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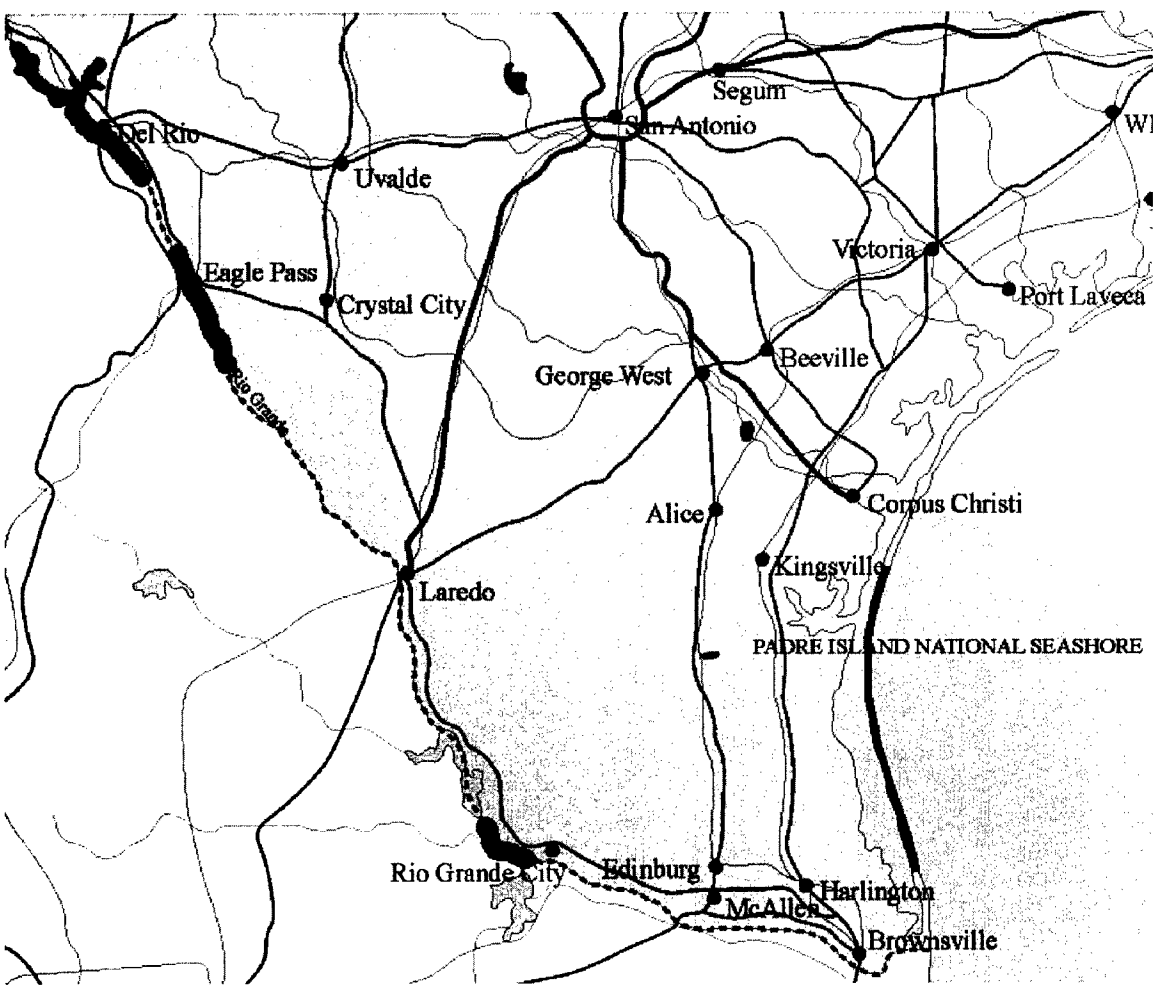
A Survey of the Invasive Aquatic and Riparian Plants of the Lower Rio Grande

Chetta S. Owens, Michael J. Grodowitz, and Fred Nibling

April 2005



Aquatic Plant Control Research Program

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A Survey of the Invasive Aquatic and Riparian Plants of the Lower Rio Grande

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Final report

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ABSTRACT: Hydrilla (*Hydrilla verticillata*) has exhibited extensive range expansion along the Rio Grande since its first discovery in early 1990 and is now found in areas far removed from the original infestation (Brownsville, TX). Hydrilla, a nonindigenous aquatic plant species, has been implicated in restricted water delivery, inaccurate water accounting, and an overall breakdown of system maintenance. In addition, the presence of hydrilla has had a decided impact on native flora by the formation of extensive monocultures in many areas. In 2001 and 2003, surveys were conducted starting below Amistad Reservoir to immediately below Falcon Reservoir to assess the distribution and expansion of the hydrilla infestations and document the presence of other invasive aquatic and riparian plant species. Several small infestations of hydrilla, as well as several other invasive aquatic and riparian plant species, were observed during the 2003 survey. Small sections of the river were surveyed. A total of six introduced plant species were observed, including hydrilla, Eurasian watermilfoil, parrotfeather, elephant-ear, giant cane, and salt cedar.

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Preface

The work reported herein was conducted as part of the Aquatic Plant Control Research Program (APCRP), Work Unit 33084. The APCRP is sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE), and is assigned to the U.S. Army Engineer Research and Development Center (ERDC) under the purview of the Environmental Laboratory (EL). Funding was provided under Department of the Army Appropriation Number 96X3122, Construction General. Mr. Robert C. Gunkel, Jr., EL, was Program Manager, APCRP. Program Monitor during this investigation was Mr. Timothy R. Toplisek, HQUSACE.

Principal Investigator for this study was Dr. Michael J. Grodowitz, Aquatic Ecology and Invasive Species Branch, Ecosystem Evaluation and Engineering Division (EEED), EL. The report was prepared by Chetta S. Owens, Analytical Services, Inc., Lewisville Aquatic Ecosystem Research Facility (ASI-LAERF), Dr. Grodowitz, and Dr. Fred Nibling, Bureau of Reclamation. The report was reviewed by Dr. Judy Shearer, EEED, and Mr. Joe Snow, LAERF. The Texas Commission on Environmental Quality, the Texas Parks and Wildlife Department, and the U.S. Border Patrol provided invaluable assistance in this survey.

This investigation was performed under the general supervision of Dr. Elizabeth Fleming, Acting Director, EL; Dr. Dave Tazik, Chief, EEED; and Dr. Al Cofrancesco, Chief, Aquatic Ecology and Invasive Species Branch, EL.

COL James R. Rowan, EN, was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

The Rio Grande is the nation's second longest river, of which almost 2,000 miles forms an international boundary between the United States and Mexico. Since much of the Rio Grande flows through arid land, several reservoirs have been impounded on the river to increase water availability for Texas and Mexico.

