Final Report

Re-survey and Inventory of the Mammals of Jean Lafitte National Historical Park and Preserve,

Barataria Preserve

(Cooperative Agreement H7530100057)

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ABSTRACT

This report describes a re-survey inventory of mammal species occurring in the Barataria Preserve of Jean Lafitte National Historical Park and Preserve (JLNHPP) located in southeastern Louisiana. Field studies were conducted from April 2011 to June 2012. Small and medium-sized mammals were observed using live trapping, motion-triggered cameras, and field observations of tracks and sign. Large mammals were observed using motion-triggered cameras, and field observations of tracks and sign. Bats were documented using mist nets and electronic bat detectors. Field work included 2,636 trap-nights (live trapping), 5,627 camera-days (motion-triggered cameras), 18 net-nights (bat netting), and 63 detector-nights (bat electronic detection).

25 species of mammals were documented or confirmed as occurring in the marsh, swamp, bottomland hardwood forests, and on the natural and man-made spoil banks of waterways (bayous and canals). The following were especially noteworthy findings:

- Documentation / confirmation of 7 species of bats inhabiting Barataria Preserve, especially including Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and the southeastern myotis (*Myotis austroriparious*) both of which are considered uncommon in southeast Louisiana.

- Confirmation of continued maintenance of a maternity colony of the evening bat (*Nycticeius humeralis*) using bridge supports at Kenta Canal on Bayou Coquille trail. Confirmation of marsh rice rats (*Oryzomys palustris*) and white-footed mice (*Peromyscus leucopus*) as the resident rodent species in marsh and bottomland hardwood forests, respectively.

- Documentation of a large, resident population of feral hogs (*Sus scrofa*) in all major habitats in the park.

- Documentation of coyotes and bobcats at hardwood forest, swamp, marsh, and spoil bank habitats

- Documentation of large mammals and establishment of baseline data set of motion-triggered camera traps with seasonal data.

INTRODUCTION

1. DESCRIPTION OF JLNHPP AND STATEMENT OF PROBLEM

The following is a brief description of the Barataria Preserve of JLNHPP that will place the present study in an appropriate context to understand the problem addressed in the mammal inventory.

A. General Description.

Barataria Preserve. The Barataria Preserve of JLNHPP is a large and diverse natural area located a few miles south of New Orleans on the westbank of the Mississippi River The park unit is found within the Barataria Basin which historically derived its freshwater from the Mississippi River at its northern edge. Nearly 70% of this park unit is comprised of marsh habitats. The marshes of the region vary from highly productive freshwater and intermediate marsh systems to areas that are being severely degraded by saltwater intrusion and erosion. Lakes Cataouatche and Salvador are large, shallow freshwater systems that form the entire western boundary of this park unit. Additionally, over 30 miles of man-made canals, mostly dredged in the mid-1900s for oil and gas exploration, course through the area. The spoil banks of these canals support diverse plant and animal communities. Swamps dominated by bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), and dwarf palmettos (*Sabal minor*) are found bordering the marsh systems as one travels eastward towards the forested areas. Several natural bayous course through the area, supporting bottomland hardwood forest systems. The most heavily forested region of the unit is comprised of about 800 hectares (2,000 acres) east of Bayou des Familles (along LA Hwy 45). Recently, a large area of swamp habitats in Bayou aux Carpes was added to the park.

This general description of the Barataria Preserve reveals that very diverse, complex, and productive ecosystems exist within this park unit. The marsh habitats include unique ecological assemblages, including flotant (floating) marshes. Swamp zones are found both west and east of Bayou des Familles. The bottomland hardwood forests of the more upland areas adjacent to and east of Bayou des Familles include some of the last remnant forests of the Barataria Basin south and west of New Orleans and the Mississippi River. Finally, a unique aspect of this park unit is that public hunting, trapping, and fishing are permitted and incorporated into the park management. The extensive marsh systems that comprise the western two-thirds of the Barataria Preserve support populations of waterfowl, furbearers, fish, and shellfish that can be accessed and harvested (under appropriate permits) by the public.

B. Historical Studies, Previous (Non-Mammalian) Inventories and Current Projects.

Historical studies. Because JLNHPP was established in 1978, limited NPS-sponsored studies have been conducted on the natural history of its park units. In 1991, Betsy Swanson published a history of the Barataria Preserve, with special emphasis on the forested (upland) areas adjacent to Bayou des Familles. The forests and swamps of the Barataria Preserve have been heavily used and modified by people of the region for over 2000 years, resulting in substantial changes

in the physical landscape, as well as the historic flora and fauna. Native Americans, French, Canary Islander, and American settlers successively occupied and farmed the forested higher grounds of the Barataria Preserve (Swanson 1991). However, during the past 100 years, these forested/agricultural areas have undergone secondary succession. In the absence of agriculture, logging and other land-use practices, the bottomland hardwood forests are returning to more natural forest systems.

The marsh habitats of the Barataria Preserve have experienced significant physical and biotic change, as well. Beginning in the mid-1900s, exploration for oil and gas deposits in the Barataria Preserve marshes resulted in the single most significant factor effecting coastal wetlands in Louisiana today – the dredging of canals for oil/gas exploration and navigation. Canal dredging has resulted in over 30 miles of canals coursing through the Barataria Preserve, as well as hundreds of miles of canals connecting this region to the Gulf of Mexico. These canals and their spoil banks have severely altered the natural hydrological systems, effectively subdividing large estuarine systems into fragmented habitat islands. They also provide access of saltwater from gulf coastal waters to intrude into freshwater and intermediate marsh areas. During the past 50 years, the combined effect of disrupting freshwater (and sediment) flow into Barataria Preserve marshes, together with saltwater intrusion, has caused significant degradation of the western boundary of the Barataria Preserve marshes and swamps.

C. Mammal Inventories and Ongoing Mammal Studies.

Historical mammal inventories. Hood (2006) reported the results of a two year mammal inventory with field work from 2003-2005, that is the basis for this re-survey. As described in that final report, two superficial mammal inventories had been conducted in the Barataria Preserve (Smalley 1982, Demastes and Rossman 1989) and both of these are considered incomplete. Smalley's (1982) study was part of a general survey of the fauna of the forested areas of the Barataria Preserve and did not undertake a collection protocol that would have documented mammal species with voucher specimens. Demastes and Rossman's (1989) study was a more systematic effort, which included study of Lowery's (1974) specimen and species distribution lists, as well as confirmation of specimens housed at the LSU Museum of Natural Science (LSUMNS). The survey did include some trapping and observational protocols, but yielded only a limited number of voucher specimens.

The mammalian fauna of southeast Louisiana is rather poorly known. George Lowery's (1974) *Mammals of Louisiana and Adjacent Waters* remains the most comprehensive professional reference, although it is now nearly 40 years out of date. In 1994, Choate et al. published the *Handbook of Mammals of the South-Central States*, which provided an updated, but very general reference to the mammals of the south including Louisiana. This publication has distribution maps, but lacks voucher specimen lists or locality symbols to identify specific locations to document distribution and status of mammal species. Few distributional studies have been published since Lowery (1974), although several dissertations have focused on specific taxa {e.g., gray squirrels (*Sciurus carolinensis*), Moncrief 1993; bats, Lance 1999, Lance et al. 1996, Lance et al. 2001}. Additional recent publications on mammals of southeast Louisiana include studies of mammals that are deposited at the Tulane Museum of Natural History (TMNH), which are described further, below (Jones 1967, Jones, 1975, Suttkus and Jones 1991, Suttkus and Jones 1999).

Although not expected to be encountered, any records or observations of the Louisiana black bear or Florida panther, the two listed endangered species of mammals in Louisiana, would be remarkable. In addition to these native mammals, it is expected that introduced and domesticated mammals will be encountered and documented. The distribution and abundance of introduced rodents (especially *Rattus* spp.), feral hogs, domestic dogs and cats are of special concern in JLNHPP.

Reference collections at Tulane Museum of Natural History (TMNH) and LSU Museum of Natural Science (LSUMNS). The major systematic collections housing mammals from southeast Louisiana, including the Barataria Basin, are found in the TMNH and the LSUMNS. Lowery (1974) provided detailed lists of the mammal holdings of both of these collections through about 1972. However, beginning in the mid-1980s, field collections of small mammals were undertaken by students and faculty of Tulane University, yielding over 4,000 mammal specimens from southeast Louisiana. Most of these specimens, including bats, are from bottomland hardwood and natural levee and spoil bank habitats in northern Plaquemines and Jefferson parishes, which are very similar to those found at the Barataria Preserve. Therefore, a large reference collection of rodents and bats from nearby localities was an important resource for the present mammal inventory project.

E. Statement of Problem.

The present mammal inventory provides baseline data on the status and relative abundance of mammals in the Barataria Preserve of JLNHPP.

As described in the Statement of Work provided by the JLNHPP resource managers, Hood (2006) represents the baseline mammal species list and species status. **In addition to re-surveying (re-sampling) all mammal species, the status of feral hogs and other large mammals (especially carnivores) is the special focus of this current study.**

The following outlines the specific tasks conducted in this mammal inventory project that provide the needed baseline data and accommodate the Basic Inventory Standards and the Statement of Work for JLNHPP.

To address the JLNHPP Statement of Work, this mammal species inventory included:

- documentation and status of bats
- documentation and status of small/medium mammals (rodents, lagomorphs, Virginia opossums, nine-banded armadillos)
- documentation of large mammals (carnivores, ungulates)
- collection of voucher specimens and associated data for newly recorded species (only species previously un-documented).

Existing species lists and collections reviews:

- search of historical and recent literature
- search/review of reference specimens from nearby localities housed at TMNH and LSUMNS

Sampling protocols used included:

- mist netting and electronic monitoring of bats
- live-trapping of small and medium-sized mammals
- photographic / observational methods for large mammals
- non-invasive marking (passive integrated transponder; hereafter PIT, tags) of all captured mammals
- global positioning systems (GPS) data collected for all encountered mammals

Sampling design to address diverse habitats in Barataria Preserve of JLNHPP included:

- sampling of marsh and spoil bank habitats -- boat travel
- sampling of swamp habitats
- sampling of forest and upland habitats
- use of seasonal collection protocols
- use of GPS data and PIT tags to document occurrence and relative abundance in habitats

Scientific identification included:

- current mammalian nomenclature to species level
- identification by comparison of voucher specimens to reference collections

2. RESEARCH DESIGN AND PROTOCOLS

This section describes the specific research design and protocols.

A. Existing Species Lists and Collections

Historical and recent literature on mammals recorded from the Barataria Preserve and Battlefield adjacent areas were reviewed. Major general references include Lowery (1974) and Choate et al. (1994). Recent relevant literature reporting data on mammals of southeast Louisiana were consulted, especially for nearby study sites. The mammal collections of TMNH and LSUMNS were surveyed in Hood (2006) and updated for this present study.

Examination of existing voucher specimens from the Barataria Preserve. Hood (2006) reviewed previous inventory reports by Smalley (1982) and Demastes and Rossman (1989). The general study by Smalley (1982) did not collect any mammal voucher specimens.

The full species list documented in Hood (2006) included mammal 24 species and represent the baseline species inventory that is the basis of the present study.

B. Sampling Designs and Protocols

Overall sampling design. Mammals were documented using capture techniques (live-traps, capture by hand, and mist nets), though observational methods including electronic detection of bats, and motion-activated cameras, and through examination of mammal sign (tracks, scat). Logistical challenges in the Barataria Preserve (and in southeast Louisiana, generally) are very substantial and include, a) difficulty in accessing habitats in wet terrain (especially in inundated forests and swamps), b) extreme heat during the summer which limits mammal activity and poses health risks to investigators, c) seasonal migratory habits of some taxa (especially several species of bats), and d) access to most areas of the park by the general public. The sampling of marsh habitats that comprise nearly 70% of the Barataria Preserve required extensive use of boat travel and fieldwork within marsh vegetation.

Documentation of the occurrence and status (relative abundance) of bats, small/medium mammals, and large mammals inhabiting the diverse habitats and ecological associations of the Barataria Preserve required specific sampling protocols that address the biology of each of these groups of taxa. The sections below describe the specific protocols, references, and adaptation to the present project.

Count-per-unit-effort (CPUE). In any study of field organismal monitoring, it is critical to standardize collection effort to make comparisons across the sampling units that are collected. In mammalian ecological and biodiversity studies a common method is to calculate count-per-unit-effort (CPUE) which is simply the observation or data recorded adjusted per sampling unit

or design. CPUE can be calculate by sampling unit (e.g., at a given site) or for some period of time (e.g., per year or study), or a given method (e.g., comparing different specific methods). In the present study, CPUE was calculated for all mammal data as follows:

- For bats using mist-netting protocols, CPUE is, bats collected per bat net-night, where captures are live-captured bats and net-nights are the number of mist nets deployed at a site or time period.

- For bats using electronic detection protocols, CPUE is, bat pass sequences per detector-night, where detector-nights are the number bat detectors deployed at a site or time period. In

- For live-trapped mammals, CPUE is animals live-captured per trap-night, where trap-nights are the number of traps deployed at a site or time period.

- For camera-trap protocols, CPUE is animals photographed (trigger events) per camera-day, where camera-days are the number of camera-traps deployed at a site or time period.

Documenting bat species. Although bats can be observed flying at dusk or on moonlit nights, documenting occurrence and abundance of species requires capture and observational methods (Jones et al. 1996, Kunz et al. 1996, ASM 1998, Kunz and Kurta 1988). Bats are typically mist-netted as they leave diurnal roost sites or as they forage during the evening (Kunz and Kurta 1988). There are no caves and few other natural structures that allow roosting of very large colonies of bats in Louisiana (Lowery 1974). Most bats occurring in the region roost in small to medium-sized colonies (*Nycticeus humeralis*), in small groups (*Corynorhinus rafinesquii*), or singly (*Perimyotis subflavus* and lasiurines). Thus, mist-netting and electronic detection focused on foraging sites and required an intensive field effort.

Electronic detection of bats as a method for identification of species to document their occurrence and relative abundance has developed rapidly in recent years (for reviews see Anderson and Miller 1977, Fenton 1988, Kunz et al. 1996). These methods record the ultrasonic echolocation calls of bats and, provided that call libraries exist for the species encountered at the study site, the calls can be identified by their quantitative bioacoustic signature pattern. A large literature of field and laboratory studies has demonstrated the utility and limitations of electronic detection for species identification of bats (O'Farrell and Gannon 1999, O'Farrell et al. 1999, Robbins et al. 1999, Parsons et al. 2000). The principle benefits of using electronic detection is the ability to identify individuals that cannot be captured with mist-nets due to the height or style of their flight. Additionally, species identification without handling during capture promises to reduce stress or damage to rare or endangered species. Use of electronic detection in inventory and monitoring programs has become widespread (Lance et al. 1996, Britzke et al. 1999, Murray et al. 1999). However, the studies cited have demonstrated that it is critical to develop a high quality, local call library and to include mist-netting to confirm occurrence of species at a given locality. Most studies have demonstrated that electronic detection records some taxa that mist-netting misses, but it also can fail to record some taxa that are captured by mist nets. Electronic detection proved very useful and powerful tool to document occurrence and abundance of bats in concert with mist-netting in the present mammal inventory.

Specific localities and sampling effort for bats at JLNHPP. – Maps illustrating the sites for documentation of bats and photos of field methods are shown in **FIGURES 1, 2A.**

Electronic monitoring of bat calls at Barataria Preserve were coordinated with mist-netting to maximize efficiency of effort. Two to six ANABAT bat detectors and field crews were used simultaneously in different areas at a field site to allow data to be collected in different areas of the park. Captured bats were recorded, GPS data collected, PIT tagged (see below), and calls recorded (for call library if needed). In addition to development of call libraries from bats collected on site, call libraries constructed by Hood (2006) included confirmed species from Barataria and from bats collected from nearby locations.

The **Barataria Preserve** includes diverse habitats that are divided for the purposes of this description into four major areas – 1) the bottomland hardwood forests east of Bayou des Familles (LA Hwy 45) at the extreme eastern boundary of the park, 2) the swamp and hardwood forest habitats west of Bayou des Familles (LA Hwy 45), 3) the swamp and hardwood forest habitats of the Bayou aux Carpes area, and 4) the marsh habitats encompassing the western two-thirds of the unit. Mist netting and electronic detection sampling sites were established within the bottomland hardwood forest sites east of Bayou des Familles, at sites along Bayou Coquille that include swamp habitats transitioning to marsh, and at sites along natural levees and spoil banks of the marsh habitats in the western two-thirds of the unit. Standard 3 by 10-meter nylon mist nets (2-5) were deployed at each site each night.

Documenting small and medium-sized mammals. Small to medium-sized non-volant mammals include insectivores, rodents, lagomorphs, Virginia opossums (*Didelphis virginiana*), and small carnivores {e.g., weasels (*Mustela* spp.)}. Standard methods for documenting specific species are effected by their natural history; however, generally live-trapping methods are required (Jones et al. 1996). Observational methods included visual sightings during the day and crepuscular periods and identification of sign (tracks, feeding activity, scat).

Specify localities and sampling effort for small/medium mammals at JLNHPP. – Maps illustrating the sites for documentation of small/medium sized mammals and photos of field methods are shown in **FIGURES 3-7**.

Rodents (including native and introduced mice, rats, squirrels), lagomorphs, Virginia opossums, and small carnivores were documented by live-trapping and observation (identification of sign, visual observation, road-killed specimens, use of motion-activated still cameras). Live-trapping transects were located in the two areas previously studied in Hood (2006) within the Barataria Preserve. Sherman live traps (small rodents), Havahart #1 traps (squirrels, small carnivores), Havahart #2 traps (squirrels to opossums). Live traps were monitored nightly and closed or removed when not attended. GPS location data, environmental data, habitat description and field identification of species were made at each capture. All captured mammals were PIT-tagged for identification. Only individuals representing a newly documented species

was sacrificed and saved as voucher specimens (with all data, including GPS location data).

At the Marsh Trapping Site (**FIGURES 3-4**), three Sherman live-trap lines were set at 5 m intervals between traps on marsh vegetation. A total of 200 traps were checked each morning for 4 days for a total of 800 trap-nights of trapping effort. At each capture, rodents were identified, sexed, measured, weighed, and marked or noted as a re-capture and released, and GPS location of the trap recorded (see **FIGURE 5**).

