hydrilla. In addition, the fish would provide control beyond the reach of the harvester (deeper than 5 ft, near obstructions and in undiscovered infestations).

However, TPWD denied the request (Appendix B) and recommended pursuing herbicides and harvesting instead. The city investigated herbicides as a more immediate option, and the results of that investigation are in Section 5.2.4. In addition, information was gathered on other lakes with grass carp (Section 4.3.1). The revised management plan now recommends integrating herbicide application with carp, as has been done in Texas' Lake Jacksonville and Lake Conway in Florida, among others.

A vegetative survey done by TPWD in July 2000 showed that all vegetation in the lake had increased dramatically in the past year, giving the lake a total vegetative cover of 32 %. In August, TPWD indicated a willingness to reconsider its position on the Lake Austin carp stocking, and the city submitted a grass carp permit on October 23, 2000 (Appendix C). Stocking rate was reduced to 4 fish per acre of hydrilla, in part to even further limit the potential for the fish to remove too much vegetation, but also to allay LCRA's concerns regarding the potential for the fish to leave the lake and enter the Colorado River below Austin. LCRA has indicated that they will support this lower stocking rate.

Because of the concern that the fish could leave the lake, either during normal hydro-generation (through deep water releases) or surface gates opened only for flood events, a radio tracking study will be undertaken in conjunction with stocking of grass carp. Data gathered through such a study will allow for an accurate evaluation of grass carp as a control method. Without the study, there would be no way of knowing whether an increase in hydrilla coverage was a result of inadequate stocking rates, or simply movement of large numbers of fish out of the lake. TPWD has indicated that the tracking study is an important factor in their approval of stocking grass carp in public waters, particularly in riverine systems like the Colorado River where grass carp have not previously been introduced.

One concern particularly related to downstream escape is the possible movement of the fish into Barton Springs Pool, where the federally endangered Barton Springs Salamander is found. It is possible that the fish could enter the pool from Town Lake by way of Barton Creek, primarily during a flood event providing an avenue for upstream migration for the fish. As strict herbivores, the fish pose no direct threat to the salamander, but they could interfere with current revegetation and habitat enhancement efforts in the pool. Discussions are ongoing with United States Fish and Wildlife Service regarding a minor amendment to the Barton Springs Salamander Habitat Conservation Plan, part of the City's Section 10a 1b permit allowing operation of Barton Springs Pool. The minor amendment would address contingency plans in the event of carp migrating into the pool, to prevent impacts to aquatic plants that provide salamander habitat. These plans would be developed well prior to actually stocking the fish in Lake Austin.

The radio tracking study will cost between $20,000 and $25,000, which will include $5,000 for 25 radio tags. The remainder of the monies will fund the research itself, which will be conducted by university staff with expertise in fisheries management. The tracking study cost is currently not affected by any acreage increases because the number of tagged fish will remain constant.

Using TPWD July 2000 vegetative cover data, the proposed stocking rate of 4 fish per hydrilla acre will mean stocking 800 fish with a total cost including fish, radio tags and tracking study of approximately $35,000. The target date for grass carp stocking was March 2001.

TPWD denied the permit application by letter on November 20, 2000 (Appendix J). The City will continue to pursue this option, as TPWD has indicated that they will reconsider the application if hydrilla reaches 'crisis' proportions. In the meantime, citizen groups are organizing to provide a strong voice regarding aquatic vegetation management on the state level, as well as for Lake Austin in particular.

Enhancing Native Vegetation Populations

Although native plants will never displace hydrilla in the deeper water, it is possible to establish a shallow water 'fringe' of natives that could prevent hydrilla from re-colonizing these near shore areas. Some promise is shown in studies where native plants successfully compete with hydrilla, but only where strong, established populations exist prior to hydrilla's introduction. Because of this, plantings in areas where hydrilla exists should not be considered until some control is affected. Establishing natives well upstream of hydrilla beds could provide a source for downstream spread once hydrilla is controlled. Discussions about this type of project are ongoing with Lewisville Aquatic Ecosystem Research Facility and other agencies, and plantings would typically occur in the spring.

Efforts would also include planting native vegetation following successful control endeavors. Volunteer diving clubs may be solicited for assistance in this effort, similar to revegetation operations which occur in Barton Springs Pool.

5.3.4 Aquatic Herbicides

In the task force's original management plan, herbicides were included as a treatment of 'last resort' to be used only after other control methods (mechanical harvesting and grass carp) were shown to be less than successful. Spot treatments with chelated copper complexes on localized weed beds were recommended to reduce hydrilla if other methods did not provide acceptable results.

After TPWD denied the grass carp request, herbicides had to be re-considered as a more immediate option. Combining an herbicide application with a lower stocking rate of carp has shown some success in TPWD pilot studies such as Lake Jacksonville, with the integration of two control options aimed at limiting the need for either repeated herbicide treatments or large numbers of carp.

The City of Austin's Water and Wastewater Department reviewed several chelated copper compounds and approved the use of Nautique in Lake Austin for hydrilla control. This choice was based in part on the EPA's labeling of the chemical, which indicates no restrictions for use in a potable water reservoir. Maximum allowable use rate for this chemical is 1.0 mg/L.

Background copper levels in the water column for Lake Austin are less than the detection limit of 0.006 mg/L, and the City's Water and Wastewater Department reports copper at below this detection limit for both raw and treated water at their plants. Copper pipes used in homes could provide an additional source of copper in treated water, but the City's treatment process produces a thin layer of calcium carbonate scaling inside pipes, thus reducing copper leaching. The most recent copper sampling results from homeowners' taps (done every three years by the Texas Department of Health) indicated that 90% of the homes had less than 0.01 mg/l of copper and none exceeded the action level of 1.3 mg/l.

Another factor in Water and Wastewater's approval of this herbicide is that the copper does not stay in solution for more than 12-24 hours. City drinking water intakes are at least 3 miles downstream of any possible treatment area, and with the large volume of water that moves through the lake during normal releases, it is anticipated that even after treatment, city raw water intakes will measure no detectable levels of copper. Davenport Ranch water intake is 1500 ft downstream of Loop 360, where a major bed of hydrilla is located. Officials with that water supply corporation have evaluated the low application rate and large dilution expected from surrounding water and concluded that the plan will cause no copper contamination of their raw water. They will be pulling samples during the application to test for copper levels, and are considering not pumping water during the actual application time, since with prior planning, they can have several hours of storage available to them during the months of October through April. Other drinking water providers that may be in close proximity to a treated area will be notified to allow the opportunity for similar precautions.

Private water users will be notified of any upcoming application to allow them to secure an alternate source of drinking water for the period of the application. Although detectable levels of copper are not anticipated even in private drinking water intakes, notification will provide an opportunity for concerned homeowners to use alternate drinking water sources during the short (twelve hour) treatment period.

In addition to drinking water users, Austin's high tech industry has specific needs regarding copper in source water, and Water and Wastewater will work with these customers to provide adequate notification prior to any herbicide application.

Nautique is not the only chelated copper product that could be used to control hydrilla, but the high level of public concern for herbicide applications in a potable water supply requires an equally high level of customer service which has been offered by Nautique's manufacturer. In addition to providing a highly experienced individual for the actual application of the chemical, the manufacturer will provide a technical evaluation of the site before treatment, as well as pre- and post-treatment monitoring of plant growth to determine herbicide effectiveness. Besides the services provided by the manufacturer, the City's Watershed Protection Department will monitor water column and sediment levels of copper before, during and after the application to assess any impacts.

Nautique (Chelated copper) and elemental copper.
Copper is a naturally occurring element and essential at low concentrations for plant growth. Nautique contains the active ingredient copper in the formulation of 0.9 lbs copper per gallon of Nautique, or approximately 9.1 % copper. It is an EPA-approved herbicide for use in potable water supplies. It is a Class II Toxicity category because of reversible eye and skin irritation caused by the concentrated compound. This is a concern primarily to applicators and others who handle it in its concentrated form. Once applied, it is diluted by surrounding water and no longer presents the same concerns to humans or animals. It rapidly precipitates from water following application, becoming insoluble in water within 24 hours, but can

accumulate in bottom sediments after repeated applications. High levels in sediment can affect bottom dwelling, or benthic, organisms and then potentially move through the food chain.

Nautique is a chelated copper compound with the chelate added to help the copper stay dissolved in water longer. This chelate helps it be more effective than copper sulfate, which precipitates out of water much faster. The chelate is in the form of ethylenediamine and triethenolamine. The level of application is orders of magnitude below any levels showing toxicity, but toxicity data for each of these (chelates and copper) is discussed below.

Toxicity of Nautique

The short-term toxicity of Nautique can be compared to other substances by assessing the dose necessary to kill one half of the test animals. This dose is called the lethal dose 50% or the LD_{50}. This dose is given as the amount in mg per animal body weight in kg. Thus, the more toxic the substance, the smaller the value for the LD_{50}. This information is from National Toxicity P??? Chemical Repository database at www.ntp-db.niehs.nih.gov/NTP_Reports

Acute oral LD_{50} (rats) for :

Aspirin	891 mg/kg	Least Toxic
Nautique	680 mg/kg	↓
Caffeine	192 mg/kg	
Nicotine	50 mg/kg	Most Toxic

Another way to look at toxicity of copper is by examining data for aquatic organisms. The following table provides information from the USEPA Ecotoxicology database, and describes the LC_{50} (median lethal concentration , or the concentration of copper in water at which 50% of organisms are observed to die). These values are for static, not flowing, experimental set ups. It is important to note the exposure period given in days. For comparison, the copper resulting from an application of Nautique will be present in the water column at a concentration of 1 mg/l for only 12 hours before precipitating out into the sediment and becoming biologically unavailable in the water column.

Table 4
Copper Aquatic Biotoxicity

Species	Exposure Period, days	Acute Toxicity LC_{50}, mg/L
Crayfish	3	8.1
Fathead Minnows	4	1.6 - 21
Striped Bass	4	4
	Time in water column	Max Allowable Concentration
Nautique	0.5 (12 hours)	1.0 mg/L

Additional information from the same database provides toxicity data for both chemicals used as chelates in Nautique. Values are well above the application level.

Toxicity Ranges for Triethanolamine (chelate used in Nautique)

Goldfish LC_{50}	>5000 mg/L
Daphnia LC_{50}	1390 mg/L
Fathead minnow	1.06×10^4

Ethylene diamine (chelate used in Nautique)

Fathead minnow	LC_{50}	220 mg/L
Guppy	LC_{50}	1544 mg/L
Daphnia	EC_{50} *	14 mg/L *indicates an effect other than death

Accumulation of Copper in Sediment

Although there is not a large amount of data on this issue, studies in Florida show a substantial increase in sediment copper levels in untreated (2-10 mg Cu/kg sediment) and treated areas (34-71 mg Cu/kg sediment) of three reservoirs. (Leslie, 1992). This elevation in copper is a result of several years of treatment with chelated copper, not the result of a single treatment.

Calculations by the same author indicate that a one-gallon treatment with chelated copper of a formula similar to Nautique (9% copper) would result in an increase of 3.9 mg copper/kg in the top 5 cm of sediment above background levels each time the area was treated. Florida's average treatment of 3.6 gallons (close to the 3.0 rate recommended for Nautique) would theoretically result in an increase of 14 mg copper/kg sediment in this same area, for each treatment.

In the years from 1987 and 1995, Lake Austin copper levels in sediment range from 8-17 mg copper per kg sediment (USGS). Using the above calculations, a one time treatment of 3.6 gallons per acre would result in values between 22 and 31 mg copper/kg sediment. The state screening criteria for copper in sediment is 33 mg/kg.

These data strengthen the concern that Watershed Protection Department staff has about using herbicide as a single control method; without integrating grass carp into the management plan, treatment with herbicides would have to be repeated as often as three times per growing season for many years to affect any reasonable control. This could result in sediment accumulations of copper similar to those seen in Florida, and possibly exceed the state's criteria for copper in sediment.

Application of Nautique

Mode of action for chelated copper is by uptake through plant cells where the copper ion inhibits plant photosynthesis. These contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and capable of regrowth. The activity of these herbicides may be reduced if there is insufficient light penetration into the water or if the plants are covered with silt or algae. Temperature is also a factor, as the water needs to be at least 65 degrees F for proper chemical activity. A calm, sunny day during the active growth period of the plant is the best time for application.

Within 3-4 days of application, the plants will begin to discolor. The majority of the plant material will sink below the surface, and as it dies, the mass of the plant will disintegrate (it is 90 % water, and once the cell wall breaks down, it loses most of its mass and structure.) Within one week, some pieces of hydrilla may be seen on the surface, but most of the plant material will have disintegrated.

Potential for depression of dissolved oxygen (DO) by decaying plant material is minimal due to the size of Lake Austin and the nature of the hydrilla growth on the lake. In small impoundments with 70-80% cover, treating a large area can result in a drop in DO and impact fish. Lake Austin is an approximately 1,600 acre lake with 200 acres of hydrilla growing along a long, linear shoreline. The herbicide application will be focused along either shore, leaving the deeper channel of the lake untreated. There is hydrilla in these areas but it is too deep for effective herbicide treatment. These untreated areas provide two things during application: first, water with normal DO levels that can mix with the areas of decaying vegetation and second, a refugia for fish and other organisms to migrate in the event of a depression of DO along the shore in treated areas. The City will coordinate with LCRA during herbicide application to restrict releases during the first twelve hours after treatment (to allow for herbicide action) and then to begin releases, bringing fresh water through the treated areas. This, along with having long stretches of untreated areas adjacent to treated ones, should limit potential for any drop in DO.

It is important to keep in mind that healthy hydrilla itself causes huge swings in DO every 24 hours, as the plants continue to respire throughout the night but are not generating oxygen. DO values in a dense hydrilla patch have been measured as low as 0.5 mg/L, a value low enough to cause fish kills.

Any application of an aquatic herbicide will need to be made at a time when no upstream releases are planned. This is normally between mid-October and March. Because of the multiple factors (water temperature, depth and density of growth) influencing herbicide application and effectiveness, it is difficult to accurately estimate cost of treatment at this time, but an estimate for one type of contact herbicide treatment is $950.00/acre for hydrilla growing in an average of 10 feet of depth. This includes the cost of chemicals and the licensed applicator. At this rate, it would cost approximately $190,000 to treat the 200 acres of hydrilla that were documented in July 2000.