Hydrilla (*Hydrilla verticillata* (L.f.) Royle), a nonindigenous species whose center of origin lies in Southeast Asia, was first observed on sections of the lower Rio Grande in the late 1990s. Hydrilla exhibits aggressive growth strategies, rapidly expanding to the surface and forming a dense canopy, thereby restricting water delivery, allowing for inaccurate water accounting, and contributing to an overall breakdown of system maintenance (Chilton 2002, Grodowitz et al. 2000, Nibling and Grodowitz 2001). Once hydrilla invades an aquatic ecosystem, several factors contribute to its spread, including localized spread through development of stolons and subterranean tubers and dispersal via axillary turion releases and fragmentation (Madsen and Smith 1999, Madsen and Owens 1998). Hydrilla has exhibited extensive range expansions along the Rio Grande and is now found in areas far removed from the original infestations. Since hydrilla has several highly efficient mechanisms for dispersal, it is important to document its presence along the Rio Grande and develop more efficient management programs to inhibit further new infestations locally and downstream.

In 2001, 20 sites on the Rio Grande River were surveyed from Amistad Reservoir to Anzulduas Dam for the presence of hydrilla and other invasive aquatic weed species (Grodowitz et al. 2000, Nibling and Grodowitz 2001). Although this survey encompassed over 300 river miles, only a small section of the river was actually examined due to difficulties in accessing the river. During the 2001 survey, hydrilla was found in Amistad Reservoir and below Falcon Reservoir. In August 2002, hydrilla fragments were observed in plant material collected from the trash racks of the Maverick Irrigation District. Because of this discovery at the Maverick trash racks, better access to the river became a priority for the survey planned for 2003. Unfortunately, this section of the river has limited road access, and much of the terrain is inhospitable and rural. Local Texas Parks and Wildlife and U.S. Border Patrol personnel were contacted to determine better access and knowledge of the conditions of the Rio Grande.

2 Objectives and Methods

Objectives

The primary objectives of this study were to:

a. Locate hydrilla infestations, especially those that may serve as potential sources of re-infestations downstream, and determine the extent of the infestations qualitatively (observational).

b. Evaluate introduced leaf-mining fly (*Hydrellia* spp.) population numbers and leaf damage and identify possible release areas for the introduced leaf-mining flies *H. pakistanae* and *H. balciunasi*.

c. Determine the presence or absence of other invasive weed species threatening the Rio Grande.

d. Locate and identify native aquatic, wetland, and riparian plant species.

Methods

Between 18 August 2003 and 22 August 2003, 11 sites on the Rio Grande River were surveyed via boat from below Amistad Reservoir to immediately below Falcon Dam. This 2003 survey was conducted to determine the presence of hydrilla and other invasive aquatic and riparian plant species in the river. Additionally, native aquatic and riparian plant species were noted in an effort to develop a native plant species list for this region of the Rio Grande.

3 Results and Discussion

Results

In all, 22 species of aquatic, wetland, and riparian plants were observed at least once during the 2003 survey (Tables 1 and 2). Of these 22 species, 6 were exotic. It has yet to be determined if the common reed (*Phragmites australis*) on the Rio Grande is a native species or an introduced genotype, although it has been identified as a Haplotype I, the Gulf Coast Genotype.[1] Of the remaining 15 native plant species, 6 were submersed and 9 were emergent. Two algal species were recorded, including muskgrass (*Chara* spp.), a macroalgae, and black moss (*Lyngbya wollei*), a potentially problematic blue-green algae that has been found increasingly in nutrient-rich aquatic systems in Texas and other parts of the United States.

Discussion

Hydrilla and other introduced weedy species

While no hydrilla was found during the 2001 survey below Amistad or above Falcon Reservoirs, extensive infestations of hydrilla were found in Amistad Reservoir (Nibling and Grodowitz 2001). These infestations could provide the opportunity for fragment dispersal into the river (Owens et al. 2001). During the 2003 survey, hydrilla was located in several "topped out" mats throughout the upper reaches of the river around Del Rio, Indio, and the Lonesome Dove sites (Table 2, Figures 1 and 2). Most of the mats of hydrilla were along the edges of the river or in coves where hydrilla fragments apparently had settled, rooted, and established. Fragments of hydrilla were found in the Maverick Irrigation District's trash racks during the 2003 survey.

Because "topped out" hydrilla infestations were observed below Falcon Reservoir in the 2001 survey, this river reach was targeted in 2003 for a large-scale release with subsequent long-term monitoring of the hydrilla biocontrol agents, *Hydrellia pakistanae* (Figure 3) and *H. balciunasi* to determine establishment and impacts on the hydrilla. The release site identified as TCEQ T5 (Table 2) was located near Roma, TX. The site contained large, contiguous mats

[1] Bernd Blossey, Ecology and Management of Invasive Plants Program, Department of Natural Resources, 122E Fernow Hall, Cornell University, Ithaca, NY, 14853.

of "topped out" hydrilla intermixed with water stargrass (Figure 4). During the week of September 8, 2003 approximately one million insects of both *Hydrellia* species were released into this area. Additionally, approximately 500,000 leaf-mining flies were released at the Lonesome Dove site and immediately below Eagle Pass during the first week of October 2003.

Table 1
Species List from the 2003 Rio Grande Survey Including Scientific Name, Common Name, Native/Exotic Status, and Growth Form

Scientific Name	Common Name	Native (N) or Exotic (E)	Growth Form
Arundo donax L.	giant cane	E	Emergent
Ceratophyllum demersum L.	coontail	N	Submersed
Chara spp.	muskgrass	N	Submersed
Colocasia esculenta (L.) Schott	elephant-ear	E	Emergent
Echinochloa walteri (Pursh) Heller	coast cockspur grass	N	Emergent
Eleocharis spp.	common spikerush	N	Emergent
Eleocharis quadrangulata (Michx)	square-stem spikerush	N	Emergent
Heteranthera dubia (Jacq.) Small	water stargrass	N	Submersed
Hydrilla verticillata (L.f.) Royle	hydrilla	E	Submersed
Hydrocotyle spp.	pennywort	N	Emergent
Ludwigia spp.	water primrose	N	Emergent
Lyngbya wollei	Snotweed black moss	?	Submersed
Myriophyllum aquaticum (Vell.) Verd	parrotfeather	E	Submersed/ Emergent
M. heterophyllum Michx	various-leaved watermilfoil	N	Submersed
M. spicatum L.	Eurasian watermilfoil	E	Submersed
Phragmites australis (Cav.) Trin.ex Steud	common reed	?	Emergent
Polygonum spp.	smartweed	N	Emergent
Pontederia cordata L.	pickerelweed	N	Emergent
Potamogeton illinoensis Morong.	Illinois pondweed	N	Submersed
P. pectinatus L.	sago pondweed	N	Submersed
P. vaginatus Turcz.	sheathed pondweed	N	Submersed
Sagittaria spp.	arrowhead	N	Emergent
Scirpus spp.	bulrush	N	Emergent
Tamarisk spp.	salt cedar	E	Emergent

Table 2
Sites on the Rio Grande Surveyed for Hydrilla and Other Plant Species (GPS Coordinates (UTM 14) and Observed Plants are Included)

