3. Mullica River Watershed

a. Habitats
b. Wildlife of Greatest Conservation Need
c. Threats to Wildlife and Associated Habitats
d. Conservation Goals
e. Conservation Actions
f. Partnerships to Deliver Conservation
g. Monitoring Success

a. Habitats

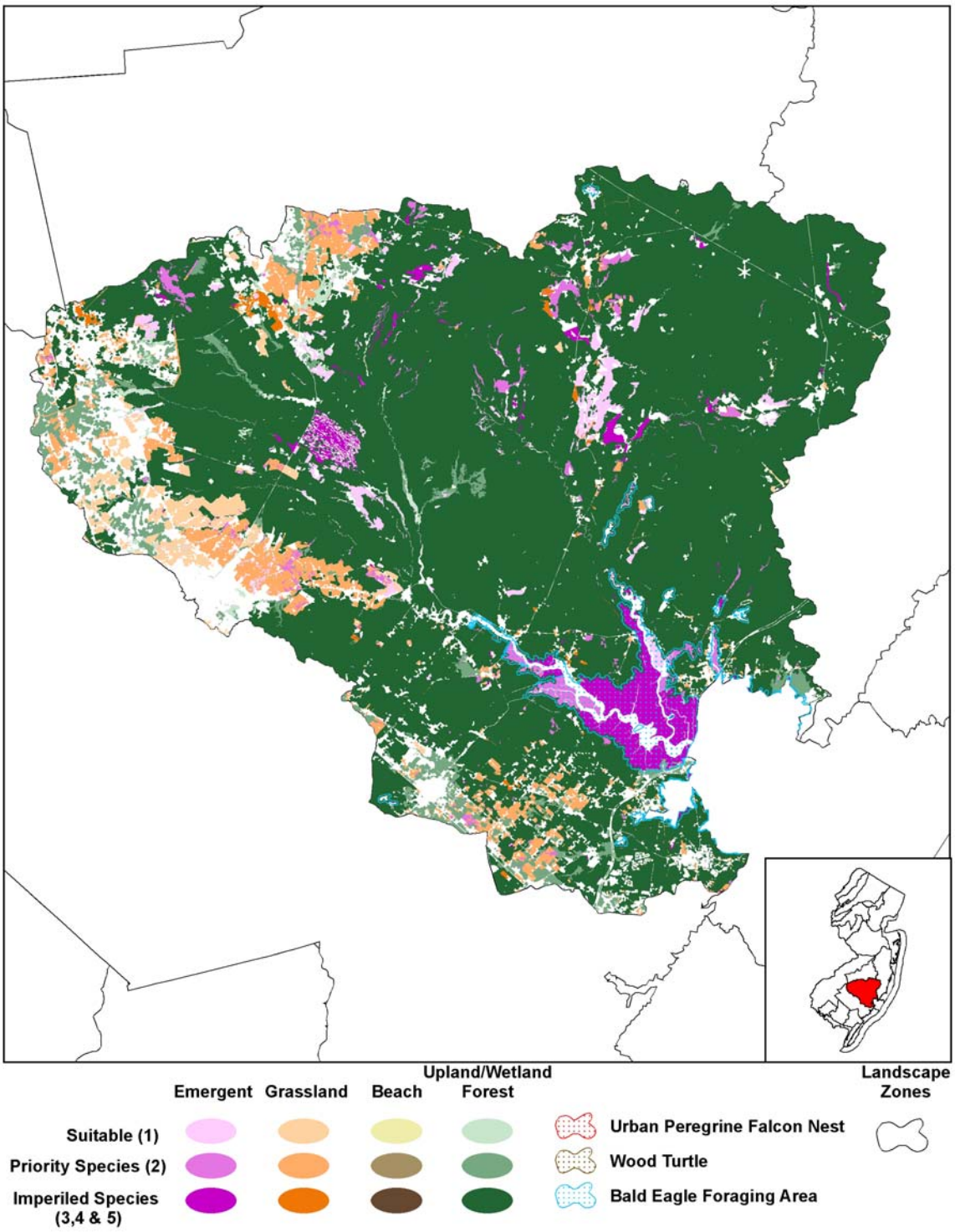
The Mullica River Watershed is the most pristine conservation zone in the Pinelands landscape region (Figure 25). This zone is almost completely within Pinelands National Reserve (98%) and over half of it is contained within the Preservation Management Area of the Pinelands. As a result, many of the pine-oak forests and Atlantic white cedar swamps in the Mullica River Watershed exist as large contiguous tracts. Only 6% of this zone is classified as "urban" based on the NJ DEP's 95/97 Land-use, Land-cover (LULC) data. Tidal marshes occur along the eastern fringe of this zone at the mouth of the Mullica River. Penn State Forest and the Bass River State Forest are conservation areas of opportunity in the Mullica River Watershed.

b. Wildlife of Greatest Conservation Need

The Mullica River Watershed supports six state endangered, seven state threatened, and 78 nongame species of conservation concern. The state endangered species in this zone are the bald eagle, the foraging black skimmer, red-shouldered hawk, corn snake, timber rattlesnake, and arogos skipper. Barred owl, black-crowned night-heron, Cooper's hawk, red-headed woodpecker, northern pine snake, osprey, and Pine Barrens treefrog are state threatened species. Special concern wildlife include forest passerines, raptors, scrub-shrub/open field birds, reptiles, and amphibians. Regional priority game species in this zone include the American black duck, northern bobwhite quail, and Virginia rail. In addition, summer populations of forest-dwelling bat species occur in the Mullica River Watershed.

The pitch pine-oak forests are home to bald eagle, red-headed woodpecker, forest-dwelling bats, corn snake, northern pine snake, timber rattlesnake, wood turtle, and Pine Barrens treefrog populations; and cavity-nester, colonial waterbird, forest passerine, raptor, and shrub-scrub/open field bird communities. Wetlands and open water along the Mullica River are habitat for foraging osprey, bald eagles, black skimmers, colonial waterbirds, northern diamondback terrapins, and special concern amphibians. Certain species of amphibians, such as carpenter frogs and Pine Barren treefrogs, have adapted to the acidity of the Pinelands cedar water. Tables P23 – P29 identify the species of greatest conservation need within this zone.

Figure 25. Critical landscape habitats within the Mullica River Watershed conservation zone, as identified through the Landscape Map (v2).



