



A Gap Analysis of the UrBIN Pilot Project Watershed

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A GAP ANALYSIS OF THE UrBIN PILOT PROJECT WATERSHED

FINAL REPORT

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EXECUTIVE SUMMARY

The Urban Biodiversity Information Node (UrBIN) is a part of the National Biological Information Infrastructure (NBII) coordinated by the U.S. Geological Survey's Biological Resource Division (USGS-BRD). This project was initiated to compile information about biodiversity within the Hunting Creek watershed in Northern Virginia. The UrBIN Gap Analysis Project (GAP) was funded by the National Gap Analysis Program to provide additional biodiversity information from the information compiled in UrBIN. Thus, the UrBIN GAP is a cooperative effort between the National Gap Analysis Project and the NBII UrBIN.

The major objective of this project was to apply Gap Analysis to the Hunting Creek watershed, a heavily urbanized area located in the Washington D.C. metropolitan area. The watershed includes portions of Fairfax County and the cities of Alexandria and Falls Church. Sub objectives of this project were (1) produce GIS-databases describing the actual land cover type, predicted distributions of terrestrial vertebrates, and land management status at a target scale of 1:24,000, (2) identify land cover types and terrestrial vertebrate species that currently are not represented or are underrepresented in areas managed for biodiversity (i.e., "gaps"), and (3) facilitate cooperative development and use of information so that institutions, agencies, and private land owners may be more effective stewards of natural resources. This project is a preliminary step toward the more detailed efforts and studies needed for long-term planning for biodiversity within Virginia's increasingly urban landscape.

We used a modified Anderson (1976) level 1 classification scheme and mapped the area to 5 general classes (forest, residential, developed, park/field, and open water). Mapping was done using TNT-MiPS image processing software. An ISODATA unsupervised classification was performed on the 6 bands of imagery. The resulting clusters were then assigned a land cover classification by interpreting a false color-infrared RGB display of the same Landsat ETM imagery. We assessed the accuracy of the classification by comparing pixel values with a random sample of 258 points referenced to digital aerial photography. The overall map accuracy was 72.7% (kappa 0.602).

We created predicted distributions for 228 vertebrate species (23 amphibians, 32 reptiles, 25 mammals and 148 birds) known or likely to be present within the watershed. Information on wildlife habitat relationships was largely obtained from BOVA, a computerized fish and wildlife information system developed cooperatively by the VDGIF and the Fish and Wildlife Information Exchange in Blacksburg, Virginia (now a division of the Conservation Management Institute). Each predicted species distribution is a function of 1 or more GIS layers, including land cover, wetlands (NWI) and various layers created from these, such as distance to water, or forest patch size. Individual species' biology dictated which and how many layers were used for each model.

Because of the urbanized nature of the study area, traditional gap stewardship properties such as wilderness areas, national forests, and national parks, do not apply. What undeveloped land remains is typically municipal parkland. We therefore used county and city parklands as a surrogate for important conservation lands (status 1). These properties comprise approximately 6% of the watershed area.

Of the 228 species modeled in UrBIN GAP, about three-quarters (167/228) of the species had between 10% and 50% of their predicted distribution within status 1 lands. Approximately 5% (11/228) of species have less than 1% of their predicted distribution within status 1 lands, and only 6% (13/228) of species have more than 50% of their predicted distribution within status 1 lands.

We identified species that may be vulnerable based upon the size of their predicted distribution within the watershed and the portion of the distribution found on status 1 lands. We considered species with a moderate or restricted distribution in the watershed with low representation on status 1 lands to be at greater risk. We found that most species are represented more than expected on status 1 lands. No amphibians or reptiles, and only 2 mammals, are represented less than expected on status 1 lands. Most birds are also represented more than expected. Given the heavily urbanized nature of the watershed, we believe that these results suggest that many species are present within the watershed only because of the refuge that parks provide, and that many species likely had larger distributions prior to urbanization. In support of this, many species found in greater proportion on status 1 lands require larger areas of contiguous forest or areas buffered from development, and within the study area only parks provide these requirements. With the exception of status 1 lands, nearly all developable lands have been utilized for residential or industrial purposes.

These results emphasize the importance that parks may play in species conservation within the watershed. Without these refuges some species may be lost from the watershed. Most of the status 1 areas within the watershed are managed for recreation rather than biodiversity, and the potential for increasing biodiversity protection within the watershed is therefore great.

1. INTRODUCTION

How This Report is Organized

This report is a summation of a scientific project. While we endeavor to make it understandable for as general an audience as practicable, it reflects the complexity of the project it describes. The organization of this report follows the general chronology of project development, beginning with the production of the individual data layers and concluding with analysis of the data. It diverges from standard scientific reporting by embedding results and discussion sections within individual chapters. This was done to allow the individual data products to stand on their own as testable hypotheses and provide data users with a concise and complete report for each data and analysis product.

This report contains both new text and sections taken from the Gap Analysis Final Report template used by the National Gap Analysis Program. We gratefully acknowledge all those who contributed in its writing.

