HABITAT USE AND FOOD HABITS OF NUTRIA (*MYOCASTOR COYPUS*) IN THE RIO GRANDE VILLAGE AREA OF BIG BEND NATIONAL PARK

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

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Nutria are large, semi-aquatic rodents introduced into the United States from South America as a fur resource during the early 1900s. The feeding activities of this invasive exotic species is destructive to wetland habitats and competitive with native species. Nutria first were reported at Rio Grande Village, Big Bend National Park, in 1993. They inhabit the Rio Grande River and adjacent wetlands including the Rio Grande Village (RGV) Beaver Pond, which sustains a population of the endangered Big Bend gambusia (*Gambusia gaigei*) and the endangered Mexican beaver (*Castor canadensis mexicanus*). The National Park Service is concerned that nutria and their associated activities may negatively impact these wetland habitats and

endangered species. I surveyed the Rio Grande River from Gravel Pit, near Hot Springs, to the mouth of the Boquilla Canyon, including the Beaver Pond and Daniel's Ranch within RGV for nutria activity sites and possible food sources. I documented and recorded approximately 30 locations of nutria activity along the Rio Grande. I captured, marked, and released 24 nutria. Using the Schnabel and Chapman methods, I estimated that 38-74 nutria inhabit the RGV area. I collected stomach contents from 14 nutria for food habit analysis. To identify and quantify the plant species in the stomach contents, I made reference slides of 19 resident plant taxa for microhistological comparison of plant epidermal tissue and stomach contents. Stomach contents contained common cane (*Phragmites australis*) (59.86%), water pennywort (*Hydroctyle umbellata*) (12.71%), giant reed (*Arundo donax*) (6.3%), spikerush (*Eleocharis caribaea*) (6.14%), bermudagrass (*Cynodon dactylon*) (4.79%), water hyssop (*Bacopa monnieri*) (2.0%), foxtail (*Alopecurus sp.*) (0.93%), and flatsedge (*Cyperus sp.*) (0.71%). Line-intercept techniques were used to quantify vegetation surveys along the Rio Grande River and at the Beaver Pond. Bermudagrass, salt cedar (*Tamarix sp.*), baccharis (*Baccharis sp.*), and *Arundo* composed the majority of the riparian vegetation. Beaver Pond vegetation was composed primarily of *Arundo* and *Phragmites.*

INTRODUCTION

Nutria (*Myocastor coypus* Molina 1782) are large hystricomorph rodents adapted to aquatic environments (Gosling 1981). This monotypic species is native to Brazil, Bolivia, Paraguay, Uruguay, Argentina, and Chile (Carter and Leonard 2002) where it occupies wetland habitats such as ponds, streams, rivers, and marshes. Nutria occupy similar habitats throughout its range in North America, including marshes and swamps in both freshwater and brackish water communities (Borgnia et al. 2000).

In the early 1800s, nutria were recognized as a potentially valuable fur resource from South America. The desire to capitalize on this fur resource led to increased importation of nutria to North America and several countries in Europe, East and Central Asia, and Africa (Carter and Leonard 2002). The first nutria in North America were imported to California in 1899 (Ashbrook 1957).

Raising nutria in captivity later became widespread in the United States during the 1920s and 1930s. However, during the second World War, nutria fur-farming failed as a result of poor pelt prices and poor reproductive success (Marx et al. 2003). Consequently, many nutria ranchers released their stock into the wild (Bounds and Carowan 2000). The Gulf coast population in the United States may have originated from Avery Island, Iberia Parish, Louisiana. In 1938,

E. A. McIlhenney released nutria into a fenced marsh (Swank and Petrides 1954, Kinler et al. 1998). Some nutria escaped in 1939, and in 1940 about 150 more escaped during floods produced by a hurricane. Fur buyers in Dallas, Texas, first reported nutria trapped west of Port Arthur, Texas in 1946 (Simpson 1980).

The spread of nutria inland in Texas was aided by their reputed utility for clearing noxious plants from vegetation-choked lakes and farm ponds (Schmidly 1983). State and federal agencies intentionaly released nutria as "weed cutters" in Alabama, Arkansas, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Oklahoma, and Texas to control aquatic vegetation (Carter and Leonard 2002). Swank and Petrides (1954) reported that by 1950 a Texas landowner, C. N. Campbell, was responsible for releasing nutria into at least 21 counties as a control measure for aquatic vegetation.

Nutria were introduced farther west in New Mexico as early as 1938 (Findley et al. 1975), and now are year round residents along the Pecos and Rio Grande rivers in Texas and New Mexico (Schmidly 2004). Restricted riparian habitat along waterways in arid regions probably limit nutria population size, although colonies of nutria are capable of living in high densities in small areas (Brown 1975).

Once released into suitable habitat, nutria populations rapidly increased and became established as invasive members of the North American fauna. Within a short time, questions arose as to the nutria's impact on native vegetation and wildlife. Damage to marshes by nutria has been widely documented (Swank and Petrides 1954, Glazner 1958, Ehrlich 1962, Ehrlich and Jedynak 1962, Harris and Webert 1962, Evans 1970, Johnson and Foote 1997, Ford and Grace

1998, Carter et al. 1999, Bounds and Carowan 2000). As nutria populations increased, concern was expressed regarding competition with waterfowl or muskrats (*Ondatra zibethicus* Linnaeus 1766) for native plant foods (Davis 1956, Ahsbrook 1957, Hoffmeister 1958, Woods et al. 1992, Bounds 2000, Schmidly 2004). A major food source of nutria includes monocots associated with water (Borgnia et al. 2000). These herbivores consume approximately 25% of their body weight daily, and excavate soil in their burrowing activity and search for food (LeBlanc 1994). Atwood (1950), Swank and Petrides (1954), Milne and Quay (1966), and Simpson (1980) reported that nutria consumed plants which Chamberlain (1959) and Singleton (1965) reported as important food sources for resident and wintering waterfowl in Texas.

The ability of nutria to damage agricultural crops (Kinler et al. 1998, Marx et al. 2003) such as rice and sugarcane has been documented in Louisiana. They also have disrupted natural plant communities and contributed to marsh fragmentation and loss (Marx et al. 2003) by destroying drainage systems and impacting resident flora and fauna (Abbas 1991, Gosling and Baker 1991). Nutria are an increasing concern in areas with limited wetland habitat. The Barataria-Terrebonne National Estuary Program of Louisiana determined that ". . . damage was not limited by marsh type; swamps and bottomland hardwoods, as well as fresh, intermediate and brackish marshes were identified as being damaged by nutria" (Louisiana Department of Wildlife and Fisheries 1998 p.1). They are officially regarded as a noxious exotic animal by the National Park Service (NPS) and suspected to ". . . disrupt complex native ecological communities, jeopardize endangered native plants and animals, and degrade native habitats" (United States Department of the Interior 1997 p.1).

