Barataria-Terrebonne
NATIONAL ESTUARY PROGRAM

A Survey of Vegetative Damage Caused by Nutria Herbivory in the Barataria and Terrebonne Basins

BTNEP - 31
April 1997

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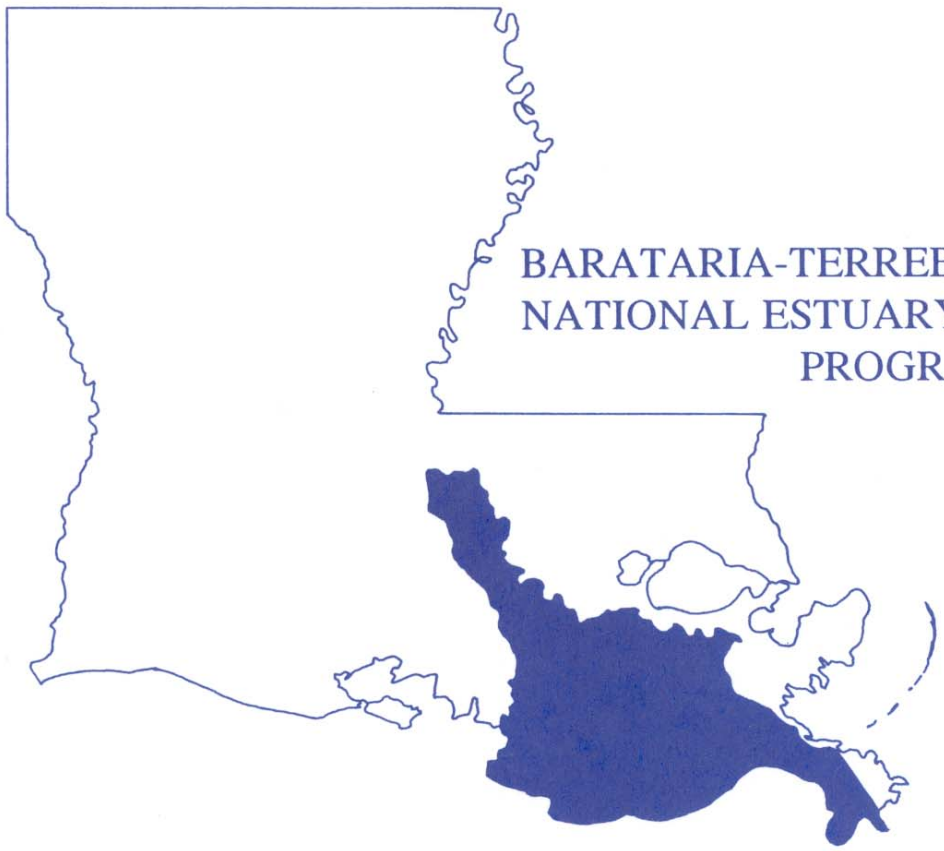

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A Survey of Vegetative Damage Caused by Nutria Herbivory in the Barataria and Terrebonne Basins

A publication of the
Barataria-Terrebonne National Estuary Program

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This public document was published at a total cost of $428. Seventy-five copies of this public document were published in this first printing at a cost of $428. The total cost of all printings of this document, including reprints, is $550. This document was published by the Barataria-Terrebonne National Estuary Program, NSU Campus, P.O. Box 2663, Thibodaux, LA 70310, to provide the public with environmental information under the authority of La. R.S. 30:2011. This material was printed in accordance with standards for printing by state agencies established pursuant to La. R.S. 43:31.

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EXECUTIVE SUMMARY

Helicopter surveys were flown in May and December 1993, April 1995 and April 1996 to identify and quantify areas of vegetative damage caused by nutria herbivory in the Barataria-Terrebonne basins. North-South transects, placed 1.8 miles apart were flown throughout the fresh, intermediate and brackish marshes of each basin.

During the initial survey, 51 damaged sites were located and an estimated 12,614 acres of marsh were damaged. In December of 1993, 39 additional herbivory sites were located with a total estimated 15,476 acres impacted. Fresh marsh habitat contained 54% of the damage sites and 67% of the damaged acres. Recovery of damaged sites from May to December 1993 was less than predicted.

Due to limited funding only western Terrebonne (Atchafalaya River to Houma Navigation Channel) was flown in 1995. All previously identified damage sites (33) were reassessed and 23 new sites located. In 1996, the lower Barataria-Terrebonne basins were again surveyed. A total of 157 sites were visited~ these included 97 of which had been previously identified and 61 new sites that were located. We estimated that a total of20,642 acres were damaged along the transects. In 1996, fresh marsh was more heavily impacted (70 sites, 8596 acres) than either intermediate or brackish marsh habitats. As in all previous surveys, Terrebonne Parish contained more damage sites (88) and impacted acres (10,506) than any other Parish. Of all sites assessed, only 15 (9%) had recovered from previous herbivory impact. Clearly, the trend identified, was a continued increase in both the number of sites and extent of nutria herbivory damage in the Barataria- Terrebonne basins.

The plant species impacted remained consistent from 1993-1996. *Scirpus olneyi* and *Eleocharis* spp. were most commonly impacted in the brackish and intermediate marshes. In fresh marsh *Eleocharis* spp. and *Hydrocotyle* spp. were the species most affected.

Habitat damage due to nutria herbivory increased from 1993 to 1996. Although it is difficult to accurately extrapolate these survey results to a Basin-wide estimate of nutria herbivory, total acreage impacted is probably 3 to 4 times larger than the area estimated in this survey.

In conclusion, nutria herbivory is playing a major role in the Barataria- Terrebonne basins. Direct vegetation removal contributes directly to permanent loss of vegetated wetlands. However vegetative loss is not the only impact observed. Nutria are currently and we suspect have historically, played a major role by influencing species composition throughout these basins. Of great concern is, only a small fraction of damage sites have recovered since our initial surveys in 1993. Most areas identified during those initial surveys are still being impacted in 1996. These fragile wetlands may not be able to withstand this continued stress in years to come.

INTRODUCTION

The nutria *(Myocastor coypus)* is a large semi-aquatic rodent indigenous to South America. The first introduction of nutria occurred in California in 1899, however it was not until the 1930's that additional animals were introduced in seven states. These importations, primarily for fur farming, failed during the Second World War as a result of poor pelt prices and poor reproductive success (Evans 1970). Willner (1982) listed 15 states where feral populations of nutria were established.

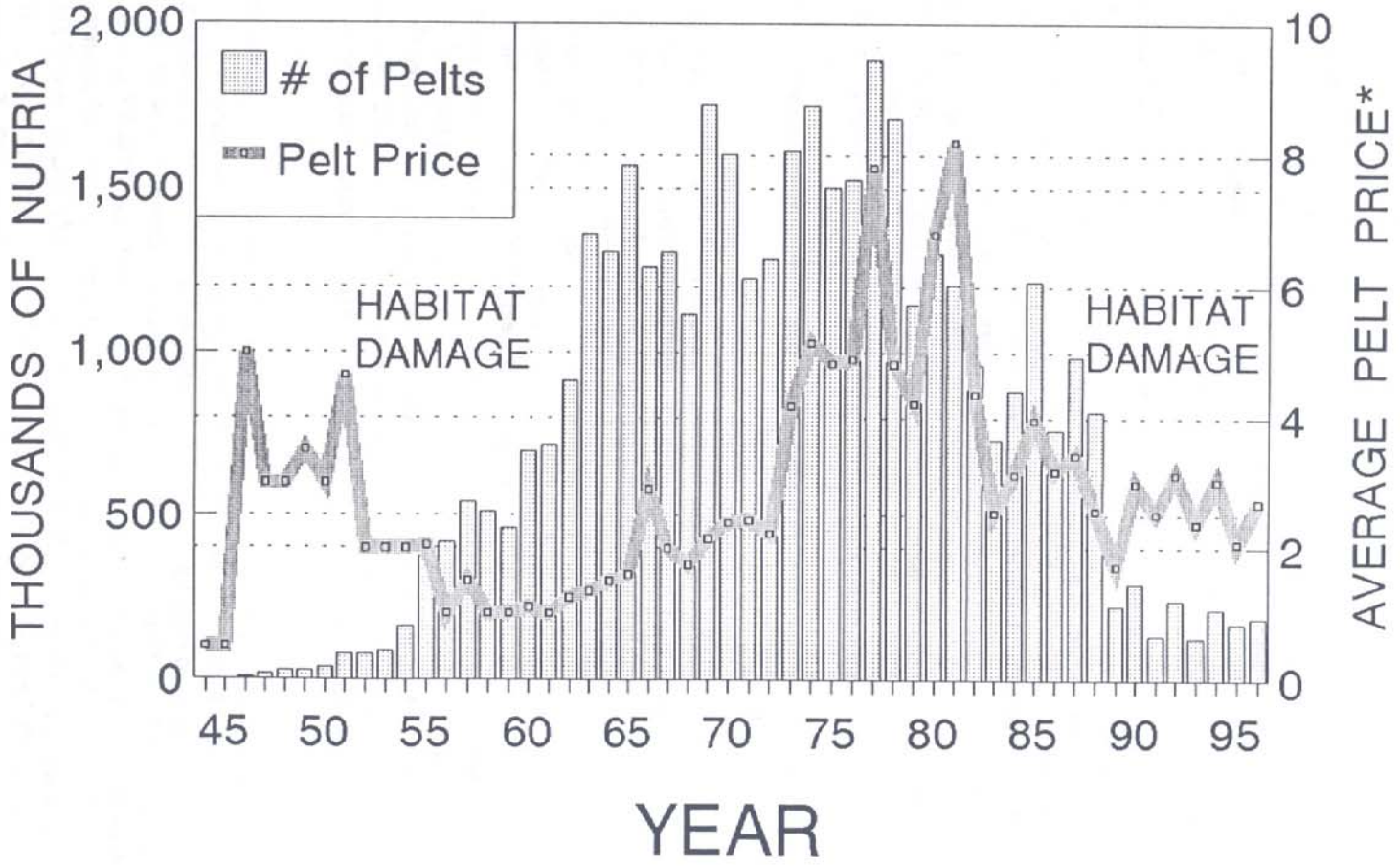
Evans (1970) reported that the Gulf Coast nutria population originated in Louisiana in 1937 from 13 animals imported by E. A. McIlhenny from Argentina. After numerous escapes in earlier years, approximately 150 nutria escaped during a hurricane in 1940. McIlhenny expected that the animals would perish in a few days because of high alligator densities in the surrounding marshes (Ted O'Neil, per. commun.), but the nutria survived and by 1956, the annual harvest was 419,000. Populations first became established in the western portion of the state then later spread to the east through natural expansion as well as stocking. During the mid-1950's muskrat populations were declining, nutria had little fur value, and serious damage was occurring in rice fields in southwestern Louisiana and sugarcane fields in southeastern Louisiana. The nutria problem became a political nightmare with rice and sugarcane farmers complaining about damage to crops and levee systems and muskrat trappers blaming the nutria for declining numbers of muskrats. In 1958, the Louisiana Legislature placed the nutria on the list of unprotected wildlife and created a $0.25 bounty on every nutria killed in 16 south Louisiana parishes.

