EFFECT OF AGE OF FOREST ON MAMMALS IN THE UPPER MOBILE-TENSAW RIVER DELTA, ALABAMA

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EFFECT OF AGE OF FOREST ON MAMMALS IN THE UPPER MOBILE-TENSAW RIVER DELTA, ALABAMA

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EFFECT OF AGE OF FOREST ON MAMMALS IN THE UPPER MOBILE-TENSAW RIVER DELTA, ALABAMA

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Date of Graduation

VITA

Michael Dewayne Gay, son of Wayne Gay and Pamela (Mitchell) Cox was born 12 July 1969, in Andalusia, Alabama. He graduated from Benjamin Russell High School in 1987. He briefly attending Virginia Polytechnic Institute and State University in Blacksburg, Virginia, before enrolling at Auburn University in January 1988, and graduated with a Bachelor of Mechanical Engineering in March 1992. After working for the Alabama Department of Environmental Management as an environmental engineer for 3 years he returned to Auburn University in January 1996, and graduated *summa cum laude* with a Bachelor of Science in Wildlife Management in June 1998. He worked as a computer consultant and then as an applications analyst for Renfro Corporation in Mount Airy, North Carolina, before entering Graduate School at Auburn University in August 2003. He married Samantha Wade, daughter of Donald and Melba Wade, on 9 September 1989. He has two daughters: Michaela born 11 May 1998 in Alexander City, Alabama, and Lydia born 28 June 2002 in Winston-Salem, North Carolina.

THESIS ABSTRACT

EFFECT OF AGE OF FOREST ON MAMMALS IN THE UPPER MOBILE-TENSAW RIVER DELTA, ALABAMA

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Ecosystems provide services to humans through ecological processes, raw materials, and aesthetics, but these services often are negatively impacted by human activities. Flood-prone riparian areas are called upon increasingly to provide these services, but these areas, while being naturally impacted by flooding, are further impacted by human activities such as harvest of timber. The Mobile-Tensaw River Delta historically has been used for harvesting timber, but large portions of it recently have been placed in the public trust. This study examined relationships between age of forest and composition of mammalian communities. By using traps and monitoring cameras, I surveyed northern portions of the Mobile-Tensaw River Delta for mammals. Age of forest, dominant species of canopy tree, and type of habitat were recorded for each area surveyed. While robust populations of two mesopredators, *Procyon lotor* and *Didelphis virginiana*, occurred throughout the study area, few small mammals were captured.

Average age of forest was not significantly different where small mammals were captured compared to average age of forest where small mammals were not captured. Dominant species of overstory tree was not different among sites where small mammals were captured and sites where small mammals were not captured. Age of forest, dominant species of tree, and type of habitat were not significantly different for sites where mesopredators were recorded compared to areas where mesopredators were not recorded. Further studies are needed to fully understand the dynamics of small mammals in this area and how periods of extensive drought and flooding might affect them.

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INTRODUCTION

Humans are placing ever-increasing demands on natural systems for both products and services. These products and services have collectively been referred to as ecosystem services. According to Daily (1997), ecosystem services are the "conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life." These services may manifest themselves by cleaning up polluted waste water, controlling floods, providing raw materials for industry, or simply a beautiful mountain view. Because technological substitutes for ecosystem services are often costly, limited in their effectiveness, or unavailable, it is important to both understand and preserve ecosystems (Daily 1997). However, while virtually no place on Earth remains untouched by human influence, the value of ecosystem services often is not appreciated until they are lost or disrupted (Daily 1997).

Riparian areas are increasingly expected to fulfill ecological functions, as well as social functions such as recreation and aesthetics. These areas are very productive and unusually diverse portions of the landscape (Naiman and Decamps 1997). Riparian sites are a complex of shifting habitats created and destroyed by natural disturbances, most frequently by flooding (Naiman and Decamps 1997). Many functions provided by riparian areas are controlled by the organisms that live in these unique habitats (Naiman and Decamps 1997). Human activities can have adverse effects on habitats within these areas by changing the flow of water with dams, removing timber, and altering widths of channels for navigation (Naiman and Decamps 1997). Changes in availability or nature of habitat can alter the biological diversity of an area by producing changes in the abundance of species in an area (Pulliam and Danielson 1991). This is important because the function and stability of an ecosystem is affected by loss in biological diversity (Tilman 1997).