Nutria first were documented in the Trans-Pecos by Hollander et al. (1992). They have been present in Big Bend National Park (BBNP) along the Rio Grande River and associated tributaries since 1993 (Skiles personal communication 2004). Desert wetland areas, such as springs, seeps, and riparian corridors are fragile and small in size (Hubbs 1977, Schmidly 1977, Wauer 1977). Nutria activity in such areas could lead to irreparable damage to indigenous taxa.

The Rio Grande supports the only major aquatic and riparian habitat in the park. An approximately 0.25-hectare complex of warm natural springs and ponds adjacent to the river near Big Bend's Rio Grande Village (RGV) development support the only wild populations of the endangered Big Bend gambusia (*Gambusia gaigei* Hubbs 1929) (Williams et al. 1989, Reeder 2001). The Rio Grande Fishes Recovery Team (RGFRT), coordinated by the U.S. Fish and Wildlife Service (USFWS), conducted a review of the Big Bend gambusia population in 1984 determining that the minnow-sized fish is highly adapted to spring outflows and were listed as endangered in 1967 (Texas Parks and Wildlife 2005). The study proposes that if continuity of Big Bend gambusia habitat is not maintained, the survival of the species is under continued threat. In addition, the exceedingly small geographic range is of great concern because one seemingly minor environmental change in temperature or pH could exterminate the species (Rio Grande Fishes Recovery Team 1984, Chadwick and Associates 1992).

Based on impact in other areas (Louisiana Department of Wildlife and Fisheries 1998, United States Geological Survey 2000, Swank and Petrides

1954, Marx et al. 2003, Carter and Leonard 2002), nutria may dramatically change the emergent and submerged aquatic vegetation in wetlands. Disruption of foraging sites, shade, and sheltering vegetation may put the gambusia population at critical risk (Rio Grande Fishes Recovery Team 1984). At BBNP, nutria have denuded emergent and aquatic vegetation from approximately 30% of gambusia habitat (Raymond Skiles personal communication 2003). At the current rate, remaining habitat may be degraded by nutria within a few years (Marx et al. 2003). As an emergency measure, a "nutria-proof" fence was built around Spring 1 pond that serves as a refugium (Skiles personal communication 2003), and is currently the only gambusia habitat protected from nutria impact (Rio Grande Fishes Recovery Team 1984, National Park Service 2005).

Nutria also may impact the endangered Mexican Beaver (*Castor canadensis mexicanus* Bailey 1913) which inhabits this area. While nutria do not typically consume woody vegetation, beaver depend on herbaceous vegetation in habitats with limited woody vegetation (Schmidly 2004). The RGV beaver population maintains a beaver dam which forms the largest pond containing Big Bend gambusia (Reeder 2001). Should the presence of nutria disrupt the maintenance of the beaver dam and pond, it could further jeopardize the gambusia population (Rio Grande Fishes Recovery Team 1984, National Park Service Water Resources Division 1992).

Non-woody wetland plants have been reported as the primary source of food for nutria (Ashbrook 1948, Atwood 1950, Shirley et al. 1981, Towns et al. 2003). However, Warkentin (1968) observed nutria feeding on willow branches which are used by beaver for dam construction and food caches (Nowak 1991).

When nutria population densities are high they can be damaging to wetland vegetation and can contribute to wetland loss (United States Geological Survey 2000). The rapacious appetite of nutria in wild areas has led to severely damaged wetlands (Jenkins 2002). Nutria in desert habitats are limited in available food resources. This study is the first to evaluate nutria food habits in wetland habitats of the Chihuahuan Desert.

A nutria management program may be essential to preserving the Big Bend gambusia and Mexican beaver populations. Under NPS policies (National Park Service United States Department of the Interior 2003), an appropriate program includes Integrated Pest Management (IPM) strategies for the nutria population and impact monitoring, establishment of thresholds for control, and a science-based control plan that accommodates local ecological conditions, best available methods, and social constraints as influenced by human use patterns. President W. J. Clinton signed Executive Order 13112 (1999), establishing the National Invasive Species Council, which oversees the control of invasive species by working with Federal, State, and International agencies to implement the Invasive Species Management Plan. These are active programs intended to control this exotic species and their impact on native flora and fauna.

I found no published information documenting nutria populations or their food habits in a desert environment. This research represents the first step in developing an IPM plan for nutria in BBNP. The objectives of my study are to: 1) determine nutria distribution along the Rio Grande River from Gravel Pit to the mouth of Boquillas Canyon, including Hot Springs, Daniel's Ranch and the Beaver Pond near Rio Grande Village (RGV), 2) describe and quantify centers of nutria activity, 3) describe and quantify nutria impact on vegetation and habitat through foraging activity, and 4) determine nutria population size in the primary study area.

MATERIALS AND METHODS

Study Site

I conducted this research near the RGV campground in BBNP, Brewster County, Texas, approximately 33 km southeast of the park headquarters at Panther Junction (Fig. 1). Natural resources within the park have been protected since 1944 (Strong unpublished Masters thesis 1979). BBNP is a 324,471 hectare area located in the Trans-Pecos ecological region of Texas. RGV is approximately 520 m above sea level (Strong unpublished Masters thesis 1979) and includes approximately 9 km of the Rio Grande River from Gravel Pit to the mouth of Boquillas Canyon. It consists of mountainous and riverine topography. The average temperature ranged from 31.25-11.9 °C and the average precipitation was 8.65 inches for 2003 (Amy Davis, BBNP weather data electronic communication 2005). Wetlands adjacent to the river, the settling ponds at Daniel's Ranch, Spring 4 pond, and the Beaver Pond also were included.

Campsites, picnic areas, hiking trails, and interpretive stations are interspersed throughout the area. Mexican farms and villages are near the study area. Boquillas del Carmen, Coahuila, Mexico is the largest village in the area covering approximately 2 km of the Rio Grande.