Wildlife Species and Associated Habitats of the Mullica River Watershed

Table P23. Federal Endangered and Threatened Species*

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Mammals				
Indiana Bat				X**

*All Federal Endangered and Threatened species have an Endangered status on the NJ List of Endangered Wildlife
**Potential presence.
X: Species occurs within the identified habitat.

Table P24. State Endangered Species

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Birds				
Bald eagle		X	X	X
Black skimmer		X		
Red-shouldered hawk				X
Reptiles				
Corn snake				X
Timber rattlesnake				X
Insects				
Arogos skipper		X	X	

X: Species occurs within the identified habitat.

Table P25. State Threatened Species

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Birds				
Barred owl				X
Black-crowned night heron		X		
Cooper's hawk				X
Osprey		X		
Red-headed woodpecker				X
Reptiles				
Northern pine snake			X	X
Wood turtle				X
Amphibians				
Eastern mud salamander				X
Pine Barrens Treefrog			X	X

X: Species occurs within the identified habitat.

Table P26. Nongame Species of Conservation Concern

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Mammals				
Eastern red bat				X*
Eastern small-footed myotis				
Hoary bat				X*
Marsh rice rat		X		
Silver-haired bat				X*
Southern bog lemming				X
Birds				
Acadian flycatcher				X
American kestrel			X	
Baltimore oriole				X
Black-and-white warbler				X
Black-billed cuckoo				X
Blue-winged warbler				X
Broad-winged hawk				X

Nongame Species of Conservation Concern (continued)

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Birds (continued)				
Brown thrasher				X
Common Barn owl			X	
Common nighthawk				
Dickcissel			X	
Eastern kingbird			X	
Eastern meadowlark			X	
Eastern screech-owl				X
Eastern towhee				X
Eastern wood-pewee				X
Field sparrow			X	
Gray catbird				X
Great blue heron		X		
Great crested flycatcher			X	
Great egret		X		
Green heron		X		
Hooded warbler				X
Indigo bunting			X	
Kentucky warbler				X
King rail		X		
Least flycatcher				X
Little blue heron		X		
Louisiana waterthrush				X
Marsh wren		X		
Northern flicker				X
Northern parula				X
Pine warbler				X
Prairie warbler				X
Prothonotary warbler				X
Rose-breasted grosbeak				X
Saltmarsh sharp-tailed sparrow		X		
Scarlet tanager				X
Seaside sparrow		X		
Snowy egret		X		
Spotted sandpiper		X		
Tricolored heron		X		
Veery				X
Wood thrush				X
Worm-eating warbler				X
Yellow-billed cuckoo				X
Yellow-breasted chat				X
Yellow-throated vireo				X
Yellow-throated warbler				X
Reptiles				
Coastal plain milk snake				X
Eastern box turtle			X	X
Eastern kingsnake				X
Northern diamondback terrapin		X		
Spotted turtle			X	X
Amphibians				
Carpenter frog				X
Fowler's toad		X	X	X
Marbled salamander				X
Insects				
A geometrid moth *Idaea violacearia*				X
A noctuid moth *Apharetra dentata*				X
A noctuid moth *Macrochilo louisiana*			X	

Nongame Species of Conservation Concern (continued)

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Insects (continued)				
A noctuid moth *Meropleon cosmion*		X		
A spanworm *Itame sp 1*				X
Buchholz's gray *Hypomecis buchholzaria*				X
Carter's noctuid moth *Spartiniphaga carterae*			X	
Chain fern borer moth *Papaipema stenocelis*				X
Doll's merolonche *Merolonche dolli*				X
Dotted skipper *Hesperia attalus*			X	
Granitosa fern moth *Callopistria granitosa*				X
Hessel's hairstreak *Callophrys hesseli*				X
Lemmer's pinion moth *Lithophane lemmeri*				X
Pine Barrens bluet *Enallagma recurvatum*		X		
Pine Barrens zale *Zale sp 1*				X
Pitcher plant borer moth *Papaipema appassionata*		X		
Placentia tiger moth *Grammia placentia*			X	
Rare skipper *Problema bulenta*				X
Scarlet bluet *Enallagma pictum*		X	X	
Southern ptichodis *Ptichodis bistrigata*			X	
The consort, or consors underwing *Catocala consors sorsconi*				X
Two-spotted skipper *Euphyes bimacula*		X		
Fish				
Banded sunfish**	X			
Black-banded sunfish	X			
Mud sunfish	X			

*Potential presence.
**Species are also recognized as target species of ecoregional concern by the Nature Conservancy – NJ Chapter.
X: Species occurs within the identified habitat.

Table P27. Game Species of Regional Priority

Note: Species identified within the table have seasonal harvests within New Jersey.

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Birds				
American black duck		X		
American woodcock			X	X
Canada goose (Atlantic population)	X	X		
Northern bobwhite			X	X
Virginia rail		X		
Wood duck		X		X

X: Species occurs within the identified habitat.

Table P28. Fish Species
Note: Species identified within the table are nongame species within New Jersey, currently without state or regional status.

Common Name	Water
Fish	
Pirate perch	X

X: Species occurs within the identified habitat.

Table P29. Game Species
Note: Species identified within the table have seasonal harvests within New Jersey and currently are not identified as regional priority species, but they are considered by NJDFW to be species of concern.

Common Name	Water	Wetlands	Grasslands	Forests and Forested Wetlands
Mammals				
River otter	X	X		X
Birds				
Ruffed grouse				X
Sora rail		X		

X: Species occurs within the identified habitat.

c. Threats to the Wildlife and Habitats of the Mullica River Watershed

For complete literature review on the impacts of habitat loss and fragmentation, please see New Jersey's Landscape Project Report, Attachment A or visit our website: www.njfishandwildlife.com/ensp/landscape/lp_report.pdf

Habitat-specialists in the Mullica River Watershed are vulnerable to any upland development and habitat fragmentation by roads. Development and upland agriculture in the northwestern portion of this zone contribute to water quality degradation; pH increases and mounting demands on the Pinelands groundwater supply can lead to the loss of wetland habitats. Contaminants continue to plague bald eagles. Finally, disturbance and encroachment from recreational activities threaten sensitive wildlife in the Pinelands. Also see Section I-E "Threats to Wildlife and Habitats" (page 17) of this document.