Timber has been harvested from riparian areas throughout the southeastern United States (Dunn 1998). This practice can have dramatic effects on the composition of animal communities in an area (Annand and Thompson 1997, Mitchell et al. 1995, Schmid-Holmes and Drickamer 2001, Yahner 1992). Specifically, timber management can affect small mammals by altering conditions in and around a forest stand (Bowman et al. 2001). Methods of harvest include clearcutting, shelterwood cutting, and single-tree removal (Klenner and Sullivan 2003, Von Trebra et al. 1998), and each of these forms of harvest can have different impacts on populations of small mammals. Several researchers have reported that clearcutting increases populations of small mammals in an area because of increases in growth of understory plants (Constantine et al. 2004, Fantz and Renken 2005, Kirkland 1990); however, others have found an opposite effect (Klenner and Sullivan 2003). Shelterwood or partial harvest of timber either increases the size of populations of small mammals (Fantz and Renken 2005, Klenner and Sullivan 2003, Von Trebra et al. 1998) or has no (Fuller et al. 2004) impact on small mammals. Single-tree removal also has no discernable impact on abundance of small mammals (Klenner and Sullivan 2003). These widely varied results serve to illustrate a robustness of many populations of small mammals to timber management (Bowman et al. 2001). Although many studies have shown a positive relationship between timber management and populations of small mammals, it should be noted that an increase in size of populations and number of species of small mammals in response to timber management may create an unnatural situation. Mitchell et al. (1995) found that intensive timber management in coastal areas of North Carolina produced much different and more diverse communities of small mammals than were found naturally in that area.

Understanding how periodic flooding influences communities of small mammals in riparian areas also is important for a thorough understanding of these areas. Many researchers have noted that flooding decreases the size of populations of small mammals (Blair 1939, Chamberlain and Leopold 2003, Grinnell 1939, McCarley 1959, Miller et al. 2003, Williams et al. 2001). However, effects vary among species of mammals and floodplain habitats (Williams et al. 2001). Indeed, some researchers have shown no significant effects of flooding on populations of small mammals (Ellis et al. 1997, Stickel 1948). Andersen et al. (2000) found that small mammals in areas with predictable flooding regimes did not move to upland areas, but chose instead to remain in their home range as long as possible and then only briefly moving to higher ground. Several species of *Peromyscus* seek refuge in trees during floods (*P. maniculatus*---Andersen et al. 2000; *P. leucopus*---Ellis et al. 1997). Changes in sizes of populations of small mammals in response to flooding appear to be influenced by several parameters, including the speed at which water rises, maximum water levels, and duration of flooding (Andersen et al. 2000, McCarley 1959, Williams et al. 2001).

Understanding how demands by humans affect ecosystems is vital to maintaining those systems and the ecosystem services they provide. My study concentrates on effects of timber harvest on diversity of mammals in the Mobile-Tensaw River Delta. The objective of my study was to identify what effect, if any, age of forest and dominant species of tree had on mammalian communities. Understanding whether modifications to these components of the ecosystem are detrimental to mammals is important to properly manage forest resources. I tested the hypothesis that age of forest is a determining factor in abundance and composition of mammalian communities on sites subjected to frequent flooding as part of their natural annual cycle. I predicted that younger forest would have a greater abundance of mammals and more species. Also, I predicted that there will be a difference in composition of mammalian communities in forests of differing ages.

MATERIALS AND METHODS

Study area.---The Mobile-Tensaw River Delta in southwestern Alabama is a riparian area that has been logged extensively during the past 150 years. The Mobile-Tensaw River Delta is the largest inland delta in the United States and is formed by the confluence of the Alabama and Tombigbee rivers in southwestern Alabama (Isphording et al. 1996). It encompasses portions of Mobile and Baldwin counties and consists of 756 km^2 of rivers, lakes, bayous, and swamplands. The waters that make their way to the Mobile-Tensaw River Delta drain 115,513 km^2 of land including 86% of Alabama and portions of Georgia, Mississippi, and Tennessee. Unlike most deltas, the Mobile-Tensaw River Delta is unusually long and narrow (13.5 by 56 km). It empties into Mobile Bay some 50 km north of the Gulf of Mexico (Isphording et al. 1996). This long narrow shape, coupled with annual rainfall that averages 165 cm/year, lead to frequent flooding (Jeffcoat et al. 1991). The recent acquisition of large portions of this area into the public trust has provided an opportunity to study how timber management practices have affected the organisms there. Few studies have been done previously on mammals in the

Mobile-Tensaw River Delta, with all previous studies being surveys of mammalian diversity (Linzey 1970); the most extensive was by Howell (1921). Extensive logging has left this area a mosaic of different aged stands of forest. My study was conducted in the northern portions of the Mobile-Tensaw River Delta, which is slightly drier than areas to the south and partially accessible by roads.

Trapping of small mammals.---Three sites were chosen in the upper Mobile-Tensaw River Delta based on ease of access and proximity of timber of different ages at each site (Fig. 1). Each site contained three stands of different ages, one young (<15 years), one middle-aged (25-45 years), and one old (>55 years), for a total of nine stands. The age of forest in each stand was determined using GIS data provided by International Paper to the state of Alabama when the area was purchased. Stands at each site were as close to each other as was practical. A single transect was established in each of the nine stands. Each transect consisted of 100 trapping stations 5 m apart with a single Sherman live trap (7.5 by 9 by 23 cm, H. B. Sherman Traps, Inc., Tallahassee, Florida) baited with rolled oats placed at each station during each trapping session. Trap stations were marked with PVC pipe inserted into the ground. Three trapping sessions were conducted during spring and summer 2004 and an additional two trapping sessions were conducted during spring and summer 2005. Traps were open for three consecutive nights during each session and were checked and rebaited each morning and afternoon. Captured animals were weighed and marked using a passive induced transducer (PIT tag) before being released at the trap site. Species, sex, reproductive condition, and whether the animal was an adult or subadult also were recorded for each animal captured. Additionally, 25 sites were chosen throughout the Mobile-Tensaw River Delta and 40