Although herbicide application in Lake Austin was not a preferred solution, it is understood that some control needs to be initiated, and WWW recommended conducting a pilot study of at least 10 acres to determine herbicide effectiveness and cost. This is planned well before full scale treatment, when irrigation releases have been curtailed and after water temperatures are normally above 60 degrees F. However, water temperatures and weather will dictate timing for the pilot; if the weather is not clear and sunny while water temperatures are above 65 degrees, the pilot may have to be postponed until optimum conditions prevail. This protocol will be followed in order to get a representative sample of the level of control possible from the herbicide. It is hoped that LCRA can restrict releases after irrigation season begins in mid-March, allowing for a pilot in early spring and a more extensive herbicide application in later spring. Cost of this pilot is estimated at $10,000-$15,000.

5.4 Evaluation of Techniques

A variety of evaluation techniques are available for determining the success of the proposed hydrilla management plan for Lake Austin. The plan will require some short term evaluation to determine the effectiveness of contact herbicide in the pilot study as well as to obtain environmental data to extrapolate to full scale implementation. For the lakewide treatments, the plan will also require such environmental data to track concentrations of copper in water and sediment and to monitor changes in water quality resulting from treatment and decay of hydrilla. The sampling associated with this evaluation can be performed by staff from the entities comprising the Lake Austin Hydrilla Task force or contracted specialists. Grass carp introduction will require a concentrated tracking study on the short term and periodic evaluation of the fish after major flood events. Finally, longer term monitoring of the lake will rely on the periodic vegetation, fisheries, and water quality surveys already conducted by the various natural resource agencies supporting the lake. The following section outlines each of these evaluation methods

5.4.1 Pilot Study Evaluation

Dye dispersion study has been suggested during the pilot application to determine actual contact concentrations and time over the treatment period. If employed, this would require mixing the herbicide with a known concentration of a non-toxic water soluble tracer such as Rhodamine WT. The concentration at the surface and various depths could then be monitored from a sample pump mounted on board a small water craft and connected to a flow-through fluorometer with appropriate wavelength filters to measure Rhodamine. Background levels would first be determined in the sampling area. The sampling would then be conducted twice immediately following application by running the sampling boat through the 10 acre treatment area and recording fluorometer readings. Boat location during sampling could be monitored through a handheld GPS system. Data could then be used in a kriging program to determine dye contours at various depths following the application period. The subsequent sampling could be performed daily during the post treatment period for the first ten days over which the plants are expected to degrade and sink. In this manner, the pilot study would provide data on the herbicide contact concentrations and exposure times to compare to level of hydrilla control. Use of this method of evaluation will be coordinated with the herbicide applicator.

Treatment effects with complexed copper are anticipated during the first ten days following treatment. The pilot study area will therefore be evaluated by boat runs every two days over the first two weeks following application to examine plant conditions. This will require pulling plants at defined intervals in the treatment area for inspection. During these surveys, a multiparameter water quality probe will also be used to determine conductivity, temperature, dissolved oxygen and pH at several depths over the treatment area. These parameters may be useful in determining the relative level of herbicide induced stress from copper complex activity as the plant cell membranes are disrupted and photosynthesis is inhibited. Diurnal measurements of these parameters may be necessary immediately following application as minimum dissolved oxygen would only be seen in the early morning hours. A grid system will be set up through buoys or GPS to determine the extent of effect from the application area. This same grid will be used to obtain water and sediment samples for laboratory analysis. Routine chemical water quality parameters as well as total and dissolved copper will be determined from water samples. These parameters will include nutrients such as nitrates and phosphates determine if soluble levels will fluctuate significantly with decay and total organic carbon (TOC) to determine if water treatment impacts can be expected from increased disinfection byproducts levels. At the Davenport Ranch MUD WTP, Davis WTP, and Ulrich WTP operated by the City of Austin, taste and odor, total organic carbon, total trihalomethanes, and copper levels will be monitored. Levels of copper in finished water are particularly important at the City of Austin WTP's because of the number of industries with copper limitations due to cooling tower makeup water requirements and semiconductor manufacturing. Sediment samples will be analyzed for total copper and leachable copper as well as conventional physical characterization parameters such as particle size and total water content. Such sampling will be conducted once prior to application, once immediately after application, and once within three weeks following the application.

Length of time for re-growth will also be documented by monthly surveys of the treatment area. These surveys will be conducted by drop rakes and visual examination for the first four months following the application. If equipment is available, Plexiglas 0.25 m box samplers will be used to determine biomass at select locations in the treatment patch. This will be compared to pre-treatment levels. Drop dredge samples of sediment will be examined for condition of tubers. Data collected from these evaluations will be compiled in a short report for evaluation prior to a determination of full scale treatment for the lake. Purchasing deadlines may require contingent contracts to be set up for full scale implementation prior to having all of the data from the pilot; however, the initial effectiveness of the treatment will be the deciding factor in whether to proceed with the larger application.

5.4.2 Lake Treatment Evaluations

The larger herbicide application in late spring will be conducted based on the results of the pilot study and available funding. Water deeper than 10 feet is not targeted for application, due to difficulty with delivery of adequate herbicide into the deeper water. The main subjects to be evaluated with a lakewide treatment include the immediate effectiveness and impact of the herbicide application, the monitoring of the activities of carp released in the lake, and the long term ongoing monitoring of lake water quality and fishery health.

Herbicide Treatment Evaluations

Prior to either herbicide application or carp stocking, hydrilla will be surveyed in spring 2001 for any increase in area coverage. The final location and extent of herbicide application will be determined at that time in coordination with public drinking water suppliers and the herbicide applicator.

Vegetation Evaluations

Vegetation evaluations for a larger treatment will be conducted in a fashion similar to the pilot study but the entire treatment area will not be monitored. Condition of plants will be determined at predetermined locations throughout the treatment area. Frequency and extent of sampling will be determined from data obtained during the pilot study.

Water Quality Evaluation

Water quality evaluation will consist of concentrated field sampling during and immediately following the application of herbicides. This will focus on the copper level in water and sediment and the water quality changes observed during the first ten days as the plants die and sink to the sediment. Follow-up monitoring will consist of more routine sampling to determine if hydrilla decay has an impact on dissolved oxygen or nutrient levels in the water column. These data will supplement the quarterly sampling conducted by LCRA, the semiannual sampling conducted by USGS, the bimonthly sampling conducted by the COA Water and Wastewater Department, and the daily intake sampling conducted at COA water treatment plants.

Sediment Quality Evaluation

Sediment quality will be evaluated from sampling conducted in the treatment areas and downstream in Town Lake at increased intervals following the application of herbicide. Surface sediment samples will be collected at several locations within one month of the application period and analyzed for total and leachable copper. The number of samples and frequency of follow-up sampling will be determined from data obtained in the pilot study. These data will supplement annual sediment sampling currently performed by USGS in Town Lake and Lake Austin.

Carp Evaluation

The number of carp stocked will be negotiated with TPWD and will be based on amount of existing vegetation present during Spring 2001 surveys.

Escapement and Movement

TPWD will be consulted on appropriate rates and types of tracking surveys to be conducted, using primary evaluation tools for carp escapement and movement monitoring. A research/ educational institution with the appropriate equipment will conduct a radio tracking study. If conducted as in previous Texas releases, the study will include several surveys by boat over the entire lake, Town Lake, and a limited distance in the Colorado River below Austin at an interval of once per week for 8-10 weeks. This will be followed by monthly surveys thereafter for the first year following release. After this period, surveys will be conducted after each major flood event requiring substantial spillway releases from Lake Austin. Parameters to be evaluated from these surveys in addition to presence/absence and individual location/clustering include home range, core use, and activity centers for carp.

Growth and Condition Evaluation

From case histories available in the technical literature and experience of TPWD scientists, a recapture program for grass carp in Lake Austin would have little chance for success. One suggestion has included the use of bowfishing tournament targeted at the carp, but otherwise, the best that can be hoped for is the collection of individuals who are captured inadvertently by anglers or die of natural causes. These individuals will be evaluated as available for growth and condition as indicators of the standing stock in Lake Austin.

Long Term Vegetation Evaluation

If stocking of carp is approved, it is important to allow sufficient time for control to take effect. Typically, TPWD does not entertain requests for repeated stocking until at least five years after the initial stocking with carp. For this reason, the annual vegetative coverage surveys conducted by the TPWD regional office in San Marcos may be sufficient for monitoring hydrilla control during this period. This can be supplemented by localized data from native revegetation efforts and biomass sampling in remaining hydrilla beds.

Fisheries Evaluation

Of paramount importance in the evaluation of the management plan is the impact on the ecosystem of Lake Austin. For this reason, a fisheries evaluation is appropriate to monitor the distribution and diversity of species long term. Such surveys are currently conducted by TPWD on a rotating basis. Data is available from 1994 and 1997 in the TPWD Performance Report for the Statewide Freshwater Fisheries Monitoring and Management Program. Depending on funding, it is anticipated that TPWD will continue these surveys on a similar frequency in the future. Therefore, if surveys are conducted in 2001 and 2004, the impact of the hydrilla infestation and management methods employed to address it may be determined. A revision to the Hydrilla Management Plan for Lake Austin would be appropriate after evaluation of this later survey and all of the data from evaluations previously outlined.

6.0 REFERENCES

Armstrong, N.E., C.W. Johnson, et al. 1991. Water Quality Studies in Lake Austin and Town Lake. Center for Research in Water Resources. University of Texas at Austin, Austin, Texas.

Booms, Travis. 1999. Vertebrates removed by mechanical weed harvesting in Lake Keesus, Wisconsin. Journal of Aquatic Plant Management 37:34-36.

City of Austin (COA) Water and Wastewater Utility Database 2000.

Colle, D. E. and J.V. Shireman. 1980. Coefficients of condition for largemouth bass, bluegill and redear sunfish in hydrilla infested lakes. Transactions of the American Fisheries Society 109:521-531. (in McKinney, L.D. and Philip Durocher. 2000)

Doyle, Robert D. and R. Michael Smart. 2001. Dessication on Tubers of Hydrilla verticillata, an Exotic Aquatic Weed. Weed Science Journal, Volume 49:135-140.

Doyle, Robert. 2000. Potential control of Hydrilla verticillata by use of an insect biocontrol agent in combination with a competitive native species, Presentation to Texas Aquatic Plant Management Society. 25-27 September 2000, Denton, Texas.

Durocher, Philip. Director of Inland Fisheries, Texas Parks and Wildlife Department, Letter to Nancy L. McClintock, Division Manager, Environmental Resources Management, Watershed Protection Department, City of Austin, Texas. June 1, 2000.

Engel, S. 1990. Ecological impacts of harvesting macrophytes in Halverson Lake, Wisconsin. Journal of Aquatic Plant Management 28:41-45.

Haller, W.T. 1978. Hydrilla: a new and rapidly spreading aquatic weed problem. University of Florida Circular S-245. (in McKinney, L.D. and Phil Durocher. 2000)

Haller, W.T., J.V. Shireman, and D.F. DuRant. 1980. Fish harvest resulting from mechanical control of hydrilla. Trans. Am. Fish Society. 109: 517-520.

LCRA. 2000a. Lake Bastrop Management Plan Evaluation and Update. Lower Colorado River Authority, Austin, Texas.

LCRA. 2000b. Water Quality Data Summary Tables, File Lake Austin COA.xls. Lower Colorado River Authority, Austin, Texas.

Leslie, Andrew J. 1992. Copper Herbicide Use-Patterns in Florida Waters. Florida Department of Natural Resources, Tallahassee, Florida.

Leslie, Andrew J., Rue S. Hestand III, Jess M. Van Dyke. 1993. Grass Carp: Lakes and Large Impoundments. Florida Department of Environmental Protection, Tallahassee, Florida.

Leslie, Andrew J., et al. 1994. Effects of Grass Carp on the Aquatic Vegetation in Lake Conway, Florida. In: Proceedings of the Grass Carp Symposium, 7-9 March 1994, Gainesville, Florida. US Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. pp. 121-128.

Magnelia, Stephan and John E. Tibbs. 1998. Statewide Freshwater Fisheries Monitoring and Management Program, Survey Report for Austin Reservoir, 1997. Inland Fisheries Division, Texas Parks and Wildlife Department, Austin, Texas.

Mallison, Craig T., Rue S. Hestand III, Boyd Z. Thompson. 1994. Response of Fish Populations to Aquatic Plant Management in Lake Yale. In: Proceedings of the Grass Carp Symposium, 7-9 March 1994, Gainesville, Florida. US Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. pp. 136-145.

McKinney, L.D. and Philip Durocher. 2000. Aquatic Vegetation Management in Texas (Draft). Inland Fisheries Division, Texas Parks and Wildlife Department, Austin, Texas.

Mikol, G.F. 1985. Effects of harvesting on aquatic vegetation and juvenile fish populations at Saratoga Lake, New York. Journal of Aquatic Plant Management 23:59-63.

Netherland, Mike. 1999. Management Impacts on the Quiescence and Sprouting of subterranean turions of dioecious hydrilla. Dissertation. University of Florida.

Raines, T. H. and Walter Rast. 1998. Characterization and Simulation of the Quantity and Quality of Water in the Highland Lakes, Texas, 1983-1992. USGS Water-Resources Investigations Report 99-4087. USGS, Austin, Texas.

Sutton, David L. and Vernon V. Vandiver, Jr. 1986. Grass Carp: A Fish for Biological Management of Hydrilla and Other Aquatic Weeds in Florida. Florida Agricultural Experiment Stations, Bulletin 867. Gainesville, Florida.

Texas Water Development Board. 1999. Volumetric Survey of Lake Austin. Prepared in conjunction with Lower Colorado River Authority, Austin, Texas.