At the Hardwood Forest Trapping Site (**FIGURES 6-7**), two Sherman live-trap lines were set at 5 m intervals between traps on the forest floor. A total of 100 traps were checked each morning for 9 days for a total of 1,800 trap-nights of trapping effort. At each capture, rodents were identified, sexed, measured, weighed, and marked or noted as a re-capture and released, and GPS location of the trap recorded (see **FIGURE 7**). At this site 4 Havahart traps were set and checked each day (total of 36 trap-nights) with the same protocol.

Documenting large mammals. Large mammals present challenges to collection and observation. Typically they are much less abundant and move greater distances on a daily basis than smaller mammals. Live-trapping and handling large mammals is difficult (Jones et al. 1996). Standard techniques for documenting large mammals include observational protocols, focused live-trapping for specific species, and observation of sign (tracks, scat) and road-killed animals (Rudran et al. 1996, Wemmer et al. 1996).

Specify localities and sampling effort for large mammals at JLNHPP. – Maps illustrating the sites for documentation of large mammals using motion-activated digital cameras and sign are shown in **FIGURES 8-15**.

Large mammals in the Barataria Preserve include white-tailed deer (*Odocoileus virginianus*), feral pigs, native and domesticated canids and felids, raccoons, and nine-banded armadillos. Some of these taxa were observed visually during daylight hours or at dawn and dusk, which varies seasonally. Others are nocturnal. Species were documented by observation (identification of sign, visual observation, road kill specimens, and use of remote still cameras). The walking trails and roads that course through the bottomland hardwood forest habitats are major routes of movement for these mammals, as are the natural levee and spoil banks found throughout the swamp and marsh habitats in the Barataria Preserve. Wildlife monitors (motion-activated still cameras) were placed in major habitats within the Barataria Preserve.

In the previous mammal inventory by Hood (2006), motion-activated SLR (film-based) camera traps were used. These camera-traps had short battery life (30-45 days) and used 35 mm film that limited the system to 24-36 photographs per deployment. The systems generated a date (but not time) stamp on each photograph, however frequently the date was obscured by the background image. The development of digital camera-traps during the past 5 years allows for longer deployments and more detailed data (date, time stamps on each digital image and 30 second re-sets for a new trigger event).

For the present study, two camera-trap systems were used. The protocol for deployment and use of the cameras generally follows TEAM Network (2008) for

terrestrial vertebrate monitoring and is briefly described below. **Cuddeback Capture Game Scouting cameras** with 3.0 megapixel images were used at 35 sites (see FIGURES 8-15 for sites and deployment photographs). Cuddeback cameras have been reviewed as being reliable and affordable for mammal surveys (see recent report by Swann et al., 2011, and Meeks, 2012). Cuddeback cameras were prepared with batteries and SD memory cards prior to deployment in the field. Cameras were set to take photos immediately, and to re-set for another triggering event (a new photograph) in 30 seconds. Each photograph represents a triggering event, although the camera-trap can capture the same individual if that individual remained in the camera triggering zone. At the initial deployment of a camera at a site, the field crew tested the camera to determine the range of triggering (about 10-12 meters at most sites) and that the camera was taking photographs. Upon return to a site, field members walked in front of camera to test whether the camera was still operating and the batteries and SD cards checked (Cuddeback camera traps usually took photographs for 2.5 months without battery changes) and replaced.

Reconyx HC600 Hyperfire cameras were used at 5 sites (see **FIGURES 8-15** for sites and deployment photographs). Reconyx cameras have higher fidelity, have extremely long deployment battery life (up to 6 months), can take photographs at shorter re-setting trigger times, but are 3 x more expensive. Reconyx cameras were prepared and deployed and monitored in the same way as Cuddeback camera traps, except that at each triggering event a burst of 10 photographs are taken, followed by a 10 second re-set to the next triggering event. Therefore, each triggering event generates 10 photographs. Because these cameras re-set at 10 seconds (vs. 30-seconds for Cuddebacks) it is possible for Reconyx systems to capture the same animal (or triggering phenomenon) to generate many thousands of photographs. Reconyx cameras can be prone to taking false triggered photographs by moving vegetation or debris, they can generate 1,000s of non-animal photographs. As described in the RESULTS section, **triggering events** are reported for Reconyx camera-site data in order to make them more comparable to the data generated by Cuddeback systems.

Data management was modified following the TEAM Network (2008) protocol as follows. SD memory cards were "swapped out" at each visit to camera-traps, and cards were brought to a lab where the data were downloaded. Downloaded photographs were labeled with the site and date the photograph was taken – e.g., a photograph taken by Site 1 on December 20th, 2011 has a file label of **SITE01photo2011-12-20.jpg** Data from the sites (total of over 40,000 photographs / files) were examined by viewing the images and recording site/date/time data and scoring them for animals captured in an EXCEL spreadsheet.

Marking captured mammals with PIT tags. To document the occurrence and relative abundance of mammals at JLNHPP all live-captured mammals were marked for identification. Mark/recapture protocols allow multiple observations of individuals and also allow for estimates of species richness, distribution, and abundance by application of established sampling and statistical designs (for general reference. see, Nichols and Conroy 1996). The inventory project is not designed to provide data on population size or density, seasonal variation in abundance, home range or dispersal. However, the mark/recapture data allowed for relative abundance estimates that are preferable to collection without recapture.

Rudran and Kunz (1996) summarized a diversity of marking methods, which have a wide range of characteristics in permanence, reliability, and behavioral or physiological stress on the animals. Among newer methods of marking animals that allows outstanding permanence, reliability, and minimal stress is PIT technology (Camper and Dixon 1988, Ball et al. 1991, Germano and Williams 1993). PIT tags are tiny microchips that respond to electromagnetic fields generated by a reading device, responding with a unique numeric code. The tags have been used extensively in fisheries research and management and more recently have been increasing used by mammalogists and wildlife managers (Fagerstone and Johns 1987, Thomas et al. 1987, Schooley et al. 1993, Williams et al. 1997). PIT tag technology requires an initial capture of individuals and subcutaneous insertion of the tag in a stable location (typically the nape of neck), followed by subsequent recapture of individuals and recording of the tag via the reader/scanner. Tags are considered permanent and continue to respond for over 20 years, well beyond the lifespan of most mammals that would be encountered at JLNHPP.

Wherever possible, every mammal captured was implanted with a PIT tag and a GPS location recorded at the place of capture. This permanently marks (identifies) the individual and records its place of first capture. Subsequent captures (recaptures) will be recorded with GPS locator data. These data will allow detailed records of the occurrence of mammals and also provide a means to estimate relative abundance. Although the study of movement and dispersal are not goals of the inventory project, those data can be extracted from the database. Although monitoring is not a goal of this inventory project, the use of PIT tags also provides a means to permanently mark individual mammals for future monitoring studies at JLNHPP.

Recording GPS and environmental data. The Basic Standard for all inventory projects requires collection of spatial, environmental, and specimen data that will be integrated into the NPS Gulf Coast Inventory and Monitoring Network Geographic Information System (GIS) database. GPS locator data, environmental (weather), habitat description, and specimen data were recorded at every trap location, mist-net and remote still camera location used in this inventory project. As described above, capture data will include field identification of species, recording or insertion of PIT tag information, and voucher information (if the specimen is sacrificed for voucher).

C. Voucher Specimens

Traditional voucher specimens are essential for positive identification and documentation of status. Representative specimens encountered during live-trapping and mist-netting (bats) will be sacrificed and prepared as standard museum study specimens (Jones et al. 1996). **Only specimens representing new records for Barataria Preserve were collected in the current study.** Voucher specimens will be deposited in the Mammal Collections of the LSU Museum of Natural Science.

RESULTS

1. SPECIES LISTS

The following are checklists of the mammal species documented in this study at the Barataria Preserve of JLNHPP.

A. Species List of Documented Recent Mammals – Barataria Preserve

A total of **25 mammal species** were documented as occurring within the Barataria Preserve in Hood (2006) and the present study. Species with asterisk (*) are introduced or domesticated.

ORDER MARSUPIALIA—Marsupials

Family Didelphidae (opossums)
Didelphis virginiana (Virginia opossum)

ORDER CHIROPTERA—Bats

Family Vespertilionidae (vespertilionid bats)
Myotis austroriparius (southeastern myotis)
Perimyotis subflavus (eastern pipistrelle, tri-colored bat)
Lasiurus borealis (eastern red bat)
Lasiurus intermedius (yellow bat)
Nycticeius humeralis (evening bat)
Corynorhinus rafinesquii (Rafinesque's big-eared bat)

Family Molossidae (free-tailed bats)
Tadarida brasiliensis (Brazilian free-tailed bat)

ORDER XENARTHRA—Edentates

Family Dasypodidae (armadillos)
Dasypus novemcinctus (nine-banded armadillo)

ORDER LAGOMORPHA—Lagomorphs

Family Leporidae (hares and rabbits)
Sylvilagus aquaticus (swamp rabbit)

ORDER RODENTIA—Rodents

Family Sciuridae (squirrels and allies)
Sciurus carolinensis (eastern gray squirrel)

Family Cricetidae (native mice and rats)
Oryzomys palustris (marsh rice rat)

Peromyscus leucopus (white-footed mouse)
Sigmodon hispidus (hispid cotton rat)
Ondatra zibethicus (common muskrat)

*Family Muridae (Old World rats and mice)
**Rattus rattus* (black rat)
**Mus musculus* (house mouse)

*Family Myocastoridae (myocastorids)
**Myocastor coypus* (nutria)

ORDER CARNIVORA—Carnivores

Family Canidae (canids)
Canis latrans (coyote)

Family Procyonidae (procyonids)
Procyon lotor (Northern raccoon)

Family Mustelidae (mustelids)
Mustela vison (mink)
Lutra canadensis (Nearctic river otter)

Family Felidae (cats)
Felis rufus (bobcat)

ORDER ARTIODACTYLA— Even-toed ungulates

Family Cervidae (cervids)
Odocoileus virginianus (white-tailed deer)

*Family Suidae (pigs)
**Sus scrofa* (feral hog)

B. Species Reported but Undocumented or No Longer Present – Barataria Preserve

The following species have been reported (in previous NPS inventories, public hunting and trapping records, naturalist reports), or have been observed by NPS staff as occurring within the Barataria Preserve in the past (before 1990). Species with asterisk (*) are introduced or domesticated.

ORDER RODENTIA—Rodents

Family Sciuridae (squirrels and allies)
Glaucomys volans (southern flying squirrel)

Family Castoridae (beavers)
Castor canadensis (American beaver)

Family Cricetidae (native mice and rats)
Neotoma floridana (eastern woodrat)

ORDER CARNIVORA—Carnivores

Family Canidae (canids)
Vulpes vulpes (red fox)
Urocyon cinereoargenteus (gray fox)

2. RESULTS FOR BATS – MIST-NETTING

The following is a summary of the results of documenting bats occurring within the Barataria Preserve. **FIGURES 1-2** illustrate maps and field photographs of sampling localities. A total of 7 site localities, 18 mist net-nights resulted in capture of 4 *Nycticeius humeralis*. The maternity colony of *Nycticeius humeralis* discovered in the bridge supports of the Kenta Canal / Bayou Coquille bridge by Hood (2006) remains intact and is being used by evening bats. Overall netting success was very low and of 4 individuals captured none were recaptures from the 2006 study and none were re-captured during this study. A summary of mist netting effort and results follows:

Summary of **Mist-netting** Results: (**FIGURE 1**)

Site 1 (Bayou des Familles Bridge) 2 net-nights. no captures
Site 3 (Old Barataria trail # 1) 2 net-nights. no captures
Site 4 (Old Barataria trail # 2) 2 net-nights. no captures
Site 5 (Old Barataria trail # 3) 2 net-nights. no captures
Site 6 (Christmas road trail) 2 net-nights. no captures
Site 12 (Kenta Canal trail) 2 net-nights. no captures
Site 13 (Kenta Canal/Coquille Bridge) 2 net-nights,
4 *Nycticeius humeralis* (4 marked/released)

3. RESULTS FOR BATS – ELECTRONIC DETECTION

The following is a summary of the results of electronic detection of bats occurring within the Barataria Preserve. **FIGURES 1 and 2** illustrate maps and photographs of sampling localities and methods. The use of electronic bat detectors at 10 site localities for 63 detector nights resulted in the documentation of 1,809 bat pass sequences and 20,080 bat calls for the 7 species. Of the 1,624 bat pass sequences recorded, 94% were positively identified as one of the 7 species (**FIGURE 2**). The remaining 6% were documented as bat calls but were unidentifiable.

Summary of **Bat Electronic Detection** Results: (**FIGURE 1**)

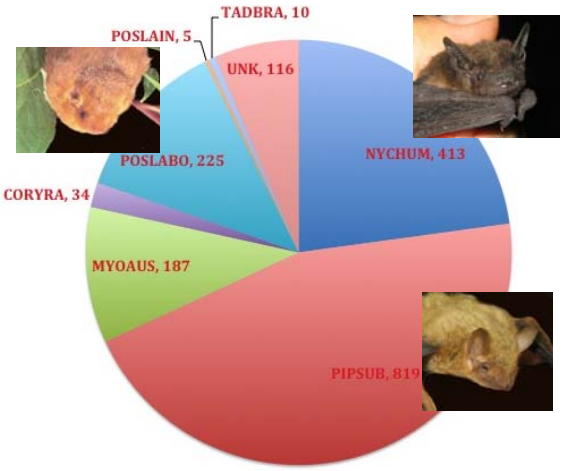
Site 1 (Bayou des Familles Bridge) 2 detector-nights.
Site 2 (Bayou des Familles Canoe Launch) 2 detector-nights.
Site 3 (Old Barataria trail) 2 detector-nights.
Site 4 (Old Barataria trail) 2 detector-nights.
Site 7 (Passive Pumphouse roof) 17 detector-nights.
Site 8 (Passive Education Center) 28 detector-nights.
Site 9 (Coquille trail # 1) 2 detector-nights.
Site 10 (Coquille trail # 2) 2 detector-nights.
Site 11 (Coquille trail # 3) 2 detector-nights.
Site 13 (Kenta Canal/Coquille Bridge) 4 detector-nights.

Bayou / Canal sites: Sites 1,2,13
Swamp sites: Sites 9, 10, 11
Hardwood Forest: Sites 3,4,7,8

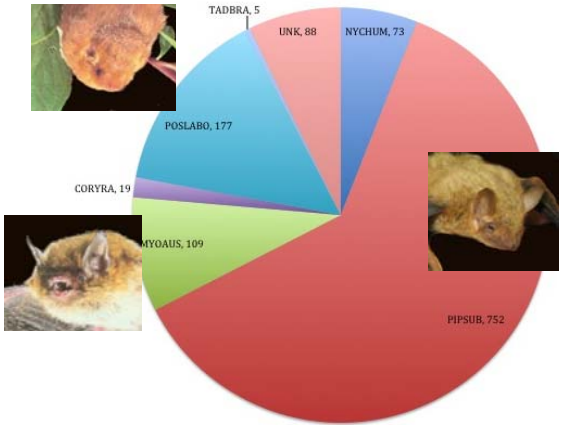
Summary of **Electronic Detection** Results – **by Species**

Species	Number of Sequences	Percent of Sequences	Number of Calls	Frequency Min.
Perimyotis subflavus	819	45.3 %	11,257	42-44
Nycticeius humeralis	413	22.8 %	4,889	35-37
Myotis austroriparious	187	10.3 %	1,809	45-47
Corynorhinus rafinesquii	34	2.9 %	122	47
Tadarida brasiliensis	10	0.6 %	25	27
Lasiurus borealis/seminolis	225	12.4 %	1,709	38-40
Lasiurus intermedius	5	0.3 %	22	26
Unidentified	116	6.4 %	208	
Totals	**1,809**	**100%**	**20,041**	

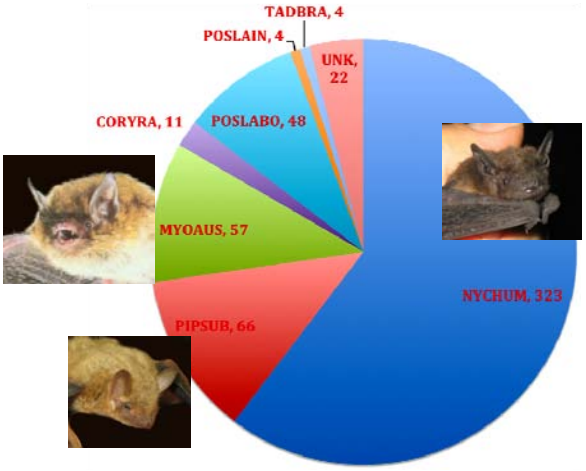
Total Bat Sequences (individuals)



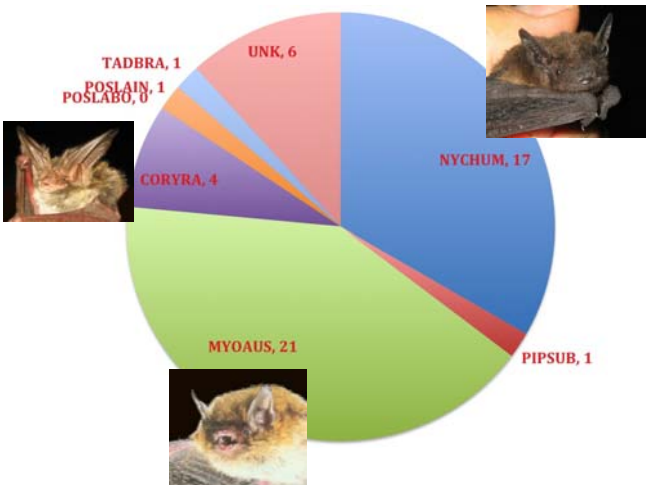
Hardwood Forest Sequences



Bayou/Canal sequences



Swamp (Coquille trail) sequences



Overall, *Perimyotis subflavus* (eastern pipistrelle or tri-colored bat) was the most commonly recorded species (45% of total detector captures), with *Nycticeius humeralis* (evening bat) also being commonly encountered (23% of total detector captures). Southeastern myotis, *Myotis austroriparious*, is also relatively common, although the species is generally uncommon in the region. Recordings of bats at 38-40 mHz, which have the characteristic signature of *Lasiurus borealis* (red bat) and/or *Lasiurus seminolus* (seminole bat) were relatively commonly recorded. Neither of these species of *Lasiurus* have been captured by mist-nets and therefore future studies should focus on clarifying which species (or both species) occur in Barataria. Although much less frequently recorded, electronic recordings of *Lasiurus cinereus*, *Corynorhinus rafesinquii*, and *Tadarida brasiliensis* were made at a number of sites.

