Nutria (*Myocastor coypus*) in the Chesapeake Bay: A Draft Bay-Wide Management Plan

Prepared by:
The Chesapeake Bay Nutria Working Group

November 2003

Chesapeake Bay Nutria Working Group

Robert Colona, Maryland Department of Natural Resources
Randy Farrar, Virginia Department of Game and Inland Fisheries
Steve Kendrot, U.S. Department of Agriculture, APHIS – Wildlife Services
Jonathan McKnight, Maryland Department of Natural Resources
Ted Mollett, University of Maryland Eastern Shore
Dan Murphy, U.S. Fish and Wildlife Service
Lars Olsen, University of Maryland College Park
Kevin Sullivan, U.S. Department of Agriculture, APHIS – Wildlife Services

Table of Contents

Executive Summary

Nutria (*Myocastor coypus*) are prolific, aquatic rodents native to South America. Nutria were first introduced into the United States to California in 1899 and then to southern states in the early 20th century for fur farming and weed control. The species was subsequently introduced to 22 states by the mid-20th Century. Since its introduction in 1943, the nutria population on Maryland's Lower Eastern Shore has increased to approximately 50,000, as estimated in the early 1990's from work conducted on the Chesapeake Marshlands National Wildlife Refuge Complex (CMNWRC) Blackwater unit.

In Maryland, nutria seem to prefer to eat the roots of the Olney three-square bulrush (*Schoenoplectus americanus),* a native emergent grass that grows 4-5 feet above water and supports a submersed root mat in very erodible sediment. Since their introduction, nutria have destroyed over 7000 acres of marshland on the CMNWRC Blackwater Unit, nearly half of its marsh acreage. Nutria excavate plant roots, exposing the marsh sediment to erosion. The wetland is quickly converted to open water, removing all habitat benefits of the marsh for native species.

Recognition of the threat that nutria pose to important wetland habitats is shared by public natural resource agencies in all geographic areas in which nutria have been established outside their native range. In the late 1980's, resource managers in the Chesapeake Bay region began to consider options for controlling or eradicating nutria. This led to the creation of the Maryland Nutria Project in 2000. The multi-agency project, financed by State, Federal, and private funds, was established to investigate nutria eradication methods and apply the most successful methods to eradicate nutria from Maryland and, ultimately, the entire region. After almost two years of analysis, eradication on the Delmarva Peninsula of Maryland began in earnest in fall 2002 and continues to this day. As of August 2003, over 5000 nutria have been captured, resulting in the protection of 13,000 acres of wetlands from further degradation. In early 2003, President Bush signed the Nutria Eradication and Control Act of 2003, which authorizes the expenditure of $20 million over five years for nutria eradication in Maryland. In order to mobilize the effort necessary to eradicate nutria from Maryland, it is imperative the project be funded to the fullest potential under law. Additionally, it will be necessary to eradicate nutria not only from Maryland, but from the entire Chesapeake and Delaware Bay regions, including the states of Virginia and Delaware, since nutria recognize no political boundaries.

Resource managers in the Chesapeake Bay watershed face multiple challenges in managing marsh habitat for wildlife. Invasion of nutria into many of these marshes further increases the difficulty of managing for wildlife. Control options are limited and costly, justifying the need for a regional approach to preventing new invasions and prioritizing control efforts in invaded areas where effective management can be achieved and native habitat equilibrium can be re-established.

To better coordinate prevention and control efforts for aquatic invasive species on a regional basis, the Chesapeake Bay Program's Invasive Species Workgroup (CBP's ISWG) developed the following two goals for the Chesapeake 2000 Agreement: "By 2001, identify and rank non-native aquatic and terrestrial species which are causing or

have the potential to cause significant negative impacts to the Bay's aquatic ecosystem. By 2003, develop and implement management plans for those species deemed problematic to the restoration and integrity of the Bay's ecosystem." In September 2001, the ISWG developed a questionnaire that was sent to the CBP signatory jurisdictions and federal partners to identify six species that are causing or have the potential to cause adverse ecological effects in the Bay's ecosystem. The nutria was identified as one of the six priority species for which a Bay-wide management plan would be written. In May 2002, the CBP in partnership with the Maryland Sea Grant College sponsored a workshop in Baltimore, Maryland aimed at developing draft Bay-wide management strategies for each of the six species. In 2003, a Chesapeake Bay Nutria Working Group was appointed by the CBP, comprised of many of the workshop participants, as well as other natural resource managers and researchers, to develop a final Bay-wide management plan.

This final management plan is a product of the draft Bay-wide management strategy developed for Nutria at the May 2002 workshop and lessons learned during the initial stages of the Maryland Nutria Project. Workshop participants developed a draft management strategy utilizing four different components: 1) Leadership, Coordination, and Regulatory Authority; 2) Prevention; 3) Control and Management; and 4) Communication and Information Access. Participants identified specific actions within each of the components that should be taken to meet the goal of their management strategy. An implementation table was developed and included a time frame for completing the actions, identification of agencies responsible for leading actions, the partners that should be involved, the funding/cost share, and the source of funding. To insure that the draft management strategy developed at the workshop was realistic in terms of feasibility of implementing actions, including agency leads and sources of funds available to implement actions, a Bay-wide Working Group was established to evaluate the draft management strategy, make changes if needed, and develop a final plan to be submitted to the Implementation Committee of the Chesapeake Program for approval.

This final plan relies heavily on close coordination and cooperation with the Maryland Nutria Project, which is already underway. Increased funding for the project as outlined in the Nutria Eradication and Control Act of 2003 will be necessary to insure the achievement of nutria eradication goals in the Chesapeake Bay region.

The goal of this plan is as follows:
By 2009, eradicate nutria from the Chesapeake Bay watershed to ameliorate adverse effects to the Chesapeake Bay.

I. Introduction

A. Method and History of Introduction

Nutria (*Myocastor coypus*) were intentionally introduced into the United States first to California in 1899 and then to southern states in the early 20th century for fur farming and weed control (Evans 1970; Willner et al 1979; LeBlanc 1994; Hess et al. 1997). The species was subsequently introduced to 22 states by the mid-20th century (Evans 1970). Nutria introduced intentionally for fur farming in North America were first imported to Elizabeth Lake, California in 1899; these nutria apparently were not successful in reproducing, and very little information is available on their eventual fate. The 1930s are generally considered the boom years for establishing nutria ranches in the United States, though between 1899 and 1940 ranches were established in California, Washington, Oregon, Michigan, New Mexico, Louisiana, Ohio, Utah and elsewhere (Evans 1970).

Shortly after the boom years, World War II came and nutria farming virtually collapsed. The collapse was attributed to poor reproduction, low fur prices and competition with beaver pelts (also bringing low prices). Some ranchers released their nutria or did nothing to recapture those that escaped because of inadequate holding facilities, storms or floods (Evans 1970). State and federal agencies and individuals translocated nutria into Alabama, Arkansas, Georgia, Kentucky, Maryland, Mississippi, Oklahoma, Louisiana and Texas, with the intent that nutria would control undesirable vegetation and enhance trapping opportunities. Nutria were also sold as "weed cutters" to an unknowing public throughout the Southeast. A hurricane in the late 1940s aided dispersal by scattering nutria over wide areas of coastal southwest Louisiana and southeast Texas (Evans 1983).

In 1943, the federal government introduced nutria to Dorchester County, Maryland in order to establish an experimental fur station at the Chesapeake Marshlands National Wildlife Refuge Complex (CMNWRC) Blackwater Unit (formerly known as Blackwater National Wildlife Refuge). Nutria were also introduced in Maryland in the 1950s to promote the fur industry. In a relatively short period of time, captive rearing proved unprofitable and the remaining project nutria either escaped and/or were inadvertently released; in addition, a limited number of nutria were reportedly released by adjacent landowners. These animals functioned as the origin of the now overwhelming populations in the state (Colona pers. comm.). Currently, there is virtually no commercial fur market and only a very small meat market for nutria. This situation combined with the animal's reproductive success has led to a population boom: for example, estimates on a 10,000 acre parcel of land located in Dorchester County have expanded from less than 150 nutria in 1968 to 35,000 to 50,000 animals today (Colona pers. comm.).