We begin with an overview of the Gap Analysis Program mission, concept, and limitations. Finally, we introduce this project and briefly describe the study area.

The Gap Analysis Concept in the UrBIN Context

The mission of the Gap Analysis Program is to prevent conservation crisis by providing conservation assessments of biotic elements (plant communities and native animal species) and to facilitate the application of this information to land management (Klopfer and McClafferty 2001). Although this idea can be applied in an urbanized landscape, the opportunities are few and the expense is high. With limited resources available to land management entities within this landscape, management of biodiversity is often a by-product to more pressing social needs.

However, it is of interest to all parties to examine what remains in the urbanized landscape. Just as it would be ludicrous to assume biodiversity is unchanged when the greater landscape changes from natural types to a built environment, so too is it unreasonable to assume that species numbers drop to near zero. This project will provide information as to which species are likely to persist in the urban landscape and which will likely disappear, thereby further delineating which species are “gap species” in the original spirit of the word.

In UrBIN GAP, we feel it is less useful to follow the objectives expected of regional or state projects but adhere closely to the premise of the program. By utilizing the same basic steps, we are able to not only identify which species are likely to disappear from the Hunting Creek watershed (if indeed they remain) but also gain insight into the importance of remaining lands to biodiversity across broader regions.

Introduction – UrBIN GAP

Development, and the resulting loss of natural habitat, is the greatest threat to wildlife biodiversity. However, the loss of native diversity is not complete, and many species may persist in an urban landscape if their basic habitat needs are met, or they can successfully adapt to the changing environment.

Often, municipal agents are tasked with balancing economic development, quality of life, and environmental quality. This is increasingly difficult when one directive is directly counter to another. It is useful for these agents to have some information on what wildlife resource remains in their landscape, and to know where these resources are concentrated. This allows for more effective decision-making in the face of many, often conflicting, interests.

This information is difficult to obtain. With limited resources allocated to project review and municipal management, detailed surveys of biodiversity are impractical. A reasonable alternative is species distribution modeling. This allows for spatial representations based on information that is much easier and less expensive to compile and work with. The resulting predicted distributions can illustrate the likely presence of species within a given area with relative accuracy.

This type of analysis has been used successfully by the USGS National Gap Analysis Program to assess biodiversity for many states, regions, and waterways in the continental US. This same protocol is also being used in Canada, Mexico, and other places. The basic concept behind Gap Analysis is that species (and their habitat) can be modeled accurately over large areas, and the resulting distributions can be quantified in terms of the amount of a species distribution in “protected” status. Hence, species not found on existing protected lands (called “stewardship lands”) would be designated as “gap” species, since managers have little ability to implement management activities to affect the species (either positively or negatively).

The techniques used to synthesize predicted species models and project them on the landscape can be used in the urban situation to show where species are expected to occur, and from that estimates of biodiversity can be obtained. These data could then be used to show managers where areas of high biodiversity are located within their municipality and how valuable individual parcels are to the whole area. The contributions of specific parks, natural areas, or other non-developed areas can be evaluated as a function of the whole area of interest, allowing managers to make more informed decisions about development.

Another advantage to completing a Gap Analysis for an urban landscape is that it allows us to examine the post-development landscape and the importance of protected land to diversity. Often, Gap Analysis identifies the sites that require the most protection, whereas developed landscapes contain little remaining land of significant biodiversity conservation value. So, the benefit of completing a Gap Analysis in these types of landscapes is that we can quantify the biodiversity preservation result of protecting tracts of natural habitat from further development.

Study Area – Hunting Creek Watershed

The purpose of this investigation was to complete a Gap Analysis for the Hunting Creek watershed. This area includes Holmes and Tripps Run, Cameron Run, Hunting Creek, and Lake Barcroft watershed located in Arlington, Falls Church, and Fairfax County region of Northern Virginia (Figure 1-1). This 29,000-acre watershed was investigated as part of the UrBIN pilot study. This watershed has predominantly developed land areas dissected with major roads and industrial centers. Scattered throughout the landscape are forested parks, natural areas, wetlands, and other vegetated open spaces (Figure 1-2). Even though this area is largely urbanized, there are several areas that are likely to provide sufficient habitat for a suite of species. Our goal is to identify these areas through the Gap Analysis process and assess their value to the overall biodiversity network.