Site	Date	Xcoord	Ycoord	Native	Exotic
Above Del Rio	8/18/03	307098 303934	3249452 3252972	*Chara* spp. *Eleocharis* spp. H. dubia *Hydrocotyle* spp. *Ludwigia* spp. *M. heterophyllum* *P. illinoensis* *P. pectinatus* *P. vaginatus*	*A. donax* *H. verticillata* *M. aquaticum* *M. spicatum*
Below Del Rio	8/18/03	313582 323531	3245477 3238196	*C. demersum* *H. dubia* *Hydrocotyle* spp. *Ludwigia* spp. P. cordata *Polygonum* spp. *P. illinoensis* *Scirpus* spp.	*A. donax* *C. esculenta* *H. verticillata* *M. spicatum* *Tamarisk* spp.
Above Eagle Pass, boat launch	8/19/03	347868 346333	3189867 3189991	*H. dubia*	*A. donax*
Above Eagle Pass, south of boat launch	8/19/03	350398 352499	3176435 3185437	*H. dubia* *Polygonum* spp.	*A. donax* *C. esculenta*
Maverick-Diversion Dam	8/19/03	327580	3228239		*A. donax* *M. spicatum*
Lonesome Dove	8/19/03	326528 326469	3234396 3234395	*C. demersum* *E. quadrangulata* *H. dubia* *Ludwigia* spp.	*A. donax* *H. verticillata* *M. aquaticum* *M. spicatum*
Indio-Below Eagle Pass, Predon Ranch	8/20/03	368428 369217	3140826 3145596	*Polygonum* spp. P. vaginatus	*A. donax* *C. esculenta* *H. verticillata* *Tamarisk* spp.
Indio-South of boat launch	8/20/03	368532 371166	3140573 3136846	*C. demersum* *H. dubia* *Polygonum* spp.	*A. donax* *C. esculenta* *H. verticillata* *Tamarisk* spp
Above Roma, below Falcon	8/21/03	488433 490331	2932460 2929282	*E. walteri* *H. dubia* *P. australis*	*H. verticillata* *L. wollei* *P. australis*
Below Roma, TCEQ T5	8/21/03	500410 498737	2919021 2919078	*H. dubia* *P. australis* *P. vaginatus*	*H. verticillata* *L. wollei* *P. australis*
Above TCEQ T5	8/21/03	500608 499854	2918906 2919125	*H. dubia* *P. australis* *P. pectinatus* *P. vaginatus*	*H. verticillata* *L. wollei* *P. australis*