B. Life History

Nutria use marsh vegetation to create resting platforms and consume whole plants, including roots and tubers. This creates circles of mud flats called “eat outs”

within contiguous marsh, which eventually become open water when the fluid sediment erodes with tidal action (Harris and Webert 1962; Foote and Johnson 1993; Linscombe and Kinler 1997). In Maryland, nutria seem to prefer to eat the roots of the Olney three-square bulrush (*Schoenoplectus americanus)*, a native emergent grass that grows 4-5 feet above water and supports a submersed root mat in very erodible sediment. Since their introduction, nutria have destroyed over 7000 acres of this marsh on the CMNWRC Blackwater Unit, nearly half of its marsh acreage. Nutria excavate the roots, exposing the soil to erosion and the brackish wetland to salt water intrusion. The wetland is quickly converted to open water, removing all habitat benefits of the marsh for native species. Nutria also fragment the marsh by creating deep swimming channels, preventing less mobile, marsh-dependant species from using all available habitat. The swim channels and edges of created ponds exposed to wave action cause further erosion of plants and soil. This in turn causes increased intrusion of salt water and turbidity in interior brackish ponds, further damaging the viability of submerged aquatic vegetation (SAV). SAV is a critical food source for wintering waterfowl and provides food and habitat for a variety of fin and shellfish. SAV also prevents erosion and contributes dissolved oxygen to the water, upon which fish and aquatic invertebrate life depends. Nutria also have been known to eat agricultural crops (Norris 1967; Anon. 1978) and dig large burrows into river banks, dykes, and other structures (Cotton 1963; Gosling 1989; Bounds 2000) causing damage to agricultural land and possibly residential areas in flood prone areas.

Erosion of marsh sediments prevents establishment of new native plant colonies, because many marsh plants are very sensitive to changes in soil elevation. A decrease in soil elevation by as little as three to four inches can convert vibrant emergent marsh into open water (MDNR 2002). Damage to the marsh from sea level rise and land subsidence, tidal flooding, and salt water intrusion is increased as the marsh plants, which buffer erosion from tidal and wave action, are removed.

Nutria is a Spanish word for "otter", but the species is a semi-aquatic rodent native to South America. About 5-10 times larger than our native muskrat, adult nutria can reach 18 lbs and measure 24 inches from tip of nose to tip of tail, but on average weigh between 12-15 lbs. Males are slightly larger than females. They are designed for aquatic life, with webs between their first four toes of their back feet and with eyes, nostrils and ears located high on their heads to enable them to expose as little of their bodies as possible when breathing at the surface of the water. Their fur is yellow brown or reddish-brown with a dense, soft, gray undercoat guarded by long, course hairs. Their front teeth are large and yellow to orange red on the outer surface. Nutria are primarily nocturnal, however, when food is limited and during cold weather daytime activity increases (Gosling et al. 1980). Chabreck (1962) confirmed their nocturnal activity by placing recorders along the trails of nutria in the wild. They inhabit fresh and brackish marshes, rivers, bayous, farm ponds, freshwater impoundments, drainage canals, swamps and various other types of wetlands.

In the U.S., nutria prefer to eat the roots, rhizomes, and tubers of the following types of plants: cordgrass (*Spartina alterniflora*), saltmarsh hay (*Spartina patens*), bulrush, spikerush, chafflower, pickerelweed, cattails, arrowheads, and flatsedges. On the Delmarva Peninsula, nutria prefer Olney three-square bulrush, which forms dense stands comprising most of the vegetation in open, estuarine marsh and tidal-influenced, riverine wetlands. In Great Britain, the flowering rush *(Butomus umbellatus)* and

cowbane (*Cicuta virosa)* became rare due to selective eating by nutria (Ellis 1963). Gosling (1974) found that nutria can consume about 25% of their body weight each day. Nutria generally feed at the waterline, cutting off or digging up food and taking it to a feeding platform of vegetation, about 5-6 feet across. Nutria are known to eat a variety of agricultural crops, especially grains and root crops, lawn grasses, and ornamental plants.

Nutria are poorly adapted to harsh winters when water in the marsh freezes (Newson 1966; Gosling et al. 1981). In Maryland, nutria are not known to burrow, although they are reported to burrow in the banks of ditches and rivers in low-lying East Anglia (Cotton 1963). In Maryland, nutria gather together in piles to keep warm. Maryland trappers report that piles of frozen nutria were found during harsh winters in the 1970's.

Nutria groom themselves with their teeth and claws. They swim by propelling themselves with alternate thrusts of their hind feet and will sometimes remain immobile on the surface of the water. Like rabbits, nutria reingest their feces. The material is usually reingested after the animal has bedded down in its resting platform (Gosling 1979).

Genetic variation in Maryland nutria was examined by Morgan et al. (1981) by analyzing serum eye lens proteins, and liver enzymes. The conclusion of this work was that this population is homogeneous in its genetic composition, as evidenced by lack of variation in soluble proteins and enzymes.

Nutria are highly prolific and breed throughout the year. Nutria can produce two to three litters per year or five litters over two years (Brown 1975; Willner et al. 1979). Gestation is about 130 days. When not pregnant, females come into reproductive state every 24 to 26 days. Males are fertile and can mate at any time of the year. When in estrus, females may breed with one or more males. Estrus begins one to two days after a miscarriage or after giving birth and can last up to 60 days, with healthy females occasionally showing no cycles over several months (Newson 1966). In their home range, nutria have an average of four or five young. In their introduced range, average nutria litter size is four to six young, but a female may have as many of 13 offspring per litter (Willner 1982). Young nutria weigh about 8 oz. at birth, are precocious and are capable of surviving without the mother after about 5 days of nursing (Nowak 1991). Most young nutria continue to nurse for 7-8 weeks and remain with their mother for about 10 weeks, although they can consume plant material within 24 hours of birth (Whitaker 1988). The young nurse on a set of 4-5 pairs of teats high on the sides of the female, enabling them to swim with her while nursing (Gingerich 1994). They are ready to breed at 4-6 months of age, depending upon food supply and availability (Brown 1975; Willner et al. 1979).

Exact population estimates of nutria in a specific place and time are difficult, if not impossible, to achieve (Gosling 1989; Linscombe 2001 pers. comm.). Gosling et al. (1981) were able to model population size in Great Britain by reconstructing the numbers alive, each month in the past, from the numbers and ages of the animals caught in a control operation. Between 1968 and the early 1990's, nutria on the CMNWRC Blackwater Unit increased from 250 animals to between 35,000 and 50,000 (Bounds and Carowan 2000). The population of nutria on nearby privately-owned Tudor Farms was estimated to be between 17,000 and 20,000 between 1995 and 1998 (L. Ras 1999). The Dorchester County population was most recently estimated between 52,000 and 75,000

animals. In Louisiana, the population of nutria has risen from a few pairs of animals to an estimated 20 million animals by 1950 (Nowak 1991).

Mortality, or the percentage of animals that die in a population each year, is estimated to be 80% during the first year of life and few animals live more than two or three years. Predation, disease and parasitism, water level fluctuations, habitat quality, highway traffic, and weather extremes affect mortality (Willner 1982). Carter et al. (1999) link high survivorship with reduction in habitat quality, causing periodic population crashes which may be interpreted by other models as an ability of the species to maintain high densities while experiencing high rates of mortality. Predators of nutria in the Chesapeake Bay include humans, bald eagles, and carnivorous mammals. Disease, parasitism, traffic, flooding, and extreme weather changes also play a role in mortality of nutria in the Chesapeake Bay. Population wide mortality is estimated to be 60% annually (Willner 1982).

