New Jersey's Landscape Project

NJ Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program
Wildlife habitat mapping for community land-use planning and endangered species conservation

Version 2.1

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Terms & Definitions

Biological and Conservation Database (BCD) - Biodiversity data management software developed by NatureServe, which was formerly used by the New Jersey Department of Environmental Protection's Natural Heritage Program and Division of Fish and Wildlife's Endangered and Nongame Species Program before it was replaced by Biotics in 2004.

Biotics - Biodiversity data management software used by the Endangered and Nongame Species Program (ENSP). The successor to the Biological and Conservation Database, this data management software was developed by NatureServe and, within New Jersey, is maintained jointly by the ENSP (animal data) and the Natural Heritage Program (plant and ecological community data).

endangered species - A species included on the list of endangered species that the Department promulgates pursuant to the Endangered and Nongame Species Conservation Act, N.J.S.A. 23:2A-13 et seq. and any species or subspecies of wildlife appearing on any Federal endangered species list. The Endangered and Nongame Species Conservation Act defines an endangered species (with respect to wildlife) to be a species or subspecies of wildlife whose prospects for survival or recruitment are in jeopardy or are likely within the foreseeable future to become so due to any of the following factors: (1) the destruction, drastic modification, or severe curtailment of its habitat, or (2) its over-utilization for scientific, commercial or sporting purposes, or (3) the effect on it of disease, pollution, or predation, or (4) other natural or manmade factors affecting its prospects of survival or recruitment within the State, or (5) any combination of the foregoing factors. The term shall also be deemed to include any species or subspecies of wildlife appearing on any Federal endangered species list.

feature label - A label assigned to each occurrence that describes the specific occurrence type (i.e. nest, den, dead on road, etc.).

Highlands Region - The New Jersey Highlands Region is the area designated pursuant to the Highlands Water Protection and Planning Act, at N.J.S.A. 13:20-7; an over 800,000 acre region covering over 1,250 square miles and 88 municipalities in seven counties (Bergen, Hunterdon, Morris, Passaic, Somerset, Sussex and Warren). The Highlands Region is an essential source of drinking water for half of the residents of New Jersey.

imperiled species - Includes all wildlife species considered to be endangered or threatened as defined elsewhere in this document.

location use class - A label used for aerial and marine migrants that occupy disjunct locations by season (i.e. breeding or nonbreeding). Applies to migratory species only.

major roadway - A roadway classified by the New Jersey Department of Transportation as a 500 Series County Route or higher. Major roadways are Interstate Highways, U.S. Routes, NJ State Highways, Toll Authority Routes and 500 Series County Routes.

Natural Heritage methodology - A set of standard procedures used for gathering, organizing, and managing information on biodiversity, used in common throughout the NatureServe network.

NatureServe - A non-profit conservation organization that provides scientific information and tools to help guide effective conservation action. NatureServe represents an international network of biological inventories (known as natural heritage programs or conservation data centers) operating in all 50 states, Canada, Latin America, and the Caribbean.

NJDEP Landuse/Landcover (LU/LC) - A geographic information system (GIS) dataset produced by visually interpreting color infrared aerial photography of New Jersey. Through this process, photo-interpreters examine each image, and based on their knowledge of photo signatures, classify the image into various land use/land cover categories. The classifications are converted into a land use/land cover GIS digital file, with each delineated polygon representing a distinct land use/land cover type.

Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA) - An active research and development program focusing on advancing the application of various geo-spatial technologies including remote sensing, geographic information systems and global positioning systems. CRSSA also develops spatial-statistical analysis/modeling techniques for the environmental, agricultural and natural resource sciences and management.

species occurrence area - A species-specific polygon that is applied to all occurrences in the Biotics database that is used to value habitat in the Landscape Project. The area of the polygon is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP's research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in New Jersey. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25m radius) is applied to take into account locational uncertainty. These occurrence areas are used to value patches of habitat. In Version 2.0 of the Landscape Project, a species occurrence area was referred to as a "species model."

species of special concern - Nongame wildlife species that, based upon review by a panel of experts, warrant special attention because of inherent vulnerability to environmental deterioration or habitat modification that would result in their becoming Threatened or Endangered or ranked S3 in New Jersey's Biotics database. This category would also be applied to species that meet the foregoing criteria and for which there is little understanding of their current population status in the state**.**

threatened species - An indigenous nongame wildlife species of New Jersey designated pursuant to the Endangered and Nongame Species Conservation Act, N.J.S.A.23:2A-13 et. seq., and its implementing rules, N.J.A.C. 7:25-4.17, as most recently amended. Threatened species are generally defined to be species that may become endangered if conditions surrounding them begin or continue to deteriorate.

Geographic Information Systems Terminology from Environmental Systems Research Institute's Online GIS Dictionary (http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.gateway)

ArcView - Full-featured geographic information system software for visualizing, analyzing, creating, and managing data with a geographic component.

ArcView Shapefile - A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.

dissolve - A geoprocessing command that removes boundaries between adjacent polygons that have the same value for a specified attribute.

geoprocessing - A geographic information system (GIS) operation used to manipulate GIS data. A typical geoprocessing operation takes an input dataset, performs an operation on that dataset, and returns the result of the operation as an output dataset. Common geoprocessing operations include geographic feature overlay, feature selection and analysis, topology processing, raster processing, and data conversion. Geoprocessing allows for definition, management, and analysis of information used to form decisions.

GIS - Acronym for *geographic information system*. An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed.

GPS - Acronym for *Global Positioning System*. A system of radio-emitting and -receiving satellites used for determining positions on the earth. The orbiting satellites transmit signals that allow a GPS receiver anywhere on earth to calculate its own location through trilateration. Developed and operated by the U.S. Department of Defense, the system is used in navigation, mapping, surveying, and other applications in which precise positioning is necessary.

raster - A spatial data model that defines space as an array of equally sized cells arranged in rows and columns, and comprised of single or multiple bands. Each cell contains an attribute value and location coordinates. Unlike a vector structure, which stores coordinates explicitly, raster coordinates are contained in the ordering of the matrix. Groups of cells that share the same value represent the same type of geographic feature.

union - A topological overlay of two or more polygon spatial datasets that preserves the features that fall within the spatial extent of either input dataset; that is, all features from both datasets are retained and extracted into a new polygon dataset.

vector - A coordinate-based data model that represents geographic features as points, lines, and polygons. Each point feature is represented as a single coordinate pair, while line and polygon features are represented as ordered lists of vertices. Attributes are associated with each vector feature, as opposed to a raster data model, which associates attributes with grid cells.

Conversions

Area:

1 hectare = 2.47 acres

Distance:

1 meter = 3.28 feet

1 kilometer = 0.62 miles

The Landscape Project

a model for imperiled wildlife protection (Version 2.1)

New Jersey is the most densely populated state in the nation. One of the consequences of this distinction is the extreme pressure that is placed on our natural resources. As the population grows, we continue to lose or impact the remaining natural areas of the state. As more and more habitat is lost, people are beginning to appreciate the benefits — and necessity — of maintaining land in its natural state. For example, we now know that wetlands play an important role in lessening the damage from floods and naturally breaking down contaminants in the environment. Forests and grasslands protect the quality of our drinking water, improve the quality of the air we breathe and provide important areas for outdoor recreation. Collectively, these habitats are of critical importance to the diverse assemblage of wildlife found in New Jersey, including more than 70 species classified as threatened or endangered.

In 1994, the New Jersey Division of Fish and Wildlife's (DFW) Endangered and Nongame Species Program (ENSP) adopted a landscape level approach to imperiled species conservation by developing the Landscape Project. Through geographic information system (GIS) technology, the Landscape Project uses species location data and land-use/land-cover as well as species life history information to produce maps that depict critical wildlife habitat throughout the state. The goal of the project is to protect New Jersey's biological diversity by maintaining and enhancing imperiled wildlife populations within healthy, functioning ecosystems.

Figure 1. *Over 50% of the state's bog turtle habitat (top) and 40% of the Cape May Peninsula's migratory bird habitat (bottom) has been lost to sprawl in the past three decades. The Landscape Project aims to reverse this trend.*

Why we need the Landscape Project

As people leave our cities to live in the "country," suburban sprawl has consumed land at a rapid rate. Some analysts predict that at current patterns all remaining available land would be developed within 40 years, making New Jersey possibly the first state in the nation to reach build-out (Hasse and Lathrop 2001).

Despite New Jersey's protection efforts, which include strict land-use regulations and an aggressive open space acquisition program (Green Acres), we continue to lose critical wildlife habitat at an alarming rate. In just the last three decades we have lost 40% of the remaining critical migratory bird stopover habitat on the lower third of the Cape May Peninsula. During the same period, approximately 50% of the state's bog turtle habitat has disappeared (***Figure 1***). The Landscape Project serves as a tool to help reverse this trend (***Figure 2***).

The purpose of the Landscape Project

The Landscape Project has been designed to provide users with peer-reviewed, scientifically sound information that is easily accessible and can be integrated with the planning, protection and land management programs of non-governmental organizations and private landowners and at every level

New Jersey's Changing Landscape

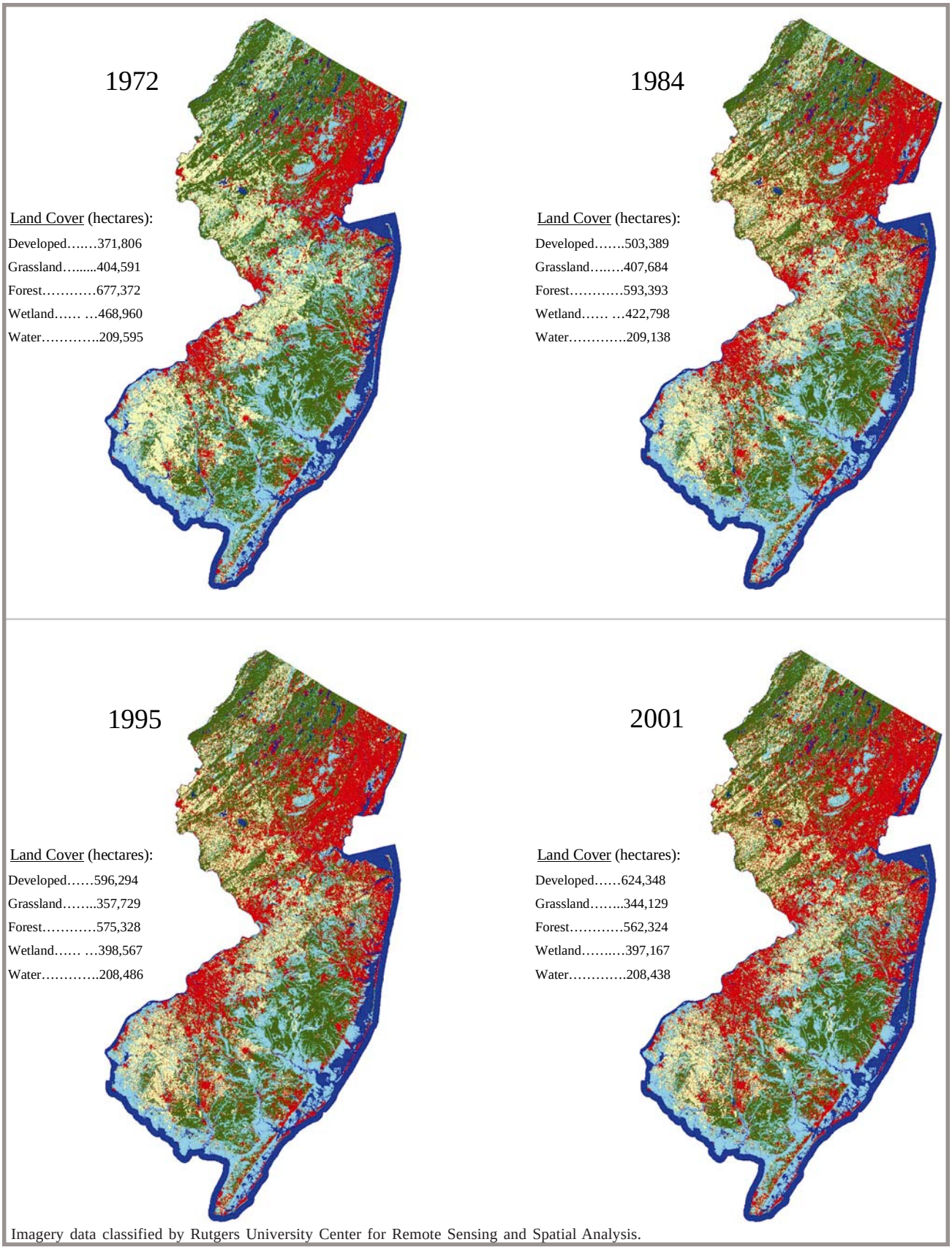


Figure 2. *New Jersey's Landscape is rapidly changing. Since 1972, more than 8,000 hectares/year of wildlife habitat has been lost. Moreover, much of the habitat that remains is less suitable for wildlife due to habitat fragmentation. This is especially detrimental to rare and imperiled wildlife, as many of these species require large, contiguous tracts of habitat to survive. The goal of the Landscape Project is to reverse this trend by identifying, delineating and ultimately protecting habitat critical to the long-term survival of New Jersey's wildlife.*

of government — federal, state, county and municipal. As in Version 1.0, Version 2.1 of the Landscape Project has gone through an extensive peer review process. Landscape maps and overlays provide a basis for proactive planning such as the development of local habitat protection ordinances, zoning to protect critical wildlife areas, management guidelines for imperiled species conservation on public and private lands, and land acquisition projects.

Most importantly, the critical area information provided by the Landscape Project can be used for planning purposes before any actions such as proposed development, resource extraction (eg. timber harvests) or conservation measures occur. Proactive planning with accurate, and legally and scientifically sound information will result in less conflict. Less time will be wasted, and less money spent, attempting to resolve after-the-fact endangered and threatened species issues.

Landscape Project Applications

DEP Agencies:

· **Division of Land Use Regulation:** The Division of Land Use Regulation (DLUR) uses the Landscape Project maps to identify and protect habitat for endangered and threatened species. Several state land use regulations contain provisions for the protection of habitats determined to be critical to endangered and threatened wildlife. These include the Freshwater Wetlands Protection Act Rules (N.J. A.C.7:7A), the Coastal Zone Management Rules (N.J.A.C. 7:7E), the Flood Hazard Area Control Act Rules (NJAC 7:13), and the Highlands Water Protection and Planning Act, Special Adopted Rules (NJAC 7:38).

Landscape Project data is reviewed to determine whether a particular site contains "documented habitat" for State or Federally listed species. Within areas of documentation, ground surveys are typically conducted to confirm actual site suitability for a specifically documented species. Permit applications recieved by DLUR are now better prepared because the public has access to the Landscape Project data. Since applicants now have access to base line data concerning endangered and threatened species occurrences, they can better address potential impacts to State or Federally listed species in their permit applications or environmental impact statements, thereby minimizing environmental impacts and the time required to issue permits.

· **Green Acres:** The Landscape Project is used by the Green Acres Program (GAP) to support the preservation of high quality natural resources in three valuable ways. First, the mapped data is represented on site-specific planning maps showing habitat locations so that consideration is given to these prime areas during decision making. Site specific maps are also submitted as part of the application for the Federal Land & Water Conservation Fund to show characteristics of those applicant properties. Lastly, but perhaps most importantly, the data is used in the evaluation of lands offered to the state for acquisition. GAP scores all land offers based on their natural resource values. Wildlife occurrence is one of the criteria evaluated. The Landscape Project data format allows for statistical analysis to determine the quality and quantity of state and federal endangered species habitats on the offered properties.

· **NJDEP's Natural and Historic Resources:** The Natural & Historic Resources (N&HR) programs within NJDEP are responsible for managing over 900,000 acres of parks and forests, recreation areas, historic sites, wildlife management areas, and natural areas. A newly established policy requires land managers to obtain prior Department review when proposing any activity on state lands that may modify the terrestrial or aquatic landscape. Land managers use Landscape Project maps to conduct an initial screen to determine the presence of landscape patches ranked 3, 4 or 5. If these features are on the proposed project site the land manager is required to request a detailed review by ENSP. The project may be approved, approved subject to conditions or recommended for denial in order to minimize damage to critical imperiled species habitat.

· **DFW's Landowner Incentive Program:** The Landscape Project is an important tool for the Landowner Incentive Program (LIP). When applications are submitted to LIP, biologists use the Landscape Project as a screening tool to determine the species that may inhabit the site. Based on the Landscape Project and the project description, biologists determine if the project warrants a site visit and use the Landscape Project to create a map of the

site and surrounding landscape. LIP staff also use the Landscape Project to support the species and habitat management plan developed for each property.

Federal Agencies:

· **U.S. Fish and Wildlife Service:** The U.S. Fish and Wildlife Service (USFWS), New Jersey Field Office (Service) uses the data layers in the Landscape Project to assist with project planning, assessment, and implementation of habitat restoration projects through the *Partners for Fish and Wildlife* program. Specifically, information in the Landscape Project on wetlands, sensitive species, grasslands, and other habitat types assist the Service in large-scale geographic planning and targeting of habitat restoration projects. The Landscape Project is also useful for site-specific assessments of wetland restoration and creation opportunities.

· **US Department of Agriculture Natural Resources Conservation Service:** The Natural Resources Conservation Service (NRCS) has utilized the Landscape Project for several years as part of its day to day activities. NRCS field staff conducts environmental evaluations for all projects where federal funds are utilized as part of its National Environmental Policy Act (NEPA) responsibilities. These evaluations include threatened and endangered species assessments of planned NRCS actions.

The Landscape Project provides invaluable information as to the possibility of threatened and endangered species occurrence at a site and helps guide NRCS planning efforts. The Landscape Project has also been used for several years in the competitive ranking of Wildlife Habitat Incentive Program (WHIP) projects. Projects that will have positive impacts to threatened and endangered species habitat receive additional points in the WHIP ranking system and have a greater chance of being funded. The Landscape project data is used as the basis for the threatened and endangered portion of the ranking.

Other Agencies and Private Citizens:

· **Prioritize conservation acquisitions:** The Landscape Project is used to prioritize land parcels for purchase through acquisition programs such as Farmland Preservation and the USFWS's refuge system.

· **Guide regulators and planners:** Landscape Maps provide land-use regulators and state, county and local planners with the tools they need to enhance protection through the regulatory and planning process.

· **Provide citizens with conservation tools:** The Landscape Project provides the tools to guide citizen actions to protect imperiled and rare species habitat at the local level. By combining critical area maps with other GIS data layers such as roads, development and publicly owned lands, important areas in need of protection can be easily identified.

· **Guide stewardship of conserved areas:** New Jersey already has more than 400,000 hectares of open space. These lands are managed by a variety of agencies and organizations, both public and private. Landscape Maps identify important imperiled and rare species habitats on these lands. ENSP biologists work hand- in-hand with land managers and landowners to develop appropriate best management practices for the long-term conservation of imperiled and rare species.

Figure 3. *The Landscape Project aims to identify, delineate and ultimately protect critical areas for all New Jersey wildlife, including the bobcat, pictured above.*

Who benefits

Protecting large expanses of fields, forests and wetlands helps to ensure that imperiled species will remain a part of New Jersey's future (***Figure 3***). In addition to identifying habitat important for the conservation of imperiled species, the Landscape Project will result in more open space for outdoor recreation, as well as public health and environmental benefits. Recent surveys by the US Fish and Wildlife Service (2006) reveal more than 87.5 million U.S. residents sixteen and older participate in some form of wildlife-related recreation. Open spaces provide places where people can escape the confines and stresses of urban and suburban living. Retaining habitats in their natural state provides other benefits such as reducing the threat of flooding, allowing for the biodegradation of environmental contaminants and recharging ground water reserves. In short, the Landscape Project provides potential benefits for everyone.

New Jersey's Landscape Regions

A landscape level perspective

Since animal populations require large expanses of natural habitat for their long-term survival, the Landscape Project focuses on large areas called Landscape Regions where plant and animal communities are ecologically similar (***Figure 4***). ENSP has identified and mapped habitat for imperiled species within each Landscape Region utilizing an extensive database that combines imperiled and rare wildlife location information with land-use/land-cover classification data and species' habitat requirements. These landscape maps provide a highly accurate, reliable and scientifically sound basis for habitat protection within each landscape.

One of the Landscape Project's unique features is its focus on the big picture, and not just on individual locations of imperiled species as those areas become threatened. Thus, within large landscapes, the Landscape Project identifies critical wildlife areas that must be preserved now if we want to ensure the conservation and recovery of New Jersey's imperiled wildlife for future generations.

Skylands Landscape

This landscape region combines two of New Jersey's physiographic regions, the Ridge and Valley and the Highlands. It encompasses all or parts of Sussex, Warren, Hunterdon, Somerset, Passaic, Essex, Bergen, and Morris counties. The region contains extensive tracts of contiguous upland and wetland forests that support diverse animal populations including red-shouldered hawk, northern goshawk, cerulean warbler, timber rattlesnake, long-tailed salamander, and the state's only known wintering populations of Indiana bat. Bog turtles and great blue herons inhabit the extensive freshwater wetland systems found throughout the region.

Delaware Bay Landscape

This landscape encompasses all or parts of Cape May, Atlantic and Cumberland counties. It features significant populations of bald eagle, barred owl, eastern tiger salamander, Cope's gray treefrog and other endangered and threatened species. The vast woodland tracts of this region are among the largest in the state and support a large portion of New Jersey's neotropical birds and interior-forest bird populations. The extensive saltwater marsh and sandy overwash beaches support a significant horseshoe crab breeding area and shorebird migration, including the red knot, of worldwide ecological significance. Despite the heavy loss of habitat, the Cape May Peninsula remains one of the country's most important migratory "stopovers" for hundreds of bird and insect species. The expansive habitat mosaic of rivers and streams flowing into the tidal Delaware Bay supports concentrations of imperiled and rare wildlife and wintering waterfowl.

Piedmont Plains Landscape

This landscape region also combines two of New Jersey's physiographic regions, the Piedmont and the Inner Coastal Plain. It encompasses all or parts of Burlington, Gloucester, Salem, Mercer, Middlesex, Monmouth, Hunterdon, Somerset, Union, Essex, Hudson, Passaic, and Bergen counties. It is dominated by the Delaware and Raritan rivers and is characterized

by farmed areas, extensive grasslands, fragmented woodlands and tidal freshwater marshes that are among the world's most productive. Imperiled and rare species within this landscape include grassland birds such as the endangered upland sandpiper and woodland raptors such as the barred owl and Cooper's hawk.

Pinelands Landscape

This landscape encompasses all or parts of Atlantic, Ocean, Burlington, Camden, and Gloucester counties. An internationally recognized ecosystem and National Reserve, the Pinelands supports extremely diverse reptile, amphibian and invertebrate populations including northern pine snake, corn snake, Pine Barrens treefrog, Pine Barrens bluet and arogos skipper. Extensive cedar swamps and wetland systems contain numerous insect species, as well as sustainable populations of many neotropical birds. Its waterways support aquatic communities unique among mid-Atlantic states.

Atlantic Coastal Landscape

This landscape encompasses parts of Monmouth, Ocean and Atlantic counties. New Jersey's Atlantic Coast beaches and marshes are among the most productive coastal habitats in the country. Despite heavy development, they support important portions of Atlantic Coast populations of colonial nesting birds, such as common terns, little blue herons and great egrets, and endangered beach-nesting birds such as least terns and piping plovers. The coastal habitats also support most of the state's ospreys and peregrine falcons, as well as a large number of northern harriers.

New Jersey's Landscape Regions

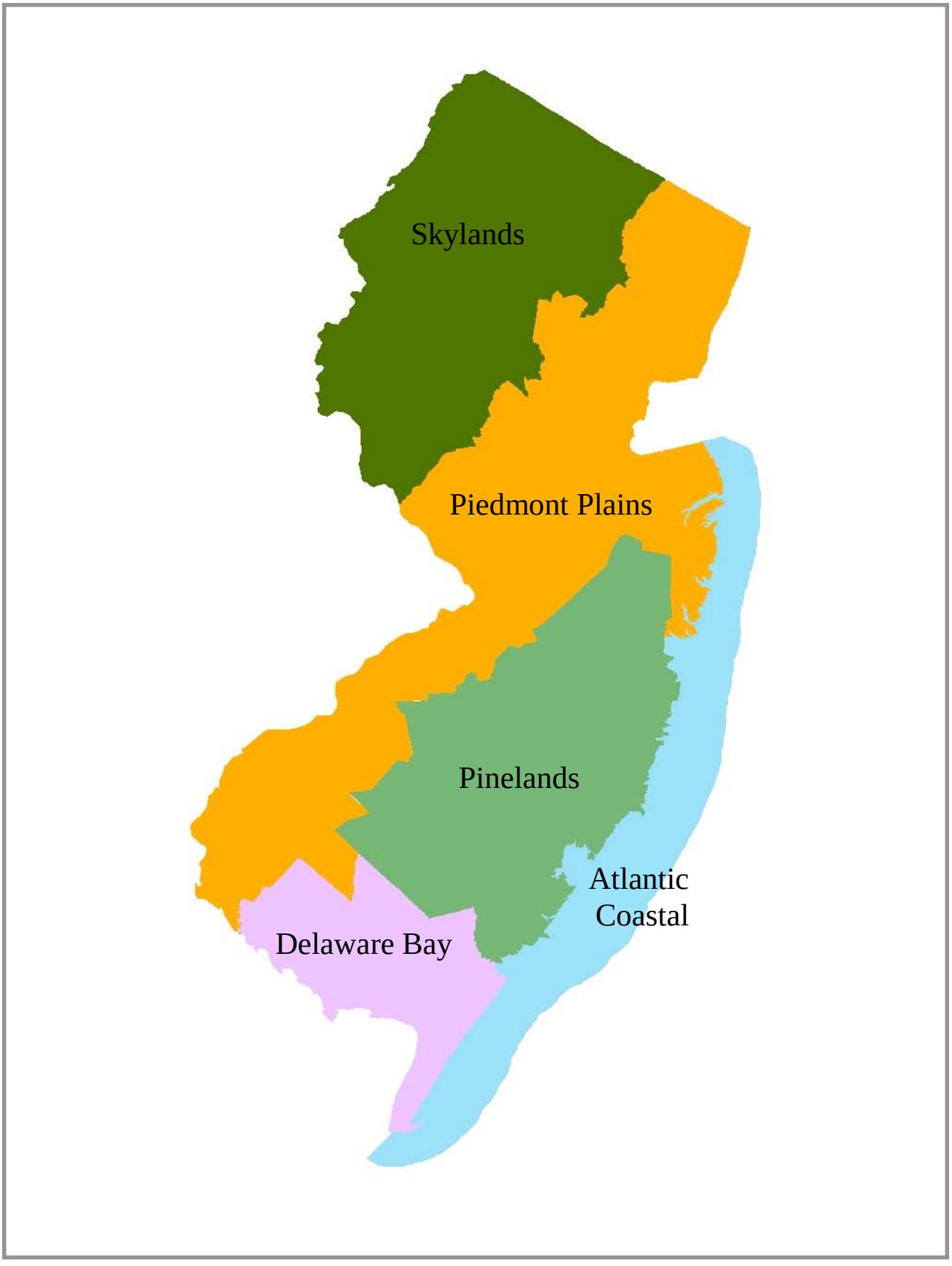


Figure 4. *New Jersey's Landscape Regions.*

Landscape Project Mapping

Methodology for Identifying and Delineating Critical Wildlife Areas

Data

Land Use/Land Cover: In early 2004, Version 2.0 of the Landscape Project was released. For this version the ENSP opted to use the DEP's air photo-based land-use/land-cover (LU/LC) data primarily because of the desire for consistency with other geographic data and mapping applications that employ these data across the department. The increased resolution of the aerial photo-based data and the commitment by the DEP to update the imagery provided additional rationale for using the NJDEP LU/LC data.

For complete details on New Jersey 2002 LU/LC data consult the DEP's website (http://www.nj.gov/dep/gis/lulc02shp.html).

Version 2.1: The Department recently completed an update of the 1995 LU/LC data set using 2002 aerial imagery. In order to reflect this new information along with new species occurrence information, ENSP completed an update to the Landscape Project using methodology from Version 2.0.

As in 2.0, in Version 2.1 the unique LU/LC classes are combined into five general habitat types: forest, forested wetland, grassland, emergent wetland and beach. Version 2.1 also includes specific mapping protocols for bald eagle foraging areas, urban peregrine falcon nests and wood turtle habitat as set forth in Version 2.0 with minor modifications.

The methods for delineating imperiled and special concern species habitat areas in Version 2.1 are described in the following sections of this document: "General Methodology for Delineating Critical Areas," "Detailed Methodology for Delineating Critical Areas by Habitat Type," and "Detailed Methodology for Delineating Critical Areas by Special Habitat Requirements."

Version 3.0 (Highlands): On August 10th, 2004, the Highlands Water Protection and Planning Act was passed. The Act mandated the establishment of the New Jersey Highlands Water Protection and Planning Council (Highlands Council) that is charged with the task of developing a Regional Master Plan (RMP). One of the major goals of the Highlands RMP is protecting natural and cultural resources. Therefore, an update of the Landscape Project was warranted.

Concurrent with the release of Version 2.1, the NJDEP released Version 3.0 of the Landscape Project within the New Jersey Highlands Region. This new version represents not only new LU/LC and species occurrence information, but also a new mapping methodology.

In updating the 1995 LU/LC data set using 2002 imagery, the Highlands Region was the first area of the state to be completed in final form. This 2002 LU/LC now forms the base layer for Version 3.0 of the Landscape Project, a species-based patch approach.

See the following document for further information: "*New Jersey's Landscape Project, (Version 3.0 Highlands): A species-based patch approach to rare and imperiled wildlife habitat mapping for community land-use planning and species conservation.*"

Future updates: The NJDEP will continue to update the Landscape Project using the Version 3.0 methodology until it is completed statewide. As the remainder of the state is updated to Version 3.0, it will become the standard for all NJDEP applications. Version 2.1 will be erased in areas where Version 3.0 has become available . These updates and any schedule of future releases can be found on the Landscape Project website (http://www.state.nj.us/dep/fgw/ensp/landscape/).

Species Data: In previous versions of the Landscape Project the main source of species data was from the NHP's BCD. ENSP staff reviewed all animal records for acceptability/reliability and subsequently accepted or rejected records for inclusion in the BCD (***Appendix I***). However, maintenance of the database was the responsibility of the NHP staff. Species

Landscape Project Version

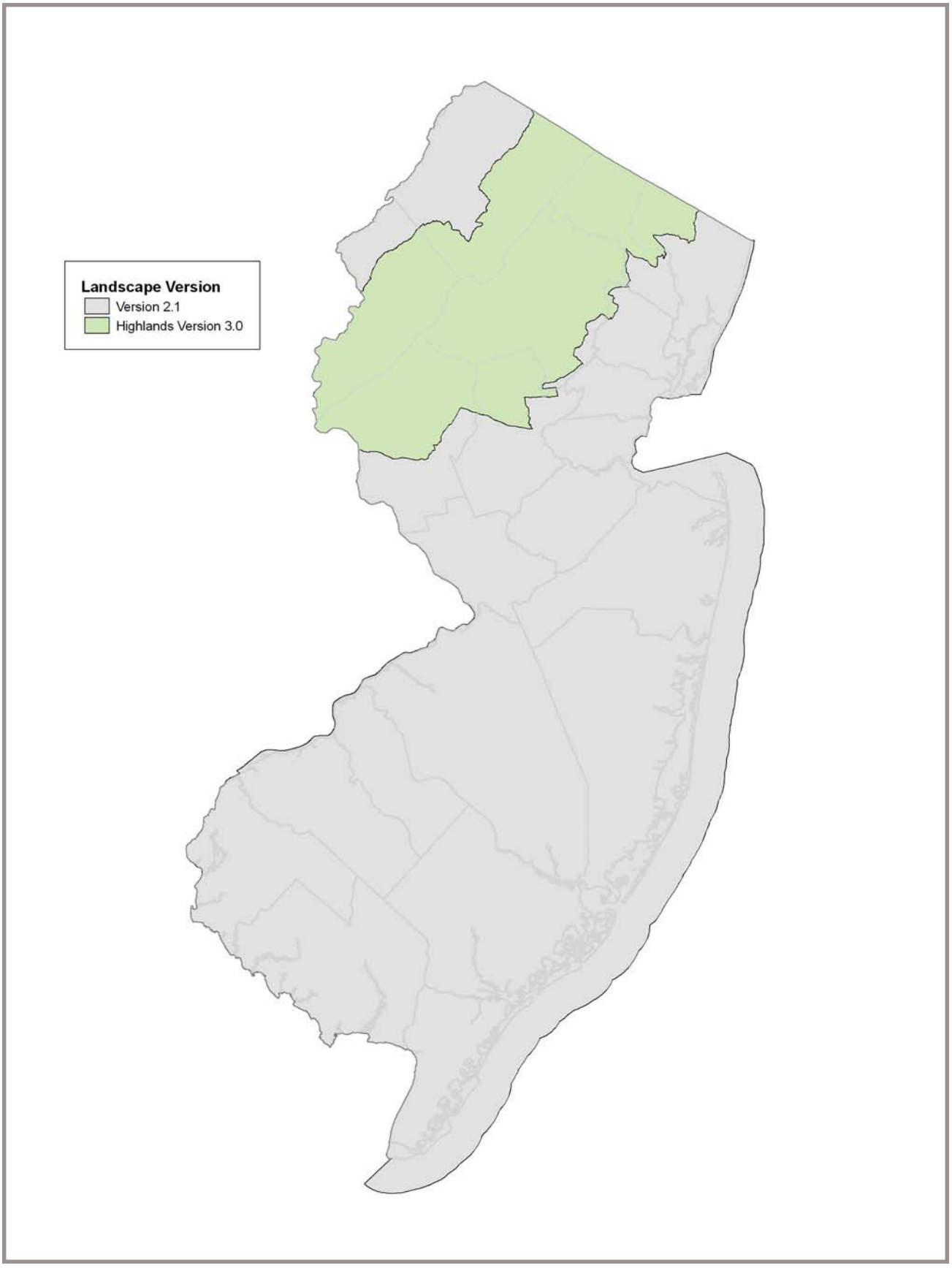


Figure 5. *Areas of New Jersey covered by Version 2.1 vs. Version 3.0 (Highlands) in the concurrent release of the Landscape Project.*

occurrences were exported from the BCD database to a file format compatible with GIS for use in the Landscape Project. A polygon, referred to as a "species occurrence area," was applied to each species location record in the database. These occurrence areas are used to value patches of habitat (See ***Appendix III*** for descriptions of all species occurrence areas). Species occurrences in the BCD were derived from a variety of sources including ENSP surveys, DEP staff reports, private consultant reports and those reports from the general public that were reviewed and accepted by ENSP biologists.

In 2004, ENSP took full control of maintaining animal records and both programs, upgraded from the BCD to an Oracle-based database called Biotics. Biotics is the new standard used throughout the NatureServe network, which extends across all 50 states, Canada, Latin America and the Caribbean, for tracking imperiled and rare species occurrences. It offers many advantages that include multi-user capabilities, a user-friendly interface, established scientific standards for biological inventory and biodiversity data management and an ability to interact with GIS software.

While making the conversion to Biotics, ENSP took full advantage of the opportunity to review all imperiled and rare animal occurrences and supplied new standards for how occurrences would be reviewed and used for the Landscape Project. In previous versions of the Landscape Project, ENSP used all occurrences dated 1970 or later for which there existed precise location information ($\pm$70m). The 1970 date for sightings coincides with the time when biologists started to track and record precise locations of imperiled and rare species. It also coincides with the start of ENSP, which began in 1973. The 1970 cut-off date and high precision requirements are still being used, but all records were reviewed to verify that suitable habitat remains in the immediate vicinity of the occurrence. If suitable habitat no longer exists in the vicinity of the occurrence it is not used to value patches in the Landscape Project. All occurrences now receive a 'feature label' as well as a 'location use class." Both of these are used to record more information about the occurrence. A feature label describes the type of occurrence, e.g. nest, den, etc. A 'location use class' is specified for migratory species and indicates the season or behavior that is associated with the occurrence.

General Methodology for Delineating Critical Areas

The method for delineating critical areas is relatively straightforward. First, the relevant classes for each habitat type (forest, grassland, forested wetland, emergent wetland and beach) are extracted from the NJDEP's LU/LC data layer. Dissolving the different LU/LC classes for each habitat type creates contiguous habitat polygons. Using boundaries between habitat types and major roads (county level 500 and above), contiguous patches for each habitat type are delineated. Each patch is then assigned a unique link ID. Imperiled species occurrence areas are then intersected with habitat patches. Habitat patches are classified based on the status of the species present as follows (***Figure 9***):

- **Rank 5** is assigned to patches containing one or more occurrences of at least one wildlife species listed as endangered or threatened on the Federal list of endangered and threatened species.
- **Rank 4** is assigned to patches with one or more occurrences of at least one State endangered species.
- **Rank 3** is assigned to patches containing one or more occurrences of at least one State threatened species.
- **Rank 2** is assigned to patches containing one or more occurrences of species considered to be species of special concern.
- **Rank 1** is assigned to patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species.