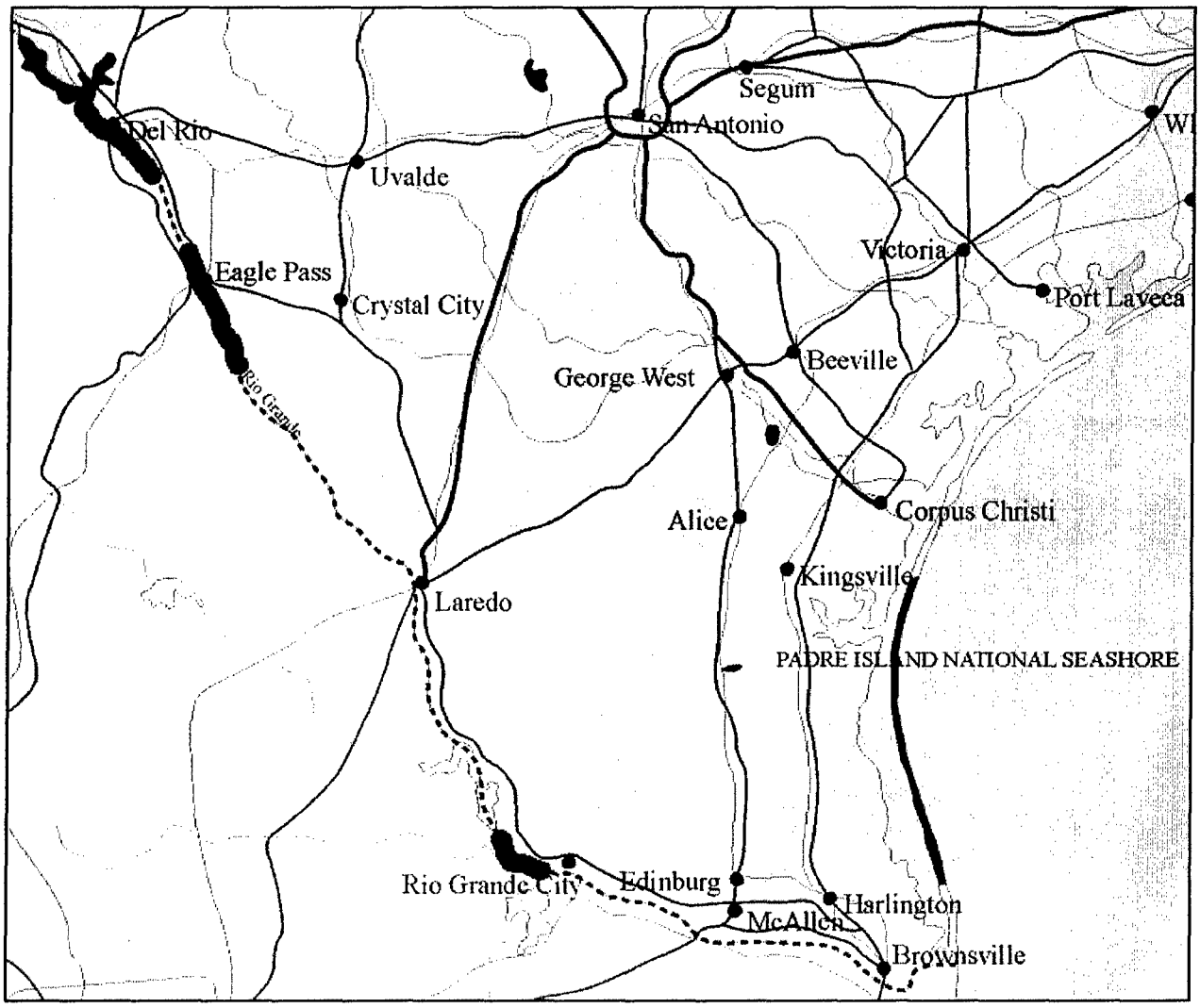

Figure 1. Map showing all the areas surveyed on the Rio Grande by boat

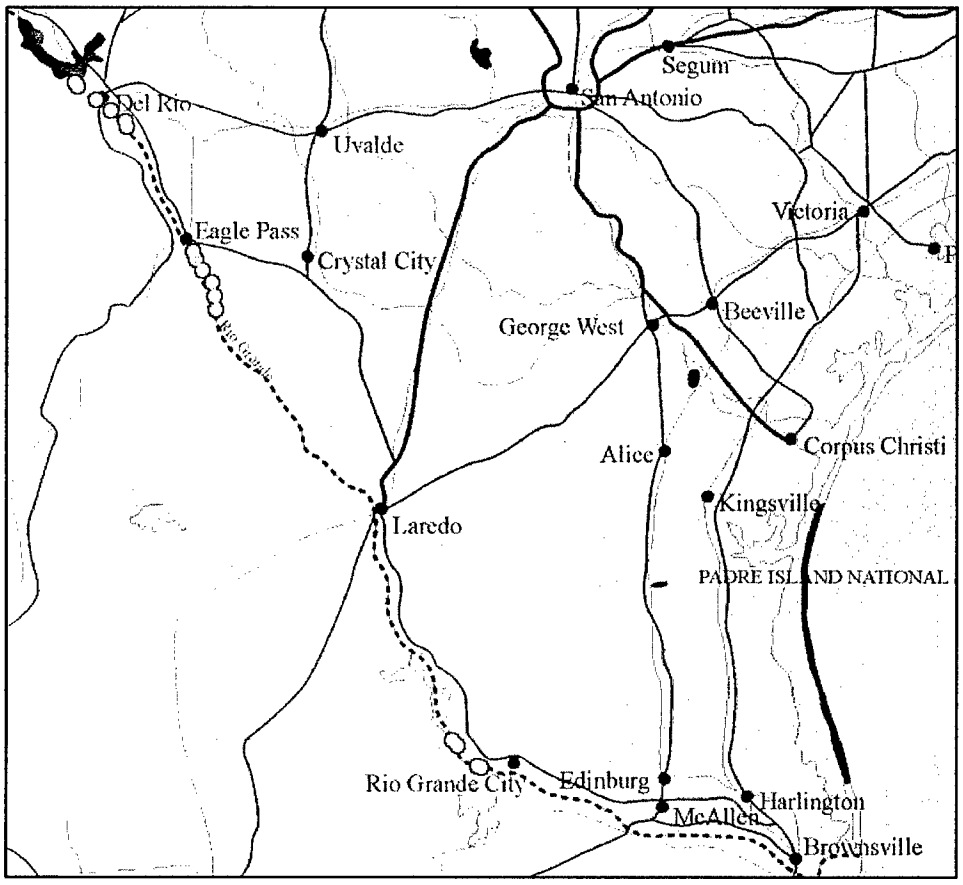

Figure 2. Map showing areas of the Rio Grande surveyed where hydrilla was observed

Figure 3. *Hydrellia pakistanae* female with eggs on leaf of hydrilla

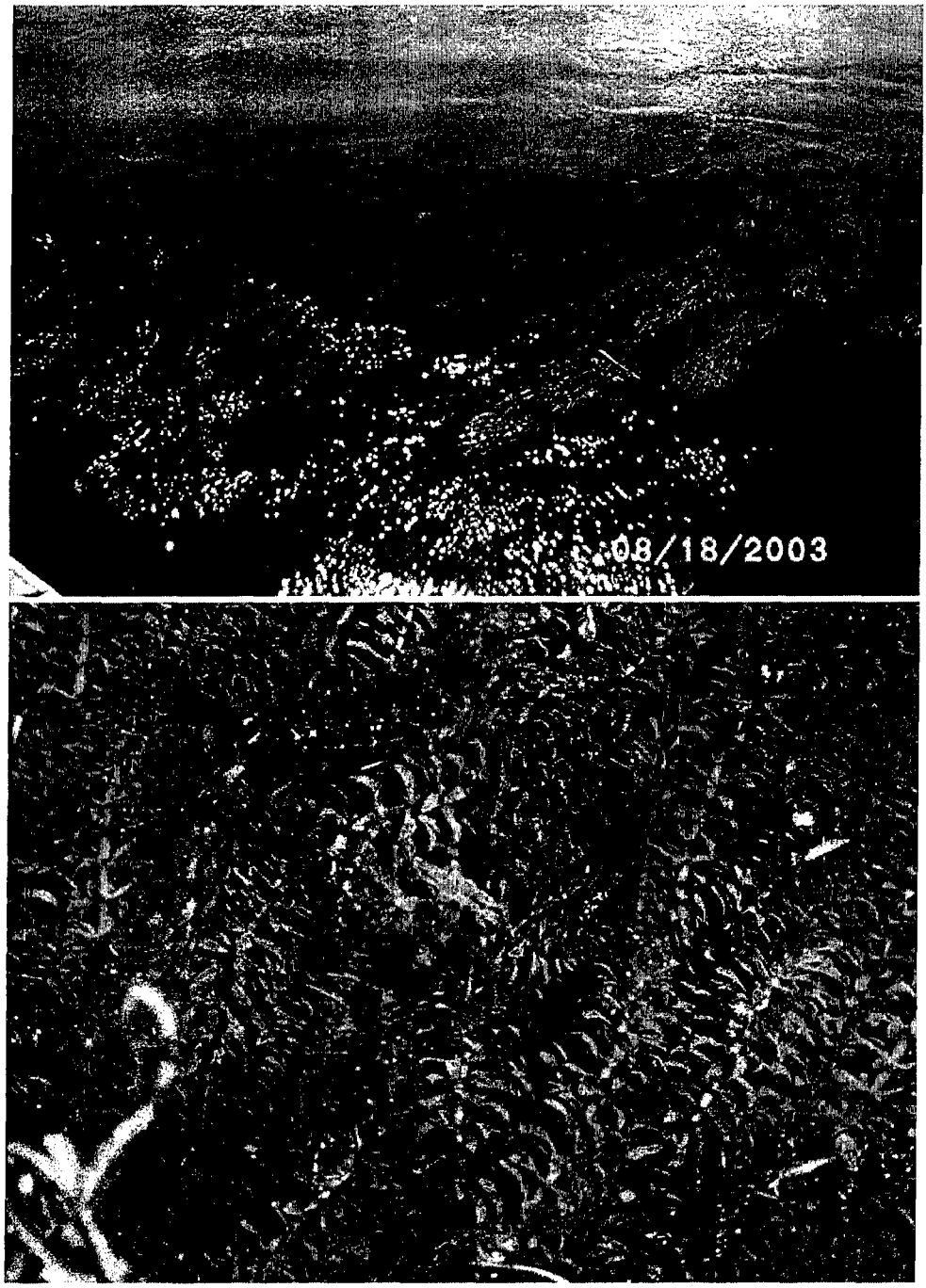

Figure 4. Hydrilla intermixed with water stargrass (top) and close-up of hydrilla on Rio Grande

While one of the main objectives of the 2003 survey was to locate hydrilla infestations, several additional introduced and potentially damaging plant species were observed. These included giant cane (*Arundo donax*) (Figure 5), elephant-ear (*Colocasia esculenta*) (Figure 6), Eurasian watermilfoil (*Myriophyllum spicatum*) (Figures 7 and 8), parrotfeather (*M. aquaticum*), and salt cedar (*Tamarisk* spp.) (Figure 9). According to data collected during the 2001 (Nibling and Grodowitz 2001) and 2003 surveys, extensive stands of giant cane are now

found from Del Rio to Zapata, TX. Giant cane displaces native riparian and wetland vegetation and increases the risk of wildfires and some studies suggest that it causes increased water loss because of increased evapotranspiration. This is based on the fact that giant cane has more leaf surface area than many of the native plant species, thereby allowing for increased transpiration (DiTomaso and Healy 2003). Of interest is the fact that the United States shoreline has more giant reed than is found in Mexico. A possible explanation may be that tick fences keep U.S. cattle from the riverbanks, whereas, in Mexico, cattle have complete access to the river where they possibly graze on the young stalks of giant reed. It was further noted that, while Mexico has less giant reed than the United States, more elephant-ear was observed. Cattle do not appear to forage on elephant-ear; therefore, more open area is available for colonization (Personal communication, 2003, Fred Nibling, Research Botanist, Bureau of Reclamation, U.S. Department of Interior, Denver, CO).