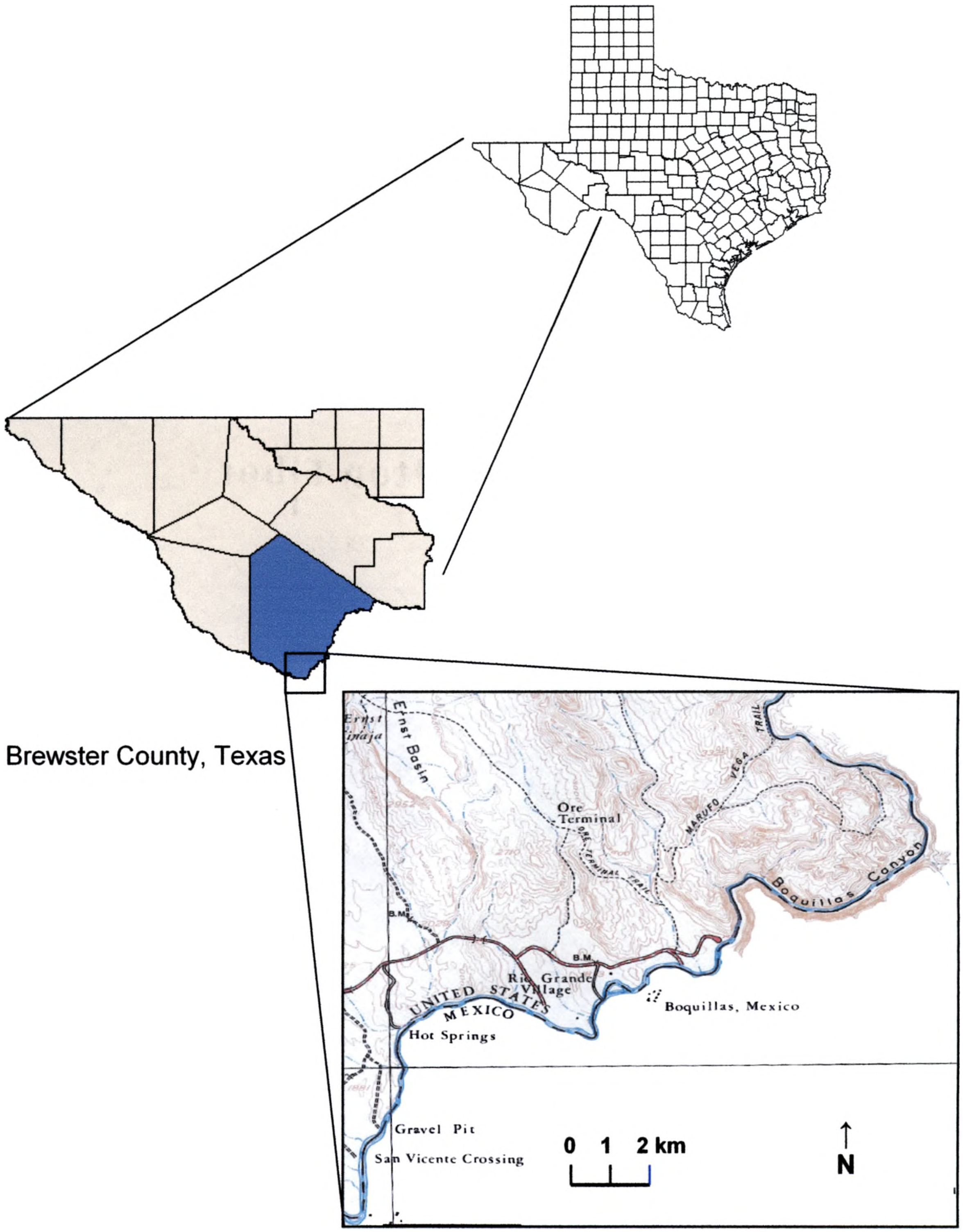

Figure 1. Map depicting Rio Grande Village, Big Bend National Park, Brewster County, Texas.

The vegetation consists of thick stands of the introduced giant reed (*Arundo donax*) and common cane (*Phragmites australis*) on the United States side of the river, while baccharis (*Baccharis glutinosa*), salt cedar (*Tamarix sp.*), and bermudagrass (*Cynodon dactylon*) comprise the majority of vegetation on the Mexican side. The Beaver Pond is bisected by a boardwalk used for visitor access to hiking trails. The pond is surrounded by dense stands of *Arundo* with *Phragmites* occupying the interior. Emergent and submerged vegetation include water hyssop (*Bacopa monnieri*), spikerush (*Eleocharis caribaea*), water pennywort (*Hydroctyle umbellata*), and cattail (*Typha latifolia*). Woody vegetation, especially cottonwoods (*Populus acuminata*) and huisache (*Acacia smallii*) are interspersed throughout the area.

Within a short distance of this riparian zone, the vegetation is typical of the Chihuahuan desert. It is primarily a shrub desert characterized by ocotillo (*Fouquieria splendens*), a variety of yuccas (*Yucca sp.*), cactuses and chollas (*Opuntia sp.* and *Echinocereus sp.*), cenizas (*Leucophyllum sp.*), Texas persimmon (*Diospyros texana*), agarito (*Berberis trifoliolata*), and many other xeric species (Wauer 1973, Evans 1998).

Trapping and Population Estimation

I used Tomahawk live traps (90x33x30cm, Tomahawk Live Trap Company), to capture nutria (Texas State University IACUC #HOASJQ 02, NPS Permit # BIBE-2003-SCI-0003). I baited the traps with sweet potatoes (Schmidly 2004) and checked them the following morning. I weighed captured nutria using a spring scale and sedated them with ketamine hydrochloride at 0.25 cc/kg (Bó et al. 1994, Jalanka and Roeken 1990). I recorded sex (Willner et al. 1979) and standard external measurements (weight in kg, total length, tail vertebrae length, hind foot length, and ear length in mm). I initially tagged nutria in the ear with a National Band & Tag Co. tag (Jiffy style 893, size 3). Later, tags were attached to the hind-foot webbing; in the right hind-foot if male, and left if female. I applied commercial hair bleach and developer (Clairol Company®) to the top of the head for visual recapture (Johnson 1992). Global Positioning Satellite (GPS) data was taken at the site of capture and release. I conducted diurnal and nocturnal surveys to assess nutria numbers and activity throughout the study.

Capture data were used to estimate the nutria population by using Schnabel (1938) and Chapman (Schneider 1998) estimates based on number of trap nights, trap success, and recaptures.

Nutria Activity

I surveyed the Rio Grande via canoe from Gravel Pit to the mouth of Boquillas Canyon. I recorded locations of nutria sign using a Garmin GPS III Plus (Garmin International Corporation 1998) GPS unit. At each site I recorded substrate, shoreline vegetation, riparian zone width (from waters edge to Chihuahuan Desert vegetation), resting and grooming sites, feeding platforms, tracks, vegetation clippings, and possible den sights. I separated nutria sign from beaver sign based on tracks, tail-drag, and clipping styles (Nowak 1991, LeBlanc 1994).

Vegetation Survey

I collected vegetation data using line intercepts (Burnham et al. 1980) where access to shoreline vegetation was available. I collected and identified potential food plants (Table 1) along the vegetation transects. Thick stands of giant reed on the United States (U.S.) side of the river made vegetation analysis difficult due to limited access. Canyons with steep walls on the U.S. side also were inaccessible for vegetation study restricting my vegetation survey primarily to the Mexican side of the river.