Partitioning the data by major habitat type (see pie charts above) reveals that although *P. subflavus* is the most common hardwood forest species, it is less common and *N. humeralis* is most common in swamp / swamp transition habitats (Coquille Trail viewing platforms) and along waterways (Bayou des Familles and Kenta Canal). Because there were more detector-nights at the Hardwood Forest sites (49 detector-nights) compared with the Swamp (6 detector-night) and Bayou (6 detector-night) sites, catch-per-unit-effort (CPUE) were compared. These revealed that despite the much larger data set for Hardwood Forest sites, *P. subflavus* is not only the most common species in that habitat, but it was recorded consistently each night. As an example, comparing 1 night where Hardwood Forest Passive detectors (Sites 7 and 8) were operating at the same time as Bayou site detectors (Sites 1,2) generated the following results that are consistent with the more complete data.

Hardwood Forest Sites on June 30, 2012

Species	**Number of Sequences**	**Percent of Sequences**	**Number of Calls**
Perimyotis subflavus	30	58.8 %	573
Nycticeius humeralis	8	15.7 %	88
Myotis austroriparious	5	9.8 %	39
Corynorhinus rafinesquii	0	0 %	0
Tadarida brasiliensis	0	0 %	0
Lasiurus borealis/seminolis	5	9.8%	104
Lasiurus intermedius	0	0 %	0
Unidentified	2	3.9 %	5
Totals	**51**	**100%**	**819**

Bayou / Canal Sites on June 30, 2011

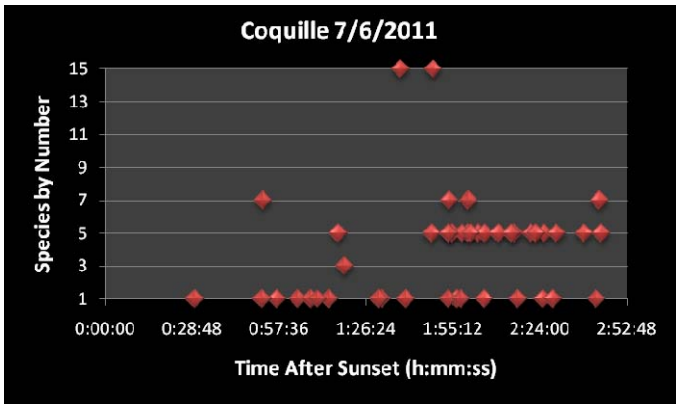
Species	**Number of Sequences**	**Percent of Sequences**	**Number of Calls**
Perimyotis subflavus	36	24.0 %	632
Nycticeius humeralis	69	46.0%	1,018
Myotis austroriparious	20	13.3 %	367
Corynorhinus rafinesquii	1	0.7 %	16
Tadarida brasiliensis	1	0.7 %	4
Lasiurus borealis/seminolis	21	14.0 %	249
Lasiurus intermedius	0	0 %	0
Unidentified	2	1.3 %	4
Totals	**150**	**100%**	**2,290**

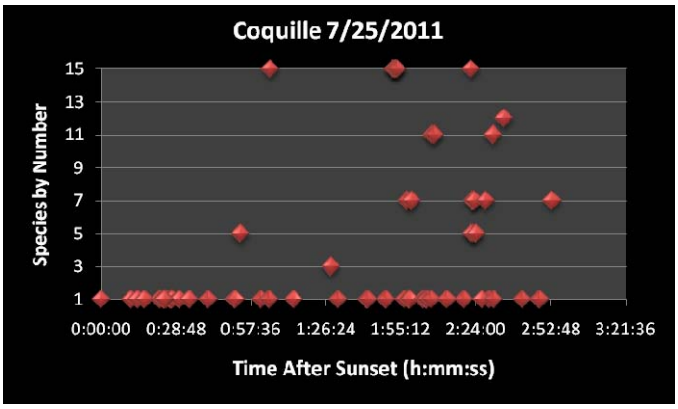
NIGHTY ACTIVITY PATTERNS – TWO EXAMPLES

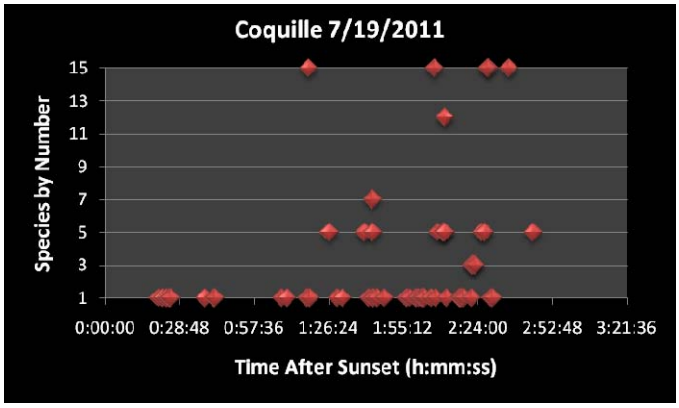
Bats emerge from their roosts shortly after sunset and begin their nightly activity. Below are two examples to illustrate nightly activity patterns by species.

Example with Active Monitoring – Kenta Canal / Coquille Bridge Site 13

The following are activity patterns collected with active monitoring (handheld detectors deployed from sunset to 3 hours after sunset.

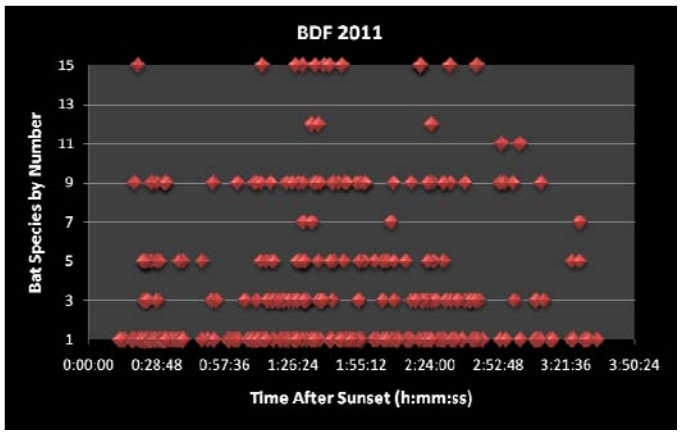






Number	Bat Species
1	*Nycticeius humeralis*
3	*Perimyotis subflavus*
5	*Myotis austroriparious*
7	*Corynorhinus rafinesquii*
9	*Lasiurus borealis*
11	*Lasiurus intermedius*
12	*Tadarida braziliensis*
15	Unknown

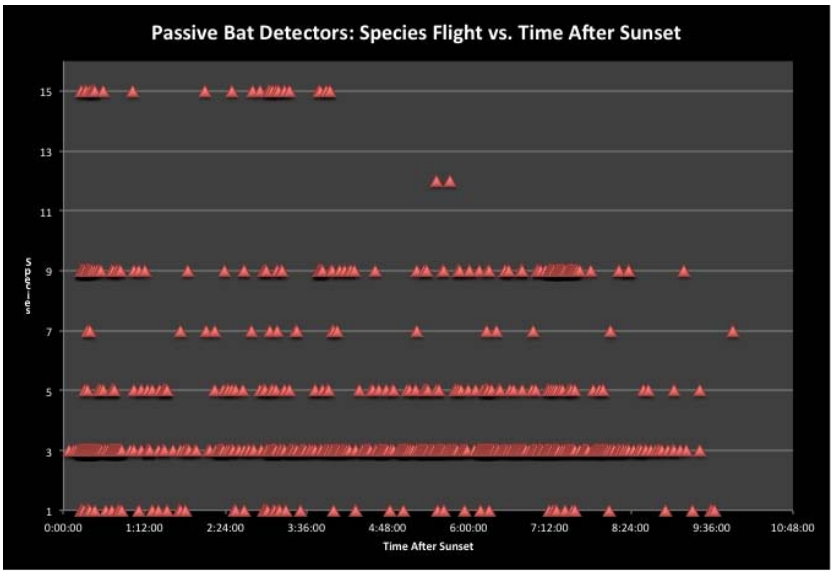
At this site, *Nycticeius humeralis* is the first species to emerge and maintain activity throughout the first 3 hours post-sunset. This is partly attributed to evening bats roosting in the bridge structure nearby. Some species, e.g., *Tadarida brasiliensis* and *Lasiurus intermedius*, are only encountered at this site well after dark.



At right is a summary of nightly activity for active monitoring at Bayou des Familles Bridge (Site 1). *N. humeralis* is the first species to emerge and be active over the bayou, with many other species active over much of the 3 hour monitoring session.

Example with Passive Monitoring – Education Center Passive (Site 8)

The following are activity patterns collected with passive monitoring (detector activates at 6:00 pm each night and ends recording at 6:00 am the next morning) over 28 nights.



Number	Bat Species
1	*Nycticeius humeralis*
3	*Perimyotis subflavus*
5	*Myotis austroriparious*
7	*Corynorhinus rafinesquii*
9	*Lasiurus borealis*
11	*Lasiurus intermedius*
12	*Tadarida braziliensis*
15	Unknown

At this site, *Perimyotis subflavus* is first to emerge, with many other species also recorded in the first 20 minutes after sunset. Activity patterns for most species are uniform throughout the evening, extending until less than 1 hour prior to sunrise (5:00 am). Records for *Tadarida brasiliensis* occur only several hours after sunset and are consistent across other sites. Unknown (unidentified) bat calls are usually early in the evening when there are many bats flying about – likely resulting in "disturbed" echolocation calls.

COMPARISONS WITH PREVIOUS MAMMAL INVENTORY – HOOD (2006)

In the previous study, Hood (2006) reported the results of mist-netting and electronic detection of bats occurring within the Barataria Preserve. In that study, 5 species of bats were collected by mist nets – *Pipistrellus subflavus, Nycticeius humeralis, Myotis austroriparious, Corynorhinus rafiniquii, Tadarida brasiliensis*. **[NOTE: the scientific name of the eastern pipistrelle/tri-colored bat has recently been changed from *Pipistrellus subflavus* to *Perimyotis subflavus*].**

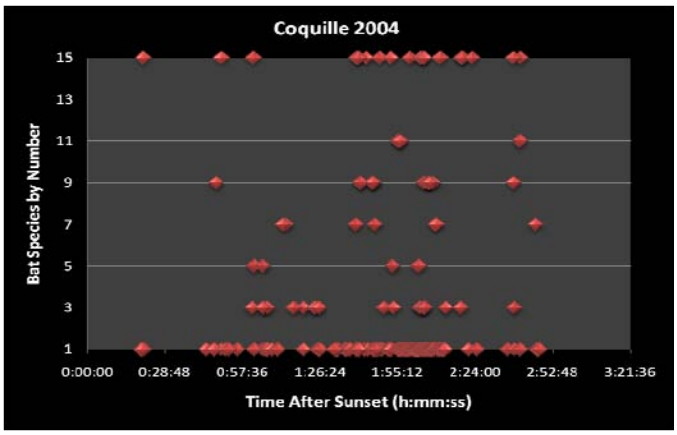
In Hood (2006), electronic bat detectors at 9 site localities for 44 detector nights resulted in the documentation of 1,624 bat pass sequences and 46,745 bat calls for the 5 mist-net captured species, as well as for 2 additional species that were not captured in mist nets: *Lasiurus borealis* (eastern red bat) and *Lasiurus intermedius* (yellow bat). The most frequent species encountered was *Perimyotis subflavus*, which comprised nearly 50% of the bat pass sequences with *Nycticeius humeralis* being very common (>25%).

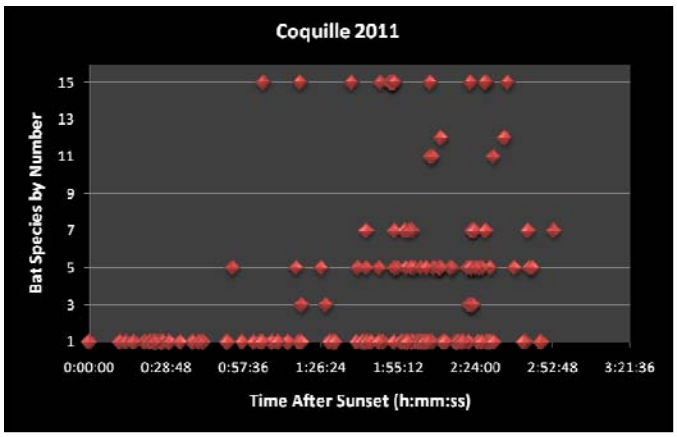
A summary of electronic detecting results in the previous study:

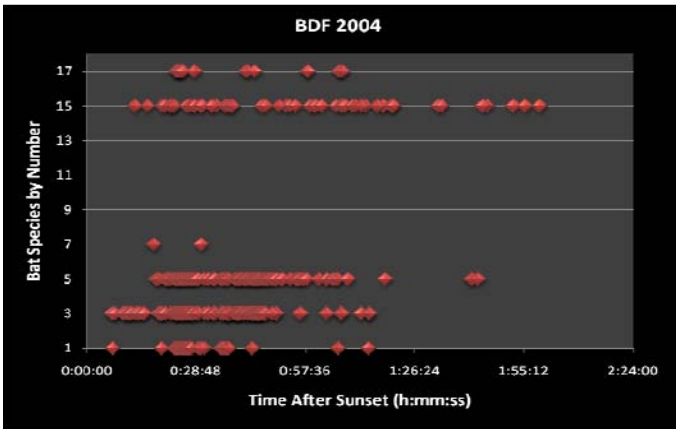
Summary of Hood (2006) Electronic Detection Results – by Species

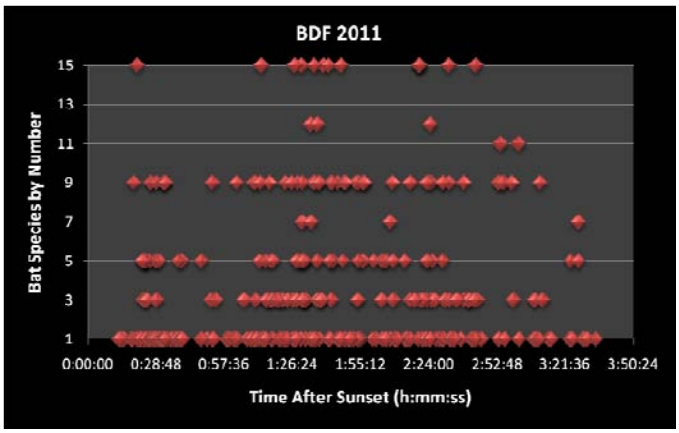
Species	Number of Sequences	Number of Calls	Frequency Min.
Perimyotis subflavus	567	18,650	42-44
Nycticeius humeralis	300	6,526	35-37
Myotis austroriparious	123	3,465	45-47
Corynorhinus rafinesquii	33	458	47
Tadarida brasiliensis	21	409	27
Lasiurus borealis	153	4,785	40
Lasiurus intermedius	3	33	26
Multiple	154	9,112	
Unidentified	270	3,307	
Total	**1,624**	**46,745**	

These overall results are consistent with those obtained in the present study. Below are some comparisons across studies (field work reported by Hood, 2006 was conducted in 2004; field work in the present study in 2011) of nightly activity patterns at Bayou des Familles Site 1 and Kenta Canal/Coquille Bridge Site 13. The Kenta Canal/Coquille Bridge site recorded the same 5 species between studies, however the Bayou des Familles Bridge recorded only 4 species in 2004 compared with 7 species in 2011.









4. TRAPPING RESULTS FOR SMALL/MEDIUM-SIZED MAMMALS

The following is a summary of the results of live-trapping for documenting mammals occurring within the Barataria Preserve. **FIGURES 3-7** illustrate maps and field photographs of trapping localities. A total of **2 site localities**, **6 traplines**, and **2,636 trap-nights** resulted in capture of **98 mammals** (a few of which were recaptures) representing 2 species – *Oryzomys palustris* and *Peromyscus leucopus*, A summary of trapping effort and results follows:

MARSH HABITAT (See maps & field photographs, **FIGURES 3-5**)

At this site, several traplines were placed within flotant marsh. A total of 1 site, 3 traplines, and 800 trap-nights resulted in capturing 54 individuals of *Oryzomys palustris* with 7 additional recaptures of these individuals (total of 61 total captures).

As illustrated and described in **FIGURES 3-5**, the marsh trapping site was flotant marsh off of the WWL Radio Towers near Horseshoe Canal. Traps were set out on February 20th, 2012 and monitored for the next 4 nights/days, ending on February 24th, 2012. The marsh was truly flotant, with heavy overnight rains after the first trapping night resulting in a 6 inch rise in the mat. Trapline 3 passed through wax myrtle stands that were embedded in the flotant. Each night, 200 Sherman live traps were set to capture mammals.

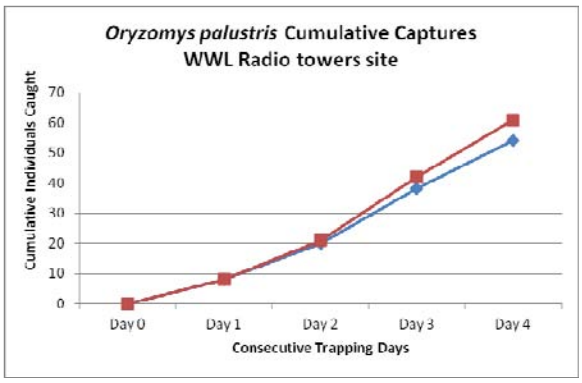
Summary of Marsh Site Trapping Results:

WWL Radio Towers Marsh Site – 3 traplines, 800 trap-nights

- 54 *Oryzomys palustris* (and 7 recaptures) for a total of 61 captures
- 32 Males and 22 Females captured with recaptures of 7 males.
- Weights of Males (mean 35.8, range 13-63 gms), Females (mean 27.2, range 15-52), with 20 individuals $\leq$ 25 gms
- CPUE of 0.070, 6.63 % trapping success rate, 15.09% recapture rate

There was a high number of juveniles/subadults captured (30% of captures) indicating that the population was actively reproducing (trapping was Feb 20-24, 2012) and the high number of males encountered and recaptured (32 of 54 captures of individuals, all 7 recaptures being male) is consistent with the higher activity patterns of subadult male rodents in winter.