Although one small area of Eurasian watermilfoil was found near Del Rio, TX, during the 2001 survey, in 2003, large mats of Eurasian watermilfoil were located from Del Rio to the Lonesome Dove site, and fragments of Eurasian watermilfoil were located in the Maverick Irrigation District's trash racks (Figure 10). It was suggested in the 2001 report that Eurasian watermilfoil could pose a serious threat to the river if conditions allowed the plant population to increase and disperse. These new findings suggest that the small infestation of Eurasian watermilfoil present near Del Rio in 2001 is rapidly expanding throughout this area of the river.

The parrotfeather and elephant-ear infestations appear to be recent and are currently at minimal levels. However, it should be noted that both of these nonindigenous species have severely impacted other river systems in the southwest such as the Colorado River, AZ, (Personal communication, 2003, Fred Nibling, Research Botanist, Bureau of Reclamation, U.S. Department of Interior, Denver, CO) and the San Marcos River, TX, (Owens et. al 2001). Salt cedar was also observed in this section of the Rio Grande, and it should be noted that salt cedar creates serious impacts farther upriver (Personal communication, 2003, Fred Nibling, Research Botanist, Bureau of Reclamation, U.S. Department of Interior, Denver, CO). It is therefore recommended that management options be undertaken as soon as possible before infestations of these invasive plants become larger and more difficult to control.

Native plant species on the Rio Grande River

Several native submersed and wetland plants were observed on the Rio Grande. The greatest diversity and frequency were found at the Del Rio site with six submersed and six emergent plant species and the macroalgae muskgrass (Tables 1 and 2). Species richness and frequency decreased downstream from Del Rio until only three submersed native aquatic plants were found at the Roma site. Whether this decrease in diversity and frequency is related to habitat, water chemistry, competition from introduced species, or a combination of factors is unclear. Further research is warranted including implementing more quantitative surveys to determine frequency of the aquatic and wetland plant species that are native to these areas.

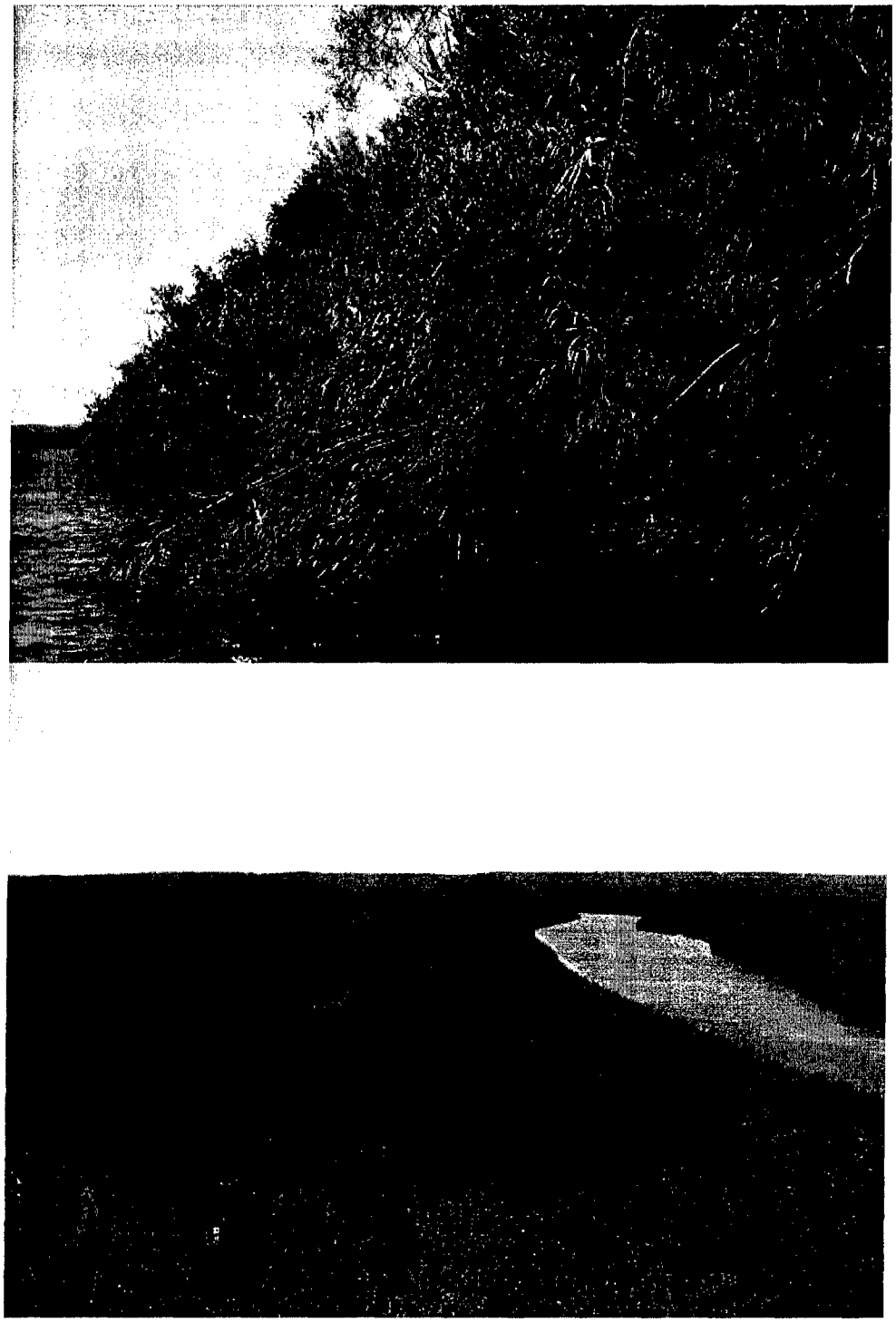

Figure 5. Photographs showing extensive infestations of giant cane along the Rio Grande (upper photograph is located near Del Rio, TX; lower photograph is located near the Maverick Irrigation District)

Figure 6. Elephant-ear was found commonly along many stretches of the river from Eagle Pass to Del Rio