Nutria generally have a small home range. Adams (1956) noted that daily movement of nutria was less than 45m in Louisiana. Most movement occurs along water routes (Robicheaux 1978). Linscombe et al. (1981) reported that the farthest that recaptured nutria traveled in a Louisiana brackish marsh was 3.2 km. Ras (1999) found that nutria on Tudor Farms generally traveled no more than 40 acres a day. Research conducted on movement of nutria in the Nutria Pilot Project (Nutria Project Phase I) generally supported these findings. However, some individual males traveled fairly long distances including one that traveled over 7 miles from its home range. Monitoring in Louisiana has shown that few nutria will cross drainage ditch boundaries around their home range (Linscombe, pers. comm. 2001). Although there is limited documentation of social behavior of nutria, they are thought to be gregarious, living in groups with related adult females and their offspring and a large male (Gosling 1977).

C. Ecological and Economic Impacts

In the past 40 years, the CMNWRC Blackwater Unit has lost over 7,000 acres of marsh, primarily due to nutria feeding activity. The effects of nutria feeding are in turn exacerbated by a combination of sea level rise and erosion of soil that supports marsh plants. This represents a significant loss of habitat for nesting waterfowl, including black ducks, which are declining in population, wetland birds, including the state-listed black rail; and a variety of song birds. The loss of these species, in turn, reduces the value of these areas for commercial and recreational fisheries and for local ecotourism, which brings $15 million each year from visitors to CMNWRC alone. In 1991, nearly 500,000 visits were made to view wildlife in Maryland wetlands, contributing to a total wildlife viewing recreation economic impact of $458 million (Southwick Assoc. 1995). The economic benefits to Maryland from hunting waterfowl and other species dependent upon wetlands is estimated at well over $300 million annually (USFWS 1995). The loss of brackish marsh in the southeastern Chesapeake Bay significantly reduces both habitat for fish and wildlife and their value to citizens and visitors of the state, as well as to national and international conservation interests. Nutria also compete with native muskrats for habitat in the marsh and effectively remove much of the marsh that supports this important furbearer species. Nutria pose a significant threat not only to the health of the Chesapeake Bay, but also to the very conservation purposes for which state, federal,

and private conservation refuges were purchased and are maintained, with both public and private funds.

Wetlands help maintain environmental quality by purifying natural waters through the filtering of nutrients, chemical and organic pollutants, and sediments. Wetlands are excellent water filters because of their locations between land and open water. In addition, wetland vegetation helps minimize shoreline erosion by increasing sediment stability, dampening wave action, and reducing current velocity through friction (Dean 1979). Wetlands also produce much of the food and forage upon which the majority of the living resources in the Chesapeake Bay rely.

Maryland's brackish marshes provide spawning and nursery habitat for a variety of anadromous and interjurisdictional finfish, including white and yellow perch and striped bass, and for shellfish, including clams, oysters, and blue crabs. Other species, such as shad and herring, migrate through these habitats on their way to upstream spawning areas. Metzgar (1973) found that 44 fish species use Dorchester County wetlands for spawning, nursery, and feeding. Goodger (1985) found that in Maryland, the American oyster and white perch complete their entire life cycles in estuarine waters. The Chesapeake Bay provides over $60 million annually in commercial finfish and shellfish landings. For example, in 1995, landings for the blue crab were 40.3 million pounds valued at $29 million (Holiday and O'Bannon 1996). State residents spent $475 million directly on recreational fishing, according to the U.S. Fish and Wildlife Service's (USFWS) 2001 Survey on Fishing, Hunting and Wildlife-Associated Recreation.

Marshes on the Chesapeake Bay also serve as staging and wintering habitat for about 1 million waterfowl, including Canada and snow geese, tundra swans, hooded mergansers, blue-winged teal, green-winged teal, common loons, northern pintails, American widgeon, pied-billed grebes and wood ducks. This represents 35% of all waterfowl in the Atlantic flyway (Chesapeake Bay Program 1990). Thousands of shorebirds and waterbirds use the marshes and mud flats associated with them, including great egrets, dunlin, glossy ibis, Virginia and clapper rails, sandpipers, yellow-legs, and semipalmated plovers in spring and fall. Songbirds, including warblers, vireos, orioles, and flycatchers use the forests and fields that are currently protected by marsh habitat from wave and tidal erosion. Migratory song birds both nest in these forests and collect in them during the fall migration period because the Delmarva Peninsula is geographically convenient for migrating birds to stop before traveling over water to Central and South America.

D. Population Status and Distribution

Nutria are native to Brazil, Bolivia, Argentina, Paraguay, Uruguay, and Chile (Nowak 1991). Introduced populations of nutria are now found in Europe, Asia, Africa and the Middle East, the Soviet Union, Japan, Canada, and the United States (Van Der Brink 1968; Hall 1981; Carter and Leonard 2002). Nutria were introduced to 22 states and are now established in 16 (Bounds 2000; Figure 1). Currently, nutria occupy over one million acres of habitat on National Wildlife Refuges in these states (Bounds 2000).

In Maryland, nutria have been recorded in all Eastern Shore counties and sighted as far north as Bombay Hook National Wildlife Refuge in Delaware and along Virginia's Eastern Shore (Figure 2). Since its introduction in 1943, the nutria population on Maryland's Lower Eastern Shore has increased to approximately 50,000, as estimated in

the early 1990's from work conducted on the CMNWRC Blackwater Unit (Carowan 2003 pers. comm.).On the Western Shore of the Chesapeake Bay, nutria have been sighted from the Patuxent River to Back Bay National Wildlife Refuge, approximately 15 miles south of Virginia Beach.

E. Existing Research and Management Strategy

Maryland

Recognition of the threat that nutria pose to important wetland habitats, hydrology and agricultural crops is shared by public natural resource agencies in all areas in which nutria have been established outside their native range. In the United States, Louisiana has been attempting control for many years. In Great Britain and Europe, control and eradication of established nutria populations have been on-going since the mid-20th century. Great Britain was finally successful in eradicating nutria in the 1980's. Maryland has consulted with the expertise developed in Louisiana and Britain to develop an eradication strategy, described below.

In 1989, the Maryland Department of Natural Resources (MDNR) and the USFWS began a rebate program that paid trappers a $1.50 rebate on public land lease fees for every nutria killed. Bounties are statutorily prohibited in Maryland. In 1990, MDNR and the USFWS began attempts to estimate nutria population numbers in Dorchester County, Maryland. In 1993, the first multi-agency task force was assembled in Maryland to consider the damage nutria were doing to Maryland's wetlands. A bill was passed in the Maryland Senate that provided limited funding. In 1994, MDNR invited Dr. Morris Gosling from Great Britain to evaluate the nutria situation in Maryland and to make recommendations on its management (Bounds 1998).

In 1994, the Maryland General Assembly passed a measure requiring the MDNR to develop and implement a management program to eradicate nutria in Maryland. In 1995, the MDNR partnered with the U.S. Geological Survey (USGS), which conducted an exclosure study on the CMNWRC Blackwater Unit (Haramis and Colona unpublished). The study consisted of 18 30m x 30m fenced exclosures randomly placed in marsh habitat. The fencing prevented access by adult nutria, but allowed most other wildlife, including muskrats, to enter. The hypothesis was that marsh would recover or show stronger growth in the absence of adult nutria within two annual growth cycles. The result was conclusive: marsh within the exclosures recovered well, while surrounding marsh continued to degrade. The difficulty in controlling nutria was made clear by the experience of Tudor Farms, where between 4,000 and 5,000 nutria were harvested per year, yet damage to the marsh remained unabated and the nutria population on the farm was not affected (Ras 1999). At CMNWRC, lands leased to trappers resulted in an average harvest of 8,500 nutria per year, yet nutria damage to the marsh continued. As a result of past experience, it was concluded that efforts to control nutria through commercial and recreational trapping are ineffective in stemming the nutria – caused damage to wetlands.