See ***Figure 6*** for a statewide distribution of habitat by landscape region and ***Figure 7*** for a statewide distribution of critical areas (rank 3,4,5) by landscape region.

Detailed Methodology for Delineating Critical Areas by Habitat Type

Forest: Critical area maps for forest-dependent species are generated by selecting specific land-use classes from the NJDEP's LU/LC data set. See ***Appendix IV*** for a list of DEP land-use classes and the corresponding habitat types. Using GIS software, the ENSP has developed the following protocols (***Figure 8***):

Outside of the Pinelands

- Extract all appropriate forest types (upland and wetland forests) from the NJDEP LU/LC dataset into one forest layer (***Appendix IV***).
- Combine all of the NJDEP LU/LC forest types that are directly adjacent to one another by dissolving the boundaries between them making a layer of contiguous forest polygons.
- Bisect the resulting forest coverage using major roads (500 level and above) to create ecologically significant boundaries between contiguous forest patches.
- Clip the resulting forest coverage by the Pinelands Area Boundary of New Jersey.
- Identify these patches and sections of patches as Pinelands Area patches.

For Pinelands Area patches proceed to protocol under the subheading "Pinelands." For all other forest patches continue below:

- Identify forest patches that have a core area of 10 hectares or greater. Core area is defined as interior forest greater than 90 meters from the forest edge.
- Buffer all forest patches inward from the perimeter by 90 meters.
- Erase this buffer from each patch.
- If the sum of the remaining area is 10 hectares or greater, then the original patch is recoded as core. These patches receive a minimum rank of 1.

- Combine the Pinelands Area patches and sections of patches with the remaining forest patches that are directly adjacent to one another by dissolving the boundaries between them making a layer of contiguous forest polygons.
- Assign each new patch a unique Link ID used for tracking patches.
- Intersect forest species models with the new forest layer. This intersection results in a new layer with the Link ID from the forest layer and an ID from the species models. From this layer queries can be made to determine the number of records and conservation status of each patch based on the species present.
- All forest patches in the Coastal Landscape Region and the lower 10 kilometers of the Cape May peninsula are considered critical areas due to the importance of these habitats to migrating birds. These patches receive a minimum rank of 1 regardless of whether or not they contain 10 hectares of core forest.
- Habitat patches are classified based on the conservation status of the species present as detailed in the "General Methodology for Delineating Critical Areas," section.

Pinelands

- Identify Pinelands Area connection corridors. Pinelands Area patches connected by any corridor that is greater than 91.44 meters in length and less than 91.44 meters wide are considered separate patches.
- Buffer all forest patches inward from the perimeter by 45.73 meters. This action eliminates all Pinelands connecting corridors that do not meet the required dimensions.
- Pinelands Area patches that meet the required dimensions are buffered outward from the perimeter by 45.73 meters and merged with any overlapping forest polygons. This buffer brings the forest patch back out to its original extent minus Pinelands connection corridors that do not meet the required dimensions.
- Identify Pinelands Area patches that have a core area of 10 hectares or greater. Pinelands core area is defined as contiguous interior forest greater than 90 meters from the forest edge.
- Buffer all forest patches inward from the perimeter by 90 meters.
- Erase this buffer from each patch.
- If a contiguous section of the remaining area is 10 hectares or greater, then the original patch is re-coded as core and receives a minimum rank of 1.
- Combine the Pinelands Area patches and sections of patches with the remaining forest patches that are directly adjacent to one another by dissolving the boundaries between them making a layer of contiguous forest polygons.
- Assign each new patch a unique Link ID used for tracking patches.
- Intersect forest species models with the new forest layer. This intersection results in a new layer with the Link ID from the forest layer and an ID from the species models. From this layer queries can be made to determine the number of records and conservation status of each patch based on the species present.
- All forest patches in the Coastal Landscape Region and the lower 10 kilometers of the Cape May peninsula are considered critical areas due to the importance of these habitats to migrating birds. These patches receive a minimum rank of 1 regardless of whether or not they contain 10 hectares of core forest.
- Habitat patches are classified based on the conservation status of the species present as detailed in the "General Methodology for Delineating Critical Areas," section.

Forested Wetland: Critical area maps for forested wetland dependent species are generated by selecting specific land-use classes from the NJDEP's LU/LC data set. See ***Appendix IV*** for a list of DEP land-use classes and the corresponding habitat types. Using GIS software, the ENSP has developed the following

Hectares of Critical Area by Landscape Region (percentage of total area within each region)

Skylands Region

Bald Eagle Foraging Area (3.0)	2661	(<1%)
Species-based Patches (3.0)	262443	(52%)
Bald Eagle Foraging Area (2.1)	3123	(<1%)
Wood Turtle (2.1)	5951	(2%)
Emergent Wetland (2.1)	2702	(<1%)
Forested Wetland (2.1)	7449	(1%)
Forest (2.1)	69189	(14%)
Grassland (2.1)	14788	(3%)

Piedmont/Plains Region

Bald Eagle Foraging Area (3.0)	190	(<1%)
Species-based Patches (3.0)	14388	(<1%)
Urban Peregrine Falcon Nest (2.1)	5026	(<1%)
Bald Eagle Foraging Area (2.1)	32311	(1%)
Wood Turtle (2.1)	9992	(<1%)
Emergent Wetland (2.1)	25270	(1%)
Forested Wetland (2.1)	49911	(2%)
Forest (2.1)	106637	(3%)
Grassland (2.1)	87424	(3%)
Beach (2.1)	100	(<1%)

Pinelands Region

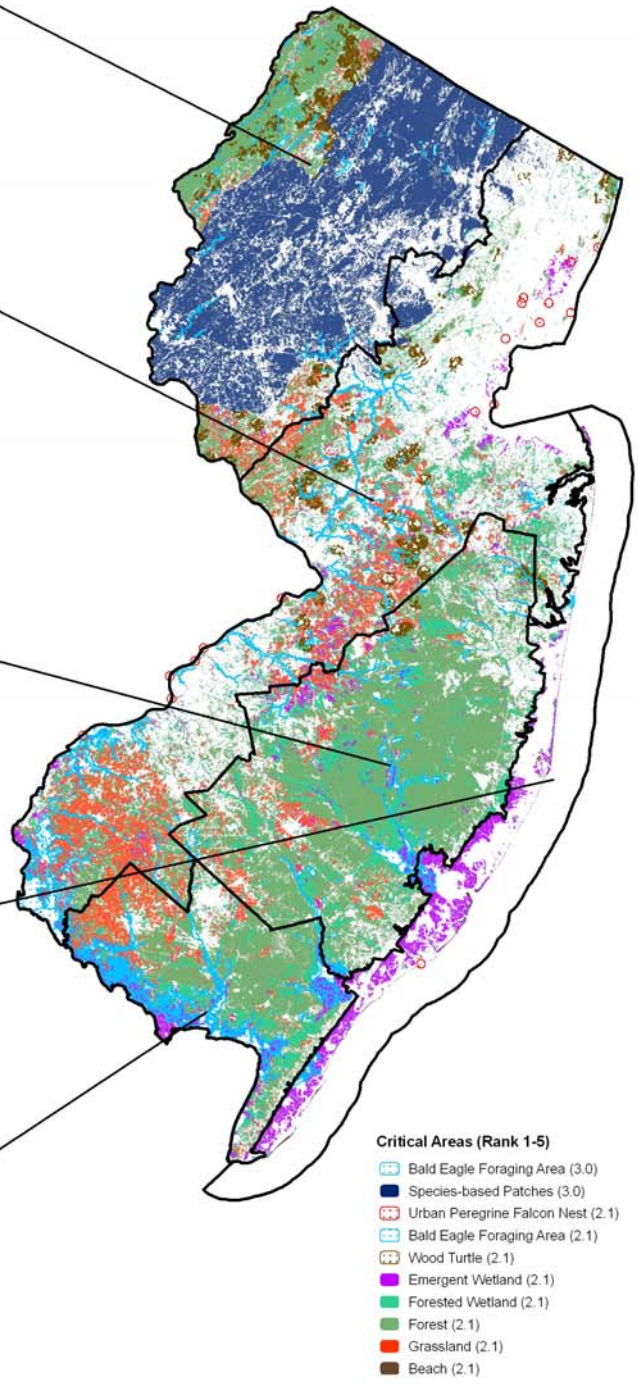
Bald Eagle Foraging Area (2.1)	9929	(2%)
Wood Turtle (2.1)	841	(<1%)
Emergent Wetland (2.1)	13746	(3%)
Forested Wetland (2.1)	65586	(14%)
Forest (2.1)	248259	(52%)
Grassland (2.1)	28428	(6%)
Beach (2.1)	15	(<1%)

Coastal/Atlantic Region

Urban Peregrine Falcon Nest (2.1)	314	(<1%)
Bald Eagle Foraging Area (2.1)	2810	(2%)
Emergent Wetland (2.1)	35580	(31%)
Forested Wetland (2.1)	1952	(2%)
Forest (2.1)	1414	(1%)
Grassland (2.1)	63	(<1%)
Beach (2.1)	2140	(2%)

Delaware Bay Region

Bald Eagle Foraging Area (2.1)	16087	(8%)
Emergent Wetland (2.1)	27147	(13%)
Forested Wetland (2.1)	24833	(12%)
Forest (2.1)	71994	(36%)
Grassland (2.1)	25551	(13%)
Beach (2.1)	105	(<1%)



*Due to overlap among layers, hectares and percentages were calculated only once where area overlap occurs.

***Figure 6**. Hectares of each habitat type expressed as a percentage of the total land area within each Landscape Region.*

Hectares of Critical Area Valued for Imperiled Species by Landscape Region (percentage of total area within each region)

Skylands Region

Bald Eagle Foraging Area (3.0)	2661	(<1%)
Species-based Patches (3.0)	228892	(45%)
Bald Eagle Foraging Area (2.1)	3123	(<1%)
Wood Turtle (2.1)	5951	(1%)
Emergent Wetland (2.1)	1342	(<1%)
Forested Wetland (2.1)	6462	(1%)
Forest (2.1)	64575	(13%)
Grassland (2.1)	5945	(1%)

Piedmont/Plains Region

Bald Eagle Foraging Area (3.0)	190	(<1%)
Species-based Patches (3.0)	11734	(<1%)
Urban Peregrine Falcon Nest (2.1)	5026	(<1%)
Bald Eagle Foraging Area (2.1)	32311	(1%)
Wood Turtle (2.1)	9992	(<1%)
Emergent Wetland (2.1)	8583	(<1%)
Forested Wetland (2.1)	9738	(<1%)
Forest (2.1)	49406	(2%)
Grassland (2.1)	5945	(1%)
Beach (2.1)	73	(<1%)

Pinelands Region

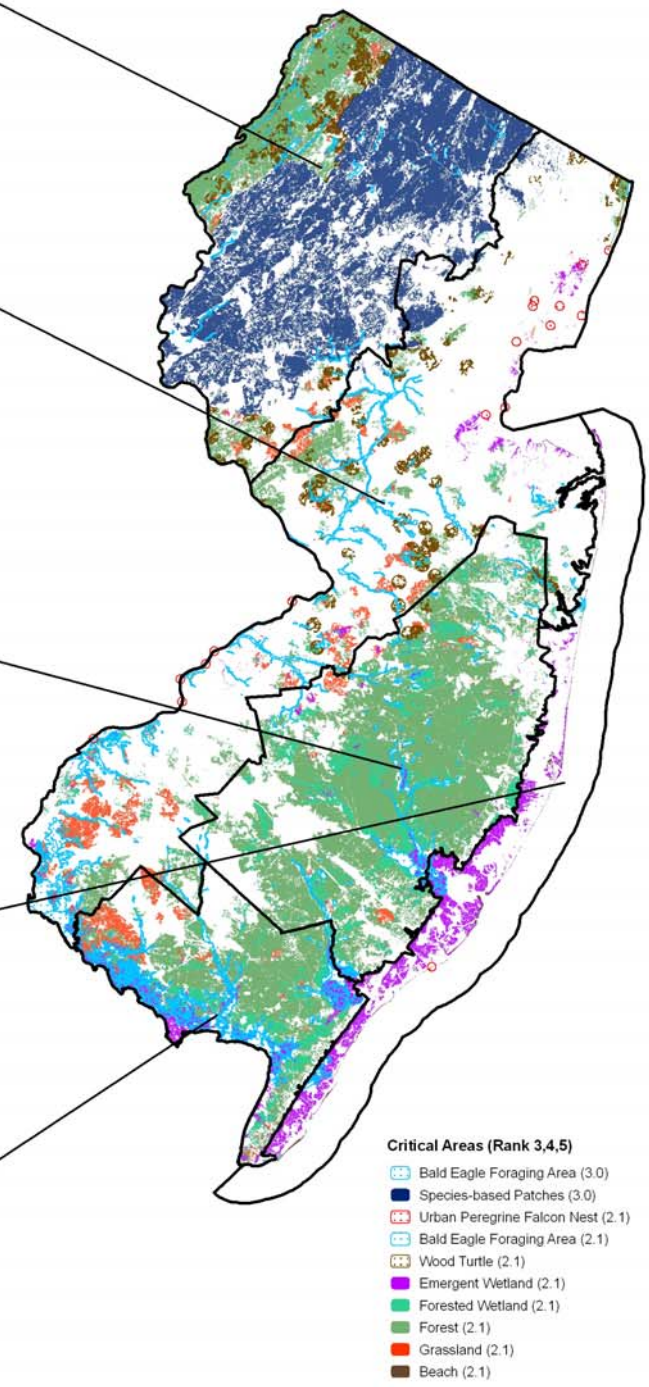
Bald Eagle Foraging Area (2.1)	9929	(2%)
Wood Turtle (2.1)	841	(<1%)
Emergent Wetland (2.1)	5099	(1%)
Forested Wetland (2.1)	52743	(11%)
Forest (2.1)	227509	(48%)
Grassland (2.1)	5385	(1%)
Beach (2.1)	9	(<1%)

Coastal/Atlantic Region

Urban Peregrine Falcon Nest (2.1)	314	(<1%)
Bald Eagle Foraging Area (2.1)	2810	(2%)
Emergent Wetland (2.1)	35473	(31%)
Forested Wetland (2.1)	528	(<1%)
Forest (2.1)	315	(<1%)
Grassland (2.1)	8	(<1%)
Beach (2.1)	2106	(2%)

Delaware Bay Region

Bald Eagle Foraging Area (2.1)	16087	(8%)
Emergent Wetland (2.1)	25705	(13%)
Forested Wetland (2.1)	21538	(11%)
Forest (2.1)	64510	(32%)
Grassland (2.1)	11791	(6%)
Beach (2.1)	98	(<1%)



*Where overlap occurred among layers, hectares and percentages were calculated only for areas with the highest rank.

***Figure 7**. Total hectares of critical area by habitat type within each Landscape Region.*

protocol:

- Extract all appropriate forested wetland types from the NJDEP's LU/LC data set into one forested wetland layer (***Appendix IV***).
- Combine all of the NJDEP LU/LC forested wetland types that are directly adjacent to one another by dissolving the boundaries between them making a layer of contiguous forested wetland polygons.
- Bisect the resulting forested wetland coverage with major roads (500 level and above) to create ecologically significant boundaries between contiguous forested wetland patches.
- Assign each new patch a unique Link ID used for tracking patches.
- All forested wetland patches are considered critical areas regardless of size. Therefore, all forested wetland patches receive a minimum rank of 1.
- Intersect forested wetland species models with the new forested wetland layer. This intersection results in a new layer with the Link ID from the forested wetland layer and an ID from the species models. From this layer queries can be made to determine the number of records and conservation status of each patch based on the species present.
- Habitat patches are classified based on the conservation status of the species present as detailed in the "General Methodology for Delineating Critical Areas," section.

Emergent wetland: Critical area maps for emergent wetland dependent species are generated by selecting specific land-use classes from the NJDEP's LU/LC data set. See ***Appendix IV*** for a list of DEP land-use classes and the corresponding habitat types. Using GIS software, the ENSP has developed the following protocol:

- Extract all appropriate emergent wetland types from the NJDEP's LU/LC land-use/land-cover data set into one emergent wetland layer (***Appendix IV***).
- Combine all of the NJDEP LU/LC emergent wetland types that are directly adjacent to one another by dissolving the boundaries between them making a layer of contiguous emergent wetland polygons.
- Bisect the resulting emergent wetland coverage with major roads (500 level and above) to create ecologically significant boundaries between contiguous emergent wetland patches.
- Assign each new patch a unique Link ID used for tracking patches.
- All emergent wetland patches are considered critical areas regardless of size. Therefore, all emergent wetland patches receive a minimum rank of 1.
- Intersect emergent species models with the new emergent wetland layer. This intersection results in a new layer with the Link ID from the emergent wetland layer and an ID from the species models. From this layer queries can be made to determine the number of records and conservation status of each patch based on the species present.
- Habitat patches are classified based on the conservation status of the species present as detailed in the "General Methodology for Delineating Critical Areas," section.

Grassland: Critical area maps for grassland dependent species are generated by selecting specific land-use classes from the NJDEP's LU/LC data set. See ***Appendix IV*** for a list of DEP land-use classes and the corresponding habitat types. Using GIS software, the ENSP has developed the following protocol:

- Extract all appropriate grassland habitat types from the NJDEP's LU/LC data set into one grassland layer (***Appendix IV***).
- Combine all of the NJDEP LU/LC grassland types that are directly adjacent to one another by dissolving the boundaries between them making a layer of contiguous grassland polygons.
- Bisect the resulting grassland coverage with major roads (500 level and above) to create ecologically significant boundaries between contiguous grassland patches.
- Assign each new patch a unique Link ID used for tracking patches.

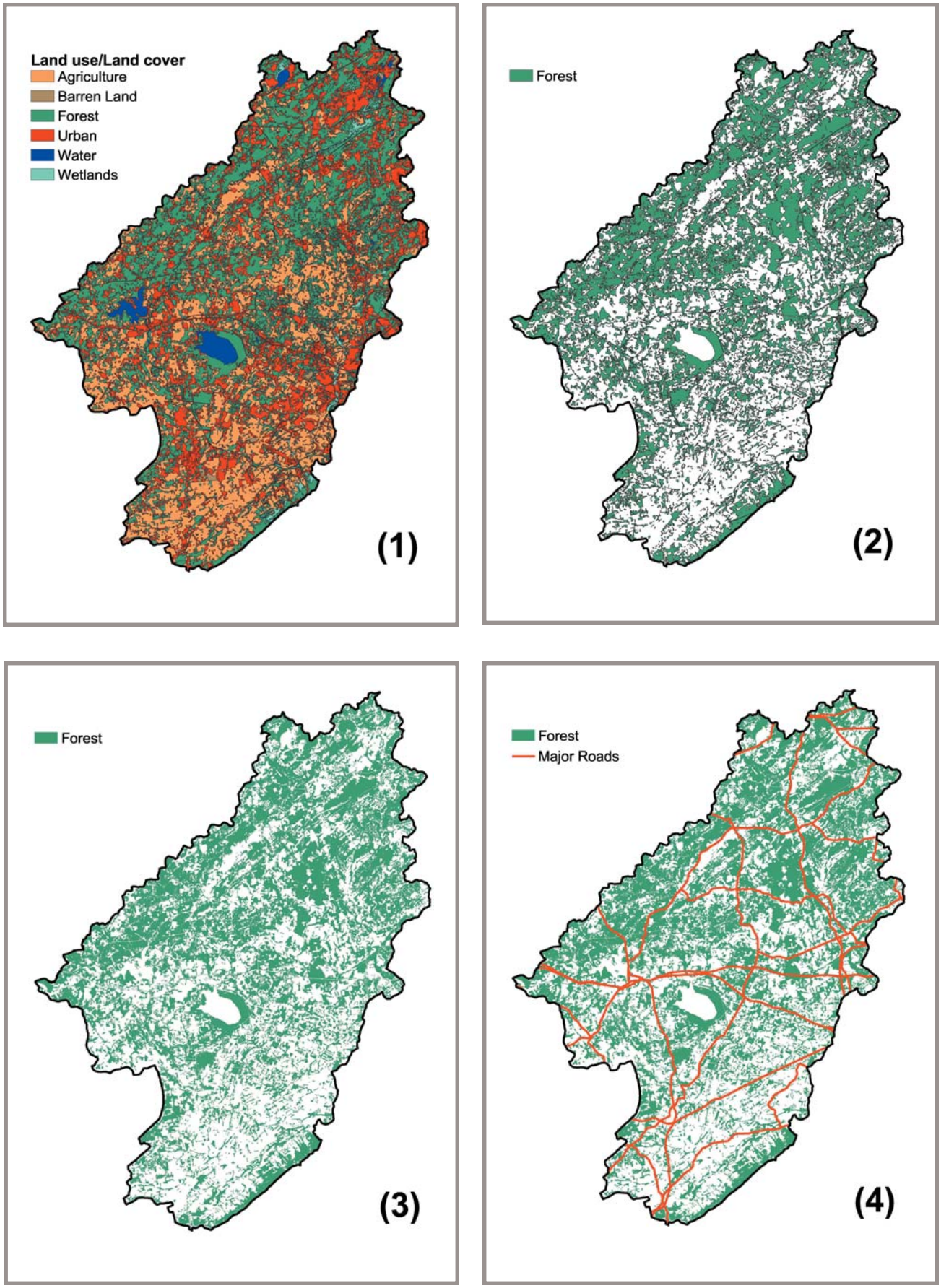


Figure 8. *A multistep process is used to delineate critical forest areas in North and South Branch Raritan Watershed Management Area. (1) NJDEP's 2002 land-use/land-cover types. (2) Extract all forest types from the land-use/land-cover data. (3) Contiguous patches are created by dissolving boundaries between adjacent forest polygons. (4) Bisect contiguous forest patches using major roads to create ecologically significant boundaries.*

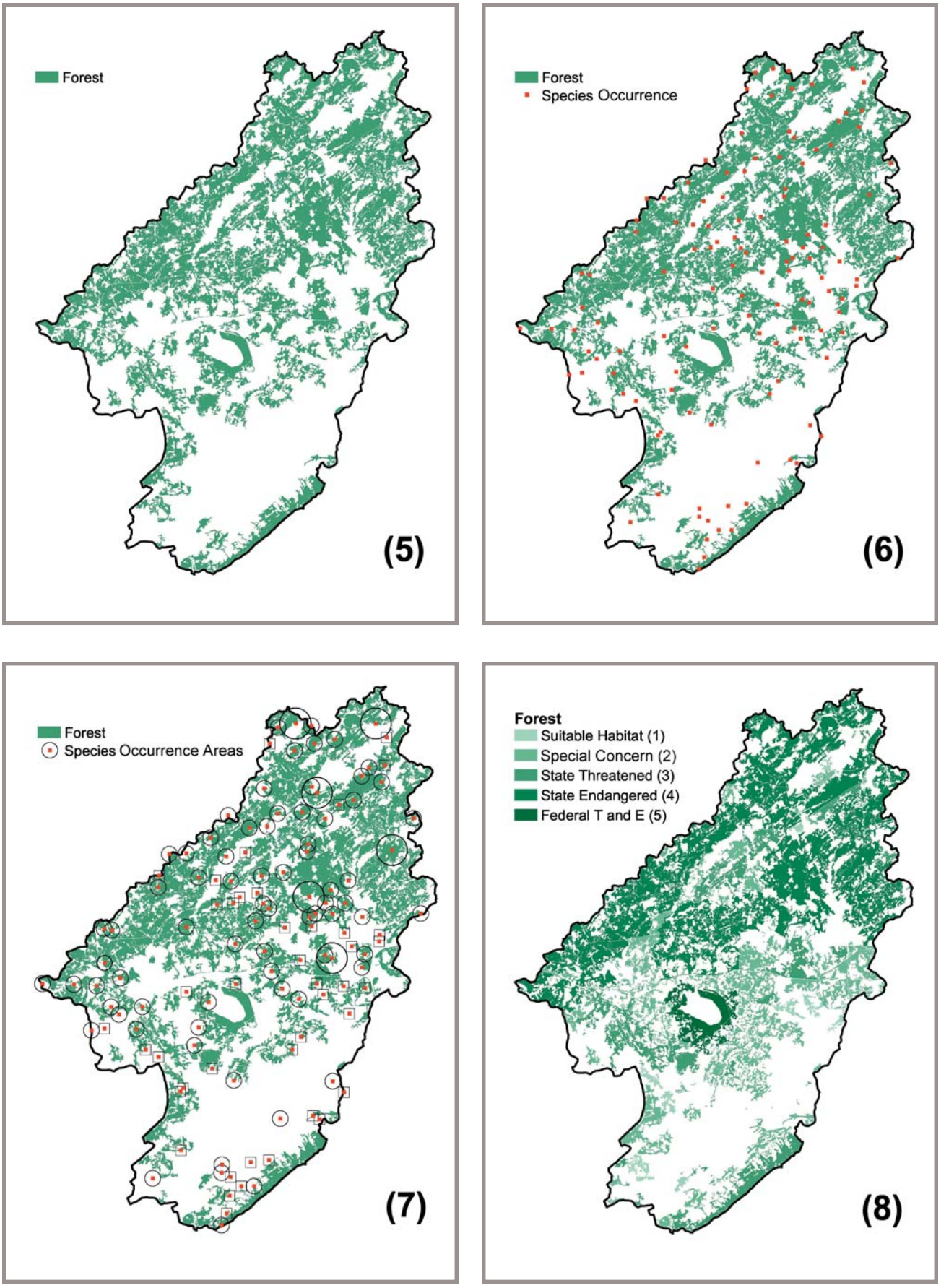


Figure 8 (Cont.). *(5) Select forest patches meeting the minimum core size. (6) Overlay species occurrences on the forest layer. (7) Intersect species occurrence areas with the forest patches. (8) Rank habitat patches based on the conservation status of species present.*

- Select all grassland patches greater than 18 hectares. These patches meet the minimun size requirement for grasslands and receive a minimum rank of 1.
- All grassland patches in the lower 10 kilometers of the Cape May peninsula are considered critical areas. This is due to the importance of this habitat to migrating birds. These patches receive a minimum rank of 1 regardless of whether or not they contain 18 hectares of core.
- Intersect grassland species models with the new grassland layer. This intersection results in a new layer with the Link ID from the grassland layer and an ID from the species models. From this layer queries can be made to determine the number of records and conservation status of each patch based on the species present.
- Habitat patches are classified based on the conservation status of the species present as detailed in the "General Methodology for Delineating Critical Areas," section.

Beach: Critical area maps for beach dependent species are generated by selecting specific land-use classes from the NJDEP's LU/LC data set. See ***Appendix IV*** for a list of DEP land-use classes and the corresponding habitat types. Using GIS software, the ENSP has developed the following protocol:

- Extract the beach habitat type from the NJDEP's LU/LC data set. Only one beach class exists in the data set (***Appendix IV***).
- Beach habitats are bisected by natural breaks such as inlets and rivers and by hand digitized boundaries around species locations.
- Assign each new patch a unique Link ID used for tracking patches.
- All beach patches are considered critical areas regardless of size. Therefore, all beach patches receive a minimum rank of 1.
- Intersect beach species models with the new beach layer. This intersection results in a new layer with the Link ID from the beach layer and an ID from the species models. From this layer queries can be made to determine the number of records and conservation status of each patch based on the species present.
- Habitat patches are classified based on the conservation status of the species present as detailed in the "General Methodology for Delineating Critical Areas," section.

Detailed Methodology for Delineating Critical Areas by Special Habitat Requirements

For some species, additional specific mapping protocols were developed and are set forth below.

Bald Eagle Foraging Area: The bald eagle foraging model is similar to the Version 2.0 model. The layer has been updated to use the NJDEP 2002 LU/LC. All known bald eagle nests are recorded using Global Positioning System (GPS) equipment. To run the model, all water polygons from the NJDEP LU/LC as well as water bodies from surrounding states (New York, Pennsylvania, Delaware) having an area equal to or greater than 8 hectares are converted to a 5-meter grid. ENSP decided to include surrounding states LU/LC data to better represent the eagles foraging resources, independent of state boundaries. A radius around the nest site is incrementally increased, one cell (5 meters) at a time, until an area of 660 hectares of open water has been identified. All emergent wetland patches (including NY, PA and DE LU/LC) within 90 meters of the identified water are selected. The emergent wetland patches are combined with the

identified open water. A 90-meter buffer is applied to the combined water/emergent wetland layer to protect perching sites. The following TYPE02 Urban LU/LC classes are then erased from the resulting layer within NJ:

1110	RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING
1120	RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY
1130	RESIDENTIAL, SINGLE UNIT, LOW DENSITY
1140	RESIDENTIAL, RURAL, SINGLE UNIT
1150	MIXED RESIDENTIAL
1200	COMMERCIAL/SERVICES
1211	MILITARY INSTALLATIONS
1300	INDUSTRIAL
1400	TRANSPORTATION/COMMUNICATION/UTILITIES
1411	LP MAJOR RDS
1440	AIRPORT FACILITIES
1462	UPLAND RIGHTS-OF-WAY DEVELOPED
1500	INDUSTRIAL/COMMERCIAL COMPLEXES
1600	MIXED URBAN OR BUILT-UP LAND
1700	OTHER URBAN OR BUILT-UP LAND
1800	RECREATIONAL LAND
1804	ATHLETIC FIELDS (SCHOOLS)
1810	STADIUM THEATERS CULTURAL CENTERS AND ZOOS

In Version 2.1 bald eagle foraging habitat, and its associated 90-meter buffer, is not used to value patches that intersect with it. The bald eagle foraging model remains a stand-alone GIS layer that does not value habitat patches.

LU/LC from surrounding states was utilized in the creation of the bald eagle foraging areas so that New Jersey waters and wetlands occurring at the state borders were not valued to the exclusion of suitable foraging habitats in adjacent states. The following LU/LC classes were extracted from the surrounding states' datasets:

2002 Delaware Land Use and Land Cover (http://stateplanning.delaware.gov/information/gis_data.shtml)

Waterways/Steams Canals
Natural Lakes and Ponds
Bays and Coves
Man-made Reservoirs and Impoundments
Wetlands

National Land Cover Database 2001, New York (http://landcover.usgs.gov/)

Open Water
Emergent Herbaceous Wetlands

Pennsylvania Land Cover, 2000 (http://www.pasda.psu.edu/)

Water
Emergent Wetland

In addition all Pennsylvania nests within 25 km of the New Jersey border that are associated with the Delaware River were obtained from the Pennsylvania Natural Heritage Program and were used in creating the bald eagle foraging area.

Peregrine Falcon: In Version 2.1, peregrine falcon nests are separated into two types, urban and non urban depending on the type of landscape in which they are located. For urban nests a 1-kilometer radius area around the nest is now valued as peregrine falcon habitat regardless of the land-cover type. Urban peregrine nests continue to value emergent wetland patches that intersect with the 1-kilometer radius area delineated around a peregrine falcon nest. Non-urban peregrine falcon nests continue to value only emergent wetland patches that intersect with the 1-kilometer radius area around the nest. The urban peregrine falcon model is a stand-alone GIS layer that values emergent wetland habitat patches.

Wood Turtle: Critical areas for wood turtles are mapped following a four-step process.

First, a 322-meter (0.2 miles) buffer is applied to all NJDEP streams within a 1.6 kilometer radius (one mile) of each wood turtle sighting location. The buffers are clipped so that all areas being designated as critical wood turtle habitat are within 1.6 kilometers of a wood turtle sighting. Second, the NJDEP LU/LC layer is overlaid on the buffered areas. All areas classified as urban, with the exception of undeveloped upland rights-of-way, are deleted from the buffered areas. Third, all areas classified as wetlands in the NJDEP LU/LC layer with the exception of cemetery on wetlands, and saline marshes, are overlaid on the stream buffers. All wetlands that are contiguous with the buffered areas are selected and clipped to only include wetlands within 1.6 kilometers of a sighting. Those wetlands are then merged into the stream buffers. Finally, a staff turtle biologist conducts a detailed inspection and revision of each resultant polygon to ensure biological accuracy. The wood turtle model is a stand-alone layer that is not used to value habitat patches.

Technical Information

Critical area maps are available in ArcView Shapefile and File Geodatabase formats and projected to New Jersey State Plane feet, datum NAD 83, zone 4701. The maps are best viewed using ArcGIS 9.x. These software products allow the user full functionality for viewing and manipulating Landscape Project data. Non-GIS users can view the maps using ArcGIS Explorer, a free GIS data browser that can be downloaded from the ESRI Web site:

- http://www.esri.com/software/arcgis/explorer/index.html

Landscape Project data and maps are available by the following methods:

GIS Data

- Dowload on NJDEP's Bureau of GIS website (http://www.nj.gov/dep/gis/).
- On CD by request to ENSP, at the address below.

Maps

- An available GIS layer on NJDEP's interactive mapping application site (http://www.nj.gov/dep/gis/).
- An available interactive map book on DFW's ENSP website (http://www.nj.gov/dep/fgw/ensp/mapbook.htm).
- An interactive map book on CD by request to ENSP, at the address below.

Upon request to:

New Jersey's Landscape Project
Department of Environmental Protection
Division of Fish and Wildlife
Endangered and Nongame Species Program
PO Box 400
Trenton, NJ 08625-0400
Phone:(609) 292-9400
Fax:(609) 984-1414

Appendices.

Appendix I. Protocol for Accepting or Rejecting Species Sighting Reports

1. When a sighting report arrives at the ENSP office it is logged in and tracked in a database, regardless of acceptability.

2. If no additional information is needed, the sighting report is sent to the appropriate ENSP biologist for review.

3. If additional information is needed, an attempt is made to obtain the required information. This can include sending a map to the observer to mark the location of the sighting, a telephone interview to clarify information, etc. After all of the required information is obtained the report is sent to the appropriate ENSP biologist for review.

4. ENSP biologist receives the sighting report and reviews it for acceptability/reliability. A species sighting is accepted or rejected based on the following criteria:

- Did the sighting occur within the known range of the species?
- Did the sighting occur in the known/recognized habitat for the species?
- Is the species easily identified, or is it often confused with another?
- Did anyone else confirm the sighting, or can someone else vouch for the observer's identification skills?
- Do we have first-hand knowledge of the observer's identification skills?
- Did the observer include a photograph?
- Is the species listed as endangered, threatened or special concern for the season in which it was reported? (Some species can have a separate status for breeding season and non breeding season).
- If uncertainty remains about the validity of the sighting, the observer is interviewed by the ENSP biologist.

  a. If sufficient information accompanies the sighting report the record is either accepted or rejected by an ENSP biologist.
  b. If accepted, the reviewing biologist assigns the sighting a feature label and determines whether the sighting should be used in the Landscape Project. For some species,only occurrences assigned specific feature labels are included in the Landscape Project. For example, for many of the raptors a sighting of a migrating bird may be considered valid, but not for inclusion in the Landscape Project. The report is then returned to ENSP's GIS staff and advances to step 5 if accepted.
  c. The reviewing biologist may determine that it is necessary to gather additional information (e.g., ascertain observer experience, ask if there have been additional sightings, ask for photos, ask for verifications by second observer, etc.) before the record can be accepted. If the record is accepted, advance to step 5.
  d. If the reviewing biologist determines that the sighting must be field checked, it is initially rejected until fieldwork can be scheduled to verify the sighting.

5. ENSP GIS staff digitizes the sighting location and prepares the data in a standardized format to enter into the Biotics database.

6. ENSP staff perform a quality check of the documentation, mapping and data entry before the record is complete and filed.

Appendix II. Additional Methods for Extracting Critical Wildlife Areas from Urban Land-use/Land-cover Classes

LU/LC class 1463

1463 Upland Rights-of-Way, Undeveloped
Included in this category are Rights-of-Way in uplands that usually exist in undeveloped non-urban areas. They typically support shrubby forms of the surrounding vegetation, which may be periodically cut or mowed back. Because of alterations associated with creating the rights-of-way, these areas may support the natural vegetation found in adjacent unaltered natural areas. It should also include areas adjacent to agricultural areas but not visibly used in connection with any agricultural or urban land use. Textures will generally be smooth to slightly rough depending on whether the dominant vegetation is low herbaceous species or taller shrubs.

- Select the polygons from the "1463 Upland Rights-of-Way, Undeveloped", as coded in the NJDEP Land Use/ Land Cover, that have less than or equal to 5% impervious surface.
- From this subset intersect the grassland species models. Where there is overlap, recode these polygons as "Grassland." All other polygons from the subset will be recoded as "Forest."
- Merge the recoded polygons into the existing "Grassland" and "Forest" layers respectively.
- Dissolve the resultant "Grassland" and "Forest" layers.
- Assign a unique Link ID to each of the independent "Grassland" and "Forest" polygons (patches).