The cumulative capture graph, below, illustrates that new individuals continued to be encountered with very few re-captures.



Cumulative capture graph depicts number of total new individuals captured (in BLUE). RED symbols illustrate total captures that include re-captures. On days 3 and 4 a few originally captured marsh rice rats were recaptured.

BOTTOMLAND HARDWOOD FOREST (See maps & field photographs, **FIGURES 6, 7**)

As illustrated and described in **FIGURE 6**, the bottomland hardwood forest trapping site included several traplines. A total of 1 site, 3 traplines, and 1,836 trap-nights resulted in capturing 37 *Peromyscus leucopus* with no re-captures for a total of 37 captures.

The traplines began 100 m N of the southernmost Plantation trail within, bottomland hardwood forest with a moderate level of palmetto (*Sabal minor*) understory. Traps were set out on January 30th, 2012 and monitored for 9 nights/days, ending on February 8th, 2012.

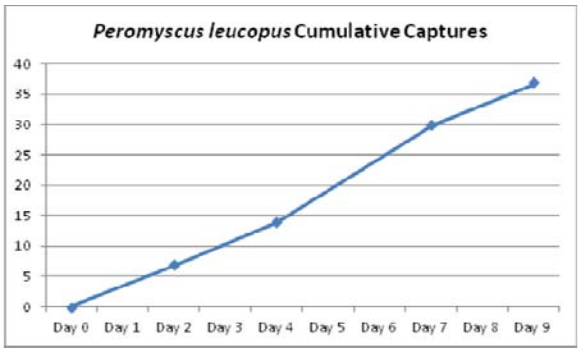
Each night, 200 Sherman live traps and 4 Havahart live traps were set to capture mammals.

Summary of Site Trapping Results:

Plantation Trail Forest Site – 3 traplines, 1,836 trap-nights

- 37 *Peromyscus leucopus* (and 0 recaptures) for a total of 37 captures
- 25 Males, 10 Females, and 2 un-sexed mice were captured.
- Weights of Males (mean 19.3, range 1.5-28.5 gms), Females (mean 18.7, range 10-26), with 8 individuals $\leq$ 15 gms
- CPUE of 0.020, 2.02 % trapping success rate, 0% recapture rat

The cumulative capture graph, below, illustrates that new individuals continued to be encountered after 9 days with no re-captures.



Cumulative capture graph depicts number of total new individuals captured in BLUE. There were no re-captures (as in the Marsh site), therefore no RED symbols. At the end of 9 consecutive days of trapping new individuals were still being captured at a steady rate.

COMPARISONS WITH PREVIOUS MAMMAL INVENTORY – HOOD (2006)

Comparisons of Marsh Sites

The marsh sites of the present study were comparable to Site 3 (Tarpaper Canal Flotant Marsh) reported in Hood (2006). Results from that earlier study were:

Hood (2006) Site 3 (Tarpaper Canal Flotant Marsh) – 3 traplines, 685 trap-nights

- 23 *Oryzomys palustris* (and 21 recaptures) for a total of 34 captures
- CPUE of 0.050, 4.97 % trapping success rate, 91.3% recapture rate

The present study has very comparable results, with a large number of marsh rice rats being captured and re-captured. CPUE in 2012 was 40% higher (0.070 vs. 0.050), as was trapping success rate (6.63% vs. 4.97%). Re-capture rate was high, but much lower than reported in Hood (2006, 15.09% vs. 91.3%). The capture of a large number of juvenile/subadult individuals in the present study provides evidence of a healthy, reproductively active population.

Comparisons of Bottomland Hardwood Forest Sites

The bottomland hardwood forest sites of the present study were comparable to Original Site 4 (E. Plantation Trail Forest) reported in Hood (2006).

Hood (2006) Site 4 (E. Plantation Trail Forest) – 2 traplines, 1,596 trap-nights

- 7 *Peromyscus leucopus* (and 11 recaptures) for a total of 19 captures
- CPUE of 0.011, 1.13 % trapping success rate, 157.14% recapture rate

The present study has very comparable results, with a large number of white-footed deer mice being captured. CPUE in 2012 was twice as high (0.020 vs. 0.011), as was trapping success rate (2.02% vs. 1/13%). Re-capture rate in the present study was 0. The capture of many more mice, together with high number of juvenile/subadult individuals and no re-captures in the present study provides evidence of a healthy, reproductively active population.

5. MOTION-ACTIVATED CAMERA RESULTS FOR LARGE MAMMALS

The following is a summary of the results of motion-activated camera-traps for documenting mammals occurring within the Barataria Preserve. **FIGURES 8-15** illustrate maps and site photographs of 39 camera site localities. A total of **39 site localities** and **5,637 camera-days** resulted in **6,149 photographs of animals** (with repeated photographs of some individuals) representing 12 mammal species – *Didelphis virginiana*, *Dasypus novemcinctus*, *Sylvilagus aquaticus*, *Sciurus carolinensis*, unidentified rodents, *Canis latrans*, *Procyon lotor*, *Lutra canadensis*, *Felis rufus*, *Felis catus*, *Odocoileus virginianus*, *Sus scrofa.*

The results by Species, by Site, and by Time are presented in:

TABLE 1 –	Summary of all records (includes repeated photos of individuals)
TABLE 2 –	Summary of all records (excludes repeated photos of individuals)
TABLE 3 –	Summary of records for comparable sites reported in Hood (2006)
FIGURE 16 –	Records by Species & Site (expressed in Catch-per-unit-effort, CPUE)
FIGURES 17-25	Representative Camera-trap photos by Species
FIGURE 26 –	Records by Species and Month
FIGURE 27 –	Records by Species and Hour

COMPARISON of CUDDEBACK and RECONYX CAMERA-TRAPS

FIGURE 8 illustrates the deployment of Cuddeback camera-traps (total of 35 sites) and Reconyx camera-traps (total of 5 sites). At Sites 1 and 20 both types of cameras were deployed simultaneously to test/compare the captures they recorded. As described in the methods, when triggered by movement, Cuddeback cameras were programmed to take a photograph and re-set for additional trigger events in 30 second intervals. Reconyx cameras were programmed to take a burst of 10 photographs at a trigger event, re-setting for additional trigger events in 10 seconds. Thus, all Reconyx records presented in tables and figures are **trigger events**.

Cuddeback camera-traps did not experience a large number of false-trigger events (movement of vegetation, debris, or heavy rain triggering a photograph), but Reconyx cameras at Sites 23 and 29 had 1,000s of false triggers (generating 10,000s of photographs) due to moving vegetation.

A direct comparison of the systems was made at Sites 1 and 20, where both Cuddeback and Reconyx cameras were deployed on the same tree (see **FIGURE 15, pg 86**) for 77 and 68 camera-days, respectively. The table below details the mammals recorded by each system at each site.

STATS for CUDDEBACK SITE 1 COMPLETE DATASET in OVERLAP WITH RECON01 DATA													
	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPU
CUDDEBACK 1	12	4	5	7	4				16		48	77	0.623377
Captures found by REC01	11	4	3	5	2				10		35		
Precent found	91.67%	100.00%	60.00%	71.43%	50.00%				62.50%		72.92%		
RECON01	171	18	8	22	14			3	50	4	290	77	3.766234
Captures found by CUDDE 1	10	4	2	5	2			0	12	0	35		
Percent found	5.85%	22.22%	25.00%	22.73%	14.29%			0.00%	24.00%	0.00%	12.07%		
											0		

STATS for CUDDEBACK SITE20 COMPLETE DATASET in OVERLAP WITH RECON20 DATA													
	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPU
CUDDEBACK 20	95	9	6	3	2	1				1	117	68	1.720588
Captures found by REC20	90	9	4	1	0	1				0	105		
Percent found	94.74%	100.00%	66.67%	33.33%	0.00%	100.00%				0.00%	89.74%		
RECON20	360	17	29	11	9	3			17	1	447	68	6.573529
Captures found by CUDDE 20	95	7	7	1	0	1			0	0	111		
Percent found	26.39%	41.18%	24.14%	9.09%	0.00%	33.33%			0.00%	0.00%	24.83%		

At these two sites (Sites 1 and 20), the Reconyx camera captured 73% and 89%, respectively, of the same animal trigger events recorded by the Cuddeback camera. For example, if a Cuddeback camera at Site 1 photographed an 8-point antlered white-tailed deer at 8:30 pm on October 28th and the Reconyx also captured that same event, then the Reconyx was scored as also capturing the event. In contrast, the Cuddebacks only captured 12% and 25%, respectively, of animal trigger events recorded by the Reconyx camera at a given site. Some species (rabbits, opossums, squirrels) captured by Reconyx cameras were entirely "missed" by the Cuddeback cameras and would have been un-recorded from the site without the use of Reconyx cameras. About half of the missed records of white-tailed deer (*Odocoileus virginianus*) and feral hogs (*Sus scrofa*) by Cuddeback cameras were due to the multiple photographs. Catch-per-unit-effort (CPUE) by site and individual species were 4-5X higher for Reconyx cameras than for Cuddebacks.

These results confirm that data from Cuddeback and Reconyx camera-traps should be reported and analyzed separately, which was done in all Tables and Figures in this final report. However, Cuddeback cameras were still very successful in capturing mammal activity with many photographs of individuals at ~ 10 m distance.

COMPARISONS ACROSS SITES & TIME

At each of the 39 sites, 1-2 cameras were placed on with marsh, forest/swamp, or adjacent natural levee bank/canal spoil bank. 6,146 photographs were captured of medium-sized and large mammals, especially white-tailed deer, feral hogs, coyotes, bobcat, raccoons and rabbits. Although there were repeated photographs of the same individuals, the camera-traps documented a substantial population of these large mammals (**TABLES 1 and 2**). Records of large antlered white-tailed deer and feral hogs include dozens of different individuals at an individual site and in comparison with immediately nearby sites.

TABLE 1 -- SUMMARY OF ALL CAMERA-RECORDS OF ANIMALS (includes repeated photos of individuals)

SITE	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPUE
1	24	23	9	11	4				16	2	89	188	0.47
2	170	1								0	171	233	0.73
3	378	40		1			1			2	422	245	1.72
4	103	44	104		7	2				3	263	246	1.07
5	1093	43	3	1						4	1144	335	3.41
6	353	4								9	366	292	1.25
7	382	7	3	4		1				2	399	297	1.34
8	166	12							3	1	182	278	0.65
9	43	4								2	49	320	0.15
10	31	1	2			2				3	39	252	0.15
11	5										5	22	0.23
12	4	1									5	22	0.23
13	21									9	30	143	0.21
14	7	1									8	54	0.15
15											0	19	0.00
16			2							2	4	19	0.21
17	41	1								1	43	99	0.43
18	43										43	134	0.32
19	4										4	45	0.09
20	117	10	6	3	2	5	4			1	148	113	1.31
21	35	0				2				1	38	146	0.26
22	2										2	146	0.01
24	8	38				5				3	54	146	0.37
25			23	2	17	2	3			3	50	146	0.34
27	4										4	122	0.03
28	14									4	18	162	0.11
30	7			0					10		17	117	0.15
32	2					1				1	4	117	0.03
33	7		1	11		1	2	1		4	27	117	0.23
34	3										3	94	0.03
35										1	1	83	0.01
36	8		11	1		3				2	25	79	0.32
37	4		2								6	91	0.07
TOTALS	3079	230	166	34	30	24	10	1	29	60	**3663**	**4922**	0.74

SUMMARY CAMERA TRAP DATA -- ALL RECONYX SITES-- ALL TRIGGERED RECORDINGS INCLUDING SAME ANIMAL (PREV)													
SITE	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPU
RECON01	398	34	35	53	15	4		7	98	13	657	148	4.4392
RECON20	700	41	188	36	115	21	1	46	55	13	1216	170	7.1529
RECON23	172		10	6	39				1	10	238	101	2.3564
RECON26	6		32	1	64		11			20	134	126	1.0635
RECON29	5				4						9	24	0.375
RECON31	33		30	10	100	6	1	7	31	14	232	136	1.7059
TOTALS	1314	75	295	106	337	31	13	60	185	70	**2486**	**705**	3.5262

GRAND	4393	305	461	140	367	55	23	61	214	130	**6149**	**5627**

SITE -- Site number with Cuddeback camera-Trap, annotations of RECONY is a deployed Reconyx camera

SPECIES -- **DEER** -- *Odocoileus virginianus* **COYOTE** -- *Canis latrans*
HOG -- *Sus scrofa* **BOBCAT** -- *Felis rufus*
RAC -- *Procyon lotor* **OPOS** -- *Didelphis virginiana*
ARM -- *Dasypus novemcinctus* **SQUIR** -- *Sciurus carolinensis*
RAB -- *Sylvilagus aquaticus* **OTHER** -- includes domestic cats, humans, river otter, rodents, birds

CPUE -- Catch-per-unit-effort. Captures / Camera days

DATA -- Records are photograph images of individual mammals, some photographs include multiple individuals. RECONYX records are TRIGGER EVENTS, with a burst of 10 photographs per trigger event. The same individual is not reported more than once in these records, unless captured by subsequent trigger events.

TABLE 2 -- SUMMARY OF ALL CAMERA-RECORDS OF ANIMALS (EXCLUDES repeated photos of individuals)

SITE	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPU
1	22	22	9	11	4				15	2	85	188	0.4521
2	164	1								0	165	233	0.7082
3	343	39		1			1			2	386	245	1.5755
4	87	38	87		7	2				3	224	246	0.9106
5	984	41	3	1						4	1033	335	3.0836
6	293	4								9	306	292	1.0479
7	333	7	3	4		1				2	350	297	1.1785
8	151	12							3	1	167	278	0.6007
9	26	4								2	32	320	0.1
10	31	1	2			1				3	38	252	0.1508
11	5										5	22	0.2273
12	2	1									3	22	0.1364
13	13									9	22	143	0.1538
14	5	1									6	54	0.1111
15											0	19	0
16			2							2	4	19	0.2105
17	34	1								1	36	99	0.3636
18	40										40	134	0.2985
19	4										4	45	0.0889
20	110	9	6	3	2	4	3			1	138	113	1.2212
21	30	0				2				1	33	146	0.226
22	2										2	146	0.0137
24	8	38				4				3	53	146	0.363
25			20	2	16	2	3			3	46	146	0.3151
27	4										4	122	0.0328
28	8									4	12	162	0.0741
30	5			0					10		15	117	0.1282
32	2					1				1	4	117	0.0342
33	5		1	11		1	2	1		4	25	117	0.2137
34	3										3	94	0.0319
35										1	1	83	0.012
36	7		10	1		3				2	23	79	0.2911
37	4		2								6	91	0.0659
TOTALS	2725	219	145	34	29	21	9	1	28	60	**3271**	4922	0.6646

SUMMARY CAMERA TRAP DATA -- ALL RECONYX SITES-- TRIGGERED RECORDINGS EXCLUDING SAME ANIMAL (PREV)

SITE	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPU
RECON01	223	26	25	40	13	2		7	77	13	426	148	2.8784
RECON20	347	36	136	29	64	12	1	37	51	13	726	170	4.2706
RECON23	71		8	3	29				1	10	122	101	1.2079
RECON26	4		20	1	18		2			15	60	126	0.4762
RECON29	3				4						7	24	0.2917
RECON31	12		25	9	59	3	1	7	23	14	153	136	1.125
TOTALS	660	62	214	82	187	17	4	51	152	65	**1494**	705	2.1191

GRAND	3385	281	359	116	216	38	13	52	180	125	**4765**	**5627**

SITE -- Site number with Cuddeback camera-Trap, annotations of RECONY is a deployed Reconyx camera

SPECIES -- **DEER** -- *Odocoileus virginianus* **COYOTE** -- *Canis latrans*
HOG -- *Sus scrofa* **BOBCAT** -- *Felis rufus*
RAC -- *Procyon lotor* **OPOS** -- *Didelphis virginiana*
ARM -- *Dasypus novemcinctus* **SQUIR** -- *Sciurus carolinensis*
RAB -- *Sylvilagus aquaticus* **OTHER** -- includes domestic cats, humans, river otter, rodents, birds

CPUE -- Catch-per-unit-effort. Captures / Camera days

DATA -- Records are photograph images of individual mammals, some photographs include multiple individuals. RECONYX records are TRIGGER EVENTS, with a burst of 10 photographs per trigger event. The same individual is not reported more than once in these records, unless captured by subsequent trigger events.

Hardwood Forests and Swamp Habitats.—

TABLE 1 and **FIGURE 16** summarize records expressed as CPUE by species to allow comparison across sites in bottomland hardwood and swamp forests. Cuddeback Camera Sites 1-8 and 20 had the highest mammal activity. Sites 1-8 are in bottomland hardwood forest, whereas Site 20 is in a hardwood/swamp transition near Bayou des Familles. Sites 9, 10, 12 have a heavy palmetto understory, and although they recorded fewer mammals, large white-tailed deer and feral hogs were recorded in that dense habitat. Sites 11-17 are forested habitats that are near roads and park trails and may have had less mammal species activity due to human use. Cuddeback Camera Sites 30, 32, 33-37, are in swamp or hardwood/swamp transition areas and recorded deer, coyotes, bobcats, raccoons, and medium-sized mammals, but no feral hogs.

Reconyx Camera Sites 1, 20, 31 had high mammal activity, including many white-tailed deer, feral hogs, rabbits and raccoons. Reconyx cameras captured rarer species, including coyotes, bobcats, opossums, and rodents.