Wrenn, W.B., M. J. Maceina, and D. R. Lowery. Grass Carp in Guntersville Reservoir: A Review of Fisheries Impact Assessments. In: Proceedings of the Grass Carp Symposium, 7-9 March 1994, Gainesville, Florida. US Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. pp. 216-225.

Washington State web page. 2000.
www.ecy.wa.gov/programs/wq/plants/management/dredging.html

Appendix A
May 12 Treatment Proposal for TPWD

City of Austin

Founded by Congress, Republic of Texas, 1839
Municipal Building, Eighth at Colorado, P.O. Box 1088, Austin, Texas 78767 Telephone 512/499-2000

Dr. Earl Chilton, Fisheries Biologist
Texas Parks and Wildlife Department
4200 Smith School Road
Austin TX 78744-3292

May 12, 2000

Dear Dr. Chilton,

Please find attached the City of Austin's Aquatic Vegetation Treatment Proposal for management of hydrilla in Lake Austin. This proposal is based on acreage from the vegetative survey conducted by Texas Parks and Wildlife on May 4, 2000.

In developing this treatment proposal, the Lake Austin Hydrilla Task Force used an integrated approach to vegetation management, as outlined in TPWD's draft guidance, Aquatic Vegetation Management in Texas. This approach entails implementation of control options beginning with the least harmful alternative. Although the treatment proposal only specifies mechanical and biological control, other steps are being taken to minimize the spread of hydrilla including boat ramp signage, educational brochures and web page information.

Beyond these educational efforts, the task force is recommending harvesting two densely vegetated public access areas and then stocking with grass carp at 15 fish per vegetated acre. To better judge the effectiveness of the biological control, we also intend to conduct a radio tracking study concomitant to stocking with grass carp.

The effectiveness of the grass carp will be evaluated through this study, as well as additional vegetation surveys in early 2001. If it is apparent that the carp are not effective, the use of aquatic herbicides will be considered.

To assist you in evaluating the proposal, a map of Lake Austin showing areas targeted for harvesting is included in this packet. In addition, the draft Lake Austin Hydrilla Management Plan is also attached which describes the sequential implementation and evaluation of education, harvesting, grass carp, and chemical management methods.

Thank you for your consideration of this treatment proposal. We would appreciate a written response at your earliest convenience. If you have any questions or need additional information, do not hesitate to call Mary Gilroy (499-2717) or Ed Peacock (499-2224) for assistance.

Sincerely,

Nancy McClintock

Nancy McClintock
Division Manager
Environmental Resource Management
Watershed Protection Department

Aquatic Vegetation Treatment Proposal

Water Body Name: Lake Austin Submission Date: May 12, 2000

Date Surveyed: 5/4/00 Proposed Treatment Date: starting May 22,2000

Target Plant Species: *Hydrilla verticillata* Estimated Acres 152

Recommended Treatment: Mechanical (X), Biological (X), Chemical ( ), Experimental ( ).

Type of Application: Harvesting, Grass Carp.

Applicator Name: City of Austin.

License Number: Not Applicable.

Floating or Emergent Vegetation:

Treatment Location	Relative Surface Coverage	Treatment Area (acres)	Treatment Rate (organisms, gals, lbs./acre)	Total (organisms, gals., lbs)
Not Applicable				
Total				

Submerged Vegetation:

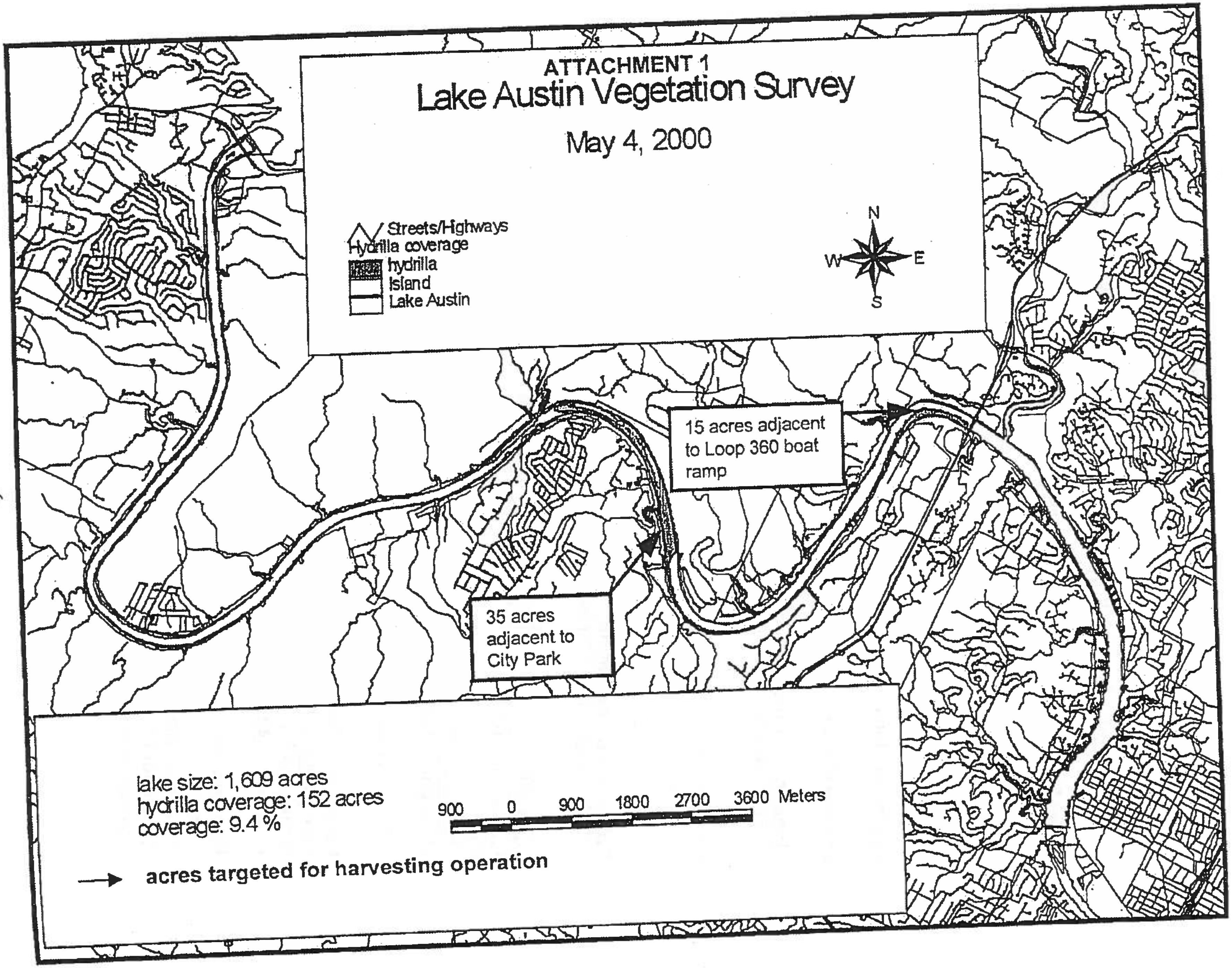
Treatment Location	Relative Surface Coverage	Treatment Area (acres)	Treatment Rate (organisms, gals, lbs./acre)	Total (organisms, gals., lbs)
Loop 360	.93%	15 acres	Harvester	Unknown
Emma Long (City) Park	2.17%	35 acres	Harvester	Unknown
Total to be Harvested	3.10 %	50 acres	Harvester	Unknown
Throughout Lake	9.4 %	152 acres	15 fish/ veg acre	2280 fish
Total				2280 fish

Comments: **Prior to May 22, 2000, a one-time harvesting operation is planned for public access areas with densest growth (approx 50 acres). Grass Carp stocking is planned for August 2000 at a rate of 15 fish per acre, coincidental with release of 25 radio tagged fish for tracking study to be conducted by UT/SWTSU.**

Plans are good for six months from the date of submission, unless application plans change.

A map of the water body with proposed treatment sites indicated should be See **Attachment 1.**

***A separate form should be filled out for **each plant species treated.**


ATTACHMENT 1
Lake Austin Vegetation Survey
May 4, 2000
Streets/Highways
Hydrilla coverage
hydrilla
island
Lake Austin
N
W
E
S
15 acres adjacent to Loop 360 boat ramp
35 acres adjacent to City Park
lake size: 1,609 acres
hydrilla coverage: 152 acres
coverage: 9.4 %
900 0 900 1800 2700 3600 Meters
acres targeted for harvesting operation

Appendix B
TPWD June 1 Grass Carp Letter

TEXAS PARKS & WILDLIFE

COPY

To manage and conserve the natural and cultural resources of Texas for the use and enjoyment of present and future generations.

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512-389-4800
www.tpwd.state.tx.us

June 1, 2000

Nancy McClintock, Division Manager
City of Austin
Environmental Resource Management
Watershed Protection Department
P.O. Box 1088
Austin, Texas 78767

Dear Ms. McClintock:

Thank you for the opportunity to review the *Lake Austin Hydrilla Management Plan*. The plan is well written and informative. The central premise of the plan, Integrated Pest Management, is certainly one that TPWD fully supports. However, I believe the continued expansion of hydrilla has already placed the infestation well beyond the Tier I (immediate response and eradication) category. An infestation of nearly 10% clearly places the lake in the Tier II (management) category. Therefore, I would suggest some changes in your management approach.

With maintenance rather than eradication the objective, I believe a combination of mechanical harvesting and herbicides (a number of herbicides have been registered by the U.S. EPA for use in potable water) would be the most effective and least invasive control option. With this approach only problematic vegetation would be removed. Native vegetation stands would be unaffected.

We are concerned about a treatment option (triploid grass carp) which could lead to total vegetation removal. The present coverage, native plus non-native, creates a near ideal situation for fish production. Lake Austin's fishery has evolved into one of the areas best because of the presence of native vegetation. Lake Austin's largemouth bass record of 14.35 lbs. is the best of all the Highland lakes. Additionally, Lake Austin ranks 2nd among the Highland lakes for record Guadalupe bass, striped bass, and bluegill sunfish.

Our experience, and the scientific literature, indicates that vegetation coverage above 30% can be detrimental to a fishery. The plan you submitted is based on the supposition that the hydrilla in Lake Austin will continue to increase in coverage to levels far above the ideal. Although the potential is there for this to

COPY

occur, there is no certainty that it will. It is hard to predict what hydrilla will do. We have seen instances where it has expanded, and also instances where it has not. In fact, in some cases, hydrilla decreased in coverage without any control measures being implemented. With those uncertainties as a background, our recommendation is to implement a control regime for hydrilla which deals with current access and recreational use issues without jeopardizing valuable native plants.

Therefore, at the present time TPWD would not issue a permit to stock triploid grass carp in Lake Austin. If hydrilla continues to spread and if mechanical harvesting in combination with herbicide use prove ineffective in controlling that spread, this agency would certainly reconsider triploid grass carp as an option (probably concomitant with a tagging study to evaluate emigration rate).

In order to facilitate evaluation of mechanical harvesting as a viable option, we are in the process of setting up a Federal Aid contract to help defray the cost of harvesting for one year. Federal Aid would pay for 75% of the costs associated with aquatic weed harvesting and the city the remaining 25%. However, please note that this is a demonstration, and would last only for one year. If harvesting proved useful, the City of Austin would incur full costs in subsequent years.

If you have any questions or concerns please contact Dr. Earl Chilton (512/389-4652), our habitat specialist, or myself (512/389-4643). Again, thank you for the opportunity to review the *Lake Austin Hydrilla Management Plan*. I look forward to continued cooperation between the City of Austin and TPWD.

Sincerely,

Phil Durocher

Philip P. Durocher
Director of Inland Fisheries

PD:EC:nn

Appendix C
Grass Carp Permit Application

TEXAS PARKS AND WILDLIFE DEPARTMENT

APPLICATION TO STOCK TRIPLOID GRASS CARP INTO PUBLIC WATERS

Name of Applicant(s) or agent: City of Austin

Address: (primary applicant, or legal representative of all applicants) PO Box 1088, Austin TX 78767

Driver's License No.: Not Applicable

Telephone No.: 512/ 499-2550 (AC)

Date of Birth: Not Applicable

Lake or Pond Name: Lake Austin

County of lake or pond location: Travis

Attach directions to lake or pond (including distances)

Surface area of water to be stocked: 1609 acres

Number of triploid grass carp requested: 800
(No more than 7 per surface acre will be permitted)

Has the lake or pond been previously stocked with grass carp? ☐ Yes ☒ No

If so, when ____/____ (mm/yy)

Does the lake or pond empty into public waters? ☒ Yes ☐ No

If so, which one? Colorado River, Town Lc

Fees: The number of fish requested x $2.00 = $ 1600.00
Total amount remitted with application = $ 1600.00

Description of proposed stocking site:

Closest river, creek or stream: Colorado River

Can water level be controlled? ☒ Yes ☐ No

Lake or pond access controlled by: private access and public boat ramps

Purpose of pond or lake (check one): (several apply)

flood control ✓ pass through for flood water

power generation ✓

recreation ✓

other ____

Have other vegetation control procedures been tried? (check one)

chemical ____

mechanical ✓

other ____

(Please sign and complete affidavit on back) fishing ✓ swimming ✓ boating ✓

Open to the public? ☒ Yes ☐ No

Vegetation (weeds, algae or moss):

Species present (if known) Hydrilla verticillata, Myriophyllum spicatum, Potomogeton spp., Chara sp., Scirpus spp., Typha spp.

Acres of vegetation present 512.61 (196.41 of hydrilla) Is the lake or pond fertilized? ☐ Yes ☒ No

Applicant Statement:

I have received and read the information provided with the Application to Stock Triploid Grass Carp. I understand that random inspections are conducted by the Texas Parks and Wildlife Department and I consent to allow inspections of my pond(s) to verify the information provided on this application.

Jody R. Hamilton for Michael J. Hite
Signature of Pond Owner or Legal Representative

10, 24, 2000
Date

AFFIDAVIT

Before me, the undersigned authority, on this day, personally appeared Jody R. Hamilton, duly sworn, depose and says that all of the foregoing statements and information contained in the application and true and correct.

Subscribed and Sworn Before Me this 24th day of Oct, 19 2000.

