2.5 LIVING RESOURCES

2.5.1 INTRODUCTION

Through the millennia that humans have inhabited what is today the Inland Bays/Atlantic Ocean Basin, the plants and animals with which they have shared the landscape have gone through great changes. When the first humans arrived in the Basin about 13,000 years ago, the Atlantic shoreline was well to the east of its present location. The area where the bays are today was upland and a mosaic of open spruce/fir forest and grassland vegetated Pleistocene Delaware. Mastodons, woolly rhinos, caribou, and giant beavers, along with more familiar fauna populated the ancient landscape. By the time Europeans arrived in the 17th century, the coastline had migrated to (more or less) its current position as the Wisconsin glacier melted and the sea flooded ancient river valleys. The spruce/fir forest migrated northward, following the receding ice. When Europeans set foot on the peninsula, Delmarva was covered with pine/oak forest. In fact, forest in one form or another cloaked the entire eastern half of the continent from the Atlantic to the Mississippi.

The fauna present in the Inland Bays/Atlantic Ocean Basin when Europeans arrived on the scene was vast and rich. In spring and fall, vast flocks of waterfowl, shorebirds, and songbirds passed through or stopped to feed and rest during their annual migrations. The forests were populated with deer, squirrels, bears, wolves, turkeys, passenger pigeons, and a host of other creatures. The Inland Bays and the waters of Lewes Creek teemed with fish, oysters, and other shellfish.

The seemingly limitless living resources of the region were soon to experience a level of exploitation previously unprecedented on the North American continent. Forests were cleared to provide lumber and make way for agriculture. Within a century and a half, once-abundant wildlife was being decimated by loss of habitat and over-hunting. The beaver, other furbearers, and predators were the first to go. These animals were extirpated in the first century after Europeans arrived. The immense flocks of passenger pigeons that once darkened the skies were a memory by the middle of the 19th century. White-tailed deer, wild turkeys, and wading birds were also among the list of species extirpated, or nearly so, during the 19th century by over-hunting and habitat destruction.

In the first half of the 20th century, legislation designed to protect dwindling wildlife populations and improved wildlife management techniques turned the tide of exploitation and some populations recovered; however, habitat loss and environmental degradation continued. The use of DDT to control mosquitoes led to the decline of ospreys and bald eagles. Increased development along the coast and recreational use of the beaches has

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contributed to the decline of several species of beach-nesting birds and other plants and animals that depend on beach and dune habitat.

As we begin the 21st century, the flora and fauna of the Inland Bays/Atlantic Ocean Basin is in a state of dichotomy. Bald eagle and osprey populations are more secure than at anytime in the last 40 years. White-tailed deer, wild turkey, and beaver are once again common inhabitants of the Basin. However, for a host of other plants and animals, the future is uncertain in the face of habitat loss, poor water quality, and other anthropogenic factors. The following communities and species are integral components of the living resources of the Inland Bays/Atlantic Ocean Basin.

2.5.2 PRIORITY TERRESTRIAL COMMUNITIES

2.5.2.1 Mature Upland Forest

The forests of Delaware's Inland Bays contain a mixture of pine and hardwood species. Forests found in the Inland Bays/Atlantic Ocean Basin contain several tree species, including loblolly pine *(Pinus taeda),* Virginia pine *(Pinus virginiana),* white oak *(Quercus alba),* southern red oak *(Quercus falcata),* scarlet oak *(Quercus coccinea),* willow oak *(Quercus phellos),* tulip tree *(Liriodendron tulipifera),* red maple *(Acer rubrum),* sweet gum *(Liquidamber styraciflua),* black gum *(Nyssa sylvatica),* sassafras *(Sassifras albidum),* dogwood *(Cornus florida),* and others. The floor of a healthy mature forest is usually vegetated with an understory composed of a variety of woody and herbaceous plants.

The activities of Delawareans have significantly affected these forests as virtually the entire forest has been harvested at least twice since the arrival of European settlers. Furthermore, much of the area was cleared for agriculture with some areas reverting to forest during the Great Depression. Human activity continues to have a profound effect on the forests of the Inland Bays/Atlantic Ocean Basin and the flora and fauna within them.

Mature forests, with a diversity of canopy and understory vegetation provide habitat for a number of native animals. Many species of invertebrates, several amphibians and reptiles, many bird species, including Neotropical migrant songbirds, and several mammals depend on mature forests for survival.

Within the Basin, there are an estimated 55,000 to 60,000 acres of forested lands. Most forestland is owned by private landowners, including approximately 3,500 acres owned by the forest industry. These landowners manage their forests for a variety of objectives, including timber production, wildlife habitat, and recreational activities. The Delaware Department of Agriculture (DDA) Forest Service estimates that approximately 12,000 to 13,000 acres of the forestlands within the Inland Bays/Atlantic Ocean are managed primarily for loblolly pine. Most of these stands are intensively managed, as they contain hand-planted, genetically improved seedlings. Herbicides are applied to control brush and other competition, and these forests are often thinned at age 17–24, prior to the final clear-cut harvest around age 40 to 50, in order to increase growth. Such intensely managed forests generally support lower plant and animal diversity better than natural mature forests.

2.5.2.2 Scrub-Shrub

Scrub-shrub communities can be quite variable, are generally small in areal extent, and some may only represent an early seral stage of a forested community. Many of the scrub-shrub communities are more accurately described as impenetrable thickets, with a dense understory of brambles and greenbriar. The more persistent scrub-shrub communities are usually found along streamside and seepage wetlands and are often situated between marsh and forest habitats. The upland edges of salt marshes are usually composed of scrub-shrub communities dominated by bayberry *(Myrica pennsylvanica, M. cerifera),* groundsel *(Baccharis halimifolia),* eastern red cedar (*Juniperus virginiana*), and marsh elder *(Iva frutescens).*

Scrub-shrub communities are important to several species of birds that nest in the Inland Bays/Atlantic Ocean Basin, including bobwhite *(Colinus virginianus),* marsh wren *(Cistothorus platensis),* yellow warbler *(Dendroica petechia),* prairie warbler *(Dendroica discolor),* yellow-breasted chat *(Icteria virens),* common yellowthroat *(Geothlypis trichas),* blue grosbeak *(Guiraca caerulea),* and seaside sparrow *(Ammodramus maritimus).* Migrating birds also depend on scrub-shrub, especially along the coast in fall, as resting and feeding habitat during migration.

Scrub-shrub losses have occurred in the Basin as a result of changes in agricultural practices and residential development.