LU/LC class 1700

1700 OTHER URBAN OR BUILT-UP
Included are undeveloped, open lands within, adjacent to or associated with urban areas. Some structures may be visible, as in the case of abandoned residential or commercial sites that have not yet been redeveloped. The land cover in these areas may be brush-covered or grassy. Large, managed, maintained lawns common to some residential areas, and those open areas of commercial/ service complexes, educational installations, etc., are also included. Undeveloped, but maintained lawns in urban parks are also part of this category, if a specific recreational use is not evident. In addition, areas that have been partially developed or redeveloped but remain unfinished are included. Cemeteries were included in this category in 1986 & 1995, but were separated out for 2002.

- Select the polygons from the "1700 OTHER URBAN OR BUILT UP LANDS," as coded in the NJDEP Land Use/ Land Cover, that have less than or equal to10% impervious surface.
- From this subset, select the polygons within 0.8 kilometers of an airport (1440 Airport Facilities), as coded in the NJDEP Land Use/Land Cover.
- Create a new grassland/airport shapefile using the selected polygons.
- From grassland/airport shapefile, recode all of the polygons in the lower 10 kilometers of Cape May as "Grassland."
- For all areas outside of the lower 10 kilometers, select the polygons that meet the minimum size requirement for grasslands (18 hectares). Add to that selected set, the polygons that intersect a grassland species model.
- Recode the selected polygons as "Grassland."
- Merge all of the recoded polygons into the existing "Grassland" layer.
- Dissolve the resultant "Grassland" layer.
- Assign a unique Link ID to each of the independent "Grassland" polygons (patches).

LU/LC class 1700 & 1211 within McGuire Air Force Base and Naval Air Engineering Station Lakehurst

1700 OTHER URBAN OR BUILT-UP
Included are undeveloped, open lands within, adjacent to or associated with urban areas. Some structures may be visible, as in the case of abandoned residential or commercial sites that have not yet been redeveloped. The land cover in these areas may be brush-covered or grassy. Large, managed, maintained lawns common to some residential areas, and those open areas of commercial/service complexes, educational installations, etc., are also included. Undeveloped, but maintained lawns in urban parks are also part of this category, if a specific recreational use is not evident. In addition, areas that have been partially developed or redeveloped but remain unfinished are included. Cemeteries were included in this category in 1986 & 1995, but were separated out for 2002.

1211 MILITARY INSTALLATIONS
Military bases and camps, armories, ordinance depots, missile sites, National Guard and Reserve armories are included in this category. Boundaries of major military installations are identified by fence lines and roads along their perimeter. Military facilities have a wide variety of conditions including training camps, missile sites, etc. Auxiliary land uses, particularly residential, commercial and other supporting uses located on a military base should be included in this category.

- Within these 2 military installations, the two classes 1700 and 1211of LULC , as coded in the NJDEP Land Use/ Land Cover were evaluated as potential habitat using known occurrences of grassland species
- If a polygon was determined to be potential habitat, that polygon was recoded as “Grassland”
- Merge all of the recoded polygons into the existing “Grassland” layer.
- Dissolve the resultant “Grassland” layer.
- Assign a unique Link ID to each of the independent “Grassland” polygons (patches).

MAMMALS:

Allegheny Woodrat

Feature Label	Occurrence Area
Occupied Habitat	150 meter radius

Occurrence Area Rule: Points and polygons receive the specified occurrence area radius.

Justification:

The preferred habitat of the Allegheny woodrat in NJ is rocky areas within deciduous forests. Woodrats make their dens, or middens, within the crevices and spaces between boulders at the base of cliffs or in rock outcrops. They forage in vegetated areas adjacent to their dens. The Indiana DNR (2007) states that Allegheny woodrats rarely travel more than 100 meters from their den sites. The PA Game Commission (2006) recommends that a 150 meter primary buffer be protected from the edge of the surface rock zone where the dens are located. The most comprehensive research to determine home range for Allegheny woodrats was conducted by Castleberry (2000) in the central Appalachians. Thirty-four woodrats were tracked using radio telemetry and the mean topographic home range was 4.4 ha. The maximum distance traveled from the den while foraging averaged 151 m.

Literature supporting occurrence area(s):

Castleberry, S.B. 2000. Conservation and management of the Allegheny woodrat in the central Appalachians, Dissertation, West Virginia University, [On-line Abstract]. Available:https://kitkat.wvu.edu/etd/documentdata.eTD?documentid=1503

Thirty-four woodrats were radio tracked during 1998-99 and the mean home range was 4.4 ha.

Indiana Department of Natural Resources. 2007. The Allegheny woodrat (On-line). Accessed April 4, 2007 at: http://www.in.gov/dnr/fishwild/publications/lifeseries/wdrat.htm

States that Allegheny woodrats rarely travel farther than 100 meters from their dens.

Butchkoski, C. 2006. Allegheny woodrat research/management. Annual Job Report. Project Code No. 06718, Job Code No. 71801. 27 pp.

Recommends a 150 meter primary buffer extending our from the edge of the surface rock zone.

Last researched by Mick Valent in spring 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Bobcat

Feature Label	Occurrence Area
Sighting	2.82 km radius
Den	2.82 km radius
Dead on road	2.82 km radius
Capture location	2.82 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

Bobcat home range sizes are highly variable, both geographically and intrasexually in the same geographic area particularly if suitable habitat components have a patchy distribution (Lovallo 1999). The home range size of males is generally larger than that of females. In New Jersey, the annual home range of a male in 2002 was 121 km^2 with a core of 19 km2 and the home range of a female in 2003 was 90 km2 with a core of 11.7 km^2, as estimated by kernel home range method. We apply a 25 km^2 buffer (2.82 km radius) around bobcat sightings, which is larger than the core area we estimated for a male and female bobcat in the state, and midway between the male and female home range sizes Lovallo (2000) estimated in north central Pennsylvania. It is a conservative estimate based on sizes reported for bobcats in the northeastern United States (Lovallo 2000).

Literature supporting occurrence area(s):

Conner, M., B. Plowman, B.D. Leopold, C. Lovell. 1999. Influence of time-in-residence on home range and habitat use of bobcats. Journal of Wildlife Management 63(1):261-269.

In east central Mississippi the male home range was 15.34 $\pm$ 2.12 km^2 and 15.67 $\pm$ 2.61 km^2 in consecutive years. The female annual home range was 7.81 $\pm$ .91 km^2 and 6.40 $\pm$ .57 km^2 in consecutive years.

Litvaitis, J.A., J.A. Sherburne, J.A. Bissonette. 1986. Bobcat habitat use and home range size in relation to prey density. Journal of Wildlife Management 50(1):110-117.

In Maine the average home range size of males was 95.7 km^2 and that of females was 31.2 km^2.

Lovallo, M.J., E.M. Anderson. 1996. Bobcat (Lynx rufus) home range size and habitat use in northwest Wisconsin. American Midland Naturalist 135(2): 241-252.

In northwestern Wisconsin the annual male home ranges were 60.4 km^2 $\pm$ 23.4 km^2 and the female home ranges were 28.5 km^2 $\pm$ 3.7 km^2.

Lovallo, J.M. 1999. Multivariate models of bobcat habitat selection for Pennsylvania Landscape. Ph.D. dissertation. The Pennsylvania State University, University Park. 146pp.

Attributes the highly variable home range estimates of both males and females to the patchy distribution of suitable habitat components.

Lovallo, M.J. 2000. Bobcat home range size and intraspecific social relationships. Pennsylvania Game Commission Bureau of Wildlife Management Research

Division Project Annual Job Report: Bobcat Research/Management 06630.

Median female home range was 16 km^2 (MCP) and median male home range was 42 km^2 (MCP). Lovallo (2000) also summarizes other home range sizes in the northeastern U.S. as being 36-326 km^2 for males in New York State, 71-112 km^2 for males in Massachusetts, and 28-33 km^2 for females in Maine.

Last researched by Gretchen Fowles in fall 2005.
Occurrence area applied in Version 2.1 of the Landscape Project.

Eastern Small-footed Myotis

Feature Label	Species Occurrence Area
Breeding Maternity Roost	2 km radius buffer
Breeding Capture Location	2 km radius buffer
Breeding Foraging Area	Hand-digitized polygon
Nonbreeding Hibernaculum	4 km radius buffer
Nonbreeding Roosting Area	2 km radius buffer
Nonbreeding Capture Location	2 km radius buffer
Nonbreeding Foraging Area	Hand-digitized polygon

Occurrence Area Rule: "Hibernaculum" is mapped as a point, line, or polygon, which then receives the specified radius. "Foraging Area" features are mapped as polygons which represent the Species Occurrence Areas. All other feature labels are mapped as points, which then receive the radii specified above.

Justification text:

There is a lack of knowledge regarding size of Myotis leibii home ranges and foraging areas. It is currently accepted in the scientific community that habitat requirements of Myotis leibii parallel those of other Myotis species. Therefore, the landscape models determined for Myotis sodalis are being applied to Myotis leibii until further research warrants changes.

Literature supporting occurrence area(s):

To be reviewed.

Last researched by Melissa Craddock in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Indiana Bat

Feature Label	Species Occurrence Area
Breeding Maternity Roost	2km radius buffer
Breeding Capture Location	2 km radius buffer
Breeding Foraging Area	Hand-digitized polygon
Nonbreeding Capture Location	2 km radius buffer
Nonbreeding Foraging Area	Hand-digitized polygon
Nonbreeding Roosting Area	2 km radius buffer
Nonbreeding Hibernaculum	4 km radius buffer
Travel corridor	Hand-digitized polygon

Occurrence Area Rule: "Hibernaculum" is mapped as a point, line, or polygon, which then receives the specified radius. "Foraging Area" and "Travel Corridor" are mapped as polygons which represent the Species Occurrence Area. All other feature labels are mapped as points, which then receive the radii specified above.

Justification text:

Fall roosting and foraging distance from hibernacula ranged from 2.4km-6.8km with an average distance of 4.33km. A 4km radius buffer was therefore selected to protect foraging and roosting habitat surrounding hibernacula. Summer roosting and foraging distances ranged from 0.679km – 5km to create an average radius buffer of 2km.

Literature supporting species occurrence area(s):

Callahan, E.V., R.D. Drobney, and R.L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (Myotis sodalist) in Missouri. J. Mamm. 78:818-825.

The furthest distance documented between roosts occupied by bats within a single maternity colony was 5km.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991a. Summer roost selection and roosting behavior of Myotis sodalist (Indiana bat) in Illinois. Unpublished report, Illinois Natural History Survey, Champaign, Illinois.

Radiotelemetry showed that during the maternity period, home range of Indiana bats is generally no larger than 2km in breadth.

Gardner, J.E., J.D. Garner, and J.E. Hofmmann. 1991b. Summary of Myotis sodalis summer habitat studies in Illinois: with recommendations for impact assessment. Special Report. Illinois Natural History Survey, Illinois Dept. of Conservation. Champaign, Illinois. 28 pp.

Stream, associated with floodplain forests, and impounded bodies of water are preferred foraging habitats for pregnant and lactating Indiana bats, some of which may fly up to 2.5 km from upland roosts. Mean distance moved by reproductively active females between foraging and roosting habitat was 1.04km. Maximum distance moved by reproductively active females between foraging and roosting habitat was 2.40km.

Kiser, J.D. and C.L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (Myotis sodalist) during autumn in Johnson County, Kentucky. Final report, Kentucky Dept. of Fish and Wildl. Resources, Frankfort, Kentucky. 65 pp.

In Kentucky, Kiser and Elliott found male Indiana bats roosting primarily in dead trees on upper slopes and ridgetops within 2.4km of their hibernaculum. In the fall, male Indiana bats tend to roost and forage in upland and ridgetop forests, but may also forage in valley and riparian forest; movements of 2.5-6.8km have been reported in Kentucky and Missouri.

Menzel, J.M., W.M. Ford, M.A. Menzel, T.C. Carter, J.E. Gardner, J.D. Garner, J.E. Hofmann. 2005. Summer habitat use and home-range analysis of the endangered Indiana bat. Journal of Wildlife Management 69(1):430-436.

Home ranges were determined from radio telemetry of 7 female and 4 male Indiana bats in Illinois. No significant differences were found in home-range size between male and female bats or between study years. The mean home-range size for the Indiana bats tracked was 144.7ha, which calculates to a radius of 0.679km.

Stihler, C. West Virginia Division of Natural Resources, pers observ. October 1996. Reference excerpted from USFWS Indiana Bat Revised Recovery Plan, March 1999.

During September in West Virginia, male Indiana bats roosted within 5.6km [of hibernacula] in trees near ridgetops, and often switched roost trees from day to day.

Last researched by Melissa Craddock in June 2006.
Model applied in Version 2.1 of the Landscape Project.

BIRDS:

American Bittern

Feature Label	Occurrence Area
Confirmed/Known Breeding Location	Mapped extent of occurrence or 500 meter radius around confirmed/known breeding location point.
Suspected Breeding Location	500 meter radius around suspected breeding point location.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

A study in Minnesota determined that the average home range of males and females differed considerably. Males averaged 415 ha while females averaged 337 ha (Brininger 1996). A second study, also conducted in Minnesota, found a significantly smaller average home range (males only) of 127 ha (n=20). However, the average core area (where the bittern was found more than 50% of the time) was only 25 ha (Azure 1998). These two studies led NatureServe to apply a minimum inferred extent of 0.5 km (NatureServe 2006). ENSP will use the NatureServe minimum inferred

extent of 0.5 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Azure. 1998. Aspects of American bittern ecology in northwestern Minnesota. MS thesis. University if North Dakota, Grand Forks, North Dakota. 139 pgs.
In a Minnesota study where n=20, the average home range of males was 127 ha. The average size of the core use area (defined as the area of the home range where the bittern was located >50% of the time) was 25 ha.

Brininger. 1996. The ecology of the American bittern in northwest Minnesota. MS thesis/ St. Cloud State University, St. Cloud, MN, USA.
In Minnesota, the average home range of males was 415 ha. The average female home range was 337 ha.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
The inferred minimum extent of habitat use (when actual extent is unknown) is 0.5 km. This is based on an average core home range of 25 ha (Azure 1998). Include only the nesting marsh within the boundaries of the inferred extent polygon.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

American Kestrel

Feature Label	Occurrence Area
Foraging (Breeding & Non-breeding)	100 meter radius
Nest	100 meter radius
Sighting (Breeding & Non-breeding)	100 meter radius

Occurrence Area Rule: Observations for all both feature labels are mapped as points, which then receive the radii specified above.

Justification:
This species has small breeding territories but are area sensitive. The buffer was chosen based on breeding territory size and increased for the species' mobility and need for large patches. Until more is discovered about the mobility of the species, a 100 meter radius buffer will be used.

Literature supporting occurrence area(s):

Smallwood, J. A., and D. M. Bird. 2002. American Kestrel (*Falco sparverius*). *In* The Birds of North America, No. 602 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA

Tend to occupy areas > 25 ha in size. Little information is available on breeding territory size, but estimates from breeding densities indicate territories may range from 0.5 – 1 ha.

Migratory stopover habitat consists of open patches. Wintering habitat is similar to breeding habitat but with more woody vegetation. Winter territories range from 1.4 – 3.5 km.

Last researched by Sharon Petzinger in winter 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

American Oystercatcher

Feature Label	Occurrence Area
Nest	750 meter radius
Nesting Area	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).
Nesting Territory	750 meter radius
Foraging Area	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).
Brood-rearing Area	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).
Wintering Concentration	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

There is very little information available for home ranges and foraging commutes of American oystercatchers. Nol and Humphrey (1994) report that feeding areas may be further than 1600 m from nesting areas. Tom Virzi of Rutgers University (personal communication, 12 June 2007) reports that he has observed foraging adults up to 1 km, and rarely up to 2 km, from their nesting sites. Natureserve recommends a buffer of 1.5 km when actual extent is unknown (NatureServe 2007). ENSP will use the NatureServe minimum inferred extent of 1.5 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).
The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 1.5 km.

Nol, E. and R. C. Humphrey. 1994. American Oystercatcher (Haematopus palliatus). In The Birds of North America, No. 82 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
Feeding territories may be in excess of 1,600 m from breeding territories. Maximum distance observed traveling during breeding season in Massachusetts about 3 km.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Bald Eagle

Feature Label	Occurrence Area
Nest	1.0 km radius
Foraging	Bald Eagle Foraging Model
Wintering	Hand-digitized polygon plus 500 meters radius

Occurrence Area Rule: Only points receive the specified radius for the "Nest" feature label. The "Wintering" feature label is mapped as a polygon which is the occurrence area. The "Foraging" feature label is mapped outside of Biotics as a stand-alone model, which represents the occurrence area for that feature label.

Justification:
All habitats (forest, field, wetlands) within 1 km of a nest are designated as critical habitat for bald eagles. Home range size for nesting bald eagles is variable depending on the habitat resources of the area such as food abundance, distance to adequate foraging habitat, etc (Stalmaster 1987, Therres, et al. 1993, Buehler 2000, Harmata and Montopoli 2001). Successful and continued occupancy of a nest site by eagles is also influenced by distance to human disturbance often associated with residential housing, roads, extractive industries (mining, timber) and others. The 1 km radius for nest site habitat protection equals approximately 3 km^2 of area. This is one-third larger than what may be the mean territory size (summarized in Buehler 2000), though local data are lacking.

Bald eagle foraging habitat is defined as the amount of habitat required to support a nesting pair of eagles throughout the year, as breeding bald eagles are year-round residents in NJ. Bald eagles hunt in open water for fish, waterfowl and other aquatic species, but usually do so from perches along the water's edge (Stalmaster 1987). The model calculates open water area by increasing the radius around each nest incrementally one cell (30 m) at a time until an area of 660 ha of foraging habitat has been identified. Foraging habitat is defined as all open water bodies greater than 8 ha. A 90 m buffer is applied to the identified waters to protect perching sites. All suitable

habitat patches (i.e., forest and forested wetlands) that intersect with the foraging habitat and 90 m buffer are designated as critical for eagles.

Wintering sites were identified using specific Eagle Midwinter Survey data and biologist interpretation of essential habitat, as well as recorded sightings of eagles during the winter period of November 1-January 31. Patches of suitable habitat (forest, forested wetlands, and open waters) within 500 meters of each site are designated as critical habitat. This habitat designation was not applied in Landscape Version 1 or 2, but will be included in Landscape Version 3. The Wintering feature label was not used in Highlands's release of version 3.0.

From Birds of North America (Buehler 2000): Estimates of territory size (defended part of home range) vary widely based on nesting density, food supply, and method of measurement. Most reliable estimates based on radio-telemetry are limited. Stalmaster (1987) suggested 1–2 km^2 as typical territory size. Average territory radius (*n* = 10) was 590 m in Minnesota, as measured by presentation of decoy bird to elicit defensive reactions (Mahaffy and Frenzel 1987). Assuming circular territories, average territory size was about 1 km^2. Minimum territory size was 4 km^2 for radio-tagged pair in Saskatchewan (Gerrard et al. 1992b). Spacing: About 1 nest/1.6 km of shoreline reported historically on Chesapeake Bay (Kirkwood 1895).

Literature supporting occurrence area(s):

Stalmaster, M. V. 1987. The Bald Eagle. Universe Books, New York. 227 p.

Buehler, D. A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). In The Birds of North America, No. 506 (A. Poole and F. Gill, eds.). The Birds of North America Inc., Philadelphia, PA.

Home range sizes are variable (in Florida, 2–8 km^2, larger in other areas, as small as 1 km^2 in some). Minimum territory size in Saskatchewan was 4 km^2 (Gerrard et al. 1992, in Buehler 2000). Wintering habitat is defined by food availability, presence of roost sites that provide protection from weather and absence of human disturbance (Buehler 2000).

Harmata, A. R., and G. J. Montopoli. 2001. Analysis of bald eagle spatial use of linear habitat. J. Raptor Res. 35(2):207-213.

Primary foraging areas may need protection to maintain performance of eagles nesting along rivers.

Therres, G. D., M. A. Byrd, D. S. Bradshaw. 1993. Transactions of the North American Wildlife and Natural Resources Conference, 58:62-69.

The effects of development activities on nesting bald eagles depend on the distance of the activities from the nest, the view the eagles have of the activities and the time of year the development occurs. Other factors that may contribute include the nesting history of the eagles, the birds' previous experience with humans, the availability of alternative nest sites and the amount of development in the area.

Buehler, D. A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). *In* The Birds of North America, No. 506 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Last researched by Kathy Clark in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Barn Owl

Feature Label	Occurrence Area
Nest	100 meter radius
Sighting (Breeding & Non-breeding)	100 meter radius

Occurrence Area Rule: Observations for all feature labels are mapped as points, which then receive the radii specified above.

Justification:

This species has small breeding territories but are area sensitive. The buffer was chosen based on breeding territory size and increased for the species' mobility and need for large patches. Until more is discovered about the mobility of the species, a 100 meter radius buffer will be used.

Literature supporting occurrence area(s):

Marti, C.D., A.F. Poole, and L.R. Bevier. 2005. Barn Owl (*Tyto alba*). *In* The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Barn_Owl/.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Barred Owl

Feature Label	Occurrence Area
Nest	1.0 km radius
Sighting	1.0 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

Barred owl home ranges are highly variable geographically and are generally larger during the non-breeding season (Mazur and James 2000). Home range results identified within the literature (below) illustrate this variability. As year-round residents to NJ, the barred owls are protected during both the breeding and non-breeding seasons. As such, Elody and Sloan's, 1985, estimate of home range during the non-breeding season (282 ha) was incorporated into the ENSP's determination of an appropriate occurrence area depicting critical habitat. Using the home ranges 228.6 ha, 507.8 ha, and 282 ha (Nichols and Warner 1972, Fuller 1979, and Elody and Sloan 1985, respectively), the mean home range is 339.47 ha, equivalent to 1.04 km radius. Landscape species occurrence areas are not represented by proportional figures, therefore the ENSP has accepted a conservative estimate by rounding this range territory to a 1 km radius (314 ha).

Literature supporting occurrence area(s):

Nichols, T.H. and D.W. Warner. 1972. Barred owl habitat use as determined by radiotelemetry. J. Wildlife Manage. 36(2):213-224.

- Average home range was 228.6 ha, with a range of 86.1-369.0 ha.

Fuller, M.R. 1979. Spatiotemporal ecology of four sympatric raptor species. Ph.D. Dissertation. University of Minnesota, St. Paul. 396 pp.

- Average cumulative home range, based on minimum area, was 507.8 ha.

Elody, B.J. and N.F. Sloan. 1985. Movements and habitat use of barred owls in the Huron Mountains of Marquette County, Michigan, as determined by radiotelemetry. Jack-pine Warbler 63(1):3-8.

- Average home range size was 282 ha which decreased to 118 ha during the breeding season.

Mazur, K. M., and P. C. James. 2000. Barred Owl (*Strix varia*). *In* The Birds of North America, No. 508 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Note: We used 314 ha = 1 km radius

Mean: 228.6, 507.8, and 282 = 339.47 ha = 1.04 km radius

Last researched by Melissa Craddock & Kris Schantz in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Black-billed Cuckoo

Feature Label	Occurrence Area
Breeding	71.25 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

There is little information about territories of breeding and migrating individuals so the default occurrence area was chosen for both breeding and non-breeding buffers.

Literature supporting occurrence area(s):

Hughes, J. M. 2001. Black-billed Cuckoo (*Coccyzus erythropthalmus*). *In* The Birds of North America, No. 587 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Breeding habitat includes groves of trees, forest edges, and thickets; frequently associated with water. In e. Canada and ne. U.S., usually found in edges and clearings of young deciduous and

spruces are available. Can nest on islands in New York lakes comparable in size to Maine islands, but characterized by coniferous vegetation averaging 4 m higher than in Maine. In Saskatchewan, common in white spruce forests, but absent in black spruce and jack pine. In Ontario, mostly in moist to dry hemlock forests, but also other types of conifer-dominated woodlands (white pine, cedar, spruce), and some hardwoods, especially those historically dominated by American chestnut; in southern regions of the province, has adapted to mature conifer plantations. In Quebec, most common in mixed forest with mature balsam fir stands; nesting and feeding individuals seek tall balsam spires, towering over rest of the canopy; highest relative abundance in sugar maple/yellow birch/balsam fir forests; Has disappeared from some hemlock forests of Highlands Plateau, North Carolina over the past 50 years.

Breeding territories all-purpose, and both males and females spend most of time on them. Territory size varies with habitat: smaller where favored conifers dense than in mixed coniferous-deciduous forests where primarily exploit conifers. Along Maine coast, territories between 0.4 and 0.6 ha in both red and white spruce. Territories averaged 1.1 ha in a largely deciduous forest with occasional, patchily distributed conifers, apparently in response to distribution of favored coniferous growth. Territories in fir-spruce forest in Ontario from 0.8–0.9 ha.

Last researched by Sharon Petzinger in Feb 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Black-crowned Night-heron

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, radius of 71.25 meters (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	9.6 km (6 mile) radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

Nesting area is defined by the area the herons actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default “seconds precision” circle was used around the recorded nesting location point.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long

commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the "energetically feasible" foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as "critical" foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

Black-crowned night heron foraging flight distances in South China differed between high and low tides. At high tide, the average flight was 0.47 km, with a range of 0.03-1.10 km. At low tide, the average flight was 0.57 km, with a range of .03-1.38 km (Wong 1999). The Birds of North America, however, cites foraging flights of up to 24 km (Davis 1993). NatureServe sets a minimum inferred extent of 3 km for black-crowned night herons (NatureServe 2006). Since there is very little information available for this species, we apply a conservative 9.6 km radius occurrence area to nesting colony foraging areas.

Literature supporting occurrence area(s):

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.

The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Davis, W.E.Jr. 1993. Black-crowned night heron (*Nycticorax nycticorax) In* The Birds of North America No. 74 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Foraging commuting distance can be up to 24 km.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.

A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.

> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
The inferred minimum extent of habitat use (when the actual extent is unknown) in 3 km. This is based on a low mean foraging range size.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Wong. 1999. Foraging flights of nesting egrets and herons at Hong Kong Egretry, South China. Waterbirds 22(3): 424-434.
In South China, foraging flight distances differed between high and low tides. At high tide, the average flight was 0.47 km, with a range of 0.03-1.10 km. At low tide, the average flight was 0.57 km, with a range of .03-1.38 km.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Black Rail

Feature Label	Occurrence Area
Confirmed/Known Breeding Location	Mapped extent of occurrence or 100 meter radius around point.
Suspected Breeding Location	Mapped extent of occurrence or 100 meter radius around point.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:
Black rail research from different locales around the country report similar home ranges for clapper rails. In Arizona, the average home range was 0.4 ha $\pm$ 0.2 ha, with a range of 0.1 ha – 1.8 ha (Flores 1991). In Florida, the male average home range was 1.3 ha and the female was 0.62 ha (Legare and Eddleman 2001). In the lower Colorado River, a telemetry study revealed the average home range as 0.43 ha, with a core use area of 0.10 ha (NatureServe 2006). The only report that deviates from this range (0.1-0.43) is from Maryland, where the home range is suspected to lie between 3-4 ha (NatureServe 2006). The minimum inferred extent set by NatureServe is 0.1 km. ENSP will use the NatureServe minimum inferred extent of 0.1 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Flores. 1991. Ecology of black rail in southwest Arizona. Final Report, US Bureau of Reclamation, Yuma Project Office and Arizona Department of Game and Fish. Yuma, AZ.

In Arizona, California black rails had an average home range of 0.4ha ± 0.2 ha. Home ranges observed in the study ranged between 0.1-1.8 ha.

Legare. M.L., W.R. Eddleman. 2001. Home range size, nest site selection and nesting success of black rails in Florida. Journal of Field Ornithology 72 (1): 170-7.

A telemetry study in Florida revealed that males kept an average home range of 1.3 ha, while the females averaged 0.62 ha.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.

Personal comments by R. Flores set an average home range of 0.43 ha, with a significant core size of 0.10 ha based on a telemetry study in the Lower Colorado River. Personal comments by J.G. Weske estimate a 3-4 ha home range for bitterns in Maryland.
The inferred minimum extent of habitat use (when actual extent is unknown) is 0.1 km.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Black Skimmer

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, 71.25 meter radius (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging Area	9.6 km (6 mile) radius.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Black Skimmers nest in colonies and feed primarily in the salt marshes, estuaries, lagoons and tidal pools around their nest sites (Erwin 1977, Valiela 1984). There have not been exhaustive studies on the commuting distances for black skimmers, but at least two studies have been conducted. On Long Island, New York, black skimmers foraged ≤ 8 km from the colony (Gochfeld and Burger 1994). In Georgia, they foraged approximately 5.2 km from the colony (Tomkins 1951).

Since there are so few studies focusing on black skimmers, commuting distances from related species are used to facilitate the establishment of a Landscape model. Least terns, who sometimes nest at the same sites as black skimmers, foraged an average of 3-12 km from nesting

sites (Thompson, et al 1997). California gulls foraged an average of 17.4km with a maximum of 61 km (Baird 1977). Forster's terns had a reported feeding radius of 3.2 km from nesting colonies (VanRossem 1933).

Literature supporting occurrence area(s):

Baird, P.A. 1977. Feeding ecology of ring-billed and California gulls (*Larus delawarensis* and *L. californicus*). Pacific Seabird Bulletin 4:16-17.
California Gulls foraged an average of 17.4 kilometers from colony and maximum foraging distances ranged from 32 to 61 kilometers. Ring-billed Gulls foraged an average of 11 km from colony.

Erwin, M. 1977. Foraging and breeding adaptations to different food regimes in three seabirds: the Common Tern (*Sterna hirundo*), Royal Tern (*Sterna maxima*), and Black Skimmer (*Rynchops niger*). Ecology 58: 389–397.
In Virginia, 88% of black skimmers fed in salt marsh tidal pools.

Gochfeld, M. and J. Burger. 1994. Black Skimmer (*Rynchops niger*). In The Birds of North America, No. 108 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists Union.
On Long Island, New York, main feeding areas were located < 8 km from colony. Colony sites were often located near inlets. This may reflect access to feeding areas as well as suitable substrate.

Thompson, B.C., J.A. Jackson, J. Burger, L.A. Hill, E.M. Kirsch and J.L. Atwood. 1997. Least Tern (Sterna antillarum). In The Birds of North America, No. 290 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.
Throughout their North American range, least terns foraged 3-12 kilometers from nesting colonies.

Tomkins, I.R. 1951. Method of feeding in the Black Skimmer, *Rynchops nigra*. Auk 68: 236–239.
In Georgia, black skimmers fed approximately 5.2 km from a colony.

Valiela, I. 1984. Marine ecological processes. Springer-Verlag, New York.
Black skimmers fed mainly in tidal waters of bays, estuaries, lagoons, rivers, and salt marsh pools, creeks, and ditches. These habitats concentrate small fish.

Van Rossem, A. J. 1933. Terns as destroyers of birds' eggs. Condor 35:49-51.
Forster's terns had a reported feeding radius of 3.2 kilometers.

Last researched by Christina Kisiel in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Black-throated Blue Warbler

Feature Label	Occurrence Area
Breeding	250 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 1 – 4 ha and young can move 200-300 meters from the nest within 2 weeks of fledging. Based upon the upper limit territory size and to incorporate post-fledging habitat, an occurrence area of 250 meters was chosen.

Literature supporting occurrence area(s):

Holmes, R.T., N. L. Rodenhouse and T. S. Sillett. (2005). Black-throated Blue Warbler (*Dendroica caerulescens*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Black-throated_Blue_Warbler/

Breeds mainly in large, continuous tracts of undisturbed deciduous or mixed deciduous/coniferous forests usually dominated by maples, birches, beech, and other northern hardwoods, with varying amounts of eastern hemlock, spruce, and fir. It can sometimes also be found, especially during the fledgling period, in dense patches of regenerating aspen, spruce, or in red pine plantations with a dense, deciduous sapling understory. Forests most suitable as breeding habitat contain a relatively thick undergrowth of dense, usually deciduous or broad-leaved evergreen shrubs. The species occurs where there is thick undergrowth of mountain laurel, rhododendron, creeping yew, deciduous bushes, small saplings, or tiny conifers. Where shade-tolerant understory shrub species are typically rare, or have been removed by white-tailed deer, this species tends to respond positively to low-intensity harvest (e.g., selection cutting) of closed-canopy forest, which opens the forest canopy and promotes dense patches of seedlings and saplings. Selection of habitats with a dense shrub layer seems most closely related to nesting requirements and not to foraging needs or other factors. Does not usually occur commonly in young clear-cuts or second growth, but becomes frequent once canopy becomes well developed and gaps allow the development of shrubs, usually > 50 yr following clear-cutting. Appears to be about equally common in both managed and unmanaged northern hardwoods forests. Densities not significantly affected by selective logging activities as long as there is a dense or patchily dense shrub layer and relatively complete canopy cover.

Territory size ranges from about 1 to 4 ha, depending on habitat, being smallest where the shrub layer is dense and heterogeneous. Young can move 200-300 meters from nest during the 1st 2 weeks after fledging.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Black-throated Green Warbler

Feature Label	Occurrence Area
Breeding	50 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification:

Little is known about the territory size of BTNW, but it does depend on the type of habitat. Because the favored spruce habitat is not common in New Jersey, the territory size will likely be larger than territories in favored habitat (0.25 ha). Thus, the upper range of listed territory sizes was chosen to create the breeding occurrence area. Non-breeding black-throated green warblers are listed as stable in New Jersey so no occurrence area was specified.

Literature supporting occurrence area(s):

Morse, D. H. and A. F. Poole (2005). Black-throated Green Warbler (*Dendroica virens*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology.

Habitat consists of boreal coniferous forests and transition areas between coniferous and deciduous forests – prefers coniferous forests but can inhabit mixed and deciduous forests, often associated with hemlock forests.

Little data on territory size. Territory size depends on habitat – smaller territories occur in favored habitat of coniferous forest compared to less favored mixed forests. Smallest territory in favored habitat is 0.25 ha. Ontario territories ranged from 0.3 – 0.9 ha.

Last researched by Sharon Petzinger in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Blue-headed Vireo

Feature Label	Occurrence Area
Breeding	100 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

The breeding occurrence area was chosen based upon a territory size of 3 ha. Non-breeding individuals are listed as stable in NJ so no occurrence area was chosen.

Literature supporting occurrence area(s):

James, R. D. 1998. Blue-headed Vireo (Vireo solitarius). In The Birds of North America, No. 379 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Typically breeds in evergreen forests with spruce, fir, hemlock, and pine, or conifers with associated deciduous growth that may be alder and willow shrubs as understory, or include poplar, birch, and/or maple trees in varying numbers. In highlands of e. U.S., usually above 300 m elevation in North and 600–1,000 m in South, extending as high as forest is available to >2,000 m in some areas Here an even broader habitat tolerance is seen, from pure hardwood forest of beech, maple, oak, hickory, etc., on dry sites, through mixed mesophytic forest, pure pine or hemlock stands, to fir and spruce on mountaintops. Presence corresponds closely with areas where extensive forest predominates, but given that requirement, may be found almost anywhere with trees that are middle-aged to mature, with high percent canopy closure (usually >75%), and where there is some (but not dense) understory of shrubs and saplings, often near small openings or edges of wetlands and lakes.

After mating, most activity occurs within 100 m of nest (about 3-ha area).

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Bobolink

Feature Label	Occurrence Area
Breeding	200 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.45 – 2.5 ha (Dechant et al. 1999, Martin and Gavin 1995), but the closest study in NY had average territories of 0.5 ha (Dechant et al. 1999). The breeding occurrence area was chosen based upon the NY average of 0.5 ha and increased because the home range size encompasses several territories and the increase of home range due to movement of post-fledging chicks (Martin and Gavin 1995). Little is known about migratory stopover habitat use so the migrant occurrence area chosen is the default.

Literature supporting occurrence area(s):

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, A. L. Zimmerman, and B. R. Euliss. 1999 (revised 2001). Effects of management practice on grassland birds: Bobolink. Northern Prairie Wildlife Research Center, Jamestown, ND. 24 pages.

Territories did not vary much with location. Wisconsin mixed hayland floodplain territories ranged from 0.45 – 0.69 ha where dry pasture territories were 2.5 ha, New York hayfields contained territories of 0.5 ha, tame hayfields in Michigan had territories of 1.4 ha. Illinois minimum area for tallgrass prairie was 10-30 ha. Nebraska minimum area for wet meadows was 46 ha and perimeter-area ratio of 0.010.

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

Maine had 40% incidence at 500 ha, but not in optimal habitat for bobolink (see Vickery et al. below). New York's minimum area was 16 ha with a mean of 56.6 ha. Another study in NY had 96% incidence at 10-20 ha, 68% incidence at 5-10 ha, and 18% incidence at 3-6 ha. Illinois had 50% incidence at 50 ha and a minimum area of 10-30 ha.

Martin, S. G. and T. A. Gavin. 1995. Bobolink (Dolichonyx oryziorus. In The Birds of North America, No. 176 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Territories vary according to the density of bobolinks and type of habitat. In Wisconsin territories ranged from 0.7 – 2 ha. Mean territory size in New York was 0.49 ha, Oregon was 0.74 – 1.45 ha. Courtship occurs within 40 m of nest. Gathering nesting materials occurs within 80 m of nest. Fledglings can move up to 70 m the first day out of nest.
During breeding season, home ranges of males and females encompass area of several male territories (TAG), an area of use that becomes larger when nestlings fledge.