Sherman live traps baited with rolled oats and spaced 5 m apart were set in these areas for one night. Locations of all trap sites are shown in Fig. 2. Two traps were placed in six different abandoned houses along the water's edge. These wood-framed houses on stilts were built as hunting and fishing lodges and as weekend retreats by individuals who had leased hunting rights from International Paper Company before the area was purchased by the state of Alabama. Species, sex, weight, reproductive condition, and approximate age were recorded for animals captured before they were released at the trap site. For all nine transects, as well as the additional areas trapped, age of forest, predominant species of tree, and type of habitat were taken from the GIS data provided by International Paper Company.

Use of cameras to study mesopredators.---Cameras have been used successfully to survey populations of mammals such as foxes (Harrison et al. 2002) and tigers (Karanth and Nichols 1998). They also have been used in studies of bird nest predation (Bayne and Hobson 1997) and in examining effects of habitat fragmentation (Perault and Lomolino 2000). Therefore, I believed they would provide a convenient method of surveying larger mammals that are not as easily captured and handled. Digital game cameras (Snapshot Sniper LLC., Duncan, Oklahoma) were placed at locations in the northern portions of the Mobile-Tensaw River Delta to document presence of mesopredators. Locations of camera sites are shown in Fig. 3. Cameras were attached to trees using elastic straps about 40 cm above the ground. Bait piles consisting of 470 cm^3 dry corn, 470 cm^3 dry dog food (Old Roy, Walmart Stores, Inc., Bentonville, Arkansas), 156 g of canned cat food (Special Kitty, Walmart Stores, Inc., Bentonville, Arkansas), and 115 g of sardines (Great Value, Walmart Stores, Inc., Bentonville, Arkansas) were placed about 1.5 m in front of the camera. Cameras were left in place for 1-2 weeks and were then moved to another location. Camera sites were not rebaited during the 1-2 weeks. Digital images were downloaded to a lap-top computer and later sorted by what mammals were photographed. Age of forest, predominant species of tree, and type of habitat were recorded for each site where a camera was placed. During my study, research sites included five types of habitat: levees, which were higher elevated corridors of sediment next to larger flowing rivers; cypress-tupelo ponds, which were wetland depressions where the surface remains saturated or inundated; ridges, which were narrow bands of different soil types with slightly higher elevation not associated with a stream; first bottoms, which were lower in elevation, and poorly drained; and second bottoms, which were higher in elevation, well-drained productive sites supporting higher-valued species of timber.

Statistical analysis.---Rates of capture were compared between traps located on transects and traps not located on transects, between years, and among different species of dominant trees using a normal approximation of a binomial distribution (Fleiss 1981). Student *t*-tests were used to compare average age of forest stands containing trap sites where small mammals were captured to average age of forest stands containing trap sites where no small mammal was captured. Regression analysis was used to assess patterns in age of stands where small mammals were captured (Sokal and Rohlf 1995).

Average ages of forest stands where mesopredators were photographed were compared using a Student *t*-test (Sokal and Rohlf 1995). A Fisher-Irwin test was used to compare presence or absence of mesopredators among dominant species of tree and types of habitat (Fleiss 1981).

RESULTS

A total of 95 small mammals were captured (including 32 recaptures) in 15,180 trap nights. Sixty-three cotton mice, *Peromyscus gossypinus* (including 26 recaptures), 31 marsh rice rats, *Oryzomys palustris* (including 6 recaptures), and one hispid cotton rat, *Sigmodon hispidus*, were captured during my study. The majority of trap nights, 13,500, were conducted on the nine established transects. Twelve trap nights were in abandoned wood-framed houses along the edge of the river. The remaining 1,668 trap nights were in areas throughout the Mobile-Tensaw River Delta. Eighty-five of the captures were from transects, three from abandoned wood-framed houses, and seven from other areas in the Mobile-Tensaw River Delta. A summary of captures of small mammals and trap nights in each area is presented in Tables 1 and 2. Of the 85 captures from transects, three came from site 1, 76 came from site 2, and six came from site 3. Because so few captures were made on sites 1 and 3, they were not used in examining the role of dominant species of tree on presence of small mammals. Additionally, type of habitat was the same (second bottoms) for all stands within site 2, and so I could not examine effects of type of habitat on small mammals.

Fig. 1. Location of the three sites used for transects to study small mammals in the Mobile-Tensaw River Delta, Alabama, 2004 and 2005. Locations are 1, 31° 6.373’ N, 87° 54.824’ W; 2, 31° 8.391’ N, 87° 54.522’ W; and 3, 31° 7.229’ N, 87° 53.285’ W.