2.5.3 PRIORITY AQUATIC COMMUNITIES

2.5.3.1 Palustrine Forested Wetlands

Palustrine forested wetlands occur along rivers and streams or in upland depressions. This is the most abundant and widely distributed wetland type in Delaware (Tiner, 1985). In 1985, Sussex County accounted for 64,564 of the 115,664 acres, or 55.8 percent of the forested wetlands in Delaware. However, the majority of forested wetlands in Sussex County are found in the Nanticoke watershed and the Great Cypress Swamp. Within the Inland Bays/Atlantic Ocean Basin, the largest tracts of forested wetland are found in the Indian River watershed

along Whartons and Iron branches and the tributaries of Indian River emptying into Millsboro Pond. A few isolated pockets can be found west of Rehoboth Bay and between Indian River and Little Assawoman bays.

Palustrine forested wetlands can be divided into two broad community types: deciduous and evergreen-forested wetlands. Deciduous forested wetlands are by far the more common of the two types. Dominant tree species include red maple *(Acer rubrum),* black gum *(Nyssa sylvatica),* tulip tree *(Liriodendron tulipifera),* sweet gum *(Liquidamber styraciflua),* and green ash *(Fraxinus pennsylvanica).* A number of trees, shrubs, and herbaceous plants can be found in association with these dominant tree species. Bald cypress *(Taxodium distichum),* a deciduous, needle-leaved tree is a dominant species in forested wetlands in southwestern Sussex County. In the Inland Bays/Atlantic Ocean Basin it is relatively rare. A single 22-acre mixed hardwood-bald cypress floodplain forest, located south of Millsboro, is the sole occurrence of this community in the Basin. Two types of evergreen-forested wetlands occur in the Basin. They are dominated by loblolly pine *(Pinus taeda)* or Atlantic white cedar *(Chamaecyparis thyoides).* Only two Atlantic white cedar wetlands occur in the Basin; one is 20 acres north of Millsboro, and the other is an exceptional 40-acre swamp east of Millsboro.

Palustrine forested wetlands are important for a number of reasons. Along streams, rivers, and ponds, they provide a buffer between adjacent uplands and open water. In upland locations, they may contribute to ground-water recharge. They may be most important as habitat for other plants and animals. Several rare animals are found almost exclusively in palustrine-forested wetlands in Delaware. The list includes copperhead (S1), red-belly water snake (S1), red-shouldered hawk (S2B), barred owl (S2), and hooded warbler (S1B).

2.5.3.2 Coastal Plain Ponds

Coastal Plain ponds, also known as Carolina Bays, or Delmarva Bays, are shallow, generally elliptical freshwater wetlands found along the Atlantic Coastal Plain from New Jersey to Florida (McAvoy and Clancy, 1994). While their origin remains a mystery, the importance of these ponds as habitat for rare plants and animals is well documented. Nearly 60 species of rare plants are found in Delaware's Coastal Plain ponds. Eastern tiger salamander *(Ambystoma tigrinum),* spotted salamander *(Ambystoma maculatum),* barking tree frog *(Hyla gratiosa),* and Cope's tree frog *(Hyla chrysoscelis)* are rare amphibians that are found primarily in Coastal Plain ponds in Delaware (Clancy and McAvoy, 1994). At least twelve other species of amphibians, reptiles, and invertebrates depend on Coastal Plain pond habitats. More than 1,000 Coastal Plain ponds are known to exist in Delaware. The majority of these ponds are found in central Delaware, but a few are found within the Inland Bays/Atlantic Ocean Basin, including 10 at the Assawoman Wildlife Area. Unfortunately, it is estimated that more than half of the Coastal Plain ponds in Delaware have been destroyed or severely impacted by human activity (McAvoy and Clancy, 1994).

2.5.3.3 Interdunal Swale Wetlands

Swales are low-lying areas between dunes. When these depressions are low enough to contact the water table, unique interdunal swale wetland communities may develop. Due to the dynamic character of the dune systems where they are found, these swale wetlands are somewhat ephemeral in nature. They may be destroyed as a result of natural events, such as filling by wind-blown sand or over-wash during storms. Human destruction also occurs as a result of development in the dune zone. Swale wetlands can also be formed during the natural process of dune movement.

Interdunal swale communities are only found in Delaware in the coastal strand of the Inland Bays/Atlantic Ocean Basin. These communities provide habitat for a large number of rare plant species. The Delaware Natural Heritage Program has identified 23 rare plant species in interdunal swales (McAvoy and Clancy, 1994). Swale wetlands are also important as habitat and source of fresh water for a number of animal species associated with dune systems. The globally rare firefly, *Photuris bethaniensis,* endemic to Delaware, has so far only been found in and around swales in the ocean dunes of the Inland Bays/Atlantic Ocean Basin. Presently, the only remaining interdunal swales are in state park lands.

2.5.4 PRIORITY ESTUARINE/ MARINE COMMUNITIES

2.5.4.1 Hard Clam Bed

The hard clam *(Mercenaria mercenaria)* is a dominant and important member of the infaunal benthic community of Indian River and Rehoboth bays. Hard clams are slow-growing, long-lived bivalves, which take about three growing seasons to reach minimum legal size (1½ inches). Distribution is based on salinity and sediment type. Hard clams are important in areas with high or moderate salinity (polyhaline, mesohaline) and prefer coarser (sand) or mixed (sand-mud) substrates. The majority of habitat in Indian River and Rehoboth Bays is suitable for hard clams, exclusive of most tributaries where seasonal run-off reduces salinity below acceptable levels. Little Assawoman Bay has no hard clam resource because it is far from any inlet and subject to seasonally low salinity in spring. In addition it is not known whether the dominant phyto-

plankton of Assawoman Bay provide adequate food for hard clams.

The amount of hard clam habitat in our coastal bays has varied radically over time. Prior to 1938, when the present inlet was opened by a storm, there was virtually no high-salinity area available for hard clams. With the stabilization of the inlet in 1940, exchange with the ocean allowed hard clams to colonize extensive new habitat. Since the 1970s, the average cross-sectional profile of the Indian River Inlet has increased from 20 feet of depth to 70 feet of depth. This has increased salinity and hard clam habitat as the oligohaline and tidal freshwater habitat has been compressed into the tributaries.

The hard clam is the benthic community's dominant species, in terms of biomass, in polyhaline waters, and with the stout razor clam *(Tagelus plebius)* is the dominant species in the mesohaline salinity zone. Hard clams and other filter feeders have the potential to beneficially impact water quality. An active hard clam filters many gallons of water per day. When this is multiplied by tens of millions of clams within the system, there is a potential to reduce suspended sediment, cull excess phytoplankton, and tie up nutrients. When hard clams are harvested, nutrients are removed from the system.

The hard clam is the only commercially harvested shellfish species in the Inland Bays. Historic landings began in 1943 and peaked in 1956 at about 20 million clams and remained at a relatively high level through 1965. Landings reached a historic low in 1987 when about 300,000 clams were harvested. Recent landings are about 2 million clams, annually, valued at about $200,000. Commercial harvesters may harvest clams greater than 1½ inches in shell height by hand methods of take (tongs, bull rake). The daily limit is 2,500 clams per day.