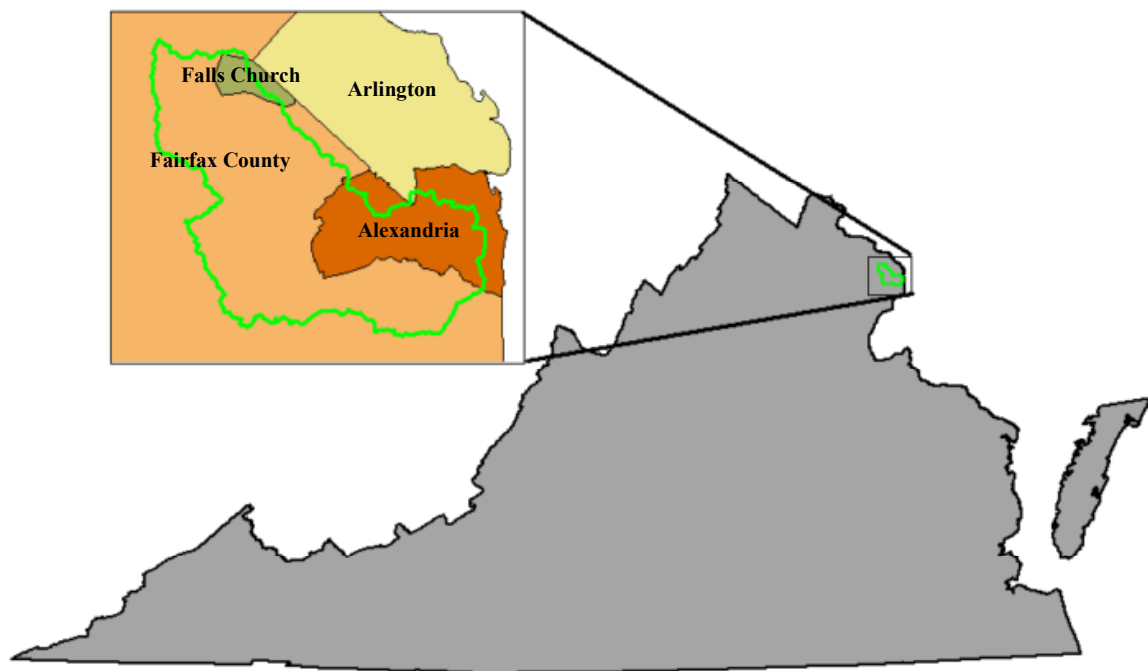


Figure 1-1. The study area is located in Northern Virginia and is comprised, in part, by Fairfax County, the city of Falls Church, and the city of Alexandria.



Figure 1-2. The color-infrared digital orthoquad (1998) shows the interspersion of residential areas with forested parks and impervious surfaces.

2. LAND COVER CLASSIFICATION AND MAPPING

Introduction

A prerequisite for creating potential species distribution maps is a habitat surface. This layer must match species models in order to provide the spatial context in which to depict the predicted distribution.

The appropriate habitat surface will have selected characteristics judged to be most adequate for the modeling task. These characteristics fall into two general categories of thematic and spatial characteristics. For the UrBIN GAP, we first had to identify the desired level of spatial and thematic accuracy, and then create the habitat surface from the many geospatial layers available to us. We then created each spatial layer within the appropriate context of the actual species models developed concurrently.

Methods

Mapping Standards, Data Sources, and Land Cover Classification:

The target mapping scale for the UrBIN GAP effort was 1:24,000. This scale is much greater than that of previous gap investigations in Virginia. The scale of the VA-GAP was 1:100,000 (Klopfer and McClafferty 2001) with a minimum mapping unit of 30 m; matching the pixel resolution of the available Landsat TM imagery. We chose to use Landsat ETM imagery for this project, which also has a pixel resolution of 30 m. This level of detail is necessary to incorporate the fine-scale landscape heterogeneity of the urban-suburban area in which this study was conducted. Although this level of detail is prone to some thematic error, we felt the benefits outweighed the costs.

A basic land-use land cover map is integral to any Gap Analysis effort, and the UrBIN GAP is no exception. Most Gap Analysis projects have utilized remotely sensed imagery to provide current, accurate base information with which to synthesize habitat surfaces. Our imagery was taken in October of 2001 during the leaf-off time period. This imagery was provided to us in a georectified format through the Multi-Resolution Landscape Characteristics Consortium 2000. The UrBIN watershed is located entirely within the row 15, path 33 image (Figure 2-1).