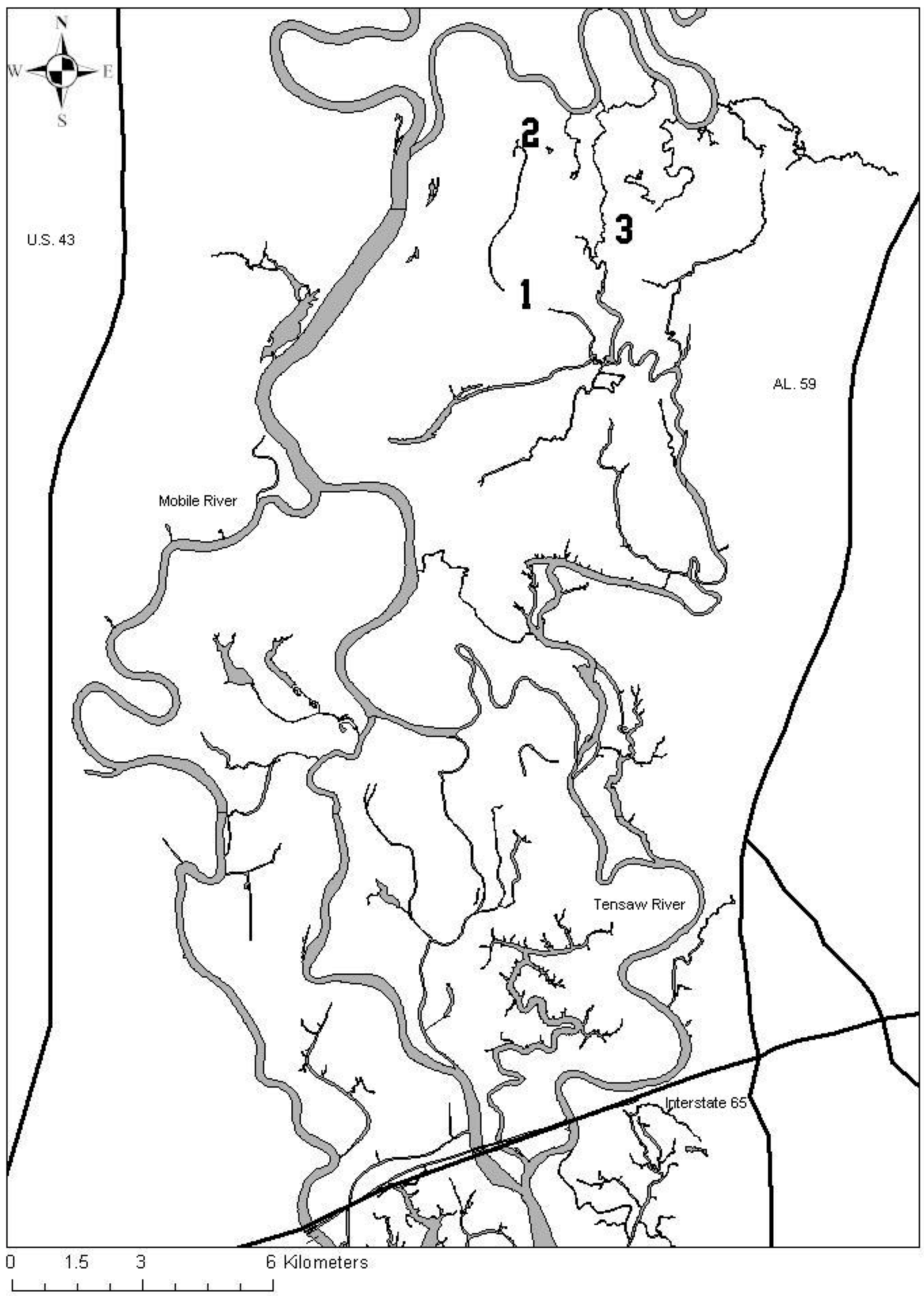

Fig. 2. Locations (stars) where small mammals were trapped in the Mobile-Tensaw River Delta, Alabama, 2004 and 2005.