One threat to the accessibility of public shellfish bottom is closures due to public health concerns. Public health closures began in Indian River and Rehoboth Bays in the early 1960s. Presently, 33 percent of existing shellfish bottom is closed due to bacteriological test results that show high mean bacteria levels. Another type of seasonal closure is based on the presence of marinas, with boats in the water and the potential for illegal discharge of untreated sewage. In 1991, when this type of closure policy went into effect, about 40 percent of the available recreational clam bottom in the Inland Bays was closed. Future marina development has the potential to close additional public clam bottom.

The hard clam is ecologically as well as commercially and recreationally important in our coastal bays. The population seems to be responding during the past decade to generally improved water quality in the eastern part of the bays due to increased exchange through the inlet. Landings have increased from a low in 1987, and the percentage of small clams has increased from 20–22 percent to 35–50 percent, indicating the production of strong year-classes of young clams on a more regular basis. Improving water quality should benefit this resource, which has the potential to support a more thriving commercial and recreational fishery. One challenge is to keep as much of this resource accessible to the public as possible by curtailing competing uses of the bays.

2.5.4.2 Surf Clam Bed

The surf clam *(Spisula solidissima)* is a large, commercially important bivalve, which inhabits polyhaline and euhaline environments from the ocean surf zone to a depth of about 140 feet. Surf clams inhabit only predominantly sandy or gravel bottom areas. Firm sand bottom is necessary to help keep the valves closed because surf clams have relatively weak adductor muscles. Surf clams require 5–6 years to reach minimum commercial size (4½–5 inches) and are fairly long lived (20+ years).

Surf clams range from southern Maine to Cape Hatteras, but are most abundant off the coast of the Delmarva Peninsula and New Jersey. In Delaware, commercial processing of surf clams began in the early 1950s, working on clams caught off New Jersey. The Delmarva stock of surf clams began to be exploited in 1966. Commercial landings peaked between 1970 and 1972 when an average of 8 million pounds was harvested annually. Many of these clams came from sand shoals in state jurisdictional waters. Hen and Chickens Shoal, a large ebb-tide shoal near Cape Henlopen, produced surf clams worth millions of dollars in the early 1970s. Depleted by 1975, Delaware's inshore surf clam resource has not returned in commercial densities. Three surveys of surf clam habitat during the 1980s and early 1990s have shown almost no adult surf clams, although juveniles are common in benthic grab surveys.

Delaware has authority to manage surf clams, by regulation, within state waters, under Title 7, *Delaware Code.* Since 1976, the Mid-Atlantic Fishery Management Council has managed surf clams in the Exclusive Economic Zone.

One concern regarding surf clams is that the prime habitat for this species, shoal tops and edges, be conserved until a viable commercial population can be reestablished. Presently, part of Hen and Chickens Shoal has been permitted by the U.S. Army Corps of Engineers as a borrow site for beach replenishment for Rehoboth Beach. The Corps' commitment to this replenishment effort covers the next 50 years. Areas near Cape Henlopen are dynamic, being rebuilt by ebb tide currents. The extensive offshore areas, such as the permitted borrow site, are relic structures, built during fairly recent geologic time when the coastline was farther east and sea level was lower. Once sand from relic shoals is removed, they will not rebuild and are permanently lost as surf clam habitat.

2.5.5 PRIORITY TERRESTRIAL SPECIES

2.5.5.1 Tiger Beetles

Tiger beetles are small predatory insects found in sandy habitats along streams and rivers and sunny openings in forested areas. While there are several common species in the state, the beach-dune tiger beetle *(Cicindela hirticollis)* (S1) and the little white tiger beetle *(Cicindela lepida)* (S1) are found only in open dune habitats. Along with beach nesting birds, they are good indicators of the ecological integrity of beach and dune communities. In Delaware, they have only been recorded at the dunes at Cape Henlopen State Park.

2.5.5.2 Neotropical Migrant Songbirds

Neotropical migrants are birds that breed in temperate North America and migrate to wintering areas in tropical America. Seventy-seven species of songbirds that nest in eastern North America winter in the tropics. They usually arrive in the Northeast in May and begin their return migration in August and September. Seven to eight months of the year, these birds are either migrating or wintering in tropical habitats. Thirty-nine neotropical songbird species nest in the Inland Bays/Atlantic Ocean Basin. A majority of these species require forest habitat for nesting. The Delaware Natural Heritage Program ranks five species that breed in the Basin as S1 or S2 breeders.

The majority of the 38 species that do not nest in the Basin stop to feed and rest as they pass through during their annual spring and fall migrations. During migration a wide range of habitats is utilized. Along the Atlantic coast, maritime forest and scrub communities provide important habitat for migrating neotropical migrants. A study conducted on the Delmarva Peninsula found greatest songbird diversity in mixed forest, deciduous forest, and scrub-shrub habitats. Loss of these habitats throughout the Atlantic seaboard for residential and commercial development could potentially pose a threat to populations of neotropical migrants.

2.5.5.3 Bald Eagle

The bald eagle *(Haliaeetus leucocephalus)* began to decline in the United States in the 1940s as a result of habitat loss, outright killing, and the effects of DDT on reproduction. DDT was used widely in the Mid-Atlantic to control mosquitoes. By the early 1970s, populations in the lower 48 states approached the brink of extinction. The bald eagle was officially listed as endangered under the Endangered Species Act in 1973. Since that time, protection of eagle habitat and the ban of DDT in the United States have led to an impressive recovery. On August 11, 1995, the bald eagle's status was officially upgraded to threatened.

In Delaware, bald eagle recovery seems slowed by lack of suitable nesting, foraging, and roosting habitat (i.e., secluded areas along waterways with ample fish populations and large trees). Data from a federal aid report on studies of nesting biology of bald eagles in Delaware (Gelvin-Innvaer, 1998) show that although occupied eagle nests in Delaware increased from 3 in 1978 to 13 in 1998, successful nests (ones producing eaglets which fledged), only went from 0 to 7 nests in those 20 years. Productivity ranged from 0 to 2.5 young/nest, but averaged 1.03 in this 21-year span (Gelvin-Innvaer, 1998).

Today, five pairs of nesting eagles inhabit the Inland Bays/Atlantic Ocean Basin: Pepper Creek (adjacent to the Piney Point Tract), Millsboro Pond (upper Indian River), Love Creek, Miller Creek (on the Assawoman Wildlife Area), and near the Sussex Landfill west of Millsboro. Three of the five nests are among the most productive nests in the state. In 1998, a total of seven eaglets were produced, which represented 58 percent of the state's eagle production that year (Gelvin-Innvaer, 1998). The Love Creek and Sussex Landfill nests were unsuccessful.

The eagle's sensitivity to human disturbance puts its full recovery on a collision course with shoreline development. Most nests occur on private lands statewide (62 percent), where protection is harder to achieve. Protection of eagle habitat is not included within local or state land-use laws. Eagles feed primarily on fish that forage close to the water surface (e.g., menhaden, catfish) making water turbidity a real concern from a forage availability standpoint. In the Little Assawoman Bay, diamondback terrapins are utilized as a food, as evidenced by shells found on duck blinds.