Mixed-sex and -age flocks begin forming in late Jun. In some locations flocks leave nesting hay fields and meadows by late Jul; in others, flocks remain until mid-Aug. Birds then seek shelter of freshwater marshes and coastal areas to complete Prebasic molt before migration. This species has not been studied intensively outside the breeding season, habitat use during Aug–Sep is probably the least-known period of its annual cycle.

Vickery, P. D., M. L. Hunter, Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4): 1087-1097.

Bobolinks have positive area effects but had low incidence because sites did not have enough graminoid cover to be a preferred site.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Broad-winged Hawk

Feature Label	Occurrence Area
Nest	100 meter radius
Sighting (Breeding & Non-breeding)	100 meter radius

Occurrence Area Rule: Observations for all feature labels are mapped as points, which then receive the radii specified above.

Justification:
This species has small breeding territories but are area sensitive. The buffer was chosen based on breeding territory size and increased for the species' mobility and need for large patches. Until more is discovered about the mobility of the species, a 100 meter radius buffer will be used.

Literature supporting occurrence area(s):

Goodrich, L. J., S. C. Crocoll, and S. E. Senner. 1996. Broad-winged Hawk (Buteo platypterus). In The Birds of North America, No. 218 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Brown Thrasher

Feature Label	Occurrence Area
Breeding	200 meter radius
Migrant	71.25 meter radius
Wintering	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:
Breeding territories range from 0.5 – 1.13 ha, but fledglings can move a median 200 meters (up to 800 meters) from the nest within a few weeks of fledgling. Therefore, the breeding occurrence area was chosen to incorporate a territory and the median post-fledging habitat. Brown thrashers migrate through and winter in NJ. Little is known about the migratory stopover or wintering habitat use, so the default occurrence area was used for migrating and wintering individuals.

Literature supporting occurrence area(s):

Cavitt, J. F., and C. A. Haas. 2000. Brown Thrasher (*Toxostoma rufum*). *In* The Birds of North America, No. 557 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Breeds in dry, open country along coastal plain of Long I., NY, especially in thickets and scrubby fields; in w. New York, prefers brushy hillsides covered with hawthorn. In New Jersey pine barrens, breeds at high densities in regularly burned habitat dominated by pitch pine and scrub oaks and black jack oak but absent or rare in areas where fire suppression allows canopy oaks or white oaks. Not found breeding in New Jersey woodlots <0.8 ha in size and rare in woodlots of <4 ha. In Georgia, found in thickets and underbrush at edge of cotton fields in the Piedmont and Okefenokee Swamp. Only occasionally breeds in urban settings, including yards, gardens, and fencerows.

Although uses a wide variety of habitats, reaches highest densities in shrub or midsuccessional stages of forests. Habitat suitability index model included 3 variables; suitability peaked when density of woody stems ?1.0 m tall was 10,000–30,000/ha, percentage of canopy cover of trees was 10–30%, and percentage of ground surface covered by litter ?1 cm deep was >80%. Breeding-territory size varied from 0.5 to >1.0 ha even within limited area, probably depending on habitat quality; in some cases, pairs nested within 15 m of each other. In IL, average breeding territory size varied from 0.65 to 1.13 ha over a 3-yr period. Most activities (including construction of up to 4 nests) of a pair seem to be confined to territories. In N. Dakota, young moved a median distance of only 200 m from nest in 6 wk. One fledgling moved 0.8 km within 12 d.

During migration, observed in hedgerows and railroad rights-of-way during fall migration in Illinois. Occasionally observed in chaparral in San Patricio Co., TX, during migration, but did not defend winter territories in this habitat. Found in mature deciduous forests, urban gardens, yards, and parks, particularly those with fruit-bearing plants and feeders.

During the winter, abundant in riparian woodlands and absent from chaparral in San Patricio Co., TX. Foraged at sites with well-developed overstories and only rarely in open areas without canopy cover. Occurs in thickets and brushy woodland edges, often in yaupon holly thickets, in Texas in both winter and summer. Also frequents fencerows, gardens, yards, and cultivated areas. Occurs in riparian forest, oak woodland, and mesquite chaparral within Texas Coastal Bend. In Mississippi, found within vine-covered thickets, brier patches, and hedgerows. In Illinois, typically found in sheltered areas with heavy brush and often near feeders. Maintains winter territories in Texas by chasing and calling. Returns to same winter territory from one year to next.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Canada Warbler

Feature Label	Occurrence Area
Breeding	100 meter radius buffer
Migrant	71.25 meter radius buffer

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Little data are available on territory size. The mean of the territories provided was 0.66 ha, but it was noted that Canada warblers feed fledglings 60 – 90m away (Conway 1999) and 100 m buffer from wetland edge is adequate for a Canada warbler territory (Lambert and Faccio 2005), so the breeding occurrence area chosen was 100 meters. There is little information about the territories during migration, so the default occurrence area will be used for non-breeding Canada warblers.

Literature supporting occurrence area(s):

Conway, C. J. 1999. Canada Warbler (*Wilsonia canadensis*). *In* The Birds of North America, No. 421 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Wide range of deciduous and coniferous forests. Most abundant in moist, mixed coniferous-deciduous forests with a well-developed understory. Often near open water. At lower elevations, often restricted to cool, wet, low-lying areas: cedar (Cupressaceae) woods, swampy forests, sphagnum (*Sphagnum* spp.) bogs, moist forest clearings and woodland edges, spruce (*Picea* spp.)–tamarack (*Larix laricina*) bogs, aspen (*Populus* spp.) and moist spruce-birch (*Betula* spp.) forests, and alder (*Alnus rugosa*) and willow (*Salix* spp.) stands along stream banks. Less common in shrub wetlands.

In Ontario, average territory size 0.2 ha in Algonquin Provincial Park; one territory in Québec 0.4. Two paired males apparently defended areas of 0.8 and 1.2 ha in New York. Two pairs feeding newly fledged young just out of nest only 60–90 m apart. Three pairs nesting <30 m away from each other along stream in West Virginia and 5 nests found along 46 m of stream in Vermont (Cornell Nest Records Program [CNRP]). Size of singing area for 1 male in New York State was 0.24 ha, but he ranged over a 0.8 ha area (1.2 ha for another male) after nesting began.

Lambert, D. J. and S. D. Faccio. 2005. Canada warbler population status, habitat use, and stewardship guidelines for northeastern forests. Vermont Institute of Natural Science, Woodstock, VT.

Inhabits lowland and upland habitats, including swamps, streamside thickets, brushy ravines, moist forests, and regenerating timber cuts with well-developed shrub layer and structurally complex forest floor. They are area sensitive in “settled” areas but not in forest-dominated regions. In Rhode Island, the greatest incidence occurred in swamps > 6 ha and where forest covered 50% of landscape within 2km. “A 100-m distance from shoreline or wetland edge is adequate to encompass a typical Canada warbler territory.”

Last researched by Sharon Petzinger in Feb 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Cattle Egret

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, buffer of 90 meters around confirmed/known breeding location point.
Nesting Colony Foraging	7 mile radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Nesting area is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the "energetically feasible" foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as "critical" foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

This species is has a wider range of diet items than other herons and egrets nesting in New Jersey. Along with small fish, they will also eat grasshoppers, crickets, spiders, flies, frogs, noctuid moths and small mammals (Telfair 2006). Therefore when looking at the areas to be valued by this model, special attention should be paid to the marsh islands or inland areas that lie within the radius of the nesting colony, as well as the open water that other egret models value.

The worldwide range of this species is quite expansive, including parts of all continents except Antarctica (Telfair 2006). Due to this, there have been many studies conducted on this species and reported commuting distances are wide ranging. In North Carolina, cattle egrets traveled from 4-6 km to foraging sites from their nesting colonies (Custer and Osborn 1978). In Barbados, cattle egrets were observed foraging up to 5.7 km from breeding colonies (Krebs et al 1994**)**. In southeastern Australia, 60% of cattle egrets fed within 6.5 km of the breeding colony (Richardson and Taylor 2003). In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km (maximum distance 20.4 km) and 53% of the herons in the study fed within 4 km of the colony **(**Thompson 1978). In Texas, foraging flights ranged from 4-25 km, with 67% of those flights from 10-15 km (Mora and Miller 1998). In Baja, California, cattle egrets flew 2.5 - 35 km to foraging sites, most (80%) within 15 km of the breeding colony and 46% from 10-12.5 km (Mora 1997). In Alabama, cattle egrets traveled from 26-32 km from their breeding colonies to foraging sites (Bateman 1970). The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 3 km which is based on a low mean foraging range size for this group (NatureServe 2007**)**.

Literature supporting occurrence area(s):

Bateman, D.L. 1970. Movement-behavior in three species of colonial nesting wading birds: a radio-telemetric study. Ph.D. dissertation, Auburn University, Auburn, AL.
In Alabama, cattle egrets traveled from 26-32 km from their breeding colonies to foraging sites.

Custer, T.W., R. G. Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. Auk 95: 733-743.
In North Carolina, cattle egrets traveled from 4-6 km to foraging sites from their nesting colonies.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.
The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.
A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.
> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

Krebs, E.A., D. Riven-Ramsey, W. Hunte 1994. The colonization of Barbados by Cattle Egrets (*Bubulcus ibis*) 1956-1990. Colon. Waterbirds 17: 86-90.
In Barbados, cattle egrets were observed foraging up to 5.7 km from breeding colonies.

Mora, M.A. 1997. Feeding flights of Cattle Egrets nesting in an agricultural ecosystem. Southwest Naturalist 42: 52-58.
In Baja, California, cattle egrets flew 2.5 - 35 km to foraging sites, most (80%) within 15 km of the breeding colony. Forty-six percent flew from 10-12.5 km.

Mora, M.A., J. M. Miller 1998. Foraging flights, reproductive success and organochlorine contaminants in Cattle Egrets nesting in a residential area in Bryan, Texas. Texas Journal of Science 50: 205-214.
In Texas, foraging flights ranged from 4-25 km, with 67% of those flights falling from 10-15 km.

NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.2. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: August 2, 2007).
The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 3 km. For the breeding season, this figure is based on a low mean foraging range size for this group.

Richardson, A.J., I. R. Taylor 2003. Are rice fields in southeastern Australia an adequate substitute for natural wetlands as foraging areas for egrets? Waterbirds 26: 353-363.
In southeastern Australia, 60% of cattle egrets fed within 6.5 km of the breeding colony.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.

In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Telfair, R. C. II. 2006. Cattle Egret (*Bubulcus ibis*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Cattle_Egret/.

This species is has a larger range of diet items than other herons and egrets nesting in New Jersey. Along with small fish, they will also eat grasshoppers, crickets, spiders, flies, frogs, noctuid moths, and some small mammals.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Cerulean Warbler

Feature Label	Occurrence Area
Breeding	65 meter radius
Migrant	65 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

The breeding occurrence area distance was chosen based upon the upper confident limit of the mean territory size (1.04 ha ± 0.16 SE), which calculates to 1.35 ha. Little is known about non-breeding territories, but based on the area-sensitivity of the species, the breeding occurrence area distance was chosen.

Literature supporting occurrence area(s):

Hamel, P. B. 2000. Cerulean Warbler (*Dendroica cerulean*). *In* The Birds of North America, No. 511 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Routinely identified with predominantly forested landscapes, mature forest, large and tall trees of broad-leaved, deciduous species with an open understory; in wet bottomlands, or upland situations including mesic slopes, and mountains, from <30 to >1,000 m elevation. Expanding populations in ne. North America now occupy landscapes formerly cleared for agriculture. Thus, species will occupy second-growth as well as mature forest. Minimum habitat requirements of this species along the Roanoke River in N. Carolina: (1) a closed canopy; (2) presence of scattered, very tall, old-growth canopy trees; (3) distinct zonation of canopy, subcanopy, shrub, and ground-cover layers. In Missouri breeding habitats, canopy cover averaged 85%, minimum value 65%.

Usually considered an area-sensitive species. Minimum forest-tract size varies, e.g. from 20–30 ha in Ohio to 700 ha in the Middle Atlantic states and 1,600 ha in Mississippi Alluvial Valley of Tennessee. Mueller et al. (1999) suggest tracts >8,000 ha may be required to support stable breeding populations in the Mississippi Alluvial Valley. In Ontario, however, found breeding in

tracts as small as 10 ha (J. Jones pers. comm.). Species response to habitat fragmentation may reflect factors that covary with fragment size, such as intensity of Brown-headed Cowbird (*Molothrus ater*) parasitism and of predation, rather than particular behavioral aversion to small fragment size or to edges

Mean breeding territory size of 1.04 ha ± 0.16 SE based on 18 Ontario territories that ranged in size from 0.38 to 2.4 ha. Maximum breeding densities on published Breeding Bird Censuses suggest that territories smaller than these are possible.

Rosenberg, K. V., R. W. Rohrbaugh, Jr., S. E. Barker, J. D. Lowe, R. S. Hames, and A. A. Dhondt. 1999. A land manager's guide to improving habitat for scarlet tanagers and other forest-interior birds. The Cornell Lab of Ornithology.

Cerulean warblers share some habitat characteristics with Scarlet Tanagers. In the Piedmont Plains and Delaware Bay regions, they prefer areas at least 70% forested, deciduous or mixed, and the suitability increases with proximity of forest patches to larger, contiguous forest patches. In the Highlands, they prefer areas at least 50% forest, deciduous, and mixed and occasionally coniferous, and the suitability increases with proximity of forest patches to larger, contiguous forest patches.

Last researched by Sharon Petzinger in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Cliff Swallow

Feature Label	Occurrence Area
Breeding	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

Not available.

Last researched by Mick Valent in 2006.

Occurrence area applied in Version 2.1 of the Landscape Project.

Common Nighthawk

Feature Label	Occurrence Area
Breeding	300 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 4 – 34 ha depending on habitat. The breeding occurrence area was chosen based upon the upper limit of the breeding territories (28 ha) for nesting habitat. Common nighthawks migrate in flocks and are not territorial, but little information is available about stopover habitat use, so the default occurrence area was chosen for migrant nighthawks.

Literature supporting occurrence area(s):

Poulin, R. G., S. D. Grindal, and R. M. Brigham. 1996. Common Nighthawk (*Chordeiles minor*). *In* The Birds of North America, No. 213 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Nesting habitat includes coastal sand dunes and beaches, logged or slashburned areas of forest sites, woodland clearings, prairies and plains, sagebrush and grassland habitat, farm fields, open forests, rock outcrops, and flat gravel rooftops of city buildings. Nests in open areas on the ground in Texas, extensively logged and burned areas in British Columbia, on bare sand and among small tufts of grass in Louisiana, in cultivated fields or atop fence posts throughout its range, and in open native grassland in s.-central Canada and n.-central U.S.. Prefers flat, gravel roofs in urban areas. Generally selects large roofs with parapet, close to walls (<0.5 m), and not according to roof height. Aluminum roofs avoided, and flat roofs not used in the Okanagan Valley, BC, where natural sites are apparently preferred. Density of flat roofs is primary factor in selection of urban home ranges. Nesting areas chosen secondarily in association with large trees for roosting and vegetation for the production of flying insects for food. Average commuting distance from roost to feeding grounds is 2.7 km (SE ± 0.1, *n* = 284 trips). No evidence of roosting or nesting to minimize commuting distance to feeding areas.

Strongly territorial – males seldom cross territorial boundaries. Around Saskatoon, SK, greatest number of territories (*n* = 48) found within city limits, with greatest density downtown; 1 male/18.62 ha downtown, 1 male/33.6 ha in natural field.
Variable territory size in different habitats. In cities: in Saskatoon, SK, 10.53 ha; in Detroit, MI, 10.4 ha (range 4.14–22.8) for 13 territories defended by males. In natural habitat: 28.34 ha (field).
Home range size not correlated with measured environmental factors. Generally the same as territory. Average home range 10.5 ha (urban), 10.4 ha (Detroit, MI), 28.34 ha (field).

Few data on migratory stopover habitat; farmlands, river valleys, marshes, coastal dunes (e.g., s. New Jersey), open woodlands.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Common Tern

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, 50 meter radius around confirmed/known breeding location point.
Nesting Colony Foraging	7.5 mile radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification: In New Jersey, common terns nest in the coastal landscape on wrack mats on marsh islands and in the dunes of barrier islands. They forage for small fish in the ocean or bay and their commuting distances are widely reported in the literature. The birds of North America notes that across the breeding range, most breeding birds feed within 20 km of colony-sites, often much less if numbers small and/or prey locally abundant. (Nisbet 2002). On the Atlantic Coast they usually foraged within 1 km of shore. (Duffy 1986). At Lake Ontario most terns flew either 0.9 km to a small pond (30% of trips) or 1–8 km to other foraging sites (Moore 1993). In another study the mean trip distance for foraging flights for common terns was 2.4–4.2 km, with a maximum distance of 20 km (n = 99 males, >1,000 trips) (Moore 2001). Individuals from Bird Island, Massachusetts were observed defending feeding territories up to 19 km away from nesting colonies. (Nisbet 1983). Another study at Bird Island fund that some terns made triangular feeding flights of at least 60 km, including 15 km return flights with fish. (Heinemann 1992). Around Cape Cod, Massachusetts, terns fed in tidal inlets or between islands but were also observed feeding up to 20 km offshore. (Trull et al. 1999). The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 5 km **(**NatureServe 2007).

Literature supporting occurrence area(s):

Duffy, D.C. 1986. Foraging at patches: interactions between Common and Roseate Terns. Ornis Scand. 17: 47–52.
On Atlantic Coast, the terns usually foraged within 1 km of shore.

Heinemann, D. 1992. Foraging ecology of Roseate Terns on Bird Island, Buzzards Bay, Massachusetts. U.S. Fish and Wildlife Service, Newton Corner, MA.
Some birds nesting at Bird Island, Massachusetts made triangular feeding flights of at least 60 km, including 15 km return flights with fish.

Moore, D.J. 1993. Foraging ecology and parental care of Common Terns (Sterna hirundo) nesting in Windermere Basin, Lake Ontario. M.S. thesis, Brock Univ., St. Catharines, Ontario.

At Lake Ontario most birds flew either 0.9 km to a small pond (30% of trips) or 1–8 km to other foraging sites.

Moore, D.J. 2001. The provisioning tactics of parent Common Terns (Sterna hirundo) in relation to brood energy requirement. Ph.D. dissertation, Simon Fraser Univ., Burnaby, British Columbia.
The mean trip distance for foraging flights for common terns was 2.4–4.2 km, with a maximum distance of 20 km (n = 99 males, >1,000 trips).

NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.2. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: August 2, 2007).
The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 5 km.

Nisbet, I.C.T. 1983. Territorial feeding by Common Terns. Colonial Waterbirds 6: 64–70.
Some birds from Bird Island were observed defending feeding territories up to 19 km away from nesting colonies.

Nisbet, I. C. T. 2002. Common Tern (Sterna hirundo). In The Birds of North America, No. 618 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.
Most breeding birds feed within 20 km of colony-sites, often much less if numbers small and/or prey locally abundant.

Trull, P., S. Hecker, M. J. Watson, I. C. T. Nisbet 1999. Staging of Roseate Terns Sterna dougallii in the post-breeding period around Cape Cod, Massachusetts, USA. Atlantic Seabirds 1: 145–158.
Around Cape Cod, Massachusetts, many terns fed in tidal inlets or between islands. They were observed feeding up to 20 km offshore.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Cooper's Hawk

Feature Label	Occurrence Area
Breeding Sighting	1.0 km radius
Foraging (Breeding)	1.0 km radius
Nest	1.0 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:
The home ranges of Cooper's hawks' are highly variable, both geographically and seasonally. Only breeding records of Cooper's hawks are used in the Landscape Project to value habitat. Home range calculations reported in the literature for Cooper's hawks during the breeding season

range from 65.5 ha to 784 ha. The average being 348 ha, or an area equivalent to having a 1.1 km radius. The ENSP uses a 1.0 km radius to represent the occurrence area boundary for all Cooper's hawk breeding records used in the Landscape Project. This represents a slightly conservative estimate of the breeding season home ranges of Cooper's hawks as reported in the literature.

Literature supporting occurrence area(s):

Mannan, R. W. and C. W. Boal. 2000. Home range characteristics of male Cooper's hawks in an urban environment. Wilson Bull. 112(1):21-27.

- Average home range during breeding season was 65.5 ha, with a range of 13.3-130.6 ha.

Murphy, R.K., M.W. Gratson, and R.N. Rosenfield. 1988. Activity and habitat use by a breeding male Cooper's Hawk in a suburban area. J. Raptor Res. 22:97-100.

- Average home range during breeding season was 784 ha.

Craighead, F., and J. Craighead. 1956. Hawks, owls, and wildlife. Dover Publ. Inc., New York.

- **Average home range during the breeding season for four pairs of Cooper's hawks was 1.43 sq miles, 1.55 sq miles, 0.37 sq miles, and 1.45 sq miles. Using the conversion of 1 square mile equals 640.0 acres and 1 acre equals 0.4046856 hectares, the average home ranges were 370 ha, 401 ha, 96 ha, and 376 ha.**

The above studies result in mean = 348 ha, or 1.1 km radius

Last researched by Melissa Craddock and Kris Schantz in 2005 and 2006, respectively. Occurrence area applied in Version 2.1 of the Landscape Project.

Eastern Meadowlark

Feature Label	Occurrence Area
Breeding	125 meter radius
Migrant	71.25 meter radius
Wintering	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 1.2 – 6.1 ha (Hull 2000, Lanyon 1995) but commonly range from 2.8 – 3.2 ha (Lanyon 1995). The breeding occurrence area is based upon the upper limit of territory sizes. Because little is known about migratory stopover or wintering habitat use, the default occurrence area was chosen for the non-breeding individuals.

Literature supporting occurrence area(s):

Hull, S. D. 2000 (revised 2002). Effects of management practice on grassland birds: Eastern Meadowlark. Northern Prairie Wildlife Research Center, Jamestown, ND. 35 pages.

Territories range from 1.2 – 4.8 ha and seem to prefer areas > 5 ha for breeding. Not affected by core area (or lack thereof). Had 50% incidence at 5 ha. Wisconsin territories ranged from 1.2 – 6 ha with an average of 2.3 ha. Oklahoma territories averaged 2 ha. In PA they were found in warm and cool-season grasses and fields > 1.4 ha. Not considered area sensitive by studies in New York and Missouri. 50% incidence at 5 ha. In Maine 40% incidence at 500 ha grassland barrens.

Lanyon, W. E. 1995. Eastern Meadowlark (*Sturnella magna*). *In* The Birds of North America, No. 160 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Territories in Wisconsin varied from 1.2 to 6.1 ha but commonly 2.8–3.2 ha. In New York, 15 territories averaged 2.8 ha. Wintering habitat consists of open country, including cultivated fields and feedlots; also marshes. Northern limit of winter range correlated with temperature: absent from regions having mean minimum winter temperature below -12°C.

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

Meadowlarks tend to use areas > 20 ha.

Vickery, P. D., M. L. Hunter, Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4): 1087-1097.

Meadowlarks have positive area effects but had low incidence because sites did not have enough graminoid cover to be a preferred site.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Glossy Ibis

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, buffer of 71.25 meters (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	14.6 km (9.1 mile) radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

Nesting colony is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default "seconds precision" circle was used around the recorded nesting location point.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the "energetically feasible" foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as "critical" foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

Research in North Carolina found that 84% of breeding long-legged waterbirds flew to foraging areas, which is why habitat outside the vicinity of the colony must be valued as crucial to the success of the colony (Custer and Osborn 1978). This same study documented the mean distance flown to foraging habitat by glossy ibis was 7.3 km with a maximum distance flown as 12.4km. (Custer and Osborn 1978). In New Jersey, glossy ibis use the entire area of salt marsh pools rather than just the edge as other long legged species may be inclined to do (Wiese 1979). NatureServe recommends a minimum inferred extent of 3 km and justifies it by noting a low mean foraging range size for this group (NatureServe 2006). We apply a 14.6 km radius around a colony to protect foraging areas.

Literature supporting occurrence area(s):

Custer, T. W., R. G. Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. Auk 95: 733–743.

In North Carolina, this small-scale study found that the mean distance to foraging habitat during breeding season was 7.3 km (*n* = 5). The longest observed flight was 12.4 km. In North Carolina, 84% of breeding individuals flew to tidal foraging habitat. They generally prefer brackish/marine habitats with relatively shallow water.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.
The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.
A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.
> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).
The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 3 km. For the breeding season, this figure is based on a low mean foraging range size for this group.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Wiese, J. H. 1979. A study of the reproductive biology of herons, egrets, and ibis nesting on Pea Patch Island, Delaware. Final report. Manomet Bird Observertory, Manomet, MA.
In salt-marsh pools in New Jersey, ibises use the entire pool rather than just the edge.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Golden-winged Warbler

Feature Label	Occurrence Area
Breeding	800 meter radius with 20-m buffer into adjacent forest from valued habitat
Non-breeding	250 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

In New Jersey, territory sizes ranged from 0.17 to 7.84 hectares with the mean territory size of 1.66 (± 0.42) hectares and males have been observed in areas > 800 meters from their nest and defended territory (DeFalco pers. obs.). Territories in New York ranged from 0.4 – 6 ha (Confer 1992). The breeding buffer was chosen based upon the mean territory size and mobility of the species. This species predominately uses scrub-shrub habitat but will use the forest edges up to 30 meters into the forest (Confer 1992).

Literature supporting occurrence area(s):

Confer, John L. 1992. Golden-winged Warbler. *In* The Birds of North America, No. 20 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Territories range from 0.4 – 6 ha, depending on density of male, and can extend 5-30 m into forest. No information was provided on migratory stopover habitat.

Last researched by Sharon Petzinger in winter 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Grasshopper Sparrow

Feature Label	Occurrence Area
Breeding	90 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Mean breeding territories range from 0.19 to the highest upper confidence limit of 2.76 ha (Vickery 1996). The breeding occurrence area was chosen based upon the upper limit territory size. Little is known about the stopover habitat use, so the default occurrence area was chosen for the migrant individuals.

Literature supporting occurrence area(s):

Dechant, J. A., M. F. Dinkins, D. H. Johnson, L. D. Igl, C. M. Goldade, B. D. Parkin, and B. R. Euliss. 1998 (revised 2002). Effects of management practice on grassland birds: Grasshopper Sparrow. Northern Prairie Wildlife Research Center, Jamestown, ND. 28 pages.

Average territory size < 2 ha. Minimum area need to support breeding population may be > 30 ha. Illinois minimum area 10-30 ha, not found in areas <10 ha, Nebraska 8- 12 ha with perimeter-area ratio of 0.018.

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for

management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

Maine 50% incidence at 100 ha, but periphery species there (see Vickery et al. 1994 below). New York minimum area 16.2 ha but mean 49.1 ha. Another study in NY found GRSP in fields 4.6 -17.4 ha (only in cool-season grasses). Missouri minimum area of 1-10 ha and Illinois 10-30 ha. Abundance increases with field size.

Vickery, P. D. 1996. Grasshopper Sparrow (Ammodramus savannarum). In The Birds of North America, No. 239 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Minimum area requirements in Maine was 100 ha, Illinois 30 ha. Historically found in natural clearings a few ha in size. Pennsylvania territories average 0.8 ha, Connecticut 0.66 ± 0.39 (SE) ha in 1986 (*n* = 11) and 0.78 ± 0.24 (SE) ha in 1987, Wisconsin 0.85 ha, Michigan 1.4 ha, Florida 1.8 ± 0.96 ha. Western PA territories 0.19 ± 0.13 SD, W. Virginia 0.32 ha, s. California 0.37 ± 0.16 SD. Territories shift during breeding season with arrival of late males. Males sing >50 m from nest.

Vickery, P. D., M. L. Hunter, Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4): 1087-1097.

In Maine, Grasshopper sparrows reached 50% incidence at 100 ha, which may differ from other areas due to rarity of species in Maine.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Gray-cheeked Thrush

Feature Label	Occurrence Area
Non-breeding	25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Gray-cheeked thrushes do not breed in NJ, so no breeding buffer was chosen. Based upon the radio-telemetry study on spring migrants, a 25-meter occurrence area was chosen for non-breeding gray-cheeked thrushes.

Literature supporting occurrence area(s):

Lowther, P. E., C. C. Rimmer, B. Kessel, S. L. Johnson, and W. G. Ellison. 2001. Gray-cheeked Thrush (*Catharus minimus*). *In* The Birds of North America, No. 591 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Little information about migratory stopover habitat. “May be sighted in any treed or shrubby area, even in city parks and suburban gardens” (Ouellet 1996: 1170). Favors well-wooded sites with thick understory or shrub layer, scarcer in more open woodlands, and infrequent in places with sparse or no canopy (WGE)—habitats structurally similar to those used on breeding grounds (above). Mist-net capture of migrant on 1 Jun 2000 in montane fir forest on Mt. Mansfield, VT, at

1,125 m elevation (CCR) suggests selection of breeding-like habitat. Reports from scrub and shrub habitats in Colombia and n. Venezuela seem referable to migrants (Paynter 1995). In an Illinois radio-tracking study, 8 spring migrants confined daytime activities to 0.04–0.20-ha areas

Breeding habitat consists of areas with closed canopy of medium-height shrubs combined with a dense woody undergrowth

Last researched by Sharon Petzinger in Feb 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Great Blue Heron

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, radius of 71.25 meters (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	12 km (7.5 mile) radius around nesting colony.
Roosting Area (Non-breeding)	Mapped extent, if available, otherwise, radius of 71.25 meters (seconds precision circle) around roosting area point.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

Nesting area is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default “seconds precision” circle was used around the recorded nesting location point

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the “energetically feasible” foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as “critical” foraging habitat for a particular nesting colony. Conversely, using an

average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

The average foraging flight for great blue herons has been firmly established in the literature. The average foraging flight has been observed at 2.3 km – 6.5 km (Butler 1991, Custer and Galli 2002, Dowd and Flake 1985, Parris 1979, Thompson 1978). The range of distance flown falls between <1 km- 27 km (Custer and Galli 2002, Thompson 1978). Although great blue herons have been recorded feeding as far away as 27 km, three studies found that the majority (at least 50%, and in one study 85%) of nesting herons fed within 4 or 5 km of the colony (Custer et al. 2004, Dowd and Flake 1985, Thompson 1978). Kelly, et al (1993) found that > 95% of great blue herons in their study fed within 20 km of the colony. The NatureServe minimum inferred extent is 3 km (NatureServe 2006). We apply a 12 km radius around a colony to protect foraging areas, which is likely to capture the majority of the foraging habitat for that colony.

Literature supporting occurrence area(s):

Butler. 1991. Habitat selection and time of breeding in the Great Blue Heron. PhD dissertation. University of British Columbia, Vancouver.
The average foraging commute in this study is btw. 2.3-6.5 km.

Custer, C.M., J. Galli. 2002. Feeding habitat selection by Great Blue Herons and Great Egrets nesting in east central Minnesota. Waterbirds 25(1): 115-24.
In a study conducted in Minnesota great blue herons flew a median distance of 2.7 km (n=63) from their colony to a foraging area. The range of distances flown fell between <1 km – 27 km. Most wetlands that herons were located at were >350 ha.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.
The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.
A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.
> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
Inferred minimum extent of habitat use (when actual extent is unknown) is 3 km. This is based on a low mean foraging rate for this group.

Parris. 1979. Aspects of Great Blue Heron foraging ecology in southwest Lake Erie. MS Thesis. Ohio State University, Columbus, Ohio.
The average foraging commute in this study is btw. 2.3-6.5 km.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Gull-billed Tern

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, 71.25 meter radius (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	4.8 km (3 mile) radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:
Gull-billed terns are unique among the breeding terns in New Jersey in that their primary prey items are not small fish. Fish are part of their diet, but they are more likely to consume lizards, insects and chicks of other species (Parnell, et al. 1995). Therefore when looking at the areas to be valued by this model, special attention should be paid to the marsh islands that lie within the radius of the nesting colony, instead just the open water that other tern models value. No species specific information is available for the foraging commute of this species. NatureServe recommends a minimum inferred extent of 2 km, noting that this is a conservative estimate (NatureServe 2006). Considering the paucity of information available we chose to stay consistent with other *Sterna* species and we apply a 4.8 km buffer around the colony to protect foraging areas.

Literature supporting occurrence area(s):

Parnell, J.F., R.M., Erwin, K.C. Molina. 1995. Gull-billed tern (Sterna nilotica). In The Birds of North America, No. 140 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia and The American Ornithologist's Union, Washington, D.C.

Unlike other terns nesting in the coastal marshes of New Jersey this species does not feed primarily on fish but instead consumes lizards, insects, and sometimes chicks of other species.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).

The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 2 km. The authors note that this is a conservative estimate.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Henslow's Sparrow

Feature Label	Occurrence Area
Breeding	75 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.18 – 1 ha but have an upper confidence limit of 0.83 ha (Herkert 2001, Herkert et al. 2002). The breeding occurrence area was chosen based on the upper limit territory size and increased to account for shifting territories during the breeding season (Herkert et al. 2002). Little is known about migratory stopover habitat use, so the default buffer was chosen.

Literature supporting occurrence area(s):

Herkert, J. R. 1998 (revised 2002). Effects of management practice on grassland birds: Henslow's Sparrow. Northern Prairie Wildlife Research Center, Jamestown, ND. 17 pages.

Individual territories range from 0.18 – 1 ha. In Kansas and New York, HESP are found in areas > 30 ha of grasslands. Illinois had 50% incidence in areas >55 ha. Another study in New York had HESP in areas > 8 ha. Largest patches occupied first, but patches < 50 ha can also be used for breeding. Isolated patches may also affect use of patch – used 16-ha patch that was within 1.6km of larger occupied patch, but absent from 28-ha isolated patch. Territory size in Michigan was 0.3 ha, 0.7 ha ± 0.26 SD (*n* = 4) in Wisconsin, 0.18 ha ± 0.05 SD (*n* = 22) in w PA. Territories shift during breeding season.

Herkert, J. R., P. D. Vickery, and D. E. Kroodsma. 2002. Henslow's Sparrow (Ammodramus henslowii). In The Birds of North America, No. 672 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Average territory size was 0.3 ha in Michigan, 0.7 ha ± 0.26 SD (*n* = 4) in Wisconsin, and 0.18 ha ± 0.05 SD (*n* = 22) in w. Pennsylvania. Males tend to shift territories throughout the breeding season. In Robins' (1971a) study, 10 males had only 1 territory that appeared to remain stable throughout breeding season, 2 maintained 2 successive territories, 2 had 3 territories, and 4 had 4 territories.

Approximately 50% of foraging trips by both sexes were beyond territorial borders defended by males. Males and females tended to forage in separate areas within or close to the home territory; mean distances of males flying from the nest to forage was 30.8 m ± 4.3 SD, of females 24.9 m ± 2.1 SD.

Migratory stopover habitat includes brushy places, along hedgerows, at edges of shrubby places as well as in grassy fields, prairies, and wet meadows

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

There were 5 studies in New York: one had minimum area of 36 ha and mean of 66 ha, another minimum of 33.2 ha and mean 51.7 ha, another had habitat size ranging from 4.5 – 8.7 ha, another between 3 and 20 ha, and another stating that at low population numbers Henslows may require larger patches than actual minimum. In Illinois, habitat size ranged from 10-30 ha with 50% incidence at 55 ha. Missouri habitat size ranged from 10 – 100 ha.

Pruitt, L. 1996, Henslow's Sparrow Status Assessment. USFWS, Bloomington, IN.
This species can possibly breed in New Jersey and was confirmed breeding in the 1980s. They do, however, migrate through New Jersey.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Hooded Warbler

Feature Label	Occurrence Area
Breeding	250 meter radius
Non-breeding	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.5 – 0.75 ha in size and females may utilize areas 200 meters from their territories to care for post-fledging chicks (Evans Ogden and Stutchbury 1994). Based upon a median territory of 0.62 ha and adding the 200-meter post-fledging distance, a breeding occurrence area of 250 meters is recommended for this species. Although hooded warblers are territorial on their wintering grounds, little is known about their migrating behavior. Therefore, the default occurrence area was chosen for non-breeding hooded warblers.

Literature supporting occurrence area(s):

Evans Ogden, L. J. and B. J. Stutchbury. 1994. Hooded Warbler (*Wilsonia citrina*). *In* The Birds of North America, No. 110 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Breeding territories range from about 0.5–0.75 ha in size. Nearest neighbor distance in a high density population averages (± SE) 99–112 m. Males and females feed mainly on their territory, with males making forays off the territory for extra-pair mating attempts. Female not known to furtively leave their territories during their fertile period (D. Neudorf and BJS unpubl. data).

Females may take fledged broods some distance (200 m) from natal territory, while males generally feed their portion of brood on or near natal territory.