Research efforts were initiated by the federal government in the southeast sugarcane region of the state to determine what control techniques might be successful. This research conducted by the U.S. Fish and Wildlife Service during the 1960's examined movements in relation to sugarcane damage and recommended shooting, trapping, and poisoning in agricultural areas (Evans 1970). Ted O'Neil, Chief of the Fur and Refuge Division, La. Dept. of Wildlife and Fisheries (LDWF), believed that the problem could only be solved through the development of a market for nutria pelts. A market for nutria developed slowly during the early 1960's and by the mid-1960's over 1 million pelts were being utilized annually by the German fur trade. The nutria surpassed the muskrat in 1962 in total numbers harvested and has remained the backbone of the Louisiana fur industry since that time. In 1965, the state legislature returned the nutria to the protected list. As prices showed a slow rise during most of the 1970's and early 1980's, harvest averaged 1.5 million and complaints from agriculture became uncommon. Reports of marsh vegetation damage were also much less common.

However, the market began changing during the mid-1980's. In 1981-82 the nutria harvest dropped slightly below 1 million. This declining harvest continued for two more seasons, then in 1984-85, the harvest jumped back up to 1.2 million. During the 1980-81 season, the average price paid for nutria was $8.19. During the 1981-82 season, the price dropped to $4.36, then in 1982-83, the price dropped to $2.64. Between the 1983-84 season and the 1986-87 season, prices fluctuated from slightly over $3.00 to slightly under $4.00. Then in 1987-88 and again in 1988-89 prices continued to fall (Figure 1). Since 1988-89, the number of nutria harvested annually has remained below 300,000 and prices have remained at or below a $3.00 average. Reports of marsh vegetation damage from land managers became common again starting in 1987. Such complaints became routine by 1988 and the Fur and Refuge Division, LDWF initiated limited aerial flights, particularly in southeast Louisiana. These flights showed that damage was

LOUISIANA NUTRIA INDUSTRY

HARVEST AND AVERAGE PELT VALUE



*PRICE IN U.S. DOLLARS

occurring, but the severity, distribution and duration of the damage was unknown. Helicopter rental time was budgeted, approved, then lost during budget reductions in 1988-89. Fur and Refuge Division personnel continued to express concern about marsh vegetation damage caused by over-population of nutria. We continued to believe that without a region-wide aerial survey it would be impossible to determine the significance of the damage. Public and private concern about nutria herbivory became much more obvious as a result of the Nutria and Muskrat Management Symposium held in October, 1992. This symposium was sponsored by the Louisiana Wildlife Biologists Association, Louisiana Land and Exploration Company, LDWF, LSU Agricultural Center -Cooperative Extension Service and the Louisiana Chapter of the Wildlife Society. The Conference Proceedings reported the following conclusions: nutria and muskrat herbivory (particularly nutria) has produced substantial adverse economic and environmental impacts on agricultural, forestry and coastal marsh resources, and existing programs and efforts are not sufficient to address and arrest those adverse impacts. Symposium participants concluded that securing funds for LDWF to conduct surveys during Winter 1992-93 should be the most immediate priority action item. This first such region-wide aerial survey became possible because of the interest and concern of many state and federal agencies, coastal land companies and, in particular, funding provided by the Barataria-Terrebonne National Estuary Program (BTNEP).

The objectives of the survey were to: (1) determine the distribution of damage along the transect lines as an index of damage basin-wide, (2) determine the severity of damage as classified according to the nutria relative abundance rating, (3) determine the species of vegetation being impacted and (4) resurvey and assess the current status of damage sites located in prior year surveys.

METHODS

Two initial helicopter surveys were conducted to identify and quantify areas of vegetative damage caused by nutria herbivory in May and December 1993. In 1995 and 1996 two additional surveys were cQnducted to reassess previously identified damage sites and to document additional areas
impacted by nutria herbivory. In March and April 1995 the area between the Atchafalaya River and the Houma Navigation Channel was surveyed with funding from a federal project related to marsh impacts caused by Hurricane Andrew. In March and April 1996 the entire Barataria-Terrebonne Estuary was surveyed for impact of nutria herbivory with BTNEP funding.

North-South transects were flown throughout the fresh, intermediate and brackish marshes of the Barataria- Terrebonne basins. Portions of Terrebonne, Lafourche, Jefferson, Plaquemines, St. John and St. Charles Parishes were included in the surveys. Transects were spaced approximately 1.8
miles apart, starting at the swamp-marsh interface and continuing south to the beginning of the salt marsh. Due to low nutria population density, salt marsh habitat was not included in the surveys. Approximately 600 miles of transects were flown for each survey (except 1995). Although altitude did vary, depending upon visibility and vegetative conditions, an altitude of300-400 feet was
optimum. At this altitude, vegetative damage was identifiable and allowed for a survey transect width of 1/4 mile on each side of the helicopter. Flight speed was approximately 60 mph.

Two observers were used to conduct the survey, each positioned on opposite sides of the helicopter. In addition to locating vegetative damage, one observer navigated along the transect and the other observer recorded all pertinent data.

When vegetative damage was identified, the following information was recorded (Figure 2).

(1) Location of each site was determined by recording latitude and longitude utilizing GPS equipment. During 1993 and 1995, a Garmin 55 was utilized. If the site was small, an ocular estimate of acreage was made. If the site was large, 3 to 4 coordinates were obtained and the acreage was calculated. For the 1996 survey, a differential GPS (Trimble Pro XL in combination with a Pro Beacon) was utilized to allow for more accurate location of damaged sites. Additionally, for large areas of damage, the circumference of the area was flown, logging in numerous data points so that size of the area impacted could be accurately determined.

2) The severity of damage was classified in one of the following nutria relative abundance rating categories: no nutria sign visible, nutria sign visible, abundant nutria sign, heavy feeding sign, moderate vegetative damage or severe vegetative damage.

3) The dominant plant species in the damaged area that were impacted by nutria feeding activity and those in the adjacent area were identified and recorded.

4) The age of damage and condition was determined from one of the following categories: recovered, old recovering, old not recovering, recent recovering, recent not recovering, or current (occurring now).

5) The prediction of vegetative recovery by the end of 1993 was characterized by one of the following categories: full recovery, partial recovery or increased damage.

6) The number of nutria observed at each site was recorded.