While state and federal law physically protects eagles and their nests, habitats essential for survival do not have full protection within the land use arena. Should eagles be de-listed, protection given by their endangered status may erode gains. In particular, protection to habitat other than the nest tree is presently weak and could get worse if future land-use planners/developers perceive that bald eagles have recovered (Gelvin-Innvaer, 1998). Often, nest trees become isolated from suitable protective habitat when development occurs. Birds that choose a nest site near humans rather than the other way around demonstrate higher tolerance levels and generally are more productive (Gelvin-Innvaer, 1998). Additionally, concern about contamination from organophosphates, the quality and quantity of forage fish, and disturbance to nesting and feeding adults is great. The bald eagle's ability to continue to expand is jeopardized by continued shoreline development within the Basin.

2.5.5.4 Beach-Nesting Birds

Five species of birds, piping plover *(Charadrius melodius),* least tern *(Sterna antillarum),* common tern *(Sterna hirundo),* black skimmer *(Rhynchops niger),* and American oystercatcher *(Haemotopus palliatus)* are

intimately tied to the beach and dune habitat of Delaware's Atlantic coast. Nests of all five are shallow depressions in the sand where eggs are deposited and incubated. While all are ranked as S1 breeders by the Delaware Natural Heritage Program, the piping plover is also federally listed as threatened. In the 1960s, beach-nesters resided in good numbers in Delaware. Fifty pairs of black skimmers were counted at Cape Henlopen State Park in 1968.

Black skimmers have not attempted to nest in Delaware since 1990. Common terns attempt to nest sporadically in small numbers. The last attempt was at Delaware Seashore State Park in 1995. American oystercatchers and least terns continue to nest, or attempt to, annually in small numbers at Cape Henlopen, Delaware Seashore, and Fenwick Island State Park. Piping plovers continue to nest each year at Cape Henlopen State Park; however, the number of fledged young has been consistently low. Predation by crows, grackles, and foxes seems to be the primary cause of this low productivity. The Delaware Nongame and Endangered Species Program administered by the Division of Fish and Wildlife is responsible for monitoring beach-nesting birds and erecting predator exclosures around piping plover nests. With assistance from the Division of Parks and Recreation, nesting beaches are closed and posted to reduce human disturbance during the nesting season.

2.5.5.5 Northern Bobwhite Quail

The northern bobwhite *(Colinus virginianus)* is tied closely to and dependent upon early successional/grassland habitats. This type of habitat was common on the small family farms that once dotted Delaware's landscape. However, farm hedgerows that once provided escape cover for quail have been eliminated to accommodate more crops and the large equipment used for planting and harvesting. As a rule, crops are now planted to the wood's edge, leaving no buffer strips of grasses or weeds. In addition, today's crop harvesting techniques are much more efficient than they used to be. As a result, the amount of waste grain left for quail has been reduced. Finally, the use of chemical pesticides and herbicides has increased over the years. All of these factors combined have caused a rapid decline in bobwhite quail numbers.

Delaware is situated on the northeast extremity of the bobwhite's range. However, past agricultural practices created conditions favorable for their survival, and bobwhites have thrived. Quail numbers peaked during the 1940s but began a gradual (and initially unnoticed) decline as landscapes degraded and shrank. By 1985, the decline brought attention from hunters and biologists, and several surveys were initiated to document bobwhite population status.

Although bobwhite numbers are depressed in Delaware, substantial numbers still exist in rural areas. Quail can rapidly rebound from low populations, when the habitat is available. Quail hunting seems to be self-limiting (i.e., as the game becomes scarce, hunting interest and hunter numbers decline as well). Hence, a decline in harvest does not suggest a catastrophic or irreversible loss of bobwhites (Whitman, 1998).

Bobwhite populations were at their lowest point in 1998. The decline in Inland Bays/Atlantic Ocean Basin quail populations appears to follow the state trend as indicated by the 1997 survey results. Recovery to former levels will depend on favorable weather and the availability of suitable habitat. Gains in suitable habitat will come from lands enrolled in the Conservation Reserve Program, and Delaware Division of Fish and Wildlife's Wildlife Habitat Enhancement Program. Acreage within these programs is limited.

2.5.5.6 Wild Turkey

The wild turkey *(Meleagris gallopave)* was extirpated from Delaware by the mid-1800s. Wild turkeys are very adaptable and use a variety of habitats, from mature forests to open agricultural fields. The current mix of these habitats in the Inland Bays/Atlantic Ocean Basin makes the area good turkey habitat. Agricultural land provides an important winter food source in the form of waste grain. Forestland (especially forests with a significant oak component) provides food as well as nesting and roosting habitat.

In 1984, Delaware began a wild turkey restoration program with the reintroduction of 34 wild-caught birds from Pennsylvania, New Jersey, and Vermont. Twenty-eight wild birds from New York State were released on the Assawoman State Wildlife Area in 1997. This has been the only turkey release within the Inland Bays/Atlantic Ocean Basin. It is too soon to determine how successful this release will be. The rapid increase in the human population and loss of habitat throughout the Basin may not bode well for the successful long-term reintroduction of wild turkeys throughout the Basin.

Since 1990, selected turkey management zones have been surveyed for wild turkeys. Several zones have most or all of their area within the Inland Bays/Atlantic Ocean Basin. Due to manpower limitations, not all zones are surveyed each year. The data collected, however, indicate increasing turkey populations in the Basin.

2.5.5.7 Delmarva Fox Squirrel

The Delmarva fox squirrel *(Sciurus niger cinereus)* is a sub-species of the Eastern fox squirrel. It was once a common inhabitant of forests on the entire peninsula. The species is found mostly in mixed stands of mature hardwoods and loblolly pine located along streams and bays. In some locations, squirrels occur in forest stands dominated by loblolly pines adjacent to salt marshes. Due to

declines caused by loss of their forest habitat to development, timber harvest, and forest conversion, the Delmarva fox squirrel was placed on the Federal Endangered Species List in 1967. Naturally occurring populations occur only in four counties on Maryland's Eastern Shore. Animals have been reintroduced in Pennsylvania, Delaware, and Virginia. Assawoman Wildlife Area, located within the Inland Bays/Atlantic Ocean Basin, is the site of one of Delaware's introductions. The fox squirrel has persisted on the site; however, numbers appear low.

2.5.5.8 White-Tailed Deer

The white-tailed deer *(Odocoileus virginianus)* is native to the Inland Bays/Atlantic Ocean Basin and has adapted and thrived in the human-altered habitat. The white-tailed deer is a common species in the Basin. Deer numbers appear to be increasing somewhat as evidenced by the 131 percent increase in hunter harvest between 1992 and 1997.