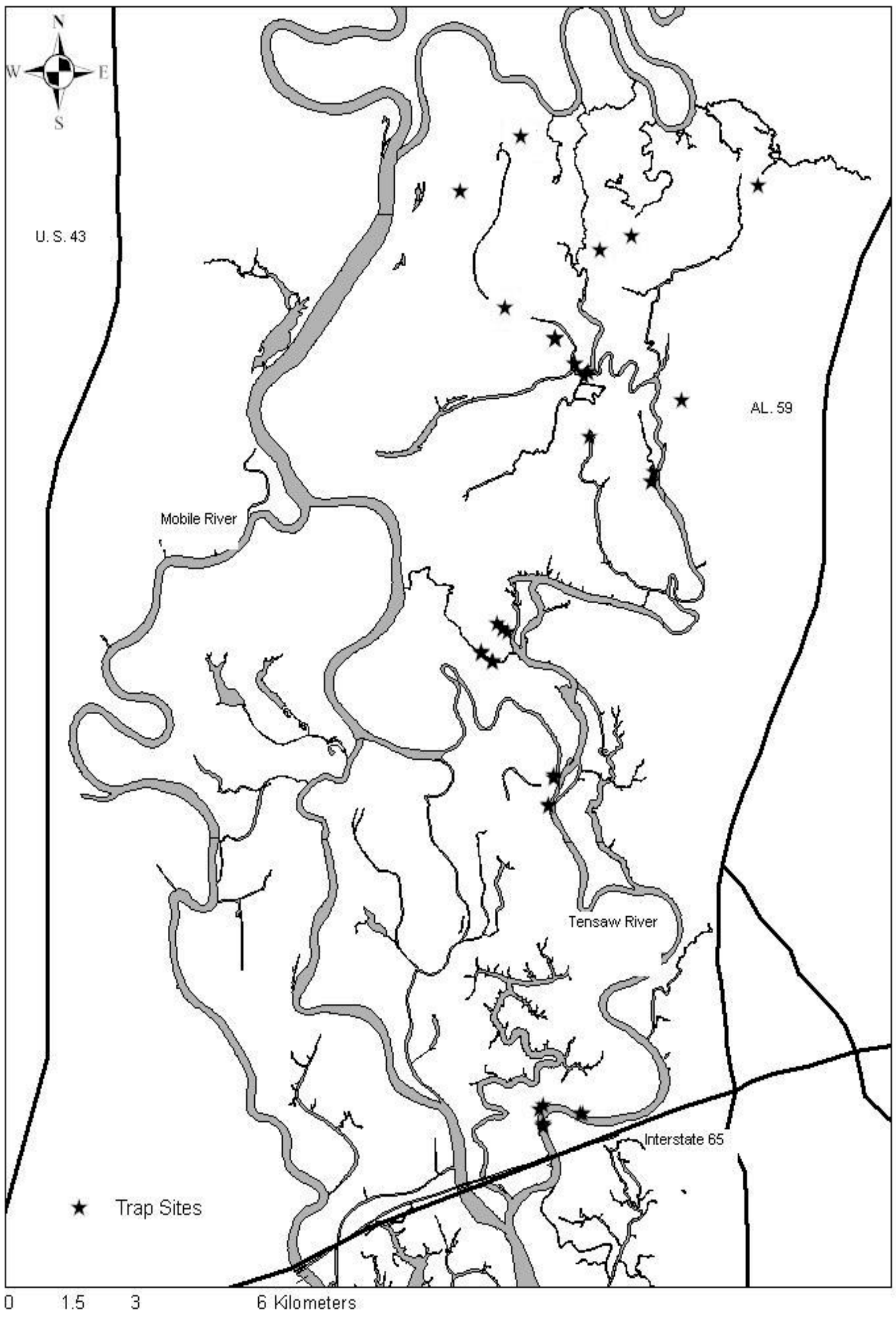

Fig. 3. Locations of camera monitoring sites (crosses) in the Mobile-Tensaw River Delta, Alabama, 2004 and 2005.