d. Conservation Goals

- Identify, protect, maintain, enhance and/or restore endangered, threatened and special concern wildlife and fish populations and their habitats through full implementation of Landscape Project.
- Identify, protect, maintain, enhance, and restore large contiguous tracts of forest and forested wetlands as identified by the Landscape Project for the long-term viability of forest-dwelling, area-sensitive and interior-nesting wildlife including interior-forest raptors and passerines, corn snake, northern pine snake, timber rattlesnake, freshwater wetland birds, rare reptiles and amphibians, and rare dragonflies, damselflies, butterflies, and moths.
- Identify, protect, maintain, enhance, and restore important early succession (areas comprised of <5% woody vegetation, with a mix of native grasses, forbes and bare soil) as identified by the Landscape Project for grassland birds and scrub-shrub/open field wildlife populations.
- Identify, protect, maintain, enhance, and restore critical aquatic ecosystems, riverine and riparian habitats, and water quality to preserve aquatic ecosystems particularly for species

of conservation concern that rely on high water quality or low pH waters such as rare amphibians, and native fish.
- Protect and restore characteristic Pinelands communities.
- Preserve the ecological quality and integrity of wetland habitats and vernal pool communities.
- Inventory, determine distribution, and monitor wildlife and nongame fish species of greatest conservation need in the Mullica River Watershed.
- Prevent, stabilize, and reverse declines of interior-forest raptors and passerines, and stabilize populations of corn snake, northern pine snake, timber rattlesnake, freshwater wetland birds, rare reptiles and amphibians, rare dragonflies, damselflies, moths and butterflies, grassland and scrub-shrub/open field wildlife populations, and native Pinelands fish species such as the blackbanded sunfish, banded sunfish, mud sunfish, and pirate perch.
- Prevent illegal collection of rare reptiles and amphibians.
- Maintain ecological integrity of natural communities and regional biodiversity by controlling invasive species and overabundant wildlife.
- Assess large-scale habitat change (every five to 10 years).
- Promote public education and awareness and wildlife conservation.

e. Conservation Actions

The actions below are identified as primary (1° or priority) and secondary (2°). Prioritization was determined by the Pinelands Regional Landscape stakeholders during a meeting held on June 13, 2007 (see *Attachment I*). These actions, with a focus on the priority actions, should be incorporated in planning and project development in conjunction with the priority state-level objectives (goals) and strategies (actions).

Priority	Conservation Action
Protect critical habitats identified by the Landscape Project and critical aquatic habitats	
1º	Review existing Landscape Project species occurrence areas through research and, where lacking, develop new species occurrence areas as data on species habitat requirements become available. Develop, review, and improve species-habitat associations as new land use/land cover data become available. *(Protect habitat - Landscape Project)*
1º	Identify, prioritize, and reclaim degraded rare species habitats by working with land management agencies to determine the appropriate actions needed to restore habitat values for the documented species. Appropriate actions might include the control of harmful, invasive, vegetation, restoring natural stream flows, revegetation with native plants or restoring habitat structure. *(Evaluate restoration – invasives)*

Priority	Conservation Action (continued)
Protect critical forest and forested wetlands habitats identified in the Landscape Project	
1º	Manage forests on a regional scale to provide a mix of seral (successional) stages for a wide range of forest-dwelling species (e.g., woodland raptors, northern pine snakes, corn snakes, timber rattlesnakes, pine warbler, black-throated green warbler, ruffed grouse, and woodcock) within large contiguous tracts while maintaining suitability for area-sensitive species per the Forest Management Guidelines for Nongame Species in New Jersey. These forest types include but are not limited to: mature and near-mature forests with large trees, > 80% canopy closure and an uneven-age structure; mature forests with 65-85% canopy closure and structural diversity; pine-oak savanna with < 25% canopy closure; scrub-oak communities; and regenerating stands of forests (e.g., Atlantic white cedar). *(Silviculture – Land management; Protect habitat – Landscape Project, migratory birds, rare wildlife)*
1º	Use GIS measures, other remote sensing tools, and surveys to identify and assess critical core forests for forest-interior songbirds, forest raptors (e.g., barred owl), forest-dwelling bats, corn snakes, Pine snakes, timber rattlesnakes, and bald eagles. Take action to minimize habitat loss and maintain large core areas by restoring, enhancing and/or protecting habitat on public and private lands through programs such as fee purchases, conservation easements, landowner incentives, forest management and stewardship plans. Maintain information in the Landscape Project and Biotics database, and provide this information to the Pinelands Commission. *(Silviculture – land management; Protect habitat – Landscape Project, development; Enhance habitat – private lands)*
1º	Increase the effective size and connectivity of forests on permanently protected public lands and surrounding private lands through incentive programs and targeted land acquisition. Use GIS measures, other remote sensing tools, and surveys to identify important corridors that connect large, contiguous tracts of forest and target these areas for acquisition to maintain a system of large, connected tracts of forest within and between conservation zones. Where appropriate, enhance and restore forested habitat through reforestation, revegetation, forest improvement cuts, and other forest management prescriptions. *(Enhance habitat – private lands; Corridors – sprawl, migratory birds; Protect habitat – Landscape Project)*
1º	Develop, implement, and evaluate best management practices (BMPs) for maintaining and enhancing healthy Pinelands forests. *(Protect habitat - Landscape Project; Conserve wildlife – rare wildlife)*
2º	Use GIS measures, other remote-sensing tools, and wildlife surveys to identify forested stopover areas important for migrant forest raptors, passerines and bats during spring and fall migration. Use appropriate measures (e.g. regulations, land acquisition, incentive programs) to protect habitat and develop conservation forestry plans. *(Protect habitat – Landscape Project, migratory birds)*