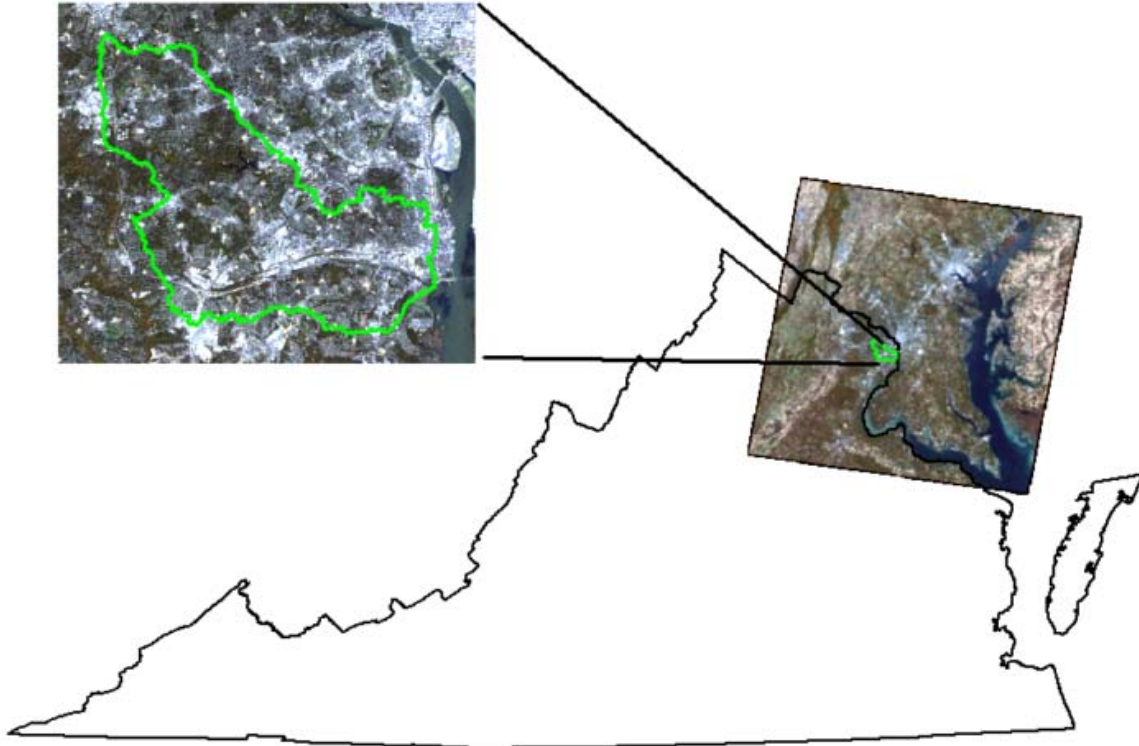


Figure 2-1. True-color image composite of Landsat ETM path 15 row 33 used for UrBIN GAP.

The watershed area was buffered by 1 km in order to avoid edge-effects in proximity functions, and the resulting polygon was used to cut out the study area from each band of raw imagery. We elected to use a relatively simple land cover classification system for this project. We used a modified Anderson (1976) level 1 classification scheme and mapped the area to 5 general classes (Table 2-1).

Mapping was conducted using TNT-MiPS (MicroImages, Inc., 11th Floor - Sharp Tower, 206 South 13th Street, Lincoln NE 68508-2010, USA) image processing software. An ISODATA unsupervised classification was performed on the 6 bands of imagery. The resulting clusters were then assigned a land cover classification by interpreting a false color-infrared RGB display of the same Landsat ETM imagery (Figure 2-2).

Table 2-1. Land cover classes used in the URBIN GAP and their descriptions.

Class Name	Class Description
Predominantly Forested	This class is predominantly covered by relatively continuous forest canopy. May include residential areas with heavy tree cover.
Residential	A mixed class of structure, open/lawn, and woody vegetation found in close proximity (often < 100m) from each other. Also includes some impervious surface.
Developed	Areas largely covered by impervious surfaces. This class includes parking lots, industrial areas, and travel corridors.
Open/Groomed/Field	Areas dominated by herbaceous vegetation; usually highly managed (includes golf courses, cemeteries, and school grounds).
Open Water	Areas dominated by surface water; includes ponds, lakes, and wider open-canopy rivers

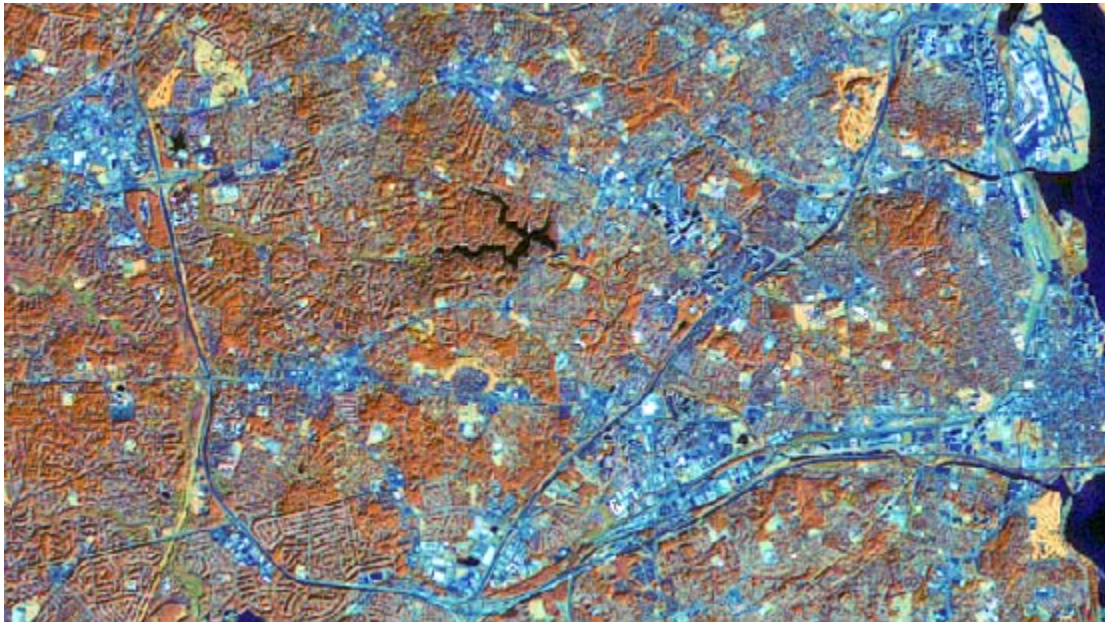


Figure 2-2. Color-infrared composite of Landsat ETM imagery used to guide the landcover classification. Lake Barcroft appears as a black-body, while forest canopy appears as various shades of red and developed areas are clearly identified in blues. Note that the resolution of the imagery is sufficient to recognize strips of trees found in residential developments.