Inhabits a variety of forested habitats with an area > about 15 ha. Territories usually include small clearings where a shrub understory is available for nesting, and females often place nests in shrub at forest edge. Typically inhabit mature forests where trees are large enough to create significant tree fall gaps. Commonly invades selectively logged deciduous forests 1–5 yr after harvesting, and remains as long as there is suitable understory shrubs for nesting. In some cases, local populations have declined dramatically as shrub layer disappeared. Often associated with moist woodlands and ravines. Found breeding at elevations of 1,100 m, but more abundant at lower elevations.
Deciduous forests occupied usually dominated by maple, beech, or oak. A typical high-density population in nw. Pennsylvania occupies a selectively logged habitat with major overstory trees of beech, sugar maple, black cherry, and hemlock; principal understory trees and shrubs at this site include blackberry, cherry, prickly gooseberry, maple-leaf viburnum, and common spicebush. S. Ontario population occupied a deciduous forest with a canopy height of 28 m, canopy cover of 88%, and shrub cover of 87%. This site consisted of several dominant species in shrub layer: maple-leaf viburnum, red and black raspberry, white ash, choke cherry, and red maple.

Stopover sites include "cheniers" (coastal woodlands) along sw. coast of Louisiana and wooded islands along the coasts of Alabama, Mississippi, and e. Louisiana. Cheniers support luxuriant vegetation dominated by hackberry and live oak. Favors holly forests in s. New Jersey.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Horned Lark

Feature Label	Occurrence Area
Breeding	150 meter radius
Migrant	150 meter radius
Wintering	150 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Territories range from 0.008 – 5.1 ha (Beason 1995, Dinkins et al. 2000) and there is no minimum patch size (Dinkins et al. 2000, Mitchell et al. 2000). The breeding occurrence area is based upon the upper limit of the largest mean territory size and increased to incorporate the mobility of the species. The migrant and wintering occurrence areas are based upon the wandering flocks formed while migrating and wintering.

Literature supporting occurrence area(s):

Beason, R. C. 1995. Horned Lark (*Eremophila alpestris*). *In* The Birds of North America, No. 195 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Territories range from 0.6 – 3.1 ha in the midwest, 0.3 – 5.1 ha in Colorado. Territory size is related to density of males in a patch. Adults will fly 40 meters to discard fecal sacs and land 20 m from nest and walk in to feed young. Wintering birds are not territorial and form large flocks that are nomadic and wander over large areas for food.

Migratory stopover habitat is similar to breeding habitat but with increased use of beaches and sand dunes; also mowed areas such as airfields. North American flocks of migrants often intermix with resident conspecifics, and even form mixed-species flocks with other migrants such as longspurs and buntings. Wintering habitat is similar to habitats occupied during breeding and migration periods. In Oklahoma, for example, the shortest vegetation available, in Massachusetts, ocean beaches, sand dunes, airfields. Frequently concentrated along roadsides when ground is covered with deep snow.

Dinkins, M. F., A. L. Zimmerman, J. A. Dechant, B. D. Parkin, D. H. Johnson, L. D. Igl, C. M. Goldade, and B. R. Euliss. 2000 (revised 2002). Effects of management practices on grassland birds: Horned Lark. Northern Prairie Wildlife Research Center, Jamestown, ND. 34 pages.

Colorado territories in lightly-grazed pastures ranged from 0.3 – 1.5 ha and average 0.7 ha; heavily grazed pastures had territories ranging from 1 – 1.7 ha and average 1.5 ha; mixed-grass pasture average 1.1 ha; idle mixed-grass averaged 1.6 ha. Midwestern cropland territories ranged from 0.6 – 3.1 ha and averaged 1.6 ha; hayland territories ranged 1 – 2.5 ha. One Illinois territory was 0.008 ha. Found on patches < 10 ha in Illinois.

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

Areas range from 1-10 ha

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Kentucky Warbler

Feature Label	Occurrence Area
Breeding	200 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 1.21 to 3.75 ha with an average 2.21 ha, and adults tend to forage off territories. Furthermore, fledglings will travel up to 200 m from the nest a week after fledging. The breeding occurrence area was chosen to incorporate post-fledging habitat. There is little information about migrating individuals, so the default occurrence area will be used for migrating species.

Literature supporting occurrence area(s):

McDonald, M. V. 1998. Kentucky Warbler (*Oporornis formosus*). *In* The Birds of North America, No. 324 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Breeds in bottomland hardwoods and woods near streams with dense understory, often at low elevations. Rarely observed in agricultural habitats. Well-developed ground cover for ground nesting, and a thick understory, are essential. Studies of forest fragmentation in Missouri indicate that blocks of suitable habitat (at least 500 ha) are necessary for successful breeding. An analysis of floristic, structural, isolation, and area variables of forest fragments on coastal plain of Maryland found that forest area, independent of its covariates, strongly affected presence/absence of Kentucky Warbler.

Breeding-ground territories function as nesting and foraging areas that pairs (or unmated males) occupy nearly exclusively through breeding season, although after fledging young may wander into neighboring territories and parents follow, often unchallenged (perhaps undetected) by neighbors. Early in breeding season, adults of both sexes sometimes forage off their territories, and seek extra-pair copulations (MVM) as distantly as 500 m, but more often within 100 m of home. In Virginia, average territory size is 2.21 ha (range 1.21–3.75, n = 493). Young travel up to 200 m from nest within 1st week of fledging.

Little known about migratory habitat. May occur in suburban gardens and city parks.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

King Rail

Feature Label	Landscape Model
Confirmed/Known Breeding Location	Mapped extent of occurrence or 100 meter radius.
Suspected Breeding Location	Mapped extent of occurrence or 100 meter radius.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification text:

There is very little information on the home ranges of king rails, so the models are based on a similar species, the clapper rail, for which many studies have been conducted. Clapper rail home ranges are widely reported in the literature and vary by study. Studies from Arizona, California and Louisiana report average breeding season home ranges between 0.40-6 ha (Eddleman 1988, Eddleman 1989, Zembal et al. 1989, and Sharp 1976). Other studies from South Carolina, Virginia and Louisiana report average breeding season home ranges between 31-487 m (Bland 1963, Conway, et al. 1993, Meanley 1985 and Roth et al. 1972). Additionally, males maintain slightly larger home ranges than females (Eddleman 1989). In New Jersey, a six-year study revealed a nesting density of 1-1.16 per ha (Mangold 1974). NatureServe has set a minimum extent at 0.1-km (NatureServe 2006). We are accepting the NatureServe minimum inferred extent of 0.1 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Bland. 1963. Renesting and multiple brooding studies of marked clapper rails. Proc. Ann. Conf. Southeast Game and Fish Commission 17"60-68.

The range of values for the home range of clapper rails in South Carolina was 183-274 m.

Conway, et al. 1993. Seasonal changes in Yuma clapper rail vocalization rate and habitat use. Journal of Wildlife Management 56:282-90.

The average movement per day (in meters) of the clapper rail varied throughout the year. In Jan-Feb, the average movement was 140 m (n=88). In Mar-Apr it was 155 m (n=151). In May-Jun it was 111m (n=495). In Aug-Oct it was 121 m (n+305). In Nov-Dec it was 161 m (n=57).

Eddleman, W.R. 1988. Conservation of North American Rallids. Wilson Bulletin 100: 458-475.

The average home range size of clapper rails in Arizona was 3-6 ha.

Eddleman, W.R. 1989. Biology of the Yuma clapper rail in the southwest United States and northwest Mexico. Final Report, Intra-Agency Agreement No. 4-AA-30-02060, US Bureau of Reclamation, Yuma Project Office, Yuma, Arizona.

In Arizona, the average home range for males was 24 ha $\pm$ 15.7 ha SD (n=6) and 21 ha $\pm$ 8.7 ha SD (n=8) in January and February. During incubation, the average home range for males was 3.6 ha $\pm$ 2.8 ha SD (n=4) and 2.2 ha $\pm$ 1.8 ha SD for females.

Eddleman, W.R., Conway, C.J. 1998. Clapper rails (*Rallus longirostris*). In the Birds of north America, No. 340 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.
The volume for clapper rails presents a range of values for home range of 0.12-3.59 ha in Arizona.

Kozicky, E.L., F.W. Schmidt. 1949. Nesting habits of the clapper rail in New Jersey. Auk 66:355-64.
If a barrier (such as vegetation) was present, the minimum distance between nests in New Jersey was 13 m. If no barrier was present, the minimum distance between nests was 23 m.

Mangold. 1974. Clapper rail studies. 1974 Final Report, USFWS Accelerated Research Program. Contract No. 14-16-0008-937. Trenton, NJ.
Density of clapper rails nesting in New Jersey ranged between 1-1.6 per ha during a six year study.

Meanley, B. 1985. The marsh hen: A natural history of the clapper rail of the Atlantic coast salt marsh. Tidewater Publishing. Centreville, MD.
The smallest territory observed for a clapper rail in Virginia was 0.1 ha.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
The inferred minimum extent of habitat use (when actual extent is unknown) is 0.1 km.

Roth, R.D., J.D. Newman, L.L. McNease.1972. The daily and seasonal behavior pattern of the clapper rail in the Louisiana coastal marshes. Proc. SE Assoc. Game Fish Commission. 26:136-59.
In December- February in Louisiana, the mean max. movement of clapper rails along canals was 154 ± 37m SD to 487 ± 467 SD. The mate of an incubating clapper rail was usually within 15 meters of the incubating bird (and therefore the nest).

Sharp. 1976. Predation and distribution of the clapper rail in a Louisiana salt marsh. MS Thesis, Louisiana State University, Baton Rouge, Louisiana.
In Louisiana the average breeding home range of clapper rails was 0.53 ha and the average daily home range was 0.44 ha (n=3).

Zembal, et al. 1989. Movements and activity patterns of light-footed clapper rails. Journal of Wildlife Management 53:39-42.
The home range of clapper rails in California ranged from 0.4-1.7 ha. Individuals only used a small portion during a single day and the home range of adjacent individuals overlapped considerably.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Least Bittern

Feature Label	Landscape Model
Confirmed/Known Breeding Location	Mapped extent of occurrence or 175 meter radius
Suspected Breeding Location	Mapped extent of occurrence or 175 meter radius

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification text:

Very little research has been conducted on this secretive marsh bird. One telemetry study in New York reported a mean home range for adults was 9.7 ha with a range of 1.8 ha – 35.7 ha. NatureServe does not suggest an inferred extent for this species. The New York Study appears to be the most relevant to New Jersey. A mean home range of 9.7 ha equates to a circle of radius 0.175km. We will use this value as an "inferred extent" until such time as we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Bogner, H.C., G.A. Baldassarre. 2002. Home range, movement and nesting of least bittern in western New York. Wilson Bulletin 114(3): 297-308.

A telemetry study in New York tracked 33 adults and 12 chicks. The mean home range of the adults was 9.7 ha, with a range of 1.8-35.7 ha (which depended on whether the birds used one or two breeding sites per season). The mean movement of the chicks was 13.4 m between capture and 23 days post-hatch and 29.4 m between 24-27 post-hatch.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Least Flycatcher

Feature Label	Occurrence Area
Breeding	100 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.01 – 0.38 ha. Furthermore, fledglings will use areas within 100 meters of a nest in the first month of fledging. The breeding occurrence area was chosen to incorporate the territory size and the post-fledging habitat.

Non-breeding least flycatchers are listed as stable in NJ so no occurrence area was chosen.

Literature supporting occurrence area(s):

Briskie, J. V. 1994. Least Flycatcher (*Empidonax minimus*). *In* The Birds of North America, No. 99 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Mean territory size in Ontario: 0.13 ± 0.10 ha (range 0.03–0.38, *n* = 10); in New Hampshire: 0.18 ± 0.01 ha (*n* = 59); in Michigan: 0.07 ha (range 0.01–0.20, *n* = 33). Area utilized by flycatchers for foraging, however, generally exceeds that defended by territorial male. Size of territory decreases after laying.

Despite defense of exclusive territories, most flycatcher territories distributed in dense aggregations or "colonies," leaving apparently adjacent suitable habitat unoccupied. Amount of forest occupied by aggregations averaged 18.05 ± 3.38 ha (range 1.65–38.5) in Michigan. MacQueen (1950) observed that large open areas near territory aggregations sometimes used as neutral feeding grounds by all flycatchers nesting nearby and suggested such behavior may decrease intraspecific conflict and size of individual territories. Use of neutral feeding areas not reported by other workers and requires further study.
Territories of Least Flycatchers overlap extensively with those of other flycatcher species (e.g., Eastern Phoebe [*Sayornis phoebe*], Great Crested Flycatcher, and Eastern Wood-Pewee; Johnston 1971); however, flycatchers often exclude American Redstarts via interspecific aggression, leading to partial interspecific territoriality. Both Least Flycatchers and American Redstarts have converged on ecological niche of flycatching—both species overlap significantly in body size, bill morphology, foraging behavior, and patterns of habitat exploitation. Most important method of ecological segregation through horizontal spatial separation (i.e., decreased overlap of territories; Sherry 1979). Degree of interspecific territoriality varies with redstart age: adult redstarts overlap territories less than second-year redstarts.

Fledglings generally recaptured within 100 m of nest site until 10–14 d after leaving nest; thereafter gradually dispersing so that by 20–24 d post-fledging they are about 500 m from nest, and by 30–34 d > 800 m from nest.

No published studies of habitat use during migration. Ely (1970) noted migrating Least Flycatchers in w.-central Kansas generally confined to wooded habitats along water courses, gullies and windbreaks, although occasionally found in tall weed growth and isolated trees.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Least Tern

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, 71.25 meter radius (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging Area	4.8 km (3 mile) radius.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Least terns nest primarily on Atlantic coast beaches in New Jersey, with the exception of a few inland nesting sites in areas such as abandoned sand mines and airports. In coastal colonies in Georgia, least terns foraged up to 4.9 km from colony locations (Tomkins 1959). In California, least terns in coastal colonies preferred foraging in the ocean as opposed to other non-ocean foraging options. In that study, 90-95% of the terns foraged within 1.6 km of the shoreline, and were never observed at distances of greater than 3.2 km (Atwood 1983). At interior sites, Schweitzer found that least terns would forage up to 12 km from nesting sites (Schweitzer 1994). The majority of observed least terns along the Missouri River foraged within 100-200m from nesting sites and the maximum sighting was 4.5 km away (Hill 1993). In some locations, least terns will nest on rooftops. At a rooftop nesting site in Mississippi, terns foraged up to 4.5 km away (Jackson 1994). NatureServe (2006) does not make any recommendations for inferred minimum extents.

Literature supporting occurrence area(s):

Atwood, J.L., D. E. Minsky 1983. Least Tern foraging ecology at three major California breeding colonies. West. Birds 14: 57–71.

Approximately 75% of surveyed least terns in coastal California colonies foraged in the ocean as opposed to other bodies of water. Approximately 90-95% of the birds feed within 1.6 km of the shoreline in water less than 18.2 meters in depth. They were rarely observed foraging between 1.6 - 3.2 km offshore and were never observed at greater distances than 3.2 km miles.

Hill, L.A. 1993b. Design of constructed islands for nesting interior Least Terns. Pp. 109–118 in Proceedings of the Missouri River and its tributaries: Piping Plover and Least Tern Symposium (K. F. Higgins and M. R. Brashier, eds.). South Dakota State Univ., Brookings, SD.

Least terns in interior areas forage primarily in 100–300 m from riverine nesting sites. However, they may forage in areas up to 4.5 km away.

J. A. Jackson 1994. Terns on tar beach. Natural History 103(7): 46–53.

Least terns foraged 4.5 km from rooftop nest sites in Mississippi.

Schweitzer, S.H. 1994. Abundance and conservation of endangered interior Least Terns nesting on salt flat habitat. Ph.D. diss., Oklahoma State Univ., Stillwater.

In response to localized abundance of suitable fish, terns foraged up to 12 km from inland salt flat colonies.

Tomkins, I.R. 1959. Life history notes on the Least Tern. Wilson Bulletin 71: 313–322.

Nesting least terns foraged up to 4.9 km away when carrying food to a colony in Georgia.

Last researched by Christina Kisiel in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Little Blue Heron

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, buffer of 71.25 meters (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	13.1 km (8.1 mile) radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Nesting area is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default "seconds precision" circle was used around the recorded nesting location point.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the "energetically feasible" foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as "critical" foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

Research in North Carolina found that 84% of breeding long-legged waterbirds flew to foraging areas, which is why habitat outside the vicinity of the colony must be valued as crucial to the success of the colony (Custer and Osborn 1978).Foraging commuting distances for little blue herons are highly variable, likely due to factors such as prey availability and water depth and fluctuation (Rodgers and Smith 1995). This variability can be observed in the flowing studies. In Florida, the average commuting distance was found to be 10.2 km (Bancroft et al. 1990). In North

Carolina, the average distance was 2.9 km (Custer and Osborn 1978). NatureServe recommends a minimum inferred extent of 3 km and justifies it by noting a low mean foraging range size for this group (NatureServe 2006). We apply a 13.1 km radius around a colony to protect foraging areas.

Literature supporting occurrence area(s):

Bancroft, G. T., S. D. Jewell, A. M. Strong. 1990. Foraging and nesting ecology of herons in the lower everglades relative to water conditions. Final report to South Fla. Water Manage. Dist., West Palm Beach, FL.

In Florida, the average commuting distance of little blue herons to foraging sites from a marsh island colony was 10.2 km.

Custer, T. W., R. G. Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. Auk 95: 733–743

In North Carolina, little blue herons commuted an average of 2.9 km from a coastal colony to foraging sites.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.

The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.

A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.

> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).

The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 3 km. For the breeding season, this figure is based on a low mean foraging range size for this group.

Rodgers, J. A., Jr., and H. T. Smith. 1995. Little Blue Heron (Egretta caerulea). In The Birds of North America, No. 145 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Choice of foraging sites and length of time a particular area is used are highly variable, depending on prey available, water depth, and water-level fluctuation. Flight distance to foraging sites varies among studies, probably reflecting food availability.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Loggerhead Shrike

Feature Label	Occurrence Area
Migrant	250 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Little is known about the occurrence of this species in New Jersey, but it is unlikely that this species breeds in New Jersey (Pruitt 2000). Elsewhere, territories ranged from 2.7 to 34 ha (Dechant et al. 1998, Yosef 1996). The occurrence area was chosen based upon the upper range of territory size.

Literature supporting occurrence area(s):

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, M. P. Nenneman, A. L. Zimmerman, and B. R. Euliss. 1998 (revised 2002). Effects of management practices on grassland birds: Loggerhead Shrike. Northern Prairie Wildlife Research Center, Jamestown, ND. 19 pages.

Territories 6-9 ha averaging 2.7 ha in Alberta to 25 ha in Idaho. Alberta ROW territories were 8.5 ha. Average Missouri territories were 4.6 ha.

Pruitt, L. 2000. Loggerhead Shrike Status Assessment. USFWS, Bloomington, IN.
This species has not been documented breeding in New Jersey since the early 1900s. It is a partial migrant only in northern part of range and migration may depend on severity of winter and food availability in breeding habitat during wintertime. Stopover sites are different in spring than fall and individuals may migrate between wintering sites.

Winter habitat is not different from breeding habitat. May move from pastures to more shrub-forest habitat in winter, particularly when snow-covered. Could also use more cropland in winter.

Yosef, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*). *In* The Birds of North America, No. 231 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Breeding territories averaged 13.4 ha in Alberta, 34 ha in California, 4.6 ha in Missouri, 7.5 ha in New York, 8.35 ha in Florida, and 8.9 ha and 25 ha in Idaho. No information on minimum patch size was provided. Breeding territories maintained year-round in Florida and S. Carolina, but not in California.

No information provided on migratory habitat – assume similar to breeding habitat. Winter habitat also similar to breeding habitat but hay fields and idle pastures used in addition to scrub-shrub and open forest habitat.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Long-eared Owl

Feature Label	Species Occurrence Area
Nest	400 meter radius
Sighting - Breeding	400 meter radius
Roosting Area – Non-breeding	400 meter radius
Sighting – Non-breeding	400 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification text:

No information was found regarding home range/territory sizes for long-eared owls in the northeast. Reported home ranges for this species are highly variable and range from 0.7 – 20.25 km^2 (Kirschbaum and Ivory 1999). Craighead and Craighead (1956) reported home ranges for long-eared owls in Wyoming ranging from 34 – 106 ha with an average of 51 ha. Knight and Erickson (1977) estimated breeding densities along the Columbia River to be approximately 1 pair/12 linear km. Along the Snake River in Idaho an average of 0.28 – 0.42 nesting pairs per square km was estimated, as compared to areas in southern Idaho where from 0.64 – 1.55 pairs per square kilometer where found (Marks 1986). Due to the paucity of information on home range for long-eared owls, especially in the northeast, a conservative home range estimate of 50 ha has been adopted based on the available literature.

Literature supporting occurrence area(s):

Craighead, J.J., and F.C. Craighead, Jr. 1956. Hawks, owls and wildlife. Stackpole Books, Harrisburg, PA. 443pp.

Home ranges in Wyoming ranged from 34 – 106 ha with an average of 51 ha.

Kirschbaum, K.,and A. Ivory. 1999. Asio Otus (On-line) Animal Diversity Web. Accessed April 4, 2007 at http://animaldiversity,ummz.umich.edu/site/accounts/information/Asio_otus.html **.**

Reported that home ranges were highly variable and ranged from 0.7 – 20.25 square kilometers.

Knight, R.L., and A.W. Erickson. 1977. Ecological notes on long-eared and great horned owls along the Columbia River. Murrelet 58:2-6.

Reported 1 pair per 12 linear kilometers of riparian habitat in Washington.

Marks, J.S. 1986. Nest site characteristics and reproductive success of long-eared owls (*Asio otus*) in southwestern Idaho. Wilson Bull. 98:547-60.

Reported home ranges in Idaho along the Snake River ranging from 238 to 357 ha. Elsewhere in southeastern Idaho home ranges varied from 65 to 155 ha.

Marks, J. S., D. L. Evans, and D. W. Holt. 1994. Long-eared Owl (*Asio otus*). *In* The Birds of North America, No. 133 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Two breeding pairs were tracked for 8-9 nights and were found to use a core area within 1 km of the nest with occasional forays up to 3 km from the nest.

Last researched by Mick Valent in spring 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Migratory Raptor Concentration Site

Feature Label	Occurrence Area
Concentration Site	Mapped extent of concentration area.

Occurrence Area Rule: Mapped as polygons only, which are the occurrence areas.

Justification:

Mapped polygons represent all non-urban habitat (2002 NJDEP LU/LC) in the lower 10 kilometers of the Cape May peninsula.

Literature supporting occurrence area(s):

McCann, J. M., S. E. Mabey, L. J. Niles, C. Bartlett, and P. Kerlinger. 1993. A regional study of coastal migratory stopover habitat for Neotropical migrant songbirds: Land management implications. Trans. N. Amer. Wildlife and Natural Resources Conf. 58:398-407.

Niles, L.J., J. Burger, and K. E. Clark. 1996. The influence of weather, geography, and habitat on migrating raptors on Cape May peninsula. Condor 98:382-394.

Last researched by Kathy Clark in July 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Migratory Shorebird Concentration Site

Feature Label	Occurrence Area
Migratory Concentration	Mapped extent of concentration area, if available, otherwise, radius of 71.25 meters (seconds precision circle) around confirmed/known concentration area point.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

Not available.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Nashville Warbler

Feature Label	Occurrence Area
Breeding	60 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Little information is known about breeding territories of Nashville warblers, so the breeding occurrence area was chosen based on what was available – the territory size of 1.1 ha (Williams 1996). The nonbreeding population is listed as stable, so no occurrence area was chosen.

Literature supporting occurrence area(s):

Williams, J. M. 1996. Nashville Warbler (*Vermivora ruficapilla*). *In* The Birds of North America, No. 205 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Breeding territory in East: 5–15 pairs/40.5 ha in Vermont. In subalpine area in White Mtns. of New Hampshire, territory size 1.1 ha, with 9 pairs (± 3 SE)/km2; in nearby area of virgin spruce grove, density increased to 24 pairs/km2. During spruce-budworm outbreak in Maine and New Hampshire, territorial density >0.5 territories/ha.

Prefers second growth, open deciduous, or mixed-species forests, with high level of light penetration; preferably with shrubby undergrowth. Never found in unbroken forest. In New York, nests in mixed forests, edges, and fields. In the East, sometimes inhabits mountains slopes, including fairly steep ones, as high as 1,400 m, but not above timberline. Nests farther south are found in drier, more open, cut-over areas and in second-growth forests, especially with aspen, birch, and alder (*Alnus*).

During migration, frequents deciduous trees or shrubs in open mixed forests at mid-canopy level, bushy edges of woodlands along streams, roads, and paths, or edges of fields, meadows, and ponds, swamps, or marshes. Often seen in mixed-species flocks in both spring and fall migration.

Last researched by Sharon Petzinger in Feb 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Goshawk

Feature Label	Occurrence Area
Sighting (Non-Breeding)	1.0 km radius
Sighting (Breeding)	1.0 km radius
Nest	1.0 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

Northern goshawks' home range sizes vary both seasonally and by sex. Males generally have larger territories than females, although there are exceptions, and both sexes have larger territories during the non-breeding season than during the breeding season (Squires and Reynolds 1997). Breeding habitats are more selective, the hawks preferring large, contiguous tracts of mature forests and forested wetlands (Squires and Reynolds 1997, Bosakowski and Speiser 1994), while non-breeding habitats may also include young forests, scrub-shrub habitats and ecotones between forest and open fields and agricultural lands (Squires and Reynolds 1997, Bosakowski and Speiser 1994). Results from research on home ranges sizes vary greatly and no home range size determination has been developed for eastern populations. However, due to the similarity in habitat preferences and behavior of northern goshawks and red-shouldered hawks in NJ and NY (Bosakowski and Speiser 1994), the same occurrence area will be used as a conservative estimate of northern goshawk critical habitat until new research suggests differently.

Literature supporting occurrence area(s):

Squires, J. R., and R. T. Reynolds. 1997. Northern Goshawk (*Accipiter gentilis*). *In* The Birds of North America, No. 298 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

- **Home range studies varied in methodology and focused on western populations of northern goshawks:**
  - **Arizona males' ranges varied from 1,758 ha ± 500 (std. dev.) (range 896 – 2,528 ha).**
  - **New Mexico males' ranges varied from 2,106 ha ± 635 (std. dev.) (range 1,698 – 2,837 ha); New Mexico females' ranges varied from 569 ha ± 473 (std. dev.) (range 95 – 1,292 ha).**
  - **California males' ranges varied from 1,340 ha ± 810 (std. dev.) (2 males, one with 1,790 ha range and 3,010 ha range).**
  - **Northern California males' ranges varied from 2,425 ha (1,083 ha – 3,902 ha); Northern California females' ranges varied from 3,774 ha (2,007 – 6908 ha).**

Bosakowski, Thomas and Robert Speiser. 1994. Macrohabitat Selection by Nesting Northern Goshawks: Implications for Managing Eastern Forests. Studies in Avian Biology. 16:46-49.

Last researched by Kris Schantz in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Harrier

Feature Label	Occurrence Area
Nest	500 meter radius
Foraging (Breeding)	500 meter radius
Sighting (Breeding)	500 meter radius
Foraging (Non-breeding)	300 meter radius
Sighting (Non-breeding)	300 meter radius

Occurrence Area Rule: Observations for all feature labels are mapped as points, which then receive the radii specified above.

Justification:

Breeding territories range from about 1 ha to over 1,500 ha (Dechant et al. 1998, MacWhirter and Bildstein 1996). The breeding occurrence area was chosen based upon evidence of large territories, the distance traveled for foraging, and the mobility of the species (Dechant et al. 1998). The non-breeding occurrence area was chosen based upon evidence of smaller territories (MacWhirter and Bildstein 1996) than breeding territories and the mobility of the species. No minimum patch size was chosen due to evidence that harriers will use smaller patches (Dechant et al. 1998).

Literature supporting occurrence area(s):

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, M. P. Nenneman, and B. R. Euliss. 1998 (revised 2002). Effects of management practices on grassland birds: Northern Harrier. Northern Prairie Wildlife Research Center, Jamestown, ND. 15 pages.

In North Dakota, uncommon in areas < 100 ha. In Illinois, nested in grasslands 8-120 ha in size. May respond to total amount of grassland in area instead of patch size – small fragments may be used if located near larger patches. Missouri nesting density: 121 ha per pair. Male home ranges averaged 890 ha. In Manitoba males defended 27.7 ha centered on nest. In Minnesota traveled over 259 ha to hunt. Idaho territories averaged 1570 ha for males and 113 ha for females.

MacWhirter, R. B., and K. L. Bildstein. 1996. Northern Harrier (*Circus cyaneus*). *In* The Birds of North America, No. 210 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Not very territorial except of the nest. In New Brunswick male breeding territories were 100 ha, female territories 10 ha. In Idaho, male territories were 0.8 ha. Nonbreeding territories were 65 ha in SE US, California ranged from 3.9 – 125 ha and a mean of 33.6 ha.

Last researched by Sharon Petzinger in winter 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Parula

Feature Label	Occurrence Area
Breeding	50 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.08 – 0.65 ha. The breeding occurrence area was chosen based upon the upper limit territory size. Non-breeding individuals are listed as stable in NJ so no occurrence area was chosen.

Literature supporting occurrence area(s):

Moldenhauer, R. R., and D. J. Regelski. 1996. Northern Parula (*Parula americana*). *In* The Birds of North America, No. 215 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Primarily a riparian species; usually associated with mature forest with epiphytic growth. Prefers tall, mature coniferous forests with spruce, hemlock, and fir in moist bog and swamp habitat where beard moss is abundant. In hardwood stands of sugar maple, red maple, paper birch, and yellow birch in Nova Scotia, most abundant in 40-yr-old stands of trees, less numerous in younger and older-aged. Density positively correlated with tree density, basal area, percent canopy cover, and

canopy height. In n.-central Minnesota, inhabits primarily mature undisturbed mixed forest of predominately deciduous trees with moderate ground and shrub cover and >75% canopy cover. Numbers positively correlated with the presence of sycamore in s. Illinois. In Middle Atlantic states, forest area was a significant predictor of this species' relative abundance; in a forest area of >3,000 ha, maximum probability of occurrence, with probability of occurrence dropping to 50% for forest areas of 520 ha. Rarely encountered in forests of <100 ha.

In Nova Scotia, mean territory size 0.32 ha (*n* = 26, range 0.08–0.65). Potential competitors affect territory size and density; mean territory size 0.4 ha (0.30–0.51) for birds inhabiting the mainland spruce forests of Maine, but species occupies offshore islands only 0.16 ha in size.

Last researched by Sharon Petzinger in Feb 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Osprey

Feature Label	Occurrence Area
Nest	300 meter radius

Occurrence Area Rule: Nests are mapped as point features only, which then receive the specified radius.

Justification:

All wetland habitats within 300 meters of a nest are designated as critical habitat. Home range size is much larger than 300 meters and determined by availability of food (fish); only the nest area itself is defended.

Literature supporting occurrence area(s):

Poole, A. F., R. Bierregaard, and M. S. Martell. 2002. Osprey (*Pandion haliaetus*). In The Birds of North America, No. 683 (A. Poole and F. Gill, eds.). The Birds of North America Inc., Philadelphia, PA.

The nest area is determined by food availability, nest structure availability, and type of nest structure (artificial nest-pole, tree, channel marker, cell tower) and height.

Poole, A. F. 1989. Ospreys: a natural and unnatural history. Cambridge Univ. Press. Cambridge, U.K.

Nests in MA were spaced 140 m apart in a salt marsh area with artificial nest structures, farther in upland situations (Table 8.6 in Poole 1989).

In NJ colonies, some nests are as close as 120 meters, but most are more than 500 meters apart (KEC). While ospreys generally tolerate and nest in proximity to people, human activity of certain types and at certain times of the season will disrupt nesting and can cause injury or mortality to young.

Last researched by Kathy Clark in 2006.

Occurrence area applied in Version 2.1 of the Landscape Project.

Peregrine Falcon

Feature Label	Occurrence Area
Nest	1.0 km radius
Urban Nest	1.0 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

All emergent wetland habitats within 1 km of a nest are designated as critical habitat. Home range size is much larger than 1 km, as peregrines forage on birds found in open habitats within 5 km of the nest. Prey species are mainly passerines, shorebirds and doves found in open habitats, usually within 1-5 km of the nest. Typical hunting habitats are emergent marsh, scrub-shrub, beach, dunes and intertidal flats. In urban areas, any of those habitat types are used, in addition to the urban setting itself, where peregrines hunt rock pigeons (*Columba livia*). In urban areas, *Columba* species may comprise 31% of the peregrine diet, and resident bird species (including *Columba* species) more than 90% (by occurrence; Nadareski 2001). In contrast, Steidl et al. (1997) found that nearly 70% of the diet of NJ coastal peregrines consisted of migratory birds, predominantly shorebirds. These diet figures point to the habitat differences between coastal/marsh nesting peregrines and urban-nesting peregrines.

Literature supporting occurrence area(s):

White, C. M., N. J. Clum, T. J. Cade, and W. G. Hunt. (2002). Peregrine Falcon (*Falco peregrinus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Peregrine_Falcon/.

Steidl, R. J., C. R. Griffin, T. P. Augspurger, D. W. Sparks, L. J. Niles. 1997. Prey of peregrine falcons from the New Jersey coast and associated contaminant levels. Northeast Wildlife 52:11-19.

Nadareski, C. A. 2001. Analysis of prey of the peregrine falcon (*Falco peregrinus*) for the Port of New York/New Jersey. Unpublished report to U.S. Fish and Wildlife Service. May 2001.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Pied-billed Grebe

Feature Label	Landscape Model
Confirmed/Known Breeding Location	Mapped extent of occurrence or 110 meter radius.
Suspected Breeding Location	Mapped extent of occurrence or 110 meter radius.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification text:

The average home range in one study was found to be 1.3 ha, although another study reports a home range as large as 35 ha (Glover 1953, Muller 1995). A similar species, the red-necked grebe, had a home range of 114 meters (Palmer 1962). Pied-billed grebes will defend a circular area with a radius of 46 m from the nest, but sometimes the radius will be smaller than this (Johnsgard 1987). NatureServe reports a minimum inferred extent of 0.11 km (NatureServe 2006). We are accepting the NatureServe minimum inferred extent of 0.11 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Glover. 1953. Nesting ecology of the pied-billed grebe in northwestern Iowa. Wilson Bulletin 65:32-9.

The average home range of pied-billed grebes in Iowa was 1.3 ha (n=44), which is roughly a circle with a diameter of 130 m.

Johnsgard. 1987. Diving birds of North America. University of Nebraska Press. Lincoln xii. 292 pp.

An area of a radius of 46 m around the nest is defended by pied-billed grebes, though it is sometimes smaller than this.

Muller. 1995. Pied-billed grebes nesting on Green Lake, Seattle Washington. Washington Birds 4:35-59.

Some pied-billed grebes had a home range as large as 35 ha.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.

Inferred minimum extent is 0.11 km.

Palmer. 1962. Handbook of North American birds. Vol 1. Loons through flamingoes. R.S. (ed.). Yale University Press, New Haven. 567 pgs.

Red-necked grebes had a home range of approximately 114 meters.

Last researched by Christina Kisiel in July 2006.

Occurrence area applied in Version 2.1 of the Landscape Project.

Piping Plover

Feature Label	Occurrence Area
Nest	750 meter radius
Nesting Area	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).
Nesting Territory	750 meter radius
Foraging Area	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).
Brood Rearing Area	Mapped extent if available, otherwise, radius of 71.25 meters (seconds precision circle).

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Piping plovers nest singly or in loose colonies on the Atlantic coast beaches in New Jersey. They maintain a breeding territory that consists of a section of shoreline (for feeding) and a portion of beach (for nesting) (Whyte 1985). Males defend territories (pre-nest) of up to 10,000m^2 (Cairns 1982). Home range during incubation is generally confined to the vicinity of the nest. Distances to nearest nest highly variable: averages include 50 m apart in Nova Scotia (Cairns 1977) to a range of 500m – 5000m in New York (Elias-Gerken 1994). In New Jersey, piping plover territories appear to be at least partially based on the amount of habitat available. Pairs with fewer conspecifics on the site tend to maintain larger territories, and pairs that are spaced at a higher density tend to have smaller territories (C. Kisiel, personal communication, February 23, 2007).

Piping plover chicks are precocial and therefore highly mobile (Cairns 1982). In NJ, broods have been documented traveling maximum distances of up to three-quarters of a mile (1207 meters) (T. Pover, personal communication, February 13, 2007). Chick mobility varies in other states: in Maryland and Virginia distances varied from 32m – 600+ meters (both studies n=59 broods) (Patterson 1988, Cross 1989). At another Maryland study, brood distances averaged 143m (n=87 broods), but three weeks post hatch increased to an average of 237m (n=80broods). In North Carolina, the average was 274.23m (n=14 broods) (Coutu, et al 1990).In Massachusetts, 50% the focal chicks moved >200m in the first 5 days post hatch (50% moved <100m) (n=10 chicks) (Strauss 1990).