After exploring its options and consulting with experts in Louisiana and Great Britain, MDNR joined forces in 1997 with the USFWS to organize a Nutria Control Summit. This resulted in the formation of the Maryland Nutria Project Partnership, with 17 initial partners. The Partnership grew to include the 26 partners involved today

(Appendix 1). The Partnership's goals are: 1) to determine the feasibility of eradicating nutria on Maryland's Eastern Shore and if possible, how to efficiently and economically accomplish the project; 2) to restore marsh habitats; and 3) to promote public understanding of the importance of preserving Maryland's wetlands.

In 1998, a three-year pilot project proposal was finalized and submitted to Congress for funding. The project was planned in two phases: an assessment phase and an eradication phase. The assessment phase was focused on assessing nutria populations in Dorchester County on three sites: CMNWRC Blackwater Unit (federal), Fishing Bay Wildlife Management Area (state), and Tudor Farms, Inc. (private), a total area of about 60,000 acres. Experimental sites were established on sections of the Little Blackwater River on CMNWRC (2,500 acres), the Transquaking/Chicamaomico Rivers on Tudor Farms (3,800 acres) and at the Head of Fishing Bay at the Transquaking/Blackwater Rivers (2,000 acres). The objectives of the assessment phase were: 1) to establish an estimate of nutria populations and animal densities in the three study areas; 2) to monitor nutria behavior and movement, especially in response to intensive trapping; 3) to evaluate the reproductive status and overall health of the population, especially in response to intensive trapping on the study sites; 4) to evaluate trapping strategies; and 5) to educate the public about the value of Maryland's wetlands and the impacts of exotic species on native fish, wildlife, and their habitats (Bounds 1998).

The proposal included four components: nutria management, nutria research, public education, and a wetland restoration demonstration project (Bounds 1998). For more details on the original Pilot Project Proposal, see Bounds, D.L. (Ed.) 1998, Marsh Restoration Partnership Report to Congress, 30 pp. After the proposal was submitted to Maryland Congressional Representatives for funding, President Clinton signed Public Law 105-322 in 1998 authorizing $2.9 million over three years, starting in FY99, to fund the Pilot Project. About $1.7 million of that amount was appropriated for the project during the following three years.

Although preliminary work for the Project was conducted between 1998 and 2000, the official start was in 2000. At that time, an Environmental Assessment (EA) for the Project was issued by the USFWS in compliance with the National Environmental Policy Act (NEPA). The EA evaluated ways by which nutria damage management could be carried out to protect Chesapeake Bay marshlands. The EA analyzed alternatives to reduce or eradicate nutria populations and the associated nutria damage, and the potential environmental and social effects of reducing nutria damage to marsh and semi-aquatic habitats on public and private lands in the Chesapeake Bay area of Maryland. The USFWS decision was that the Nutria Pilot Project and its proposed methods to reduce nutria populations and impacts on local marshes had "no significant environmental impact." The Pilot Project was officially implemented in 2000. Additional funding was received through grants from the National Fish and Wildlife Foundation and the U.S. Department of Agriculture (USDA) and in-kind contributions were made from Tudor Farms, MDNR, CMNWRC, the University of Maryland Eastern Shore (UMES), and the USGS Cooperative Fish and Wildlife Research Unit (Management Team files). Although the original Pilot Project Proposal included objectives related to the development of management strategies for nutria and the evaluation of various factors on the potential success of marsh restoration, these goals were not addressed. In approaching the eradication phase of the Pilot Project, the Nutria Management Team

decided to conclude the original Pilot Project and reference it as Phase I of the Nutria Project. The eradication phase (Phase II) was developed from a separate and more detailed strategy, proposed to continue for two to five years, and officially commenced in the fall of 2002.

In 2002, the Maryland Nutria Management Team, which includes the USFWS, MDNR, the USDA Animal and Plant Health Inspection Service (APHIS) Wildlife Services, the U.S. Army Corps of Engineers (ACOE), the USGS Cooperative Fish and Wildlife Research Unit, Tudor Farms, Inc., and the UMES, began Phase II and drafted a Memorandum of Understanding to implement Phase II. During Phase II, 16 technicians are setting traps across grids of 40 acres throughout the three study areas. They also work with surrounding landowners to trap on private properties that are adjacent to these areas. As of August 2003, over 5000 nutria have been captured, resulting in the protection of 13,000 acres of wetlands from further degradation. Meanwhile, the ACOE is testing sediment spraying and planting of 3-square bulrush on CMNWRC Blackwater Unit salt marsh as potential marsh restoration measures.

The objectives of Phase II are: 1) to determine the feasibility of eradicating nutria populations inhabiting the marshland complex comprised of the CMNWRC Blackwater Unit, Fishing Bay Wildlife Management Area, and Tudor Farms (the Nutria Eradication Zone or NEZ); 2) utilize animal management tools (e.g. trapping, toxicants, shooting, dogs) to ascertain control strategies that provide the highest efficacy in permanently removing nutria from infested wetlands; 3) to determine the economics of a nutria eradication program; and 4) develop written guidelines to aid conservation agencies in other locales to develop effective nutria control or eradication programs. Once nutria have been extirpated from the NEZ, the project will expand through the remaining wetland habitats in Maryland into the entire Chesapeake and Delaware Bay regions, including the states of Virginia and Delaware, since nutria recognize no political boundaries and could eventually recolonize from untrapped areas. To the greatest extent possible, information from Phase I is used to guide the eradication process in Phase II. The following knowledge was gained from Phase I: nutria females breed all year; nutria have limited home ranges; it is not possible to precisely determine nutria population levels at a given time or place; and nutria activity peaks in the spring and fall. Also, it was determined from the exclosure study that dramatic recovery of the marsh can occur if nutria are removed before marsh is converted to mud flats and open water.

Behavioral/Population Research

In Phase I, nutria were trapped and fitted with radio collars so that biologists could track their movements. Data from a graduate student's work on nutria at Tudor Farms helped the Partnership establish a grid size of 40 acres across the marsh to test trapping strategies. Data collected in the Phase I experimental sites helped the Management Team to understand that nutria move more in spring and fall and less in winter and summer. Animals were marked so that their recapture could be documented Although the locations of marked animals continued to be recorded in Phase II, experience has taught the Management Team that it is difficult to accurately estimate nutria populations over an extensive and diverse wetland habitat as that represented by Chesapeake Bay's coastal marshes.

Reproductive Research

It is theorized that nutria could increase the number of young per litter and the frequency of breeding in response to declining populations. Research is being conducted to help biologists understand nutria reproductive physiology. This research has been conducted in both unharvested and harvested populations. Animals used in the study also are evaluated for physical condition and overall health.

Testing of Trapping Methods and Population Control Strategies

Sixteen technicians are trapping in contiguous, 40-acre grids across the entire marsh in CMNWRC Blackwater Unit, Fishing Bay Wildlife Management Area, and Tudor Farms. Various traps and trapping strategies are being tested for their efficiency in capturing nutria under various natural conditions. Trapping success is monitored by measuring reduction of nutria by catch-per-unit effort in an initial, intensive harvest, followed by surveys of nutria sign and additional trapping to determine whether nutria were eradicated and the impact of trapping techniques on non-target animals. Research is underway to determine how well geographic and trapping barriers are preventing emigration of animals from untrapped areas into trapped areas. The lower the population density becomes, the more the effort shifts from finding travel areas and trapping animals to searching for or attracting individuals over a wide area.