Marsh and Adjacent Spoil Bank Habitats.—

TABLE 1 and **FIGURE 16** summarize CPUE by species to allow comparison across sites in marsh and adjacent spoil bank habitats (Cuddeback Camera Sites 21-29 and 38-39). Cuddeback Camera Sites 24 and 25 had the highest mammal activity. Site 24 is especially noteworthy as this was on the removed Tarpaper Canal spoil bank with adjacent marsh. At Site 24, feral hogs (38 photographs of large, adult animals) were common, with the highest CPUE for this species of any site in this study. **This was the only marsh site that recorded feral hogs.** Site 25 recorded coyotes, bobcats, raccoons, rabbits, and an otter (see **FIGURES 17-25**). This site was studied by Hood (2006, Original site 2), which also recorded coyotes, raccoons and rabbits.

Reconyx Camera Sites 23 and 26 recorded white-tailed deer, raccoons, armadillos, bobcats, rodents and some birds. Reconyx cameras consistently captured rarer species, including coyotes, bobcats, opossums, otter, and rodents.

Patterns by Month and Hour.—

FIGURE 26 summarizes records by month for the most common mammals. Comparison of total capture-days by month for all species records illustrate that encounters (mammal movement activity) is highest from October through January. This was especially true for white-tailed deer, which are by far the most abundant large mammal. Feral hogs were more uniformly active through the study period.

FIGURE 27 summarizes records by hour for the most common mammal species. Most patterns of activity mirror that expected for these common species (see Lowery, 1974; Choate et al., 1994). Most mammal species are nocturnal or crepuscular, whereas species such as gray squirrels are clearly diurnal.

COMPARISONS WITH PREVIOUS MAMMAL INVENTORY – HOOD (2006)

In the previous study, Hood (2006) reported the results of camera-trap data for **11 site localities** with **1,462 camera-days** resulting in **438 photographs** of mammals (with some repeated photographs of individuals) representing 9 species – *Didelphis virginiana, Dasypus novemcinctus, Sylvilagus aquaticus, Sciurus carolinensis, Myocastor coypus Canis latrans, Procyon lotor, Felis catus, Odocoileus virginianus.*

In the present study, a total of **39 site localities** and **5,627 camera-days** resulted in **6,149 photographs** of mammals (with repeated photographs of some individuals) representing 12 mammal species – *Didelphis virginiana, Dasypus novemcinctus, Sylvilagus aquaticus, Sciurus carolinensis*, unidentified rodents, *Canis latrans, Procyon lotor, Lutra canadensis, Felis rufus, Felis catus, Odocoileus virginianus, Sus scrofa.*

TABLE 3 (below) provides details of camera-trap captures of co-located sites between studies. A summary of the comparison includes:

- There are now large, resident populations of feral hogs (*Sus scrofa*) in hardwood/swamp forests (Sites 1-10, 12, 14, 17, 20, RECONYX 20, 33) and 1 marsh/spoil bank (Site 24) that were entirely absent in the 2006 study. Hogs were not found in Bayou aux Carpes nor in any marsh areas, except for Site 24.

- First camera records of bobcats (*Felis rufus*). These were in hardwood/swamp (Sites 2, 4, 33) and marsh/spoil bank (Sites 25, RECONYX 26).

- First camera record of river otter (*Lutra canadensis*). This was in marsh/spoil bank (Site 25).

- Additional camera records and of coyotes (*Canis latrans*) in hardwood/swamp (Sites 4, 7, 10, 20, 32, 36) and marsh/spoil bank (Sites 21, 24, 25, RECONYX 26). The large number of coyotes photographed in 2006 came from two sites (located at current Sites 25, 33) which were baited with coyote urine scent in 2006, **but not baited in the present study**.

- Armadillos were commonly captured by camera-traps in 2006, but were much less commonly encountered in the present study.

TABLE 3 -- COMPARISON with data from Hood (2006) (EXCLUDES repeated photos of individuals)

SITE	Sum of DEER	Sum of HOG	Sum of RAC	Sum of ARM	Sum of RAB	Sum of COYOTE	Sum of BOBCAT	Sum of OPOS	Sum of SQUIR	Sum of OTHER	GRAND Total	CAMERA DAYS	SITE CPU
1	22	22	9	11	4				15	2	85	188	0.4521
2006 (11)	44		1	49	2	5					101	292	0.3459
5	984	41	3	1						4	1033	335	3.0836
2006 (10)	17		1	33	1	2		6	15		75	188	0.3989
6	293	4								9	306	292	1.0479
2006 (9)	2		2	2					3		9	90	0.1
11	5										5	22	0.2273
2006 (7)	37			2					2	1	42	101	0.4158
20	110	9	6	3	2	4	3			1	138	113	1.2212
RECON20	347	36	136	29	64	12	1	37	51	13	726	170	4.2706
2006 (8)	13		4	1	8	2			1		29	80	0.3625
21	30	0				2				1	33	146	0.226
2006 (3)	7		3								10	45	0.2222
22	2										2	146	0.0137
2006 (4)			1		2						3	75	0.04
RECON23	71		8	3	29				1	10	122	101	1.2079
2006 (5)	31				5	11			1		48	99	0.4848
24	8	38				4				3	53	146	0.363
2006 (6)	20		4	2	5				2		33	60	0.55
25			20	2	16	2	3			3	46	146	0.3151
2006 (2)	1		20		3	37					61	284	0.2148
33	5		1	11		1	2	1		4	25	117	0.2137
2006 (1)	5		7	5	2	36		3	2		60	78	0.7692
TOTALS this study	1877	150	183	60	115	25	9	38	67	50	2574	1922	1.3392
TOTALS 2006 study	524	36	179	123	92	105	1	46	77	14	1197	1562	0.7663

SITE -- Site number with Cuddeback camera-Trap, annotations of RECONYX is a deployed Reconyx camera
2006 (SITE x) is the Camera-trap data reported from the same site in Hood (2006)

SPECIES --
DEER -- *Odocoileus virginianus*
HOG -- *Sus scrofa*
RAC -- *Procyon lotor*
ARM -- *Dasypus novemcinctus*
RAB -- *Sylvilagus aquaticus*
COYOTE -- *Canis latrans*
BOBCAT -- *Felis rufus*
OPOS -- *Didelphis virginiana*
SQUIR -- *Sciurus carolinensis*
OTHER -- includes domestic cats, humans, river otter, rodents, birds

CPUE -- Catch-per-unit-effort. Captures / Camera days

DATA -- Records are photograph images of individual mammals, some photographs include multiple individuals. RECONYX records are TRIGGER EVENTS, with a burst of 10 photographs per trigger event. The same individual is not reported more than once in these records, unless captured by subsequent trigger events.

RECONYX camera-traps capture many more animals than Cuddeback cameras (current study) and 35 mm SRL cameras (used in 2004-6).

6. SPECIES ACCOUNTS

The following accounts provide assignments of a) park status, b) abundance, c) residency, d) voucher/observation status, and e) additional comments of the mammal species documented in this study at the Barataria Preserve of JLNHPP.

ORDER MARSUPIALIA—Marsupials
Family Didelphidae

Didelphis virginiana (Virginia opossum)

PARK STATUS: Present. Occurs in swamp, bottomland hardwood forest, natural levees/canal spoil banks, and marshes throughout the Barataria Preserve.

ABUNDANCE: Common.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher photographs of live captured specimens, numerous photographic and personal observations of tracks and live individuals. The present study documented additional camera-trap records.

COMMENTS: Although secretive, Virginia opossums were observed in all major habitats of the Barataria Preserve with motion-activated cameras, live-trapping, and observations of sign. A native of wetland habitats of southeast Louisiana, they are an expected resident species of the Barataria Preserve. JLNHPP hunting records dating back to the mid 1980s record Virginia opossums being occasionally taken as "by-catch" to nutria-trapping in swamp and marsh habitats.

In the present study, opossums were photographed at four sites (Sites 33, RECONYX 1, RECONYX20, and RECONYX 31), **see example camera photographs in FIGURE 17**. It was noteworthy that Cuddeback camera traps at Sites 1 and 20 did not capture opossums, whereas the Reconyx camera traps at those same locations did, especially in the periods of time when both kinds of traps were operating simultaneously. Without the use of Reconyx cameras the presence of opossums would have been missed at 3 sites where they are expected.

Activity patterns by month show opossum activity being highest in winter months (January-February) with few records in the spring and summer months (**FIGURE 26**).

During nights of field work to capture and detect bats, opossums were sighted by field workers at Bayou des Familles Bridge, along Christmas Road Trail, and Coquille Trail. Visitors to the park in the early evening report seeing them along roads and trails.

ORDER CHIROPTERA—Bats
Family Vespertilionidae (vespertilionid bats)

Myotis austroriparius (southeastern myotis)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Uncommon. May be locally common in bottomland hardwood forests and swamps, but population size is likely low.

RESIDENCY: Resident and likely Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimens, photographs of live captured specimens, and electronic detection of calls from the bottomland hardwood forests east of Bayou des Familles and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal.

COMMENTS: Southeastern myotis are uncommonly and rarely encountered throughout their range in the southern United States. In southeast Louisiana and along the Mississippi Gulf Coast, they have been most commonly found in inhabiting bridges and occasionally roosting in hollow trees of oaks, hickories (*Carya* spp.), tupelos. The live-trapping of one individual by Hood (2006) and the frequent electronic recording of the species at the study localities throughout the evening hours suggest that the species is resident in the Barataria Preserve and is likely using the bottomland hardwood forest (and swamp) trees as roost sites.

In the present study, *Myotis austroriparious* was the third most commonly recorded bat with electronic bat detectors (see **RESULTS** section and **FIGURE 2C**). Southeastern myotis were recorded at bottomland hardwood forest, bayou/canals and in swamp habitats. They are not one of the early emerging species, but passive bat detectors deployed at Sites 7 and 8 showed they are active throughout the night until near sunset. The population status of this species should be studied further at the Barataria Preserve, especially their use of roost tree species. The Louisiana Natural Heritage Program does not list southeastern myotis as a species of concern, but does recommend the need for study to understand its status in the state. Other states and some National Wildlife Refuges list it as a species of concern. Given that southeastern myotis are relatively commonly encountered, Barataria Preserve may be an important population site for the species in Louisiana.

Perimyotis subflavus (eastern pipistrelle or tri-colored bat)
[Note: scientific name recently changed from *Pipistrellus subflavus*]

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Common.

RESIDENCY: Resident and likely Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimens, photographs of live captured specimens, and electronic detection of calls from the hardwood forests east of Bayou des Familles and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal.

COMMENTS: Eastern pipistrelles (now also known by the common name tri-colored bat) are one of the most commonly encountered bat species at the Barataria Preserve. They are common throughout their range in the southern United States. In southeast Louisiana and along the Mississippi Gulf Coast, they have been most commonly found inhabiting man-made structures, buildings, and occasionally roosting in trees (hardwoods and pines). The live capture of 3 individuals by Hood (2006) and the frequent electronic recording of the species at all localities in that study throughout the evening hours seasons suggest that the species is resident in the Barataria Preserve and is likely using the bottomland hardwood forest (and swamp) trees as roost sites. As has been found in other studies of eastern pipistrelle, this species was found to be first species to emerge in the very early evening hours. The documentation of eastern pipistrelles as being resident throughout the year was an important new finding by Hood (2006).

In the present study, *Perimyotis subflavus* was the most commonly recorded bat with electronic bat detectors considering all sites (see **RESULTS** section and **FIGURE 2C**). Eastern pipistrelles were recorded at bottomland hardwood forest, bayou/canals and in swamp habitats, however they are most common in hardwood forests and along bayous and canals. At Sites 9, 10, 11 (along Coquille Trail at observation platforms) only a single bat pass sequence (bat flying in range of one detector) was recorded, whereas *Nycticeius humeralis* and *Myotis austroriparious* were commonly captured electronically.

In previous published Louisiana studies (see Jones and Pagels 1968, Jones and Suttkus 1973), eastern pipistrelles from southeast Louisiana migrate north during the winter/spring to establish maternity colonies. The population status of this species should be studied further at the Barataria Preserve, especially their use of roost tree species.

Lasiurus borealis (eastern red bat) and ***Lasiurus seminolis*** (seminole bat)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Uncommon. May be locally common (in bottomland hardwood forests and swamps), but population size is likely low.

RESIDENCY: Unknown, possible Resident or Migrant. Native

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher electronic recordings of echolocation calls from the hardwood forests east of Bayou des Familles and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal. No red bats were captured in mist nets.

COMMENTS: Eastern red bat are commonly encountered throughout its range in the eastern United States. In southeast Louisiana and along the Mississippi Gulf Coast, they have been

most commonly found roosting among Spanish moss-covered hardwoods, in swamps, and in coastal marshes. Based on distributional records in southeast Louisiana, eastern red bat was expected to be a commonly encountered bat species at the Barataria Preserve. However, mist netting did not capture any individuals in the previous (Hood, 2006) nor in the present study. Hood (2006) recorded calls identified as eastern red bat is presented as documentation evidencing their occurrence at the Barataria Preserve. The calls of red bats are considered readily identified compared with other bat species with a characteristic frequency sweep that terminates between 35-40 kHz (see **FIGURE 2C**). The echolocation calls of the seminole bat (*L. seminolis)*, is the only other lasiurine bat species that could overlap with red bats and they are known to terminate at 40 kHz.

In the present study, numerous recordings of bats at 38-40 kHz were made with electronic bat detectors at bottomland hardwood forest, bayou/canals and in swamp habitats, however they were most common in hardwood forests and along bayous and canals (**RESULTS and FIGURE 2C**). These bats are likely either red or seminole bats. The population status of this species should be studied further at the Barataria Preserve, especially their use of roost tree species.

Lasiurus intermedius (yellow bat)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Uncommon. May be locally common (in hardwood forests and swamps), but population size is likely low.

RESIDENCY: Unknown, possible Resident or Migrant. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher electronic recordings of echolocation calls from the bottomland hardwood forests east of Bayou des Familles and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal. No yellow bats were captured in mist nets.

COMMENTS: Yellow bat is uncommonly encountered throughout their range in the eastern United States. In southeast Louisiana and along the Mississippi Gulf Coast, they have been most often found roosting among Spanish moss-covered hardwoods and in association with palmettos. Based on distributional records, yellow bat could possibly be encountered at the Barataria Preserve. However, mist netting did not capture any individuals in the previous (Hood, 2006) nor in the present study. Hood (2006) recorded calls identified as yellow bat is presented as documentation evidencing their occurrence at the Barataria Preserve. The calls of yellow bats are considered readily identified compared with other bat species with a characteristic frequency sweep that terminates at about 25 kHz. No other bats in our area have calls that have echolocation characteristics that overlap with yellow bats.

In the present study, more electronic records were obtained at Sites 1 (Bayou des Familles Bridge), 2 (Bayou des Familes Canoe Launch), 10 (Coquille Trail Platform # 2), and 13 (Kenta Canal/Coquille Bridge), therefore although rare, yellow bats have were recorded at bottomland hardwood forest, bayou/canals and in swamp habitats (see **RESULTS** section). The population status of this species should be studied further at the Barataria Preserve, especially their use of roost tree species.

Nycticeius humeralis (evening bat)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Uncommon. May be locally common (in bottomland hardwood forests and swamps), but population size is likely low.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) collected voucher specimens, photographs of live captured specimens, and electronic detection of calls from the bottomland hardwood forests east of Bayou des Familles and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal. The present study documented additional mist-net and bat detection records.

COMMENTS: Evening bats are commonly encountered throughout their range in the eastern United States. In southeast Louisiana and along the Mississippi Gulf Coast, they have been most often found roosting in buildings, other man-made structures, and in hollow trees (hardwoods and pines) in uplands and swamps. Hood (2006) discovered a maternity colony at the bridge supports at Kenta Canal/Bayou Coquille, live-captured 25 individuals, and frequently electronically recording the species at all study localities throughout the evening hours.

In the present study, four *Nycticeius humeralis* were caught in mist nets at Site 13 (the Kenta Canal/Coquille Bridge site) and they were very commonly recorded with electronic bat detectors at all sites (see **RESULTS** section and **FIGURE 2C**). Evening bats were recorded at bottomland hardwood forest, bayou/canals and in swamp habitats, however they are most common in along bayous and canals and in swamp habitats.

Evening bats are likely using the bottomland hardwood forest (and swamp) trees as roost sites, in addition to man-made structures. Given the discovery of a maternity colony location, the population status and breeding biology of this species should be studied further at the Barataria Preserve.

Corynorhinus rafinesquii (Rafinesque's big-eared bat)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Uncommon. May be locally common (in bottomland hardwood forests and swamps), but population size is likely low.

RESIDENCY: Resident and likely Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimens, photographs of live captured specimens, and electronic detection of calls from the hardwood forests east of Bayou des Familles, and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal. The present study documented additional bat detection records.

COMMENTS: Rafinesque's big-eared bats are uncommonly and rarely encountered throughout their range in the southern United States. In southeast Louisiana and along the Mississippi Gulf Coast, they have been most often found in maternity or mixed sex colonies inhabiting bridges, buildings, and occasionally roosting in hollow trees (hardwoods). Hood (2006) mist netted two individuals and made electronic recordings of the species at the study localities early in the evening suggests that the species is resident in the Barataria Preserve and is likely using the bottomland hardwood forest trees as roost sites.

In the present study, *Corynorhinus rafinesquii* were electronically recorded at nearly every site and were found in bottomland hardwood forests, along bayous / canals and in swamp habitats (see **RESULTS** section and **FIGURE 2C**). They are not one of the early emerging species, but passive bat detectors deployed at Sites 7 and 8 showed they are active throughout the night until near sunset. Although not common, there appears to be clear evidence that Rafinesque's big-eared bats have and are maintaining a resident population in Barataria Preserve.

The population status of this species should be studied further at the Barataria Preserve, especially their use of roost tree species. The Louisiana Natural Heritage Program does not list Rafinesque's big-eared bats as a species of concern, but does recommend the need for study to understand its status in the state. Other states and some National Wildlife Refuges list it as a species of concern.

Family Molossidae (free-tailed bats)

Tadarida brasiliensis (Brazilian free-tailed bat)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and along waterways.

ABUNDANCE: Uncommon. May be locally common (in bottomland hardwood forests and swamps), but population size is likely low.

RESIDENCY: Unknown, possible Resident. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimens, photographs of live captured specimens, and electronic detection of calls from the hardwood forests east of Bayou des Familles, and in swamps and along waterways adjacent to the Coquille trail (paralleling Bayou Coquille) and Kenta Canal. The present study documented additional bat detection records.