Food Habits

I placed the stomach contents from euthanized nutria in 10% formalin for later analysis. Voucher specimens (skulls) were sent to the Natural Science Research Laboratory, The Museum, Texas Tech University. Stomach contents were taken to Texas State University-San Marcos for laboratory analysis.

I rinsed the stomach contents with tap water through a 35 mesh sieve (0.5 mm) to remove formalin and small fragments of epidermal tissue following methods used by Towns et al. (2003). Rinsed stomach contents were kept in a 70% ethanol solution. I measured the stomach content volumes and removed approximately 10% of each for analysis. I cleared the removed samples with sodium hypochlorite 6% (household bleach) (Holechek and Valdez 1985). Each sample was soaked for approximately 7 minutes to remove any residual chlorophyll within the epidermal cells, then rinsed with tap water. I used a ten-point frame for stomach volumes ≥125 ml (Chamrad and Box 1964). This amount allowed for appropriate dispersal of material. I used a 20x20 mm grid,

Table 1. Plant species collected and identified from the Beaver Pond and the Rio Grande River in the Rio Grande Village area, Big Bend National Park.

Plant Species	Common Name
Acacia smallii	huisache
Alopecurus sp.	foxtail
Arundo donax	giant cane
Baccharis glutinosa	baccharis
Bacopa monnieri	water hyssop
Chloracantha spinosa	Mexican devilweed
Cynanchum barbigerum	bearded swallow-wort
Cynodon dactylon	bermudagrass
Cyperus ochraceus	flatsedge
Eleocharis caribaea	spikerush
Hydroctyle umbellata	water pennywort
Nicotiana trigonophylla	desert tobacco
Panicum gymnocarpum	panic grass
Phragmites australis	native cane
Prosopis glandulosa	honey mesquite
Sorghum halepense	Johnsongrass
Tamarix sp.	salt cedar
Typha latifolia	cattail
Vitis arizonica	canyon grape

with a petri-dish, for those samples less than 125 ml to provide suitable distribution. I used a ten-sided die to select each specimen for microhistological analysis using the cleared 10% sample volume (Towns et al. 2003). I then prepared fifty slides for each stomach sample by mounting the cleared specimens on slides with Mount-Quick® mounting medium and covering them with a 22x22 mm cover slip. I dried each slide for at least five hours before inspection. I used a National (MFG# 163-ASC) microscope to view each slide. I divided the slides into two fields of view for comparative analysis with reference slides. Plant fragments closest to the pointer within the microscope field of view were used for analysis. I examined 100 fields of view for each stomach.

I calculated percent occurrence and frequency of occurrence of each plant species per stomach (Fracker and Brischle 1944) where:

Percent Occurrence = (# of plant fragments of species "x")/(total fields of view)

and,

Frequency of Occurrence = (# of stomachs)/(presence of plant species)

I pooled these data and established an overall percentile based on 1400 fields of view (Table 2).

Reference Slides

To identify plant species in the nutria stomach contents, I prepared slides from roots, stems, and leaves of wetland plants of the RGV area. I scraped tissue from plant samples using a razor blade or scalpel leaving only the

Table 2. Percent occurrence and frequency of occurrence of vegetative species composition of nutria stomach contents collected at Rio Grande Village, Big Bend National Park (N=14, *=species not found in microhistological view field)

		Collected Nutria															
Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	% Occurrence	Frequency of Occurrence
Alopecurus sp.	foxtail	*	7	3	*	*	2	*	*	1	*	*	*	*	*	0.93	28.57
Arundo donax	giant cane	3	2	2	*	*	17	3	3	14	6	10	10	7	11	6.3	85.71
Bacopa monnieri	water hyssop	9	*	6	*	3	3	2	*	*	2	*	*	*	3	2	50
Cynodon dactylon	bermudagrass	8	2	10	2	7	5	7	1	4	6	5	6	4	*	4.79	92.86
Cyperus sp.	flatsedge	*	*	*	*	*	*	*	8	*	2	*	*	*	*	0.71	14.29
Eleocharis caribaea	spikerush	7	11	50	*	*	3	*	8	*	5	*	2	*	*	6.14	50
Hydroctyle umbellata	water pennywort	57	32	7	*	13	46	12	*	*	*	*	*	*	11	12.71	50
Phragmites australis	common reed	11	38	18	89	72	17	67	77	70	75	80	75	83	66	59.86	100
Unidentified Material	*	5	8	4	9	5	7	9	3	8	4	5	8	6	9	6.43	100

epidermal layer (Green et al. 1985). Both sides of the epidermal layers were used (Korschgen 1973, Towns et al. 2003). Reference material was cleared with bleach as discussed above, mounted to slides using Permount® and a 22x22 mm coverslip, and allowed to dry for at least two days. I took photographs using a mounted camera (Nikon Cool Pix 995) to the National (MFG# 163-ASC) microscope, via an adaptor, and cataloged them for comparison. Trichomes, cell wall shape and structure, stomata, and overall cell arrangement were used in species identification (Baumgartner and Martin 1939, Green et al. 1985, Litvaitis et al. 1996, Towns et al. 2003).

RESULTS

Trapping and Population Estimate

I made 8 trips to BBNP during January, February, March, April, May, July, August, and November of 2003 resulting in 234 trap nights. Twenty-four nutria were captured, marked, and released during the study (Appendix 1 and 2). Seven of these were recaptured. I collected 14 nutria for stomach content analysis and 3 were recaptures. I trapped 23 of 24 nutria in or around the Beaver Pond. One nutria was processed and released on the river. These data were used to estimate the nutria population in the Beaver Pond area of RGV using the Schnabel estimate (Schnabel 1938) and the Chapman estimate (Schneider 1998). The Schnabel estimate suggests a population of 38 nutria within or near the Beaver Pond. Though this method is typically used for closed systems, it allows for multiple trapping efforts where accumulation of captured and marked animals is allowed (Krebs 1989). The Chapman variation of the Petersen estimate, where captures may be used to calculate populations months after recapture (Schneider 1998), suggests a population of 74 nutria in the Beaver Pond area.

Nutria Activity

Approximately 30 locations of nutria activity were identified and recorded along the Rio Grande corridor (Figure 2) and approximately 19 within the Beaver Pond area (Figure 3). Water depth near nutria sign averaged 0.8 m. Substrate was typically mud and rock. Thick *Arundo* stands composed the majority of shore-line vegetation, especially on the United States side of the river. The riparian zone width averaged approximately 25 m where nutria activity occurred (Appendix 3).