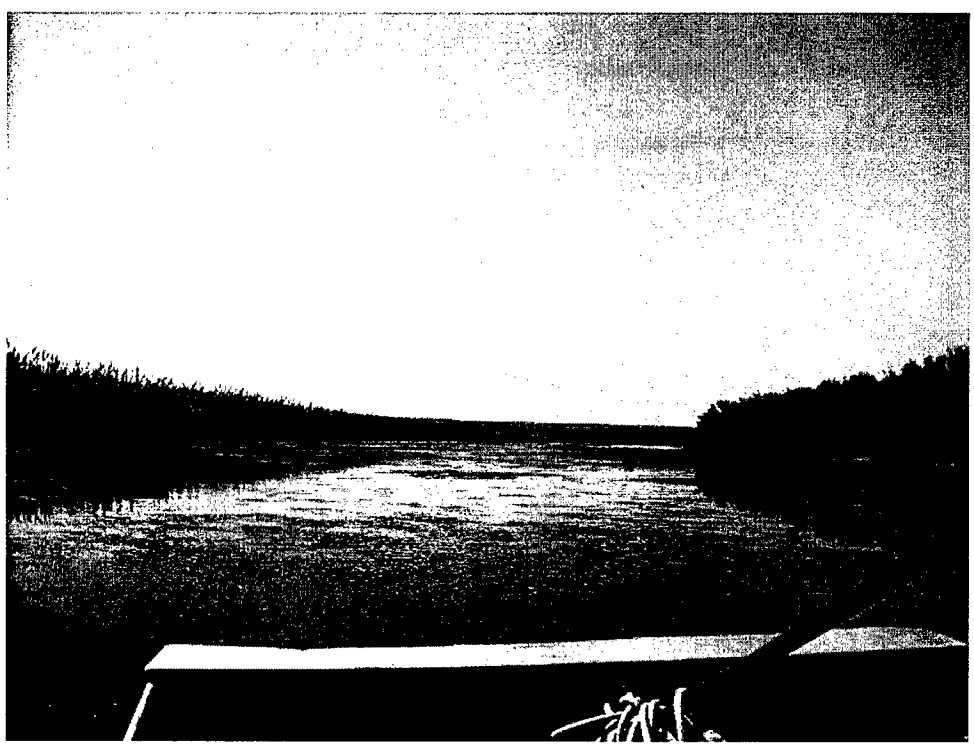

Figure 7. Eurasian watermilfoil mat covering the entire river from shore to shore above the Maverick Irrigation District dam