COMMENTS: Free-tailed bats are commonly encountered throughout its range in North America. Along the Mississippi Gulf Coast they have been most often found roosting in buildings and other man-made structures. Free-tailed bats form very large colonies (1,000s of individuals), usually occupying large cave systems or abandoned buildings. Based on their natural history and distributional records in southeast Louisiana, free-tailed bats was expected to be encountered at the Barataria Preserve as a non-resident bat, foraging at the park from nearby urban areas. Hood (2006) mist-netted 4 individuals and made electronic recordings of the species at Kenta Canal and Bayou des Familles late in the evening suggesting that the species is not a resident in Barataria and is likely foraging in the park habitats.

In the present study, no Mexican free-tailed bats were captured by mist nets, but a few electronic recordings were made that were very similar to the 2006 results (see **RESULTS** section and **FIGURE 2C**). The passive bat detectors at Sites 7 and 8 had but two pass sequences at about 6 hours after sunset (after midnight). These results are consistent with other records to suggest that free-tailed bats may well be roosting outside of Barataria. The status of this species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park.

ORDER XENARTHRA—Edentates
Family Dasypodidae (armadillos)

Dasypus novemcinctus (nine-banded armadillo)

PARK STATUS: Present. Occurs in swamp, bottomland hardwood forest, natural levees/canal spoilbanks, and marshes.

ABUNDANCE: Common.

RESIDENCY: Resident and Breeder. Non-native. (to southeast Louisiana and Barataria)

VOUCHER / OBSERVATIONS: Hood (2006) generated a voucher specimen, photographs of live captured specimens, photographic and personal observations of burrows, tracks and live individuals. The present study documented additional camera-trap records.

COMMENTS: Armadillos are non-native to Louisiana and to the Barataria Preserve, having extended their range from northern Mexico into western Louisiana in the 1920s. The occurrence of nine-banded armadillos in southeast Louisiana and in the vicinity of the Barataria Preserve is as recent as the 1970s. Hood (2006) reported that they are among the most common mammals sighted in daylight and early evening hours in the bottomland hardwood forests and swamps east of Bayou des Familles and along all public trails of the park. Nine-banded armadillos were observed in all major habitats of the Barataria Preserve with motion-activated cameras, and observations of sign.

In the present study, armadillos were photographed at 14 sites in all habitats (**TABLE 1**). It is noteworthy that sign (tracks, digging) was also very commonly observed on all natural levee and canal spoil banks throughout the park, including spoil banks extending far into the marsh. The ability of nine-banded armadillos to traverse waterways to become distributed on all spoil banks of the park is remarkable, **see example camera photographs in FIGURE 18**.

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 6 of the sites; at 4 sites armadillos recorded in 2006 were not documented in the present study; at 1 site they were undocumented in 2006 but recorded in the present study (**TABLE 3**). For these 11 co-located sites, the total number of armadillos recorded in the present study was much lower than that reported in 2006 (CPUE in 2006 of 0.079, CPUE in present study of 0.031)

Activity patterns by month show armadillo activity being highest in fall and winter months (September-February) with few records in the spring and summer months (**FIGURE 26**). Hourly records show that armadillos can be active throughout most hours of a 24 hour period, but the highest activity is in the early and later evening hours (**FIGURE 27**). The activity of nine-banded armadillos (digging for food and constructing burrows) in the bottomland hardwood forests and swamps are likely to be contributing various ecological services to the forest floor ecosystem.

ORDER LAGOMORPHA—Lagomorphs
Family Leporidae (hares and rabbits)

Sylvilagus aquaticus (swamp rabbit)

PARK STATUS: Present. Occurs in swamp, hardwood forest, natural levees/canal spoilbanks, and marshes.

ABUNDANCE: Common.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) generated voucher photographs and personal observations of burrows, tracks and live individuals. The present study documented numerous additional camera-trap records.

COMMENTS: Swamp rabbits were observed in all major habitats of the Barataria Preserve with motion-activated cameras, live-trapping, observations of sign (scat, tracks) and live individuals. In southeast Louisiana and along the Mississippi Gulf Coast, they are one of the most common mammals of coastal wetlands, including both marsh and swamp habitats. Hood (2006) reported that swamp rabbits are active and sighted in early morning and early evening hours in the bottomland hardwood forests and swamps east of Bayou des Familles, along public trails of the park, on natural levees and canal spoil banks, and especially in marsh habitats. Examination of owl pellets collected from barn owls (*Tyto alba*) and barred owls (*Striz varia*) on spoil banks adjacent to marsh habitats contain fragments of swamp rabbit bones. Coyote scats examined throughout the park have swamp rabbit fur and bones. Thus, swamp rabbits represent a major food resource for the raptors and carnivores inhabiting the Barataria Preserve. JLNHPP hunting and trapping records dating back to the late 1980s record swamp rabbits being regularly taken as "by-catch" to nutria-trapping in swamp and marsh habitats.

In the present study, swamp rabbits were photographed at 16 sites in all habitats (**TABLE 1**). It is noteworthy that sign (scat) was also very commonly observed on park trails, within bottomland hardwood forests, and on natural levee and canal spoil banks throughout the park, including spoil banks extending far into the marsh, **see example camera photographs in FIGURE 18**.

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 6 of the sites; at 4 sites swamp rabbits recorded in 2006 were not documented in the present study; at 1 site they were

undocumented in 2006 but recorded in the present study (**TABLE 3**). However, overall, swamp rabbits were commonly encountered and their populations appear to be strong.

Activity patterns by month show swamp rabbit activity being highest in winter months (December-February) with few records in the spring, summer, and fall months (**FIGURE 26**). Hourly records show that swamp rabbits are strongly nocturnal (**FIGURE 27**).

ORDER RODENTIA—Rodents
Family Sciuridae (squirrels and allies)

Sciurus carolinensis (Eastern gray squirrel)

PARK STATUS: Present. Occurs in swamps, bottomland hardwood forests, and natural levees/canal spoil banks.

ABUNDANCE: Common. Occurs in forested (non-marsh) habitats

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) generated a voucher specimen, photographs of live captured specimens, photographic and personal observations of tracks, scat and live individuals. The present study documented additional camera-trap records.

COMMENTS: Eastern gray squirrels were observed in all major habitats of the Barataria Preserve, except for marshes, with motion-activated cameras, live-trapping, and observations of sign (scat, tracks) and live individuals. In southeast Louisiana and along the Mississippi Gulf Coast, they are a common squirrel of wooded areas, especially near cities and towns. Hood (2006) reported that eastern gray squirrels are active and sighted in daylight hours in the bottomland hardwood forests and swamps east of Bayou des Familles, along public trails of the park, on natural levees and canal spoil banks. Owl pellets collected from barred owls on spoil banks adjacent to marsh habitats can contain fragments of eastern gray squirrel bones. Coyote scats examined throughout the park can include gray squirrel fur and bones. Thus, eastern gray squirrels represent a food resource for the raptors and carnivores inhabiting the Barataria Preserve. JLNHPP hunting and trapping records dating back to the mid 1980s record eastern gray squirrels as being taken regularly during the fall hunting season. During the 2002-2004 hunting seasons, several hundred were taken by hunters annually (pers. comm., Leigh Zahm, NPS Law Enforcement officer). In 2006, enforcement officers and park naturalists report that in reviewing hunting takes of squirrels, all were eastern gray squirrels, as opposed to fox squirrels (*Sciurus niger*).

In the present study, gray squirrels were photographed at 8 sites in hardwood forest and swamp habitats (**TABLE 1**),**see example camera photographs in FIGURE 19**. As gray squirrels are small mammals, the ability of motion-triggered camera traps to detect them can be questioned. At Sites 1 and 20, where both Cuddeback and Reconyx camera traps were simultaneously deployed for several months, the Reconyx camera photographed many more individuals than did the Cuddeback.

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 1 of the sites; at 1 sites gray squirrels recorded in 2006 were not documented in the present study; at the remaining 9 sites they were undocumented in 2006 but recorded in the present study (**TABLE 3**). These data may indicate that squirrel activity and populations are greater now than in 2006. However, the ability of the digital camera-traps used in the present study may also explain a higher number of records.

Activity patterns by month show gray squirrel activity in fall and winter months (September-March) with the highest activity in the months of October and September (species not included in FIGURE 26). Hourly records show that swamp rabbits are strongly diurnal (species not included in FIGURE 27).

Family Cricetidae (native mice and rats)

Oryzomys palustris (marsh rice rat)

PARK STATUS: Present. Occurs in marsh and swamp habitats.

ABUNDANCE: Common. Occurs in marsh habitats.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimens, photographs of live captured specimens, photographic and personal observations of live individuals. In the present study, **Oryzomys palustris** were commonly live-captured and re-captured in flotant marsh.

COMMENTS: Marsh rice rats are the most common rodent inhabiting marsh habitats in the Barataria Preserve. Hood (2006) reported a total of 70 individuals live-trapped within marsh and an additional 40 recaptures were made. However, of over 400 trap-nights on spoil banks adjacent to marsh habitats, no marsh rice rats were captured. This suggested that they do not frequently use spoil bank habitats. Additionally, of over 5,000 trap nights in bottomland hardwood forests and swamps, no rice rats were captured. Examination of owl pellets collected from barn owls and barred owls on spoil banks adjacent to marsh habitats predominately contain fragments of marsh rice rat bones.

In the present study, marsh rice rats were live-captured and re-captured at the Marsh Site near Horseshoe Canal during 800 trap-nights in February 2012 (**RESULTS** section and **FIGURES 3-5**). Of these individuals, two-thirds were males and nearly half were juveniles/subadults.

Comparisons with a comparable trapping site from Hood (2006), Tarpaper Canal Marsh, showed very comparable results, although the CPUE and capture rates were higher and the re-capture rates lower in the present study. These results suggest healthy populations of marsh rice rats inhabit the flotant marshes of Barataria.

Camera-traps on spoil banks at Sites 26 (adjacent to marsh habitat) and 31 (adjacent to swamp habitat) recorded large rodents that could not be identified, but could have been large, adult

Orzyomys palustris (**see example camera photographs in FIGURE 19**). Site 26, adjacent to a flotant marsh is a plausible location for marsh rice rats to utilize spoil banks.

Peromyscus leucopus (white-footed mouse)

PARK STATUS: Present. Occurs in bottomland hardwood forest and swamp habitats.

ABUNDANCE: Common. Occurs in suitable bottomland hardwood forest and swamp habitats.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimens, photographs of live captured specimens, photographic and personal observations of live individuals. In the present study, Peromyscus leucopus were commonly live-captured in bottomland hardwood forest.

COMMENTS: The white-footed mouse is one of the common rodents inhabiting forested areas and riparian habitats in the eastern United States. Given distributional and previous voucher records, it was not surprising that it is the most common rodent inhabiting forested habitats in the Barataria Preserve. Hood (2006) reported 29 individuals live-trapped within hardwood forests and swamps and an additional 18 recaptures were made. However, of over 400 trap-nights on spoil banks adjacent to marsh habitats, no white-footed mice were captured. Likewise, owl pellets collected from barn owls and barred owls on spoil banks adjacent to marsh habitats did not contain any fragments of white-footed mice bones. This suggests that they do not frequently use spoil bank habitats deep within the marsh.

In the present study, 37 white-footed mice were live-captured (none re-captured) at the Hardwood Forest Site N of Plantation Trail during 1836 trap-nights in January-February 2012 (**RESULTS** section and **FIGURES 6-7**). Of these individuals, two-thirds were males and one-quarter were juveniles/subadults.

Comparisons with a co-located trapping site from Hood (2006), Original Site 4, showed very comparable results, although the CPUE and capture rates were much higher and the re-capture rates lower (zero vs. 91%) in the present study. These results suggest healthy populations of marsh rice rats inhabit the bottomland hardwood forests of Barataria.

In southeast Louisiana and the Mississippi Gulf Coast, white-footed mice can be found sympatrically with a congener, cotton mouse (*Peromyscus gossypinus*). To date, the cotton mouse had not been documented to occur in the Barataria Preserve.

Sigmodon hispidus (hispid cotton rat)

PARK STATUS: Present. Only recorded from marsh habitats.

ABUNDANCE: Uncommon. May be locally common (in marsh and swamp habitats), but population size is likely low.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported no voucher specimens, but two individuals were live captured and marked/released. No additional records were documented in the present study.

COMMENTS: The hispid cotton rat is a common rodent inhabiting many grassland, wetland, forest and riparian habitats, as well as agricultural land in the United States, including Louisiana. Given its distributional records, hispid cotton rats were expected to be found in some or all of the habitats in the Barataria Preserve. Hood (2006) reported 3 individuals live-trapped and these were captured (and multiply re-captured) within a *Saggitaria*-dominated marsh. These individuals were marked and released and no others captured thereafter, thus the lack of a voucher specimen. Over 400 trap-nights on spoil banks adjacent to marsh habitats did not result in any captures. None of the owl pellets collected from barn owls and barred owls on spoil banks adjacent to marsh habitats contained fragments of cotton rat bones. Hispid cotton rats were not captured in over 5,000 trap-nights of collecting in forests and swamps. Despite the lack of additional captures or observations, the documentation of cotton rats within a marsh site far from other habitats suggests that there is a resident population at the Barataria Preserve.

In the present study, no hispid cotton rats were live-captured and re-captured at the Marsh Site near Horseshoe Canal during 800 trap-nights in February 2012 (**RESULTS** section). The status of this species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park.

Ondatra zibethicus (muskrat)

PARK STATUS: Present. Occurs in marsh habitats

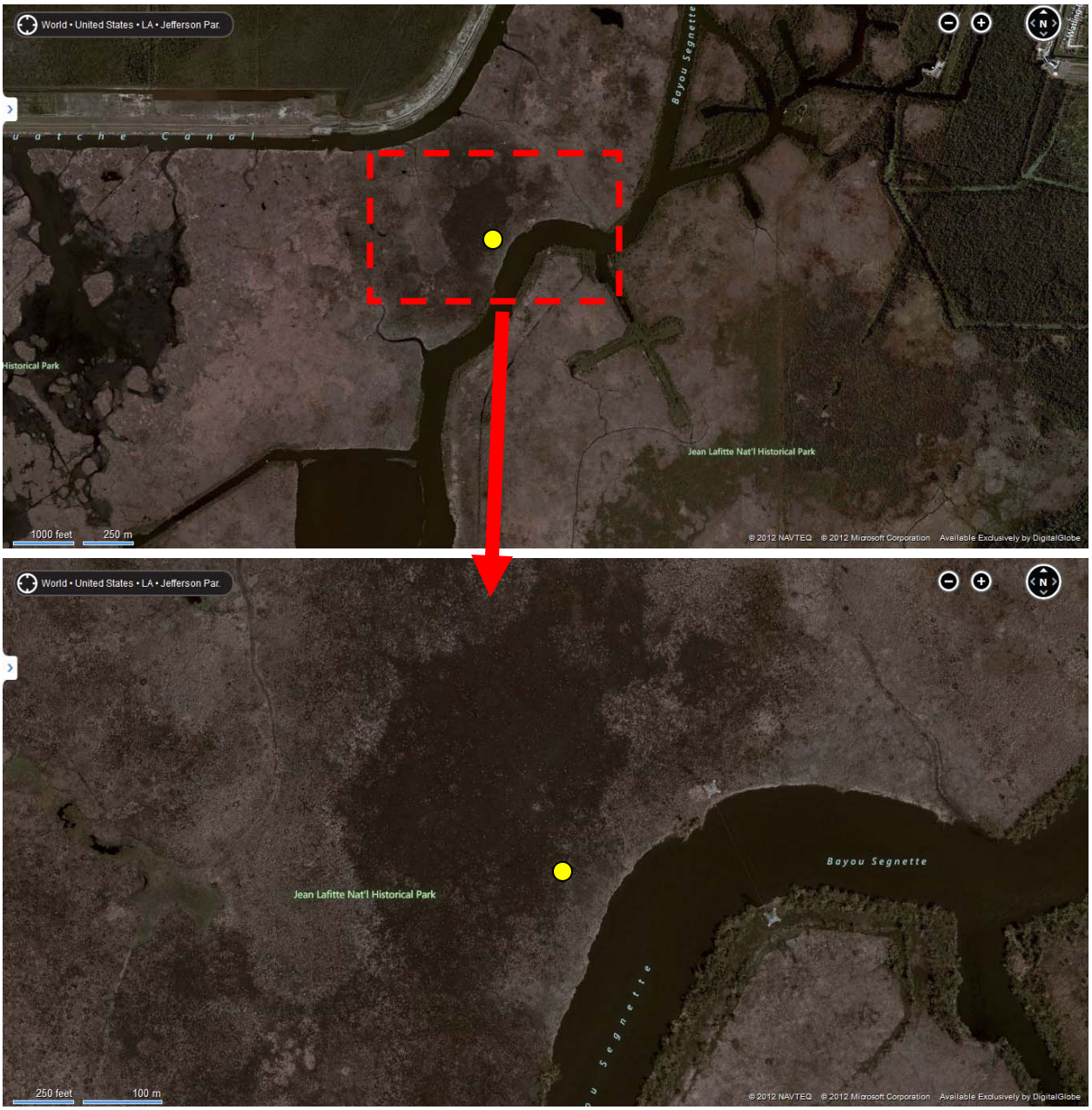
ABUNDANCE: Uncommon. May be locally common (in marsh habitats), but population size is likely low.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimen (skull) and photographs of an active muskrat mound and personal observations of tracks and scat. No additional voucher specimens were documented in the present study, however, areas of marsh damage ("muskrat eatouts") have been observed in flotant marshes in the northern end of Barataria.

COMMENTS: Historically, muskrats were the most important fur-bearing mammal in coastal Louisiana. However, significant declines in muskrat populations have been noted during the past several decades. Some resource managers attribute this to population expansion by nutria. Apparently, muskrats have not been abundant in Barataria for many decades. Hood (2006) reported that at that time they appeared to be restricted to *Scirpus* spp.-dominated marsh habitats, which are uncommon and patchy in Barataria. JLNHPP hunting and trapping records dating back to the mid 1980s record muskrats being rarely taken as "by-catch" to nutria-trapping in swamp and marsh habitats.