Priority	Conservation Action (continued)
2º	Develop a species occurrence area of Indiana bat habitat to incorporate into the Biotics database. Identify appropriate protection strategies to maintain and enhance habitat (landowner incentives for protecting summer habitat, public education regarding importance of bat conservation, development of best management practices). As GIS data layers become available, develop a predictable model of Indiana bat summer habitat. *(Protect habitat – Landscape Project; Conserve wildlife – rare wildlife)*
Protect critical early successional habitats identified in the Landscape Project	
1º	Research different techniques for maintaining suitable habitat for species dependent on early successional habitats (e.g., prescribed burning, mowing, brush-hogging, and other methods). *(Conserve wildlife – rare wildlife)*
1º	Develop, implement, and evaluate best management practices (BMPs) for maintaining and enhancing early succession habitats which will improve habitat quality for grassland- and scrub-shrub-dependent species. BMPs will be implemented on large grassland patches (areas with >75 % herbaceous and <25% woody vegetation) on public lands and along utility line rights-of-way (scrub-shrub). *(Protect habitat – humans; Conserve wildlife – rare wildlife; Agriculture – land management; Other practices – land management)*
2º	Encourage landowners to delay mowing to allow grassland-dependent species to successfully breed; this can be accomplished through public education and incentive programs. Continue to evaluate the effectiveness of delayed mowing for grassland-dependent species including birds, invertebrates, reptiles, and amphibians. *(Protect habitat – humans; Enhance habitat –private lands)*
2º	Use GIS measures, other remote sensing tools, and wildlife surveys to identify grassland habitats (areas with >75 % herbaceous and <25% woody vegetation), assess their condition for nesting grassland birds and other wildlife, and maintain information. Identify protection (e.g., landowner incentives, farmland preservation, and acquisition) and management (timing restrictions for mowing, prescribed burning) strategies to maintain and enhance these habitats in perpetuity. Focus on habitat patches that can be managed at a size and scale that is similar to historic patch size of this habitat type as being researched by the Pinelands Commission as part of their "Right-of-way Project." *(Conserve wildlife – rare wildlife; Enhance habitat – private lands; Agriculture – land management Protect habitat – sprawl, Landscape Project, development)*
2º	Use GIS measures, other remote sensing tools, and surveys to identify critical scrub-shrub habitats (areas with >25% woody vegetation <20 feet in height), assess their condition for nesting birds (golden-winged warbler and woodcock) and other wildlife, and maintain information. Identify protection (e.g., landowner incentives, farmland preservation, and acquisition) and management (e.g., timing restrictions for management, cooperative agreements with utility companies for maintenance of rights-of-ways) strategies to create them. *(Conserve wildlife – rare wildlife; Enhance habitat – private lands; Agriculture – land management Protect habitat – sprawl, Landscape Project, development)*

Priority	Conservation Action (continued)
Protect critical riverine and riparian habitats identified in the Landscape Project	
2º	Increase the effective size and connectivity of wetlands on permanently protected public lands and surrounding private lands through incentive programs and targeted land acquisition through local land use policy and planning. Use GIS measures, other remote sensing tools, and surveys to identify important corridors that connect wetland habitats and target these areas for acquisition or work with public and private landowners to enhance and restore the corridors. *(Enhance habitat – private lands; Corridors – sprawl, migratory birds; Protect habitat – Landscape Project)*
2º	Use GIS measures, other remote sensing tools, and surveys to identify and assess core forested wetland and riparian/floodplain habitat for forest-dependent breeding species: forest raptors (red-shouldered hawk, long-eared owl, and barred owl), forest-interior songbirds, timber rattlesnakes, and Indiana bats. Take action to minimize habitat loss by restoring, enhancing and/or protecting habitat on public and private lands through programs such as fee purchases, conservation easements, landowner incentives, and/or forest management and stewardship plans. *(Silviculture – land management; Protect habitat – Landscape Project, development; Enhance habitat – private lands)*
2º	Identify and protect habitat for fish by performing QA/QC of the NJDEP - DFW, Bureau of Freshwater Fisheries' FishTrack Database and plotting distributions of special concern fish species (as identified by the Delphi process), and integrate those data into the Biotics database. *(Protect habitat – Landscape Project, fish)*
2º	Protect water quality and aquatic-dependent species by appropriately designating Category One waters. *(Protect habitat - rare wildlife, fish)*
Protect and restore characteristic Pinelands communities	
1º	Restore the dynamic nature of this ecosystem by developing management plans for state lands which incorporate the needs of Pinelands plants and animals and generate the spatial patch diversity needed by species within this community. *(Conserve wildlife – rare wildlife)*
1º	Research different management techniques (e.g., ecologically-based forestry activities, prescribed burns) that might be used to mimic the historic role of fire and other natural disturbances in shaping this ecosystem. Implement appropriate management actions in areas where natural disturbances, such as wildfire, have been precluded. *(Conserve wildlife – rare wildlife)*
1º	Identify, enhance, and restore Atlantic white cedar communities within the Pinelands for timber rattlesnakes, red-shouldered hawks, barred owls, and Cooper's hawks. *(Protect habitat - Landscape Project; Conserve wildlife – rare wildlife)*
2º	Use GIS measures, other remote sensing tools, and surveys to identify rare and unique Pinelands plant communities and increase protection for these areas through acquisition, proper management, or increased enforcement. *(Protect habitat - Landscape Project)*

Priority	Conservation Action (continued)
2º	Work with the Division of Parks and Forestry including the Office of Natural Lands Management, the Forest Fire Service, and Forest Service to determine the historic and future role of fire in the creation and management of unique Pinelands communities. *(Conserve wildlife – rare wildlife)*
2º	Develop, implement, and evaluate best management practices (BMPs) for utility line rights-of-way that favor the establishment and persistence of native, early-successional Pinelands communities. *(Protect habitat - Landscape Project; Conserve wildlife – rare wildlife)*
Preserve the ecological quality and integrity of wetlands and vernal pool communities	
1º	Locate potential vernal pools through aerial imagery and surveys, conduct species surveys, and integrate certified vernal pool data into the DEP regulations database and Landscape Project. *(Protect habitat – Landscape Project)*
1º	Identify threats to vernal pools through systematic monitoring and devise strategies to protect vernal pool-dependent species. *(Conserve wildlife – rare wildlife)*
1º	Maintain optimal biological buffers (beyond regulatory requirements) around wetlands, riparian, and floodplain areas and minimize destruction per the NJ DEP Wetland Buffer Guidelines for Species of Conservation Concern in New Jersey (in prep). Stabilize wetland buffers and streambanks by encouraging plantings of native vegetation through public education, volunteer programs, and land managers to stabilize wetland buffers and stream banks and prevent erosion. *(Protect habitat – Landscape Project, sprawl; Enhance habitat – private lands)*
2º	Protect water quality and aquatic-dependent species by appropriately designating Category One waters. *(Protect habitat – rare wildlife, fish)*
2º	Maintain stream water chemistry/ water quality important for species native to the Pinelands by limiting developed land and upland agriculture to less than 10% of a watershed. For example, maintain low pH waters important for breeding populations of carpenter frogs. *(Conserve wildlife – rare wildlife; (Protect habitat – rare wildlife)*
Inventory and monitor endangered, threatened and special concern wildlife and fish	
1º	Use the Biotics database and Landscape Project to identify where species location data and monitoring gaps exist. Design and implement coordinated presence/absence surveys and monitoring to acquire data in those areas. *(Protect habitat - Landscape Project)*
1º	Survey suitable habitats to identify unidentified populations of arogos skipper. Develop a management plan to maintain and enhance habitat for arogos skipper using controlled burns. *(Protect habitat - Landscape Project)*
1º	Conduct surveys and work with herpetologists to locate undocumented hibernacula of corn snakes, northern pine snakes, and timber rattlesnakes, and incorporate data into the Biotics database and Landscape Project. *(Protect habitat - Landscape Project; Conserve wildlife – rare wildlife)*
1º	Conduct surveys for dragonflies and damselflies in appropriate habitats throughout the Mullica River Watershed to determine species distributions and identify habitat protection needs. *(Enhance habitat - odonata)*