In addition to searching for new damaged sites, all previously identified damaged sites were revisited to assess extent and duration of damage or to characterize recovery. All data were entered into a computer for compilation and transferred to the National Wetlands Research Center (NWRC), National Biological Survey in Lafayette, Louisiana. Personnel at NWRC compiled the 1993 data and prepared five maps, each at a scale of 1: 100, 000, covering the Barataria and Terrebonne Basins. The maps were constructed utilizing the 1988 habitat data with damage rating symbols located at each damaged site detected along transects. A summary of data collected at each site is listed in tabular form at the bottom of each map and in Appendix A. These five maps were submitted to BTNEP in a bound atlas. The 1995 and 1996 survey data was added to the 1993 database and a new herbivory map developed. A data summary is provided on the herbivory map and in Appendix
B.

1993
NUTRIA VEGETATIVE DAMAGE AERIAL SURVEY
(BTNEP)

DATE: _____

TRANSECT # :_____
MARSH TYPE :_____
WAY PINT # : _____ GPS

LAT:_____ LAT:_____
LON:_____ LON:_____

LAT:_____ LAT:_____
LON:_____ LON:_____

LAT:_____ LAT:_____
LON:_____ LON:_____

LOCATION DESCRIPTION

ON TRANSECT _____
EAST OF TRANSECT _____
WEST OF TRANSECT _____

DAMAGE DESCRIPTION

_____DAMAGE NOT RELATED TO NUTRIA FEEDING
_____DAMAGE – STORM RELATED
_____DAMAGE – OTHER _____
_____DAMAGE -- MUSKRAT
_____DAMAGE – NUTRIA

_____ESTIMATED SIZE OF AREA (ACRES)
_____DAMAGED AREA SUBJECT TO TIDAL ACTION: _____YES _____NO

NUTRIA RELATIVE ABUNDANCE RATING

_____NUTRIA SIGN VISIBLE (FEEDING/TRAILS)	(1)
_____ABUNDANT NUTRIA SIGN	(2)
_____HEAVY FEEDING SIGN (MINOR VEGETATIVE DAMAGE)	(3)
_____MODERATE VEGETATIVE DAMAGE	(4)
_____SEVERE VEGETATIVE DAMAGE	(5)

PLANT SPECIES IMPACTED

_____ _____
_____ _____
_____ _____

PLANT SPECIES ADJACENT

_____ _____
_____ _____
_____ _____

AGE OF DAMAGE AND CONDITION

_____OLD RECOVERING
_____OLD NOT RECOVERING
_____RECENT RECOVERING
_____RECENT NOT RECOVERING
_____CURRENT (OCCURRING NOW)

PREDICTION OF RECOVERY BY END OF 1993 GROWING SEASON

_____FULL RECOVERY
_____PARTIAL RECOVERY
_____INCREASED DAMAGE

NUTRIA VISIBLE ABUNDANCE IN AREA

_____WERE NUTRIA SIGHTED: _____YES _____NO
_____IF YES, HOW MANY? _____

PHOTOGRAPHIC RECORD

PHOTOGRAPH 1

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

PHOTOGRAPH 2

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

PHOTOGRAPH 3

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

PHOTOGRAPH 4

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

PHOTOGRAPH 5

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

PHOTOGRAPH 6

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

PHOTOGRAPH 7

CAMERA TYPE: _____35mm SLIDE
_____220 PRINT
ROLL #: _____
LAT: _____
LON: _____

SIDE OF DAMAGE (N, S, E, W) _____
LOOKING (N, S, E, W)_____
ALTITUDE: _____
REMARKS: _____

RESULTS & DISCUSSION

1993 Survey

A total of 51 damaged sites were detected along the transects during the May, 1993 survey. During the December, 1993 survey, these 51 sites were checked and 39 new sites were detect~d. Western Terrebonne Parish, that area between Atchafalaya Bay and the Houma Navigation Channel, contained 37% of the damaged areas detected during the December, 1993, survey. Eastern Terrebonne Parish (North of Lake Boudreaux) contained 4% of the damaged areas. Lafourche Parish contained 21% of the damaged sites. St. John Parish (bordering Lake Des Allemands) contained 12% of the damaged areas and St. Charles Parish (Salvador WMA) contained 10% of the areas. Jefferson Parish and a portion of Plaquemines Parish contained 15% of the damaged areas detected (Table 1). During the May survey a total of 12,614 acres of marsh were estimated to be damaged along transect lines surveyed in the Barataria and Terrebonne Basins (Table 2). In fresh marsh 8,663 acres were detected, in intermediate marsh 656 acres were detected and in brackish marsh 3,295 acres were detected. During December, acres of damaged areas increased to 15,476. In fresh marsh 10,428 acres were detected, in intermediate marsh 1,346 acres were detected and in brackish marsh the damaged areas totaled 3,702 acres. During the May survey approximately 53% of the sites occurred in fresh marsh and during the December survey approximately 54% occurred in fresh marsh. The percentage of sites in the intermediate marsh type increased from 16 in May to 21 in December. The percentage of sites in brackish marsh decreased from 31 in May to 24 in December.

During the May survey, 10% of the damaged sites were classified as heavy feeding sign, 66% of the sites were classified as moderate vegetative damage, and 20% of the sites were classified as severe vegetative damage. The December survey showed similar data with 24% classified as heavy feeding sign, 56% classified as moderate damage, and 10% classified as severe vegetative damage.

We classified each damaged site as to age and level of recovery. This classification was based on observations of recent nutria feeding sign, sprouting plants and exposed soil. Table 3 shows the classifications for the May and December surveys. The higher percentages of recovery recorded during the May survey as compared to the December survey was not surprising considering the new or regrowth that would occur during the summer. The percentage of sites with current damage was 27 during the May survey and 61% during the December survey. This increase in current damage was explained by new damaged sites in December that are a result of the fact that the growing season ended during the fall while nutria feeding continued.

During the May survey we predicted that 90% of the damaged sites would recover, however by December only 38% of these sites actually recovered. Sixty-three percent of the sites that we predicted would partially recover stayed the same. In May only 8% of the sites showed increasing damage, but in December 66% of all sites (May sites and new December sites) showed increasing damage. Table 4 shows the condition of damaged sites detected in May, 1993 and checked again in December, 1993. The number of damaged sites where nutria were sighted was high in May (90%) and dropped only slightly in December (72%). In Mayan average of 55 nutria were sighted in fresh marsh areas with damage. The average was 18 in intermediate marsh and 14 in brackish marsh. During the December survey the average number of nutria observed in a fresh marsh damage area

Table 1. Frequency of nutria damage sites by parish and nutria relative abundance ratins in December, 1993.

Area	Nutria Sign Visible	Abundant Nutria Sing	Heavy Feeding	Moderate Damage	Severe Damage	Totals
Western Terrebonne	3	1	12	15	3	34
Easter Terrebonn (Lake Bourdreaux Area)				3	1	4
Western Lafourche	1		3	1	2	7
Easter Larfourche	1		4	6	1	12
St. John			1	8	2	11
St. Charles	1	1		7		9
Jefferson/ Plaquemines	1		3	10		4

Table 2. Number of acres of damaged vegetation observed on transects in southeast Louisiana during May and December, 1993.

	Fresh	Intermediate	Brackish	Total
May	8,663	656	3,295	12,614
December	10,428	1,346	3,702	15,476

Table 3. Number of damaged areas by age of damage and condition rating.

Number of Areas		
Rating	May 1993	December 1993
Old Recovering	8	8
Old Not Recovering	6	9
Recent Recovering	17	17
Recent Not Recovering	6	1
Current (Occurring Now)	14	55

Table 4. Numbre of damaged sites* by marsh type, by condition classification in December, 1993.

Number of Sites			
Condition	Fresh	Intermediate	Brackish
Recovered	7	4	7
Remained the Same	18	4	8
Increased	2	-	1

*These damaged sites were first deteted in May, 1993.

was 31. In intermediate marsh areas an average of 4 nutria were observed while in brackish marsh the average was 8.

The average estimated size of damaged areas during the May survey was 321 acres in fresh marsh, 2 acres in intermediate marsh and 206 acres in brackish marsh. The average estimated size of damaged areas during the December survey were somewhat smaller. In fresh marsh the average was 213 acres, in intermediate marsh it was 71 acres, and it was 168 acres in brackish marsh.

The plant species most frequently impacted in brackish and intermediate marshes were *Eleocharis* spp. and *Scirpus olneyi.* In fresh marsh the two plants most frequently impacted were *Eleocharis* spp. and *Hydrocotyle* spp. Plant species most frequently found adjacent to damaged areas were *SparlinG patens, Sagittafia lancifolia, Eichhornia crassipes, Myrica cerifera, Panicum hemitomon, Bacopa* spp., and *Bidens laevis.*

Kinler et. al (1987) summarized the literature on vegetative damage caused by nutria. Hillbricht and Ryszkowski (1961) studied nutria in Poland under conditions they considered to be natural, but with higher densities (2-4 animals per acre). They observed that habitat destruction was of two types, focal and linear; focal destruction resulted from patches of destroyed vegetation, whereas linear destruction occurred mainly along the water-land boundary. Their study indicated that vegetation that had undergone complete destruction did not recover rapidly, and regrowth was not evident even after 3 years.