[signature]
Notary Public

MARY AREVALO
NOTARY PUBLIC
State of Texas
Comm. Exp. 07-02-2001
(affix notary seal)

NOTE: This application will not be considered unless fully completed.

Return to: Permit Coordinator, Inland Fisheries
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Appendix D
Resolution from Environmental Board

ENVIRONMENTAL BOARD MOTION 080200-D1

Date: August 2, 2000

Subject: Hydrilla Problem

Motioned By: George Avery Seconded By: Joyce Conner

Whereas, the alarming and aggressive expansion of hydrilla in Lake Austin is increasing exponentially, and

Whereas, the very existence of hydrilla on such a scale greatly decimates endemic, aquatic species while eradicating lake ecosystems, and

Whereas, the characteristic of hydrilla clogging Lake Austin greatly hinders recreational use and threatens lives,

Therefore, the Environmental Board very strongly urges the City Council to adopt a highly aggressive strategy to reverse the explosive expansion of this obnoxious weed and to do so without any further delay.

The Environmental Board further recommends a group of scientific experts be consulted to assist in developing a strategy for controlling the plant in Lake Austin.

Vote: 5-0-0-0

For: Alvarez, Avery, Conner, Jones, Leffingwell

Against: None

Abstain: None

Absent: None

Approved By:

Lee Leffingwell, Chair

Appendix E
City of Austin Hydrilla Disposal Guidelines

Austin
Parks and
Recreation

8/2/00

FOR IMMEDIATE RELEASE

Hydrilla Problems Increase With Improper Disposal Of Cuttings

Hydrilla is a prolific, non-native aquatic plant, which threatens the use of Lake Austin both recreationally, and as a water source.

When efforts to control the growth of hydrilla such as harvesting or cutting are used, it is important that cuttings be properly disposed of so as not to contribute to the spread of the plant. Like many plants, hydrilla cuttings can take root in water and grow.

To help prevent this spread of this prolific and potentially harmful aquatic plant, lake front owners who are having hydrilla cut, or harvested, these disposal or stockpiling methods are recommended.

- Stockpiling of harvested hydrilla to be dried should be done outside the 75-foot critical water quality zone. This zone is measured 75 feet inland from the shoreline of the lake.
- If stockpiling of harvested hydrilla to be dried should be done inside the 75-foot critical water quality zone, silt fencing must be installed on the down slope of the stockpile area so as to provide a barrier between the stockpile and lake.

Disposal of the plant back into Lake Austin can result in fines up to $2,000 per plant.

Hydrilla grows in depths 25 feet and greater. In the past year on Lake Austin, the area of hydrilla has grown from 26 acres to more than 150 acres. As the plant spreads and grows from lake bed to surface, the surface of the lake becomes matted with vegetation. Additionally, the thickness of the vegetation growth below the surface down to the lake bed becomes nearly impassable.

In addition to covering the lake, hydrilla can become a problem with water intakes and diminish recreational opportunities.

Lake Austin is the main source of drinking water for Austin. Hydrilla grows thick enough to clog the water intake lines from the lake.

In regards to its recreational impact, as hydrilla spreads it reduces the area of water available to boaters, skiers and swimmers. If left unchecked, hydrilla could reduce areas suitable for fishing as well.

###

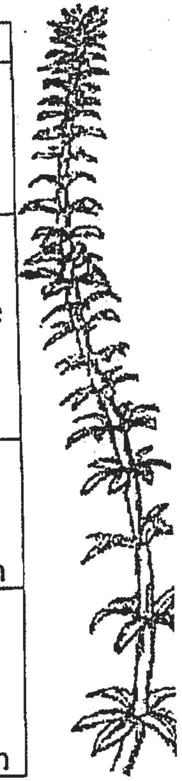
Media Contact:
Jim Halbrook
Austin Parks and Recreation
(512) 499-6745

Appendix F
Chart of Landowner Options

Hydrilla in Lake Austin

HYDRILLA CONTROL OPTIONS FOR SHORELINE AREAS

METHOD	DESCRIPTION	ADVANTAGES	DISADVANTAGES
MANUAL REMOVAL	Pulling plants up by hand, rake or with cutting tool	Inexpensive, selective for nuisance plants, easy to target certain areas	Labor intensive, disturbs sediment, can be difficult with dense growth, plants will re-grow
HARVESTERS	Large machine cuts plants five feet below surface, collects and moves material to shore	Opens access to shore, remaining plant serves as habitat	Like 'mowing the lawn', harvesting must be done multiple times in one season Fairly expensive ($250/hr) if plants are dense Shoreline disposal area required, material is bulky at first Some fragments escape and can re-grow
BOTTOM BARRIERS	Covers bottom like a blanket, reducing light and compressing plants	Easy to build and install Provides fairly good control	Material must be porous to allow gas to escape, Can be difficult to anchor Needs regular inspection and maintenance Installation easiest during low-growth season
WEED ROLLERS	Motorized metal pipe attached to dock, moves in semicircle along bottom, rolling plants up on pipe	Periodic use suppresses re-growth, works on small areas, inexpensive to operate	Substantial initial cost ($3000) Requires removal of plants from roller May disturb sediment and create depressed area on bottom, Need to limit human activity during operation



NOTE:
One type of contact herbicide (copper-based chemicals) is approved for use on Lake Austin, but not recommended for the home applicator because of the large number of individual and public drinking water intakes on the lake. Herbicide application should be done only by licensed individuals, after proper notification of all water users.

For links to more detail on these and other options, check out the hydrilla section of the City of Austin Watershed Protection Department's web page www.ci.austin.tx.us/watershed/hydrilla.htm.

city of austin Watershed Protection

Appendix G
Lake Austin Hydrilla Task Force Lake Lowering Correspondence

MEMORANDUM

TO: Jesus Garza

FROM: Michael J. Heitz, Director
Watershed Protection Department

DATE: October 24, 2000

SUBJECT: Lake Austin Lowering

In years past, Lake Austin has been lowered every other year to provide control for the nuisance non-native aquatic plant, Eurasian milfoil, commonly known as duckweed. Although this plant still proves to be a problem in the area of the lake downstream of Loop 360, in the last year, hydrilla has become the dominant plant in much of the lake.

Although lake lowering has been an effective strategy for milfoil, it may not prove to be successful with hydrilla. Lowering the water level may kill the exposed hydrilla, but since it produces numerous underground tubers that are resistant to drying and freezing, it is more likely to grow back than milfoil. Texas Parks and Wildlife's Draft Aquatic Vegetation Management Guidelines also indicate that "drying seems to act as a trigger to cause increased (hydrilla) tuber sprouting." This was confirmed through personal conversation with staff from the Lewisville Aquatic Ecosystem Research Facility. In addition, removal of milfoil through a lake drawdown may open new areas for hydrilla colonization, particularly downstream of Loop 360 where little hydrilla currently exists.

On the positive side, lake lowering could benefit lakeside property owners by facilitating mechanical control techniques, such as placement of bottom barriers in shallow areas, and possibly hand removal of hydrilla roots and tubers. In addition, property owners have traditionally used the drawdown period for tasks such as dock maintenance.

In mid September, Lake Austin Hydrilla Task Force provided the Lake Austin Advisory Panel with this information, stating that long-term control of hydrilla could not be anticipated by lake lowering. However, the panel felt strongly that the hydrilla had greatly increased over the winter of 1999-2000 when the lake was not lowered. In addition, they had other objectives (milfoil control, dock maintenance) that would be met by lowering, so they proceeded with the request.

Recent conversations with Texas Parks and Wildlife Department and review of their 1998 Fisheries Management Plan for Lake Austin indicate a way to meet the landowners' objectives without completely removing milfoil as a buffer against hydrilla. By lowering the lake only 6 feet instead of 10-12 feet, a fringe of milfoil in deeper water could be maintained to provide competition from encroaching hydrilla. This would still allow for dock maintenance during the drawdown period and remove vegetation closest to shore, clearing access for boats and swimmers.

This information was also presented to the panel, and they did not feel the limited lowering would provide adequate milfoil control. However, it seems to be a reasonable alternative to not lowering the lake at all. LCRA has also indicated that current drought conditions could result in limited (6 foot or less) lake lowering or none at all, as there might not be sufficient water to refill the lake.

Michael J. Heitz, AIA, Director
Watershed Protection Department

MJH/MG/mg
Cc: Toby Futrell, Deputy City Manager
Marcia L. Conner, Assistant City Manager

LAKE AUSTIN ADVISORY PANEL

RECEIVED
OCT 23 2000
WATER AND WASTEWATER UTILITY

RECEIVED
OCT 19 2000
CITY MANAGER'S OFFICE

October 17, 2000

Hon. Jesus Garza
City Manager, City of Austin
P.O. Box 1066
Austin, Texas 78767

Dear Mr. Garza:

I am writing to you in my capacity as a chairman of the Lake Austin Advisory Panel. Our panel unanimously asks you to request the LCRA to lower Lake Austin this winter to stifle the aquatic growth (duckweed). As you are aware, the duckweed, if left unchecked, threatens the water quality, public safely and recreational opportunities, as well as the aesthetic beauty of the lake water and the shoreline.

The Council's policy for many years has been to lower Lake Austin on a biennial basis. The lake was last lowered in January 1999, and 2001 is the next regular lowering date

LCRA meteorologists have determined that the coldest temperatures of the year occur between December 20th and February 5th, with the very coldest time during this period being from January 9th through January 16th. In order to have Lake Austin sufficiently lowered during the above time frame, we recommend that the lowering of Lake Austin begin on Friday, December 29, 2000 and that it be re-filled after approximately six weeks.

Our panel, while working closely with the LCRA, has determined that the herein requested lake lowering can be accomplished with virtually no loss of water or generating capacity and this was demonstrated to be the case by the lowering of January, 1997. The procedure for lowering Lake Austin with no loss of water is explained in the attached Lake Austin Advisory Panel Resolution dated December 2, 1996.

Please feel free to call on us as a panel, or as individuals, if we may be of assistance to you or your staff.

Yours very truly,

Dudley Fowler, Chairman, Lake Travis Advisory Panel

cc: Honorable Joe Beal, LCRA
Chris Lippe, City of Austin

RESOLUTION OF THE LAKE AUSTIN ADVISORY PANEL
DECEMBER 2, 1996

Whereas, the purpose of the Lake Austin Advisory Panel is to consult with and advise the Lower Colorado River Authority about issues of importance to the citizens of its jurisdiction with regard to Lake Austin; and,

Whereas, issues of human safety, health, and clean water are of paramount interest to the citizens of Austin; and,

Whereas, during fifty six years of seeking to control Lake Austin duckweed growth, the City of Austin, and the Lower Colorado River Authority have found that Lake Austin must be lowered at least every two years, with January 1997 being the next time for lowering in accordance with the two year schedule agreed upon more than twenty years ago; and,

Whereas, the LCRA is currently discharging 500 acre feet of water per day from Lake Travis to meet instream flow requirements, and Lake Austin can be lowered twelve feet and refilled with no loss of water by 1) stopping discharge from Lake Travis for 30 days and saving the 15,000 acre feet of water that would otherwise be discharged at the rate of 500 acre feet per day 2) providing the required instream flow for these 30 days by releasing 500 acre feet per day from Lake Austin, thereby lowering it twelve feet, and 3) refilling Lake Austin with the 15,000 acre feet saved in Lake Travis during the 30 days when Lake Austin supplied the required 500 acre feet per day for instream flow purposes.

Therefore, be it unanimously resolved that the Lake Austin Advisory Panel strongly recommends and requests that the LCRA continue to follow the successful policy of lowering Lake Austin every second year for the purpose of managing and controlling duckweed and thereby restoring Lake Austin to a lake that can be safely used as the recreational asset that it is intended to be.

Respectfully submitted,

Dudley Fowler, Chairman
Lake Austin Advisory Panel

Appendix H
Nautique Label

NQSL8416

SePRO

Nautique*

Aquatic Herbicide

For use in potable water sources, lakes, rivers, reservoirs, and ponds, slow-flowing or quiescent water bodies, crop and non-crop irrigation systems (canals, laterals, and ditches), fish, golf course, ornamental, swimming, and fire ponds and aquaculture including fish and shrimp

Active Ingredient:	
Copper Carbonate†	15.9%
Inert Ingredients	84.1%
Total	100.0%

†Metallic copper equivalent, 9.1%

Keep Out of Reach of Children

DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted no detalle. (If you do not understand this label, find someone to explain it to you in detail.)

Statement of Practical Treatment

If in eyes: Hold eyelids open and flush eyes with a gentle steady stream of water for 15 minutes. Get medical attention.
If on skin: Wash with plenty of soap and water. Get medical attention.
If swallowed: Call physician or poison control center. Drink a large quantity of milk, egg white, or gelatin mixture, or if these are not available large quantities of water. Do not give anything by mouth to an unconscious person.
Note to Physicians: Possible mucosal damage may contraindicate the use of gastric lavage.

Please refer to label booklet for additional precautionary information, directions for use, and storage and disposal information.

In case of emergency endangering health or the environment involving this product, call INFOTRAC 1-800-535-5053.

EPA Reg. No. 67690-10 EPA Est. No. 44616-MO-1
SC-84-0042

*Trademark of SePRO Corporation
SePRO Corporation • Carmel, IN 46032 U.S.A.

Herbicide

Net Contents 2.5 gal

Cover

T3D/SL*9/LABEL/US/XXXX/18

SePRO

SePRO Corporation • 11550 North Meridian Street • Suite 600 • Carmel, Indiana 46032-4565
Phone: (317) 580-8282 • *Fax:* (317) 580-8280

October 13, 1999

Mr. Charlie Thomas
Pesticide Registration
Texas Department of Agriculture
P.O. Box 12401
17th & Congress
Austin, TX 78711-2401

RE: Captain* Liquid Copper Algaecide (EPA Reg. No. 67690-9)
Nautique* Aquatic Herbicide (EPA Reg. No. 67690-10)
Amended Label

Dear Mr. Charlie Thomas:

Enclosed please find the following to support our amended label changes for the products Captain Liquid Copper Algaecide (EPA Reg. No. 67690-9) and Nautique Aquatic Herbicide (EPA Reg. No. 67690-10).