The final land cover map consisted of 5 distinct classes (Figure 2-3). These represented various levels of vegetated coverage and development. Although the land cover class is important, we required additional information for our species modeling efforts. Spatial characteristics such as patch size and juxtaposition are equally important to predict whether a species can exist on a specific parcel of land. In order to create the most accurate distribution models, we derived several spatial layers from the final landcover map. The ancillary spatial datasets derived from the land cover map are described in detail in Chapter 3 (Distribution Modeling).

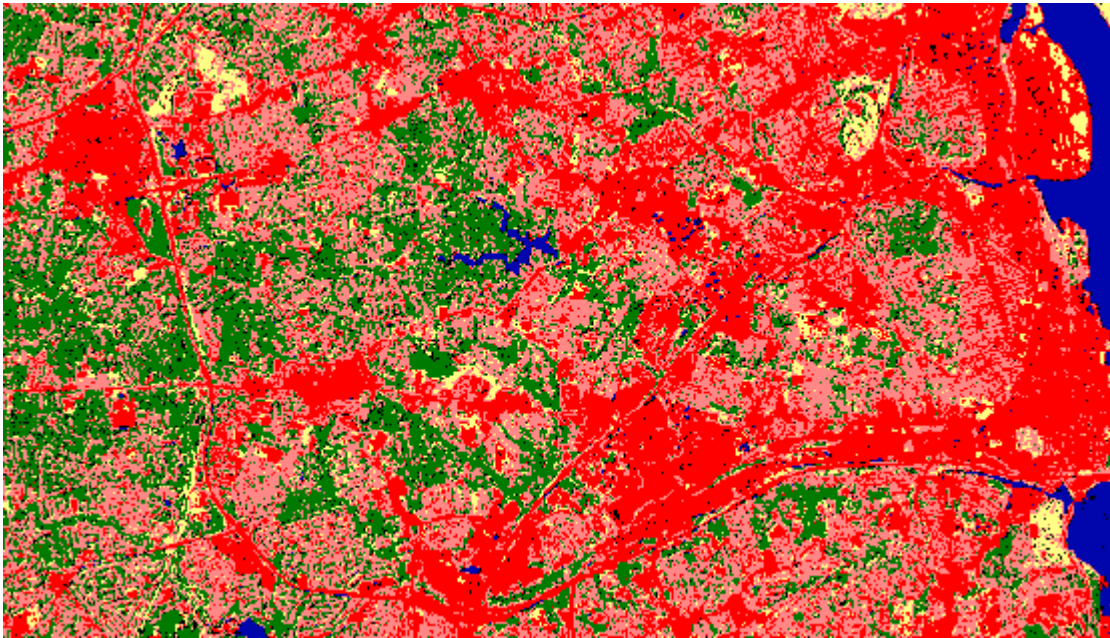


Figure 2-3. Final classified image with land cover classes for forest (green), residential (pink), developed (red), and open/field (yellow).

Key large-scale landscape water features were largely unavailable from the Landsat imagery. These include small holding ponds, wetlands, and streams with obvious wildlife potential that were not well represented in the final land cover map. We elected to use the available 1:24,000 National Wetlands Inventory (NWI) (U.S. Fish and Wildlife Service) for the study area to identify these small wetland and open water areas. This dataset was rasterized to match the land cover map and was used only in the species modeling stage of the project. We also created proximity data layers derived from the wetland layer that included wetland size and proximity to wetland (see Distribution Modeling).

Results and Discussion

The land cover map provided the basic information necessary to complete the species modeling activities. Many similar mapping efforts attempt to classify land cover to a finer thematic resolution by attempting to identify dominant species within the vegetation community. Although this type of mapping can be useful, we did not require that level of thematic detail for the UrBIN GAP. There are few cases of species requiring such specific floristic detail in this watershed, and the costs of producing such a map for those species far outweighs the available time and funding resources. It is also preferable to have a less-detailed but more thematically accurate map.

It is important to note that the purpose of the land cover map was for input for species distribution modeling. Species models require spatial representations of habitat, and land cover alone cannot account for all the information necessary to define habitat. Although we attempted to include other important components of habitat (e.g., edge, patch size, etc.) we can never truly capture all the information driving species habitat. The scale is too small for that sort of operation. We can, however, make general inferences about what habitat characteristics are likely found within, or are intrinsic to, these more general land cover classes.