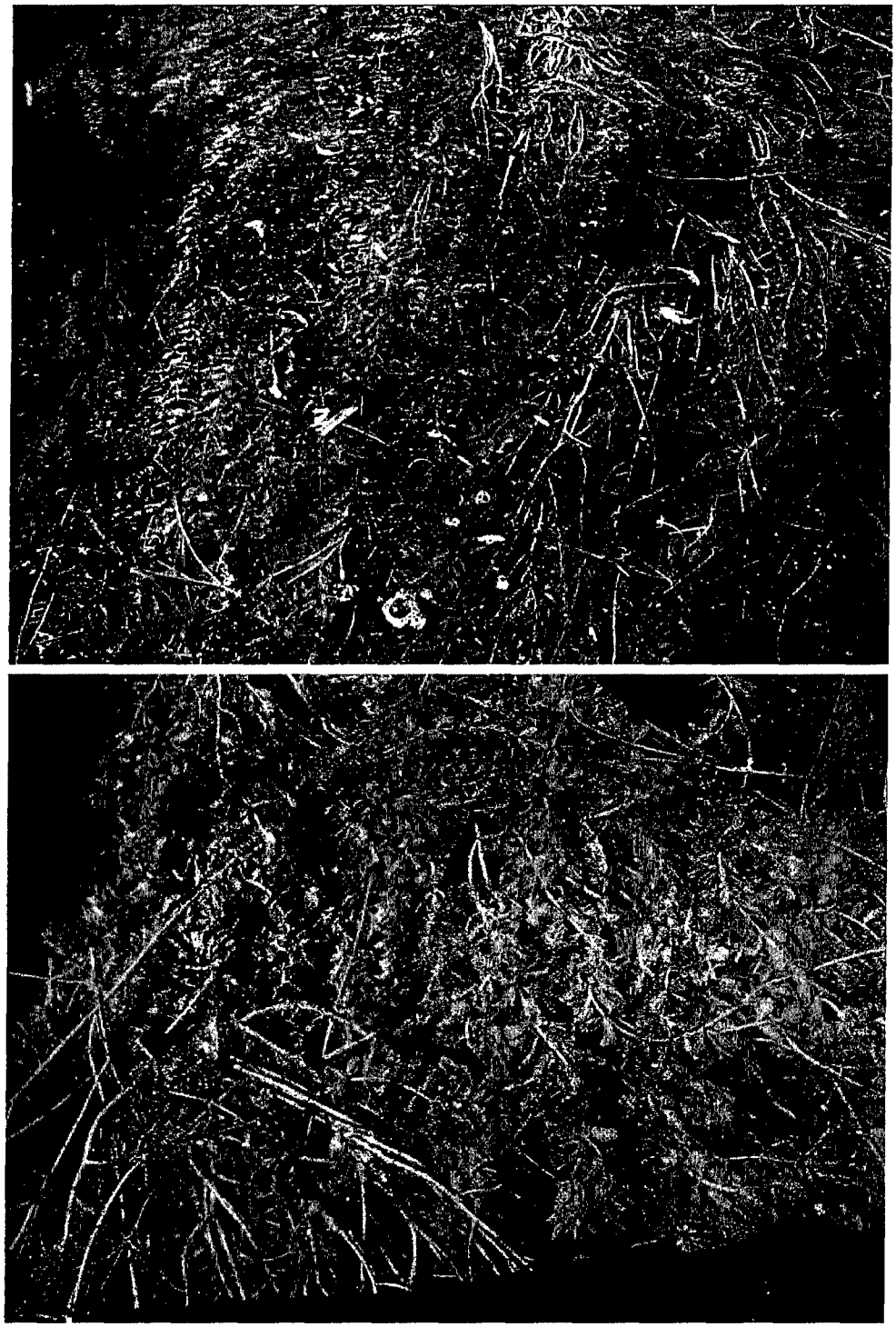

Figure 8. Close-ups of Eurasian watermilfoil from the Rio Grande

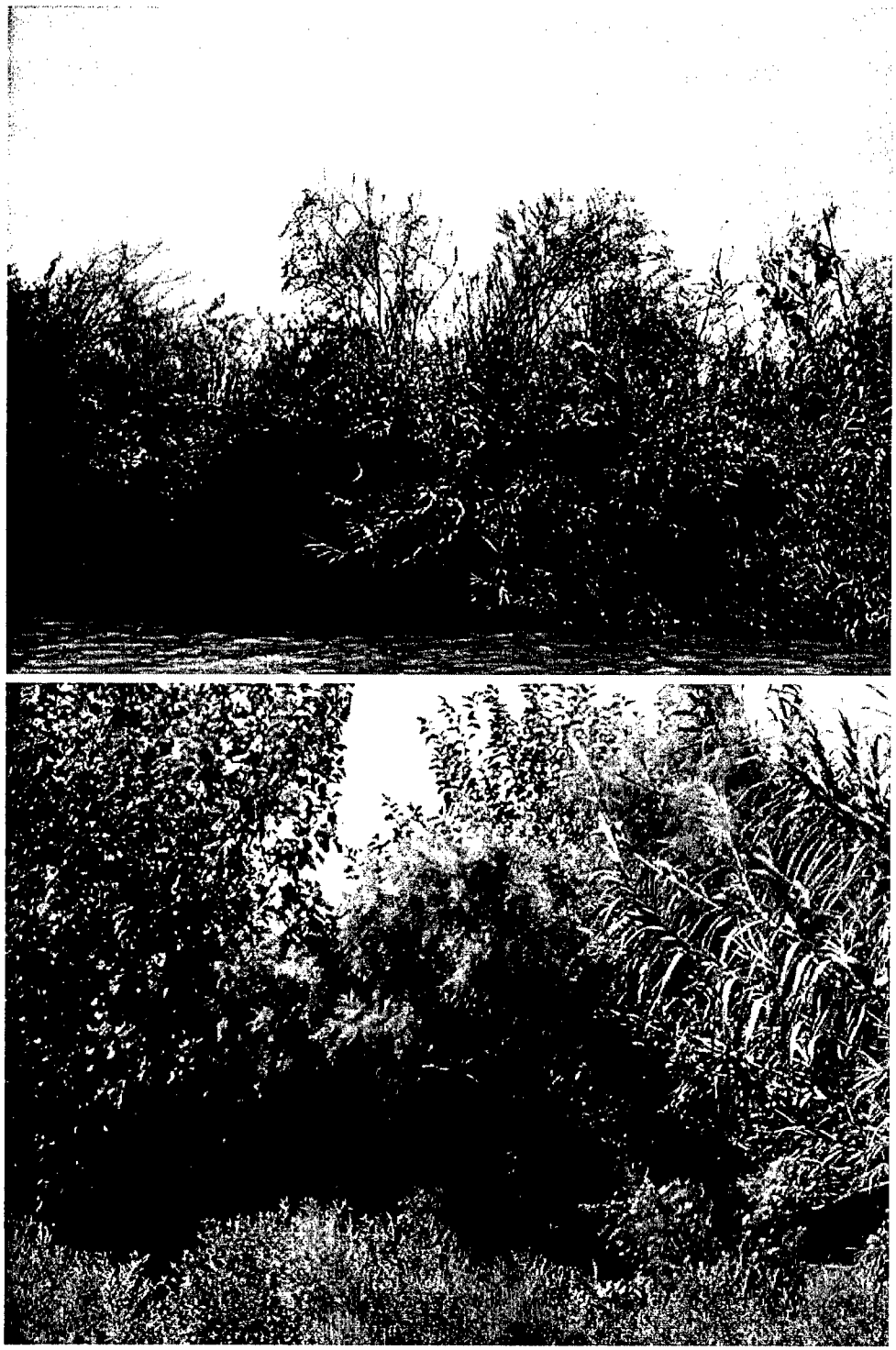

Figure 9. *Tamarisk* spp. located along the banks of the Rio Grande

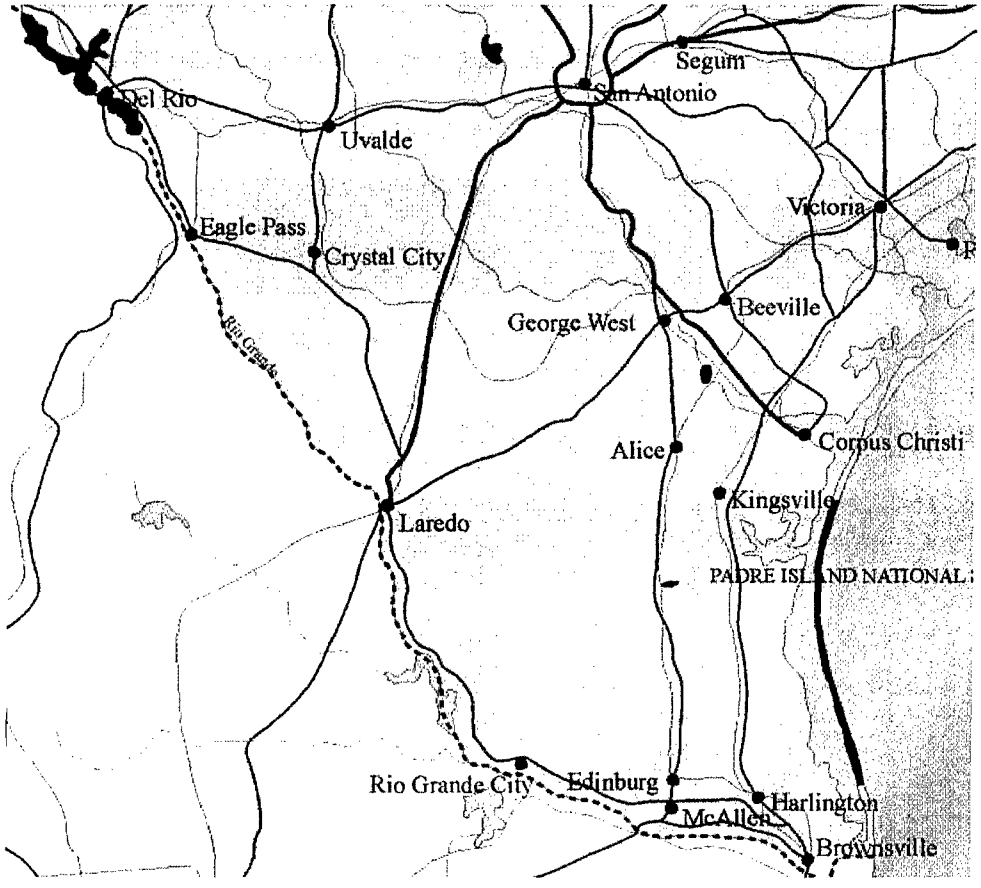

Figure 10. Map showing locations along the Rio Grande where Eurasian watermilfoil was located

It is not known if black moss is native or introduced. However, this blue-green algae has proven to be problematic in many water bodies throughout the United States. It forms dense, aromatic mats of floating algae that can negatively impact native vegetation, water quality, and aesthetics (Figure 11). Such dense mats were commonly found at sites below Roma, TX. It is typically associated with high-nutrient systems (Speziale et al. 1988, Cowell and Botts 1994). Water chemistry obtained from the Texas Clean Rivers Program (2003) indicated that sampling sites below Falcon Dam in the same area as the Roma site had high levels of total phosphate (mg/L) and ammonia (mg/L). These parameters were listed as areas of concern in the report.