Captain Liquid Copper Algaecide (EPA Reg. No. 67690-9)

1. Transmittal Document (this letter)
2. EPA Stamped Approved Label (coded T3N/SL*9/LABEL/US/****/1-6)
3. Final Printed Label Incorporating Comments (coded T3N/SL*9/LABEL/****/7-11)

Nautique Aquatic Herbicide (EPA Reg. No. 67690-10)

1. Transmittal Document (this letter)
2. EPA Stamped Approved Label (coded T3D/SL*9/LABEL/US/****/1-7)
3. Final Printed Label Incorporating Comments (coded T3D/SL*9/LABEL/US/****/8-12)
4. Notification of Labeling Revision per PR Notice 98-10 (coded T3D/SL*9/LABEL/US/****/13-17)
5. Final Printed Label Incorporating Notification Changes and Errors (coded T3D/SL*9/LABEL/US/****/18-22)

I trust that the revised label submission is complete and acceptable to the State of Texas. Thank you for your assistance. If you should have any questions or require additional information, don't hesitate to contact me at 317-580-8281.

Sincerely,

SePRO Corporation

B.E. Steve D. Cockreham

Steve D. Cockreham, Ph.D.
Director of Research and Regulatory Affairs

RECEIVED
OCT 27 1999
Pesticide Registration Program

Enclosures

SePRO

NQSL8416

PEEL FILM HERE>

Nautique*

Aquatic Herbicide

For use in potable water sources, lakes, rivers, reservoirs, and ponds, slow-flowing or quiescent water bodies, crop and non-crop irrigation systems (canals, laterals, and ditches), fish, golf course, ornamental, swimming, and fire ponds and aquaculture including fish and shrimp

Active Ingredient:	
Copper Carbonate*	15.9%
Inert Ingredients	84.1%
Total	100.0%

*Metallic copper equivalent, 9.1%

Keep Out of Reach of Children

DANGER
PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted no detaile. (If you do not understand this label, find someone to explain it to you in detail).

Statement of Practical Treatment

If in eyes: Hold eyelids open and flush eyes with a gentle steady stream of water for 15 minutes. Get medical attention.
If on skin: Wash with plenty of soap and water. Get medical attention.
If swallowed: Call physician or poison control center. Drink a large quantity of milk, egg white, or gelatin mixture, or if these are not available large quantities of water. Do not give anything by mouth to an unconscious person.
Note to Physician: Possible mucosal damage may contraindicate the use of gastric lavage.

Please refer to label booklet for additional precautionary information, directions for use, and storage and disposal information.

In case of emergency endangering health or the environment involving this product, call INFOTRAC 1-800-535-5053.

EPA Reg. No. 67690-10
EPA Est. No. 44616-MO-1

SC-84-0042

*Trademark of SePRO Corporation
SePRO Corporation •
Carmel, IN 46032 U.S.A.

Herbicide

Net Contents 2.5 gal

T3D/SL*9/LABEL/US/XXXX/22

QW 258959 10/27/99

Precautionary Statements

Hazards to Humans and Domestic Animals

DANGER: Corrosive. Causes irreversible eye damage and skin burn. May be fatal if absorbed through skin. Harmful if swallowed. Do not get in eyes on skin or on clothing. Wear goggles, face shield, or safety glasses, protective clothing and rubber gloves. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling and before eating, drinking and using tobacco. Remove contaminated clothing and wash before reuse.

Environmental Hazards

Fish toxicity is dependent on the hardness of the water. In soft water, trout and other species of fish may be killed at application rates recommended on this label. Do not use in waters containing trout or other sensitive species if the carbonate hardness of the water is less than 50 ppm. Fish toxicity generally decreases when the hardness of water increases. Do not treat more than one-half of lake or pond at one time to avoid depletion of oxygen levels due to decaying vegetation. Consult State Fish and Game Agency before applying this product to public waters.

Directions for Use

It is a violation of Federal Law to use this product in a manner inconsistent with its label directions.

General Information

Nautique Aquatic Herbicide is a chelated copper formulation that provides effective control of hydrilla, egeria (Brazilian elodea), naiads, coontail, elodea, water lettuce, water hyacinth, horned pondweed, widgeon grass and other species having a sensitivity to copper absorption. Under certain water quality conditions, such as low hardness, this product may also control Eurasian watermilfoil and various pondweed species (e.g. *P. crispus*, *P. nodosus, P. pectinatus*). Nautique may be applied to lakes, rivers, reservoirs, ponds, potable water sources, crop and non-crop irrigation systems (ditches, canals, and laterals), fish, golf course, ornamental, swimming, and fire ponds, and aquaculture including fish and shrimp.

When target vegetation is actively growing, apply Nautique Aquatic Herbicide to the area of greatest concentration of foliage in such a way as to evenly distribute the herbicide. In lakes, reservoirs, ponds, and static canals, the application site is defined by this label as the specific location where Nautique is applied. In slow moving and flowing canals and rivers, the application site is defined by this label as the target location for plant control. In order to maximize effectiveness, apply Nautique early in the day under bright or sunny conditions when water temperatures are at least 60°F (15°C). The activity of this product may be reduced if there is insufficient penetration of light into the water or if the plants and weeds are covered with silt or scale.

Treatment of aquatic plants and weeds can result in a reduction of dissolved oxygen due to the decomposition of the dead vegetation. This loss of dissolved oxygen can cause fish suffocation. To minimize this possible hazard treat 1/3 to 1/2 of the water area in a single operation, then wait 10-12 days before treating the remaining area. Begin treatment in the shallow areas, gradually proceeding outward in bands to permit the fish to move into the untreated area.

Nautique Aquatic Herbicide can be applied directly as a surface spray, subsurface through trailing weighted hoses, or in combination with other aquatic herbicides and algaecides, surfactants, sinking agents, polymers, or penetrants. These products are used to improve the retention time, sinking, and distribution of the herbicide. For surface application, this product may be applied diluted or undiluted, whichever is most suitable to insure uniform coverage of the area to be treated.

Aquatic plants and weeds will typically drop below the surface within 4-7 days after treatment. The complete results of treatment will be observed in 3-4 weeks in most cases. In heavily infested areas a second application may be necessary after 10-12 weeks. Repeating application of this product too soon after initial application may have no effect.

Use the lower rates for treating shallow water and the higher rates for treating deeper water and heavier infestations. Surface applications may be made from shore into shallow water along the shoreline.

Nautique Aquatic Herbicide inverts easily using either tank mix or multi-fluid mixer techniques. For submersed plants invert applications should be made through weighted hoses dragged below the water surface; for heavy infestations, direct application is preferable.

No Restrictions on Water Use

Waters treated with Nautique may be used immediately after application for swimming, fishing, drinking, livestock watering, or irrigating turf, ornamental plants or crops.

Permits

Some states may require permits for the application of this product to public waters. Check with your local authorities.

Application Rates

Recommended application rates in the chart below are based on minimal water flow in ponds, lakes, reservoirs, and irrigation conveyance or drainage systems. Treatments that extend chemical contact time with target vegetation will generally result in improved efficacy. In lakes, reservoirs, ponds, and static canals, the application site is defined by this label as the specific location where Nautique is applied. In conveyance systems where significant water flow results in rapid off-site movement of copper, consult the Flowing Water Treatment Instructions for the recommended application instructions.

American Pondweed, Coontail, Egeria, Elodea, Eurasian watermilfoil, Hydrilla, Naiads, Sago pondweed, Widgeon Grass[1]									
Application Rates		Gallons Per Surface Acre				Liters Per Surface hectare			
		Depth in Feet				Depth in meters			
Relative Density	ppm	1	2	3	4[2]	0.5	0.75	1.0	1.25[2]
Low Density	.5	1.5	3.0	4.5	6.0	12.0	24.1	36.1	48.2
	.6	1.8	3.6	5.4	7.2	14.9	29.8	44.7	59.6
Medium Density	.7	2.1	4.2	6.3	8.4	17.2	34.4	51.6	68.8
	.8	2.4	4.8	7.3	9.6	19.5	39.0	58.5	78.0
High Density	.9	2.7	5.4	8.1	10.8	21.8	43.6	65.4	87.2
	1.0[3]	3.0	6.0	9.0	12.0	24.1	49.2	72.3	96.4

[1]Species susceptibility may vary with water hardness
[2]For depths greater than 4 ft (1.25 m) add rates given for the sum of the corresponding depths in the chart
[3]Do not Apply more than 1.0 ppm copper per application

Free- Floating Plants Apply Nautique at a rate of 8-12 gallons/acre for control of water hyacinth and salvinia and 4-6 gallons/acre for control of water lettuce. Add Nautique and appropriate surfactant to 100 gallons of water and use an adequate spray volume to insure good coverage of the plant.

Tank Mix

Nautique + Reward® Tank Mix

The following mixture can be used to enhance control of coontail, duckweed, egeria, elodea, Eurasian watermilfoil, hydrilla, pondweeds (Potamogeton species), salvinia, water lettuce, water hyacinth, and other susceptible species. Tank mix a ratio of 2:1 or 1.5:1 Nautique to Reward. This can be applied as a tank-mix solution or metered in separately as concentrates. Do not mix concentrates in a tank without first adding water. The addition of a surfactant is recommended to enhance performance. Observe all cautions and restrictions on the labels of both products used in this mixture.

Nautique + Sonar® A.S. Tank Mix (Except CA)

The following mixture can be used to provide rapid control of dense infestations of coontail, duckweed, egeria, elodea, Eurasian watermilfoil, hydrilla, sago and American pondweed, naiads, and other susceptible species. Apply 1 to 4 gallons of Nautique per surface acre in conjunction with normal Sonar rates. Observe all cautions and restrictions on the labels of both products used in this mixture.

Flowing Water Treatment :

Drip System or Metering Pump Application for Canals, Ditches, and Laterals

This product should be applied as soon as submersed macrophytes begin to interfere with normal delivery of water (clogging of lateral head gates, suction screens, weed screens, and siphon tubes). Delaying treatment could perpetuate the problem causing massing and compacting of plants. Heavy infestations and low flows may result in pooling or uneven chemical distribution resulting in unsatisfactory control. Under these conditions increasing the water flow rate during application may be necessary. In flowing canals the application site is defined by this label as the target location for aquatic plant control.

To achieve desired control with Nautique herbicide in flowing waters, it is recommended that a minimum exposure period of three hours be maintained. Other factors to consider include: plant species and density of infestation and water temperature and hardness. Treatment on bright sunny days will tend to enhance efficacy of this product.

1. Treatment with Nautique requires accurate calculations of water flow rates. Devices that provide accurate flow measurements such as weirs or orifices are the preferred method, however, the volume of water to be treated may also be estimated using the following formula:

   Average width (ft.) x Average Depth (ft.) x Average Velocity (ft/sec) = Cubic feet per Second (CFS)

   The velocity can be estimated by determining the length of time it takes a floating object to travel a defined distance. Divide the distance (ft.) by the time (sec.) to estimate velocity (ft/sec). This measure should be repeated 3 times at the intended application site and then calculate the average velocity.

2. After accurately determining the water flow rate in C.F.S. or gallons/minute, find the corresponding drip rate in the chart below.

Water Flow Rate		ppm Copper	Chemical Drip Rate	
C.F.S	Gal/Min.		Quart/Hr	Ml/min
1	450	0.5 – 1.0	0.5 – 1.0	8.0 – 16.0
2	900	0.5 – 1.0	1.0 – 2.0	16.0 – 32.0
3	1350	0.5 – 1.0	1.5 – 3.0	23.5 – 47.0
4	1800	0.5 – 1.0	2.0 – 4.0	31.5 – 63.0
5	2250	0.5 – 1.0	2.5 – 5.0	39.5 – 79.0

Calculate the amount of product needed to maintain the drip rate for a period of 3 hours by multiplying quart/hr x 3; ml / min. by 180; or Fl. oz. / min x 180. Dosage will maintain 1.0 ppm copper concentration in the treated water for the 3 hour period. Introduction of the chemical should be made in the channel at weirs or other turbulence-creating structures to promote the dispersion of the chemical.

Pour the required amount of this product into a drum or tank equipped with a brass needle valve and constructed to maintain a constant drip rate. Use a stopwatch and appropriate measuring container to set the desired drip rate. Readjust accordingly if the canal flow rate changes during the 3-hour treatment period. This product can also be applied by using metering pumps that adjust to flow rates in the canal.

Distance of control obtained will vary depending on the density of vegetation growth. Periodic maintenance treatments may be required to maintain seasonal control.

General Treatment Notes

The following suggestions apply to the use of this product as an algaecide or herbicide in all approved use sites. For optimum effectiveness:

- Apply early in the day under calm, sunny conditions when water temperatures are at least 60 deg. F.
- Treat when growth first begins to appear or create a nuisance, if possible.
- Apply in a manner that will ensure even distribution of the chemical within the treatment area.
- Re-treat areas if regrowth begins to appear and seasonal control is desired. Allow one to two weeks between consecutive treatments.
- Allow seven to ten days to observe the effects of treatment (bleaching and breaking apart of plant material).

Storage and Disposal

Store in a cool, dry place.

Pesticide Disposal: Do not contaminate water, food or feed by storage and disposal. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of

Storage and Disposal (Cont.)

by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Container disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incinerate, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Warranty Disclaimer

SePRO Corporation warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. SePRO Corporation makes no other express or implied warranty of merchantability or fitness for a particular purpose or any other express or implied warranty.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to the label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. All such risks shall be assumed by the buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or

(2) Replacement of amount of product used.

SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such loss or damage in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employees or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

Material Safety Data Sheet

SePRO

Emergency Phone: 800-535-5053
(INFOTRAC)

General Phone: 317-580-8282

EPA Reg. Number: 67690-10
Effective Date: June 25, 1998

Nautique*

SePRO Corporation • Carmel, IN

1. INGREDIENTS: (% w/w, unless otherwise noted)

Copper as Elemental** 9.1%
Inert Ingredients.......................................90.9%
Total..100.0%

**One gallon contains 0.91 pounds of elemental copper from a mixed ethylenediamine triethanolamine copper complex (1 liter contains 110.0 grams copper).