The heterogeneity of the suburban-urban landscape within the watershed makes mapping difficult. Much of the landscape is in the residential class (Table 2-2), which is spectrally heterogeneous within itself. Since much of the landscape is heterogeneous considerable spectral mixing is expected and generalizations of this pattern (i.e., through filtering or smoothing) would only introduce more spatial and thematic error. For these reasons we chose to work with the resulting land cover map without generalization.

Table 2-2. Summary of area and composition of the UrBIN GAP study area.

Land Cover Class	Area (ha)	% Of Watershed
Forest	2,996	25.5
Residential	4,593	39.2
Developed	2,654	22.6
Open/Field	1,409	12.0
Water	79	0.7
Total	11,731	

Accuracy Assessment

Introduction:

GAP land cover maps are primarily compiled to answer the fundamental question in Gap Analysis: what is the current distribution and management status of the major natural land cover types and wildlife habitats? Besides giving a measure of overall reliability of the land cover map for Gap Analysis, the assessment also identifies which general classes or which regions of the map do not meet the accuracy objectives for the Gap Analysis

Program. Thus the accuracy assessment identifies where additional effort will be required when the map is updated. We report the results of the accuracy assessment, believing that the map is the best map currently available for the project area.

The purpose of accuracy assessment is to allow a potential user to determine the map's "fitness for use" for their application. It is impossible for the original cartographer to anticipate all future applications of a land cover map, so the assessment should provide enough information for the user to evaluate fitness for their unique purpose. This can be described as the degree to which the data quality characteristics collectively suit an intended application. The information reported includes details on the database's spatial, thematic, and temporal characteristics and their accuracy.

Assessment data are valuable for purposes beyond their immediate application to estimating accuracy of a land cover map. The reference data are therefore made available to other agencies and organizations for use in their own land cover characterization and map accuracy assessments. The data set will also serve as an important training data source for later updates.

Even though we have reached an endpoint in the mapping process where products are made available to others, the Gap Analysis process should be considered dynamic. We envision that maps will be refined and updated on a regular schedule. The assessment data will be used to refine GAP maps iteratively by identifying where the land cover map is inaccurate and where more effort is required to bring the maps up to accuracy standards. In addition, the field sampling may identify new classes that were not identified at all during the initial mapping process.

Methods:

The accuracy of the land cover map was assessed by comparing pixel values with a random sample of points referenced to digital aerial photography (USGS DOQQ 1998). A total of 519 points were evaluated. Points were overlaid onto the photographic image, and each point was classified based on the land cover class depicted in the image. Sample points within heterogeneous land cover or within 30 m of the edge of different habitat types were excluded from analyses. Points were then overlaid onto the land cover map, and their corresponding pixel values were extracted. These points were placed into a contingency table and several measures of accuracy were calculated.

Results:

The results of the accuracy assessment are provided in Table 2-3. Of the 519 points in the set, 258 were used in this assessment, and all cover types had a minimum of 16 assessment points. The overall map accuracy was 72.7% (kappa 0.602). Consumer's accuracy ranged from 37.0-83.5%. Producer's accuracy ranged from 62.5%-92.9%. The highest producer's accuracy was observed in the High Development cover type; 52 of 56 (92.9%) reference pixels were correctly classified for this type. The highest consumer's accuracy (83.5%) was observed in the Residential cover type.

Table 2-3. Contingency table and accuracy assessment for the land cover map.

Reference image	Classified image				Totals	PA (%)	EO (%)	EC (%)
	Forested	Residential	High Development	Open/field				
Forested	38	13	7	2	60	63.3	36.7	35.0
Residential	21	86	6	13	126	68.3	31.7	13.5
High Develop		2	52	2	56	92.9	7.1	30.4
Open/field		2	4	10	16	62.5	37.5	106.3
Totals	59	103	69	27	258			
CA (%)	64.4	83.5	75.4	37.0				

Percent Correct = 72.7%

Kappa = 0.602

Note. CA, consumer's accuracy; PA, producer's accuracy; EO, errors of omission; EC, errors of omission.

Limitations and Discussion

The methods employed by the research team proved appropriate for land cover mapping at this scale. Furthermore, we achieved a suitable level of classification accuracy, given the objectives of this project, and the difficulties imposed by a heterogeneous urban landscape. However, the classification of some cover types was notably more accurate than others, and this discrepancy deserves some discussion. In particular, the user's accuracy for the Open/Field class is much lower than other classes, even though the producer's accuracy for this class is comparable to others. Much of this error is due to an apparent misclassification of Residential as Open/Field; 13 of 17 errors in occurred in this way (Table 2-3). This misclassification is understandable, because many residential areas are a mix of housing, shrubs/trees, and grass lawns. The spectral signatures of Open/Field and grass lawns were nearly identical. Thus, residential areas with large grassy areas (i.e., several separate lawn areas immediately adjacent to one another) may have occasionally been misclassified as Open/Field.