I recorded little or no nutria sign in fast moving portions of the river, shallow areas, or within canyons. Nutria activity typically occurred in deep, slow-moving pools with emergent shoreline vegetation and a low or moderate shoreline slope. I conducted three 100 m line-intercepts, May, 2003. I measured one line-intercept at three different areas where nutria sign occurred. Vegetative content included bermudagrass (*Cynodon dactylon*) (36.3%), salt cedar (*Tamarix sp.*) (17.1%), baccharis (*Baccharis glutinosa*) (16.9%), *Arundo* (14.3%), and litter (15.4%).

Stomach Content Analysis

I collected 14 nutria for stomach content analysis in or around the Beaver Pond. I collected 2 nutria in May, 4 in August, and 8 in November. Percent occurrence for each food species was: *Phragmites* (59.86%); water pennywort (12.71%); *Arundo* (6.3%); spikerush (6.14%); bermudagrass (4.79%); water hyssop (2.0%); foxtail (*Alopecurus sp.*) (0.93%); flatsedge (*Cyperus sp.*) (0.71%),

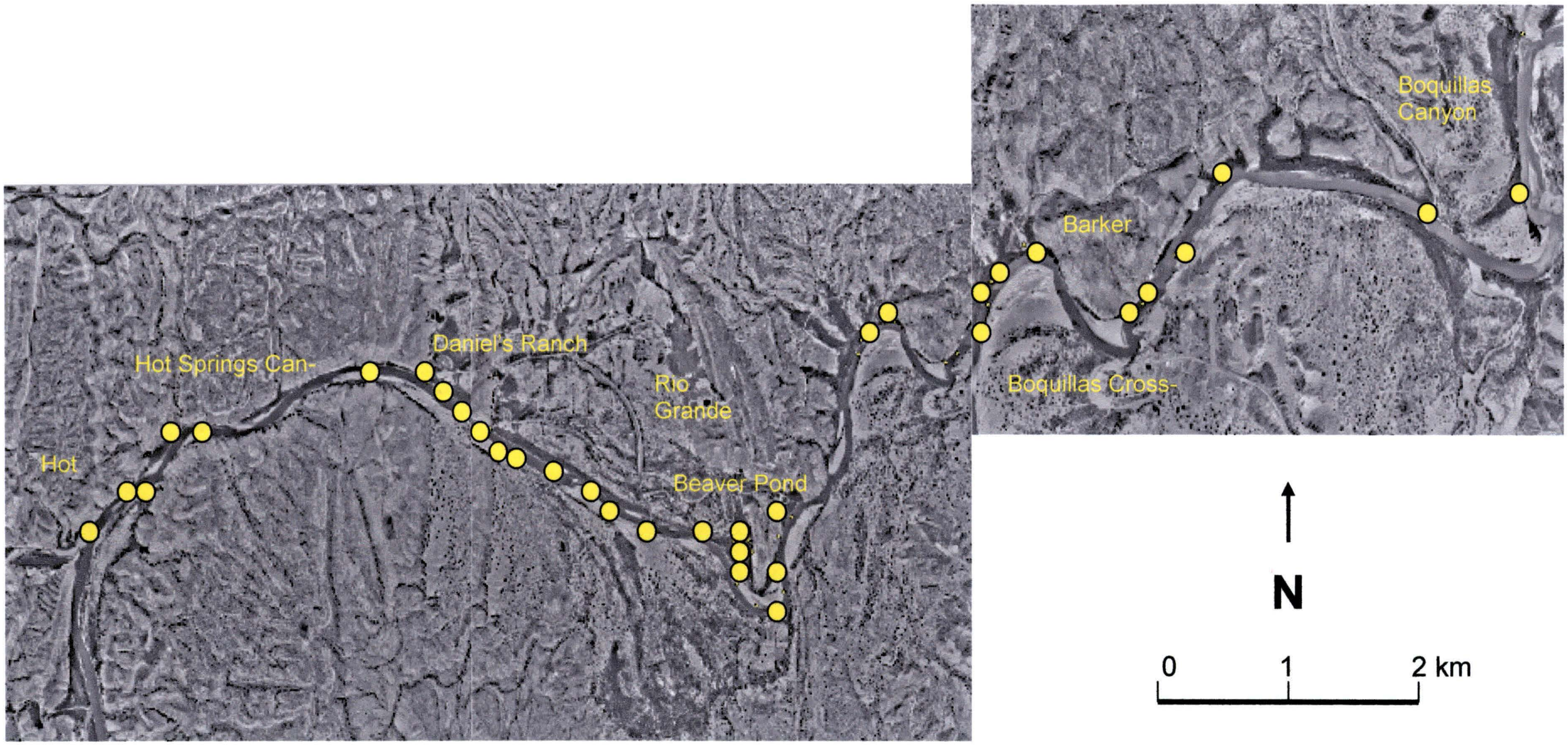

Figure 2. Map depicting Geographic Information System (GIS) data of nutria activity from Hot Springs to Boquillas Canyon Trail in Big Bend National Park. Circles indicate sites of nutria activity.