In nesting areas outside NJ, territory size also varied by point in the nesting cycle and among sites: an average of 4,000 m^2 in Nova Scotia (Cairns 1982) to 27,022 - 30,547 m^2 in Saskatchewan (Whyte 1985). Natureserve recommends a buffer of 1.5 km when actual extent is unknown.

Literature supporting occurrence area(s):

W. E. Cairns. 1977. Breeding biology and behavior of the piping plover *Charadrius melodus* in southern Nova Scotia. M.S. Thesis. Dalhousie University, Halifax, Nova Scotia. 115pp.

Pairs nested, on average, 50m apart at this Nova Scotia study site. The shortest observed distance between two nests was 3 m.

W. E. Cairns. 1982. Biology and behavior of breeding Piping Plovers. Wilson Bull.94: 531–545.

Males run distances of up to 100m during parallel run displays in pre-nesting territory disputes. Pairs maintained an average of a 4,000m^2 territory.

J. Whyte. 1985. Breeding ecology of the Piping Plover (*Charadrius melodus*) in central Saskatchewan. M.S. thesis, Univ. Saskatchewan, Saskatoon.

Describes piping plover nesting habitat requirements.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.

The inferred minimum extent habitat use (when actual extent is unknown) is 1.5 km (diameter).

A. J. Whyte. 1985. Breeding ecology of the Piping Plover (Charadrius melodus) in central Saskatchewan. M.S. thesis, Univ. Saskatchewan, Saskatoon.

Birds primarily fed within 15 m of the shoreline on Big Quill Lake, Saskatchewan but also sometimes fed near nest. Pairs maintained a 27,022 - 30,547 m^2 territory.

Haig, Susan M., and Elliott-Smith, E. (2004). Piping Plover. The Birds of North America Online. (A. Poole, Ed.) Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Piping_Plover/.

While percentage of feeding near the shoreline varies by sex, age, and stage of breeding, birds feed chiefly within 5 m of the water's edge; only at sunset do parents and broods return to feed on higher ground. In Manitoba, individual breeders seen throughout the breeding season at sites that ranged from 3–102 km apart

Elias S.P., J. D. Fraser, P. A. Buckley. 2000. Piping Plover brood foraging ecology on New York barrier islands. J. Wildl. Manage. 64: 346-354.

On ocean beaches wrack line is preferred foraging habitat for chicks followed by vegetated dunes.

Elias-Gerken, S.P. 1994. Piping plover habitat suitability on central Long island, New York barrier islands. M.S.Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 48pp.

In New York in 1992, she observed 2.1 pairs/km on Westhampton Island, 1.8 pairs/km on Jones Island and 0.2 km/pair on Fire Island.

Patterson, M.E. 1988. piping plover breeding biology and reproductive success on Assateague Island. M.S. thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 131 pp.

Eighteen of 38 broods moved to feeding areas 100+m from nest, 5 broods moved 600+m. The distances were measured parallel to the wrack line.

Cross,R.R. 1989. Monitoring, management and research of the piping plover at Chincoteague National Wildlife Refuge. Unpublished report. Virginia Department of Game and Inland Fisheries Virginia. 80pp.
At 3 sites, observers recorded broods at a mean distance from their nests of 153 m +/-97m (44 observations, 14 broods), 32m +/- 7m (8 observations, 3 broods), and 492m +/-281m (12 observations, 4 broods).

Coutu, S.D., J.D. Fraser, J.L. McConnaughy, and J.P. Loegering. 1990. Piping plover distribution and reproductive success on Cape Hatteras National Seashore. Unpublished report to the National Park Service. 67pp.
Observations of 11 broods averaged 2121m from their nests; 3 broods moved 400-725 m from their nest sites.

Strauss,E. 1990. Reproductive success, life history patterns and behavioral variation in a population of piping plovers subjected to human disturbance (1982-1989). Ph.D. dissertation. Tufts University, Medford, Massachusetts. 143pp.
Ten chicks moved more than 200m during the first 5 days post-hatch while 19 chicks moved less than 200m during the same interval.

Last researched by Christina Kisiel in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Red-headed Woodpecker

Feature Label	Occurrence Area
Breeding	150 meter radius
Non-breeding	75 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:
Breeding territories range from 3.1 – 8.5 ha while wintering territories range from 0.05 – 1 ha (Smith et al. 2000). The breeding occurrence area was chosen based upon the upper limit breeding territory size of 7 ha. The non-breeding occurrence area was based upon the upper limit wintering territory size of 0.6 ha and increased because this species will travel beyond its territory to forage (Smith et al. 2000).

Literature supporting occurrence area(s):

Smith, K. G., J. H. Withgott, and P. G. Rodewald. 2000. Red-headed Woodpecker (*Melanerpes erythrocephalus*). *In* The Birds of North America, No. 518 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.
Little is known about breeding territories. In Florida, size of summer territories (3.1–8.5 ha) larger than in winter, with overlap between adjacent territories, although overlap areas not used as much as exclusive portion

Little information on habitat use in migration. Forages on living oak, maple (*Acer*), and hickory (*Carya*) trees and dead trees during spring in Illinois. Uses shelterbelts in spring migration on Great Plains. Forms loose flocks in fall in Florida that seek mast or fruit-bearing trees in orchards, oak hammocks, and urban areas where mature oaks or fruit trees are plentiful. Some suggest that species use forest edges more in fall.

Winter habitat in north, found in mature stands of forest, particularly oak forests; oak-hickory, maple, ash (*Fraxinus*), or beech woodlands; and old oak woodlots containing overmature trees with many cavities and dead. In south, pine and pine-oak areas. Favors areas with numerous standing snags (dri-ki) resulting from flooding or girdling by beavers, beaver ponds, marshes, and swamps. Also favored elm trees that had succumbed to fungal Dutch elm disease. Presence of mast as a winter food has long been recognized as single most important factor determining winter distribution in northern part of range, leading to the rule, “No mast, no redheads”. A positive relationship existed between numbers and acorn abundance in most counties studied in Missouri and large acorn-bearing oaks in Illinois, suggesting that species may respond to acorn abundance on a local scale, but this relationship remains unstudied.

Winter territories can be small; e.g., 0.05 ha ± 0.03 SD (*n* = 8) for adults and 0.03 ha ± 0.03 (*n* = 6) for juveniles, but more typically 0.17 ha ± 0.04 SE (*n* = 20) to 0.38 ha ±0.04 (*n* = 18), to 0.5–0.6 ha to as large as 1 ha.). Acorns often gathered from beyond territory, and several individuals may be seen gathering acorns at same source, such that individuals defend their storage sites, not source of acorns.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Red Knot

Feature Label	Occurrence Area
Migrant	Mapped extent of concentration area, if available, otherwise, radius of 71.25 meters (seconds precision circle) around confirmed/known concentration area point.
Wintering	Mapped extent of concentration area, if available, otherwise, radius of 71.25 meters (seconds precision circle) around confirmed/known concentration area point.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from

information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

Not available.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Red-shouldered Hawk

Feature Label	Occurrence Area
Breeding Sighting	1.0 km radius
Non-breeding Sighting	1.0 km radius
Nest	1.0 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

According to the scientific literature home range sizes for eastern populations of red-shouldered hawks' are highly variable, both seasonally and by sex. Males generally have larger territories than females and both sexes have larger territories during the non-breeding season than during the breeding season (Crocoll 1994). Crocoll, 1994, reported that the average breeding season home range of eastern populations varied from 108.9 ha to 339 ha. The mean breeding season home range being 224 ha, an area equivalent to a circle having a 0.71 km radius. ENSP selected a slightly larger occurrence area boundary for red-shouldered hawks to account for the larger territory size used by the birds during the non-breeding season.

Literature supporting occurrence area(s):

ocoll, S.T. Red-shouldered hawk. The Birds of North America, No. 107, 1994. The Academy of Natural Sciences, Philadelphia.

- **Home range of red-shouldered hawk varies from 108.9 ha to 339 ha in eastern populations during the breeding season, with a computed average of 224 ha.**

Highlighted studies result in mean = 224 ha, or 0.71 km radius.

Last researched by Melissa Craddock & Kris Schantz in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Roseate Tern

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, 50 meter radius (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging Area	4.8 km (3 mile) radius.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

The Birds of North America reports that there is inadequate data concerning commuting distances for roseate terns (Gochfeld et al. 1998). The information that is available varies widely. In Massachusetts, many roseate terns were observed to forage within 300 m of the colony (Gochfeld et al. 1998). In Puerto Rico, most terns fed within 2 km of the colony and often within 200 m (Shealer and Burger 1995). Other reports indicate that terns feed at maximum distances of 16- 30 km from nesting colonies (Gochfeld et al. 1998, Heinemann 1992, Nisbet and Spendalow 1999). NatureServe recommends a minimum inferred extent of 2 km, noting that this is a conservative estimate (NatureServe 2006). We apply a 4.8 km buffer around the colony to protect foraging areas.

Literature supporting occurrence area(s):

Gochfeld, M., J. Burger, and I. C. T. Nisbet. 1998. Roseate Tern (*Sterna dougallii*). *In* The Birds of North America, No. 370 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

BNA reports that inadequate information exists for commuting distances of roseate terns. They report that roseate terns may forage up to 30 km from breeding colonies. In Massachusetts, many terns foraged within 300m of the colony.

Heinemann, D. 1992. Foraging ecology of roseate terns breeding on Bird Island, Buzzards Bay, Massachusetts. Report to USFWS, Newton Corner, MA. 54 pp.

In Massachusetts, researchers observed foraging flights up to 16km.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 12, 2007)

The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 2 km. The authors note that this is a conservative estimate.

Nisbet, I.C.T., Spendalow, J.A. 1999. Contribution to research to management and recovery of the Roseate Tern: review of a twelve-year project. Waterbirds 22(2): 239-252.
During this twelve year study, authors report foraging commutes up to 25 km away.

Shealer D.A., J. Burger 1995. Comparative foraging success between adult and one-year-old Roseate and Sandwich Terns. Colonial Waterbirds 18: 93–99.
At Culebra and other Puerto Rican islands, roseate terns fed primarily within 2 km of colony, and often within 200 m.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Saltmarsh Sharp-tailed Sparrow

Feature Label	Occurrence Area
Breeding	250 meter radius
Migrant	125 meter radius
Wintering	125 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Saltmarsh sharp-tailed sparrows are not territorial and have overlapping home ranges that range from 1.2 – 5.7 ha for males and 0.4 – 3.1 ha for females. However, females may travel >250 meters from the nest to forage. Based upon the distance traveled to find food for young, a breeding occurrence area of 250 meters is recommended for this species. Based upon the non-territorial behavior and the upper limit of the area needed to forage (5 ha), an occurrence area of 125 meters was chosen for migrant and wintering individuals.

Literature supporting occurrence area(s):

Greenlaw, J. S. and J. D. Rising. 1994. Sharp-tailed Sparrow (*Ammodramus caudacutus*). *In* The Birds of North America, No. 112 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
Along the Atlantic Coast south of New Brunswick, breeds in salt marshes where smooth cordgrass, saltmeadow grass, and blackgrass are bordered by cattail, reed (*Phragmites* sp.), and marsh elder. Forages on ground in dense grasses of marshes or wet meadows (e.g., cordgrass, blackgrass, and saltmeadow grass in salt marshes), ditch margins, edges of shallow pools and mud pannes, patches of wrack, and bay intertidal. Breeding females often forage close to nest but may fly long distances from nest. Females may search for food > 250 m from nest (mean = 60.7 ± 3.3 [SE], *n* = 201). Breeding males are non-territorial and have large, overlapping home ranges. In New Jersey, male home ranges estimated between 1.2 and 1.6 ha; in coastal New York, mean size 4.3 ha (3.0–5.7 ha). Females occupy breeding home ranges smaller than those of males; e.g., a mean of 1.1

ha (0.4–3.1 ha) in New York and an estimated average female home range size as 0.4 ha in New Jersey.

Migrants along the Atlantic coast are restricted to coastal marshes, with a few subcoastal and inland records from freshwater marshes. Most of the Atlantic Coast population winters in coastal cordgrass marshes, occasionally in cattail; birds often leave tidal marshes only when forced out by high tides, when they may become concentrated along shoreline. Winter foraging is also on the ground in dense grass in marshes, at edges of ponds or pools, and sometimes on floating vegetation. In fall, favors areas of tall, seed-bearing cordgrass along channels and bay margins. Along mid-Atlantic Coast congregate in loose feeding groups in tall, seed-bearing cordgrass; groups usually consist of 10–40 individuals, but larger (> 100 birds) and smaller groups (even solitary individuals) commonly occur. Wintering birds along se. Atlantic Coast also form loose feeding groups.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Savannah Sparrow

Feature Label	Occurrence Area
Breeding	150 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.05 – 1.25 ha (Swanson 1998, Wheelwright and Rising 1993). The breeding occurrence area was selected based upon the upper limit of the territory range and increased to accommodate shifting territories for second nesting attempts and nomadic behavior of juveniles (Wheelwright and Rising 1993). No minimum patch size was selected based upon evidence that the species can occupy areas < 2 ha (Swanson 1998). Non-breeding savannah sparrows are not listed in New Jersey so no non-breeding occurrence area was assigned.

Literature supporting occurrence area(s):

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

Maine had 50% incidence at 10 ha and that 5-10 ha is minimum size for birds to breed (see Vickery et al. 1994 below). New York had minimum area of 11.7 ha and mean patch size of 53.6 ha. Another study in New York had 97% incidence in areas 20 ha and larger, 88% incidence in 10-20 ha patches, 63% incidence in 5-10 ha patches, and 28% incidence in 3-5 ha patches. Missouri had minimum areas of 1-10 ha, and Illinois 10-30 ha.

Swanson, D. A. 1998 (revised 2002). Effects of management practice on grassland birds: Savannah Sparrow. Northern Prairie Wildlife Research Center, Jamestown, ND. 30 pages.

Territories range from 0.05 – 1.25 ha and they may occupy areas < 5 ha in size. In Illinois, none occurred in areas < 10 ha and 50% incidence at 40 ha.

Vickery, P. D., M. L. Hunter, Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4): 1087-1097.

In Maine, 50% incidence for SAVS was reached at 10 ha.

Wheelwright, N. T. and J. D. Rising. 1993. Savannah Sparrow (Passerculus sandwichensis). In The Birds of North America, No. 45 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Breeding territories vary in size between regions, habitats, seasons, and years. Mean size or range: Michigan, 0.11 ha, Wisconsin, 0.53–0.86 ha, coastal Nova Scotia, 0.17 ha, Kent Is., NB, 0.05–0.30 ha (NTW); Sable Is., NS 0.38–0.53 ha in densely vegetated habitat, 1.09–1.25 ha in sparse habitat. Territory diameter 60 m in Quebec. Territories tend to expand during the breeding season and females will renest 0.5 – 31 meters from original nest (19m upper conf. limit), 26.7 m in Michigan, range from 7 – 42 m in Nova Scotia. Females are also territorial and are aggressive up to 20 m from nest. Parents will drop fecal sacs 10 – 50 m away from nest. Juveniles form loose flocks after a month post-fledging and wander 500 – 1000 meters daily while foraging.

Stopover habitat includes open fields, roadsides, dune vegetation, coastal marshes, edges of sewage ponds and other ponds in open country; rarely found in open woodlands. Winter habitat includes cultivated fields, pastures, golf courses, roadsides, dumps, dune grass, and salt marshes. *P. s. rostratus* and apparently other salt marsh populations, though generally wintering in salt marshes, can be found in a variety of open habitats, including sparsely vegetated habitats on xeric islands.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Sedge Wren

Feature Label	Occurrence Area
Breeding	150 meter radius
Migrant	71.25 meter radius
Wintering	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.12 to 3.4 ha and average 3.4 ha in Illinois (Dechant et al. 1998, Herkert et al. 2001). The breeding occurrence area was chosen based upon the average territory size in Illinois and increased to account for shifting territories (Herkert et al 2001). Little is known

about the non-breeding territories, so the default occurrence area was chosen for migrant and wintering individuals.

Literature supporting occurrence area(s):

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, B. D. Parkin, and B. R. Euliss. 1998 (revised 2002). Effects of management practice on grassland birds: Sedge Wren. Northern Prairie Wildlife Research Center, Jamestown, ND. 17 pages.

In Illinois, area was not important in predictive occurrence and were present in areas < 10 ha. Minnesota territories average 0.2 ha, Illinois territories were 3.4 ha.

Herkert, J. R., D. E. Kroodsma, and J. P. Gibbs. 2001. Sedge Wren (*Cistothorus platensis*). *In* The Birds of North America, No. 582 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Territory boundaries are fluid throughout nesting season, and males may shift activity and defend new areas as season progresses. Territory size for 12 males in Minnesota averaged 1,780 m2 (range 1,274–3,559) (0.178 ha).

Migratory stopover habitats closely resemble preferred breeding habitats, but also occasionally found in other habitats including mesic grasslands; salt marshes; and alfalfa, clover, and rye fields

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Sharp-shinned Hawk

Feature Label	Occurrence Area
Nest	0.8 km radius
Foraging (Breeding & Non-breeding)	0.8 km radius
Sighting (Breeding & Non-breeding)	0.8 km radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

There are few studies available (summarized in Birds of North America). Two studies tracked four individuals, resulting in home ranges of 90-140 ha for females and 120-270 ha for males. Those areas convert to radii ranging 0.28-0.44 km (females) and 0.38-0.85 km (males). Another study tracked a pair in Utah that ranged in an area with a 0.80 km radius.

Wintering sharp-shinneds had slightly larger ranges in a NC study. Three tracked males had a mean range of 2.5 km^2 (mean of 250 ha, radius=0.79 km), while three tracked females had a mean range of 2.8 km^2 (mean of 280 ha, radius=0.88 km).

Literature supporting occurrence area(s):

Bildstein, K. L., and K. Meyer. 2000. Sharp-shinned Hawk (*Accipiter striatus*). *In* The Birds of North America, No. 482 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Short-eared Owl

Feature Label	Occurrence Area
Nest	71.25 meter radius
Sighting (Breeding & Non-breeding)	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

Not available.

Last researched by Kathy Clark in February 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Snowy Egret

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, buffer of 71.25 meters (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	15.8 km (9.8 mile) radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Nesting area is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default "seconds precision" circle was used around the recorded nesting location point.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the "energetically feasible" foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as "critical" foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

Research in North Carolina found that 84% of breeding long-legged waterbirds flew to foraging areas, which is why habitat outside the vicinity of the colony must be valued as crucial to the success of the colony (Custer and Osborn 1978). A study in Florida at Lake Okeechobee found snowy egrets flew an average of 2.8 km from colonies to foraging areas and the maximum flight recorded was 5 kilometers (Smith 1995). Another study in Florida, in Everglades National Park, found that over the course of 2 field seasons, snowy egrets flew an average of 13km, with a

maximum recorded distance of 31.5 km (Strong 1997). NatureServe recommends a minimum inferred extent of 3 km and justifies it by noting a low mean foraging range size for this group (NatureServe 2006). We apply a 15.8 km radius around a colony to protect foraging areas.

({13km +2.8 km}/2 = 7.9km *2 = 15.8km)

Literature supporting occurrence area(s):

Custer, T., R. Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. Auk 95: 733–743.
In North Carolina, 84% of breeding individuals flew to tidal foraging habitat. They generally prefer brackish/marine habitats with relatively shallow water.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.
The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.
A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.
> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).
The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 3 km. For the breeding season, this figure is based on a low mean foraging range size for this group.

Smith, J. P. 1995. Foraging flights and habitat use of nesting wading birds (Ciconiiformes) at Lake Okeechobee, Florida. Colonial Waterbirds 18 (2): 139–158.
Snowy egrets at Lake Okeechobee, FL flew an average of 2.8 km from colonies to foraging areas in vicinity of Lake Okeechobee, FL. The maximum flight recorded was 5 kilometers. High water increased foraging flight distances for individuals.

Strong, A.M. 1997. Hydrological constraints of the Tricolored Heron and Snowy Egret resource use. Condor 99(4): 894-905.
A study in Everglades National Park, FL found that 95% of all the foraging locations (for both species) were located within 22 km of a nesting colony (mean flight distance + 2 SD). In 1987,

mean distance flown to foraging location was 12.9 km + 4.8 km (n=68) and in 1988 it was 13.1 km + 6.3 km (n=156). The maximum distance traveled by a Snowy egret was 31.5 km.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Sora

Feature Label	Landscape Model
Confirmed/Known Breeding Location	Mapped extent of occurrence or 100 meter radius.
Suspected Breeding Location	Mapped extent of occurrence or 100 meter radius.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification text:

In one study, the home range for soras was reported as 0.19 ha $\pm$ 0.02 ha (n=8) (Johnson and Dinsmore 1985). NatureServe reports a minimum inferred extent of 0.1 km (NatureServe 2006). Due to the paucity of data, we are accepting the NatureServe minimum inferred extent of 0.1 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Johnson, R.R., J. J. Dinsmore 1985. Brood-rearing and postbreeding habitat use by Virginia Rails and Soras. Wilson Bull. 97: 551–554.
Brood-rearing home ranges for soras averaged 0.19 ha ± 0.02 (*n* = 8).

Melvin, S. M., and J. P. Gibbs. 1996. Sora (*Porzana carolina*). *In* The Birds of North America, No. 250 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

For soras, the average home range size was reported to be similar between sexes.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).

The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 0.1 km. The average sora breeding home range was reported as 0.19 ha.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Tricolored Heron

Feature Label	Occurrence Area
Nesting Colony	Mapped extent if available, otherwise, radius of 90 meters.
Nesting Colony Foraging	14.5 km (9.0 mile) radius around nesting colony.

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is defined by the point and the specified radius.

Justification text:

Nesting area is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default “seconds precision” circle was used around the recorded nesting location point.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the “energetically feasible” foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as “critical” foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may “under-include” suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat. Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

Research in North Carolina found that 84% of breeding long-legged waterbirds flew to foraging areas, which is why habitat outside the vicinity of the colony must be valued as crucial to the

success of the colony (Custer and Osborn 1978). In the Florida Everglades tricolored herons traveled an average of 5.6 km to forage, with a maximum reported distance of 25km (Bancroft, et al 1988). A different study in the Everglades found that over the course of three years tricolored herons traveled an average distance of 8.9 km, with a yearly average ranging from 5.4 km to 12.8 km. The range was hypothesized to be a result of varying water level fluctuations. The maximum distance traveled in this study was 27 km and 95% of the birds traveled within 22 km of their colony (Strong 1997). NatureServe recommends a minimum inferred extent of 3 km and justifies it by noting a low mean foraging range size for this group (NatureServe 2006). We apply a 14.5 km radius around a colony to protect foraging areas.

Literature supporting occurrence area(s):

Bancroft, G.T., S. D. Jewell, A. M. Strong. 1988. Foraging habitat of Egretta herons relative to stage in the nest cycle and water conditions. Third Annual Report. South Florida Water Management District, West Palm Beach, FL.

In the Florida Everglades foraging habitat was constrained to a mean foraging radius of 5.6 km ± 6.0 km SD (n=265). The maximum foraging commute recorded was 25 km.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.

The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.

A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.

> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).

The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 3 km. For the breeding season, this figure is based on a low mean foraging range size for this group.

Strong, A.M. 1997. Hydrological constraints of the Tricolored Heron and Snowy Egret resource use. The Condor 99(4): 894-905.

A study in Everglades National Park, FL found that 95% of all the foraging locations (for both species) were located within 22 km of a nesting colony (mean flight distance + 2 SD). In 1987, mean distance flown to foraging location was 12.8km + 5.8 km (n=39), in 1988 it was 8.6 km + 4.3 km (n=91) and in 1989 it was 5.4 km + 3.9 km (n=135). The fluctuation in distance traveled may be

due to the way yearly fluctuations in water level influence availability of foraging habitat. The maximum distance traveled by a tricolored heron was 27 km.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Upland Sandpiper

Feature Label	Occurrence Area
Breeding	1 km radius, min. patch size 25 ha
Migrant	500 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Upland sandpipers are area-sensitive grassland birds and sensitive to habitat fragmentation. Breeding territory sizes differ between males and females and average 8 ha for males and 85.6 ha for females (Dechant et al. 1999, Houston and Bowen 2001). This species requires large areas of a mosaic of grassland and open habitats for breeding and rearing young. Minimum patch sizes varied greatly from 26 to 50 ha (Mitchell et al. 2000, Vickery et al. 1994). The minimum patch size of 26 ha reported was located closest to New Jersey than others reported. The breeding occurrence area chosen was based on the female territory size of 85.6 ha and increased because females will travel an average 869 m (and up to 3,275 m) from the nest as well as to incorporate post-fledging habitat (Houston and Bowen 2001). However, due to the area sensitivity of the species, only patches 25 ha and greater should be valued for breeding individuals of this species.

Little is known about the stopover habitat use of migratory upland sandpipers. Therefore, the migrant occurrence area was chosen based upon evidence that upland sandpipers travel a far distance to forage (Houston and Bowen 2001).

Literature supporting occurrence area(s):

Dechant, J. A., M. F. Dinkins, D. H. Johnson, L. D. Igl, C. M. Goldade, B. D. Parkin, and B. R. Euliss. 1999 (revised 2002). Effects of management practice on grassland birds: Upland Sandpiper. Northern Prairie Wildlife Research Center, Jamestown, ND. 34 pages.

In Wisconsin territory size was 8 – 12 ha. Illinois had minimum area requirements of 30 ha, southwest Missouri 75 ha, Nebraska had 50% incidence at 50 – 61 ha, and Maine had 50% incidence at 200 ha (see Vickery et al. below).

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

A study in the northeastern United States showed minimum habitat requirement to be at least 100 ha but found 50% incidence at 30 – 40 ha. Two other studies in New York show minimum habitat requirements to be 26 ha and 46 ha. In St Lawrence River, habitat size ranged from 160 – 496 ha with a mean of 375 ha. In the Midwest, 50% incidence was found between 30 and 100 ha.

Houston, C. S. and D. E. Bowen, Jr. 2001. Upland Sandpiper (Bartramia longicauda). In The Birds of North America, No. 580 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Nests in loose colonies with little or no evidence of territoriality. Nesting territories were usually grouped. Courtship flight displays 200 – 400 m in diameter. North Dakota had an annual nesting density of 9.8 – 21.8 nests per 100 ha with a mean of 12.4 nests per 100 ha (1 nest per 8 ha). Minnesota had fledglings move 300 m and 500 m from the nest. Illinois also had recent fledglings fly 170 – 410 m from the nest. Migratory stopover habitat in Texas includes plowed fields, rarely bottomlands. Females have large home ranges (85.6 ha) and can move and average 869 m from the nest. Males have smaller home ranges (8.5 ha).

Stopped at dry salt-hay marshes in New Jersey in summer and autumn, and in harvested corn (*Zea mays*) and agave (*Agave* sp.) fields and flooded acacia (*Acacia* sp.) and sorghum (*Sorghum vulgar*) near Guadalajara, Mexico (O. Reyna pers. comm.). Along Manu River in sw. Peru, from 21 Aug through 5 Nov, used beach habitats overgrown with *Tessaria* and weeds.

Vickery, P. D., M. L. Hunter, Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4): 1087-1097.

In Maine: Upland sandpipers have the greatest area requirements of all 10 species in study. They were rare on sites less than 50 ha and increased steadily with area. Reached 50% incidence at 200 ha. Territories are > 8 ha.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Veery

Feature Label	Occurrence Area
Breeding	85 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

The breeding occurrence area was chosen based upon the upper limit of the mean territory size mentioned below (Bevier et al.), which came to 2.21 ha. There is little information about the

territories of non-breeding individuals, so the default occurrence area will be used for migrating species.

Literature supporting occurrence area(s):

Rosenberg, K., R. Hames, R. Rohrbaugh, S. Barker Swarthout, J. Lowe, and A. Dhondt. 2003. A land manager's guide to improving habitat for forest thrushes. The Cornell Lab of Ornithology.

Veeries are area sensitive and intolerant of forest fragmentation even though they use disturbed habitats. Habitat with highest suitability consists of wet areas in 400 ha deciduous or mixed forests with 70% canopy closure. They also use coniferous and hemlock forests. The amount of area needed is related to the amount of fragmentation in the area. They can tolerate smaller fragments of 1 – 8 ha.

Bevier, L., A. F. Poole, and W. Moskoff. (2004). Veery (*Catharus fuscescens*). The Birds of North America Online. (A. Poole, Ed.) Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Veery/.

Prefers disturbed forest, probably because of denser understory not found in undisturbed forests. In northern hardwood forests, Veery bred in 77% of disturbed and successional habitats available but in only 18% of mature undisturbed habitats available. In mature woodlands, moisture regime is chief factor in habitat selection, more than twice as important as herb cover. Shrub cover is chief vegetative consideration in habitat selection – probably because shrubs provide safe nest sites.

In Middle Atlantic states requires forests of 20 ha for 50% probability of occurrence. In Illinois, of 22 forest patches in which known to breed, only 2 smaller than 100 ha.; average forest size of breeding area 309 ha. In red maple swamps of s. Rhode Island, while occurring in swamps as small as 1 ha, regional forest abundance may be more critical determinant of presence and abundance than swamp size.

Territories range from 0.10 ha to a few hectares. In Ontario (n = 61), average size of territory 0.25 ha; in s. Quebec (sugar maple/hemlock stand), 0.5 ha (A. Cyr unpubl.). In Hudson Valley, occasionally build nests within 15-20 m of each other within large, overlapping territories.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Vesper Sparrow

Feature Label	Occurrence Area
Breeding	150 meter radius , min. patch size 5 ha
Non-breeding	150 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Vesper breeding territories range from 0.29 – 8.19 ha in patches 5+ ha in size (Dechant et al. 2000, Jones and Cornerly 2002). The breeding occurrence area was selected based upon the

Michigan upper limit territory size. The non-breeding occurrence area was chosen based upon the average winter home range size (Jones and Cornely 2002).

Literature supporting occurrence area(s):

Dechant, J. A., M. F. Dinkins, D. H. Johnson, L. D. Igl, C. M. Goldade, B. D. Parkin, and B. R. Euliss. 2000 (revised 2002). Effects of management practice on grassland birds: Vesper Sparrow. Northern Prairie Wildlife Research Center, Jamestown, ND. 41 pages.

Montana territories ranged from 0.29 – 3 ha and an average of 1.65 ha. Corn and soybean fields in Iowa had territories ranging from 1.6 – 8 ha and an average of 3 ha. Another Iowa study had territories ranging from 1.8 – 3.2 ha and averaging 2.3 ha. Michigan territories in a 5.6-ha field averaged 0.48 – 0.72 ha. Illinois tallgrass prairies contained vespers in small sites < 10 ha but not large sites (650 ha). Maine found vesper abundance to be positively correlated with area and 50% incidence at 20 ha.

Jones, S. L. and J. E. Cornely. 2002. Vesper Sparrow (Pooecetes gramineus). In The Birds of North America, No. 624 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

In Ohio, used open areas from 5 – 15 ha. Breeding territory size ranges from 0.29 – 8.19 ha. In Michigan, territories averaged 2.59 ha, but open field territories averaged 1.53 ha ± 0.33 SD and 1.03 ha ± 0.77 SD in fields with standing dead trees.

Stopover habitat consists of pastures and weeds bordering cultivated fields and roadsides, hedgerows, and barren to overgrown fields. Throughout much of range, commonly found near grassy or weedy ditches and fencerows, since fields are still barren upon arrival in early spring.

Wintering habitat in e. U.S. consists of patches of cleared and natural openings in forest land. On wintering range, home range of 142 m (*n* = 37) average for 3 yr; annual variation in size positively correlated to previous summer's rainfall (Gordon 2000).

Mitchell, L. R., C. R. Smith and R. A. Malecki, R. A. 2000. Ecology of grassland breeding birds in the northeastern US – a literature review with recommendations for management. USGS, BRD, NY Cooperative Fish and Wildlife Research Unit, DNR, Cornell University, Ithaca, NY 14853-3011. September 2000.

Maine had 38 pairs in a 210-ha patch and 50% incidence at 20 ha (see Vickery et al. 1994 below). Missouri had a range of patch size from 10 – 100 ha. Illinois had minimum patch size of 10 ha. No information on territory size was provided.

Vickery, P. D., M. L. Hunter, Jr. and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4): 1087-1097.

In Maine, 50% incidence for vespers were reached at 20 ha.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Virginia Rail

Feature Label	Landscape Model
Confirmed/Known Breeding Location	Mapped extent of occurrence or 100 meter radius
Suspected Breeding Location	Mapped extent of occurrence or 100 meter radius

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification text:

The Birds of North America report that information on Virginia rail home ranges is limited. In Arizona, researchers found that breeding home range varied based on habitat quality. The average home range was 1.64 ha ± 1.48 ha (Conway 1990). In Iowa it was much smaller, reported as 0.18 ha ± 0.02 ha during the breeding season (Johnson and Dinsmore 1985). NatureServe reports a minimum inferred extent of 0.1 km (NatureServe 2006). The reported home ranges would correspond to a 0.072 km (0.22 km - 0.99 km with the reported error) and 0.023 km radius. ENSP will use the NatureServe minimum inferred extent of 0.1 km until such time as that is changed or we have additional information, including New Jersey-specific data, to justify a change in this value.

Literature supporting occurrence area(s):

Conway, C.J. 1990. Seasonal changes in movements and habitat use by three sympatric species of rails. Master's thesis, University of Wyoming, Laramie.

In Arizona, this research found that home range size varied seasonally and with habitat quality. The average home range during the breeding season was 1.64 ha ± 1.48 ha and 2.41 ± 1.84 ha during the non-breeding season.

Conway, C. J. 1995. Virginia Rail (*Rallus limicola*). *In* The Birds of North America, No. 173 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

BNA reports that estimates of average home range size are limited. Reported densities range from vary from 0.1 to 8.9 pairs/ha.

Johnson, R.R., J. J. Dinsmore. 1985. Brood-rearing and postbreeding habitat use by Virginia Rails and Soras. Wilson Bulletin 97: 551–554.

In Iowa the average home range was 0.18 ha ± 0.02 ha during the breeding season. Male and female home range sizes did not differ, and home ranges of pairs overlapped extensively.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: June 4, 2007).

The breeding inferred minimum extent of habitat use (when actual extent is unknown) is 0.1 km. NatureServe reports that there is not a lot of information available about home ranges for Virginia rails and in light of this cites the home ranges of related species, such as the

clapper rail and sora. The average clapper rail home range is reported as a range from 0.4 ha to 3.6 ha. The average sora breeding home range is reported as 0.19 ha.

Last researched by Christina Kisiel in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Whip-poor-will

Feature Label	Occurrence Area
Breeding	175 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 2.8 – 11.1 ha with an average 5.1 ha. The breeding occurrence area was chosen based upon the upper limit of the breeding territories (10 ha). Little information is available about migrating whip-poor-wills, so default occurrence area was chosen.

Literature supporting occurrence area(s):

Cink, C. L. 2002. Whip-poor-will (*Caprimulgus vociferus*). *In* The Birds of North America, No. 620 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Breeds in dry deciduous or mixed forests with little or no underbrush throughout most of its range. Degree of openness in forest understory appears to be more important than forest composition. In New York State, widespread in northern hardwood forests of Hudson Valley and low-elevation forests surrounding the Adirondacks, mainly white pine and oak-northern hardwoods or aspen-gray birch-paper birch forests. Absent, however, from large, heavily forested areas of the Adirondacks and Catskills above 305 m. Prefers dry woodland such as pitch pine-scrub oak barrens on Long I. and deciduous woods inland. Prefers drier oak-hickory forests to beech-maple woods in upstate New York, yet numerous individuals found in wet woods at edge of Black Creek marshes in St. Lawrence Co., NY. In W. Virginia, occurs in oak–hickory–white pine, or hardwood-hemlock forest and sparingly in northern hardwoods (red maple, American beech, and yellow birch) forest, but not in pure red spruce. Appears to be missing from many areas of dense uninterrupted forest. Common in open and partially open pitch pine-scrub oak habitat on Cape Cod, but dramatically fewer singing in black oak-scarlet oak-pitch pine habitat along glacial moraines with closed canopy; decreased light here may influence foraging success. In the Sand Ridge State Forest of Illinois, species most common in mixed pine-oak habitats, followed by oak-dominated deciduous stands, and least abundant in jack pine plantations. In Kentucky, breeders found in a variety of semiopen habitats, in-cluding rural farmland, power-line and roadway corridors, clearcut and selectively logged forest, old fields, and reclaimed surface mines.

Shade, proximity to open areas for foraging, and fairly sparse ground cover are key elements of habitat. Although many authors suggest this preference, few data on stage of succession preferred, except that early is preferred to late. Species absent from areas where forest canopy is extensive and closed. No data on forest structure and size. Minimum forest plot size needed to

sustain a pair is unknown, but small isolated woodlots in agricultural n.-central Maryland provide poor Whip-poor-will habitat; species does not use this habitat. This suggests not only size of forest habitat used but distance from larger forest tracts may be important.