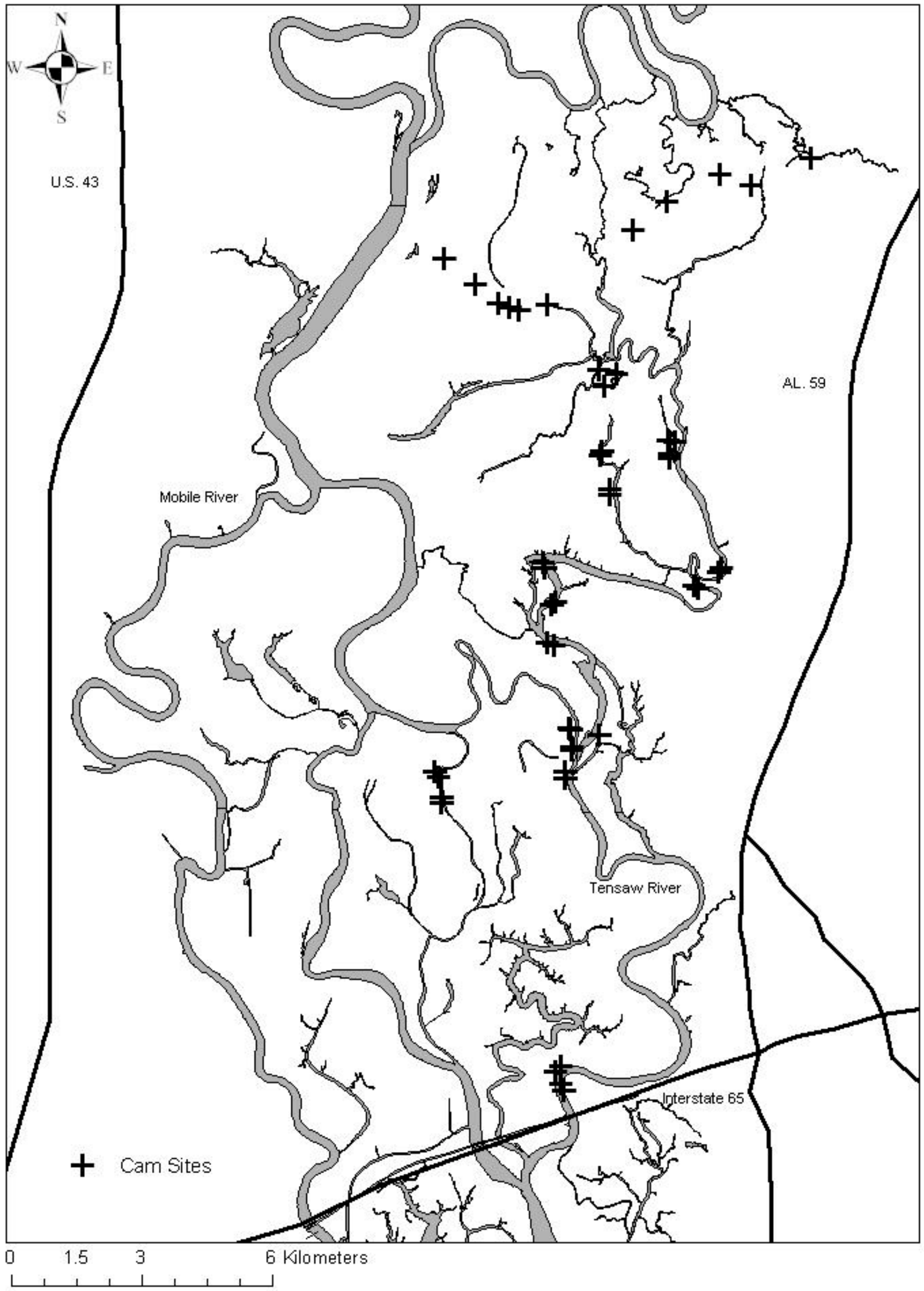

Table 1. Total number of small mammals trapped in the Mobile-Tensaw River Delta, Alabama, for each year and type of area trapped (recaptures are excluded).

	Transects		Traps not on transects		Abandoned wood-framed houses	
	Captures	Trap nights	Captures	Trap nights	Captures	Trap nights
2004	29	8,100	3	948	3	12
2005	24	5,400	4	720	-	-
Total	53	13,500	7	1,668	3	12

Table 2. Species of small mammals captured in each type of area trapped in the Mobile-Tensaw River Delta, Alabama, 2004 and 2005.

Species	Transects	Traps not on transects	Abandoned wood-framed houses
Peromyscus gossypinus	55	5	3
Oryzomys palutris	30	1	0
Sigmodon hispidus	0	1	0

.

Rates of capture did not differ between traps on transects and traps in scattered locations (0.39 % versus 0.42 %, z = -0.16, P = 0.871), traps on transects in 2004 and traps on transects in 2005 (0.36 % versus 0.44 %, z = -0.77, P = 0.441), traps not on transects in 2004 and traps not on transects in 2005 (0.32 % versus 0.56 %, z = -0.72, P = 0.471), traps on transects in 2004 and traps not on transects in 2004 (0.36 % versus 0.32 %, z = 0.21, P = 0.830), traps on transects in 2005 and traps not on transects in 2005 (0.44 % versus 0.56 %, z = -0.38, P = 0.703), or between all traps for 2004 and 2005 (0.35 % versus 0.46 %, z = -0.98, P = 0.329). Rates of capture for traps in abandoned wood-framed houses did differ significantly from capture success from all other traps (25.0 % versus 0.40 %, z = -1.97, P = 0.049).

Average age of forest at trap sites where an animal was captured was 38.6 years (S.D. = 24.4, n = 13). Average age of forest at trap sites where no animal was captured was 53.4 years (S.D. = 29.3, n = 21). Average age of forest at trap sites where small mammals were captured was not significantly different than for those with no small mammal captured (t = -1.59, *d.f.* = 29, P = 0.124). Only one dominant species of tree was represented at site 2, this was tupelo gum (*Nyssa aquatica*). The other areas were designated as "other hardwood." There was no difference in rate of capture for traps in tupelo gum as compared to traps in "other hardwood" (18.0% versus 20%, z = -0.42, P = 0.675). There was no difference in average age of forest at trap sites where *P. gossypinus* was captured compared to average age of forest at trap sites where *O. palustris* was captured (t = 1.81, *d.f.* = 12, P = 0.095). Regression analysis did not show any significant correlation between age of stand and number of captures of *P. gossypinus* (r^2 = 0.821, P = 0.278), or age of stand and number of captures of *O. palustris* (r^2 = 0.594, P = 0.440).