Deer damage to agricultural crops has become a serious concern within Delaware. As deer numbers and population density increase, so does the potential for deer-damage problems. Significant crop losses and damage to home landscaping can occur. At this point, deer complaints in this Basin are very few — less than two percent of the statewide total. As housing development increases, pushing deer into less and less habitat, significant local damage problems will likely increase. This will trigger public pressure to reduce deer population levels.

Increase in deer densities potentially endangers populations of forest birds that nest on or near the ground in dense understory vegetation. When deer browse away the forest understory, critical nesting habitat is removed.

2.5.6 PRIORITY AQUATIC SPECIES

2.5.6.1 Freshwater Mussels

Freshwater mussels are bivalve mollusks that live in the bottom sediments of freshwater streams, rivers, and ponds. While they have a worldwide distribution, they reach their greatest diversity in the United States. More than 300 species occur in this country. However, freshwater mussels are the most endangered family of animals in the United States (Neves, 1996). Nationwide, 57 species are recognized as endangered or threatened (Neves, 1996). Thirteen species of mussels occur or historically occurred within the state of Delaware. Two are still relatively common. Of the 11 remaining species, seven species are very rare (S2) or extremely rare (S1) (Delaware Natural Heritage Program, 1997). The remaining species are known to have occurred in the state but have not been recorded in the past 15 years. A single species has been reported from the State, but there is no evidence to verify or refute its existence here (DNHP, 1997).

Mussels are important indicators of ecosystem integrity. In all stages of life, mussels provide food for a host of predatory organisms. A number of small invertebrates reside within the mantle cavities of mussels. Because of their longevity and tendency to remain in the same locale unless dislodged by heavy currents or some animal agent, freshwater mussels are important monitors of environmental quality (Martin, 1997). A healthy, reproducing mussel community signifies a high-quality aquatic environment replete with sufficient food and habitats for host fishes and other aquatic organisms (Martin, 1997).

Habitat degradation is probably the primary factor in the decline of native freshwater mussels. Channelization of streams, siltation from excess runoff, and damming are several important human-induced factors. The reduction of native fish populations is also an important factor in mussel decline. Freshwater mussels depend on a host fish for successful reproduction and dispersal. Mussel larvae are released from the female's brood pouch and attach to the gills, fins, or scales of the host. Native fish faunas have been drastically altered by habitat degradation, water pollution, introduction of exotic species, and other factors that have altered species composition and abundance (Neves, 1996).

Mussel data for the Inland Bays/Atlantic Ocean Basin are lacking. Surveys by the Delaware Natural Heritage Program in the adjacent Nanticoke watershed verified the presence of seven freshwater mussel species.

2.5.6.2 Amphibians

Fifteen of the 17 species of frogs found statewide are found in the Inland Bays/Atlantic Ocean Basin. Salamander species are not as well represented within the Basin with only 5 species occurring out of a possible 11 species statewide. They are excellent indicators of water quality as they all deposit their eggs in fresh water. Salamanders and several frogs and toads are especially dependent on shallow, ephemeral pools in early spring for breeding. Others deposit their eggs in ponds, streams, and ditches. Recent research seems to indicate a worldwide decline in populations of some amphibians. The Nongame and Endangered Species Program is currently conducting an annual volunteer monitoring program throughout the state along randomly generated survey routes.

2.5.6.3 Beaver

The beaver *(Castor canadensis)* was extirpated from Delaware by the mid-1800s. They were reintroduced to the state in 1935 with the release of one pair in each county. Since then, additional animals have moved in from Maryland. In 1943, the population was estimated at 24 animals. By the mid-1980s, populations had increased

to the point where beavers were beginning to come into conflict with humans, primarily because of road and field flooding and destruction of trees. A 1991 survey of beaver colonies found 126 statewide.

2.5.7 PRIORITY ESTUARINE/MARINE SPECIES

2.5.7.1 Diamondback Terrapin

The diamondback terrapin *(Malachlemys terrapin)* is a small- to medium-sized turtle that inhabits estuarine marshes and bays. It ranges along the Atlantic coast from Cape Cod to the Florida Keys and around the Gulf coast to Texas. It is the only reptile that lives permanently in Delaware's coastal bays. It spends most of their lives in the water, emerging only rarely to bask. Females emerge for short periods in search of suitable nesting sites during a five-week period from late May to early July. Nest holes are excavated in dry areas above high tide usually adjacent to the marsh. However, females may wander considerable distances in search of nesting sites (Wood, 1995). About 8 to 10 eggs are deposited, covered, and left to incubate with the eggs hatching in about 60 days. Hatchlings emerge and head for the nearest marsh or remain in the nest to hibernate.

Terrapins are important members of the estuarine food web. They prey primarily on fiddler crabs, salt-marsh snails, hermit crabs, mussels, and the siphons of clams. In captivity, they also readily take grass shrimp and small fish. Adult terrapins have few predators. Eggs are dug up and eaten by skunks, foxes, raccoons, and dogs. The same mammals, as well as several species of birds, prey upon hatchlings.

Terrapins are still common residents of the Inland Bays. However, several potential human impacts deserve attention. Bulkheading along the upland marsh edge limits areas where females can successfully emerge in search of nest sites. This may not seem to be a problem with the extent of state-owned land along the eastern edge of the bays. However, terrapins that emerge here must cross busy Route 1 in search of suitable nesting habitat. Automobiles between Dewey Beach and Indian River Inlet kill dozens of female terrapins each summer. Increased bulkheading of privately owned property on the western side of the bays could force more terrapins to attempt the dangerous trek across Route 1. Studies in New Jersey also identified commercial crab traps as a significant source of mortality among terrapins (Wood, 1995). Traps do not discriminate among adult, juvenile, male, or female turtles.

2.5.7.2 Wading Birds

Twelve species of herons, egrets, bitterns, and ibis nest in Delaware. They typically nest in mixed species colonies in trees and shrubs adjacent to feeding areas. *Phragmites* may also be used as a support for nests. Herons, egrets, and bitterns feed on a variety of prey including fish, reptiles, amphibians, small mammals, small birds, and marine and aquatic invertebrates. Most wading birds feed in shallow bodies of fresh, brackish, and salt water. The cattle egret stalks insects in open fields and often follows behind tractors to capture disturbed insects and exposed larvae. Ibises probe for invertebrates and insect larvae in sediments, marsh sod, and in flooded fields.

The Delaware Natural Heritage Program ranks all of Delaware's wading birds as extremely rare or very rare breeders within the state. While the largest rookery north of Florida is found on Pea Patch Island in New Castle County, two colonies are found on islands in the Inland Bays/Atlantic Ocean Basin. Both are relatively small colonies, containing less than a few hundred nests each. Colonial nesting wading birds are highly sensitive to the presence of humans (Jenkins and Gelvin-Innvaer, 1995).