Ideally accuracy assessment should be accomplished with a reference image acquired at the exact same time as the classified image. In reality, however, these two data sources rarely correspond temporally. In this study, we used the best available data -- a reference image from 1998 and Landsat data from 2001 to produce the land cover map. As a result, we believe the true accuracy of the land cover map is higher than reported here. In support of this, we observed several clusters of High Development on the land cover map that appeared to be forest on the reference map. These clusters of misclassified pixels are very likely the result of development between 1998 and 2001. We observed similar discrepancies between Open/Field and High Development. Table 2-3 illustrates these relationships.

Our accuracy assessment was able to provide reasonable estimates of map class accuracy. Some classes still need improvement. We believe this map is sufficient to provide a habitat surface with which to model species predicted distributions. In fact, the majority

of the species macrohabitat information that we required for this project is more general than what is available here. Therefore, the land cover map may be more functionally accurate than the accuracy assessment indicates. We believe our objective has been successfully achieved.

3. PREDICTED ANIMAL SPECIES DISTRIBUTIONS AND SPECIES RICHNESS

Introduction

All species range maps are predictions about the occurrence of those species within a particular area (Csuti 1994). Traditionally, the predicted occurrences of most species begin with samples from collections made at individual point locations. Most species range maps are small-scale (e.g., >1:10,000,000) and derived primarily from point data to construct field guides that are suitable, at best, for approximating distribution at the regional or county level for example. The purpose of the GAP vertebrate species maps is to provide more precise information about the current predicted distribution of individual native species according to actual habitat characteristics within their general ranges and to allow calculation of predicted area of distributions and associations to specific habitat characteristics.

Typical GAP maps are produced at a nominal scale of 1:100,000 or better and are intended for applications at the landscape or "gamma" scale (heterogeneous areas generally covering 1,000 to 1,000,000 hectares and made up of more than one kind of natural community). Because of the uniqueness of this project, we have created maps at a larger scale. However, applications of these data to site- or stand-level analyses (site--a microhabitat, generally 10 to 100 square meters; stand--a single habitat type, generally 0.1 to 1,000 ha; Whittaker 1977, see also Stoms and Estes 1993) will likely reveal the limitations of this process to incorporate differences in habitat quality (e.g., understory condition) or necessary microhabitat features such as standing dead trees.

Gap Analysis uses the predicted distributions of animal species to evaluate their conservation status relative to existing land management (Scott et al. 1993). However, the maps of species distributions may be used to answer a wide variety of management, planning, and research questions relating to individual species or groups of species. In addition to the maps, great utility may be found in the consolidated specimen collection records and literature that are assembled into databases used to produce the maps. Perhaps most importantly, as a first effort in developing such detailed distributions, they should be viewed as testable hypotheses to be confirmed or refuted in the field. We encourage biologists and naturalists to conduct such tests and report their findings in the appropriate literature and to the Gap Analysis Program such that new data may improve future iterations.

Previous to this effort there were no maps available, digital or otherwise, showing the likely present-day distribution of species by habitat type across their ranges. Because of this, ordinary species (i.e., those not threatened with extinction or not managed as game animals) are generally not given sufficient consideration in land-use decisions in the

context of large geographic regions or in relation to their actual habitats. Their decline, because of incremental habitat loss can, and does, result in one threatened or endangered species "surprise" after another. Frequently, the records that do exist for an ordinary species are truncated by state boundaries. Simply creating a consistent spatial framework for storing, retrieving, manipulating, analyzing, and updating the totality of our knowledge about the status of each animal species is one of the most necessary and basic elements for preventing further erosion of biological resources.

Methods

Mapping Standards and Data Sources:

We began this process by obtaining the Biota of Virginia (BOVA) database, a computerized fish and wildlife information system developed cooperatively by the VDGIF and the Fish and Wildlife Information Exchange in Blacksburg, Virginia (now a division of the Conservation Management Institute). BOVA contains information on the status, life history, habitat requirements and distribution of over 650 vertebrate species and subspecies. An example species profile is given in Appendix A. We used the BOVA database to identify species known or likely to exist within the watershed. For purposes of this project we modeled only mammals, amphibians, reptiles, and birds, and we excluded accidental or extinct species. In addition, we excluded some species that are likely extremely rare due to inadequate habitat or due to habitat that could not be accurately modeled at the scale of this study. Species that are likely present in the watershed but not modeled are presented in Appendix B. In total, we modeled 228 species, including 148 birds, 32 reptiles, 23 amphibians, and 25 mammals (Appendix C).

Both breeding and non-breeding birds were included in an effort to capture the cumulative diversity within the watershed. However, because of the migratory nature of many birds, we treated breeding, resident, and wintering birds separately. Breeding birds were those that regularly breed within the watershed, but winter elsewhere (including many Neotropical migrants). Resident birds breed and winter within the watershed and wintering birds are generally present only during the non-breeding season. Furthermore, because of the unique habitat requirements of waterfowl, we treated non-breeding waterfowl as a separate group. We used results from the Audubon Society's Christmas Bird Count at Fort Belvoir (approximately 3 miles in distance) to identify species that are likely to winter within the watershed. Species observed 8 of the last 12 years (1990-2001) were considered to winter within the study area.