During my study, 454 photographs of mammals were taken over 383 nights. Six species of mammals were photographed including two mesopredators, the northern raccoon (*Procyon lotor*) and the Virginia opossum (*Didelphis virginiana*). The two mesopredators were the most common species photographed with 322 photographs of *P. lotor* and 120 photographs of *D. virginiana*. Additionally, five photographs were taken of white-tailed deer (*Odecoileus virginanus*), two photographs of coyotes (*Canis latrans*), one photograph of a gray squirrel (*Sciurus carolinensis*), and one photograph of a rabbit (*Sylvilagus*). There was no difference in average age of forest where mesopredators were photographed and average age of forest where mesopredators where not photographed (t = 1.16, *d.f.* = 36, P = 0.254). There was also no difference in average age of forest where *P. lotor* was photographed and average age of forest where *D. virginiana* was photographed (t = -0.33, *d.f.* = 22, P = 0.741). Photographs were taken in forest with 4 different dominant species of tree; tupelo gum (*Nyssa aquatica*), water oak (*Quercus nigra*), ash (*Fraxinus* spp.), and southern red oak (*Quercus falcata*). There was no difference in presence or absence of mesopredators among any of these dominant species of tree (tupelo gum versus water oak, Fisher-Irwin test, P = 1.0; tupelo gum versus ash, Fisher-Irwin test, P = 1.0; tupelo gum versus red oak, Fisher-Irwin test, P = 1.0; water oak versus ash, Fisher-Irwin test, P = 1.0; water oak versus red oak, Fisher-Irwin test, P = 1.0; ash versus red oak, Fisher-Irwin test, P = 1.0). Five different types of habitat were represented by the different forests where photographs were taken; levees, cypress-tupelo ponds, ridges, first bottoms, and second bottoms. There was no difference in presence or absence of mesopredators among any of these types of habitat (levees versus cypress-tupelo ponds, Fisher-Irwin test, P = 0.570; levees versus ridges, Fisher-Irwin test, P =

0.303; levees versus first bottoms, Fisher-Irwin test, $P = 0.393$; levees versus second bottoms, Fisher-Irwin test, $P = 0.656$; cypress-tupelo ponds versus ridges, Fisher-Irwin test, $P = 1.0$; cypress-tupelo ponds versus first bottoms, Fisher-Irwin test, $P = 1.0$; cypress-tupelo ponds versus second bottoms, Fisher-Irwin test, $P = 1.0$; ridges versus first bottoms, Fisher-Irwin test, $P = 1.0$; ridges versus second bottoms, Fisher-Irwin test, $P = 0.644$; first bottoms versus second bottoms, Fisher-Irwin test, $P = 1.0$).

DISCUSSION

While other research has found that communities of small mammals in riparian areas contained greater numbers of species and higher populations than did surrounding upland areas (Doyle 1990), this is likely not the case in the Mobile-Tensaw River Delta. Overall, success in trapping small mammals was only 0.625% and only three species of small mammals were captured, suggesting that the community of small mammals in the Mobile-Tensaw River Delta was depauperate. However, these results are similar to results of studies in similar areas elsewhere. Chamberlain and Leopold (2003) captured three species of rodents in Yazoo County, Mississippi, Wolfe (1985) captured four species of rodents in Harrison County, Mississippi, and Martin et al. (1991) captured three species of rodents during a study conducted in Cameron Parish, Louisiana. As in my study, both Chamberlain and Leopold (2003) and Wolfe (1985) captured *P. gossypinus*, *O. palustris*, and *S. hispidus,* while Wolfe also captured the house mouse, *Mus musculus*. Martin et al. (1991) captured *O. palustris*, *M. musculus*, and the fulvous harvest mouse, *Reithrodontomys fulvescens*. While all of these studies also documented shrews that were not captured during my study, this was most likely due to differences in trapping techniques and not necessarily to their absence from the Mobile-Tensaw River Delta.

While the number of species of small mammals in my study was comparable to results from similar areas, my results differed significantly from results of studies in other areas. Comparing number of species of small mammals I detected in the Mobile-Tensaw River Delta to other areas throughout the United States and in other parts of the world further illustrates how few species of small mammals use my study area. Studies from other areas within the United States found numbers of species of small mammals ranging from 5 to 12 (11 species in Bryan Co., Oklahoma---Clark et al. 1998, 7 species near College Station, Texas---Grant et al. 1985, 5 species in Island Beach State Park, New Jersey---Shure 1971, 11 species on Moscow Mountain in eastern Washington and northern Idaho---Hoffman 1960, 12 species in Flathead Co., Montana---Ramirez and Hornocker 1981, 7 species in Bibb, Greene, Hale, and Tuscaloosa counties, Alabama---Wolfe and Rogers 1969, and 8 species in the foothills of the Sacramento Mountains, New Mexico---Jorgensen et al. 1995). Studies from other parts of the world also detected much greater abundances of species of small mammals; 16 species in eastern Malaysia (Stuebing and Gasis 1989), 13 species in the western llanos of Venezuela (Utrera et al. 2000), 6 species in southwestern Ontario, Canada (Morris 1979), and 7 species in central Chile (Iriarte et al. 1989). The least number of species of small mammals found by any of these other studies was five, and that study was also in a coastal area although at a northern latitude. These results indicate that riparian areas along the Gulf of Mexico in the United States may not be optimal areas for small mammals.