Ehrlich and Jedynak (1962) detailed the successional setback of vegetation caused by nutria activity on a bog lake in Poland. Nutria first began depleting reeds, then moved to higher mineral meadows in 1956. In early 1957, the animals returned to the floating mat and started pulling out rhizomes.
By June, sections of the lake were cleared of the mat and by the end of 1958, the lake was open. In 1960, a boat could travel through the lake and fish became abundant.

Wentz (1971) concluded that *Sagittaria latifolia* and *Typha latifolia* were greatly reduced in abundance in Oregon as a result of nutria. This activity was considered beneficial by creating openings and recycling nutrients in these inland artificial freshwater marshes. But Willner (1982) working in Maryland, concluded that trapping and long periods of cold weather maintained populations at levels low enough to prevent significant marsh damage. More recently U. S. Fish and Wildlife Service officials in Maryland have expressed concern over high nutria populations and related vegetative damage.

In the brackish marshes of southwestern Louisiana, Harris and Webert (1962) evaluated the impact of nutria on vegetation. They concluded that nutria had little permanent effect on *SparlinG patens* and no effect on *Cladium jamaicensis.* Stands of *Scirpus olneyi* were thinned and S. *californicus* was destroyed in some locations. *SparlinG cynosuroides* was largely eliminated. The authors concluded that nutria did not have a major effect on marsh vegetation. Linscombe et al. (1981) found that in brackish marshes with *SparlinG patens* and *Scirpus olneyi* nutria at a density of 9.7 per acre can temporarily damage vegetation and create openings. Some researchers believe that the impact on vegetation resulting from tropical storms has been greater in some areas of coastal Louisiana as a result of heavy grazing by nutria. Apparently this became obvious by observing the high densities of nutria on the Mississippi delta during the late 1950's and much of the 1960's,

followed by the devastating hurricane Camille in 1968 and resulting vegetative loss (T. O'Neil and A. Ensminger, pers. comm.).

Research in the active delta of the Atchafalaya River, Louisiana utilizing exclosures, has indicated that grazing by herbivores has resulted in decreases in plant biomass and changes in dominant plant species (Evers et al., 1993). This research and other work on the emerging delta demonstrate how nutria have impacted succession, organic productivity and deltaic growth (Fuller et al., 1985; Rejmanek et al., 1990; Shaffer et al., 1990). Taylor and Grace (1993) studied nutria herbivory on the Pearl River Wildlife Management Area examining the impact on vegetation in differing marsh types. This study on marsh plant communities did not show the significant impacts found in other studies. If it is assumed that nutria densities in this study area were similar to other areas then the study would indicate that all marshes are not impacted to the same extent and do not recover to the same extent from nutria herbivory.

The results of this initial region-wide aerial survey confirmed that the vegetative damage caused by over-population of nutria was occurring throughout the marshes of both the Terrebonne and Barataria Basins excluding saline marshes (not surveyed, however nutria occur only in low densities). The inactive delta parishes yielded 68% of the nutria harvest during the late 1970's and the early 1980's and represented 63% of the coastal marshes excluding the salt marsh habitat (Linscombe and Kinler 1984). The total harvest showed Terrebonne and Lafourche as number one and two, respectively, in nutria harvest in the inactive delta. Therefore, the occurrence of 41 % of all damaged sites in Terrebonne and 21 % in Lafourche in 1993 is not surprising.

Fresh marshes in the inactive delta produced 50% of harvest and accounted for only 35% of the marsh acreage (Linscombe and Kinler 1984). Thus, in 1993, the occurrence of 53-54% of the damaged sites in fresh marsh and 67-69% of the damaged acres also seems reasonable. Results from mark and recapture experiments collected in fresh floating marshes have shown densities of 18 animals per acre (LDWF, unpubl. data). This data and many years of observation indicate that fresh floating marsh is the highest quality habitat for nutria in Louisiana. It would seem reasonable to conclude that since higher densities of nutria occur in fresh marsh, given an inadequate harvest, damage areas should appear first and be the most numerous as compared to other marsh types. However, fresh marsh appears to have a higher carrying capacity and therefore should be capable of withstanding heavier grazing pressure as compared to other marsh types. Therefore, it would seem logical to conclude that a much larger number of nutria are involved in fresh marsh damage than in intermediate or brackish marsh damage. This is supported by the higher number of nutria sighted in fresh marsh damaged areas, however visibility in fresh marsh is generally much better than in other marsh types.

The fact that 86% of the observed damage in May 1993 was classified as moderate or severe indicates that the vegetative damage was serious. The drop of this figure to 66% during the December 1993 survey would be expected since the May survey followed the winter season with little regrowth and increased food consumption by nutria during colder temperatures. In May we predicted that 90% of the damaged sites would make a full or partial recovery in the near future. However, only 38% of these sites showed some recovery, 56% stayed the same and 6% showed an increase in damage. Our prediction was too optimistic considering only one growing season

between surveys. The very important question of recovery rate can only be answered by conducting subsequent

The average estimated size of damaged areas in 1993 was inflated to some extent by a few very large areas (> 1 000 acres). Appendix A shows the tremendous range in size of these damaged areas from 1 to over 1000 acres. It must be noted that there were several very large (several thousand acres) areas where nutria feeding sign was abundant and perhaps approaching a classification of moderate damage. However, because of the size and difficulty of accurately classifying such a large area they were not included in the survey. Several such areas were observed in the large region of floating fresh marsh North of Bayou Penchant in Terrebonne Parish. Another problem area was observed North of Barataria Bay. In this area, large expanses of very old damage were observed. It was thought that some or most of this damage was related to nutria. However, the condition of these marshes was so deteriorated that we could not be certain about the cause of the damage and therefore did not include these areas in the survey.

This initial survey was an essential first step to address the problem of vegetation damage caused by over-population of nutria. We documented a great deal about distribution, severity, and short term recovery of damaged areas. We detected 91 damaged areas totaling approximately 15,476 acres. Although we would be reluctant to extrapolate, it should be obvious that the total impacted acreage in 1993 was probably several times larger. Over half the damaged areas occurred in fresh marsh while the other areas were influenced by tidal action. Sixty-six to eighty-six percent of the damage was classified as moderate or severe. Furthermore, short term recovery was not as good as we had predicted.

1995 and 1996 Survey

In 1995 we surveyed only Western Terrebonne Parish (Atchafalaya River to Houma Navigation Channel). All previously identified damage sites (33) were reassessed and 23 new sites were located within the area surveyed. A total of 28 sites were located in fresh marsh, 14 in intermediate marsh and 14 in brackish marsh. Damaged areas totaled 1509 acres in fresh, 1592 acres in intermediate marsh and 223 acres in brackish marsh (Table 5). The severity of damage was assessed for each site with the nutria relative abundance rating. Twenty-seven sites were characterized by heavy feeding sign, 11 had moderate vegetative damage and only 1 site had severe vegetative damage. Of the remaining sites, 5 had no current activity, 2 had some minor nutria sign visible and 10 were characterized by abundant nutria sign. Only three sites had recovered from the nutria herbivory that was present in 1993.

Each of the previously identified damaged sites (33) were reassessed in 1995. Based on the nutria relative abundance rating, 58% of these sites had improved by 1995. Degree of damage had increased for 15% of the sites and remained the same for the remaining 27%.

In 1996, the entire Barataria-Terrebonne Basin was surveyed. A total of 158 sites were visited; 97 of which had been previously identified and 61 new sites were located. During this survey, we estimated that 20,642 acres were impacted by nutria herbivory along the transects (Table 6). Terrebonne Parish contained 56% (n=88) of the damaged sites which represented 51% (10,506) of the total acres identified as damaged during the survey. Lafourche Parish accounted for 17% (n=27)

Table 5. Number of damaged sites and acres of vegetation damaged by marsh type along transects in southeast Louisiana during 1995 and 1996.

	1995[1]		1996	
	Number of		Number of	
	Sites	Acres	Sites	Acres
Fresh	28	1,509	70	8,596
Intermediate	14	1,592	42	6,726
Brackish	14	233	46	5,320

[1] Only western Terrebonne surveyed in 1995.

Table 6. Number of damaged sites and acres damaged along transects by Parish in southeaster Louisiana in 1996.