Post-Katrina, muskrat mounds and large areas of marsh damage by them (and perhaps nutria) were discovered by NPS resource managers in marshes at the at far northern portions of the Preserve adjacent to Bayou Segnette Waterway (yellow marker location) . These areas were recently added to the park boundaries.



Large dark area is vegetation damage, small dots are muskrat mounds.

Given the historical and cultural significance of muskrats to the region, the population status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency and population status. Study of the ecological relationship between muskrats and nutria (which are highly abundant in some locations) is another potentially important area of future research

*Family Muridae (Old World rats and mice)

Rattus rattus (black rat)

PARK STATUS: Present. Occurs in near NPS buildings, public facilities, and in nearby forested areas.

ABUNDANCE: Uncommon. May be locally common (near NPS buildings, public facilities), but population size is likely low.

RESIDENCY: Resident and Breeder. Non-native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimen and personal observations of live individuals. No additional records were documented in the present study.

COMMENTS: The black rat is an introduced species commonly associated with buildings and urban areas. At the Barataria Preserve, they are pests that occasionally occupy NPS buildings and public facilities. Hood (2006) reported 1 individual captured in trapping and that was at the Twin Canals forest trapping locality that was within 200 meters of the Twin Canals public boat launch. With no other specimens captured in over 7,500 trap-nights of effort it is likely that black rats do not occur in natural habitats of the park. An effort should be made to control the population of black rats that live near NPS facilities to ensure that their populations do not grow and expand into natural areas.

In the present study, no black rats were live-captured in a total of 2,636 trap nights in hardwood forest and marsh habitats.

Camera-traps on spoil banks at Sites 26 (adjacent to marsh habitat) and 31 (adjacent to swamp habitat) recorded large rodents that could not be identified, but could have been *Rattus rattus* (**see example camera photographs in FIGURE 19**). Site 31, adjacent to a swamp is a plausible location for black rats to utilize spoil banks.

Mus musculus (house mouse)

PARK STATUS: Present. Occurs in near NPS buildings, public facilities, and in nearby forested areas.

ABUNDANCE: Uncommon. May be locally common (near NPS buildings, public facilities), but population size is likely low.

RESIDENCY: Resident and Breeder. Non-native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher specimen and personal observations of live individuals. No additional records were documented in the present study.

COMMENTS: The house mouse is an introduced species commonly associated with buildings and urban areas. At the Barataria Preserve, they are pests that occasionally occupy NPS

buildings and public facilities. Hood (2006) reported 1 individual was captured in trapping and that was at the Twin Canals forest trapping locality that was within 200 meters of the Twin Canals public boat launch. With no other specimens captured in over 7,500 trap-nights of effort it is likely that house mice do not occur in most natural habitats of the park. As in the account of the black rat, an effort should be made to control their populations at NPS facilities so that their populations do not grow and expand into natural areas.

In the present study, no house mice were live-captured in a total of 2,636 trap nights in hardwood forest and marsh habitats.

*Family Myocastoridae (myocastorids)

Myocastor coypus (nutria)

PARK STATUS: Present. Occurs in marsh and swamp habitats

ABUNDANCE: Common.

RESIDENCY: Resident and Breeder. Non-native.

VOUCHER / OBSERVATIONS: Hood (2006) reported voucher photographs and personal observations of tracks and scat. No additional records were documented in the present study.

COMMENTS: Nutria are an introduced species that became established in Louisiana in the 1920s and dramatically expanded their distributional range and population numbers. Numbers of nutria within the marshes of the Barataria Preserve are so great that active management programs have been in place for many years. Several important recent studies concerning population biology have been conducted in the park during the past few years. Nolfo-Clements (2006a, 2009, 2012) documents their home range, fine scaled habitat use (to plant species) and movement in the flotant marsh. Nutria are usually active and can be sighted in early morning and early evening hours in swamps, along public trails of the park, on natural levees and canal spoil banks, and especially in marsh habitats. They can be seen on trails within the forests east of Bayou des Familles, but are less common there.

In the present study, it was surprising that no nutria were recorded with camera-traps that included over 5,000 camera-days and 6,000 photographs of mammals. The camera traps at marsh (and adjacent spoil bank) locations were expect to capture some nutria activity, but did not.

Given the historical and cultural significance of trapping to the region, the status of this species should be studied further at the Barataria Preserve, especially to develop management strategies [their residency and population status is well established]. A study of the ecological relationship between muskrats and nutria is another potentially important area of future research.

ORDER CARNIVORA—Carnivores
Family Canidae (canids)

Canis latrans (coyote)

PARK STATUS: Present. Occurs in swamp, bottomland hardwood forest, natural levees / canal spoil banks, and marshes.

ABUNDANCE: Common. Occurs in all habitats.

RESIDENCY: Resident and Breeder. Non-native. (Native to North America, but non-native to southeast Louisiana and the Barataria Preserve)

VOUCHER / OBSERVATIONS: Hood (2006) generated voucher photographs and personal observations of tracks, scat, and live individuals. The present study documented additional camera-trap records and personal observations of tracks and scat.

COMMENTS: Coyotes were observed in all major habitats of the Barataria Preserve with motion-activated cameras, and observations of sign. They are non-native to Louisiana and to the Barataria Preserve, having extended their range from the western United States into western Louisiana in the 1940s. The first occurrence of coyotes in southeast Louisiana and in the vicinity of the Barataria Preserve is as recent as the 1950s. The first confirmed observational record of a coyote at the Barataria Preserve was in 1987 (naturalist record). Today, coyotes are among the most common large mammals in all habitats of the park. Hood (2006) reported that motion-activated cameras captured more than 90 photographs of coyotes, many of which appear to be different individuals. Coyote sign (scat, tracks, digging) was commonly observed on natural levees and canal spoil banks throughout the park. The sound of howling (by groups of individuals) were commonly heard in the early evenings from the Marsh Overlook platform on the Bayou Coquille trail. Scats include hair and bone fragments of swamp rabbits and gray squirrels.

In the present study, coyotes were photographed at 13 sites in all habitats (**TABLE 1**). It is noteworthy that sign (scat) was also very commonly observed on park trails, within bottomland hardwood forests, and on natural levee and canal spoil banks throughout the park, including spoil banks extending far into the marsh (**see example camera photographs in FIGURE 20)**.

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 6 of the sites; at 3 sites swamp rabbits recorded in 2006 were not documented in the present study; at 2 sites they were undocumented in 2006 but recorded in the present study (**TABLE 3**). An important difference in methodology was that in Hood (2006) camera-traps were "baited" with coyote urine and that in the present study were not "baited", therefore the overall coyote activity records were very strong in the present study.

Activity patterns by month show coyotes are encountered throughout the year, with the highest activity in winter months (December-January) (**FIGURE 26**). Hourly records show that coyotes can be active throughout most hours of a 24 hour period, but the highest activity is in evening hours, (species not included in FIGURE 27).

The status of this species should be studied further at the Barataria Preserve, especially to establish its population size, dynamics, and impact on the overall ecology of the natural systems. Given the camera-trap records and sightings from the present study coyotes have established a resident population at Barataria.

Family Procyonidae (procyonids)

Procyon lotor (raccoon)

PARK STATUS: Present. Occurs in swamp, bottomland hardwood forest, natural levees / canal spoil banks, and marshes.

ABUNDANCE: Common. Occurs in all habitats.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) generated voucher photographs and personal observations of tracks, scat, and live individuals. The present study documented additional camera-trap records and personal observations of tracks, scat, and live individuals.

COMMENTS: Raccoons were observed in all major habitats of the Barataria Preserve with motion-activated cameras, observations of sign and live individuals. They are adaptable, wide ranging generalists that can live in many different habitats and settings. Today, they are among the most common medium-large mammals in all habitats of the park. Hood (2006) reported that motion-activated cameras captured many photographs of raccoons, some of which appear to be different individuals. Raccoon sign (scat, tracks,) was commonly observed on park trails, in forests, swamps, and on natural levees and canal spoil banks.

In the present study, raccoons were photographed at 13 sites in all habitats (**TABLE 1**). It is noteworthy that sign (scat) was also very commonly observed on park trails, within bottomland hardwood forests, and on natural levee and canal spoil banks throughout the park, including spoil banks extending far into the marsh (**see example camera photographs in FIGURE 21)**.

In many instances, camera-traps captured 2-3 raccoons traveling together, especially using the Reconyx cameras that capture 10-photographs per triggering event with a 10-second camera re-set for the next triggering event (**compare raccoon records in TABLE 1 and 2**)

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 6 of the sites; at 3 sites raccoons recorded in 2006 were not documented in the present study; at 2 sites they were undocumented in 2006 but recorded in the present study (**TABLE 3**).

Activity patterns by month show raccoons are active in fall and winter months, with the highest activity in winter months (December-February) (**FIGURE 26**). Hourly records show that raccoons strongly diurnal, being rarely recorded during daylight hours (**FIGURE 27**).

Family Mustelidae (mustelids)

Mustela vison (mink)

PARK STATUS: Present. Occurs in marshes and swamps.

ABUNDANCE: Uncommon. May be locally common, but population size is likely low.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) reported a voucher specimen (road-killed). No additional records were documented in the present study.

COMMENTS: Mink are not common at the Barataria Preserve, but observations and records indicate that they inhabit marsh habitats. None were documented by motion-activated cameras, trapping, or observation of sign by Hood (2006). One mink was found dead on LA HWY 45 within the park boundaries. JLNHPP hunting and trapping records dating back to the mid-1980s record mink as being occasionally taken as "by-catch" to nutria-trapping in swamp and marsh habitats. The most recent of these records are from 1992, although trapping focus has been on nutria this past decade.

In the present study, no mink were live-captured or found as road-killed specimens.

The status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency, population status, and use of the park

Lutra canadensis (river otter)

PARK STATUS: Present. Occurs in marshes, swamps, along waterways, and in bottomland hardwood forests.

ABUNDANCE: Uncommon. May be locally common, but population size is likely low.

RESIDENCY: Resident and Breeder. Native.

VOUCHER / OBSERVATIONS: Hood (2006) generated a voucher specimen (road-killed). voucher photographs and personal observations of tracks, scat, and live individuals. The present study documented a camera-trap record and a second road-killed individual (see photograph below).

COMMENTS: River otters are not common at the Barataria Preserve, but regular observations and records indicate that they are residents of the park. None were documented by motion-activated cameras, trapping, or observation of sign by Hood (2006). Two river otters were found dead on the Lafitte-LaRose HWY (LA HWY 3134) at the northern boundary park. NPS staff and visitors report visual observations of river otters along park trails (Plantation trail and the Bayou Coquille trail), in waterways (Twin Canals, Kenta Canal, Bayou des Familles), and on natural levees and canal banks within the marsh habitats of the park about 5-6 times per year.

JLNHPP hunting and trapping records dating back to the mid-1980s record river otters as being occasionally taken as "by-catch" to nutria-trapping in swamp and marsh habitats.

In the present study, a river otter was found dead on Barataria Boulevard 1 mi N of the NPS boundary and 1 was photographed at Site 25 on the Oak Chenier spoil bank (**see example camera photographs in FIGURE 19)**. Park visitors and NPS staff regularly make sightings of otters along NPS trails, especially on Coquille Trail.

The status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency, population status, and use of the park. Given the camera-trap records and sightings from the present study, river otters have established a resident population at Barataria.

Family Felidae (cats)

Felis rufus (bobcat)

PARK STATUS: Present.

ABUNDANCE: Uncommon. May be locally common.

RESIDENCY: Resident and Breeder. Native

VOUCHER / OBSERVATIONS: Hood (2006) generated a voucher photograph of tracks, personal observations of tracks at a scent station. The present study documented numerous camera-trap records at multiple sites.

COMMENTS: The distribution records of bobcats and their natural history suggests that they should be expected to occur at the Barataria Preserve. No documented records existed prior to the study by Hood (2006), although a visitor sighting (on one of the Plantation trails) was reported in 2000. A set of well preserved, fresh tracks were observed at a scent station that was established on the Oak Chenier site locality. The station had been baited with bobcat urine scent. The tracks were photographed and a motion-activated camera placed at the site. Unfortunately, no additional tracks or photographs or live individuals were captured thereafter at that time.

In the present study, bobcats were photographed at 7 sites in bottomland hardwood forests, swamps, swamp/forest transition areas, and on spoil banks adjacent to marshes (**TABLE 1 and see example camera photographs in FIGURE 22**). Visitors and NPS staff have reported sightings of bobcats fairly regularly and a litter of kittens were observed along Palmetto Trail in early summer 2012.

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 8 of the sites (no bobcat records); at 3 sites they were undocumented in 2006 but recorded in the present study (**TABLE 3**). An important difference in methodology was that in Hood (2006) camera-traps were "baited" with coyote/bobcat urine and that in the present study were not "baited", therefore the overall bobcat activity records were very strong in the present study.

Activity patterns by month show bobcats can be encountered throughout the year, with the highest activity in winter months (December-February) (**FIGURE 26**). Although sample sizes were low, the highest number of bobcats were recorded in December (with 10 records from 3 localities). Hourly records show that bobcats strongly nocturnal, with only one daytime record (species not included in FIGURE 27).

The status of this species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park. Given the camera-trap records from the present study it appears that bobcats have established a resident population at Barataria.

ORDER ARTIODACTYLA— Even-toed ungulates
Family Cervidae (cervids)

Odocoileus virginianus (white-tailed deer)

PARK STATUS: Present. Occurs in swamp, bottomland hardwood forest, natural levees / canal spoil banks, and marshes.

ABUNDANCE: Common. Occurs in all habitats.

RESIDENCY: Resident and Breeder. Native

VOUCHER / OBSERVATIONS: Hood (2006) generated a voucher specimen, voucher photographs and personal observations of tracks, scat, and live individuals. The present study documented numerous additional camera-trap records.

COMMENTS: White-tailed deer were observed in all major habitats of the Barataria Preserve with motion-activated cameras, and observations of sign. They are the most common large mammals in all habitats of the park. Visitors can observe deer or deer sign along park trails and visitors walking on the Plantation trails (in bottomland hardwood forest) in early mornings or evenings are likely to see or hear deer moving through the forest. Hood (2006) reported motion-activated camera data of over 150 photographs, many of which appear to be different individuals. Many of these records come from natural levees and canal spoil banks adjacent to marsh habitats. White-tailed deer populations are clearly quite large for the size and nature of the habitat at the Barataria Preserve. The impacts of deer populations on the park's ecology should be studied, especially as recent housing developments immediately north of the park have converted forested areas into residential subdivisions.

In the present study, white-tailed deer were photographed at 35 sites in all habitats (**TABLE 1**). Camera-trap photographs document antlered deer throughout much of the year, with most fawns being recorded in early summer into the early winter months (**see example camera photographs in FIGURE 23)**. In many instances, camera-traps captured 2-3 deer traveling together, especially using the Reconyx cameras that capture 10-photographs per triggering event with a 10-second camera re-set for the next triggering event (**compare deer records in TABLE 1 and 2**)

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 9 of the sites; at 1 site deer

recorded in 2006 were not documented in the present study; at 1 site they were undocumented in 2006 but recorded in the present study (**TABLE 3**).

Activity patterns by month show white-tailed deer are present throughout the year, but have the highest activity in fall and winter months (October-January) (**FIGURE 26**). Hourly records show that white-tailed deer can be active at all times, but their highest activity is in crepuscular hours near dawn and sunset (**FIGURE 27**).

Chamberlain and Nyman (2006), reported the results of a series of studies (see their appendices 1-5; Bernatas, 2003, 2004; Bordelon, 2005; Nyman, 2004; Scognamillo and Nyman, 2004) using analysis of hunting reports, aerial photography, thermal aerial photography and browse surveys to address white-tailed deer population size, distribution, and impacts in major habitats of the park. Their overall findings included a) the documentation of a substantial deer population in all major habitats, b), some, but limited, impact on understory vegetation browsed within the hardwood bottomland forests of the Big Woods, c) application of thermal imaging for deer census, and d) recommendations for hunting management.

The present study, utilizing camera-traps, provides complementary data that are consistent with their results – deer populations through the major habitats of the park are very substantial. The camera-trap data provide data on mammals in especially dense habitats (e.g., in hardwood forest Sites 1-12 and swamp Sites 31-33), which are difficult to census with aerial photography and hunting record, or line transect methods. The camera-trap data documented the time of activity (date, time), status of individual deer (fawn, not antlered, in velvet, antlered, spike buck, large point buck, group size), as well as behavior (travel, browse, agonistic behaviors, fighting).

Family Suidae (pigs)

Sus scrofa (feral hog)

PARK STATUS: Present, previously historical. A small number of hogs were hunted and extirpated from the park in the early 1980s. Occur in swamps and/or bottomland hardwood forests and expanding into marsh habitats along spoil bank corridors.

ABUNDANCE: Common

RESIDENCY: Resident and Breeder. Non-native

VOUCHER / OBSERVATIONS: Hood (2006) did not find any evidence of feral hogs at Barataria Preserve. The present study documented numerous camera-trap records, observations, tracks, and scat. Feral hogs have emerged as a resident population.

COMMENTS: Feral hogs (boar) are moderately-common, non-native invasive species of forests and agricultural areas in much of eastern United States. They are common in forested areas of southeast Louisiana. Large populations of hogs can be found in bottomland hardwood forests and swamps adjacent to the Mississippi River levee and in forests near Belle Chasse, LA (only 5 miles to the east of the Barataria Preserve). Given their distributional records, they were

expected to occur in the park and be a serious management concern. A small number of wild pigs were hunted and extirpated from the park in the early 1980s (pers. comm., David Muth, Chief of Planning and Resource Stewardship). None were documented by motion-triggered cameras, trapping, or observations of sign by Hood (2006). The lack of observations then suggested that wild pigs did not occur in the park at that time. In February 2006 following fieldwork for that earlier study, several visitor reports were made of wild pigs in the area of south Plantation trail. Post-Katrina, feral hogs began to establish a large, resident population in most forested areas and represent a significant natural resource management concern.