Little information is known about migratory habitat. In U.S., many occur in same types of open forests they breed in.

Whip-poor-wills travel large distances while foraging. In Kansas, size of territories varied from 2.8 to 11.1 ha (*n* = 3). In another study, most (52% of 26 birds) averaged 5.1 ha

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Winter Wren

Feature Label	Occurrence Area
Breeding	110 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification:

The breeding occurrence area was chosen based on the upper confidence limit of the mean habitat size for second nesting attempts (3.3 ha ± 1.2 SD, *n* = 22) (Hejl et al. 2002), which calculates to 3.8 ha. Non-breeding wrens are listed as stable in New Jersey, so no occurrence area was specified.

Literature supporting occurrence area(s):

Hejl, S. J., J. A. Holmes, and D. E. Kroodsma. 2002. Winter Wren (*Troglodytes troglodytes*). *In* The Birds of North America, No. 632 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Winter Wrens use all types of forest near water, especially old-growth structures (snags, downed logs, and large trees) for nesting, foraging, and roosting. Clearcutting and some types of partial logging reduce habitat suitability for the Winter Wren

Shape, size, density, and distribution of territories are influenced by habitat and topography. Territories appear to be preferentially established along streams or other water sources, especially in drier habitats, resulting in patchy distribution

Territory size varies both within and between habitats. In n. Idaho, breeding-territory size overall ranged from 0.8 to 6 ha; 0.8–4.0 ha (mean 1.9 ha ± 0.9 SD; *n* = 17) within old-growth cedar-hemlock forests and 1.0 to 3.3 in fragmented old growth (mean 2.1 ha ± 0.8 SD; *n* = 11) interspersed with 4- to 11-yr-old clearcuts. Averaged 2.0 ha ± 0.9 SD (*n* = 28) for first nesting attempts and 3.3 ha ± 1.2 SD (*n* = 22) for second attempts. Family groups used these areas after nesting. In se. Alaska, territory size ranged from 0.7 to 4.8 ha, averaged 2.2 ha ± 0.3 SD, and differed significantly among 3 sites (*n* = 15). In coastal western hemlock in British Columbia, breeding-territory sizes ranged from 0.48 to 2.21 ha and averaged 1.38 ha ± 0.51 SD (*n* = 14) in

1979 and 1.23 ha ± 0.50 SD (*n* = 12) in 1980. In a separate study in similar habitat of British Columbia, average size of territories over 3 yr ranged from 0.68 to 1.46 ha.

Conservative estimates of fall-territory size ranged from 0.42 to 1.31 ha and winter territory size ranged from 0.14 to 1.45 ha. In Idaho, territories shifted between broods (SJH and JAH). In British Columbia, territory shifts occurred at beginning of winter, at junction with breeding season, and breeding/fall juncture.

Last researched by Sharon Petzinger in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Wood Thrush

Feature Label	Occurrence Area
Breeding	300 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

The breeding occurrence area was chosen based upon the median distance traveled from the nest by post-fledging young and parents to incorporate post-fledging habitat (Roth et al 1996). There is little information about the territories of non-breeding individuals, so the default occurrence area will be used for migrating species.

Literature supporting occurrence area(s):

Rosenberg, K., R. Hames, R. Rohrbaugh, S. Barker Swarthout, J. Lowe, and A. Dhondt. 2003. A land manager's guide to improving habitat for forest thrushes. The Cornell Lab of Ornithology.

Breeds in interior and edges of deciduous and mixed forests in cool, moist sites near water. Requires moderate to dense understory with a lot of shade, moist soil, and decaying leaf litter. High suitability is in forest patches at least 81 ha (200 acres) with suitability declining in patches less than 40.5 ha (100 acres). Can breed in smaller patches but have lower reproductive success. Must factor in forest size, amount of core area, amount of edge, and vegetation structure.

Roth, R. R., M. S. Johnson, and T. J. Underwood. 1996. Wood Thrush (*Hylocichla mustelina*). *In* The Birds of North America, No. 246 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Breeds in interior and edges of deciduous and mixed forests, especially well-developed, upland, mesic ones. Key elements of oft-used sites: trees >16 m in height, high variety of deciduous tree species, moderate subcanopy and shrub density, shade, fairly open forest floor, moist soil, and decaying leaf litter. Waning of these features associated with range and altitudinal limits — 750 to 1,050 m in Vermont and 1,325 m in the Smoky Mtns. More likely to occur in larger-area forests but may nest in 1-ha fragments and semi-wooded residential areas and parks. Breeding territories range from 0.08–2.8 ha but tend to use areas outside territories. Most nesting material gathered

<35 m from nest, but females may cross territories to reach mud source. Fledglings and parents tend to be 200-400 meters away from nest within weeks of fledging.

Fall migratory habitat includes second-growth and forest-edge habitats with fruit. No data for spring transients to suggest deviation from breeding season habitats.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Worm-eating Warbler

Feature Label	Occurrence Area
Breeding	175 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.6 – 5 ha with an upper confidence limit of 1.8 ha (Hanners and Patton 1998). The breeding occurrence area was chosen to incorporate territories of second nesting attempts and post-fledging habitat (Hanners and Patton 1998). There is little information about territories of migrating individuals so the default occurrence area was chosen.

Literature supporting occurrence area(s):

Hanners, L. A. and S. R. Patton. 1998. Worm-eating Warbler (*Helmitheros vermivorus*). *In* The Birds of North America, No. 623 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Occurs regularly where large tracts of mature deciduous or mixed deciduous-coniferous forest overlap with hillsides and smaller patches of shrubs such as mountain laurel and rhododendron. Suggested minimum area requirements range from 21 to 340 ha. Plant composition of the forest community appears less important to this species than forest age and size, presence of hillsides, and occurrence of dense patches of shrub cover. Species occurs in variety of forest communities, including eastern hemlock, beech-maple, and oak-hickory associations, and may be found through a continuum of moist to dry environments

Mean territory size in Connecticut: 1.72 ha ± 0.78 SD (range 0.60–4.95, *n* = 94 territories), derived from mapping repeated observations of singing males, fights, and nest sites. No known relationship between territory size and territory quality.

Second or third nesting attempts are within 10 – 100m of first nest. Individuals may be successful at sites as small as 19 ha, but little is known about return rates of adults to these sites in subsequent years. The species is considered area sensitive and nests in highest densities in forests of at least several hundred hectares. Within first week of fledging, begin following parents widely within territory and sometimes beyond territory boundaries. Unknown when they become totally independent.

Rosenberg, K. V., R. W. Rohrbaugh, Jr., S. E. Barker, J. D. Lowe, R. S. Hames, and A. A. Dhondt. 1999. A land manager's guide to improving habitat for scarlet tanagers and other forest-interior birds. The Cornell Lab of Ornithology.

Worm-eating warblers share some habitat characteristics with Scarlet Tanagers. In the Piedmont Plains and Delaware Bay regions, they prefer areas at least 70% forested, deciduous or mixed, and the suitability increases with proximity of forest patches to larger, contiguous forest patches. In the Highlands, they prefer areas at least 50% forest, deciduous, and mixed and occasionally coniferous, and the suitability increases with proximity of forest patches to larger, contiguous forest patches.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Yellow-breasted Chat

Feature Label	Occurrence Area
Breeding	75 meter radius
Migrant	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification text:

Breeding territories range from 0.4 – 2.4 ha (Eckerle and Thompson 2001). The breeding occurrence area was based on the upper territory limit if 1.75 ha. Little information is known about migrating chats, so the default occurrence area was chosen.

Literature supporting occurrence area(s):

Eckerle, K. P., and C. F. Thompson. 2001. Yellow-breasted Chat (*Icteria virens*). *In* The Birds of North America, No. 575 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Breeding habitat consists of low, dense deciduous and coniferous vegetation, including early second-growth forest and shrub in abandoned agricultural fields, clear-cuts, power-line corridors, fencerows, forest edges and openings, and near streams, pond edges, and swamps > 0.5 ha. Tolerates areas of open grass if dense shrubs are nearby. Classified as an open-canopy obligatory species (i.e., preferred open overstory and brushy understory), with population density directly related to shrub density to a height of 4.5 m. Can also be found in areas with "dense overstory vegetation and an open subcanopy layer" in e. Tennessee, where it is rare. Readily colonizes clear-cut areas and power-line corridors. Population density positively correlated with blackberry density and patchiness in power-line corridors. In W. Virginia, occurs in forest edges and openings, and occupies openings in any forest type, including spruce forest with heavy understory growths of blackberries. Appears early in succession when woody plants begin to invade and reaches peak densities in dense shrub thickets. In se. Missouri, numbers highest in clear-cut areas compared with areas subjected to other harvesting techniques. In Delta National Forest in Mississippi, breeding densities highest 4–5 yr after clear-cutting in habitats where residual stems were left,

compared with mature forest or habitats where all residual stems were sheared. In e. Texas, presence was positively associated with increasing density of shrub stems, foliage density at 0–3 m, percentage of pine saplings, and number of shrub species; presence negatively correlated with vegetation height, percentage of canopy closure, foliage density at 12–15 m, and density of pole-sized trees. Species present in 3- to 12-yr-old mixed-oak stands in Virginia also described high densities in a heavily wooded, partly swampy floodplain forest with closing canopy. In N. Carolina prefers dense thickets in upland and floodplain habitats.

In a low-density population in s. Indiana, the yearly mean territory size ranged 1.1–1.6 ha, *n* = 4 yr; grand mean 1.2 ha ± 0.51 SD; range 0.4–2.4, *n* = 28. In a high-density population (territory size ranged from 0.5 to 1.0 ha in Virginia, however, territorial intrusions and male-male interactions were the rule, as territorial intruders were frequently captured in mist-nets well within boundaries of neighboring territories. In s. Illinois, 4 territories were 0.35–1.75 ha (mean 0.82).

Migratory habitat tends to be the same low, dense vegetation used on breeding grounds, although spring migrants occasionally found in suburban habitat.

Last researched by Sharon Petzinger in Feb. 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Yellow-crowned Night-heron

Feature Label	Occurrence Area
Nesting Colony	Mapped extent of nesting colony, if available, otherwise, radius of 71.25 meters (seconds precision circle) around confirmed/known breeding location point.
Nesting Colony Foraging	2.7 km (1.7 mile) radius

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point, the occurrence area is the area defined by the point and the specified radius.

Justification:

Nesting area is defined by the area the birds actually use, as these birds do not defend a territory except immediately around their individual nests. The boundaries of the colony are defined as much by social attraction phenomenon and by habitat suitability. Consequently there is now immediately apparent justification for buffering the mapped extent of a nesting area. Where the mapped extent of a colony was available it was used. Where the mapped extent was not available the default “seconds precision” circle was used around the recorded nesting location point.

ENSP reviewed the literature regarding commuting distance for colonial nesting long-legged wading birds which fairly consistently indicates that the importance of suitable foraging habitat decreases with the distance from the nesting area (e.g. Dowd and Flake 1985, Custer et al. 2004, Kelly et al 1993, Thompson 1978). This is not surprising considering the energy demands of long commutes and the fact that, all other things being equal, if suitable foraging habitat is randomly distributed within the possible foraging range, simple geometry would argue that availability would

increase with the square of the distance from the colony. Consequently, a particular type of wetland or riparian habitat is more critical if it is located close to a nesting area than a similar area located near the edge of the "energetically feasible" foraging range from the colony. It would therefore be unjustifiable to use the maximum foraging distance figures to define all potential foraging habitat as "critical" foraging habitat for a particular nesting colony. Conversely, using an average foraging distance figure may "under-include" suitable habitat by omitting some foraging areas that are important because they provide particularly rich and easily exploited feeding habitat.

Further, research (Custer et al. 2004) indicates that longer commuting distances are more frequent during high-demand and demographically critical nestling rearing period. Where the literature on commuting distance includes several studies, there can be wide variability in the mean commuting distances between different studies. When such was the case, we either averaged the reported mean commuting distances or used the information from the study with a large sample size or from an area most ecologically similar to New Jersey. We then doubled this figure.

A study conducted in North Carolina determined that the average foraging commute was 1.4 km (Custer and Osborn 1978). Research from the Chesapeake Bay found a smaller average foraging commute at <0.5 km. NatureServe recommends a minimum inferred extent of 3 km and justifies it by noting a low mean foraging range size (NatureServe 2006). We apply a 2.7 km radius around a colony to protect foraging areas.

Literature supporting occurrence area(s):

Bentley. 1994. Use of a landscape-level approach to determine the habitat requirements of the yellow-crowned night-heron in the lower Chesapeake Bay. Masters Thesis, College of William and Mary, Williamsburg, Virginia.
Average distance between nest and foraging area was <0.5 km.

Custer and Osborn. 1978. Feeding habitat use by colonially breeding herons, egrets and ibises in North Carolina. Auk 95:733-43.
Average distance between nests and foraging areas was 1.4 km.

Custer, C.M., S.A. Suarez, D.A. Olsen. 2004. Feeding habitat characteristics of the Great Blue Heron and Great Egret nesting along the Upper Mississippi River, 1995-1998. Waterbirds 27(4): 454-68.
The majority of the herons in this study fed <5 km from the nesting site, and avoided areas > 10 km away. They flew farther to sites during the brood-rearing period than during incubation. Only 10% of the feeding flights ended at a location where another heron was present, indicating that they prefer to feed alone.

Dowd and Flake. 1985. Foraging habits and movements of nesting Great Blue Heron in prairie river ecosystem, South Dakota. Journal of Field ornithology 56: 377-87.
A study in South Dakota found that the average distance that great blues flew from their colony to a foraging site was 3.1 km, and the maximum observed distance was 24.4 km. Eighty-five percent of the herons in the study fed within 4 km of the colony.

Kelly J. P., H. M. Pratt, P. L. Greene. 1993. The distribution, reproductive success, and habitat characteristics of heron and egret breeding colonies in the San Francisco Bay area. Colonial Waterbirds. 16:18–27.
> 95% of great blue herons and >90% great egrets fed within 20 km of their colony.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
The inferred minimum extent habitat use (when actual extent is unknown) is 3 km. This is based on a low mean foraging range size.

Thompson. 1978. Feeding areas of Great Blue Herons and Great Egrets nesting in the floodplain of the upper Mississippi River. Proc. Colonial Waterbird Group. 2: 202-13.
In central Minnesota the average distance that the herons flew from the colony to a foraging area was 6.5 km, and the maximum observed was 20.4 km. Fifty-three percent of the herons in the study fed within 4 km of the colony.

Last researched by Christina Kisiel in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

REPTILES:

Bog Turtle

Feature Label	Occurrence Area
Occupied Habitat	Hand digitized polygon + 200 meter buffer

Occurrence Area Rule: Mapped as a point or polygon, which then receives the specified buffer.

Justification text:

Glyptemys muhlenbergii is a habitat specialist that occupies wetlands that meet certain characteristics of vegetation, soils, and, most importantly, hydrology. The life history of G. muhlenbergii is somewhat unique in that it spends the majority of the year within the wetland complex and often does not venture for great periods of time into the adjacent uplands and therefore the identification of wetlands occupied by the bog turtle is critical to the recovery of this species. A percentage of wetlands with bog turtles are of a small enough size that they are not currently identified as Wetlands in the 2002 Land Use/Land Cover data layer so therefore polygons are hand digitized to reduce the chance of not capturing core habitat.

An additional 200 meters is generated around the Bog Turtle Colony polygons to account for turtle movements not identified during fieldwork as well as habitat that is valuable to the colony, but was not identified by the biologists. This new polygon is the Species Occurrence Area (SOA).

Literature supporting occurrence area(s):

Chase et al. 1989. Habitat Characteristics, Population Size, and Home Range of the Bog Turtle, Clemmys muhlenbergii, in Maryland. Journal of Herpetology 23(4): 356-362.
Discusses bog turtle habitat use as mostly isolated to specific wetland types.

Morrow et al. 2001. Home Range and Movements of the Bog Turtle in Maryland. Journal of Herpetology 35(1): 68-73.
Discusses use of wetlands as primary habitat for bog turtles throughout duration of study.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
Inferred minimum extent of habitat use for this species is 200 meters.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Coastal Plains Milk Snake

Feature Label	Occurrence Area
Occupied Habitat	71.25 meter radius
Hibernaculum	71.25 meter radius
Nest	71.25 meter radius

Occurrence Area Rule: Only points receive the specified buffer for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

No literature is available to support the “seconds precision” occurrence area, and ENSP staff was unable to locate literature supporting home range territories.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Corn Snake

Feature Label	Occurrence Area
Occupied Habitat	250 meter radius
Hibernaculum	250 meter radius
Nest	250 meter radius
Dead on Road (DOR)	250 meter radius

Occurrence Area Rule: Only points receive the specified buffer for all feature labels.

Justification:

All grasslands, and forests within 250 m of a documented corn snake sighting are consider to be critical habitat for this species. Dead-on-road sightings are still used to value corn snake habitat despite the fact that the observed and reported individual is no longer living. The explanation for this is based on the fact that habitat for this species still remains within 250 meters of the DOR snake. Furthermore, even though the individual that was killed along the road is no longer alive to make use of this habitat, it is assumed that other snakes of this species live in the area an will make use of the habitat.

Corn snakes prefer upland habitats with sandy soils and pine-dominated forests (Beans and Niles 2003). Corn snake are a fossorial species and activity range estimates for this species in the New Jersey pinelands range from 11.3 – 24.8 acres (Zappalorti et al. 1983; Zappalorti and Rocco 1990). For the purposes of creating a reasonable buffer that could be applied to corn snake sightings and to approximate habitat needs for this species, these activity range estimates were converted into estimates of square footage and assumed to be circular in configuration. Buffer distances (radii of the circular activity ranges) were then calculated and ranged from 396 to 587 feet (120 - 179 m). However, because activity ranges for this species are often oblong (Zappalorti, RT and R Gianluca) rather than circular a buffer distance of 250 m is applied to all corn snake sightings in order to capture the entire activity range for this species.

Literature supporting occurrence area(s):

Beans, BE and L Niles. 2003. Endangered and Threatened Wildlife of New Jersey. New Brunswick, NJ: Rutger's University Press.

Zappalorti O Heck. 1988. A captive breeding program of the corn snake (Elaphe guttata) with notes on a sampling program of released hatchlings in the New Jersey Pine Barrens. In. Proceedings of the 12th International Herpetological Symposium on Captive Propagation and Husbundry.

Zappalorti, RT and R Gianluca. 1990. Endangered and threatened snake studies and habitat evaluations of the route of the proposed mule road extension, Berkely Township, Ocean County, New Jersey.

Zappalorti, RT. 1993. Life history, ecology and management of the northern pine snake (Pituophis melanoleucus melanoleucus). Unpublished report to NJDEP, Division of Fish and Wildlife by Herpetological Associates.

New Jersey. Unpublished report to NJDEP, Division of Fish and Wildlife by Herpetological Associates.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Eastern Box Turtle

Feature Label	Occurrence Area
Nest	500 meters
Occupied Habitat	500 meters

Occurrence Area Rule: Only points receive the specified buffer for all feature labels.

Justification:

The eastern box turtle, Terrapene carolina, is the most terrestrial of New Jersey's turtles. Although the box turtle's home range is usually no greater than 15 hectares, individuals routinely move between populations, especially juveniles. When displaced from their home range, T. carolina is known to have some homing ability outwards to 1.5 kilometers and individuals placed outside of this distance will take up occupancy at the release point with mixed success.

As a special concern species, much of the state data collected on T. carolina is in the form of Herp Atlas reports which are mapped on 1/6 USGS Quadrangles.

Literature supporting occurrence area(s):

Dodd, C. K., Jr. 2001. North American box turtles: a natural history. University of Oklahoma Press, Norman. 231 pp.
Comprehensive text on box turtle life history

Dolbeer, R. A. 1969. Population density and home range size of the eastern box turtle (*Terrapene c. carolina*) in eastern Tennessee. ASB Bulletin 16:49.
Provides home range estimates for a population of box turtles and general habitat requirements.

Ernst, C. H., R. W. Barbour, and J. E. Lovich. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. xxxviii + 578 pp.
Literature-based life history of the box turtle.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
Inferred minimum extent of habitat use for this species is 500 meters.

Stickel, L. F. 1989. Home range behavior among box turtles (TERRAPENE C. CAROLINA) of a bottomland forest in Maryland. J. Herpetol. 23:40-44.

Describes habitat use by box turtles and home range sizes. Movements to nesting areas, which are critical to the viability of a population are often not calculated in an individual's home range.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Eastern King Snake

Feature Label	Occurrence Area
Nest	300 meter radius
Hibernaculum	300 meter radius
Occupied Habitat	300 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:
Currently under review.

Literature supporting occurrence area(s):

Currently under review.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Copperhead Snake

Feature Label	Occurrence Area
Gestation Site	71.25 meter radius
Hibernaculum	71.25 meter radius
Occupied Habitat	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:
The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25

meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

No literature is available to support the "seconds precision" occurrence area, and ENSP staff was unable to locate literature supporting home range territories.

Last researched by Kris Schantz in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Diamondback Terrapin

Feature Label	Occurrence Area
Occupied Habitat	71.25 meter radius

Occurrence Area Rule: Only points receive the specified buffer for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

No literature is available to support the "seconds precision" occurrence area, and ENSP staff was unable to locate literature supporting home range territories.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Pine Snake

Feature Label	Occurrence Area
Occupied Habitat	500 meter radius
Hibernaculum	500 meter radius
Nest	500 meter radius
Dead on Road (DOR)	500 meter radius
Telemetry: Home Range	Telemetry Model*
Telemetry: Partial Activity Range	Telemetry Model*

Occurrence Area Rule: For all non-telemetry feature labels, only points received the specified radii.
*Telemetry features were created by taking each individual snake's telemetry points and connecting them in date order (first date to last date) with a line. That line was then buffered 300 meters to produce a polygon which then valued level 3 lu/lc. The polygon itself was not buffered.

Justification:

All grasslands, and forests within 500 m of a documented northern pine snake sighting are consider to be critical habitat for this species. Dead-on-road sightings are still used to value pine snake habitat despite the fact that the observed and reported individual is no longer living. The explanation for this is based on the fact that habitat for this species still remains within 500 meters of the DOR snake. Furthermore, even though the individual that was killed along the road is no longer alive to make use of this habitat, it is assumed that other snakes of this species live in the area an will make use of the habitat.

This species is typically associated with dry upland habitats and can make long distance movements through both upland (Burger and Zappalorti 1988; Zappalorti 1993) and, in some case, extensive wetland habitats (Bien, personal communication). While home range estimates vary extensively from study to study, one radio-telemetry study of this species conducted in the New Jersey Pinelands found that pine snakes had an activity range of 5.9 to 116 acres (Zappalorti et al. 1983). For the purposes of creating a reasonable buffer that could be applied to pine snake sightings to aproximate habitat needs, these activity range estimates were converted into estimates of square footage (area calculation) and assumed to be circular in configuration. Buffer distances (radii of the circular activity ranges) were then calculated and ranged from 286 to 1268 feet (87-386 m). However, because activity ranges for this species are typically oblong (Zappalorti and Rocco 1990) rather than circular a buffer distance of 500 m is applied to all pine snake sightings in order to capture the entire activity range for this species.

Literature supporting occurrence area(s):

Burger, J and RT Zappalorti. 1988. Habitat use in free-ranging pine snakes (Pituophis melanoleucus melanoleucus) in the New Jersey Pine Barrens. Herpetologica 44(1): 48-55.

Zappalorti, RT, EW Johnson, and Z Leszczynski. 1983. The ecology of the northern pine snake (Pituophis melanoleucus melanoleucus) in southern New Jersey, with special

notes on habitat and nesting behavior. Bulletin, Chicago Herpetological Society 18:57-72.

Zappalorti, RT and R Gianluca. 1990. Endangered and threatened snake studies and habitat evaluations of the route of the proposed mule road extension, Berkely Township, Ocean County, New Jersey.

Zappalorti, RT. 1993. Life history, ecology and management of the northern pine snake (Pituophis melanoleucus melanoleucus). Unpublished report to NJDEP, Division of Fish and Wildlife by Herpetological Associates.

New Jersey. Unpublished report to NJDEP, Division of Fish and Wildlife by Herpetological Associates.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Spotted Turtle

Feature Label	Occurrence Area
Nest	500 meters
Occupied Habitat	500 meters

Occurrence Area Rule: Only points receive the specified buffer for all feature labels.

Justification:

The spotted turtle, Clemmys guttata, frequents a variety of wetland habitat types throughout its range, although terrestrial habitat use is documented. The type of wetland that the species uses may shift seasonally causing the animal to travel regularly across fields, through forests, or employ wetlands as a corridor between preferred habitats. In some cases, females will move large distances from wetlands to find suitable nesting areas.

Literature supporting occurrence area(s):

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.

Inferred minimum extent of habitat use for this species is 500 meters.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Timber Rattlesnake

Feature Label	Occurrence Area
Gestation Site	4.0 km radius
Hibernaculum	4.0 km radius
Occupied Habitat	20 meter radius
Occurrence by Den	4.0 km radius
Telemetry: Home Range	Rattlesnake Telemetry Model*
Telemetry: Partial Activity Range	Rattlesnake Telemetry Model*

Occurrence Area Rule: For all non-telemetry feature labels, only points received the specified radii.
*The Rattlesnake Telemetry Model was created by taking each individual snake's telemetry points and connecting them in date order (first date to last date) with a line. That line was then buffered 300 meters to produce a polygon which then valued level 3 lu/lc. The polygon itself was not buffered.

Justification:

Timber rattlesnakes' home ranges vary according to sex and age class. Reproductively mature males typically travel greater distances than females and young males in search of mates and/or food resources. ENSP research has shown that sub-adult males often venture farther than non-gravid females, while juveniles and yearlings [males] may maintain a smaller activity range. Non-gravid females typically maintain a larger activity range than gravid females, and gravid females may venture out to forage early in the season, but return to their gestation site/ birthing rookery by early July which is typically within 500 meters (.3 miles) of her den. Rattlesnake researchers agree that the majority of a den's population will use the habitat within a 1.5 mile (2.4 km) radius of the den with some of the larger males venturing beyond this distance in search of mates. However, telemetry research has shown that males (and less typically, non-gravid females) will travel greater distances in search of food, basking areas, and mates (Brown 1993, Martin 1993, ENSP research 2006). Therefore, the ENSP has determined that a larger occurrence area (4 km radius around a den) is required to adequately protect critical habitat for timber rattlesnake populations.
"Occurrence by Den" is typically related to early transient/ basking areas, which also may be used as gestation sites. These are critical sites near dens (thus the same model applies) that are important to the snakes upon spring emergence. These areas provide important early season basking sites before the snakes move onto their foraging grounds or shed sites. "Gestation Site" is often near the den but can be up to 500 meters (.3 miles) from the den. These sites are critical to the survival of timber rattlesnake populations in the northern region and are used for many generations. Young snakes follow scent trails, left by adult females, back to the safety of their dens in the late fall. Due to the females' condition and newborns' inexperience, they are highly vulnerable to predation at these sites. Therefore, the same model has been applied to known gestation sites in an effort to: 1) protect the site and travel corridors to/ from the den, and; 2) to capture the den within the model.

"Occupied Habitat" refers to random sightings of rattlesnakes whereby it is impossible to determine the snake's den location or critical habitat range. These sites are given a standard seconds precision occurrence area (20 meter radius). All suitable habitat that are intersected by this buffer will be valued as potential critical habitat.

Literature supporting occurrence area(s):

Brown, William S. 1993. Timber Rattlesnake: Habitat. *In* Biology, Status, and Management of the Timber Rattlesnake (*Crotalus Horridus)*: A Guide for Conservation (Joseph T. Collins ed.). Museum of Natural History – Dyche Hall, The University of Kansas, Lawrence, Kansas. Pp. 10-15.

- Transient habitat is also used by females during their reproductive years…for gestating and birthing.

Brown, William S. 1993. Timber Rattlesnake: Ecology. *In* Biology, Status, and Management of the Timber Rattlesnake (*Crotalus Horridus)*: A Guide for Conservation (Joseph T. Collins ed.). Museum of Natural History – Dyche Hall, The University of Kansas, Lawrence, Kansas. Pp. 15-24.

- Mean size home ranges:
  - New Jersey males: 207 ha
  - New Jersey nongravid females: 42 ha
  - New Jersey gravid females: 22 ha
- Mean maximum migratory distance from den:
  - New Jersey males': 4.07 km (2.5 mi)
  - New Jersey nongravid females: 2.05 km (1.3 mi)
- Maximum single migratory distance from den:
  - New Jersey males': 7.2 km (4.5 mi)
  - New Jersey nongravid females: 3.7 km (2.3 mi)

Brown, William S. 1993. Timber Rattlesnake: Land Protection. *In* Biology, Status, and Management of the Timber Rattlesnake (*Crotalus Horridus)*: A Guide for Conservation (Joseph T. Collins ed.). Museum of Natural History – Dyche Hall, The University of Kansas, Lawrence, Kansas. Pp. 39-40.

- Home ranges average 160 – 500 ac (65 – 202 ha) for males; 40 – 100 ac (16 – 40 ha) for nongravid females.
- A 1.5 mile (2.4 km) radius centered around den would encompass most of the habitat used by snakes from that den. An additional buffer of 1 mile (for a total of 2.5 mile radius, 4.0 km radius) is recommended to protect large males and some nongravid females that venture further and to buffer the habitat used by the greater portion of the individual den population from human activity.

Martin, W.H. 1993. Reproduction of the Timber Rattlesnake (*Crotalus Horridus)* in the Appalachian Mountains. Journal of Herpetology 27(2):133-143.

- Females spent most of their gestation period…usually located within 500 m (.3 miles) of their overwintering dens.

Schantz, Kris. 2006. Expert opinion. Endangered and Nongame Species Program Timber Rattlesnake Telemetry Research 1999-2000, 2003-2005.

Last researched by Kris Schantz in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Wood Turtle

Feature Label	Occurrence Area
Nest	Wood Turtle Model
Occupied Habitat	Wood Turtle Model
Wintering	Wood Turtle Model

Critical areas for wood turtles are mapped following the four-step process described below:

1) A 322-meter (0.2 miles) buffer is applied to all streams (NJDEP Streams) within a one-mile radius of each wood turtle sighting location. The buffers are clipped so that all areas being designated as critical wood turtle habitat are within one mile of a wood turtle sighting. 2) The NJDEP LULC layer is overlaid on the buffered areas. All areas classified as urban, with the exception of undeveloped uplands rights-of ways, are deleted from the buffered areas. 3) Next, all areas classified as wetlands in the NJDEP LULC layer with the exception of cemetery on wetlands, and saline marshes, are overlaid on the stream buffers. All wetlands that are contiguous with the buffered areas are selected and clipped to only include wetlands within one mile of a sighting. Those wetlands are then merged into the stream buffers. 4) Lastly, a staff turtle biologist conducts a detailed inspection and revision of each resultant polygon to ensure biological accuracy. The wood turtle model is a stand-alone layer that is not used to value habitat patches.

Justification:

A radius of one mile as the starting point for wood turtle habitat mapping was chosen based upon ecological studies that demonstrated wood turtle movements of 800m (Harding and Bloomer), 1km (Mitchell 1991), and 1.9km and 3.6km (Quinn and Tate 1991) along riparian corridors. Carroll and Ehrenfeld (1978) demonstrated that wood turtles displaced up to 2km were well within their home range. In addition to linear movements following watercourses, it is well documented that wood turtles travel beyond the riparian zone during the summer months. The 322m buffer represents a mean distance wood turtles traveled from their hibernation/breeding streams according to various natural history studies (Burt and Collins n.d.; Ernst 1986; Harding and Bloomer 1979; Strang 1983; Kaufmann 1992, 1995; Brewster and Brewster 1991; Farrell and Graham 1991; Quinn and Tate 1991), as well as ongoing research (R.L. Burke, Hofstra University; J.L. Behler, Wildlife Conservation Society).

Literature supporting occurrence area(s):

Brewster, K. N., and C. M. Brewster. 1991. Movement and microhabitat use by juvenile wood turtles introduced into a riparian habitat. J. Herpetol. 25:379-382.

Burt, C.J. and D.E. Collins. Population parameters and summer home range-habitat relationships of the wood turtle (Clemmys insculpta). Unpub. Manuscript. 26pp.

Carroll, T. E. and D. W. Ehrenfeld. 1978. Intermediate-range homing in the wood turtle, Clemmys insculpta. Copeia 1978(1): 117-126.

Ernst, C.H. 1986. Environmental temperatures and activities in the wood turtle, Clemmys insculpta. J. of Herp. 20(2):222-229.

Farrell, R. F. and T. E. Graham. 1991. Ecological notes on the turtle Clemmys insculpta in northwestern New Jersey. J. Herp. 25(1): 1-9.

Harding, J. H. and T. J. Bloomer. 1979. The wood turtle, Clemmys insculpta...a natural history. HERP Bull. N.Y. Herp. Soc. 15(1): 9-26.

Kaufmann, J. H. 1992. Habitat use by wood turtles in central Pennsylvania. J. Herpetol. 26:315-321.

Kaufmann, J. H. 1995. Home ranges and movements of wood turtles, Clemmys insculpta, in central Pennsylvania. Copeia 1995:22-27.

Mitchell, J. C. 1991. Amphibians and reptiles. Pages 411-76 in K. Terwilliger (coordinator). Virginia's Endangered Species: Proceedings of a Symposium. McDonald and Woodward Publishing Company, Blacksburg, Virginia.

Quinn, N. W. S., and D. P. Tate. 1991. Seasonal movements and habitat of wood turtles (Clemmys insculpta) in Algonquin Park, Canada. J. Herpetol. 25:217-220.

Strang, C. A. 1983. Spatial and temporal activity patterns in two terrestrial turtles. J. Herpetol. 17:43-47.

Last researched by Brian Zarate and Gretchen Fowles in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

AMPHIBIANS:

Blue-spotted Salamander

Feature Label	Occurrence Area
Breeding	300 meter radius
Non-breeding	300 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

Vernal habitats are utilized by a wide variety of amphibian species. A single vernal habitat and its surrounding upland component serve as critical habitat for a diversity of Ambystomid salamanders, including A. laterale. ENSP has determined that a buffer of 300 meters for both breeding (vernal habitat) and non-breeding (upland component) habitat provides protection for a high percentage of the species year-round range. The majority of Ambystomid salamanders breed in vernal pools in the spring for a limited number of weeks and then return to the uplands for the remainder of the year. Occurrences designated as non-breeding will mostly occur within 300 meters of a breeding habitat and therefore the occurrence area radii are the same for both feature labels.

Literature supporting occurrence area(s):

Bishop, S. C. 1941. The Salamanders of New York. Bulletin 324. Albany, NY: The New York State Museum.
Dispersals recorded past 250 m away from suitable breeding habitats.

Brown, L.J. and R.R. Jung. 2005. An Introduction to Mid-Atlantic Seasonal Pools, EPA/903/B-05/001. U.S. Environmental Protection Agency, Mid-Atlantic Integrated Assessment, Ft. Meade, Maryland. Page 10.
Seasonal pool terrestrial habitat buffer recommendation.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
Inferred minimum extent of habitat use for this species is 300 meters.

Regosin, J.V., B.S. Windmiller, R.N. Homan, and J.M. Reed. 2005. Variation in terrestrial habitat use among four pool-breeding amphibian species and its conservation implications. Journal of Wildlife Management 69:1481-1493.
Dispersal of > 100 meters by 52% of a blue-spotted salamander population.

Semlitsch, R. D., and J. R. Bodie. 2003. Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17(5): 1219-1228
Documents home ranges surrounding breeding sites up to 290 meters.

Williams, P.K. 1973. Seasonal movements and population dynamics of four sympatric mole salamanders, genus *Ambystoma*. Unpublished PhD. dissertation, Indiana University.
Documents dispersal distances of various Ambystomid salamanders.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Carpenter Frog

Feature Label	Occurrence Area
Occupied Habitat	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat

patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

No literature is available to support the "seconds precision" occurrence area, and ENSP staff was unable to locate literature supporting home range territories.

Last researched by Brian Zarate in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Cope's Gray Treefrog

Feature Label	Occurrence Area
Breeding	300 meter radius from pool edge
Non-breeding	300 meter radius

Occurrence Area Rule: For Breeding features, both points and polygons receive the specified radius. For Non-breeding features, only points receive the specified radius for all feature labels.

Justification:

All grasslands, wetlands, and upland forests within 300 m of the pond edge are considered to be critical habitat for this species. Sightings of Cope's gray treefrogs made outside of the breeding period are also buffered by 300 m.

This species is typically associated with wetlands and ponded areas during the breeding season, but is capable of making long distance movements through upland habitats. Breeding habitats include borrow pits, ditches, vernal pools, detention basins, and other natural and human-made ponded areas (Zappalorti 2002). In their 2003 study, Johnson and Semlitsch suggest that a minimum core habitat of 60 m is need around breeding ponds to protect local populations of northern gray treefrogs. Movement distances of up to 200 m were observed in this study. One New Jersey study used radio-telemetry methodologies to determine daily movement distance of Cope's gray treefrogs. This study found that treefrogs were capable of moving long distances from breeding habitats, with one individual traveling a straight line distance of 401 m in a four-day period (Golden, unpublished data). Mean daily movement distances for Cope's gray treefrogs in this study were 32 m during the breeding season and 9 m outside of the breeding season. Regular movements of 100 m during the breeding season were observed in one study from Tennessee (Ritke et al. 1991).