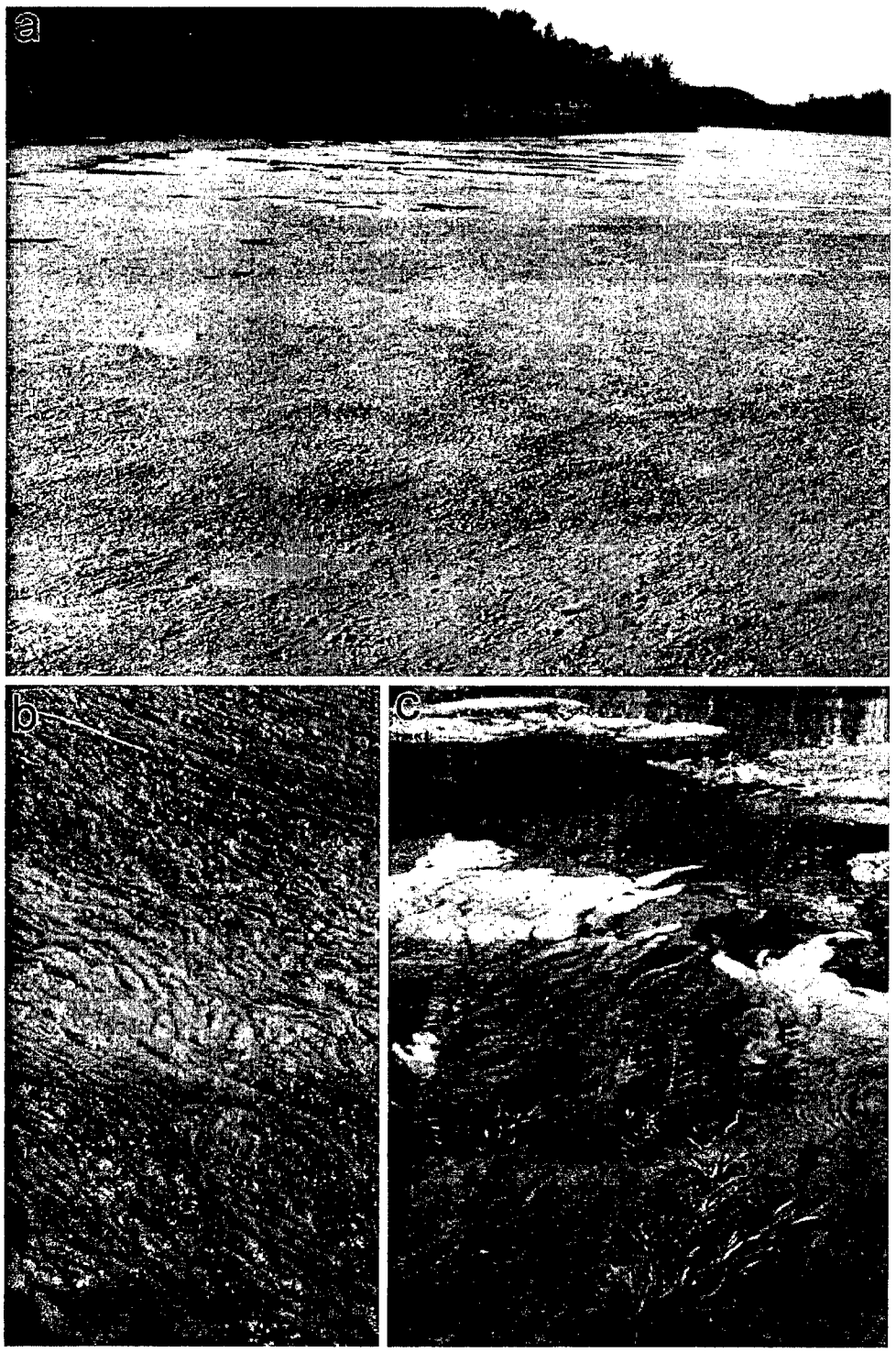

Figure 11. Black moss infestation along the lower Rio Grande below Roma, TX (a. Large population view showing infestation crossing entire river, b. Close-up of infestation, c. Black moss covering and impacting submersed aquatic plants)

4 Recommendations

In agreement with the recommendations made in the 2001 report, it is important to monitor the river on an annual basis to obtain more accurate and detailed information on the invasive plant problems on the Rio Grande. While boating access is limited, it is available; therefore, greater sections of the river should be covered.

The qualitative surveying methods used during the 2003 survey provided useful information on species presence; however, a more detailed, quantitative survey should be considered for future monitoring efforts. It would provide a more complete species list as well as statistical information on frequency of occurrence of individual species and of plant groups. In addition, Eurasian watermilfoil samples should be collected to check for native insect herbivores and fungal pathogens. Biocontrol agents for giant cane and parrotfeather are currently being identified for future releases, but such technology is years away from operational use. Further information also needs to be collected on black moss populations and future spread. It is also imperative that water chemistry data be accessed or collected to determine nutrient inputs into the Rio Grande in relation to invasive plant species presence. Management of many of these species may be accomplished to some extent by reducing nutrient inputs.

Local water operators have been trained in plant identification, especially hydrilla; however, additional training is needed for newly introduced plant species such as Eurasian watermilfoil. While intake structures are being examined for hydrilla, local operators could also note other potentially problematic plant species. Given the problems of access on many parts of the river, this would provide a mechanism to monitor the river for the appearance of other invasive plants. It is recommended that a short course on aquatic and wetland plants be developed and presented to key operational personnel at local irrigation districts.

Restoration and re-vegetation efforts on the Rio Grande are also recommended. Utilization of basal stembase aquatic plants, such as *Vallisneria americana* Michx and *Sagittaria graminea* Michx, can provide habitat and sediment stabilization, and improve water quality and fill the niche to slow progression of invasive plant species. Furthermore, due to their basal growth form, fragmentation is minimal and thus should not impact water utilization on the Rio Grande.

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14. ABSTRACT

Hydrilla (*Hydrilla verticillata*) has exhibited extensive range expansion along the Rio Grande since its first discovery in early 1990 and is now found in areas far removed from the original infestation (Brownsville, TX). Hydrilla, a nonindigenous aquatic plant species, has been implicated in restricted water delivery, inaccurate water accounting, and an overall breakdown of system maintenance. In addition, the presence of hydrilla has had a decided impact on native flora by the formation of extensive monocultures in many areas. In 2001 and 2003, surveys were conducted starting below Amistad Reservoir to immediately below Falcon Reservoir to assess the distribution and expansion of the hydrilla infestations and document the presence of other invasive aquatic and riparian plant species. Several small infestations of hydrilla, as well as several other invasive aquatic and riparian plant species, were observed during the 2003 survey. Small sections of the river were surveyed. A total of six introduced plant species were observed, including hydrilla, Eurasian watermilfoil, parrotfeather, elephant-ear, giant cane, and salt cedar.

15. SUBJECT TERMS

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Riparian plant species

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