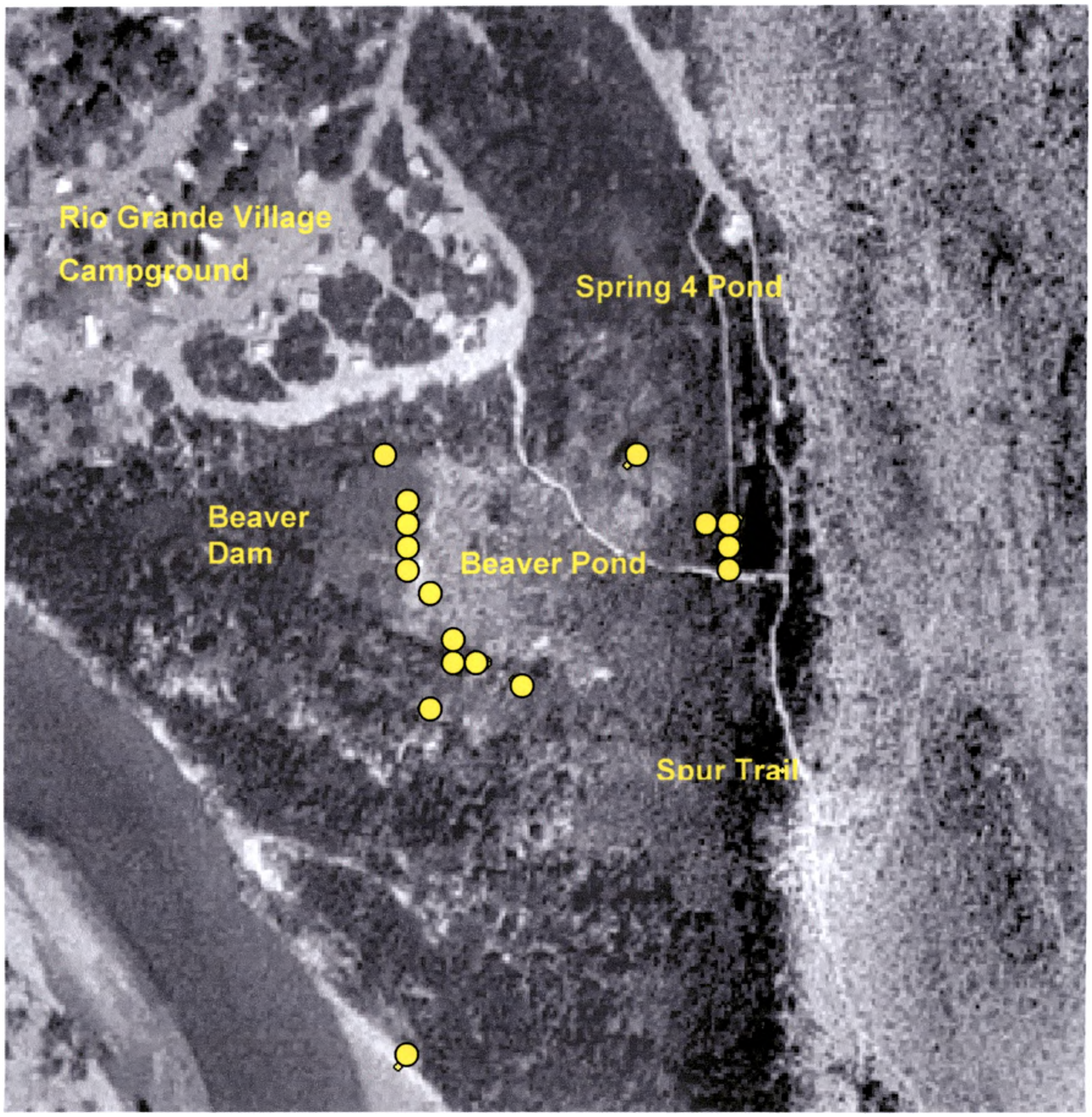

Figure 3. Map depicting Geographic Information System (GIS) data of nutria activity within the Beaver Pond area of Rio Grande Village, Big Bend National Park. Circles indicate sites of nutria activity and capture.

and unknown fragments (6.43%) (Figure 4). The unidentified or unknown fragments were either too small to identify, or were an unfamiliar species (Table 2).

Frequency of occurrence of each food species was: foxtail (28.57%); *Arundo* (85.71%); water hyssop (50%); bermudagrass (92.86%); flatsedge (14.29%); spikerush (50%); water pennywort (50%); *Phragmites* (100%); and unknown fragments (100%) (Table 2).

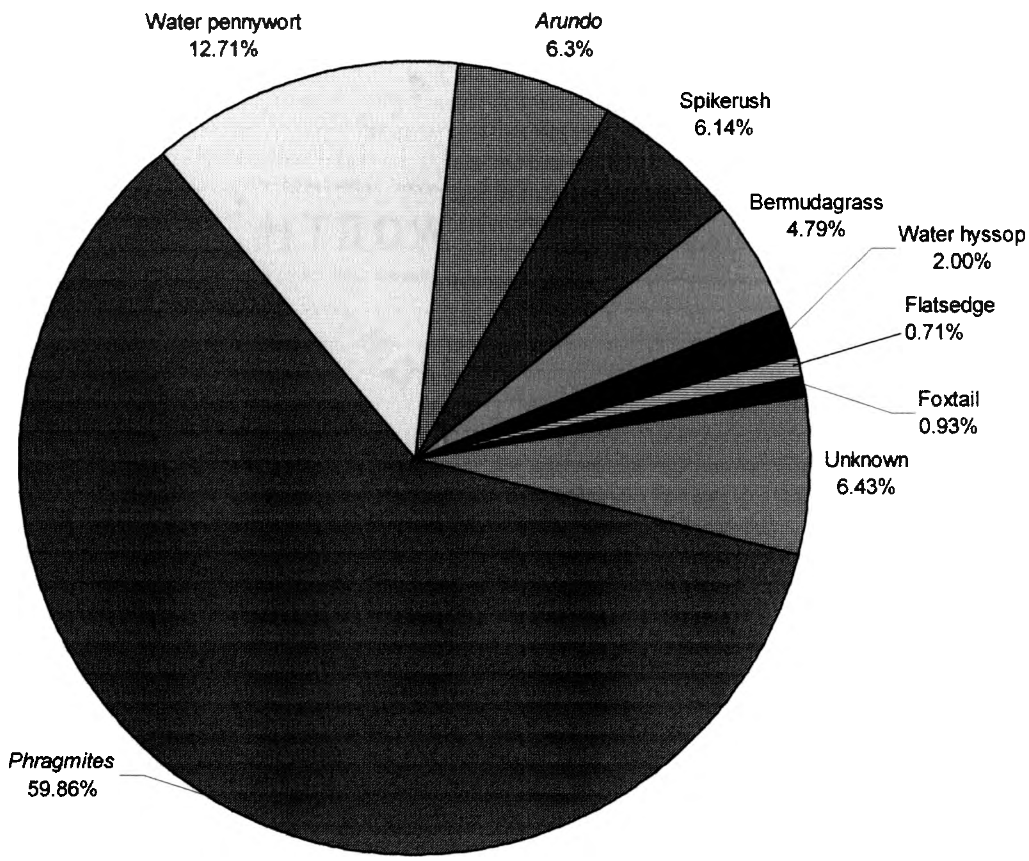

Figure 4. Relative composition of plant taxa identified in stomach contents of nutria collected from the Beaver Pond in the Rio Grande Village of Big Bend National Park.

DISCUSSION

The results of this study suggests that nutria are becoming well established in Big Bend National Park and that they are eating native vegetation. My population estimates may be an underestimate of their numbers because of a low number of recaptures due to trap theft along the river, vandalism, and the inability to trap on the Mexican side of the Rio Grande. Another problem affecting mark-recapture estimates is trap-shyness by adult nutria (Simpson and Swank 1979). Trapping was limited to Spring-four, Daniel's Ranch, the Beaver Pond, and sections of the Rio Grande near these sites.

Although nutria sign was noted throughout the study area outside of trapping locations. nutria appear to be selective in the region they inhabit. I found little sign of nutria activity in shallow, fast moving water, or within areas bounded by steep canyons with little emergent vegetation. Along the Rio Grande I observed nutria in the river near Hot Springs, the boat ramp at RGV, Boquillas crossing (including near the Barker house), and Boquillas Canyon. These rodents inhabit riparian areas with abundant food resources and deeper waters.