Priority	Conservation Action (continued)
1º	Determine baseline abundance and establish long-term monitoring programs for wildlife of greatest conservation need (e.g., develop population estimates for rare Pineland species and conduct range-wide surveys every four years). *(Monitor wildlife – long-term monitoring)*
1º	Continue volunteer-based summer bat concentration surveys to locate maternity sites and determine roost characteristics. Trap bats at summer concentration sites to identify bat species; apply colored, plastic bands to Indiana bats to aid in recognition during hibernation surveys. *(Monitor wildlife – long-term monitoring)*
1º	Identify and research water quality parameters for endangered, threatened, and native Pinelands species. Assess impacts and incorporate into BMPs. *(Conserve wildlife – rare wildlife; Protect aquatic wildlife - humans, development)*
1º	Develop and conduct nighttime surveys to inventory nightjars (common nighthawks), northern saw-whet owls, and eastern screech-owls. *(Monitor wildlife – long-term monitoring)*
2º	Continue ground surveys of all known great blue heron rookeries every 3-5 years. Improve census methods to capture population and reproductive success metrics at a finer scale. *(Monitor wildlife – long-term monitoring; Conserve wildlife – rare wildlife)*
2º	Establish a formal ground survey for inland colonies of colonial waterbirds, with a particular emphasis on black and yellow-crowned night herons. Once the survey is instituted, continue on a rotation of once every other year. *(Monitor wildlife – long-term monitoring; Conserve wildlife – rare wildlife)*
2º	Conduct concentrated field sampling for listed or special concern fish species at areas indicated by FishTrack Database queries and incorporate data into Biotics database. *(Protect habitat – fish; Monitor wildlife – fish)*
2º	Conduct the Atlantic Flyway Breeding Waterfowl Survey annually to monitor population trends. *(Monitor wildlife – long-term monitoring)*
2º	Long-term sampling of forest dwelling bat species should be conducted to determine population trends and species response to changes in habitats. *(Monitor wildlife – long-term monitoring)*
2º	Conduct sampling to determine distribution, range, and habitat use of summer bats. *(Protect habitat - Landscape Project; Monitor wildlife – long-term monitoring)*
2º	Conduct telemetry studies during summer months to determine roost characteristics and habitat requirements for maternity colonies. *(Protect habitat – Landscape Project)*
2º	Use GIS measures, other remote sensing tools, and surveys to identify and develop a model of suitable northern diamondback terrapin nesting areas. *(Protect habitat - Landscape Project)*
2º	Use GIS measures, other remote sensing tools, and surveys to identify northern diamondback terrapin key crossing areas and work with local or state transportation agencies to erect turtle barriers. *(Protect habitat – roads)*

Priority	Conservation Action (continued)
2º	Research population distribution of northern diamondback terrapin to determine critical areas for protection. *(Protect habitat – Landscape Project; Monitor wildlife – long-term monitoring)*
Prevent, stabilize, and reverse declines of rare wildlife, freshwater mussels, and native Pinelands fish species	
1º	Evaluate and assess the potential impacts of wind turbines to populations of breeding and migratory birds and bats. Carry out post-construction monitoring of both existing and future wind turbines to assess the actual impacts these structures have on birds and bats. *(Protect habitat - humans)*
1º	Work with state and non-government agencies to evaluate the impacts of enduro events on listed species and species of special concern. If such events are to be permitted in the future, work with the Division of Parks and Forestry to designate riding areas and BMPs should be developed. *(Conserve wildlife – rare wildlife; Protect habitat – humans)*
1º	Evaluate the impacts of roads on endangered and threatened species and other nongame wildlife. Research, develop, and implement methods to reduce roadside mortality of wildlife (e.g. wildlife underpasses, road closures). *(Corridors – roads, sprawl; Protect habitat – roads, fish, mussels)*
1º	Research the intensity and characteristics of threats to wildlife species of conservation concern and their habitat, including effects of habitat loss, degradation, and alteration, edge, disturbance, predation, disease, food availability, impacts of roads, competition by invasive plants and animals, and how water quality degradation and contaminants affect rare species. *(Protect habitat – sprawl, recreational vehicles, humans; Conserve wildlife – contaminants, invasives, rare wildlife, subsidized predator; Evaluate restoration – roads)*
1º	Develop and implement proactive species recovery plans for all endangered and threatened species within this zone. Develop and implement proactive habitat conservation plans that will help meet and maintain recovery goals, particularly for forest-interior species and bald eagles. *(Conserve wildlife – rare wildlife)*
1º	Investigate the impact of land-use patterns on Pine Barrens treefrog. Develop and implement proactive habitat management/conservation plans for Pine Barrens treefrogs. Such a plan should include working with regulators to maintain water quality of breeding ponds (low pH) and protect suitable buffers on ponds, ongoing surveys for this species to identify healthy populations, and a scheme to protect habitats that connect populations and maintain viable metapopulations. *(Conserve wildlife – rare wildlife)*
1º	Develop and implement management actions to enhance populations of special concern and rare fish. *(Protect habitat - fish)*
1º	Research the effects of current prescribed burning practices on Pinelands dependent species and work with foresters to develop and implement effective forest management and stewardship plans to increase or maintain the habitat quality for these species in the Pinelands. *(Conserve wildlife – rare wildlife)*