2. PHYSICAL DATA:

BOILING POINT: Not determined
MELTING/FREEZING POINT: Not determined
VAP. PRESS: Approximately the same as water
VAP. DENSITY: Not determined
SOL. IN WATER: Soluble
SP. GRAVITY: 1.2
VISCOSITY: Not determined
APPEARANCE: Dark purple liquid
ODOR: Slight ammoniacal
pH: Not determined

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: Not determined
IGNITION TEMPERATURE: Not determined
FLAMMABLE LIMITS:
LFL: Not determined
UFL: Not determined
EXTINGUISHING MEDIA: All purpose foam preferable.
FIRE FIGHTING EQUIPMENT: Wear protective clothing and positive pressure breathing apparatus.

4. REACTIVITY DATA:

STABILITY: Stable
INCOMPATIBILITY: Strong Acids and Nitrites. Should not be used in water where the pH is less than 6.0 due to the possible breakdown of the copper chelate, which could form copper ions, which would precipitate. Should not be applied to water when temperature of the water is below 60° Fahrenheit (15° C).
HAZARDOUS DECOMPOSITION PRODUCTS: Decomposes above 390°F (200°C). May form oxides of carbon & nitrogen.
HAZARDOUS POLYMERIZATION: Will not occur.

5. ENVIRONMENTAL AND DISPOSAL INFORMATION:

ENVIRONMENTAL DATA: Not determined
ACTION TO TAKE FOR SPILLS: Ventilate area. Avoid breathing vapors. Wear respiratory protection and avoid contact with skin, eyes, or clothing. Contain spill if possible. Absorb the spill with an absorbent material such as a sweeping compound, oil absorbent, or lime. Sweep up the material and place it in an appropriate waste chemical container. Wash the spill area with water containing a strong detergent, absorb it, and place in the waste chemica container. Seal the container and dispose of it in an approved manner. Thoroughly flush the spill area to remove any remaining residue.
DISPOSAL METHOD: Responsibility for proper waste disposal rests with owner of the waste. Consult with local and environmental authorities. Contaminated materials should be placed in sealed drums and shipped to an approved chemical dump for disposal in accordance with all federal, state and local regulations.

6. HEALTH HAZARD DATA:

This product meets the OSHA definition of toxic.
ACUTE ORAL LD_{50}: (Rats) – 680 mg/kg. EPA Category III
ACUTE DERMAL LD_{50}: (Rabbits) – 700 mg/kg. EPA Category II
ACUTE INHALATION LC_{50}: (Rats) – 2.1 mg/L. EPA Category IV
PRIMARY EYE IRRITATION: (Rabbits) – EPA Category I
PRIMARY DERMAL IRRITATION: (Rabbits) – EPA Category I
DELAYED CONTACT DERMAL SENSITIZATION: Sensitizer
Components are not listed as carcinogens or potential carcinogens by NTP, IARC, or OSHA.
POTENTIAL HEALTH EFFECTS EYE: Corrosive to eyes. Corneal injury may be severe, extensive, and, if not treated promptly, could result in permanent impairment of vision. Causes severe irritation, experienced as discomfort or pain, excess blinking and tear production, marked excess redness and swelling of the conjunctiva, and chemical burns of the eye. Avoid eye contact with the product by using approved safety glasses or goggles.
SKIN: Corrosive to skin. Avoid contact. May cause local discomfort or pain, severe excess redness and swelling, tissue destruction, fissures, ulceration, and possibly bleeding into the injured area. Prolonged c

Material Safety Data Sheet

SePRO

Emergency Phone: 800-535-5053
(INFOTRAC)

General Phone: 317-580-8282

EPA Reg. Number: 67690-10
Effective Date: June 25, 1998

Nautique

SePRO Corporation • Carmel, IN

widespread contact may result in the absorption of potentially harmful amounts of material.
INGESTION: May be toxic. May cause burns of mouth and throat, abdominal pain, nausea, vomiting, diarrhea, dizziness, weakness, thirst, collapse, and possible coma. The nature and severity of these signs and symptoms will be dependent on the amount swallowed. Aspiration into the lungs may occur during ingestion or vomiting, resulting in lung injury.
INHALATION: Vapor may be irritating and may cause excessive tear formation, burning sensation of the nose and throat, coughing, wheezing, shortness of breath, nausea and vomiting. Extremely high vapor concentrations may cause lung damage. Some individuals may develop asthma.

7. FIRST AID MEASURES

EYE CONTACT: Immediately flush eyes with flowing water while holding eyelid away from eyeball. Continue washing for at least 15 minutes. Do not remove contact lenses if worn. Get prompt medical attention.
SKIN CONTACT: Immediately flush skin thoroughly with water for at least 15 minutes while removing contaminated clothing and shoes. Wash thoroughly with soap and water. Get medical attention if irritation persists. Wash clothing before reuse. Discard contaminated leather articles such as shoes and belt.
IF SWALLOWED: Do not induce vomiting! Get immediate medical attention. If patient is fully conscious, give 1 or 2 glasses of water or milk.
INHALATION: Remove to fresh air. Give artificial respiration if not breathing. If breathing is difficult, oxygen may be given by qualified personnel. Obtain medical attention.
NOTE TO PHYSICIAN: Corrosive. May cause stricture. If lavage is performed, suggest endotracheal and/or esophagoscopic control. If burn is present, treat as any thermal burn after decontamination. No specific antidote. Supportive care. Treatment is based on the judgment of the physician in response to reactions of the patient. Prolonged or repeated inhalation may aggravate preexisting asthma, liver and kidney disease. Corrosive to eyes and skin. Causes irreversible eye damage.

8. HANDLING PRECAUTIONS:

ENGINEERING GUIDELINE(S): Ventilation adequate to meet exposure limits for components (See Regulatory Information)
VENTILATION: Use general or local exhaust ventilation to meet TLV requirements.
RESPIRATORY PROTECTION: Wear NIOSH approved dust and mist respirator if mists are generated during use.
SKIN PROTECTION: Waterproof rubber, neoprene or plastic groves, chemical apron, boots, etc. as needed to prevent skin contact.
EYE PROTECTION: Chemical eye goggles.
OTHER: Eye bath, safety shower

9. ADDITIONAL INFORMATION:

SPECIAL PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Utilize good personal hygiene practices and exercise normal liquid handling procedures. Store below 95°F (35°C) whenever possible. Decomposes at temperatures above 400°F (200°C). Average shelf life under proper storage conditions in the original sealed containers is 2 years. Store in a clean, dry area. Keep out of reach of children. Harmful if swallowed, adsorbed through skin, or if inhaled. Avoid breathing of spray mist or contact with skin, eyes, or clothing.

MSDS STATUS:

Date of Issue:	Revision Reflected:
June 9, 1998	First Issue

10. REGULATORY INFORMATION:

(Not meant to be all-inclusive—selected regulations represented).
NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is included for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See MSDS Sheet for health and safety information.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "hazard categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories: An immediate health hazard

Material Safety Data Sheet

SePRO

Emergency Phone: 800-535-5053 (INFOTRAC)

General Phone: 317-580-8282

EPA Reg. Number: 67690-10
Effective Date: June 25, 1998

Nautique

SePRO Corporation • Carmel, IN

EPCRA Section 302: This product contains ethylenediamine, which is an EPCRA extremely hazardous substance.

EPCRA Section 313 Toxics Release Inventory: This product contains copper, which is on the toxics release inventory (TRI) list.

TOXIC SUBSTANCE CONTROL ACT (TSCA): All components of this product are on the TSCA Inventory.

OSHA HAZARD COMMUNICATION STANDARD: The product is a "hazardous chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

DOT HAZARDOUS MATERIAL NAME: Copper based pesticides, liquid, toxic, (mixed copper ethylenediamine/triethanolamine complex)

DOT HAZARD CLASS: Class 6.1

This product is a proprietary mixture for which no human health hazard data exist. The OSHA hazard communication standard requires that such mixtures be assumed to present the same health hazard as do the components that constitute at least 1% of the mixture (0.1% for carcinogens). OSHA has noted, however, that including them in a mixture may alter the hazards of individual components. Components of this product that are listed as Hazardous Materials and/or present in quantities as defined in OSHA 29 CFR 1910.1200:

Ingredient	CAS#	EXPOSURE LIMIT
Ethylenediamine	107-15-3	10 ppm or 25 mg/m^3, TWA, OSHA & ACGIH
Triethanolamine	102-71-6	5 mg/m^3, TWA, ACGIH
Copper Dust		1 mg/m^3, TLV(ACGIH)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA 704)
(4=Extreme; 3=High; 2=Moderate; 1=Slight: 0=Insignificant)
Toxicity: 3 Flammability: 0 Reactivity: 1

Chemistry and Physical Properties

Chemical family: Copper complex

Solubility in water: Miscible

Common name: Copper chelate

Stability: Stable to light

Vapor pressure: Approximately the same as water

Trademarks and other designations: Nautique

Formulations: One single-product formulation of Nautique is available as a liquid containing .91 lb. of elemental copper. (1 liter contains 110.0 grams copper).

Decomposition temperature: 400°F (200°C)

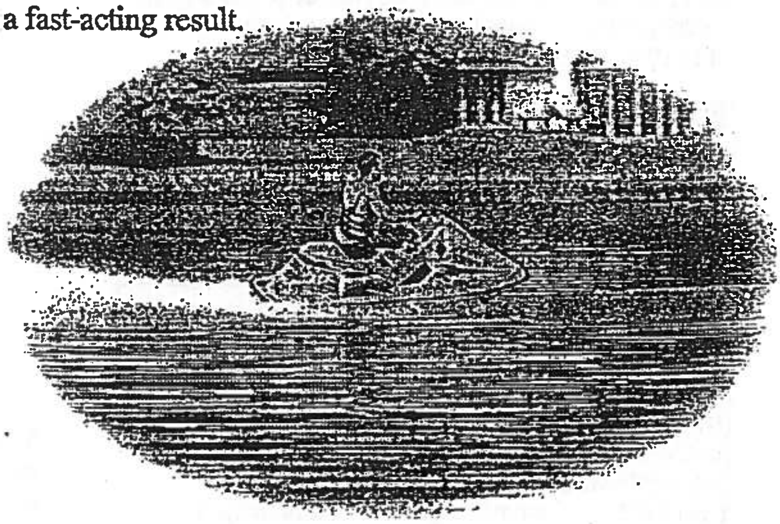
Physical state: Solid

Color: Dark purple

Odor: Slight ammoniacal

Specific gravity: 1.2

Mode of Action: Mode of action is uptake through plant cells where the copper ion inhibits plant photosynthesis providing a fast-acting result.



Application

General Information

Nautique Aquatic Herbicide provides effective control of Hydrilla, Egeria *(Brazilian elodea)*, Southern Naiad, Horned Pondweed, and Widgeon Grass in lakes, ponds, potable water reservoirs, ornamental ponds, golf course water hazards, fire ponds and industrial retention basins. This product rapidly penetrates into the plant tissues. Proper application of this contact product is, therefore, important.

When target aquatic plants are actively growing, apply Nautique Aquatic Herbicide to the area of greatest concentration of foliage in such a way as to deposit the herbicide on leaf surfaces. The activity of this product may be reduced if there is insufficient penetration of light into the water or if plants are covered with silt, scale or algae.

Nautique can be applied directly as a surface spray, subsurface through trailing weighted hoses, or as an invert emulsion. For surface or subsurface application, this product may be applied diluted or undiluted, whichever is most suitable to insure uniform coverage of the area to be treated.

Aquatic plants will drop below the surface within 4 days after treatment. The complete results of treatment will be observed in 3-4 weeks in most cases. In heavily infested areas a second application may be necessary after 10-12 weeks. Repeating application of this product too soon after initial application may have no effect.

Use the lower rates for treating shallow water and the higher rates for treating deeper water and heavier infestation. Surface applications may be made from shore into shallow water along the shoreline.

Nautique may be applied directly, tank mixed or through a multi-fluid mixer technique. For subsurface plants, applications should be made through weighted hoses dragged below the water surface using direct application, tank mixing or inverts.

No Waiting

Water may be used immediately after treatment for swimming, fishing, livestock watering and irrigation.

Application Rates to Control:

Ceratophyllum demersum (coontail), ***Egeria densa*** (Brazilian elodea), ***Eichhornia crassipes*** (water hyacinth), ***Elodea canadensis*** (elodea), ***Hydrilla verticillata*** (hydrilla), ***Ruppias maritima*** (Widgeon grass), ***Myriophyllum spicatum*** (Eurasian watermilfoil), ***Najas spp.*** (naiad), ***Pistia stratiotes*** (waterlettuce), ***Potamogeton pectinatus*** (sago pondweed) and other susceptible species.

Application Rates		Gallons per surface acre				Liters per surface hectare			
		Depth in feet				Depth in meters			
Relative Density	PPM	1	2	3	4	0.5	0.75	1.0	1.25
Low to Medium Density	.6	1.8	3.6	5.4	7.2	14.9	29.8	44.7	59.6
	.7	2.1	4.2	6.3	8.4	17.2	34.4	51.6	68.8
	.8	2.4	4.8	7.3	9.6	19.5	39.0	58.5	78.0
High Density	.9	2.7	5.4	8.1	10.8	21.8	43.6	65.4	87.2
	1.0	3.0	6.0	9.0	12.0	24.1	48.2	72.3	96.4

x depths greater than 4 feet (1.25 meters) add the rates given for the sum of corresponding depths in the chart.
o not apply more than 1.0 ppm copper. Species susceptibility may vary with water hardness.

Application

Nautique Aquatic Herbicide may be applied directly to the surface at water shorelines or in shallow water.

Subsurface application is preferable for deeper waters. Apply Nautique through weighted hoses. Adjust the hose depth to about one foot above the lake or pond bottom or at the depth where the infestation is greatest. Avoid dragging the hose on the bottom. Other plants or weeds may be controlled by varying the application rate.

Heavy infestation may require additional applications. Use lower application rates for shallow water; higher rates for deeper waters.