A number of methods will be tested to help trap animals in habitats that are not conducive to standard leghold or snap traps and that can help eradicate the few animals that may have avoided traps in the initial, intensive sweep. These may include baited traps and scent lures, as well as live traps, snares, and underwater trapping rigs. Although floating or landed baited traps were used to support the eradication effort in Great Britain with some success, attempts to use bait to trap nutria in Maryland have been unsuccessful, probably due to the abundance of naturally occurring preferred food (e.g. three-square bulrush). However, as the bulrush becomes scarce in the marsh, nutria may be more likely to use baited traps. This, and other baiting techniques, will be part of the adaptive management program to eradicate nutria.

Marsh Restoration

Nutria have contributed to the loss of thousands of acres of marsh in and around the CMNWRC Blackwater Unit. The ACOE conducted a pilot study in the summer of 2002 to study the feasibility and cost of restoring the marsh in areas where marsh has disappeared. The pilot study explored the impact of the presence of nutria in the study sites, the feasibility of adding soil to replace eroded sediment that supports plant growth, and the planting of 3-square bulrush. In Louisiana, researchers found that thin-layer deposition of soil was effective in increasing elevation of the marsh surface and promoting vegetative growth of cordgrass in areas formerly too eroded to support plant growth (Ford et al. 1998).

Success of large-scale restoration is dependent on knowledge of the factors that contribute to survival and growth of desirable plant species. The ACOE study will provide important information on the conditions that favor marsh plants on the Blackwater Unit, and will allow future restoration efforts to target creation of these conditions. The ACOE plans to use the results of this study to implement a 4-year

planned marsh restoration project, potentially covering 150 acres of denuded marsh on the CMNWRC.

Funding

Funding continues to be a challenge in the fourth year of the project. Technicians on salary, reporting to the USDA APHIS Wildlife Services, generate salary and related costs of approximately $750,000 per year. In addition, a trapping supervisor, a technician, and graduate students are funded directly by the Project. Additional staff support is supplied through the USFWS Chesapeake Bay Field Office, CMNWRC, MDNR, UMES, the USGS Cooperative Fish and Wildlife Research Unit, and the ACOE.

The cost of Phase I and II has been $4.2 million. The FY03 Interior Appropriations Bill included continued funding for the project. The cost of eradicating nutria from the Delmarva Peninsula (Phase II) is estimated to be $4 million/year for 5 years, not counting the cost of marsh restoration. In April of 2003, President Bush signed the Nutria Eradication and Control Act of 2003, authorizing the Department of the Interior to spend $20 million over five years, beginning in 2004, on nutria eradication in Maryland. Grant requests from the National Wetland Conservation Program and other sources have been submitted and the Partnership continues to contribute funds.

Delaware

There have been sightings of nutria at Bombay Hook National Wildlife Refuge, Prime Hook National Wildlife Refuge, and along the Nanticoke River. Population numbers and distribution are not well understood and appear to be limited. There are no research or management activities associated with nutria at this time. If fully funded through the Nutria Eradication and Control Act, it is expected that the Maryland Nutria Project will eventually expand into Delaware.

Virginia

At this time, there are no research or management activities associated with nutria in Virginia. Population numbers and distribution are limited. Individuals have been sighted and trapped at Saxis Wildlife Management Area and Back Bay National Wildlife Refuge. There has been no evidence of marsh damage or "eat outs" by the nutria in these two areas. If fully funded through the Nutria Eradication and Control Act, it is expected that the Maryland Nutria Project will eventually expand into Virginia.

II. Policy Background

The U.S. Environmental Protection Agency's Chesapeake Bay Program (CBP) recently identified nutria as a priority invasive species that requires regional, cooperative management. The CBP is dedicated to a commitment to restore the Chesapeake Bay through the attainment of certain environmental benchmarks, accomplished cooperatively by the State of Maryland, Pennsylvania, Virginia, and the District of Columbia, the Chesapeake Bay Commission, and the Federal Government. In 2002, the CBP's Invasive Species Work Group began developing this regional plan for nutria control (Chesapeake Bay Program 2002).

Maryland

Nutria are statutorily defined in Maryland as "unprotected," which means that it is not necessary to purchase a state hunting license in order to hunt or trap them, except in Baltimore and Frederick counties where local ordinances require that all hunting be done with a state hunting license. However, trapping of nutria and other furbearers is restricted on state owned lands to certain months and for permit holders only. Nutria may not be hunted with a rifle, except with a .22 caliber rimfire rifle (MD Ann. Code 08.03.05). For the purposes of the Nutria Project, the MDNR issued Scientific Collection Permits to USDA APHIS-Wildlife Services and to other partners on the Maryland Nutria Management Team to collect large numbers of nutria under the authority of MD Annotated Code 10-909, which requires that any person or entity collecting wildlife for scientific or education purposes must obtain a permit from MDNR.

In Maryland statute, the MDNR is required to conduct a nutria eradication program and prepare an annual report on the program for the Maryland General Assembly (MD An. Code 10-202.1).

Delaware

Nutria are regulated as a furbearer species.

Virginia

Nutria are considered a "nuisance" species in Virginia. It is unlawful to take, possess, transport or sell all other wildlife species not classified as game, furbearer, or nuisance, or otherwise specifically permitted by law or regulation. There is a continuous open season for trapping nuisance species.

III. Management Actions

Goal: By 2009, eradicate nutria from the Chesapeake Bay watershed to ameliorate adverse effects to the Chesapeake Bay. Many of the management actions described below are predicated on a Congressional appropriation of $20 million over five years for the Maryland Nutria Project under the authorization of the Nutria Eradication and Control Act of 2003. If funding is limited, some or all of the recommendations identified below will be unattainable. In order to mobilize the effort necessary to eradicate nutria from the Chesapeake Bay region, it is imperative the project be funded to the fullest potential under law.

A. Leadership, Coordination, and Regulatory Authority

Need:

There should be a mechanism for coordination among the different states in the Chesapeake Bay region. In addition to the Federal Government, the states of Maryland and Virginia, and non-governmental organizations already involved, we need to enlist the State of Delaware to develop a regional working group to share information and provide a structure for seeking agreement on strategies.

Actions:

1.1 Create a formal memorandum of understanding as a mechanism to link the interested State, Federal, and non-governmental organizations to each other and to the Maryland

Nutria Project. Among other things, this should result in the creation of a Nutria Working Group that would consist of personnel from the member organizations. A "Nutria Coordinator" position would be established to serve as administrator and primary contact for the working group. The Nutria Coordinator position could potentially be staffed by the USFWS administrative lead for the Maryland Nutria Project.

Need:

There is a need to identify private landowners with nutria on their property, gain access to private lands, and gain public trust.

Actions:

2.1 Develop regulations to enable legal access to private property to eradicate nutria. This could be facilitated by the designation of nutria as a noxious species.

2.2 Create a mechanism for landowner contact and outreach. If fully funded, the Maryland Nutria Project will fund an outreach position that, among other things, will act as landowner contact liaison.

2.3 Provide opportunities for public comment to be considered in the development of nutria policy.

B. Early Detection and Rapid Response

Need:

Locate all nutria populations in the Chesapeake Bay Region and develop an eradication strategy.

Actions:

1.1 The Maryland Nutria Team will locate nutria populations in Maryland outside the NEZ.

1.2 Query the Virginia Department of Game and Inland Fisheries, the Delaware Department of Natural Resources and Environmental Control, and trapper associations to identify locations in Virginia and Delaware of known nutria sightings and areas that contain preferred nutria habitat.