Priority	Conservation Action (continued)
1º	DEP to work with partners in conservation to establish a policy to control damage to native wildlife populations resulting from feral and free-ranging domestic cats on public lands. *(Conserve wildlife–cats, subsidized predators)*
1º	Protect wildlife species of conservation concern, especially slow moving terrestrial-bound species (e.g. reptiles, amphibians) and sensitive forest nesters (e.g. red-shouldered hawks, barred owls) by prohibiting off-road vehicles from all public and private conservation lands except where authorized by the governing agency by working with law enforcement agencies and implementing other means as they are developed. *(Protect habitat – recreational vehicles; Conserve wildlife - recreational vehicles)*
1º	Conduct surveys to find more information about species and management requirements for secretive marsh nesting birds. *(Conserve wildlife – rare wildlife)*
1º	Research the habitat requirements for species of conservation concern and implement planned silviculture practices to enhance forests for these species. *(Protect habitat – Landscape Project; Silviculture – land management; Conserve wildlife – rare wildlife)*
2º	Collaborate with DOTs, NGOs, and volunteers to identify areas with known wildlife mortality issues including road crossings for breeding amphibians and roads with high incidences of road mortality (snakes, turtles, large mammals). *(Protect habitat – roads; Corridors - roads)*
2º	Investigate terrestrial habitat requirements for the northern pine snake, and developed a predictive model to identify pine snake habitat. Such a model should be developed with input from the Pinelands Commission so that it can be a fundamental tool used in their evaluation of development applications. The model will potentially identify critical life-stage sites (e.g., nesting areas) that require additional protection from collection, disturbance, and destruction. *(Protect habitat - Landscape Project)*
2º	Develop management guidelines for private landowners with significant bald eagle, northern pine snake, Pine Barrens treefrog, cavity-nester, freshwater wetland bird, and raptor populations. *(Silviculture – land management)*
2º	Develop an Indiana bat recovery plan in accordance with federal guidelines and strategies set forth in the USFWS Indiana Bat Recovery Plan (U.S. Fish and Wildlife Service, 1999). *(Conserve wildlife – rare wildlife)*
2º	Determine carrying capacity of pinelands wetlands for breeding wood ducks, including available nest cavities and breeding season food resources. Use this data to develop appropriate management strategies (e.g., installation of wood duck boxes or habitat management to enhance and support targeted native invertebrate populations). *(Conserve wildlife – game species)*
2º	Prevent declines in wildlife populations by utilizing the Delphi process to determine species that may warrant elevated or listed status among taxa that has not undergone Delphi review (e.g., fish, moths). *(Monitor wildlife – fish; Conserve wildlife – rare wildlife)*

Priority	Conservation Action (continued)
2º	Identify critical habitats and assess their condition for breeding, migratory and wintering waterfowl. Identify protection strategies to maintain existing waterfowl habitat. *(Protect habitat – game species)*
2º	Identify and implement best management practices for bald eagle, forest-interior passerine and raptor habitat, and migratory stopover areas. *(Conserve wildlife – rare wildlife)*
Prevent illegal collection of rare reptiles and amphibians	
1º	ENSP biologists will be responsible for notifying the NJ Division of Fish and Wildlife's Bureau of Law Enforcement and the Division of Parks and Forestry Bureau of Law Enforcement and managers, where and when appropriate, of critical sites (nesting, basking, gestation, dens), particularly those used by corn snakes, northern pine snakes, and timber rattlesnakes, to implement stringent enforcement of endangered species laws, including protection of wildlife from illegal collection (northern pine snakes, corn snakes, timber rattlesnakes, and Pine Barrens treefrog) and human disturbance (off-road vehicles). *(Protect wildlife – humans, recreational vehicles)*
2º	Recruit and provide training for local law enforcement personnel that are willing to assist in the enforcement of endangered species laws. Develop a partnership between local law enforcement, US Army Natural Resources Managers, the NJ Division of Fish and Wildlife's Bureau of Law Enforcement, and the Division of Parks and Forestry's park police to enforce protection of native wildlife from illegal collection (including corn and northern pine snakes, timber rattlesnakes, and Pine Barrens treefrogs), persecution (timber rattlesnakes), and human disturbance (off-road vehicles). *(Protect wildlife – humans, recreational vehicles)*
Maintain ecological integrity of natural communities and regional biodiversity by controlling invasive species and overabundant wildlife	
1º	Identify areas where invasive, non-indigenous plants and animals are either already established or are becoming established through GIS, surveys, public participation, and creating a system for reporting and qualifying new locations of invasive species. Prioritize areas in need of control projects according to the potential level of impact on the ecosystem and species of conservation concern and the likelihood of success. *(Conserve wildlife – invasives)*
1º	Work with appropriate government agencies to survey for and monitor the spread of invasive insect species that jeopardize the health of Pinelands forest types (e.g., Atlantic white cedar, pitch-pine lowlands, oak-pine uplands, and others). *(Evaluate restoration – invasives)*

Priority	Conservation Action (continued)
1º	Work with public and private landowners and managers and regulatory agencies to employ appropriate physical, chemical, or biological control measures, or a combination of these, to reduce invasive non-indigenous plants and animals in areas that are identified as providing critical habitat for endangered, threatened or priority wildlife species and are being threatened by invasive non-indigenous plants. Control measures often cause soil disturbance that increases the chance of invasion by the same or other non-indigenous plants. *(Conserve wildlife - invasives)*
2º	The NJ Division of Fish and Wildlife, Bureau of Wildlife Management will consider forest health and biodiversity as one of the primary determinants in making deer management decisions regarding deer densities. Forest health and biodiversity will be determined by using long term monitoring of forest regeneration via a system of exclosures and vegetative sample plots (or other methods that will empirically and objectively measure the effect of deer herbivory) throughout New Jersey in order to evaluate habitat health in response to changing deer densities. DFW will recommend adjustments to existing Deer Management Zone deer densities goals and recommend changes to zone specific deer harvest and control strategies, as required in order to meet this objective. *(Conserve wildlife – deer; Evaluate restoration - deer)*
2º	Develop area-specific deer density or percent-reduction targets to reduce herd size to a sustainable level where regeneration of native vegetative communities is possible and to enhance forest health and biodiversity. *(Evaluate restoration – deer; Conserve wildlife – deer, rare wildlife)*
2º	Work with the Division of Fish and Wildlife to identify areas (primarily refuge areas where hunting is prohibited) where deer densities exist at unhealthy levels and develop a strategy to reduce deer numbers and maintain them at acceptable levels that encourage natural forest regeneration. *(Conserve wildlife – deer)*
2º	Where appropriate, continue to develop and expand incentives for harvesting antlerless deer. *(Conserve wildlife – deer)*
Assess large-scale habitat change every five years	
1º	Collaborate with NJ DEP's Bureau of Geographic Information and Analysis and Rutgers Center for Remote Sensing and Spatial Analysis to develop methods to update DEP's land use/land cover data every five years and perform critical habitat change analysis to assess trend in habitat loss and conversion.
Promote public awareness and conservation	
1º	Preventing establishment of non-indigenous species is the simplest and most cost-effective means of stopping invasions. Encourage native plant use in landscaping through public awareness and discouraging sales of non-native ornamental plants which are often a major source of non-indigenous species that invade natural plant communities. *(Education – humans; Conserve wildlife – invasives)*