A concurrent survey of nutria home range is being conducted by a graduate student from Texas State University-San Marcos. His preliminary data suggests that nutria are moving between the Rio Grande and adjacent wetlands, including areas on the Mexican side (Jason Shumate unpublished data 2005

Beaver require habitats similar to that of nutria (Retzer et al. 1956, Novak 1987). Nutria are known to occupy and use beaver sites as feeding platforms (LeBlanc 1994, King et al. 1998) and the dens of other animals (Nowak 1991). I observed activity of beaver and nutria in the same regions of the Rio Grande and the Beaver Pond.

A prescribed burn in April, 2003, escaped control of handlers within the Beaver Pond area leaving little emergent vegetation and few woody species. *Arundo* is documented invading and increasing in numbers in areas disturbed by fire or flooding (Bell 1993). *Arundo* currently comprises the majority of Poaceae species within the Beaver Pond and surrounding area. This exotic, invasive plant may dramatically alter the riparian habitat towards stands of this exotic grass (Bell 1993). Riverine areas with a high density of *Arundo* typically result in decreased water oxygen concentrations and increased pH resulting in lower aquatic diversity, including fishes (Dunne and Leopold 1978, Chadwick and Associates 1992). This plant also requires copious amounts of water to satisfy its growth rate (Perdue 1958, Iverson 1994).

Nutria in the RGV area are selectively consuming the few remaining stands of *Phragmites* rather than the more abundant *Arundo*. This may be due to toxic and unpalatable chemicals in the *Arundo* leaves which may protect the plant (Bell 1993). If this disproportionate use of *Phragmites* by nutria continues, it may exacerbate the displacement of *Phragmites* and the spread of *Arundo* stands leaving little food resources for beaver in times of stress (Strong unpublished Masters thesis 1979, Bell 1993). Should changes in the composition of vegetation within the Beaver Pond result in beaver abandoning the site, the Big Bend gambusia population may decrease. Further research is needed to study the Mexican beaver populations and their response to interspecific competition with nutria.

Nutria have been reported to feed on spikerush, water pennywort, and *Phragmites* in Louisiana and Maryland (Shirley et al. 1981, Willner et al. 1979). These plant taxa comprised a large portion of nutria diet from collected individuals in RGV. My observations suggest nutria were feeding primarily on *Phragmites*.

My results indicate that controlling nutria within the RGV area may be timely and imperative before their population size becomes too large to control effectively. Removal campaigns began in Britain (Baker and Clarke 1988) in April of 1981 because of their destructive influence on native habitats. In the United States, Congress has approved, under the Coastal Wetlands Planning Protection and Restoration Act, spending $12.5 million to pay $4 per nutria to kill them in Louisiana and Maryland (Schmidly 2004). Management of this invasive species is necessary due to its potential impact to native species; specifically, the Mexican beaver, Big Bend gambusia, and the limited remaining stands of *Phragmites* within the RGV area.

Food habits of nutria have been defined and their population numbers estimated. My project provides a baseline for nutria food habits within the Chihuahuan Desert, especially the RGV area in BBNP. This study provides information for the NPS to establish a nutria management program.

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APPENDIX I

Appendix I. Nutria captured, tagged, released, or collected in the RGV Area of Big Bend National Park. (*=no data, BB=Big Bend, M=male, F=female, COL=collected).

Date	Nutria ID	Weight (Kg)	Sex	Tag #	TL (mm)	TV(mm)	HF(mm)	E(mm)
8-Jan-03	BBF1	1.4	F	7	600	310	115	31
31-Jan-03	BBM1	5.3	M	8	815	360	136	26
2-Feb-03	BBM2	4	M	9	901	306	104	23
5-Feb-03	BBM3	1.6	M	74	535	260	97	23
24-Mar-03	BBM4	3	M	100	740	364	137	28
25-Apr-03	BBM5	4.5	M	52	880	392	145	27
25-Apr-03	BBF2	5.5	F	53	909	414	141	28
26-Apr-03	BBF3	6.2	F	26	989	443	148	26
26-Apr-03	BBUK1	4.8	*	*	*	*	*	*
26-Apr-03	BBUK2	5.2	*	*	*	*	*	*
26-Apr-03	BBUK3	0.6	*	*	309	104	*	*
13-May-03	BBF4	4.9	F	27	849	365	128	23
13-May-03	BBM6	5	M	28	992	460	146	21
13-May-03	BBM7	0.8	M	75	488	215	84	18
13-May-03	BBM8	1.2	M	29	510	240	89	19
13-May-03	BBM9	0.6	M	30	409	165	82	11
14-May-03	BBF1	*	F	*	*	*	*	*
15-May-03	BBF1	*	F	*	*	*	*	*
16-May-03	BBF1/COL1	4.3	F	*	930	405	140	25
16-May-03	BBF3/COL2	6	F	*	995	440	150	27
22-Jul-03	BBF5	1.9	F	54	844	371	136	26
22-Jul-03	BBM10	1.9	M	78	705	326	117	21
23-Jul-03	BBF6	6.3	F	55	964	422	143	31
23-Jul-03	BBM7	2.5	M	75	*	*	*	*
24-Jul-03	BBM11	4.8	M	56	932	405	139	29
14-Aug-03	COL3	1.7	F	*	600	255	102	25
14-Aug-03	COL4	1.8	M	*	725	318	110	24
15-Aug-03	BBM7/COL5	2.5	M	75	780	360	127	26
16-Aug-03	COL6	2.5	M	*	775	330	128	27
27-Nov-03	COL7	4.3	F	*	[845]	[325]	135	36
27-Nov-03	COL8	3.2	F	*	815	370	125	29
27-Nov-03	COL9	1.5	M	*	635	275	118	[25]
28-Nov-03	COL10	4.8	F	*	960	435	142	28
28-Nov-03	COL11	3.3	M	*	880	395	140	30
28-Nov-03	COL12	1.5	F	*	[590]	[250]	110	24
29-Nov-03	COL13	7.7	M	*	1070	465	155	37
29-Nov-03	COL14	1.3	M	*	563	265	107	27

APPENDIX II

Appendix II. Trapping of nutria in Big Bend National Park (*=Data unavailable, BB=Big Bend, M=male, F=female, UK=unknown, COL=collected)