<u>Directions for Use</u>

Nautique has a long shelf-life and excellent stability because the copper is totally solubilized and chelated to prevent precipitation.

For maximum effectiveness, apply Nautique to actively growing plants on bright sunny days when the water temperature is more than 60°F or 15°C.

Avoid overspraying of the spray mist, Apply Nautique to the area of greatest foliage density, allowing the herbicide spray to deposit directly on to the weed surfaces. Repeat as necessary to control re-growth and plants missed in the previous operation. Cloudy water or silt or algae layers on foliage may reduce the effectiveness of the application.

Applications:
Nautique may be applied directly, tank mixed or metered into a treatment site. Nautique may be used in combination with other aquatic herbicides to enhance control.

Invert Applications:
Nautique Aquatic Herbicide inverts easily using multi-fluid mixer techniques. For subsurface plants apply invert emulsions by dragging weighted hoses below the water surface.

AVOID INJURIOUS SPRAY DRIFT: Do not permit sprays containing this herbicide to drift onto adjacent desirable plants as injury may occur. Read and follow the Use Precautions on this product.

Environmental Fate

Environmental Hazards

This product may be toxic to fish. Trout and other species of fish may be killed at application rates recommended on this label. However, fish toxicity generally decreases when the hardness of water increases. Consult State Fish and Game Agency before applying this product to public waters.

Permits

Some states may require permits for the application of this product to public water. Check with your local authorities.

Precautions

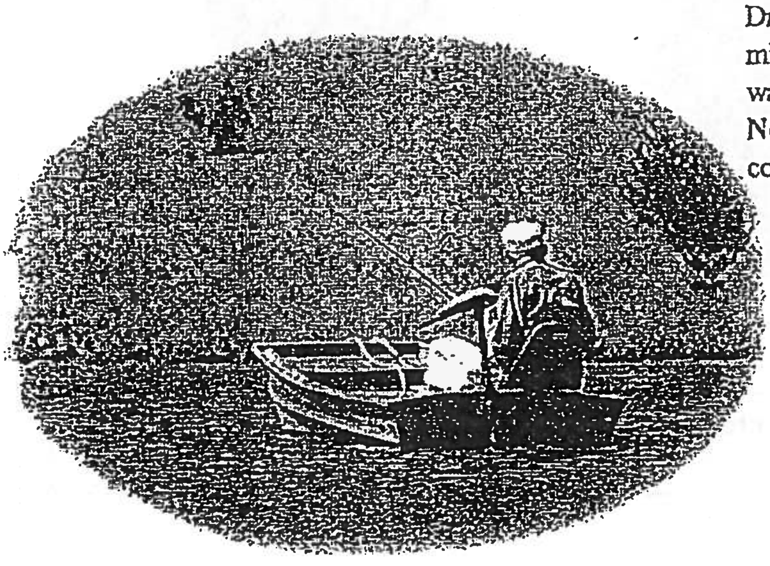
General Precautions

Desirable plants and fish: Concentrated Nautique Aquatic Herbicide may injure ornamental plants, grass or other foliage. Do not allow direct contact of Nautique with desirable plants and grass. Apply only as specified on the label.

Treating aquatic plants can result in a reduction of dissolved oxygen due to decomposition of vegetation. This loss of dissolved oxygen can cause fish suffocation. To minimize the potential hazard, treat no more than 1/2 of the water area in a single operation. Wait approximately 2 weeks before treating the remaining area. Begin treatment in the shallow areas, gradually proceeding outward in bands to permit fish to move into untreated areas.

Precautionary Statements

Hazards to humans and domestic animals:
DANGER. Corrosive. Can cause irreversible eye damage and skin burn. May be fatal if absorbed through skin. Harmful if swallowed. Do not get in eyes or on skin or on clothing.



Ventilation: Good general ventilation is sufficient for most conditions.

Respiratory protection: No respiratory protection should be needed when using Nautique according to label directions.

Eye Protection: Wear goggles, face shield or safety glasses.

Skin Protection: Wear protective clothing and rubber gloves(ie. long sleeved shirt and pants, shoes plus socks). Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling and before eating, drinking and using tobacco. Remove contaminated clothing and wash before reuse.

Keep out of reach of children.

Statement of Practical Treatment

If in eyes: Hold eyelids open and flush eyes with a gentle steady stream of water for 15 minutes.
Get medical attention.
If on skin: Wash with plenty of soap and water.
Get medical attention.
If swallowed: Call physician or poison control center. Drink a large quantity of milk, egg white or gelatin mixture or if these are not available, large quantities of water.
Note to physician: Possible mucosal damage may contraindicate gastric lavage.

Handling

Storage
Store in a cool, dry place.

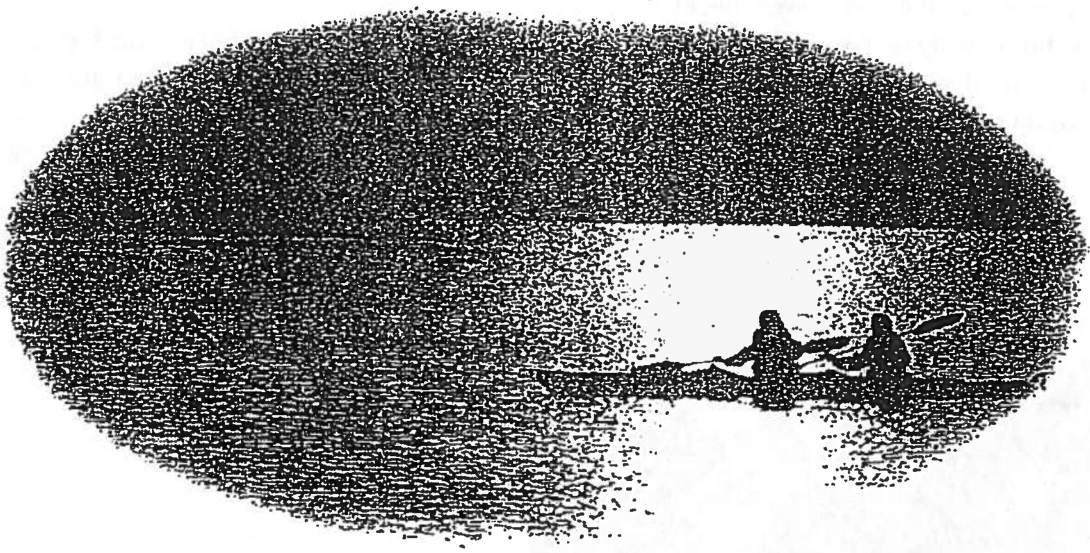
Spills
For small spills, use absorbent material to contain and clean. Dispose as waste (see "Disposal" below for instructions). Dike large spills to prevent runoff, then report to INFO-TREC and SePRO Emergency Phone: 317-580-8282.

Pesticide Disposal
Do not contaminate water, food or feed by storage and disposal. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of Federal Law.

If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

Container Disposal
Container Disposal (Plastic): Do not reuse container. Triple-rinse (or equivalent) then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill or by incineration. Or, if allowed by state and local authorities, dispose of containers by burning, but stay out of the resulting smoke.

Neither the manufacturer nor the seller makes any warranty, expressed or implied, concerning the use of this product other than indicated on the label. Buyer assumes all risk of use of this material when such use is contrary to label instructions. Read and follow label directions.



Always read and follow the directions and precautions on the Nautique herbicide labels and material safety data sheets carefully.

Appendix I
Environmental Board Questions and Answers
About Herbicides

The following questions (1-12) were asked at the August Environmental Board. #13 and 14 were brought up by staff. Answers were provided in large part by Mike Netherland, PhD. (SePro- Aquatic Research and Development),with some additional comments made by staff.

1. A list of communities/reservoirs in Texas (or elsewhere) that have used the same, herbicide (copper complexes) we're considering, and what sort of results they got.
2. Case studies (or any data) regarding maximum area that can be treated without a significant drop in dissolved oxygen from decaying plant matter.
3. Do the copper complexes kill milfoil as well as hydrilla?
4. What is the lowest concentration of herbicide needed to be effective on hydrilla?
5. How does this concentration (from #4) affect fish?
6. How does the actual rate/concentration of chemical as it is applied compare to the EPA MCL for copper?
7. If the application concentration (from #6) is higher than the MCL, and the assumption is that the chemical will be diluted to below the MCL by surrounding lake water, what will happen if the application occurs in close proximity to a private drinking water intake?
8. How does the contact herbicide actually kill the plants- what is the biological/chemical mechanism that causes mortality?
9. Would it work to harvest the dead plants, thus removing them from the system so they don't decay, etc?
10. What happens if animals eat the treated plants (fish, crayfish)?
11. What happens to the copper once the plants die?
12. Case studies/data regarding number/size of applications vs. amount of copper build-up in sediment.
13. State criteria for copper in water and sediment:

    Water Quality criteria in ug/L:

        EPA 9.0-13.0, TNRCC 28-45

    Sediment screening levels, in mg/kg

        EPA 34-270, TNRCC 33.0

    Although the actual application rate is greater than the water quality criteria, it will be applied in less than 10 % of the waterbody (hydrilla covers 200 acres of the 1600 acre lake). A pilot is planned for the fall of only 10 acres and even in the spring during the larger treatment we do not plan to treat the entire 200 acres. This is in part due to cost and also because much of the hydrilla is in water deeper than ten feet, where the pilot may show the herbicide is not effective. Because of this limited size of treatment area in relation to the lake, it is not anticipated that the application will raise the level of copper in the entire waterbody above these values. Monitoring will be done during the pilot study to determine both water column and sediment level impacts.
14. Role of TNRCC in regulating herbicide application?

    (conversation with Mary Ambrose, TNRCC Policy and Regulation Division:

    If application of herbicide is according to labeled rate and methodology, it is not considered a discharge and requires no permit from TNRCC. The state's main concerns are regarding notification of public drinking water providers and potential impacts to the waterbody for constituents of concern (i.e., if Lake Austin was listed as an impaired waterbody due to elevated copper levels, which it is not).

1. There are several sites that have used chelated coppers and specifically Nautique to address aquatic plant problems. SePro is working to put a list together for several of the larger systems that have been treated with Nautique. As copper is a required micronutrient, there are no tolerances established Nautique, therefore, there are no drinking, swimming, fishing, or irrigation restrictions on this compound. *This information should be available at the time of the public hearing.*
2. Treating 150 acres on a 1600 acre lake should not cause any widespread depression of dissolved oxygen (DO) in the reservoir regardless of the plant biomass. With this said, if all 150 acres of vegetation are located in a fairly localized area (e.g. cove or embayment), there could be a short-term depression in DO while the plants decay. Given the fact that this is a flowing reservoir, long-term depression of DO would be very unlikely. If the hydrilla is more scattered, treatment of 10 to 20 acre blocks should result in minimal depression in DO due to dilution from water outside the individual treatment areas.
To add to Dr. Netherland's response, the hydrilla is not localized in coves or embayments, but situated linearly along much of the south shore of the lake upstream of Loop 360. Other individuals with experience in applying copper herbicides and more familiar with Lake Austin are quite sure that DO depression is unlikely unless we treat a dense block of 50 acres or more. In this case, the very center of the treated block may experience a low DO, but the untreated waters of the lake alongside the dense treated areas will provide a refugia of normal DO for organisms such as fish to escape to.
In fact, untreated dense mats of hydrilla have been shown to create severe swings in DO, where nighttime levels drop below 1.0 mg/L and go well above 12.0 mg/L during the day. These wide swings occurring throughout much of the hydrilla infestation is more of an impact to water quality than will be seen from any herbicide application.
3. Nautique will impact milfoil, but it is generally much more effective on hydrilla. Due to the fact that a potable water reservoir is being treated, the use of Nautique makes sense due to the fact that there are no drinking water restrictions.
4. Due to the depth of water, Nautique should be used to achieve between 0.5 and 1.0 ppm copper in the water column. The depth of water presents a challenge in getting good distribution of the product from top to bottom. The larger the treatment block, the lower the rate that is likely to provide good control. Moreover, in areas where a longer contact time is likely (protected coves, marinas), you can often get good results at reduced use rates. It is not generally recommended to treating areas less than 1 acre due to rapid dilution.
5. At these use rates there should be no negative impacts on fish due to the copper treatment. *See information on fish toxicity on pg. 4 in the main report.*
6. EPA's Action Level for copper (1.3 mg/L, measured at the household level) is higher than maximum allowable use rate of Nautique (1.0 mg Cu /L or ppm). EPA's Allowable Level for raw water of 1.0 mg/L is equal to the maximum allowable use rate (1.0 mg/L or ppm). The application rate for Lake Austin will be closer to 0.5 mg/L.
7. As stated above, there are no drinking water restrictions on the use of copper when used at the maximum allowable use rate (1.0 ppm). Therefore application over the top of a potable water intake would constitute a legal application. If there are major

concerns, either set an established waiting period prior to drawing potable water or establish a setback distance from the intake.

8. Information from the US Army Corps of Engineers indicates that "Copper complexes act as plant cell toxicants and may inhibit photosystem II electron transport. Herbicide activity is greater when plants are photosynthesizing and may be reduced on submersed aquatic plants if there is not adequate penetration of light into the water or if plants are covered with silt or algae. Copper is taken up by aquatic macrophytes and translocated, although the element is not metabolized, and it may be stored or excreted. Copper complexes are not subject to photolysis or volatilization."
9. Attempting to harvest the decaying vegetation is unnecessary. Following treatment, the plants will sink to the bottom sediments, thereby making harvesting extremely difficult.
10. Because the application rate is so low, herbivores feeding on treated vegetation should not be affected. A common comparison of toxicity for chemicals is the LD50 or median lethal dose, the amount required to kill 50 percent of the test population. The dose is give in milligrams per kg body weight. For KOMEEN, a copper compound similar to the one proposed by WWW, the LD 50 is 498 mg/kg. (see details in main report)
11. Nautique will only require approximately 12 hours for action, after this time, the copper will precipitate out of solution and becomes bound to sediments. Once this occurs it is no longer considered to be biologically available. The copper ion is the biologically active form and once this free ion becomes bound, biological activity is lost.
12. Although data is somewhat limited in this area, significant changes in sediment copper concentrations following the use of chelated coppers has not been documented. While continuous use of copper compounds in the same area would be expected to increase sediment loads, the judicious use of chelated compounds has not resulted in unexpected increases in copper sediment levels. Generally sediment copper issues are related to continuous and repeated use of the inorganic compound copper sulfate. In some areas, copper sulfate has been used for decades and it is well-documented that sediment concentrations are well above normal background levels.