Priority	Conservation Action (continued)
1º	Develop and encourage nature tourism opportunities in the Pinelands including wildlife viewing sites, interpretive signage highlighting unique ecosystems/habitats, and wildlife-related recreational opportunities that do not negatively impact species of conservation concern and their habitats. *(Education – humans)*
1º	Educate public about the importance of keeping cats indoors through newsletters, press releases, brochures, presentations, web pages, etc. Work to develop a statewide policy for local communities to discourage managed cat colonies and trap, neuter, and release programs; encourage academic research that examines the full range of impacts of feral cat colonies on local wildlife populations and of feral cat colony management (including TNR) on local wildlife populations and local feral cat populations. *(Education – humans; Conserve wildlife – rare wildlife)*
1º	Engage landowners and NJ citizens in protection and survey efforts for endangered species by increasing enrollment in landowner incentives, forest stewardship, backyard habitat management, and Citizen Science Program. *(Education – humans; Conserve wildlife – rare wildlife)*
1º	Develop educational programs, brochures and posters for the public regarding tolerance and protection of timber rattlesnakes and their habitat. *(Education - humans)*
2º	Educate homeowners, through newsletters, press releases, brochures, presentations, etc., on the proper eviction of house-dwelling bat populations and the importance of providing alternative roosting structures for maternity colonies. *(Education – humans)*
2º	Develop brochures and posters regarding the most aggressive, invasive non-indigenous plants to educate and involve the public in detecting problem areas early while they are still manageable. Early recognition of the establishment of new populations is the key to successful control. *(Education – humans; Conserve wildlife – invasives)*
2º	Develop educational brochures and posters describing habitat management practices that can be carried out on both private and pubic lands. These brochures and posters should focus on the management, enhancement, and creation of habitat for early success ional species and include descriptions of various forestry management techniques; the primary and secondary benefits of prescribed burning should be highlighted. *(Education – humans; Conserve wildlife – rare wildlife)*
2º	Develop brochures and posters to educate the public and increase awareness of New Jersey's indigenous nongame fish species. *(Education - humans)*

f. Potential Partnerships to Deliver Conservation

Private Landowners

- Protect and enhance habitat through innovative partnerships with private landowners.
    - Implement best management practices that protect bald eagle, arogos skipper, and rare snake habitat and cavity-nester, forest passerine, freshwater wetland bird, grassland bird, raptor, and scrub-shrub/open field bird nesting sites.

- Utilize incentive programs that encourage the management of forests, grassland and scrub-shrub communities.
- Through incentive programs, encourage private landowners surrounding public natural lands to manage land for large forest patches in order to increase effective size and connectivity of forests.
- Encourage farmers to preserve farmland with conservation easements through partnerships with DEP Green Acres Program, the Nature Conservancy, Trust for Public Lands, and local municipalities for the conservation of forests, grassland and scrub-shrub communities.
- Develop and implement landowner incentives for providing, maintaining, and protecting summer bat habitat.
- Work with landowners to inventory their properties for the presence and severity of invasive non-indigenous plant invasions and harmful insect infestations. Work with them to develop effective control or eradication measures to protect critical wildlife habitats.
- Work with landowners to maintain/enhance existing habitats where listed and special concern fish species occur.
- As part of landowner incentive programs such as LIP and Forestry Stewardship, work with landowners to develop and implement deer management plans that achieve desired deer densities.

Public

- Expand volunteer Citizen Scientist recruitment and activities.
  - Collaborate with conservation groups (Pineland Preservation Alliance (PPA), New Jersey Audubon Society (NJAS), local land trusts, The Nature Conservancy – NJ Chapter (TNC), NJ Conservation Foundation (NJCF)) and other environmental, member-based organizations to recruit and train Citizen Scientists to locate, survey, and monitor wildlife habitats and populations in a systematic manner to achieve short- and long-term monitoring goals.
  - Collaborate with PPA, NJAS, NJCF, TNC, and other environmental, member-based organizations to recruit and train Citizen Scientists to monitor vegetative plots (exclosures) on state lands for evaluation of vegetative structure in response to deer densities.
  - Involve Citizen Scientists in management and protection projects, such as protection and posting of bald eagle nesting areas.
  - Continue volunteer-based summer bat concentration surveys.
  - Recruit North American Butterfly Association volunteers to conduct surveys for Lepidoptera species.
- Collaborate with NJ Audubon Society to educate public on the effects of feral cats on wildlife species of conservation concern.
- Promote backyard habitat management for migratory raptors and passerines, and for vernal pools where appropriate.

Wildlife Professionals

- Collaborate with researchers in New York, Pennsylvania, and West Virginia to develop best management practices and conservation plans for scrub-shrub/open field birds.

- Consult with animal control officers and extermination companies to implement proper removal of bats from houses and educate them on the importance of providing alternative roosting structures.