In the present study, feral hogs were photographed at 17 sites in all major habitats (**TABLE 1**). It was noteworthy that only at Site 24 (former spoil bank on Tarpaper Canal) were hogs photographed in a marsh habitat (see **RESULTS** section). Large adult hogs (black and multicolored) were regularly photographed in bottomland hardwood sites in the Big Woods area (Sites 1-12), as were piglets (**see example camera photographs in FIGURE 24)**. In many instances, camera-traps captured 2-3 large hogs traveling together, including sequences of 4-5 piglets traveling with adult male and female hogs . This was especially documented by using the Reconyx cameras that capture 10-photographs per triggering event with a 10-second camera re-set for the next triggering event (**compare** feral hogs **records in TABLE 1 and 2**)

In comparison of 11 co-located camera trap sites between the previous study (Hood, 2006) and the present study, the same presence/absence was recorded at 5 of the sites (all with no hogs, as none were recorded in 2006); at 6 sites they were undocumented in 2006 but recorded in the present study (**TABLE 3**).

Activity patterns by month show feral hogs are present throughout the year, but have the highest activity in fall and winter months (September-February) (**FIGURE 26**). Hourly records show that feral hogs are strongly nocturnal, with very few records in daylight hours (**FIGURE 27**).

To date, no hogs have been recorded in camera-trap sites in Bayou aux Carpes, nor in most marsh locations, so special efforts should be made to monitor and control their spread into these areas. The number and physical evidence of impact (destructive rooting) make the management and control of feral hogs the most important natural resource issue at Baratara Preserve.

7. SPECIES ACCOUNTS FOR SPECIES REPORTED BUT UNDOCUMENTED OR NO LONGER PRESENT

The following accounts provide comments on the status of species have been reported (in previous NPS inventories, public hunting and trapping records, naturalist reports), or have been observed by NPS staff as occurring within the Barataria Preserve in the past (before 1990). Species with asterisk (*) are introduced or domesticated.

ORDER RODENTIA—Rodents
Family Sciuridae (squirrels and allies)

Glaucomys volans (Southern flying squirrel)

PARK STATUS: Unconfirmed. Would occur in swamps and/or bottomland hardwood forests.

ABUNDANCE: Expected to be Common

RESIDENCY: Unknown Resident. Native

VOUCHER / OBSERVATIONS: None verified.

COMMENTS: Southern flying squirrels are common inhabitants of hardwood forests in the Southern United States., especially those dominated by oaks and hickories. Given their distributional records, the large number of large oak and other hardwood tree species in forested areas of the Barataria Preserve, they would be expected to occur in the park. Hood (2006) used live traps (10 stations) positioned on trees (at 2 m height) within the north and south Old Barataria trail trapping sites for 66 trapnights, but failed to capture any individuals. Motion-triggered cameras in this area also did not photograph any southern flying squirrels. The bat field work included over 20 nights of work in these areas and another 20 nights of field observation did not lead to observations of southern flying squirrels. There does not seem to be any special reason why southern flying squirrels would not occur at the Barataria Preserve, aside from their evading observation given their secretive nature. This species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park.

In the present study, no flying squirrels were live-captured or documented with confirmed observations. NPS staff and visitors have sporadically reported possible sightings.

The status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency, population status, and use of the park

Family Castoridae (beavers)

Castor canadensis (beaver)

PARK STATUS: Historical. A beaver dam was constructed in the 1980s, and occupied for a short time, no re-occurrence. Would occur in swamps and/or bottomland hardwood forests.

ABUNDANCE: Expected to be Uncommon

RESIDENCY: Unknown Resident. Non-native (Native to Louisiana, not native to the Barataria Preserve).

VOUCHER / OBSERVATIONS: No vouchers. A beaver dam was constructed in the 1980s, and occupied for a short time.

COMMENTS: Beavers are moderately-common species of forested wetlands and waterways in much of eastern United States They are not common in southeastern Louisiana. Given their distributional records, they could be expected to occur in the park. A beaver dam was observed

to be constructed N. of Kenta Canal in the early 1980s (pers. comm., David Muth, Chief of Planning and Resource Stewardship). It was not maintained for more than a couple of years and the beaver was presumed to have left. No beavers were documented by motion-triggered cameras, trapping, or observations of sign in the present study. A special effort was made in the present study to determine if beavers occur at the Barataria Preserve. The lack of observations suggests that they do not presently occur in the park. This species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park.

Family Cricetidae (native mice and rats)

Neotoma floridana (Eastern woodrat)

PARK STATUS: Unconfirmed. Would occur in swamps and/or bottomland hardwood forests.

ABUNDANCE: Expected to be Uncommon, but may be locally common in suitable habitat.

RESIDENCY: Unknown Resident. Native

VOUCHER / OBSERVATIONS: None verified.

COMMENTS: Eastern woodrats are common inhabitants of hardwood forests in the eastern U.S., especially those dominated by hardwoods. They are known to create stick middens ("woodrat middens") throughout their range and have been recorded from hardwood forests and marsh habitats in southeast Louisiana. Given their distributional records, the large number of large oak and other hardwood tree species in forested areas of the Barataria Preserve, they would be expected to occur in the park.

In the present study, no woodrats were live-captured or documented with confirmed observations. To date, no evidence of eastern woodrats have been documented through the field work of the of Hood (2006) and this present study. Care was taken to search for eastern woodrat middens and to trap in areas that included large amounts of woody debris on the forest floor (over 8,000 trap nights in Hood, 2006, and 1,800 trap nights in the present study). The status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency, population status, and use of the park

ORDER CARNIVORA—Carnivores
Family Canidae (canids)

Vulpes vulpes (red fox)

PARK STATUS: Unconfirmed. Would occur in swamps, marshes, natural levees and canal spoil banks, and/or bottomland hardwood forests.

ABUNDANCE: Expected to be Uncommon, but may be locally common in suitable habitat.

RESIDENCY: Unknown Resident. Native

VOUCHER / OBSERVATIONS: None verified.

COMMENTS: Red foxes are moderately-common inhabitants of forests, agricultural areas in northern and central Louisiana. Historically, they were targeted as furbearers. They are not common in southeast Louisiana, although they have been observed in habitats on higher ground in the region over the past 20-30 years. Given their distributional records, they would not be expected to occur in the park. Hood (2006) did not document any red fox by motion-activated cameras, scent stations (baited with red fox urine), trapping, or observations of sign in the present study. JLNHPP hunting and trapping records dating back to the mid-1980s do not record any taken as "by-catch", although annotations of "fox" occasionally are noted. This species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park

In the present study, no red fox were documented with camera-traps or with confirmed observations, despite deployment of 39 camera sites resulting in over 5,000 camera-days of observation. Coyotes and bobcats were captured with these same camera traps, but no red fox have been documented to date.

Red fox are still expected to be residents in major habitats of Barataria Preserve, especially using natural and canal spoil banks in marsh and swamp habitats. The status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency, population status, and use of the park

Urocyon cinereoargenteus (gray fox)

PARK STATUS: Unconfirmed. Would occur in swamps, marshes, natural levees and canal spoil banks, and/or bottomland hardwood forests.

ABUNDANCE: Expected to be Uncommon, but may be locally common in suitable habitat.

RESIDENCY: Unknown Resident. Native

VOUCHER / OBSERVATIONS: None verified.

COMMENTS: Gray foxes are moderately-common inhabitants of forests and agricultural areas in northern and central Louisiana. Historically, they were targeted as furbearers. They are not common in southeast Louisiana, although they have been observed in habitats on higher ground in the region in recent years. Given their distributional records, they would not be expected to occur in the park. Hood (2006) did not document any gray fox by motion-activated cameras, scent stations (baited with red fox and coyote urine), trapping, or observations of sign in the present study. JLNHPP hunting and trapping records dating back to the mid-1980s do not record any taken as "by-catch", although annotations of "fox" occasionally are noted. Several visitor reports have been made of "gray fox" on park trails, however field identification of gray fox and small (young adult) coyotes is difficult. This species should be studied further at the Barataria Preserve, especially to establish their residency, population status, and use of the park

In the present study, no gray fox were documented with camera-traps or with confirmed observations, despite deployment of 39 camera sites resulting in over 5,000 camera-days of observation. Coyotes and bobcats were captured with these same camera traps, but no gray fox have been documented to date.

The status of this species should be studied further at the Barataria Preserve, especially to increase knowledge of their residency, population status, and use of the park

RESEARCH, MANAGEMENT, AND OUTREACH RECOMMENDATIONS

The following are recommendations for future research, natural resource management, and public education outreach concerning mammals for the Barataria Preserve.

Research. Mammal inventories by Hood (2006) and the present study provide significant new knowledge about the occurrence, distribution, habitat use, and status of mammals at the Barataria Preserve. As required in the Statement of Work, the design of the inventory focused on documenting the species that occur in the park unit (as residents, migrants, or vagrants) with limited data collection on abundance. **Special effort was made to address status of carnivores, deer and feral hogs.** Thus, the inventory goals of this project did not allow for collection of data on population and community ecology, including population size or dynamics, fine-scale habitat use, movement, and of many other aspects of population biology. Nonetheless, the results provide a baseline of occurrence, associations with major habitats, rough estimates of abundance, and observations on mammal activity and natural history.

The following research opportunities are evident –

- ***Studies focused on population status, size, and dynamics of several groups of mammals should be initiated and carried forward for multiple years***. The best baseline data and opportunity for generating high quality research results are for a) bats, b) rodents – white-footed mouse in bottomland hardwood forests and marsh rice rat in marshes, and c) coyotes, bobcats, deer, and feral hogs. These have specific scientific questions that can be pursued with each species group and have specific field protocols. An important element in these studies will be to evaluate their results in the context of environmental change that is ongoing in the park. Additionally, each contributes to important natural resource management concerns (see below).

  Bats. – The inventories by Hood (2006) and the present study provide a baseline for pursuing a monitoring program for species of bats. Population ecology questions include descriptions of population size, seasonal dynamics, habitat use, and movement; none of which has been conducted in southeast Louisiana. Recent published studies of bat population ecology in other localities in the southeast United States will allow for powerful comparative studies to be conducted.

  Rodents. – The most common rodent species in bottomland hardwood forest habitats (white-footed mouse) and marsh habitats (marsh rice rat) are appropriate targets of research that aims at addressing biotic changes in response to ecosystem change. Both of these species have been used extensively in small mammal monitoring and as response organisms in landscape ecology, therefore comparative studies are possible. There are some logistical and experimental design challenges – a) the challenge of an unsecured study area in the bottomland hardwood forests (visitors frequently travel through the forests on and off-trail), b) the challenge of extended boat travel to marsh habitats, and c) the challenge of accommodating the public hunting and trapping seasons in marsh and swamp areas in the western and northern portions of the park. The use of the WWL

Radio Towers area (used as the Marsh Trapping Site), is an outstanding location for a secure area to conduct marsh research on small mammals.

Coyotes, Bobcats, White-tailed Deer, and Feral Hogs. – All of these large mammals co-occur in all major habitats throughout the Barataria Preserve. Because motion-activated cameras could be a primary research protocol for some studies, there can be an economy of scale in monitoring design and implementation to study all of these species. The use of marsh habitats and the landscape features of the park (spoil banks traverse a large area of marsh) by large mammals here is unique and allows for a number of research projects in landscape ecology. The logistical and experimental design challenges of traveling to marsh habitats throughout the park and working around the public hunting and trapping seasons are very significant, but the research opportunities are also significant.

Specific research protocols for each of these species (e.g., radio-tracking, thermal aerial photography, etc…) carried conducted by researchers trained in these methods could generate some important research studies.

- ***Studies on bats focused on their population biology (foraging and reproduction), habitat use, and roost site selection should be initiated and carried forward for multiple years.*** The inventories by Hood (2006) and the present study were not specifically focused on monitoring population ecology (as above), but on population biology phenomena. Specific studies include the assessment of habitat use and selection in foraging, day roost use, and maternity roost use. The discovery of the use of bridge supports by evening bats is a special opportunity to conduct a high quality study of reproductive ecology. The logistical and experimental design challenges include – a) the challenge of a highly unsecured study area in the bottomland hardwood forests (visitors frequently travel through the forests on and off-trail), and along the Bayou Coquille Trail, and b) the challenge of working at night when safety can become a concern.

- ***Studies on other mammal species, as described in the Species Accounts in this report.*** Several mammal species occurring in the Barataria Preserve need additional study to contribute to understanding their status in the park. Additionally, several species not documented but expected – southern flying squirrel and eastern woodrat – should be targeted for additional study. Specific projects, designed for these species should be pursued.

Natural Resource Management. Each of the recommendations for new research described above has important natural resource management implications, as well.

The following research opportunities are evident –

- ***Mammal monitoring programs should be linked to ongoing studies of environmental change to assess and conserve the habitats and ecosystem functions at the Barataria***

Preserve. These goals should be accomplished in concert with the research studies described above, however they should be distinctly focused on management issues. Ongoing invasion of all park habitats by Chinese tallow tree and of wetlands by water hyacinth (*Eichhornia crassipes*) and common salvinia (*Salvinia minima*) has been made much worse by damage done by Hurricanes Katrina and Rita in August and September 2005, respectively. The damage to the natural levees and canal spoil banks, as well as canopy in the bottomland hardwood and swamp forest is very significant and a rapid growth of these invasives is possible. The role of mammals in these systems is not well understood at the Barataria Preserve and monitoring programs should be focused on addressing those roles.

Bats and Rodents. – Bats have been successfully used as target animal species to monitor changes in forest structure. They also provide significant ecosystem functions in controlling insect populations (all species at the Barataria Preserve are insectivorous). Rodents are also significant response species to environmental change in all habitats.

Coyotes and Bobcats. – Coyotes and bobcats at the Barataria Preserve are distributed throughout the park and can provide direct measures of impacts from environmental change. However, both also provide important ecosystem services as top predators.

White-tailed Deer. The number and density of deer are very high, especially given how little natural (and suitable) habitat exists outside of the park boundaries. NPS sponsored studies by Hood (2006), Chamberlain and Nyman (2006, and appended studies), and the present study have provided baselines for managing white-tailed deer. The impacts of deer on plant community ecology in all habitats of the park may be (or become) a significant management concern, especially as the last remaining forested areas north of the park are converted to residential development.

Feral Hogs. The present study has documented the extent and scope of a large, growing population of hogs that threaten many habitats. Feral hogs are unquestionably the most important mammalian natural resource management issue at Barataria. The impacts of hogs on plant community ecology in all habitats of the park are a serious, significant management concern. Active management through hunting and removal by traps have been underway, but continued and expanded efforts to control or eradicate feral hogs should be a top priority. In a just published paper, Elsey et al. (2012) report significant impacts by feral hogs on alligator nests in western Louisiana. Their study reports 2011 surveys of alligator nest predation / destruction statewide, for which there were no records of these impacts in Jefferson Parish (see Elsey et al., 2012 figure 4).

Nutria and Muskrats. – Nutria remain an invasive mammal species of management concern at the Barataria Preserve. Their populations fluctuate annually, however their numbers are clearly significant when the limited public trapping season generates several thousand nutria taken each year. Studies by Nolfo-Clements (2006a, 2006b, 2009, 2012) have provided important baseline data on nutria ecology at Barataria.

- ***The recent rapid residential development of most forested areas immediately north of the Barataria Preserve will place significant new management pressures on the park.*** Immediately pre-Katrina (2003-2005), most of the undeveloped land north of the Barataria Preserve boundary had been identified for residential development and housing tract development is underway. Housing pressure following Hurricane Katrina will has accelerated this development. Post-Katrina, levees on north of Barataria have been significantly raised and extended. This could well generate new management pressures as follow:

  Translocation of mammals to the park. – It is likely that mammals inhabiting these areas that are capable of dispersal (especially White-tailed deer and coyotes) could take refuge in the park. This could lead to a number of ecological consequences that would transform or re-shape the ecosystem functions of the park. Of special concern would be a significant increase in deer populations leading to over-browsing and various other impacts on plant communities. Non-native mammals including feral hogs, murid rodents, feral dogs and cats may also increase. Most of the species mentioned here are known to have significant impacts on native flora and fauna. Monitoring that targets these and other species will become an important management strategy in the near future.

  Increase in human impacts. – It is likely that visitor traffic to the Barataria Preserve will increase significantly as urbanization accelerates immediately adjacent to the park. Park usage is a major factor in NPS appropriations. However, increase visitor traffic on trails (and especially off-trails where people will wander) will likely increase impacts on park ecosystems. Increase in poaching or other prohibited activities is also possible. The expansion of urban areas to the boundaries of the park will also likely place increased pressures on the park to manage mosquitoes with concerns about the nuisance of insect bites and West Nile Virus. Thus, the park will need to integrate its natural resource management and its public information strategies.

Public Education Outreach. The recommendations for research and natural resource management described above have specific implications for public education outreach and yet, improved outreach programs can make these recommendations work more efficiently and to better results.

The following public education outreach opportunities are evident –

- ***The Research and Natural Resource Management projects should be fully integrated with Public Education Outreach Programs.***

  Bats. – Bat research and conservation have been very successfully used as public education outreach tools to both educate the public and develop a sense of "stewardship" of nature. Because the selection and use of roosts and foraging for insects are major components of bat ecology, developing a sense of stewardship for bats also generates one for the hardwood forests and even of the insect community. The bat research and management projects should include electronic

monitoring stations that continuously monitor bat activity and the public should engaged in the process of the work. Public education programs, including "bat walks", and interactive web access to summarized data on bat activity has the potential to contribute very significantly to the mission of the park as interpreting the natural, cultural, and historic features and uses of the Barataria Preserve

Interpreting Large mammal Ecology – Coyotes, Bobcats, White-tailed Deer, and Feral Hogs. – All of these large mammals co-occur in all major habitats throughout the Barataria Preserve and are common in the areas (along traisl) visited by most park visitors. The data and photographs generated by motion-activated cameras provide a powerful educational tool. Large mammals, especially carnivores, but also deer and hogs, are viewed as "charismatic" fauna by many visitors. The presence of feral hogs represent another invasive mammal species in addition to nutria, to teach about a major form of environmental perturbation that is common everywhere in the world.

Monitoring Environmental Change. – Several of the recommended mammal research and management projects concern tracking environmental change including the impacts of mammals on ecosystems. Developing public education programs that identify work in the park as contributing to and remediating environmental change would be very powerful. Although mammals are not always the best species to use as bioindicators, the general public is often connected to mammals (the charismatic species phenomenon). In addition to bats, large mammals public education program.

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