Literature supporting occurrence area(s):

Johnson, JR and RD Semlitsch. 2003. Defining core habitat of local populations of gray treefrog (Hyla versicolor) based on choice of oviposition site. Oecologia 137:205-210.

Ritke, ME, JG Babb, and MK Ritke. 1991. Breeding-site specificity in the gray treefrog (Hyla chrysoscelis). Journal of Herpetology 25:123-125

Zappalorti, RT. 2002. Ecology and breeding habits of Cope's gray treefrog (Hyla chrysoscelis) in the coastal Pine Barrens of southern New Jersey. Unpublished report to NJDEP, Division of Fish and Wildlife by Herpetological Associates.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Eastern Tiger Salamander

Feature Label	Occurrence Area
Breeding	300 meter radius from pool edge
Non-breeding	300 meter radius

Occurrence Area Rule: For Breeding features, both points and polygons receive the specified radius. For Non-breeding features, only points receive the specified radius for all feature labels.

Justification:

All emergent habitat types (forest, wetland forest, emergent wetland and adjacent barren land) within 300 m of a pond edge are designated as critical habitat. In the brief "non-breeding" period, those habitats within 300 m of a sighting are designated as critical habitat.

Large terrestrial areas adjacent to wetlands are used by adult pond-breeding salamanders and newly metamorphosed juveniles through the majority of the year. Semlitsch and Bodie (2003) identified a "core habitat" for amphibians of 290 m from the wetland edge. They based this figure on studies that found adult tiger salamanders move up to 300 m from breeding ponds (Semlitsch 1983, Madison and Farrand 1998). Salamanders tracked by radio-telemetry made all movements within 300 m of the breeding pond; the greatest movements were by those animals tracked the longest (Madison and Farrand 1998). They found salamanders moved in all directions within wooded areas, but avoided grassy fields, paved roads, and commercial areas. Habitat within 300 m of the pond is critical to survival: for a related species, marbled salamander (*A. opacum*), upland survival is much better in forested habitat than in old-field (Taylor et al. 2005). In NJ, many breeding ponds are located in abandoned sand/gravel pits where the 300 m area includes some barren land cover type.

Tiger salamanders found >300 m from a breeding pond in the non-breeding season (8/1-9/30) may represent movement between ponds, and the habitat should be considered a corridor for interaction of nearby populations.

Literature supporting occurrence area(s):

Madison, D.M., and L. Farrand. 1998. Habitat use during breeding and emigration in radio-implanted tiger salamanders, *Ambystoma tigrinum*.

Semlitsch, R. D. 1983. Burrowing ability and behavior of salamanders of the genus *Ambystoma*. Canadian Journal of Zoology 61:616-620.

Semlitsch, R. D., and J. R. Bodie. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. Conservation Biology 17:1219-1228.

Taylor, B. E., D. E. Scott, and J. W. Gibbons. 2005. Catastrophic reproductive failure, terrestrial survival, and persistence of the marbled salamander. Conservation Biology 20:792-801.

Last researched by Dave Golden and Kathy Clark in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Fowlers Toad

Feature Label	Occurrence Area
Occupied Habitat	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

No literature is available to support the “seconds precision” occurrence area, and ENSP staff was unable to locate literature supporting home range territories.

Last researched by Brian Zarate in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Jefferson Salamander

Feature Label	Occurrence Area
Breeding	300 meter radius
Non-breeding	300 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

Vernal habitats are utilized by a wide variety of amphibian species. A single vernal habitat and its surrounding upland component serve as critical habitat for a diversity of Ambystomid salamanders, including A. jeffersonianum. ENSP has determined that a buffer of 300 meters for both breeding (vernal habitat) and non-breeding (upland component) habitat provides protection for a high percentage of the species year-round range. The majority of Ambystomid salamanders breed in vernal pools in the spring for a limited number of weeks and then return to the uplands for the remainder of the year. Occurrences designated as non-breeding will mostly occur within 300 meters of a breeding habitat and therefore the occurrence area radii are the same for both feature labels.

Literature supporting occurrence area(s):

Bishop, S. C. 1941. The Salamanders of New York. Bulletin 324. Albany, NY: The New York State Museum.
Dispersals recorded as far as 1,610m away from suitable breeding habitats.

Brown, L.J. and R.R. Jung. 2005. An Introduction to Mid-Atlantic Seasonal Pools, EPA/903/B-05/001. U.S. Environmental Protection Agency, Mid-Atlantic Integrated Assessment, Ft. Meade, Maryland. Page 10.
Seasonal pool terrestrial habitat buffer recommendation.

Faccio, S. D. 2003. Postbreeding emigration and habitat use by Jefferson and spotted salamanders in Vermont. Journal of Herpetology 37:479-489.
Documents dispersal distances up to 355m in one movement and macro habitat preferences.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
Inferred minimum extent of habitat use for this species is 300 meters.

Semlitsch, R. D., and J. R. Bodie. 2003. Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17(5): 1219-1228
Documents home ranges surrounding breeding sites up to 290 meters.

Williams, P.K. 1973. Seasonal movements and population dynamics of four sympatric mole salamanders, genus *Ambystoma*. Unpublished PhD. dissertation, Indiana University.
Documents dispersal distances of various Ambystomid salamanders.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Longtail Salamander

Feature Label	Occurrence Area
Occupied Habitat	100 meter radius

Occurrence Area Rule: Only points receive the specified radius.

Justification:

Very little primary literature exists on the life history of Eurycea l. longicauda. Much of the information we know about E. longicauda derives from the occurrence data in ENSP's Biotics Database. Ongoing research and personal observations have also contributed to the development of the current occurrence area.

Literature supporting occurrence area(s):

Anderson and Martino. 1966. The Life History of Eurycea l. longicauda Associated with Ponds. The American Midland Naturalist 75(2): 257-279

A unique association of E. longicauda with limestone sink ponds, also breeding areas for Ambystomid salamanders, exists in New Jersey.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.

Inferred minimum extent of habitat use for this species is 100 meters.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Marbled Salamander

Feature Label	Occurrence Area
Breeding	300 meter radius
Non-breeding	300 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification text:

Vernal habitats are utilized by a wide variety of amphibian species. A single vernal habitat and its surrounding upland component serve as critical habitat for a diversity of Ambystomid salamanders, including A. opacum. ENSP has determined that a buffer of 300 meters for both breeding (vernal

habitat) and non-breeding (upland component) habitat provides protection for a high percentage of the species year-round range. The majority of Ambystomid salamanders breed in vernal pools in the spring for a limited number of weeks and then return to the uplands for the remainder of the year. Marbled salamanders, on the other hand, breed in the fall at vernal pools. Occurrences designated as non-breeding will mostly occur within 300 meters of a breeding habitat and therefore the occurrence area radii are the same for both feature labels.

Literature supporting occurrence area(s):

Brown, L.J. and R.R. Jung. 2005. An Introduction to Mid-Atlantic Seasonal Pools, EPA/903/B-05/001. U.S. Environmental Protection Agency, Mid-Atlantic Integrated Assessment, Ft. Meade, Maryland. Page 10.
Seasonal pool terrestrial habitat buffer recommendation.

Gamble, L.R., McGarigal, K., Jenkins, C.L., and Timm, B.C. 2006. Limitations of regulated "buffer zones" for the conservation of marbled salamanders. *Wetlands* 26(2):298-306.
Documents dispersals up to 1,230 meters by marbled salamanders.

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life (web application). Version 4.7. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer.
Inferred minimum extent of habitat use for this species is 300 meters.

Semlitsch, R. D., and J. R. Bodie. 2003. Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17(5): 1219-1228
Documents home ranges surrounding breeding sites up to 290 meters.

Williams, P.K. 1973. Seasonal movements and population dynamics of four sympatric mole salamanders, genus *Ambystoma*. Unpublished PhD. dissertation, Indiana University.
Documents dispersal distances of various Ambystomid salamanders, including A. opacum, outwards to 450m.

Last researched by Brian Zarate in 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

Northern Spring Salamander

Feature Label	Occurrence Area
Occupied Habitat	71.25 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather

information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

No literature is available to support the "seconds precision" occurrence area, and ENSP staff was unable to locate literature supporting home range territories.

Last researched by Brian Zarate in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

Pine Barrens Treefrog

Feature Label	Occurrence Area
Breeding	300 meter radius from pool edge
Non-breeding	300 meter radius

Occurrence Area Rule: For Breeding features, both points and polygons receive the specified radius. For Non-breeding features, only points receive the specified radius for all feature labels.

Justification:

All wetlands, and upland forests within 300 m of the pond edge are considered to be critical habitat for this species. Sightings made outside of the breeding period are also buffered by 300 m.

Breeding habitats for this species are documented to consist of bogs, vernal pools, cedar swamps, and pitch pine lowlands (Means and Longden 1976). Common plant communities associated with breeding ponds contain red maple (Acer rubrum), pitch pine (Pinus rigida), leatherleaf (Chamaedaphne calyculata), fetterbush (Eubotrys racemosa), sheep laurel (Kalmia angustifolia), and highbush blueberry (Vaccinium corymbosum) (Laidig et al. 2001). Mean water depths of 13 Pine Barrens treefrog breeding ponds studied by Laidig et al. (2001) in the New Jersey Pinelands ranged from 30 to 65 cm. The maximum water depth of the same 13 ponds ranged from 55 to 124 cm. While research on the movements of Pine Barrens treefrogs is quite limited, one study found individuals of this species stayed within 72 m of the breeding pools during the breeding season (Freda and Gonzalez 1986). Dispersal distances were slightly higher outside of the breeding season (up to 102 m), but still less than the documented dispersal distances of related species (Johnson and Semlitsch 2003, Golden unpublished data). Because of the small sample size (n=8) of the Freda and Gonzalez study, a buffer distance for sightings on this species were adapted from data published on other treefrog species.

Literature supporting occurrence area(s):

Johnson, JR and RD Semlitsch. 2003. Defining core habitat of local populations of gray treefrog (Hyla versicolor) based on choice of oviposition site. Oecologia 137:205-210.

Laidig, KJ, RA Zampella, JF Bunnell, CL Dow, and TM sulikowski. 2001. Characteristics of selected Pine Barrens treefrog pones in the New Jersey Pinelands. Unpublished reports by the New Jersey Pinelands Commission.

Means, DB and CJ Longden. 1976. Aspects of the biology and zoogeography of the Pine Barrens treefrog (Hyla andersonii) in northern Florida. Herpetologica 32:117-130.

Last researched by Dave Golden in 2007.
Occurrence area applied in Version 2.1 of the Landscape Project.

BEETLES:

Northeastern Beach Tiger Beetle

Feature Label	Occurrence Area
Adult	71.25 Meters Radius
Larvae	71.25 Meters Radius
Pupae	71.25 Meters Radius

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point or a line, the occurrence area is defined by that feature plus the specified radius.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

Not available.

Last researched by Zack Mahon in Winter 2006/2007.

Occurrence area applied in Version 2.1 of the Landscape Project.

BUTTERFLIES:

Appalachian Grizzled Skipper, Arogos Skipper, Bronze Copper, Checkered White, Dotted Skipper, Frosted Elfin, Georgia Satyr, Harris Checkerspot, Hessel's Hairstreak, Hoary Elfin, Mitchell's Satyr, Northern Metalmark, Silver-bordered Fritillary, Two-spotted Skipper

Feature Label	Occurrence Area
Adult Casual Flyby	71.25 meter radius
Adult Mating	71.25 meter radius
Adult Nectaring	71.25 meter radius
Larvae Sighting	71.25 meter radius
Pupae Sighting	71.25 meter radius

Occurrence Area Rule: If mapped as a polygon, the polygon is the occurrence area. If mapped as a point or a line, the occurrence area is defined by that feature plus the specified radius.

Justification:

The species occurrence area is generally based on the average home range/territory size, or other appropriate life-history parameter as reported in peer-reviewed scientific literature or from information obtained through ENSP research. When searching the scientific literature to gather information to support the occurrence area polygon size, efforts were made to select research that was conducted in habitat types similar to those found in NJ. For many species that value habitat patches in the Landscape Project maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In these cases, a default occurrence area (71.25 meter radius) is applied to take into account location uncertainty. These occurrence areas are used to value patches of habitat.

Literature supporting occurrence area(s):

Beans, BE and L Niles. 2003. Endangered and Threatened Wildlife of New Jersey. New Brunswick, NJ: Rutger's University Press.

Gochfeld, M and J Burger. 1997. Butterflies of New Jersey: a guide to their status, distribution, conservation, and appreciation. New Brunswick, NJ: Rutger's University Press.

Opler, PA and V Malikul. 1998. A guide to eastern butterflies. New York, NY: Houghton Mifflin.

Scott, J. 1986. The butterflies of North America: a natural history and field guide. Stanford, CA: Stanford University Press

Last researched by Dave Golden in July 2006.
Occurrence area applied in Version 2.1 of the Landscape Project.

DRAGONFLIES AND DAMSELFLIES:

Arrowhead Spiketail, Brook Snaketail, Brush-tipped Emerald, Harpoon Clubtail, Kennedy's Emerald, Maine Snaketail, Midland Clubtail, New England Bluet, Rapids Clubtail, Sable Clubtail, Ski-tailed Emerald, Spatterdock Darner, Tiger Spiketail, Williamson's Emerald, Zebra Clubtail

Feature Label	Occurrence Area
Breeding/Courtship	500 meter radius
Casual Flyby	500 meter radius
Exuviae Sighting	500 meter radius
Foraging	500 meter radius
Larvae Sighting	500 meter radius
Territorial Display	500 meter radius

Occurrence Area Rule: Only points receive the specified radius for all feature labels.

Justification:

For many species that value habitat patches in the Landscape Project Maps, insufficient information exists in the scientific literature to support the designation of an occurrence area. In the Landscape Project, an occurrence area equates to the area a species needs to fulfill it's life history requirements (breeding, resting, feeding). Due to the absence of literature concerning Odonate species' spatial requirements, a 500 meter radius was formulated based upon the expert opinion of the biologist responsible for reviewing these species within the NJ Endangered and Nongame Species Program.

Literature supporting occurrence area(s):

To be reviewed.

Last researched by Dave Golden in July 2006.

Appendix IV. NJDEP 2002 Land-use/Land-cover Classes and Corresponding Landscape Habitats

LU02	TYPE02	LABEL02 (Level 3 Modified Class)	Habitat Type
7100	BARREN LAND	BEACHES	Beach
1461	WETLANDS	WETLAND RIGHTS-OF-WAY	Emergent Wetland
1499	URBAN	STORMWATER BASIN	Emergent Wetland
1741	URBAN	PHRAGMITES DOMINATE URBAN AREA	Emergent Wetland
2140	WETLANDS	AGRICULTURAL WETLANDS (MODIFIED)	Emergent Wetland
2150	WETLANDS	FORMER AGRICULTURAL WETLAND (BECOMING SHRUBBY, NOT BUILT-UP)	Emergent Wetland
6111	WETLANDS	SALINE MARSH (LOW MARSH)	Emergent Wetland
6112	WETLANDS	SALINE MARSH (HIGH MARSH)	Emergent Wetland
6120	WETLANDS	FRESHWATER TIDAL MARSHES	Emergent Wetland
6130	WETLANDS	VEGETATED DUNE COMMUNITIES	Emergent Wetland
6141	WETLANDS	PHRAGMITES DOMINATE COASTAL WETLANDS	Emergent Wetland
6240	WETLANDS	HERBACEOUS WETLANDS	Emergent Wetland
6241	WETLANDS	PHRAGMITES DOMINATE INTERIOR WETLANDS	Emergent Wetland
6500	WETLANDS	SEVERE BURNED WETLANDS	Emergent Wetland
4110	FOREST	DECIDUOUS FOREST (10-50% CROWN CLOSURE)	Forest
4120	FOREST	DECIDUOUS FOREST (>50% CROWN CLOSURE)	Forest
4210	FOREST	CONIFEROUS FOREST (10-50% CROWN CLOSURE)	Forest
4220	FOREST	CONIFEROUS FOREST (>50% CROWN CLOSURE)	Forest
4230	FOREST	PLANTATION	Forest
4311	FOREST	MIXED FOREST (>50% CONIFEROUS WITH 10-50% CROWN CLOSURE)	Forest
4312	FOREST	MIXED FOREST (>50% CONIFEROUS WITH >50% CROWN CLOSURE)	Forest
4321	FOREST	MIXED FOREST (>50% DECIDUOUS WITH 10-50% CROWN CLOSURE)	Forest
4322	FOREST	MIXED FOREST (>50% DECIDUOUS WITH >50% CROWN CLOSURE)	Forest
4411	FOREST	PHRAGMITES DOMINATE OLD FIELD	Forest
4420	FOREST	DECIDUOUS BRUSH/SHRUBLAND	Forest
4430	FOREST	CONIFEROUS BRUSH/SHRUBLAND	Forest
4440	FOREST	MIXED DECIDUOUS/CONIFEROUS BRUSH/SHRUBLAND	Forest
4500	FOREST	SEVERE BURNED UPLAND VEGETATION	Forest
6210	WETLANDS	DECIDUOUS WOODED WETLANDS	Forested Wetland/Forest
6220	WETLANDS	CONIFEROUS WOODED WETLANDS	Forested Wetland/Forest
6221	WETLANDS	ATLANTIC WHITE CEDAR WETLANDS	Forested Wetland/Forest
6231	WETLANDS	DECIDUOUS SCRUB/SHRUB WETLANDS	Forested Wetland/Forest
6232	WETLANDS	CONIFEROUS SCRUB/SHRUB WETLANDS	Forested Wetland/Forest
6233	WETLANDS	MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)	Forested Wetland/Forest
6234	WETLANDS	MIXED SCRUB/SHRUB WETLANDS (CONIFEROUS DOM.)	Forested Wetland/Forest
6251	WETLANDS	MIXED WOODED WETLANDS (DECIDUOUS DOM.)	Forested Wetland/Forest
6252	WETLANDS	MIXED WOODED WETLANDS (CONIFEROUS DOM.)	Forested Wetland/Forest
1211	URBAN	MILITARY INSTALLATIONS*	Grassland
1440	URBAN	AIRPORT FACILITIES	Grassland
1700	URBAN	OTHER URBAN OR BUILT-UP LAND*	Grassland
2100	AGRICULTURE	CROPLAND AND PASTURELAND	Grassland
2200	AGRICULTURE	ORCHARDS/VINEYARDS/NURSERIES/HORTICULTURAL AREAS	Grassland
2300	AGRICULTURE	CONFINED FEEDING OPERATIONS	Grassland
2400	AGRICULTURE	OTHER AGRICULTURE	Grassland
4410	FOREST	OLD FIELD (< 25% BRUSH COVERED)	Grassland
1400	URBAN	TRANSPORTATION/COMMUNICATION/UTILITIES*	Grassland/Forest

LU02	TYPE02	LABEL02 (Level 3 Modified Class)	Habitat Type
1463	URBAN	UPLAND RIGHTS-OF-WAY UNDEVELOPED*	Grassland/Forest
1110	URBAN	RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING	Not used
1120	URBAN	RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	Not used
1130	URBAN	RESIDENTIAL, SINGLE UNIT, LOW DENSITY	Not used
1140	URBAN	RESIDENTIAL, RURAL, SINGLE UNIT	Not used
1150	URBAN	MIXED RESIDENTIAL	Not used
1200	URBAN	COMMERCIAL/SERVICES	Not used
1214	URBAN	FORMER MILITARY, INDETERMINATE USE	Not used
1300	URBAN	INDUSTRIAL	Not used
1410	URBAN	MAJOR ROADWAY	Not used
1419	WATER	BRIDGE OVER WATER	Not used
1462	URBAN	UPLAND RIGHTS-OF-WAY DEVELOPED	Not used
1500	URBAN	INDUSTRIAL/COMMERCIAL COMPLEXES	Not used
1600	URBAN	MIXED URBAN OR BUILT-UP LAND	Not used
1710	URBAN	CEMETERY	Not used
1711	WETLANDS	CEMETERY ON WETLAND	Not used
1750	WETLANDS	MANAGED WETLAND IN MAINTAINED LAWN GREENSPACE	not used
1800	URBAN	RECREATIONAL LAND	not used
1804	URBAN	ATHLETIC FIELDS (SCHOOLS)	not used
1810	URBAN	STADIUM THEATERS CULTURAL CENTERS AND ZOOS	not used
1850	WETLANDS	MANAGED WETLAND IN BUILT-UP MAINTAINED REC AREA	not used
5100	WATER	STREAMS AND CANALS	Not used
5200	WATER	NATURAL LAKES	Not used
5300	WATER	ARTIFICIAL LAKES	Not used
5410	WATER	TIDAL RIVERS, INLAND BAYS, AND OTHER TIDAL WATERS	Not used
5411	WATER	OPEN TIDAL BAYS	Not used
5420	WATER	DREDGED LAGOON	Not used
5430	WATER	ATLANTIC OCEAN	Not used
7200	BARREN LAND	BARE EXPOSED ROCK, ROCK SLIDES, ETC.	Not used
7300	BARREN LAND	EXTRACTIVE MINING	Not used
7400	BARREN LAND	ALTERED LANDS	Not used
7430	WETLANDS	DISTURBED WETLANDS (MODIFIED)	Not used
7500	BARREN LAND	TRANSITIONAL AREAS	Not used
7600	BARREN LAND	UNDIFFERENTIATED BARREN LANDS	Not used

A method using impervious surface and species occurrence areas was developed to select critical wildlife areas from urban land-use/land-cover classifications (Appendix II**).*

Appendix V. Species and the Habitat Types they Value

Common Name	Landscape Rank	Feature Label	Emergent Wetland	Forested Wetland	Forest	Grassland	Beach
Mammals							
Allegheny Woodrat	4	All			X		
Bobcat	4	All	X	X	X*		
Eastern Small-footed Myotis	2	All		X	X		
Indiana Bat	5	All		X	X		
Birds							
American Bittern	4	All	X				
American Kestrel	2	All				X	
American Oystercatcher	2	All	X				X
Bald Eagle	4	All	X	X	X	X	
Bald Eagle	4	Foraging Area	NA	NA	NA	NA	NA
Barn Owl	2	All				X	
Barred Owl	3	All		X	X*		
Black Rail	3	All	X				
Black Skimmer	4	All	X				X
Black-billed Cuckoo	2	All		X	X		
Blackburnian Warbler	2	All		X	X		
Black-crowned Night-heron	3	Nesting Colony	X	X	X		
Black-crowned Night-heron	3	Nesting Colony Foraging	X				
Black-throated Blue Warbler	2	All		X	X		
Black-throated Green Warbler	2	All		X	X		
Blue-headed Vireo	2	All		X	X		
Bobolink	3	All	X			X	
Broad-winged Hawk	2	All			X		
Brown Thrasher	2	All		X	X		
Canada Warbler	2	All		X	X		
Cattle Egret	2	All	X				
Cerulean Warbler	2	All		X	X		
Cliff Swallow	2	All	X			X	
Common Nighthawk	2	All			X	X	X
Common Tern	2	All	X				X
Cooper's Hawk	3	All		X	X		
Eastern Meadowlark	2	All				X	
Glossy Ibis	2	All	X				
Golden-winged Warbler	2	All			X		
Grasshopper Sparrow	3	All				X	
Gray-cheeked Thrush	2	All		X	X		
Great Blue Heron	2	All	X	X	X		
Gull-billed Tern	2	All	X				X
Henslow's Sparrow	4	All	X			X	
Hooded Warbler	2	All		X	X		
Horned Lark	2	All				X	X
Kentucky Warbler	2	All		X	X		
King Rail	2	All	X				
Least Bittern	2	All	X				

Common Name	Landscape Rank	Feature Label	Emergent Wetland	Forested Wetland	Forest	Grassland	Beach
Least Flycatcher	2	All		X	X		
Least Tern	4	All	X				X
Little Blue Heron	2	All	X				
Loggerhead Shrike	4	All				X	
Long-eared Owl	3	All			X	X	
Migratory Raptor Concentration Site	4	All	X	X	X	X	
Migratory Shorebird Concentration Site	4	All					X
Nashville Warbler	2	All		X	X	X	
Northern Goshawk	4	All		X	X		
Northern Harrier	4	All	X			X	
Northern Parula	2	All		X	X		
Osprey	3	All	X				X
Peregrine Falcon	4	All	X				
Pied-billed Grebe	4	All	X				
Piping Plover	5	All					X
Red Knot	3	All	X				X
Red-headed Woodpecker	3	All		X	X		
Red-shouldered Hawk	4	All		X	X*		
Roseate Tern	5	All	X				X
Saltmarsh Sharp-tailed Sparrow	2	All	X				X
Savannah Sparrow	3	All	X			X	
Sedge Wren	4	All	X			X	
Sharp-shinned Hawk	2	All		X	X		
Short-eared Owl	4	All	X			X	
Snowy Egret	2	All	X				
Sora	2	All	X				
Tricolored Heron	2	All	X				
Upland Sandpiper	4	All				X	
Veery	2	All		X	X		
Vesper Sparrow	4	All				X	
Virginia Rail	2	All	X				
Whip-poor-will	2	All		X	X		
Winter Wren	2	All		X	X		
Wood Thrush	2	All		X	X		
Worm-eating Warbler	2	All		X	X		
Yellow-breasted Chat	2	All		X	X		
Yellow-crowned Night-heron	3	Nesting Colony	X	X	X		
Yellow-crowned Night-heron	3	Nesting Colony Foraging	X				
Reptiles							
Bog Turtle	5	All	X	X			
Coastal Plains Milk Snake	2	All			X	X	
Corn Snake	4	All			X	X	
Eastern Box Turtle	2	All			X	X	
Eastern King Snake	2	All		X	X		

Common Name	Landscape Rank	Feature Label	Emergent Wetland	Forested Wetland	Forest	Grassland	Beach
Northern Copperhead Snake	2	All			X		
Northern Diamond-back Terrapin	2	All	X				
Northern Pine Snake	3	All			X	X	
Spotted Turtle	2	All	X	X			
Timber Rattlesnake	4	All		X	X		
Wood Turtle	3	All	NA	NA	NA	NA	NA
Amphibians							
Blue-spotted Salamander	4	All	X	X	X		
Carpenter Frog	2	All	X	X			
Cope's Gray Treefrog	4	All	X	X	X		
Eastern Tiger Salamander	4	All	X	X	X		
Fowler's Toad	2	All	X	X			
Jefferson Salamander	2	All		X	X		
Longtail Salamander	3	All	X	X	X		
Marbled Salamander	2	All	X	X	X		
Northern Spring Salamander	2	All		X	X		
Pine Barrens Treefrog	3	All	X	X	X		
Beetles							
Northeastern Beach Tiger Beetle	5	All					X
Butterflies							
Appalachian Grizzled Skipper	4	All	X	X	X	X	
Arogos Skipper	4	All	X	X	X	X	
Bronze Copper	4	All	X	X	X	X	
Checkered White	3	All	X	X	X	X	
Dotted Skipper	2	All	X	X	X	X	
Frosted Elfin	3	All	X	X	X	X	
Georgia Satyr	2	All	X	X	X	X	
Harris' Checkerspot	2	All	X	X	X	X	
Hessel's Hairstreak	2	All	X	X	X	X	
Mitchell's Satyr	5	All	X	X	X	X	
Northern Metalmark	2	All	X	X	X	X	
Silver-bordered Fritillary	3	All	X	X	X	X	
Two-spotted Skipper	2	All	X	X	X	X	
Dragonflies and Damselflies							
Arrowhead Spiketail	2	All	X	X	X	X	X
Brook Snaketail	2	All	X	X	X	X	X
Brush-tipped Emerald	2	All	X	X	X	X	X
Harpoon Clubtail	2	All	X	X	X	X	X
Kennedy's Emerald	2	All	X	X	X	X	X
Maine Snaketail	2	All	X	X	X	X	X

Common Name	Landscape Rank	Feature Label	Emergent Wetland	Forested Wetland	Forest	Grassland	Beach
Midland Clubtail	2	All	X	X	X	X	X
New England Bluet	2	All	X	X	X	X	X
Rapids Clubtail	2	All	X	X	X	X	X
Sable Clubtail	2	All	X	X	X	X	X
Ski-tailed Emerald	2	All	X	X	X	X	X
Spatterdock Darner	2	All	X	X	X	X	X
Tiger Spiketail	2	All	X	X	X	X	X
Williamson's Emerald	2	All	X	X	X	X	X
Zebra Clubtail	2	All	X	X	X	X	X

**Only values forest patches that meet the minimum core requirements.*

Ambuel, B., and S.A. Temple. 1983. Area-dependent changes in the bird communities and vegetation of southern Wisconsin forests. Ecology 64:1057-1068.

Anthony, R.G. and F.B. Isaacs. 1989. Characteristics of bald eagle nest sites in Oregon. J. Wildl. Manage. 53(1):148-159.

Askins, A., J.F. Lynch, R. Greenberg. 1990. Population declines in migratory birds in eastern North America. Ch.1, pp. 1-57; In: D.M. Power, Ed., Current Ornithology Vol. 7. Plenum Press, New York.

Blake, J.G., and J.R. Karr. 1987. Breeding birds of isolated woodlots: Area and habitat relationships. Ecology 68:1724-1734.

Brittingham, M.C., and S.A. Temple. 1983. Have cowbirds caused forest songbirds to decline? BioScience 33:31-35.

Brown, W.S. 1993. Biology, status, and management of the timber rattlesnake (*Crotalus horridus*): a guide for conservation. Society for the Study of Amphibians and Reptiles. Herp. Cir. No. 22. 78pp.

Burke, D.M. and E. Nol. 1998. Influence of food abundance, nest-site habitat, and forest fragmentation on breeding ovenbirds. Auk 115(1):96-104.

Clark, K. NINJA data base. NJ Division of Fish, Game and Wildlife.

Copeyon, C.K. 1997. Endangered and threatened wildlife and plants; final rule to list the northern population of the bog turtle as threatened and the southern population as threatened due to similarity of appearance. Federal Register 62(213): 59605-59622.

Craighead, J.J. and F.C. Craighead, Jr. 1956. Hawks, owls and wildlife. Stackpole Publ. Co., Harrisburg, PA.

Crocoll, S. and J.W. Parker. 1989. The breeding biology of broad-winged and red-shouldered hawks in western New York. J. Raptor Res. 23:125-139.

Darr, L.J., D.K. Dawson, C.S. Robbins. Unpublished Manuscript. Land-use planning to conserve habitat for breeding forest birds in fragmented landscape.

Dawson, D. K., L. J. Darr, and C. S. Robbins. 1993. Predicting the distribution of breeding forest birds in a fragmented landscape. Trans. North Amer. Will. Nat. Rescuer. Con. 58:35-43.

DeCalesta, D. S. 1994. Effect of white-tailed deer on songbirds within managed forests in Pennsylvania. J. Wildl. Manage. 58(4):711-718.

Douglas, M.E., and B.L. Monroe. 1981. A comparative study of topographical orientation in *Ambystoma* (Amphibia: Caudata). Copeia 1981(2):463-466.

Elody, B.J. and N.F. Sloan. 1985. Movements and habitat use of barred owls in the Huron Mountains of Marquette County, Michigan, as determined by radiotelemetry. Jack-pine Warbler 63(1):3-8.

Ernst, C.H. 1986. Environmental temperatures and activities in the wood turtle, *Clemmys insculpta*. J. Herpetol. 20(2):222-229.

Flather, C.H., and J.R. Sauer. 1996. Using landscape ecology to test hypotheses about large-scale abundance patterns in migratory birds. Ecology 77(1):28-35.

Freda, J. and P.J. Morin. 1984. Adult home range of the Pine Barrens treefrog (*Hyla andersoni*) and the physical, chemical, and ecological characteristics of its preferred breeding ponds. Unpublished report submitted to the Endangered and Nongame Species Program. 42pp.

Frenzel, R. 1983. Nest-site spacing of bald eagles. In Anthony, R.G., F.B. Isaacs, and R.W. Frenzel, eds. *Proceedings of a workshop on habitat management for nesting and roosting bald eagles in the western United States.* Corvallis: Coop. Wildl. Res. Unit, Oregon State Univ.

Friesen, L.E., P.F.J. Eagles, and R.J. Mackay. 1995. Effects of residential development on forest-dwelling neotropical migrant songbirds. Cons. Biol. 9(6):1408-1414.

Fuller, M.R. 1979. Spatiotemporal ecology of four sympatric raptor species. Ph.D. Dissertation. University of Minnesota, St. Paul. 396 pp.

Hoover, J.P., M.C. Brittingham, and L. J. Goodrich. 1995. Effects of forest patch size on nesting success of wood thrushes. Auk 112(1):146-155.

Johnson, E. and P.J. Morin. 1985. 1985 blue-spotted salamander (*Ambystoma laterale*) project report. Unpublished report, NJDEP, DFGW, ENSP. 10pp.

Kiser, J.D. and C.L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (Myotis sodalis) during autumn in Jackson County, Kentucky. Final Report, Nongame Program, Kentucky Department of Fish and Wildlife Resources, Frankfort. 65pp.

Klemens, M.W. 1993. Standardized bog turtle site-quality analysis. Amer. Mus. Nat. His., New York, NY 7pp.

Martin, W.H. 1992. Phenology of the timber rattlesnake (*Crotalus horridus*) in an unglaciated section of the Appalachian Mountains. In Campbell, J.A. and E.D. Brodie, Jr. (Eds.) Biology of the Pitvipers. Selva, Tyler, Texas. pp. 259-277.

Nichols, T.H. and D.W. Warner. 1972. Barred owl habitat use as determined by radiotelemetry. J. Wildl. Manage. 36(2):213-224.

Peterson, A. 1986. Habitat suitability index models: Bald eagle (breeding season). U.S. Fish Wildl. Serv. Biol. Rep. 82(10.126). 25 pp.

Quinn, N.W.S. and D.P. Tate. 1991. Seasonal movements and habitat of wood turtles (*Clemmys insculpta*) in Algonquin Park, Canada. J. Herpetol. 25(2):217-220.

Reap, P.A. and R.T. Zappalorti. 1983. Notes on the diploid and triploid species of the *Ambystoma jeffersonianum* complex in New Jersey. Unpublished rept. to the Endangered and Nongame Species Program: 18pp.

Reinert, H.A. and R.T. Zappalorti. 1986. Habitat utilization by the timber rattlesnake, *Crotalus horridus*, in southern New Jersey with notes on hibernation. Final Report, Endangered and Nongame Species Program, Trenton, New Jersey. 172pp.

Rich, A.C., D.S. Dobkin, and L.J. Niles. 1994. Defining forest fragmentation by corridor width: The influence of narrow forest-dividing corridors on forest-nesting birds in southern New Jersey. Conservation Biology 8(4):1109-1121.

Ritke, M.E., J.G. Babb, and M.K. Ritke. 1991. Breeding-site specificity in the gray treefrog (*Hyla chrysoscelis*). J. Herpetol. 25(1):123-125.

Robbins, C.S., D.K. Dawson, and B.A. Dowell. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic States. Wildl. Monogr. No. 103:1-34.

Robinson, S.K., F.R. Thompson III, T.M. Donovan, D.R. Whitehead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. Science 267:1987-1990.

Semlitsch, R.D. 1981. Terrestrial activity and summer home range of the mole salamander (*Ambystoma talpoideum*). Canad. J. Zoology 59:315-322.

Semlitsch, R.D. and J.R. Bodie. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. Conservation Biology 17(5):1219-1228.

Stewart, R.E. 1949. Ecology of a nesting red-shouldered hawk population. Wilson Bull. 61:26-35.

Stihler, C. 1998. Indian bat radio telemetry study. West Virginia Nongame & Natural Heritage News. Summer, 1998. p. 5.

Strang, C.A. 1983. Spatial and temporal activity patterns in two terrestrial turtles. J. Herpetol. 17(1):43-47.

Whitcomb. R.F., C.S. Robbins, J.F. Lynch, B.L. Whitcomb, K. Klimkiewicz, and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of the eastern deciduous forest. Pages 125-205 in: R.L. Burgess and D.M. Sharpe, eds.,Forest Island Dynamics in Man-dominated Landscapes. Springer-Verlag, New York, NY.

Williams, P.K. 1973. Seasonal movements and population dynamics of four sympatric mole salamanders, genus Ambystoma. Ph.D. thesis, Indiana University, Bloomington, IN

Appendix VII. Literature Cited

Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper 964. 28 p.

Hasse, J, and R. Lathrop. 2001. Measuring urban growth in New Jersey. A report on recent land development patterns utilizing the 1986-1995 NJ DEP Land Use/Land Cover Dataset. Center for Remote Sensing and Spatial Analysis. Rutgers University.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2006. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. 174 pp.

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