	Number of	
Parish	Sites	Acres
Terrebonne	88	10,506
Lafourche	27	4,766
Jefferson	21	3,321
St. Charles	10	1,268
St. John	8	381
Plaquemine	4	400
Total	158	20,642

of the sites which comprised 23.1% (4766) of the total acres. A total of 21 sites (13.2%) comprising 3,321 acres (16.1%) were located in Jefferson Parish. Ten sites (6.3%) in St. Charles Parish contained 1,268 acres (6.1%). St. John parish contained 8 sites (5.1%) comprising 381 acres (1.8%). The northern portion of Plaquemines Parish, west of the Mississippi River, accounted for 4 sites (2.5%) with 400 acres (1.9%) being damaged.

Fresh marsh habitat contained a higher proportion of the damage sites (44.3%,n=70) and the most acres (8,596 acres, 41.6%) impacted (Table 5). Brackish marsh accounted for 29.1% of the impacted sites (n=46) and 25.8% of the damaged acres (5,320). Intermediate marsh had fewer sites (n=42,26.6%) than in brackish marsh but accounted for 32.6% of the damaged acres (6,726). Average size of damaged sites varied from 160 acres in intermediate marsh, 123 acres in fresh marsh and 116 acres in brackish marsh. In 1996 the damaged acres were more equally divided among habitat types than in the December 1993 survey. In 1993,67% of all damaged acres were in fresh marsh, 24% in brackish marsh and 9% in intermediate marsh.

Each impacted site we visited was classified into one of five nutria relative abundance rating varying from nutria sign visible (feeding activity or trails) to severe vegetative damage. A sixth category was utilized (no nutria sign or activity visible) to describe previously identified damage sites that were revisited and had no current nutria activity. A total of 67% of all damaged sites in 1996 were classified as having moderate or severe vegetative damage (66% of the sites found in December 1993 were placed in these categories). Heavy feeding sign with minor vegetative damage comprised 16% of the sites (24% in December 1993). No identifiable nutria sign or current activity was visible at 20% of 97 previously identified damaged sites.

Each site visited was classified as to whether the nutria herbivory was current, recent or old and whether the damage site was recovering or not recovering. The majority of the sites visited (59%, n=93) were characterized by current, ongoing nutria herbivory. Of the remaining sites, 17% (n=27) were characterized by recent damage with indications of recovery, 9% (n=15) were fully recovered, 9% (n=14) had old damage with some recovery and 6% (n=9) were not recovering. Based on conditions observed in April/May 1996, we anticipated that 83% of all damaged sites observed would recover, to some degree, by the end of the growing season (November 1996). The remaining sites (17%) were predicted to either not recover or for damage to increase.

The plant species most frequently impacted in brackish and intermediate marshes were *Eleocharis* **I**spp and *Scirpus olneyi.* In fresh marsh the two plants most frequently impacted were *Eleocharis* spp and *Hydrocotyle* spp. Plant species most frequently found adjacent to damaged areas were *Spartina patens, Sagittaria lancifolia, Eichhornia crassipes, Myrica cerifera. Panicum hemitomon. Bacops spp., and Bidens laevis*. Of the 97 previously Identified damage sites only 15 had recovered from the observed nutria herbivory. Fourteen of the recovered sites were from the 1993 surveys and 1 was located during the ': 1995 survey. Of obvious significance is that 84.5% of the damaged sites identified in previous surveys were still being impacted by nutria herbivory activity. During the 1996 survey, 61 new damage sites were located along transects indicating continued significant impact of nutria herbivroy throughout the Barataria-Terrebonne Basins. The 20,642 damaged acres in 1996 represents an increase of 5, 166 acres from the December 1993 survey. Although it is difficult to extrapolate or

expand from these survey results to a Basin-wide estimate of nutria herbivory, it is obvious that total acres damaged is probably 3 to 4 times larger than the area estimated by this survey. Additionally, there were many survey miles where we observed obvious nutria herbivory activity but marsh conditions did not warrant a "damage" classification. These areas, should however, be closely observed during future surveys.

Survey results strongly support the need for development of a trapping system which will facilitate significantly higher nutria harvest. The Louisiana Fur and Alligator Advisory Council and the Louisiana Department of Wildlife and Fisheries will continue with marketing projects to encourage improved prices to trappers, however these results suggest that additional economic incentives are needed now. Serious consideration should be given to incentive payments to faciliate increased nutria harvest.

This information should be helpful to local, state, and federal agencies and land companies planning marsh restoration projects and developing marsh management plans. Hopefully it will encourage and assist researchers to initiate research to further improve our understanding of the problem. It has improved the data base available to the LDWF to explain the significance of the problem and suggest potential solutions to decision makers.

In conclusion, nutria herbivory is playing a major role in the Barataria- Terrebonne basins. Direct vegetation removal contributes directly to permanent loss of vegetated wetlands. However vegetative loss is not the only impact observed. Nutria are currently and we suspect have historically, played a major role in species composition throughout this Basin. Of great concern is, only a small fraction of damage sites have recovered since our initial surveys in 1993. Most areas identified during those initial surveys are still being impacted in 1996. These fragile wetlands may not be able to withstand this continued stress in years to come.

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Appendix A. Summary of data collected from each site damaged by nutria herbivory in 1993.

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
1	BRACKISH	29	22.95	91	11.58	2	2	5	3	ELEOCHARIS spp. SCIRPUS OLNEYI
2	BRACKISH	29	23.49	91	10.43	5	5	4	4	ELEOCHARIS spp. SCIRPUS OLNEYI
3	BRACKISH	29	22.36	91	10.65	10	0	4	1	ELEOCHARIS spp. SCIRPUS OLNEYI
4	BRACKISH	29	25.78	91	12.10	0	20	5	4	ELEOCHARIS spp. SCIRPUS OLNEYI
7	FRESH	29	34.91	91	10.53	1	15	4	4	ELEOCHARIS spp. BIDENS LAEVIS HYDROCOTYLE spp.
8	FRESH	29	34.24	91	10.08	981	981	5	3	ELEOCHARIS spp. HYDROCOTYLE spp.
9	FRESH	29	33.86	91	08.24	1317	1317	3	3	ALTERNANTHERA PHYILOXEROIDES ELEOCHARIS spp. HYDROCOTYLE spp.
10	INTERMEDIATE	29	21.54	91	07.67	50	50	4	4	ELEOCHARIS spp. SCIRPUS OLNEYI
11	INTERMEDIATE	29	24.88	91	07.98	115	0	4	3	ELEOCHARIS spp. TYPHA spp.
12	BRACKISH	29	18.42	91	06.54	2	10	5	5	SCIRPUS OLNEYI
13	BRACKISH	29	21.57	91	06.45	5	5	5	1	SCIRPUS OLNEYI
14	FRESH	29	29.86	91	05.86	15	100	4	4	ELEOCHARIS spp. HYDROCOTYLE spp.
16	INTERMEDIATE	29	24.57	91	04.09	5	5	4	3	EICHHORNIA CRASSIPES HYDROCOTYLE spp. SAGITTARIA LANCIFOLIA SPARTINA PATENS SCIRPUS OLNEYI
17	FRESH	29	31.88	91	03.94	0	0	4	3	ELEOCHARIS spp. HYDROCOTYLE spp. BIDENS LAEVIS
18	FRESH	29	27.09	91	02.44	0	0	2	2	ELEOCHARIS spp. HYDROCOTYLE spp.
19	FRESH	29	36.23	91	02.73	20	20	5	4	ELEOCHARIS spp. HYDROCOTYLE spp.

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
21	FRESH	29	31.55	90	58.96	100	100	3	3	EICHHORNIA CRASSIPES ELEOCHARIS spp. HYDROCOTYLE spp.
22	FRESH	29	26.30	90	58.93	188	188	5	1	ELEOCHARIS spp. HYDROCOTYLE spp.
25	FRESH	29	25.13	90	53.23	0	0	4	4	ALTERNANTHERA PHILOXEROIDES ELEOCHARIS spp. HYDROCOTLY spp. TYPHA spp.
62	FRESH	29	32.50	91	07.47	N/A	15	N/A	4	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
63	FRESH	29	28.01	91	07.26	N/A	5	N/A	4	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
64	FRESH	29	28.13	91	07.36	N/A	5	N/A	4	ELEOCHARIS spp. HYDROCOTYLE spp.
65	FRESH	29	36.68	91	05.05	N/A	50	N/A	4	ALTERNANTHERA PHILOXEROIDES ELEOCHARIS spp. HYDROCOTYLE spp.
66	INTERMEDIATE	29	24.56	91	06.10	N/A	25	N/A	3	ELEOCHARIS spp.
67	INTERMEDIATE	29	23.41	91	04.56	N/A	20	N/A	3	SCIRPUS OLENYI
68	FRESH	29	27.52	91	04.18	N/A	100	N/A	3	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
69	FRESH	29	36.74	91	03.32	N/A	25	N/A	3	ELEOCHARIS spp. HYDROCOTYLE spp.
70	INTERMEDIATE	29	24.13	91	02.49	N/A	100	N/A	3	SCIRPUS OLNEYI
71	BRACKISH	29	23.74	91	02.42	N/A	50	N/A	4	SCIRPUS OLNEYI SPARTINA PATENS
72	FRESH	29	28.90	91	00.92	N/A	5	N/A	5	ELEOCHARIS spp. PANICUM HEMITOMOM
73	FRESH	29	27.27	90	58.77	N/A	20	N/A	5	ELEOCHARIS spp. HYDROCOTYLE spp.
74	FRESH	29	30.83	90	56.69	N/A	60	N/A	4	PANICUM HEMITOMOM
75	BRACKISH	29	23.21	90	56.70	N/A	25	N/A	4	SCIRPUS OLNEYI