1.3 Assuming that the Maryland Nutria Project is funded to its fullest potential, transfer funding to Virginia and Delaware to enable state biologists to delineate nutria infestation zones by inspecting locations of sightings and potential nutria habitats for sign.

1.4 Based on findings, coordinate with the Maryland Nutria Management Team to develop a strategy and a schedule for nutria eradication in Virginia and Delaware.

C. Control and Management

Need:

We need a mechanism for the eradication of nutria from the Chesapeake Bay Region.

Action:

1.1 Expand the Maryland Nutria Project beyond Dorchester County, Maryland, into the remainder of Maryland, Virginia, and Delaware. This will require that the project is funded to its fullest potential under the Nutria Eradication and Control Act.

D. Communication and Information Access

Need:

We need a mechanism for public outreach that emphasizes the importance of and rationale for the project.

Action:
1.1 If fully funded, the Maryland Nutria Project will fund an outreach position that will act as a liaison with landowners and the public at large.

IV. Implementation Table

An implementation table is provided for each of the four management components. For each action identified under the components, we have identified a time-frame for completing the actions, identification of agencies responsible for leading actions, the partners that would be involved, the funding/cost share, and the source of funding.

A. Leadership, Coordination, and Regulatory Authority

Need	Action	Action Description	Action Duration	Cost	Funding Source	Lead Agency	Partners
A mechanism for coordination among the states in the Chesapeake Region.	1.1	Create an MOU linking States, Federal agencies, and NGO's to the MD Nutria Project. This would also result in the establishment of a Working Group and a Coordinator position.	6 months	none	In-kind	U.S. Fish and Wildlife Service (USFWS)	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)
Identify private landowners with nutria on their property, gain access, and gain public trust.	2.1	Develop regulations to enable legal access to private property to eradicate nutria.	1 year	none	In-kind	States of MD, VA, and DE	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)
	2.2	Create a mechanism for landowner contact and outreach.	1 year to create	$125,000/year for 5 years	Through the U.S. Department of the Interior from the Nutria Eradication and Control Act of 2003	The MD Nutria Management Team	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)
	2.3	Provide opportunities for public comment to be considered in the development of nutria policy.	6 months	Covered in 2.2 above	Through the U.S. Department of the Interior from the Nutria Eradication and Control Act of 2003	The MD Nutria Management Team	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)

B. Early Detection and Rapid Response

Need	Action	Action Description	Action Duration	Cost	Funding Source	Lead Agency	Partners
Locate all nutria populations in the Chesapeake Bay Region and develop an eradication strategy	1.1	The Maryland Nutria Team will locate nutria populations in Maryland outside the NEZ.	1 year	$250,000	Through the U.S. Department of the Interior from the Nutria Eradication and Control Act of 2003	MD Nutria Management Team	MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)
	1.2	Query the VA Department of Game and Inland Fisheries, the DE Department of Natural Resources and Environmental Control, and trapper associations to determine locations of nutria in VA and DE	6 months	none	In-kind	MD Nutria Management Team	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)
	1.3	Transfer funding to VA and DE to detect and identify nutria populations	1 year	$40,000	Through the U.S. Department of the Interior from the Nutria Eradication and Control Act of 2003	USFWS	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)
	1.4	Coordinate with the MD Nutria Management Team to develop an eradication strategy in VA and DE.	1 year	None	In-kind	The MD Nutria Management Team, VADGIF, DNREC	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)

C. Control and Management

Need	Action	Action Description	Action Duration	Cost	Funding Source	Lead Agency	Partners
A mechanism for the eradication of nutria from the Chesapeake Bay Region	1.1	Expand the Maryland Nutria Project beyond Dorchester County, MD into the remainder of MD, VA, and DE.	1 year	$20 Million over 5 years	Through the U.S. Department of the Interior from the Nutria Eradication and Control Act of 2003	USFWS	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)

D. Communication and Information Access

Need	Action	Action Description	Action Duration	Cost	Funding Source	Lead Agency	Partners
A mechanism for public outreach that emphasizes the importance of and rationale for the project	1.1	If fully funded, the MD Nutria Project will fund an outreach position that will serve as a liaison with landowners and the public at large.	1 year	$125,000/year for 5 years (covered in A.2.1 above)	Through the U.S. Department of the Interior from the Nutria Eradication and Control Act of 2003	USFWS	The States of Virginia and Delaware and the MD Nutria Team (MDNR, USFWS, APHIS/WS, USGS, UMES, USACOE, and Tudor Farms)

V. Program Monitoring and Evaluation

Monitoring the success of an eradication program such as that being employed by the Maryland Nutria Project consists primarily of revisiting previously trapped areas in a strategic fashion until it is clear that all nutria have been removed. This process is currently being implemented on a small scale in Dorchester County, Maryland and is described below. As the project expands geographically, it is expected that similar procedures will be followed, albeit with a larger monitoring team.

Long-term monitoring of trapping units for residual nutria populations is an important component of the eradication strategy. Residual populations could result from resident animals that escaped initial trapping or from animals that immigrated into a trapped grid from neighboring un-trapped populations. Residual populations are detected and removed as quickly and efficiently as possible.

Currently, four members of the trapping team have been designated as full time monitors. Monitoring of trapping units is conducted at three-month intervals for at least one year following initial trapping. Three-month intervals have been selected to: 1) allow nutria sign (i.e. scat, tracks, bedding) present during initial trapping to deteriorate, enabling monitoring personnel to identify fresh sign left by residual populations and; 2) to prevent nutria from having time to go through a complete reproductive cycle before monitoring.

The NEZ, currently consisting of the CMNWRC Blackwater Unit, Fishing Bay Wildlife Management Area, and Tudor Farms, is divided into monitoring units comprised of numerous trapping units that share common geography, hydrology, trapping history, and access points. This simplifies the process of determining which plots are due for monitoring and ensures that monitoring resources are used efficiently. As a result, some plots within a monitoring unit may be monitored prior to three months after initial trapping is complete.

Members of the monitoring crew ensure that adequate coverage of monitoring units is obtained through GPS tracks of their movements. These GPS tracks are appended to a GIS layer that is superimposed on aerial photographs and trapping units to allow inspection for adequate coverage. Monitoring personnel collect data on the presence or absence of residual populations, categorize the type of sign found when present and estimate the number of residual nutria, and determine their status as resident or transient. Small, isolated groups of resident nutria are removed by the monitoring crew. Elimination of wide-spread re-infestation of nutria from outside trapped grids is tasked to full-time trappers. Results of monitoring surveys are used to gauge the efficacy of initial trapping efforts and, if necessary, to modify the trapping strategies.

In some cases, dense nutria populations may thrive just outside the NEZ (i.e. on lands owned by private individuals who declined to participate in eradication efforts). Trapping grids adjacent to these populations require more frequent monitoring in order to detect immigrant nutria.

Literature Cited

Adams, W.H. 1956. The nutria in coastal Louisiana. Proc. La. Acad. Sci. 19: 28-41.

Anon. 1978. Coypu: Report of the Coypu Strategy Group. Ministry of Agriculture, Fisheries and Food.

Bounds, D.L. (Ed.). 1998. Marsh restoration: nutria control in Maryland pilot project proposal. Maryland Nutria Control/Marsh Restoration Partnership Report to Congress. 30 pp.

Bounds, D.L. 2000. Nutria: an invasive species of national concern. Wetland Journal 12(3): 9-16.

Bounds, D.L. and G.A. Carowan, Jr. 2000. Nutria: a nonnative nemesis. In R.E. McCabe and S.E. Loos, eds. Proceedings of the 65th North American Wildlife and Natural Resources Conference (2000), Rosemont, IL. pp. 405-413.

Brown, L.N. 1975. Ecological relationships and breeding of the nutria (*Myocastor coypus*) in the Tampa, Florida area. J. Mamm. 56: 928-930.