2.5.7.3 Osprey

Although osprey populations recovered from low densities during and after the DDT years, researchers think that other factors impede continued expansion within Delaware. Several factors are suspected, including lowered productivity from the following:

- A lack of safe nesting sites;
- Changes in local forage fish populations;
- Human disturbance;
- Water turbidity causing foraging difficulties;
- Reproductive failure due to contaminants such as DDE, PCBs; or
- Unrelated oscillations in reproductive behaviors.

The Inland Bays have a history of robust osprey populations. A more detailed analysis of osprey population status, research, and monitoring efforts can be found within Federal Aid Reports within the Wildlife Section of the Division of Fish and Wildlife.

2.5.7.4 Bottlenose Dolphin

The bottlenose dolphin *(Tursiops truncatus)* is a common summer resident along the Atlantic coast of the Inland Bays/Atlantic Ocean Basin. Small groups arrive in local waters in April and May and are conspicuous in and just outside the surf until early October. They travel in groups of 6 to occasionally 25 or more. Females give birth shortly before or after arriving in local waters. Bottlenose dolphins are top predators in the coastal food web. They feed on a variety of fish and invertebrates. Dolphins are an important indicator of ecosystem health. In the summer and fall of 1987, a large dolphin die-off occurred along the U.S. East

Coast, from New Jersey to Florida, starting in the north and progressing southward. An annual dolphin survey is conducted along the bottlenose's entire range on a single day each summer to monitor trends in East Coast populations. The Delaware Marine Mammal and Sea Turtle Stranding Program of the Delaware Division of Fish and Wildlife coordinates the Delaware portion of the census. In addition, this program monitors marine mammal and sea turtle strandings in the state.

2.5.7.5 *Phragmites*

Phragmites (Phragmites australis) is believed by many to be the most widely distributed angiosperm in the world, ranging all over Europe, Asia, Africa, America, and Australia. *Phragmites* is considered to be native to North America since it is known to have been in New England for at least 3,500 years. It is a tall (up to 14 feet in Delaware), perennial grass that tolerates a wide range of salinity, from fresh to polyhaline.

Phragmites has a very aggressive growth pattern, and in many wetlands in Delaware has shown the ability to displace many plants in brackish and salt marshes and form a dense monotype. *Phragmites* primarily spreads vegetatively by rhizomes or runners, but it does establish new stands from seeds or rhizome fragments. When *Phragmites* is interspersed with open water or with other vegetation, it can provide some valuable wildlife habitat by adding to the plant diversity of the area. However, when the plant forms monotypic, impenetrable stands it provides very poor food and cover.

Because *Phragmites* grows in such dense stands and is characterized by a high rate of litter production, it also has an influence on marsh hydrology through its ability to "fill in" the micro-topographic relief of the marsh surface. Small first- and second-order streams are filled, thereby flattening the marsh plain and interfering with the wetting-drying cycle of the marsh. The loss of marsh creeks adversely impacts fish species that thrive in this interface between the marsh and estuarine waters. Due to the fact that dead *Phragmites* stems remain standing for several years and do not decompose readily once they come in contact with the marsh surface, this dead material is probably less available to the food chain. While the impacts of *Phragmites* invasion have not been well quantified, most wetland managers agree that since a *Phragmites* marsh is structurally very different from the marsh it displaced, its ecological function is probably different as well.

In the last 50 years, there has been a noticeable increase in *Phragmites* populations along the East Coast. A 1951 report entitled "A Survey of the Marshes of Delaware" (Chamberlain) noted that feather grass (a common name for *Phragmites)* was found in an area that encompassed Indian River, Indian River Bay, and their tributaries. Recent research indicates that the current *Phragmites* has a different chromosome makeup than our native *Phragmites,* one that is similar to populations found in Europe. This suggests that the current form was introduced from Europe, or our native population underwent a spontaneous chromosome change *in situ.* Regardless of how it got to its present form, the *Phragmites* that is currently dominating Delaware wetlands is playing the part of an exotic invader.

The Inland Bays currently do not have the immense monotypic stands of *Phragmites* seen in the fresh and brackish marshes in Kent and New Castle counties. The distribution in the Inland Bays reflects where *Phragmites* first establishes in many wetland systems — artificially elevated areas created by ditch excavation, filled areas such as dikes and levees, natural upland edges adjacent to marshes, and channel and tidal ditch edges which are elevated by the natural deposition of fluvial sediments. These are the areas where *Phragmites* was first noticed in the marshes, which are now essentially monotypic stands of the plant. It appears that once *Phragmites* establishes a foothold, its aggressive vegetative growth and expansion properties allow it to dominate an area over a period of years. It should be noted that *Phragmites* grows more robustly in lower salinity areas. Higher salinities in portions of the Inland Bays will probably slow and prevent this process from occurring.

The situation of narrow fringes of *Phragmites* around the marsh edges and scattered patches within the marsh does not constitute a big problem as far as wildlife habitat is concerned. The problem lies in the potential of these initial stands to spread and eventually form a monotype. Requests from landowners to the Division of Fish & Wildlife's cost-sharing *Phragmites* control program, revolves around "cosmetic" problems with the plant. Its tall, aerial stems growing next to the marsh edge are blocking the aesthetic views to the wetlands, and making access to these areas more difficult. Many landowners are interested in getting rid of their *Phragmites* so they can get their view back or so they can have easier access to a creek or dock.

One potential benefit of *Phragmites* that has not been well quantified, especially in natural systems, revolves around its ability as a biological filter. Scientists from Germany, Australia, the United Kingdom, and the United States (Dr. Jack Gallagher at the University of Delaware) have created wetlands of *Phragmites* for treating point-source pollution. Whether or not the *Phragmites* in the Inland Bays in its current distribution could help decrease eutrophication problems is a question with not many answers at this time.

The key to controlling established stands of *Phragmites* involves the destruction of its underground stem or rhizome

system. The rhizomes and their associated stored sugars are what the aerial stems sprout from each year. In older stands, this rhizome mat can be over 3 feet deep in the marsh substrate. The Division of Fish & Wildlife has been experimenting with *Phragmites* control since the late 1940s, with techniques including flooding, mowing, burning, and chemical control. Many of these methods do not affect the underground rhizome system sufficiently to inhibit regrowth. Others have not proven practical in the difficult and sensitive marsh environment. Repeated mowing at the right time of year (when underground reserves are at their lowest) can gradually reduce the vigor of a stand, but mowing in a wet environment is difficult to do on large areas and without causing physical damage to the marsh.

Currently the Division of Fish and Wildlife's main control method involves the use of glyphosate-based herbicides (Roundup in uplands and Rodeo in wetlands). Glyphosate works through the leaves and stems to the underground rhizome system where it acts to disrupt protein synthesis. The herbicide can be applied by ground or air, but the vast majority of spraying the Division coordinates involves a helicopter application. Following herbicide application, burning of the dead stems is recommended the following late winter to early spring. This removes the shading effect of the standing stems, reduces the heavy litter layer, and produces a sort of fertilizer out of the burned stems. This creates more favorable conditions for non-*Phragmites* vegetation to become established. Division research has demonstrated 80 to 99 percent control following one herbicide application, but also found three or four successive year applications necessary in older, more robust stands to "wear out" the thick rhizome mat.