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
31	BRACKISH	29	26.95	90	38.85	2833	2833	4	4	ELEOCHARIS spp. SCIRPUS OLNEYI
32	BRACKISH	29	25.39	90	37.88	3	3	4	4	SCIRPUS OLNEYI
51	FRESH	29	38.99	90	39.48	2767	2767	4	5	ELEOCHARIS spp. HYDROCOTYLE spp.
57	FRESH	29	44.56	90	25.83	0	1	4	3	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
76	FRESH	29	28.37	90	46.19	N/A	25	N/A	4	ALTERNANTHERA PHILOXEROIDES ELEOCHARIS spp. HYDROCOTYLE spp.
77	BRACKISH	29	25.36	90	41.15	N/A	10	N/A	5	ELEOCHARIS spp. SCIRPUS OLNEYI
78	BRACKISH	29	26.90	90	39.52	N/A	25	N/A	4	ELEOCHARIS spp. SCIRPUS OLNEYI

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
79	FRESH	29	37.19	90	34.37	N/A	25	N/A	3	ELEOCHARIS spp. HYDROCOTYL.E spp.
80	FRESH	29	34.33	90	27.42	N/A	80	N/A	5	ELEOCHARIS spp. HYDROCOTYLE spp. PANICUM HEMITOMOM
81	INTERMEDIATE	29	30.09	90	24.92	N/Z	300	N/Z	4	ELEOCHARIS spp. PASPALUM VAGINATUM
89	FRESH	29	40.38	90	28.30	N/A	10	N/A	3	ELEOCHARIS spp. HYDROCOTYLE spp. TYPHA spp.
95	INTERMEDIATE	29	29.69	90	28.55	N/A	25	N/A	1	ELEOCHARIS spp. SCIRPUS OLNEYI

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
41	FRESH	29	52.92	90	32.30	5	5	1	3	PANICUM HEMITOMOM SAGITTARIA LANCIFOLIA
42	FRESH	29	52.01	90	31.99	709	709	4	4	ELEOCHARIS spp. SAGITTARIA LANCIFOLIA
43	FRESH	29	50.97	90	29.18	2292	2292	4	4	ELEOCHARIS spp. HYDROCOTYLE spp. SAGITTARIA LANCIFOLIA TYPHA spp.
51	FRESH	29	38.99	90	39.48	2767	2767	4	5	ELEOCHARIS spp. HYDROCOTYLE spp.
52	FRESH	29	56.50	90	38.14	10	10	4	4	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
53	FRESH	29	56.65	90	38.96	1	100	4	4	BIDENS LAEVIS HYDROCOTYLE spp.
54	FRESH	29	57.79	90	35.48	40	100	3	3	HYDROCOTYLE spp. PANICUM HEMITOMOM SAGITTARIA LANCIFOLIA
55	FRESH	29	59.06	90	33.86	10	10	4	4	PANICUM HEMITOMOM SAGITTARIA LANCIFOLIA TYPHA spp.
56	FRESH	29	58.97	90	32.61	6	50	4	5	ELEOCHARIS spp. HYDROCOTYLE spp.

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
57	FRESH	29	44.56	90	25.83	0	1	4	3	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
67	INTERMEDIATE	29	23.41	91	04.56	N/A	20	N/A	3	SCIRPUS OLNEYI
82	FRESH	29	53.11	90	38.18	N/A	25	N/A	5	ELEOCHARIS spp. HYDROCOTYLE spp.
83	FRESH	29	54.23	90	37.77	N/A	10	N/A	4	ELEOCHARIS spp. HYDROCOTYLE spp.
84	FRESH	29	54.83	90	37.67	N/A	10	N/A	4	ELEOCHARIS spp. HYDROCOTYLE spp.
85	FRESH	29	54.08	90	37.40	N/A	10	N/A	4	ELEOCHARIS spp. HYDROCOTYLE spp.
86	FRESH	29	57.52	90	37.53	N/A	10	N/A	4	ELEOCHARIS spp. PANICUM HEMITOMOM
87	FRESH	29	57.96	90	30.73	N/A	10	N/A	5	ELEOCHARIS spp. HYDROCOTYLE spp. PANICUM HEMMITOMOM
88	FRESH	29	56.90	90	31.85	N/A	500	N/A	4	ELEOCHARIS spp.
89	FRESH	29	40.38	90	28.30	N/A	10	N/A	3	ELEOCHARIS spp. HYDROCOTYLE spp. TYPHA spp.

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
33	FRESH	29	51.91	90	17.88	1	1	4	4	BIDENS LAEVIS HYDROCOTYLE spp. ELEOCHARIS spp.
34	FRESH	29	51.99	90	17.63	1	1	4	4	BIDENS LAEVIS HYDROCOTYLE spp. ELEOCHARIS spp.
35	FRESH	29	52.02	90	17.50	10	10	4	4	BIDENS LAEVIS ELEOCHARIS spp. HYDROCOTYLE spp.
36	FRESH	29	51.86	90	17.28	1	1	4	4	ELEOCHARIS spp. HYDROCOTYLE spp.
37	FRESH	29	52.18	90	17.15	5	5	4	4	ELEOCHARIS spp. HYDROCOTYLE spp.
38	FRESH	29	48.19	90	14.76	25	25	3	2	ELEOCHARIS spp. TYPHA spp.
39	FRESH	29	49.11	90	09.05	8	10	4	4	ELEOCHARIS spp. ANDROPOGON spp. TYPHA spp.
40	INTERMEDIATE	29	48.93	90	10.44	280	40	4	4	ELEOCHARIS spp. ANDROPOGON spp.
47	INTERMEDIATE	29	40.72	90	07.81	4	4	4	3	ELEOCHARIS spp. HYDROCOTYLE spp. SCIRPUS OLNEYI ELEOCHARIS spp.

Site #	Marsh Type	Latitude		Longitude		Size of Area 5/93	Size of Area 12/93	NRAR 5/93	NRAR 12/93	Plant Species Impacted
48	BRACKISH/INT	29	40.03	90	07.92	1	5	2	3	SCIRPUS OLNEYI
49	BRACKISH	29	39.19	90	08.05	100	100	4	4	SCIRPUS OLNEYI
60	INTERMEDIATE	29	43.08	90	03.16	5	5	4	4	SCIRPUS OLNEYI SPATINA PATENS
61	INTERMEDIATE	29	41.49	90	00.73	10	10	5	4	SCIRPUS OLNEYI ELEOCHARIS spp. TYPHA spp.
91	INTERMEDIATE	29	41.52	90	07.16	N/A	1	N/A	4	SCIRPUS OLNEYI
92	INTERMEDIATE	29	42.12	90	04.40	N/A	100	N/A	3	ELEOCHARIS spp. SCIRPUS OLNEYI.
93	INTERMEDIATE	29	42.16	90	10.06	N/A	5	N/A	4	ELEOCHARIS PARVULA SCIRPUS OLNEYI
94	FRESH	29	52.52	90	17.25	N/A	500	N/A	4	ELEOCHARIS spp. HYDROCOTYLE spp. SACCOLEPSIS STRIATA
96	INTERMEDIATE	29	42.38	90	11.78	N/A	10	N/A	4	SCIRPUS OLNEYI
97	INTERMEDIATE	29	41.90	90	11.93	N/A	20	N/A	4	SCIRPUS OLNEYI
100	FRESH	29	48.50	90	13.00	N/A	10	N/A	1	ANDROPOGON spp. ELEOCHARIS spp. TYPHA spp.

Appendix B. Summary of data collected from each site damaged by nutria herbivory in 1995 and 1996.