Carowan, G. 2003. Personal communication with Chesapeake Marshlands National Wildlife Refuge Manager.

Carter, J., A.L. Foote, and L.A. Johnson-Randall. 1999. Modeling the effects of nutria (*Myocastor coypus*) on wetland loss. Wetlands 19(1): 209-219.

Carter, J. and B.P. Leonard. 2002. A review of the literature on the worldwide distribution, spread of and efforts to eradicate the coypu (*Myocastor coypus*). Wildl. Soc. Bull. 30(1): 162-175.

Chabreck, R.H. 1962. Daily activity of nutria in Louisiana. Journal of Mammalogy. 43(3): 337-344.

Chesapeake Bay Program. 1990. Chesapeake Bay waterfowl policy and management plan: an agreement commitment report from the Chesapeake Executive Council. U.S. Environmental Protection Agency. 71 pp.

Chesapeake Bay Program. 2002. Invasive species in the Chesapeake Bay: A Workshop to Develop Management Plan Frameworks, Final Report. pp: 90-103.

Colona, R. Personal communication with Maryland Department of Natural Resources Furbearer Biologist.

Cotton, K.E. 1963. The coypu. River Board Association Yearbook, 11: 31-39.

Dean, R.G. 1979. Effects of vegetation on shoreline erosional processes *In* P.E. Greeson et. al. (eds.) Wetland functions and values: the state of our understanding. Am. Water Resources Assoc., Minneapolis, MN. Pages 415-426

Ellis, E.A. 1963. Some effects of selective feeding by the coypu (*Myocastor coypus* Molina) on the vegetation of Broadland. Transactions of the Norfolk and Norwich Naturalists' Society, 20: 32-35.

Evans, J. 1970. About Nutria and their Control. U.S. Department of the Interior Bureau of Sport Fisheries and Wildlife, Denver. 65 pp.

Evans, J. 1983. Nutria. In R.M. Timm (ed.) Prevention and Control of Wildlife Damage. Coop. Ext. Service, University of Nebraska, Lincoln.

Foote, A.L. and L.A. Johnson. 1993. Plant stand development in Louisiana coastal wetlands: nutria grazing effects on plant biomass. p. 265-269. In M.C. Laridin (ed.) Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetland Scientists. New Orleans, LA. South Central Chapter, Society of Wetland Scientists, Utica, MS. USA.

Ford, M.A., D.R. Cahoon, and J.C. Lynch. 1998. Restoring marsh elevation in a rapidly subsiding salt marsh by thin-layer deposition of dredge material. Ecological Engineering

Gingerich, J.L. 1994. Florida's Fabulous Mammals. World Publications. Tampa Bay, 128 pp.

Goodger, T.E. 1985. The contribution of wetlands to estuarine production and fisheries: an overview with emphasis on Chesapeake Bay. Pages 121-128 *In* H.A. Groman et al. (eds.). Wetlands of the Chesapeake: Proceedings. April 9-11. Easton, MD.

Gosling, L.M. 1974. The Coypu in East Anglia. Trans. Norfolk Norwich Nat. Soc. 23: 49-59.

Gosling, L.M. 1977. Coypu chapter in The Handbook of British Mammals. G.B. Corbet and H.N. Southern (Eds), Blackwell Scientific Publications, Oxford. pp 256-265.

Gosling, L.M. 1979. The twenty-four hour activity cycle of captive coypus (*Myocastor Coypus*). J. Zool., 187(3), 341-367.

Gosling, L.M., G.E. Guyon, and K.M.H. Wright. 1980. Diurnal activity of feral coypus (*Myocastor coypus*) during the cold winter of 1978/79. J. Zool. 192(2): 143-146.

Gosling, L.M., A.D. Watt, and S.J. Baker. 1981. Continuous retrospective census of East Anglian Coypu population between 1970 and 1979. J. Anim. Ecol., 50(3): 885-901.

Gosling, L.M. 1989. Extinction to order. New Scientist 4, March: 44-49.

Hall, E.R. 1981. The mammals of North America. Second Addition. John Wiley and Sons, NY, NY, USA.

Haramis, G. M. and R. Colona. Unpublished. The effect of nutria (*Myocastor coypus*) on marsh loss in the lower eastern shore of Maryland: an exclosure study. U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland.

Harris, V.T. and F. Webert. 1962. Nutria feeding activity and its effect on marsh vegetation in southwestern Louisiana. U.S. Fish and Wildlife Service, Washington, D.C. USA. Special Scientific Report Wildlife 64.

Hess, I.D., W. Conner, and J. Visser. 1997. Nutria-another threat to Louisiana's vanishing coastal wetlands. Aquatic Nuisance Species Digest 2(2).

Holliday, M.C., and B.K. O'Bannon. 1995. Fisheries of the United States, 1995. National Marine Fisheries Service, U.S. Department of Commerce. U.S. Government Printing Office, Washington, D.C. 103 pp.

LeBlanc, D. 1994. Nutria. Animal and Plant Health Inspection Service. Animal Damage Control, Port Allen, LA. B71-B80.

Linscombe,G., N. Kinler, and V. Wright. 1981. Nutria population density and vegetative changes in brackish marsh in coastal Louisiana. p. 129-141. In J.A. Chapman and D. Pursley (eds.) Proceedings of the Worldwide Furbearer Conference, Frostburg, MD.

Linscombe, G., and N. Kinler. 1997. A survey of vegetative damage caused by nutria herbivory in the Barataria and Terrebonne Basins. Barataria-Terrebonne National Estuary Program. No. 31. Nicholls State University, Thibodaux, Louisiana, USA.

Linscombe, G. 2001. Personal Communication.

Maryland Department of Natural Resources. 2002. Maryland game program: annual report 2001-2002. Annapolis, MD. 63pp.

Metzgar, R.G. 1973. Wetlands in Maryland. Publication 157. Maryland Department of Natural Resources. Annapolis, MD 229pp.

Morgan, R.P. II, G.R. Willner, J.A. Chapman. 1981. Genetic variation in Maryland nutria, *Myocastor coypus*. Worldwide Furbearer Conf. Proc. pp. 30-37.

Newson, R.M. 1966. Reproduction in the feral coypu (*Myocastor coypus*). Symposium of the Zoological Society of London, 15: 232-334.

Norris, J.D. 1967. A campaign against feral coypus (*Myocastor coypus* Molina) in Great Britain. Journal of Applied Ecology, 4: 191-199.

Nowak, R.M. 1991. Walker's mammals of the world. Fifth edition. Johns Hopkins University Press, Baltimore, MD. 1,629 pp.

Ras, L.B. 1999. Population estimates and movements of nutria (*Myocastor coypus*) at Tudor Farms, Dorchester County, Maryland. University of Maryland Eastern Shore Thesis. 84pp.

Robicheaux, B.L. 1978. Ecological implications of variably spaced ditches on nutria in a brackish marsh, Rockefeller Refuge, Louisiana. M.S. thesis, La. State Univ. 50 pp. WR 238.

Southwick Associates. 1995. The economic benefits of watchable wildlife recreation during 1991 in Maryland. Alexandria, VA. 10pp.

U.S. Fish and Wildlife Service. 1995. Summary of wildlife restoration activities for 1994: Federal Aid Program. U.S. Government Printing Office, Washington, D.C. 49pp.

Van Den Brink, F.H. 1968. A field guide to the mammals of Britain and Europe. Houghton Mifflin, Boston, MA, USA.

Whitaker, J.O., Jr. 1988. The Audubon Society Field Guide to North American Mammals. Alfred A. Knopf, Inc. New York. 745 pp.

Willner, G.R., J.A. Chapman, and D.Pursley. 1979. Reproduction, physiological responses, food habits, and abundance of nutria on Maryland marshes. Wildl. Monogr. No. 65. 43 pp.