The Division, since the mid-1980s, has sprayed limited areas of *Phragmites* in the Inland Bays area on both public and private land. Since 1986, the Division's cost-sharing spraying program has contributed 50 percent of the costs of two helicopter sprayings on approximately 30 to 80 acres of private ground in the area per year. The Assawoman Wildlife Area has had 30 to 120 acres occasionally treated during the same time frame. This effort involves keeping the "fringe *Phragmites"* on the marsh edge from expanding too far into the wetlands. The Division of Parks and Recreation, since the middle of the 1990s, has sprayed roughly 30 to 40 acres per year in the Delaware Seashore State Park area. This control has been aimed at opening up vistas along Route 1, as well as improving wildlife habitat.

2.5.8 NON-NATIVE AND INVASIVE SPECIES

2.5.8.1 Noxious Weeds

A non-native plant species list in Delaware was compiled in 1997 by the Delaware Natural Heritage Program to highlight the threat of non-native plant species to native species. The list includes 302 species, representing 18 percent of the state's known flora (1,711 known vascular plants native to Delaware). Along with plants declared noxious weeds, species that are invasive (aggressive and capable of severely displacing native species) are listed.

Some plants have such severe negative impacts on agriculture that mandatory control is deemed necessary. There are currently four plant species designated as noxious weeds in Delaware. Delaware requires that these weeds not be allowed to exceed 24 inches in height nor be allowed to produce seed. Johnson grass *(Sorghum halepense)* was listed as a noxious weed in Delaware in 1970. In 1982, the law was changed and Canada thistle *(Cirsium arvense)* was placed on the list. In 1986, burcucumber *(Sicyos angulatus)* and giant ragweed *(Ambrosia trifidia)* were added to the noxious weed list (Delaware Department of Agriculture, 1996).

Although all four species are present within the Inland Bays/Atlantic Ocean Basin, burcucumber and giant ragweed are the two most abundant noxious weed species in Sussex County, and burcucumber is found primarily within the Inland Bays/Atlantic Ocean Basin.

The Noxious Weed Control Program within the Delaware Department of Agriculture provides management assistance to farmers, landowners, and others who have control of the land. Compliance is mandatory, but enforcement tends to focus on education and assistance.

2.5.8.2 Mosquitoes

Tiger mosquitoes *(Aedes albopictus)* first appeared in Milford in 1987, probably as a hitchhiker within a load of old tires (Stachecki, 1998). Although a native of the Pacific and southern Asia, a substantial population was detected in the United States in Houston, Texas in 1985. Twenty-five southern states documented tiger mosquito presence by 1995. They are established in Maryland (1987) and New Jersey (1995). Found as far north as Chicago, the 0°C daily mean January isotherm has been used as a conservative estimate of the species' northern limits (Crans, 1995).

Known as much for their striped abdomen, as their aggressive biting, tiger mosquitoes will bite day or night. They are smaller than salt-marsh mosquitoes *(Aedes sollicitans),* Delaware's worst biting offender, and less mobile. Fortunately they travel no more than 300 yards from breeding places, unlike salt-marsh mosquitoes , which can travel up to 40 miles for a blood meal. Tigers are known for displacing native species of mosquito. Yellow fever mosquitoes in the southern United States, formerly known as the ultimate domestic pest, are now less prevalent than the tiger mosquito (Crans, 1995).

Known as the "container" mosquito for its opportunistic breeding habits, the tiger mosquito can utilize natural and

man-made containers. Its ability to breed in as little as one-quarter inch of water makes this mosquito hard to control. It can breed in tires of all sizes, buckets, dishes, and crushed aluminum cans (Crans, 1995).

Breeding sites are difficult to locate and spray. Coupled with the species' broad range of prey, the disease potential is great. The more aggressive tiger transmits dengue fever called "bonebreak fever," a common disease of the Caribbean. Yellow fever, another virus with as high as a 30 percent death rate in children, is mosquito-spread and has been found in tiger mosquitoes in Puerto Rico and Mexico. Eastern equine encephalitis (EEE), a bird-borne virus, attacks the meninges (encapsulating tissue) of the brain and spinal cord causing swelling in these tissues. Since 1955, there have been approximately 300 reported human cases of EEE in the eastern United States. The mortality rate for EEE in humans is between 30 and 70 percent, depending upon an individual's age and level of health. Survivors of EEE often suffer permanent neurologic deficits. The last confirmed EEE human fatality in Delaware occurred in 1985. As a "front line" warning to the presence of EEE within the state, the Mosquito Control Section maintains sentinel flocks of chickens placed throughout the state — much like coal miners used canaries to warn of gas leaks. These chickens have direct contact with biting mosquitoes that may be EEE infective. On a bi-weekly schedule, each of 62 chickens is "bled" and the State of Delaware Public Health Laboratory in Smyrna tests plasma serum for the presence of the EEE antibody.

In 1999, West Nile Virus (WNV) became established in the northeastern United States. WNV is carried by wild birds and can be transmitted by mosquitoes to horses and humans. The virus is particularly lethal to crows and can be fatal to horses and humans, particularly to the very young and elderly. The Mosquito Control Section has established a statewide monitoring network for WNV, including two stations in the Inland Bays/Atlantic Ocean Basin. Monitoring is currently performed by collecting and analyzing wild mosquitoes and blood from sentinel chickens. Delaware's first cases of WNV were reported in Kent County in October 2000. To date, no cases have been reported in the Basin.

Today, mosquito populations are in much better check. The reasons include a more complete knowledge of mosquito biology/natural history; implementation of wetland modifications since 1970 known as Open Marsh Water Management that reduces mosquito breeding habitat; and the use of more effective chemical control products in a more efficient and responsible manner.

2.5.8.3 Gypsy Moth

The gypsy moth *(Porthetria dispar)* was accidentally introduced into the United States from Europe in 1869 and has been spreading throughout North America ever since. Since its introduction, this non-indigenous insect pest has defoliated millions of acres of oak hardwood forests in North America. In 1981, over 13 million acres were defoliated by the gypsy moth in the northeastern United States. In North America, the gypsy moth does not have the full complement of natural controls, such as predators, parasites, and diseases, that help control gypsy moth populations in Europe, North Africa, and Asia. Gypsy moths can reach outbreak levels more quickly and frequently than native forest insect defoliators.