Site #	Marsh Type	Latitude	Longitude	Size of Area 95	Size of Area 96	NRAR 95	NRAR 96	Plant Species Impacted
1	BRACKISH	29 22 57.69	91 11 34.8	2	2	2	3	ELEOCHARIS SPP.
2	BRACKISH	29 23 28.80	91 10 25.3	5	5	2	0	ELEOCHARIS SPP.
3	BRACKISH	29 22 21.6	91 10 39.0	3	10	2	3	SCIRPUS OLNEYI
4	BRACKISH	29 25.78	91 12.10	20	20	3	3	ELEOCHARIS SPP.
7	FRESH	29 34 54.6	91 10 31.8	25	1490[1]	3	5	ELEOCHARIS SPP.
8	FRESH	29 34 14.4	91 10 04.8	100		4	5	ELEOCHARIS SPP.
9	FRESH	29 33 51.6	91 08 14.3	25	152	3	4	ELEOCHARIS SPP.
10	INTERMEDIATE	29 21 32.4	91 07 40.1	50	50	2	4	ELEOCHARIS SPP.
11	INTERMEDIATE	29 24 52.8	91 07 58.8	115	115	3	2	ELEOCHARIS SPP.
12	BRACKISH	29 18 25.2	91 06 32.4	10	10	0	0	SCIRPUS OLNEYI
13	BRACKISH	29 21 27.3	91 06 22.9	5	5	3	3	SCIRPUS OLNEYI
14	FRESH	29 29 32.4	91 05 36.6	362	100	4	4	ELEOCHARIS SPP.
16	INTERMEDIATE	29 24 34.2	91 04 05.5	5	5	3	4	SCIRPUS OLNEYI
17	FRESH	29 31 52.8	91 03 56.5	50	50	2	2	ELEOCHARIS SPP.
18	FRESH	29 27 05.41	91 02 26.5	30	30	2	3	ELEOCHARIS SPP.
19	FRESH	29 36.23	91 02.76	20		1		ELEOCHARIS SPP.
22	FRESH	29 26 18.0	90 58 55.9	2	2	3	3	ELEOCHARIS SPP.
25	INTERMEDIATE	29 25 07.8	90 53 13.9	5	5	3	0	ELEOCHARIS SPP.
31	BRACKISH	29 26 57.0	90 38 51.0		30		0	N/A
32	BRACKISH	29 25 23.4	90 37 52.6		10		0	N/A
38	FRESH	29 48 11.4	90 14 45.6		20		3	ELEOCHARIS SPP.
39	INTERMEDIATE	29 49 07.0	90 09 03.1		10		4	ELEOCHARIS SPP.
40	INTERMEDIATE	29 48 55.8	90 10 26.4		30		4	N/A
42	FRESH	29 51 47.0	90 31 31.5		200		3	ELEOCHARIS SPP.
43	FRESH	29 50 58.2	90 29 10.7		200		4	ELEOCHARIS SPP.
45	BRACKISH	29 22 32.4	90 13 29.3		500		5	SCIRPUS OLNEYI
46	INTERMEDIATE	29 33 20.4	90 13 30.0		100		1	SCIRPUS OLNEYI
47	INTERMEDIATE	29 40 43.2	90 07 48.7		4		4	SCIRPUS OLNEYI
48	INTERMEDIATE	29 40 01.8	90 07 55.2		40		4	SCIRPUS OLNEYI
49	BRACKISH	29 38 58.9	90 08 02.3		100		4	SCIRPUS OLNEYI

Site #	Marsh Type	Latitude	Longitude	Size of Area 95	Size of Area 96	NRAR 95	NRAR 96	Plant Species Impacted
50	BRACKISH	29 33 56.4	90 07 40.1		1606		4	SCIRPUS OLNEYI
51	FRESH	29 38 59.4	90 39 28.8		0		2	ELEOCHARIS SPP.
52	FRESH	29 56 35.9	90 38 06.8		100		4	ELEOCHARIS SPP.
53	FRESH	29 56 39.0	90 38 57.5		30		1	ELEOCHARIS SPP.
54	FRESH	29 57 47.7	90 35 28.7		100		1	ELEOCHARIS SPP.
55	FRESH	29 59 08.6	90 33 51.5		10		3	ELEOCHARIS SPP.
56	FRESH	29 58 58.2	90 32 36.6		96		4	ELEOCHARIS SPP.
57	FRESH	29 44 33.6	90 25 49.8		30		1	N/A
58	BRACKISH	29 28 44.4	90 04 18.5		0		0	N/A.
59	BRACKISH	29 26 40.8	90 04 38.2		30		0	SPARTINA PATENS
60	INTERMEDIATE	29 43 04.8	90 03 09.7		20		3	SCIRPUS OLNEYI
61	INTERMEDIATE	29 41 29.4	90 00 43.9		30		0	N/A
62	FRESH	29 32 19.2	91 07 22.9	50	10	4	4	ELEOCHARIS SPP.
63	FRESH	29 28 00.6	91 07 15.6	5	5	2	1	HYDROCOTYLE SPP.
64	FRESH	29 28 18.8	91 07 08.0	5	5	2	2	ELEOCHARIS SPP.
65	FRESH	29 36 40.8	91 05 03.1	50	30	3	0	ELEOCHARIS SPP.
66	INTERMEDIATE	29 24 54.8	91 08 19.4	25	25	0	4	ELEOCHARIS SPP.
67	INTERMEDIATE	29 23 24.6	91 04 33.6	20	20	3	2	SCIRPUS OLNEYI
68	FRESH	29 27 31.2	91 04 28.9	20	5	1	3	ELEOCHARIS SPP.
69	FRESH	29 36.74	91 03.32	25		3		ELEOCHARIS SPP.
70	INTERMEDIATE	29 23.74	91 02.42	100	40	3	4	SCIRPUS OLNEYI
71	BRACKISH	29 23 44.4	91 02 25.1	50	50	3	3	HYDROCOTYLE SPP.
72	FRESH	29 28 54.0	91 00 55.1	5	30	0	0	N/A
73	FRESH	29 27.27	90 58.77	20		0		ELEOCHARIS SPP.
74	FRESH	29 30 49.8	90 59 41.3	30	30	0	0	N/A
75	INTERMEDIATE	29 23 12.6	90 56 42.0	25	15	2	2	ELEOCHARIS SPP.
76	FRESH	29 28 22.2	90 46 11.3	25	25	3	3	ELEOCHARIS SPP.
77	BRACKISH	29 25 21.6	90 41 08.9		10		5	ELEOCHARIS SPP.
78	BRACKISH	29 26 54.0	90 39 31.3		30		0	N/A
79	FRESH	29 37 11.4	90 34 22.1		30		0	N/A

Site #	Marsh Type	Latitude	Longitude	Size of Area 95	Size of Area 96	NRAR 95	NRAR 96	Plant Species Impacted
80	FRESH	29 34 05.9	90 27 20.5		80		3	ELEOCHARIS SPP
81	INTERMEDIATE	29 30 05.4	90 24 55.1		500		5	ELEOCHARIS SPP.
82	FRESH	29 52 58.2	90 38 25.5		5		4	ELEOCHARIS SPP.
83	FRESH	29 54 19.4	90 37 36.2		25		4	ELEOCHARIS SPP.
85	FRESH	29 53 49.9	90 27 38.9		25		4	ELEOCHARIS SPP.
86	FRESH	29 57 47.4	90 37 16.8		10		0	ELEOCHARIS SPP.
87	FRESH	29 57 56.0	90 31 08.2		20		2	ANDROPOGON SPP.
88	FRESH	29 56 54.0	90 31 50.9		488		5	ELEOCHARIS SPP
89	FRESH	29 40 22.8	90 28 18.1		30		0	N/A.
90	INTERMEDIATE	29 37 09.6	90 06 24.1		200		4	ELEOCHARIS SPP
91	INTERMEDIATE	29 41.52	90 07.16		30		0	N/A
92	INTERMEDIATE	29 42.12	90 04.40		100		4	ELEOCHARIS SPP
93	INTERMEDIATE	29 41.95	90 10.07		5		4	ELEOCHARIS SPP
94	FRESH	29 52 31.2	90 17 15.0		100		4	ELEOCHARIS SPP
95	INTERMEDIATE	29 29.69	90 28.55		25		4	ELEOCHARIS SPP
97	INTERMEDIATE	29 42 09.1	90 11 41.6		150		4	HYDROCOTYLE SPP.
98	BRACKISH	29 27 07.2	90 12 05.4		50		4	ELEOCHARIS SPP
99	BRACKISH	29 27 44.4	90 13 58.8		1217		5	SCIRPUS OLNEYI
100	FRESH	29 48 30.0	90 13 00.1		30		0	N/A
101	BRACKISH	29 21 02.4	90 51 37.1	3	25	3	4	SCIRPUS OLNEYI
102	INTERMEDIATE	29 21.61	90 51.68	30		3		SCIRPUS OLNEYI
103	FRESH	29 24 53.4	90 51 34.2	5	10	3	2	ELEOCHARIS SPP
104	INTERMEDIATE	29 24 35.4	90 53 24.7	24	30	4	3	HYDROCOTYLE SPP.
105	INTERMEDIATE	29 22 11.2	90 53 04.2	25	3070	3	4	SCIRPUS OLNEYI
106	BRACKISH	29 21 54.6	90 54 49.3	30	30	3	4	SCIRPUS OLNEYI
107	FRESH	29 31 49.8	90 56 31.2	5	10	5	3	ELEOCHARIS SPP.
108	FRESH	29 25 52.2	90 56 58.9	15	50	4	4	ELEOCHARIS SPP.
109	FRESH	29 31 41.4	90 59 10.7	25	25	4	3	ELEOCHARIS SPP.