To add to Dr. Netherland's comments, studies in Florida show a large difference between sediment accumulation from copper sulfate and that from chelated copper. Sediment accumulation of copper in three reservoirs treated for macrophyte control (using chelated copper) range from 34 to 71 mg/kg, while untreated areas ranged from 2 to 10 mg/kg. In examining this data, it is important to remember that treatments were repeated over several years, and that this accumulation is not the result of a single treatment. However, it does strengthen the concern that Watershed Protection Department staff have about using herbicide as a single control method; without integrating grass carp into the management plan, treatment with herbicides would have to be repeated as often as twice per year for many years to effect any reasonable control. This could result in sediment accumulations of copper similar to those seen in Florida.

Appendix J
TPWD November 20 Grass Carp Letter

November 20, 2000

Nancy McClintock, Division Manager
City of Austin
Environmental Resource Management
Watershed Protection Department
P.O. Box 1088
Austin, Texas 78767

Dear Ms. McClintock:

The City of Austin's application for a permit to stock 800 triploid grass carp into Lake Austin to control hydrilla has been reviewed by Texas Parks and Wildlife (TPW) staff from the various resource division (attached). Based on these comments and findings the permit is being denied at this time.

As stated in our earlier correspondence to the City, if the hydrilla continues to increase in coverage and reaches a point where the ecology of the Lake Austin system is threatened and/or recreational access is severely limited, TPW will again review and reconsider this application.

If you have any questions or concerns please contact Dr. Earl Chilton (512/389-4652), our habitat specialist, or myself (512/389-4643). We look forward to continued cooperation between the City of Austin and TPW.

Sincerely,

Phil Durocher

Philip P. Durocher
Director of Inland Fisheries

O SMITH SCHOOL ROAD
TIN, TEXAS 78744-3291
512-389-4800
www.tpwd.state.tx.us

Biologists Report

Triploid Grass Carp Public Water Stocking

Lake Name: Austin County: Travis

Location: City of Austin Size (Acres): 1609 acres

Problem Plant(s): Hydrilla, Eurasion watermilfoil Area Covered: 512 acres

Percent of Shoreline Developed: 30

Recommendation: Stock ________ (Number) Deny Permit X (Check)

Biological Considerations:

The proposed introduction of 800 triploid grass carp would likely not be effective in controlling nuisance aquatic vegetation in Lake Austin. Even as part of an integrated management plan, it is unlikely this introduction would produce the desired results unless large numbers were stocked to account for emigration loss. A high stocking rate could negatively affect aquatic vegetation important to the largemouth bass fishery. Emigration loss of large numbers of grass carp could negatively affect aquatic vegetation in Town Lake and the Colorado River. Potential negative impacts of this proposed introduction far outweigh possible benefits.

Due to a propensity for downstream emigration grass carp are not recommended for use in riverine type aquatic systems (Prentice et al 1998). Lake Austin is a riverine type reservoir. Water is routinely passed through the reservoir for the purpose of generating electrical power, providing minimum flows for the Colorado River and providing water for downstream irrigation. Under low flow conditions 3.5% emigration every 6 months was documented in two small Guadalupe River, Texas hydropower impoundments (Prentice et al 1998). In addition to routine releases, flood events are common in the Colorado River watershed. In the last ten years, it appears flood gates (Lake Travis > 681 msl) were open at Tom Miller Dam in 1991,1992,1993, 1995, 1997, 1998 and 1999. Major flood events occurred in 1992 and 1997, during which flood gates remained open for many months. During high river-flow conditions, grass carp have been reported to emigrate at a rate of 59% in 6 months (Prentice et al 1998). The combination of downstream emigration behavior and a high incidence of water releases make grass carp an impractical vegetation control tool in Lake Austin.

Because of the "open" nature of the Highland Lakes system a large initial stocking of grass carp, to account for anticipated emigration loss, and/or an annual stocking program for replacing emigrants would be required. Complete elimination of the reservoir's aquatic vegetation is possible under each scenario. A large stocking of grass carp eliminated all submerged aquatic vegetation in Lake Conroe, Texas (Betloli et al 1993). Drought conditions, such as those experienced in Texas during 1996 and 2000, might result in an emigration rate lower than anticipated and the number of carp per vegetated acre higher than expected. During years when submerged vegetation was reduced by unfavorable environmental conditions the number of carp per vegetated acre might also be higher than anticipated. This scenario is possible even with the current request for 800 fish. In either case, drought or a natural vegetation decline, a total elimination of the reservoir's aquatic vegetation is possible.

Incremental stockings, due to a lack of results with initial low stocking rates, may also result in elimination of submerged aquatic vegetation. Incremental stockings have been implicated in the complete elimination of submersed vegetation in Martin Creek Reservoir (TPWD, unpublished data) and North Lake, Texas (Guest, 2000, In review).

Stockings of 118,400 grass carp (approximately 6/vegetated acre) from 1988-1990 in Lake Guntersville, located on the Tennessee River in Alabama, combined with a period of high flows in the early 1990's resulted in a severe reduction (20,000 acres to 5,000 acres) in the reservoir's submersed aquatic vegetation (Morrow and Kirk 1995, Tennessee Valley River Authority (TVA), 1999). The vegetation is now at levels similar (15,000 acres) to that found prior to grass carp stocking (TVA, 1999). Emigration from this riverine reservoir may be responsible for the lack of long term control. Grass carp are not included as a control option in the TVA's present long-term aquatic vegetation management plan for Lake Guntersville. Florida, which has a long history of hydrilla control does not recommend grass carp as a control agent in large systems where containment is difficult (Schardt, 1999). Maintaining an appropriate number of grass carp for achieving a goal of 20-40% vegetative coverage in Lake Austin's open and unpredictable riverine environment would be extremely difficult.

Should large numbers of grass carp emigrate from Lake Austin, aquatic vegetation in Town Lake and the Lower Colorado River may be seriously diminished. Aquatic vegetation in Town Lake is presently below the 20-40% level recommended for maximum largemouth bass production (Magnelia and Tibbs 1997). Aquatic vegetation in the Colorado River is important for the high quality sport fishery that presently exists (TPWD, unpublished data).

Economic/Recreational Considerations:

Lake Austin is popular with Austin area bass anglers (TPWD, unpublished data). In July 2000 aquatic vegetation covered 31.85% of the reservoir. This is within the ideal range for largemouth bass production (Durocher et al. 1984, Dibble et al 1996). The reservoir is the area's only largemouth bass fishery that has consistently produced trophy bass. Three bass over 13 pounds have been entered into the TPWD Lunker Program since 1990, with the latest caught in spring 2000. In the last electrofishing survey conducted by TPWD in 1997 largemouth bass population density and size structure were at historic high levels (Magnelia and Tibbs 1998). Maintaining aquatic plant coverage in the 20-40% range will be important for maintaining the quality largemouth bass fishery that currently exists. Information is currently being gathered to assess the economic impact of the Lake Austin's fishery.

Currently, access for boaters at public boat ramps is not being hampered by aquatic vegetation coverage, although hydrilla is present at two of the reservoir's five public ramps. Shoreline angling is being negatively affected by the present level of aquatic vegetation at the Loop 360 boat ramp and at Emma Long Metropolitan Park; however, shoreline anglers make up a small fraction (<1%) of those fishing Lake Austin (TPWD, unpublished data).

Observations by TPWD Inland Fisheries staff conducting creel surveys on Lake Austin (March 1999 to present) indicate navigation for recreational boating has not been seriously affected. Creel clerks have not received a single complaint from recreational boaters, despite ample opportunity to do so. TPWD staff has routinely observed recreational boaters motoring through matted hydrilla at high speed, which is fragmenting the plant and contributing to its spread. Water skiing, which is very popular on Lake Austin, also does not seem to be negatively impacted with the present vegetation coverage.

Boat access for lakefront homeowners is being negatively impacted in several areas of the reservoir, especially on the south bank directly upstream from the Loop 360 Bridge and on the shoreline directly across from Emma Long City Park. During a creel survey on October 21, 2000 TPWD staff counted 113 homes with hydrilla present on their lake frontage.

TEXAS PARKS AND WILDLIFE

OFFICE MEMORANDUM

COORDINATION - ROUTING			
DIV.	NAME	INITIAL	DATE
REMARKS:			
RETURN TO:			

TO: Steve Magnelia

FROM: Roy Kleinsasser
David Bowles

SUBJECT: Lake Austin

RE: Vegetation control

DATE: November 16, 2000

This memorandum is in response to a proposal from the City of Austin to stock grass carp in Lake Austin to address a perceived vegetation problem. Having participated in a major instream flow study on the Colorado River and the Barton Springs Salamander Recovery Team, River Studies Program staff has significant concerns about such a plan.

A fundamental concern is the ability of grass carp to move long distances from where they are stocked and potentially impact vegetation in Town Lake, Barton Springs, and the river downstream to the coast. Vegetation provides important aquatic habitat in each of these areas. Town Lake has its own unique fishery, aquatic habitat, and management concerns. Barton Springs provides important habitat for an endangered salamander. Vegetation in the Colorado River downstream of Austin provides a base for the aquatic ecosystem as well as seasonal waterfowl habitat. If the Guadalupe River experience holds true, the fish will eventually move, meaning that they could affect these non-target areas, species, and stands of vegetation. According to Prentice et al (1998), writing about grass carp stocked in the Guadalupe River:

> "Grass carp emigration from home reservoirs occurred throughout the study. Emigration was always observed in a downstream direction. Grass carp emigrated from these reservoirs at a rate of approximately 3.5% each 6 months during the first 18 months of study, which had low-river-flow conditions. During high river-flow conditions, grass carp emigrated from these reservoirs at a rate of approximately 59% in 6 months. Seventy grass carp moved past 1-10 dams, emigrating a maximum 1-way distance of 325 km (202 miles). <u>Due to observed grass carp emigration, they are not recommended for vegetation control efforts in similar riverine aquatic systems</u> (emphasis added)."

Concerning the salamander, this proposal contradicts the city's previously issued guidance as well as that issued on introductions of exotic species by the U.S. Fish and Wildlife Service, the Department, and Barton Springs Salamander Recovery Team. The stated biological goal of the final Environmental Assessment/Habitat Conservation Plan for the Barton Springs salamander at Barton Springs Pool and adjacent springs is to improve salamander habitat and increase it's population size. Barton Springs Pool was essentially de-vegetated during the 1960-1970s due to a variety of anthropogenic disturbances. The disappearance of vegetation from the pool has been, in part, linked to the rapid decline of the salamander in recent years. Subsequently, serious efforts have been mounted by the City of Austin to restore aquatic vegetation to the pool. However, the recently approved Barton Springs Habitat Conservation Plan attributed the low success rate of the initial re-vegetation effort to the presence of a single grass carp that inhabited the pool at that time.

Accidental introduction of multiple grass carp into the Barton Springs ecosystem following their proposed stocking in Lake Austin could have immediate negative impacts on the establishment of transplanted aquatic vegetation in the pool. Ultimately, these impacts would alter the ecology of that system and the habitat of the salamander. In addition, the Barton Springs HCP clearly states that "no animals (other than humans) nor any plant, fungus or other organism may be purposely introduced into Barton Springs Pool without the approval of City and Service biological staff." The HCP specifically tasks the City of Austin to not allow the introduction of exotic plants or animals in any springs in Zilker Park. The preferred alternative identified in the HCP includes "efforts to increase aquatic vegetation in Barton Springs, Eliza Spring and Old Mill Springs (Sunken Garden)." This vegetation is considered critical to the Barton Springs system because it stabilizes the silt and sediment in the deep end of the pool, provides nutrient uptake from the water column, and offers suitable habitat for many species of fish, turtles, invertebrates and salamanders. The draft Barton Springs Salamander Recovery plan likewise indicates that a sound community of aquatic vegetation, and, to the extent possible, the removal of all exotic species from the Barton Springs system is essential for the recovery of the salamander. Introduction of grass carp to the same drainage as the Barton Springs salamander runs counter to these goals because these fish potentially could destabilize the Barton Springs Pool ecosystem through voracious feeding on aquatic vegetation. The accidental introduction of grass carp to Barton Springs via the Colorado River potentially could result in harassment and take of the Barton Springs salamander, and ultimately prolong or preclude the recovery of this endangered species. There simply are no means to ensure the exclusion of grass carp from Barton Springs following their introduction into Lake Austin.

Aquatic vegetation fulfills many of the functions listed for Barton Springs in the river downstream of Austin. Specifically, vegetation allows for increased substrate stability, provides nutrient uptake, and importantly, provides substantial habitat for the diverse aquatic community. Tilton (1961) reported 73 different species of fish from the river and its tributaries, including marine or estuarine forms. A 1980 Department survey from Webberville to Smithville netted 43 species from the main river. Included in the fishes downstream is the blue sucker, a state threatened species. Many of the prevalent fish species relate to macrophytes. There is also a substantial sportfishery in the Colorado downstream of Austin. Though the river is periodically scoured by flood flows and vegetation stands are reduced, the combination of scour and grass carp herbivory may negatively impact macrophyte stands downstream.

One could argue that the numbers of grass carp proposed for stocking are small. However, there is no guarantee additional requests will not be forthcoming, particularly if there is little effect observed in Lake Austin. The proposed action could also set the stage for requests for stocking in reservoirs on other river systems. Vegetation in Lake Austin is an issue of many years duration and will not be easily solved. However, it is presently a local issue affecting a relatively limited number of boat and home owners. If grass carp are stocked, it may not remain a local issue and could have unplanned effects reaching beyond Lake Austin.

If you have any questions, please do not hesitate to call.