Willner, G.R. 1982. Nutria. In J.A. Chapman and G.A. Feldhamer (eds.) Wild Animals of North America: Biology, Management, and Economics, pp. 1059-1076. Johns Hopkins University Press, Baltimore, MD.

Figure 1. Nutria Presence in the United States

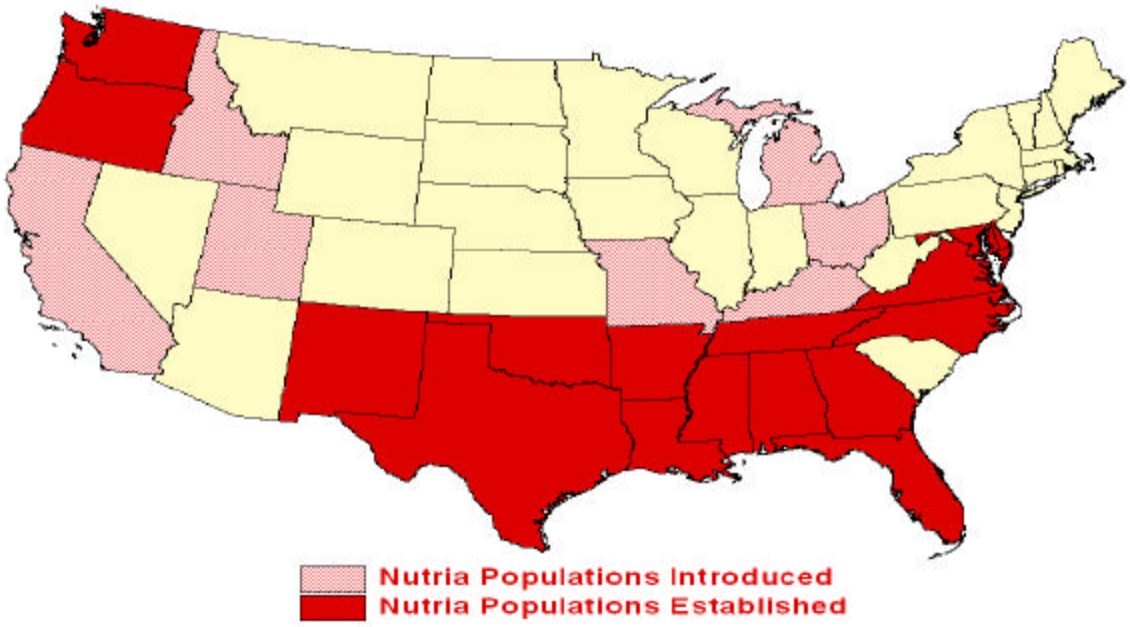
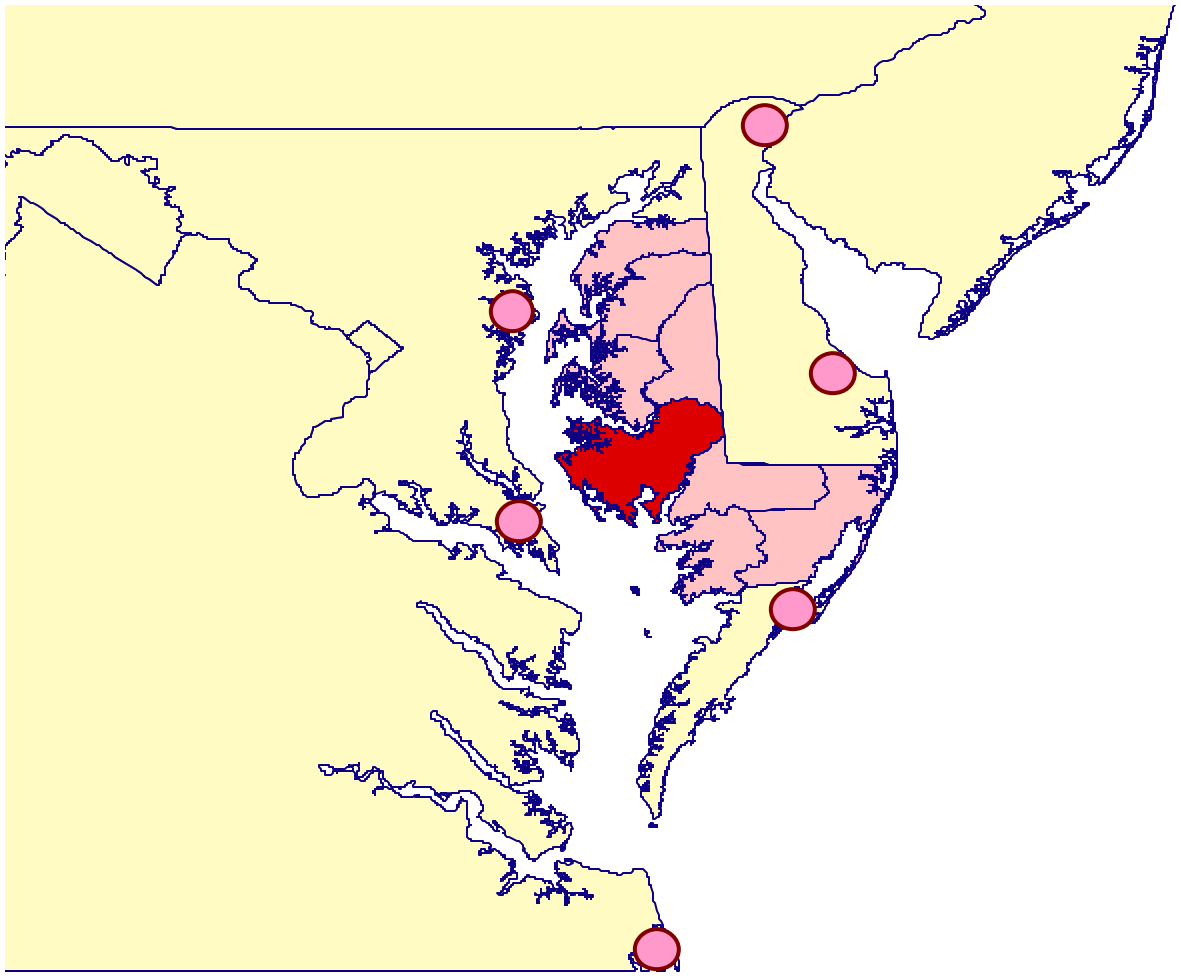


Figure 2. Nutria Presence (Shaded Areas) in the Chesapeake and Delaware Bay Region



DRAFT

Appendix I

List of Nutria Project Partners

Federal Government

U.S. Fish and Wildlife Service
- Chesapeake Bay Field Office
- Blackwater National Wildlife Refuge

U.S. Geological Survey
- Maryland Cooperative Fish and Wildlife Research Unit
- Patuxent Wildlife Research Center

U.S. Department of Agriculture
- Wildlife Services

U.S. Army Corps of Engineers
- Baltimore District

National Civilian Conservation Corps
- Americorps

U.S. Congress

Congressman Wayne T. Gilchrest

State of Maryland

Maryland Department of Natural Resources
Maryland Department of Agriculture
Maryland Department of the Environment
University of Maryland Eastern Shore
University of Maryland College Park

Local Government

Salisbury Zoological Park

Private Organizations

Chesapeake Bay Foundation
Ducks Unlimited
Friends of Blackwater
International Association of Fish and Wildlife Agencies
Maryland Farm Bureau
Maryland Fur Trappers Association
Maryland Invasive Species Council
National Aquarium in Baltimore
National Fish and Wildlife Foundation
National Trapping Association
Tudor Farms, Inc.
The Wildlife Society-MD/Del Chapter