Site #	Marsh Type	Latitude	Longitude	Size of Area 95	Size of Area 96	NRAR 95	NRAR 96	Plant Species Impacted
110	FRESH	29 31 28.8	90 49 17.4	5	10	2	0	ELEOCHARIS SPP.
111	INTERMEDIATE	29 23 52.2	90 49 34.7	5	5	3	4	ELEOCHARIS SPP.
112	INTERMEDIATE	29 24 02.4	90 47 49.9	10	10	4	5	ELEOCHARIS SPP.
113	FRESH	29 32 25.2	90 48 10.1	25	25	4	4	ELEOCHARIS SPP.
114	FRESH	29 31 37.2	90 47 40.2	2	10	3	4	ELEOCHARIS SPP.
115	BRACKISH	29 21 30.6	91 00 34.9	25	100	3	4	ELEOCHARIS SPP.
116	FRESH	29 35.86	91 03.98	452		3		ELEOCHARIS SPP.
117	INTERMEDIATE	29 23 33.0	91 03 25.2	1197	24	5	5	ELEOCHARIS SPP.
118	BRACKISH	29 21 15.6	91 02 31.9	10	10	4	5	SCIRPUS OLNEYI
119	FRESH	29 32 10.4	91 07 12.3	5	10	4	0	BIDENS LAEVIS
120	FRESH	29 36 21.0	91 04 22.1	91	984	3	4	ELEOCHARIS SPP.
121	INTERMEDIATE	29 22 22.4	91 06 15.3	1	5	4	4	SCIRPUS OLNEYI
122	INTERMEDIATE	29 21 06.0	91 15 16.9	5	3	3	4	SCIRPUS OLNEYI
123	BRACKISH	29 23 05.4	91 11 45.6	10	10	3	1	SCIRPUS OLNEYI
124	FRESH	29 31 40.731	91 11 46.136		253		5	BIDENS LAEVIS
125	FRESH	29 31 59.1	91 10 08.9		40		4	ELEOCHARIS SPP.
126	FRESH	29 32 44.9	91 10 48.7		45		4	BIDENS LAEVIS
127	FRESH	29 32 45.3	91 09 48.5		113		4	ELEOCHARIS SPP.
128	FRESH	29 34 40.9	91 07 45.7		110		5	ELEOCHARIS SPP.
129	FRESH	29 29 38.5	91 08 02.7		25		4	ELEOCHARIS SPP.
130	BRACKISH	29 17 27.5	91 10 18.2		10		3	SCIRPUS OLNEYI
131	BRACKISH	29 20 59.2	91 15 28.2		5		4	SCIRPUS OLNEYI
132	BRACKISH	29 19 56.6	91 15 40.2		50		3	SCIRPUS OLNEYI
133	BRACKISH	29 20 07.9	91 13 40.8		40		4	SCIRPUS OLNEYI
134	BRACKISH	29 19 01.5	91 13 47.6		235		4	SCIRPUS OLNEYI
135	BRACKISH	29 17 55.9	91 13 52.1		25		3	SCIRPUS OLNEYI
136	BRACKISH	29 18 28.4	91 12 08.2		25		3	SCIRPUS OLNEYI
137	BRACKISH	29 18 31.8	91 11 24.1		20		3	SCIRPUS OLNEYI
138	FRESH	29 35 09.0	91 05 56.7		30		4	ELEOCHARIS SPP.
139	FRESH	29 33 03.8	91 05 47.5		25		4	ELEOCHARIS SPP.

Site #	Marsh Type	Latitude	Longitude	Size of Area 95	Size of Area 96	NRAR 95	NRAR 96	Plant Species Impacted
140	FRESH	29 28 54.4	91 05 44.3		461		5	ELEOCHARIS SPP.
141	INTERMEDIATE	29 24 18.4	91 04 16.4		30		3	ELEOCHARIS SPP.
142	FRESH	29 35 57.8	91 00 48.7		15		4	ELEOCHARIS SPP.
143	FRESH	29 35 30.8	91 00 34.0		2		4	ELEOCHARIS SPP.
144	BRACKISH	29 20 03.8	90 58 27.4		25		4	ELEOCHARIS SPP.
145	BRACKISH	29 20 53.3	90 58 37.3		50		5	ELEOCHARIS SPP.
146	FRESH	29 32 50.3	90 56 09.1		25		4	ELEOCHARIS SPP.
147	BRACKISH	29 20 44.4	90 55 01.2		45		4	ELEOCHARIS SPP.
148	INTERMEDIATE	29 24 24.3	90 54 27.9		25		4	SCIRPUS OLNEYI
149	FRESH	29 24 57.1	90 54 48.3		20		4	BIDENS LAEVIS
150	FRESH	29 31 04.8	90 53 08.9		25		4	ELEOCHARIS SPP.
151	FRESH	29 26 03.3	90 53 25.5		15		4	SCIRPUS OLNEYI
152	BRACKISH	29 17 09.1	90 47 41.7		100		4	SCIRPUS OLNEYI
153	INTERMEDIATE	29 24 31.5	90 47 41.9		50		5	SCIRPUS OLNEYI
154	FRESH	29 31 18.5	90 45 46.2		50		5	BIDENS LAEVIS
155	FRESH	29 29 56.4	90 46 03.0		100		4	ELEOCHARIS SPP.
156	BRACKISH	29 18 46.7	90 45 53.6		50		3	BIDENS LAEVIS
157	INTERMEDIATE	29 29 13.1	90 29 03.2		207		4	ELEOCHARIS SPP.
158	FRESH	29 37 00.9	90 38 45.7		300		4	ELEOCHARIS SPP.
159	FRESH	29 38 13.4	90 39 32.9		5		4	ELEOCHARIS SPP.
160	INTERMEDIATE	29 31 01.4	90 25 32.5		952		5	SCIRPUS OLNEYI
161	BRACKISH	29 29 52.1	90 15 05.6		5		3	SCIRPUS OLNEYI
162	INTERMEDIATE	29 35 02.3	90 13 10.6		60		4	SCIRPUS OLNEYI
163	BRACKISH	29 29 11.4	90 11 55.0		10		4	SCIRPUS OLNEYI
164	BRACKISH	29 29 09.1	90 12 32.9		30		4	SCIRPUS OLNEYI
165	BRACKISH	29 28 54.6	80 11 29.5		30		4	SCIRPUS OLNEYI
166	BRACKISH	29 26 53.4	90 09 01.7		15		4	SCIRPUS OLNEYI
167	FRESH	29 54 51.6	90 37 04.7		10		4	SCIRPUS OLNEYI
168	FRESH	29 59 49.3	90 31 17.9		200		4	ELEOCHARIS SPP.
169	FRESH	29 54 24.8	90 29 19.7		100		4	ELEOCHARIS SPP.

Site #	Marsh Type	Latitude	Longitude	Size of Area 95	Size of Area 96	NRAR 95	NRAR 96	Plant Species Impacted
170	FRESH	29 49 38.3	90 29 34.7		150		4	HYDROCOTYLE SPP.
171	FRESH	29 55 24.8	90 28 18.6		255		4	ELEOCHARIS SPP.
172	FRESH	29 38 03.6	90 25 30.5		5		4	ELEOCHARIS SPP.
173	INTERMEDIATE	29 48 17.1	90 09 59.2		50		4	ELEOCHARIS SPP.
174	INTERMEDIATE	29 46 03.6	90 08 18.2		88		4	SCIRPUS OLNEYI
175	INTERMEDIATE	29 41 19.3	90 10 28.4		25		4	ELEOCHARIS SPP.
176	INTERMEDIATE	91 36 47.4	90 06 20.8		10		4	ELEOCHARIS SPP.
177	INTERMEDIATE	29 44 38.5	90 05 31.3		523		4	ELEOCHARIS SPP.
178	INTERMEDIATE	29 43 02.1	90 05 28.1		25		4	ELEOCHARIS SPP.
179	INTERMEDIATE	29 40 01.3	90 00 58.6		15		4	ELEOCHARIS SPP.
180	BRACKISH	29 33 34.4	90 00 47.6		20		4	SCIRPUS OLNEYI
181	BRACKISH	29 32 59.0	90 00 16.5		300		4	SCIRPUS OLNEYI
182	BRACKISH	29 33 03.2	89 58 29.0		100		4	SCIRPUS OLNEYI
183	BRACKISH	29 33 17.6	89 56 27.7		250		4	SCIRPUS OLNEYI
184	BRACKISH	29 31 47.5	89 56 23.0		20		5	SCIRPUS OLNEYI

[1]Areas 7 and 8 were combined when estimating size

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