DATE	TRAPS/NIGHT	NUTRIA CAPTURED
6-Jan-03	3	*
7-Jan-03	6	BBF1
30-Jan-03	2	BBM1
31-Jan-03	2	*
1-Feb-03	2	BBM2
2-Feb-03	2	*
3-Feb-03	7	*
4-Feb-03	7	BBM3
5-Feb-03	1	*
16-Mar-03	2	*
17-Mar-03	7	*
18-Mar-03	8	*
19-Mar-03	8	*
20-Mar-03	8	*
21-Mar-03	8	*
22-Mar-03	7	*
23-Mar-03	3	BBM4
25-Mar-03	3	*
25-Apr-03	3	BBM5/BBF2
26-Apr-03	6	BBF3/BBUK1,2&3
13-May-03	10	BBF4/BBM6,7,8&9/BBF1
14-May-03	10	BBF1
15-May-03	10	BBF1
16-May-03	10	BBF1/UK recapture
21-Jul-03	4	BBF5 & BBM10
22-Jul-03	4	BBF6 & BBM7
23-Jul-03	2	BBM11
24-Jul-03	2	*
13-Aug-03	12	COL3 & COL4
14-Aug-03	12	COL5
15-Aug-03	12	COL6
26-Nov-03	13	COL7,8&9
27-Nov-03	14	COL10,11&12
28-Nov-03	16	COL13&14
29-Nov-03	8	*

APPENDIX III

Appendix III. GPS locations of nutria sign on the Rio Grande River from Hot Springs to the mouth of Boquillas Canyon (L=Low nutria activity, S=Sign of nutria activity, *= Data not available, DI="Daniel's Island", RGR=Rio Grande River).

DATE	U.T. M. EAST	NORTH	ACTIVITY	WATER DEPTH (m)	SUBSTRATE	SHORE-LINE VEGETATION	RIPARIAN ZONE WIDTH (m)	NOTES
15-May-03	13 R 0697198	3230161	L	*	Gravel/litter	Tamarix/*Arundo* /bermudagrass/UKComp.#1	Island w/in RGR	DI Daubenmire and line intercept.
15-May-03	13 R 0697571	3229972	L	*	Sand/mud	bermudagrass/*Arundo*	*	Left bend in river from DI.
15-May-03	13 R 0697869	3229874	L	0.75	Mud	bermudagrass/*Arundo* /willow	25-50	Rest area; no sign of feeding.
15-May-03	13 R 0698042	3229749	L	0.6	Mud	bermudagrass/tamarix/*Arundo* /baccaris	0-25	Near boat ramp.
15-May-03	*	*	L	0.4	Mud	*Arundo* /Tamarix/UKComp. #2	0-25	Daubenmire & line intercept near boat ramp.
15-May-03	13 R 0698687	3229506	L	0.6	Mud	Tamarix/baccaris/*Arundo*	50+	Left bend up-river from 2nd Island/ Mexico.
15-May-03	13 R0698911	3229324	L	*	Mud/rock	*	*	Possible den site near 2nd Island.
15-May-03	13 R 0699078	3229061	L	0.3	Mud/rock	*Arundo* /Tamarix	0-25	Haul-out; near stolen trap @ 2nd Island.
15-May-03	13 R 0699247	3229308	S	*	*	*	0-25	Spring from Spur Trail site.
15-May-03	13 R 0699244	3229532	S	0.9	Rock	*Arundo* /baccaris	0-25	Grooming site on RGR.
15-May-03	13 R 0699342	3229659	S	0.2	Mud	Tamarix/baccaris/*Arundo* /spikerush	0-25	Grooming site on RGR 10 m down river.
23-Jul-03	13 R 0694782	3229385	L	0.5	Mud/rock	*Arundo*	0-25	Slow moving eddy/clippings/haul-out.
23-Jul-03	13 R 0694987	3229595	L	2	Mud	*Arundo*	0-10	Pool/medium paced.
23-Jul-03	*	*	L	1.25	Mud/rock	*Arundo* /Tamarix/UKA	0-10	20 meters down river from previous site/haul-out/grooming/rest site.
23-Jul-03	13 R 0695151	3229650	S	~1.0	Mud	*Arundo*	0-50	Possible denning sites/grooming/haul-out/beginning.
23-Jul-03	13 R 0695394	3229955	S	~1.0	Mud	*Arundo*	0-50	Ending of sign described above.
23-Jul-03	13 R 0695565	3230001	*	*	*	*	*	Mouth of Hot Springs Canyon.
23-Jul-03	13 R 0696734	3230346	L	0.75	Mud	*Arundo*	0-25	Tracks/haul-out/grooming sites/continuing for 30 meters.
23-Jul-03	13 R 0697099	3230256	L	0.75	Mud/rock	bermudagrass/*Arundo*	0-2	Canoe take-out point at pump station/tracks.
24-Jul-03	13 R 0697097	3230253	L	1	Mud/rock	bermuda grass/Tamarix/*Arundo* /UKA	*	Slow-moving pool/nutria tracks.
24-Jul-03	13 R 0699637	3230780	*	0.25	Mud	*	*	Beaver tracks and tail slide.
24-Jul-03	13 R 0699659	3230876	L	0.25	Mud	*Arundo* /Mesquite	2-25	Nutria tracks/haul-out site/tunnel in cane inland.
24-Jul-03	13 R 0700044	3231000	L	*	Mud/rock	*Arundo* /Mesquite	0-25	Continuous nutria sign down river from previous UTM/below Barker House.
24-Jul-03	13 R 0700102	3231008	*	*	Rock	*Arundo* /Mesquite	*	Spring below Barker House.
24-Jul-03	*	*	S	2	Mud/rock	*Arundo*	0-50	~20 meters down river from previous UTM/haul-out site.
24-Jul-03	13 R 0700486	3230722	S	0.5	Mud/rock	*Arundo* /Tamarix	0-5	Bend in river across from Boquillas/haul-out/grooming site.
24-Jul-03	13 R 0700571	3230785	S	*	Sand/mud	*Arundo* /UKB	0-5	Nutria tracks .
24-Jul-03	13 R 0700722	3230987	L	0.25	Mud	UKC	*	Many nutria tracks/shallow, slow-moving water.
24-Jul-03	*	*	S	*	*	*	*	20 meters down river/haul-out site/nutria tracks.
24-Jul-03	13 R 0700842	3231284	S	1	*	*Arundo*	0-25	Haul-out/grooming site.
24-Jul-03	13 R 0701940	3231142	L	1	Mud	*Arundo* /UKB	1.5-25	Nutria tracks continuing for ~25 meters down river.
24-Jul-03	13 R 0702361	3231275	S	0.5	*	*Arundo* /Tamarix	0-25	Haul-out trail/swift-moving pool.
24-Jul-03	13 R 0702366	3231810	L	1.5	Mud/rock	*Arundo*	0-50	Bend in river below Boquillas Canyon trail/nutria tracks/denning site.

VITA

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