Conservation Organizations

- Partner with conservation organizations such as the Pinelands Preservation Alliance (PPA), The Nature Conservancy-NJ Chapter (TNC), NJ Audubon Society (NJAS), NJ Conservation Foundation (NJCF), and other environmental, member-based organizations to protect and enhance habitats.
    - Work with TNC, NJAS, NJCF and environmental, member-based organizations to protect and enhance large tracts of contiguous forest, especially those adjacent to state lands, beneficial to bald eagle, barred owl, cavity-nesters, and raptor nesting and foraging sites.
    - Work with PPA, TNC, NJAS and other environmental, member-based organizations to manage and protect bald eagle and raptor nesting and wintering areas.
    - Protect and enhance sites hosting significant populations of rare dragonflies, damselflies, moths, and butterflies on conservation lands.
    - Conduct habitat surveys to determine geographic distribution and severity of invasive non-indigenous plant and insect invasions that can affect forest health.
    - Protect and enhance critical habitat where listed or special concern wildlife and fish occur.
- Encourage the use of the Landscape Project's critical habitat mapping to guide land acquisition by conservation organizations through programs such as Green Acres, State Agricultural Development Committee (SADC) Farmland Preservation, and local land trusts.
- Continue participation in regional and national bat conservation efforts such as the Northeast Bat Working Group and the North American Bat Conservation Partnership.
- Consult with conservation organizations to develop educational programs.

Local Government, Other State and Federal Agencies

- Partner with local, state, and federal government agencies including municipal and county planning boards, USDA's Natural Resources Conservation Service (NRCS), US Fish and Wildlife Service (USFWS) - NJ Field Office, US Department of Defense (DOD), and the Department of Community Affairs (DCA), Office of Smart Growth to protect, enhance, and create habitats and to protect NJ's native wildlife.
    - NJ Department of Environmental Protection's (DEP) Divisions of Fish and Wildlife (DFW) to collaborate with the Pinelands Commission to identify and protect important wildlife habitat. When appropriate, change the boundaries of Pinelands Management Areas to better manage development around sensitive areas.
    - Identify valuable habitats for preservation and work with the DEP's Green Acres Program to pursue acquisition of these important areas.
    - DFW and USFWS to work with New Jersey's Forest Fire Service and the DEP's Office of Natural Lands Management to develop a strategy for introducing fire ecology back into the Pinelands ecosystem through the use of prescribed burns.
    - DFW to lead in the protection of bald eagle, barred owl, cavity-nester, and raptor nesting and foraging sites.

- DFW to work with the local law enforcement officers to protect sensitive corn snake, timber rattlesnake, and northern pine snake sites from disturbance and collection.
- Foster a relationship between the DFW and private/public landowners to restrict the use of off-road vehicles in critical wildlife habitats.
- ENSP, conservation organizations, DEP's Land Use Regulation Program, and the Pinelands Commission to work together to protect vernal pools and critical habitats for corn snakes, timber rattlesnakes and northern pine snakes.
- DFW to share site information and expertise with state and federal law enforcement to increase surveillance of corn snake, timber rattlesnake, and northern pine snake sites.
- DFW to work with neighboring state fish and wildlife agencies to radio-track Indiana bats dispersing across state boundaries.
- DFW to work with USFWS and other state and federal partners to implement the American Woodcock Management Plan as appropriate.
- Expand efforts to create habitat and implement best management practices for frosted elfins, northern pine snakes, cavity-nesters, forest passerines, freshwater wetland birds, raptors, and scrub-shrub birds on state lands and with other natural resource managers, county and municipal utility authorities, utility companies, and planners.
- DFW will take lead on developing specific conservation plans for special concern reptiles and amphibians on state lands.
- DFW will integrate results of research on vegetative structure in response to deer densities into deer management strategies within deer management zones.
- DFW to work with land management agencies at the state, local, and federal levels to implement deer management plans and harvest quotas that achieve desired deer densities to maintain ecological integrity of natural communities.
- DFW to work with USDA-NRCS to ensure that deer management goals are integrated into farm conservation plans that include measurable outcomes.
- DFW to work with USFWS and other state and federal partners to implement North American Waterfowl Management Plan as appropriate.
- DFW to work with state and county mosquito commissions to prevent the use of deleterious insecticides and biological controls at known amphibian breeding sites.
- DFW and DEP's Bureau of Water Monitoring and Standards to work together to recommend classification upgrades in water bodies where listed or special concern species occur.
- DFW to partner with local, county, and state authorities to establish best management practices in areas where listed or special concern fish, freshwater mussels, and wildlife species occur.
- DFW to work with the Land Use Regulation Program to make recommendations on stream encroachment permit issues for areas where listed or special concern species occur.
- DFW to work with the USFWS and Department of Defense to develop effective plans to eradicate invasive non-indigenous plants that are threatening critical wildlife habitats on federal and state lands and aquatic systems.
- DFW to work with USDA through NRCS and the WHIP program to control purple loosestrife and other invasive plants in critical wildlife habitats.

  - Continue protection measures for northern diamondback terrapin with the Bureau of Law Enforcement by requiring excluders on commercial crab traps in small creeks and lagoons.
- DFW to lead in the development of educational materials for public and private landowners about forest-dependent and grassland-dependent wildlife and their habitats.
- DFW, conservation organizations, and park commissions to expand public outreach through on-site programs and wildlife viewing opportunities.
- DEP to encourage the use of the Landscape Project's critical habitat mapping to guide habitat protection and land acquisition by federal, state, and local governments through programs such as DEP's Green Acres Program, State Agricultural Development Committee (SADC), Farmland Preservation, local land trusts, and through mitigation.
- DEP to encourage the use of the Landscape Project's critical habitat mapping to guide land use planning and zoning decisions by planning agencies at the federal, state, and local level.

g. Monitoring Success

- Conduct habitat assessment and monitor habitat changes over time; monitor efficacy of habitat management and restoration efforts.
- Monitor abundance, productivity, distribution, and trends of bald eagle, corn snake, timber rattlesnake, northern pine snake, Pine Barrens treefrog, cavity-nester, colonial waterbird, forest passerine, and scrub-shrub/open field bird populations.
- Monitor contaminant levels that may impact bald eagle populations.
- Continue the long-term monitoring of reptile and amphibian populations through the Herp Atlas Project, the Calling Amphibian Monitoring Program, and the volunteer coverboard surveys.
- Monitor populations of breeding, migratory and wintering waterfowl of conservation concern.
- Work with volunteers, private landowners, and conservation groups to monitor the success of eradication/control projects that target invasive non-indigenous plants.
- Continue to monitor deer densities and deer harvest data.
- Develop indicator metrics for monitoring forest health and implement at the scale necessary to monitor effectiveness of deer management strategies.
- Employ/implement adaptive management techniques for the goals and conservation actions established for species of greatest conservation need. Review effectiveness of research and management, and improve techniques as necessary.