Gypsy moth caterpillars eat the leaves of hardwood trees in the spring. High moth population levels can defoliate entire tree stands in a season. Oaks are the preferred food of gypsy moth caterpillars, but this pest's diet includes over 500 plant species. The gypsy moth first arrived in Delaware in the 1960s, but noticeable defoliation did not occur until 1979 when 10 acres were defoliated in Alapocas woods north of the City of Wilmington in northern New Castle County. Defoliating population levels of the gypsy moth reached Delaware's southern border in 1994.

Defoliation by the gypsy moth has been a serious problem in Delaware since the early 1980s due to the large component of oak in the state. As the gypsy-moth defoliation front has moved southward in Delaware, the Delaware Department of Agriculture (DDA) each year has received more-and-more requests from the public to:

- Suppress gypsy moth infestations on private lands;
- Protect foliage and minimize tree mortality by preventing defoliation;
- Limit the nuisance factors (frass falling from trees, caterpillars crawling everywhere, and allergies from caterpillar hairs) associated with high density populations of gypsy moth caterpillars; and
- Protect timber resources.

Oak decline and mortality has been associated with the gypsy moth in each outbreak of this pest since the first outbreaks occurred in New England. When the gypsy moth attacks a susceptible forest for the first time, destruction is dramatic. Between 1911 and 1921 in the Melrose Highlands of eastern New England, half of the trees were lost due to gypsy moth defoliation (Baker 1941, Campbell and Sloan 1977). Later outbreaks that have occurred in New England have been shorter in duration, less frequent, and tree mortality has been less severe due to reduced numbers of oak trees. As the gypsy moth has expanded its range in North America, the first wave of infestations appears to be the most damaging. Susceptible trees already in poor condition before gypsy moth defoliation are the most vulnerable to mortality. After one year of severe defoliation, 35 percent of the oaks classified in poor condition died during the Melrose Highlands study. After two years of severe defoliation, 55 percent of trees classified as poor and 22 percent of those classified as being in good condition died within five years.

In 1995, Delaware experienced its worst gypsy moth defoliation ever recorded (65,462 acres). Previously undefoliated areas in southeastern Delaware east of Route 113 and south of the Indian River and Indian River Bay experienced defoliation by the gypsy moth for the first time.

2.5.8.4 Nutria

Nutrias *(Myocaster coypu)* are large, beaver-like, semi-aquatic rodents. They resemble beavers or muskrats but differ by having a long, round tail and webs between the inner four toes of their hind feet but not the fifth outer toe. Large males may grow to 20 pounds, and large females up to 18 pounds, but most adults average 8 pounds. They are capable of two litters a year, with up to nine young per litter. Nutrias breed when they are four months old (Timm, 1983).

Nutrias were imported from South America to the U.S. in 1899. During the 1930s, fur farms raised nutrias in at least seven western and mid-western states. After World War II, nutria fur production became unprofitable. Many animals were released or escaped. Elsewhere, trappers were transplanting nutrias into marshes. State and federal agencies also transplanted nutria. Nutrias became established on the Delmarva Peninsula either from fur ranches or transplanting in the 1940s. Like other exotic species, nutrias negatively impact the areas where they become established. They are highly prolific, have no natural predators, cause extensive damage to marshes, and displace native species. They are capable of killing large tracts of marsh by complete removal of all plant material called an "eating-out." Like muskrats, nutrias dig tunnels or burrows in banks. They compete directly with muskrats for food and cover.

Nutria distribution on the Delmarva Peninsula was restricted to the middle eastern sections of the Chesapeake Bay Basin until the early 1990s. Nutrias began appearing in Delaware along the Nanticoke River in the mid-1990s. Population estimates on the 10,000 acres of Blackwater National Wildlife Refuge in Maryland have grown from less than 150 animals in 1968 to 35,000 to 50,000 in 1998. Legislation in Maryland proposes to begin an eradication program. A pilot program proposal was drafted in July 1998, entitled "Marsh Restoration: Nutria Control in Maryland" (Bounds, 1998). This animal's expansion into the Inland Bays/Atlantic Ocean Basin is inevitable and will likely occur through our extensive ditch systems.

2.5.9 DATA GAPS AND RECOMMENDATIONS

1. Restore Atlantic white cedar forests in watersheds where these forests were historically common and protect what remains.
2. A policy of no additional loss of hard-clam bed area in the Basin should be established as a component of any review for marina and other waterfront development.
3. On the Delmarva Peninsula, maritime forest and coastal scrub-shrub habitats provide critical habitat for Neotropical migrant songbirds during spring and fall migration. Protection of this critical habitat through purchase and conservation easement should be a priority.
4. Many species of Neotropical migrant songbirds require large tracts of mature upland forest for successful nesting. Protection of existing large forest stands should be a priority. Reforestation on state owned lands to connect existing small stands should be undertaken when economically feasible.
5. Discourage the use of invasive plant species as ornamentals. Also ask public land managers to only use native, non-invasive species on public lands. Ask land managers to incorporate the use of native plant species into recommendations given to private landowners. Although the landscaping business will probably continue to use exotic species for landscaping, the Department should advocate the use of native plant species as an educational policy. *Lead Agency: Invasive Species Council, Department of Agriculture.*
6. Support efforts to control noxious weeds while striving to educate the public that not all "weeds" are bad. Many native plant species, which compete with agriculture crops, have high wildlife value. Mowing to control noxious weeds is more disruptive to wildlife habitat, than careful, and prudent, spraying with herbicides. *Lead Agency: Department of Agriculture.*
7. The Delmarva Fox Squirrel population should be supplemented with additional animals.
8. Establish historic review boards, such as the one in New Castle County, which will result in proactive measures to preserve historic buildings and efforts to record important features of those that cannot be preserved.
9. Funding should be sought for increased surveys in potential habitat for tiger beetles.
10. Increased funding for additional Nongame and Endangered Species Program seasonal biologists to provide better monitoring of beach-nesters as well as increased predator control might result in increased beach-nester productivity.
11. Protection of rookery sites within the Basin should be a high priority. Periodic surveys should be continued to monitor existing colonies and seek new ones. All efforts should be made to limit human disturbance of established colonies through education and signage.
12. Freshwater mussels are good indicators of water quality. A survey should be conducted in Inland Bays tributaries.
13. Continue monitoring existing bald eagle nests and aerial and ground surveys each year for new nest sites.
14. Increase farmer enrollment in programs to develop bobwhite quail population.

15. Recognize the value of relic shoals when looking for borrow sites for beach nourishment projects.
16. All efforts should be made to protect mature hardwood and mixed forest in the Basin. Landowner involvement in forest/habitat conservation programs available through the Division of Fish and Wildlife and the state Department of Agriculture should be actively marketed. Acquisition of quality forest tracts by state, federal, and private conservation agencies by conservation easement or outright purchase should be aggressively pursued.
17. Initiate an intensive monitoring program at productive amphibian breeding sites within the Basin to determine population trends.
18. Monitor range expansion for nutria and develop a strategy for control and containment. Publish literature for landowners with nutria problems.

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