The paucity of small mammals in the Mobile-Tensaw River Delta likely is due to severe flooding, which regularly occurs in my study area. McCay (2000) determined that woody debris was an important habitat component for *P. gossypinus*. Flooding limits access to woody debris and I observed the alteration of amount and position of woody debris within an area even after short-term flooding. *Peromyscus gossypinus* appeared to readily use trees; several climbed trees after being released. However, previous research suggests long-term use of trees as refugia during flooding may decrease survival (McCarley 1959). I also expect that frequently returning to refugia, such as trees, may keep populations low by reducing reproductive opportunities. Reproductive activities were altered in white-footed mice, *Peromyscus leucopus*, during periods of flooding (Ruffer 1961). High rates of capture of *P. gossypinus* in abandoned wood-framed houses suggest that these houses are providing refuge from flooding and predators; however, abandoned houses recently have been removed by the state of Alabama to help return the area to a more natural state.

My initial predictions were that younger forests would be more likely to hold both larger populations and greater diversity of small mammals. My research did not support these predictions. It was no more likely for small mammals to be captured in older forest than in younger forest. Most of the *P. gossypinus* I captured were in older forest stands, but there was no significant difference in the age of stands where *O. palustris* was captured. *Oryzomys palustris* occurred in slightly greater numbers in younger forest, but was about equally abundant across all age classes of forests. Fewer *O. palustris* were captured than *P. gossypinus*. This may be attributable to the upper Mobile-Tensaw River Delta being a less suitable habitat for *O. palustris,* which prefers marshes (Dueser and

Porter 1986, Kincaid et al. 1983). Dominant species of overstory tree did not play any role in presence or absence of small mammals.

Factors other than age of forest and dominant overstory species likely are playing an important role in determining whether small mammals are occupying a given area in the Mobile-Tensaw River Delta. While all areas had relatively small populations, larger populations at site 2 seemed to indicate that the area provided a preferred habitat. Factors allowing larger populations at site 2 were not determined during this study, but it would be interesting to examine this area at a microhabitat level to determine what might be influencing choice of habitat by small mammals. From the research I performed in the Mobile-Tensaw River Delta, I further believe it would be interesting to investigate the role small changes in elevation have on small mammals. While the entire area is < 3 m above sea level, site 2 may be slightly higher in elevation than the other two sites. Although I had no way to measure elevation at such a fine scale at the different sites, it appeared that site 2 flooded later and dried earlier than other sites. This certainly could be an important factor for small mammals.

It also is important to consider that I observed this system for only two years and that both of those years received slightly more than average rainfall (National Oceanographic and Atmospheric Administration 2004, 2005). Extended droughts affect this portion of the United States (Jeffcoat et al. 1991) and it may be that populations of small mammals are much larger during dry periods: this area may act as a sink in a temporal sink-source scenario (Johnson 2004). Or, based on persistent populations at site 2, there may be both a spatial and temporal sink-source scenario. This can be explored only with long-term studies and by conducting studies during dry and wet periods. In

2003, the year before my study began, 259.6 cm of rainfall was recorded in the Mobile-Tensaw River Delta which was significantly higher than the 165 cm average rainfall for the area (National Oceanographic and Atmospheric Administration 2003). I believed that populations of small mammals might rebound from the flooding associated with heavy rainfall in 2003 and I might see an increase in success of captures from 2004 to 2005, but did not. Both 2004 (187.6 cm) and 2005 (197.4 cm), were wetter than average years but were much drier than 2003 (National Oceanographic and Atmospheric Administration 2003, 2004, 2005). This may indicate that significant periods of dry weather are necessary before populations of small mammals in the Mobile-Tensaw River Delta begin to increase noticeably following a significant flood event.

Mesopredators (*P. lotor* and *D. virginiana*) were abundant throughout the Mobile-Tensaw River Delta. Being larger mammals, it is likely that they have little trouble escaping floods and different ages of timber appeared to have no influence on either species. Only five photographs showed these two species together at bait piles suggesting that either one excluded the other or there is some other factor eliminating direct competition.

While age of forest may play a role in determining the abundance and diversity of small mammals in the Mobile-Tensaw River Delta, there appear to be other factors not measured in this study that are equally, if not more, important. Further study is needed to elucidate these factors. An understanding of how anthropogenic changes to ecosystems affect their stability is important to preserving biological diversity and, in turn, in preserving the ecosystem services associated with these areas. While bringing areas such as the Mobile-Tensaw River Delta into the public trust is important, we should not fail to take advantage of the opportunity these formerly exploited areas provide for research. Many sites, such as the Mobile-Tensaw River Delta, provide a ready made experiment on a scale that could never be achieved otherwise. As the Mobile-Tensaw River Delta returns to its natural state we should continue to learn from it and use it to understand and preserve other natural areas like it around the world.

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