In addition to BOVA, we acquired a National Wetland Inventory (NWI) coverage (1:24,000) for the study area. The NWI coverage contains information on the location, extent, and characteristics of wetland and deepwater habitats within the watershed.

Wildlife Habitat Relationships:

Information on wildlife habitat relationships was largely obtained from BOVA, which contains habitat codes that could be linked to the NWI map and the land cover map. These habitat relationship fields are the result of extensive literature reviews and expert

analyses prior to the initiation of this project. Many habitat classes in BOVA were more specific than were available for this project. For instance, BOVA distinguishes between deciduous forest, evergreen forest, and mixed forest habitat types, but the land cover map used in part to create distributions in this project had only 1 forest class. Likewise, BOVA contains information regarding species habitat associations with wetland habitat types that were sometimes more specific or general than the NWI map. In these cases, we used appropriate published material to help discern wildlife habitat relationships, and habitat translations from BOVA to terrestrial land cover codes and NWI wetland types were accomplished manually. Supplementary references are given in Table 3-1.

Based on information in BOVA and elsewhere we created a species by land cover type matrix and a species by wetland type matrix. Each table was populated with 1s and 0s representing potentially suitable/not suitable habitat types for each species and habitat combination. This process was carried out for each species group. These tables were the foundation upon which models were developed, but nearly all species required additional modeling effort, described below.

Table 3-1. References used (in addition to BOVA) to develop predicted species distribution models. Full citations are presented Literature Cited.

Group	Reference
Amphibians	Petranka (1998) Martof et al. (1980)
Reptiles	Mitchell (1994) Martof et al. (1980)
Birds	Hamel (1992)
Mammals	Burt and Grossenheider (1980) Schwartz and Schwartz (1981)

Distribution Modeling:

Each predicted species distribution is a function of 1 or more GIS layers, including land cover, wetlands (NWI) and various layers created from these, such as distance to water, or forest patch size. A complete list of layers used in the species modeling process is presented in Table 3-2. Individual species' biology dictated which and how many layers were used for each model. In general, however, we used a parsimonious modeling approach, and developed each model with the fewest number of variables required to produce a reasonable predicted distribution.

For each species, based on its' unique biological requirements, a Boolean expression was developed that describes which layers and operations were used to create that species' predicted distribution. A GIS computer program was then developed to read this expression and create species models in batch mode. This approach has great utility in that models are easily interpreted and readily modified, if necessary. Expressions used to create models are presented in Appendix C and supplementary modeling information is presented in Appendices D-F

Specific notes on birds:

Models attempt to identify likely *breeding* habitat for Breeding and Resident Birds. Thus, although some species, such as the Red-tailed Hawk, may forage extensively throughout the watershed, we have identified only those areas where the species is likely to nest. We feel that this approach is more useful than simply highlighting the entire watershed. As described above, we used information presented in BOVA and Hamel (1992) to discern wildlife habitat relationships. For species requiring forest interior conditions or areas of extensive forest, we used minimum tract size values from Hamel (1992). However, because there are few large forest patches within the study area and using values in Hamel (1992) tended to produce distributions of no or very limited extent, even for species known to occur, we modified values in the following way: values between 100 and 999 ha were rounded down to 100 ha, and values greater than 1000 ha were rounded down to 1000 ha. Using this approach we feel we made a reasonable compromise between over- and under- predicting species' distributions.

Results

A total of 228 predicted species distributions were synthesized including 148 birds, 23 amphibians, 32 reptiles, and 25 mammals (Figure 3-1 to Figure 3-3 for sample distributions). Maps of all predicted species distributions are available online at <http://dc-urbanbiodiversity.nbio.gov/gap.html>

Species Richness

GAP has often been associated with the mapping of species-rich areas or "hotspots." Richness maps identify where the same numbers of elements co-occur in the same geographic locations. (In the case of our data, where numbers of animal species are mapped for the same grid cells.) These are color coded or shaded in intensity from the highest numbers of co-occurrence (richness), to the lowest. While we continue to perform this useful pattern analysis, it is only one of many that may be conducted using the data. Richest areas may or may not indicate best conservation opportunities. They may occur in already protected areas or may represent mostly already protected species or those not at risk. Still, they are often a useful starting point to examine conservation opportunities in combination with other analyses described in this report's "Introduction" and in the "Analysis" sections. We also believe they may be useful for other rewarding applications such as identifying places of interest for wildlife observation and study.

Richness is depicted for all species and by species groups. The highest diversity observed for any pixel was 167 species (73% of all species modeled) and the mean value was 32 species (14%). The most diverse areas tended to be larger forested tracts, particularly palustrine forest, and riparian areas. Diversity patterns were different across taxa, but somewhat predictable. Predicted mammal and breeding bird diversity was highest in forested areas, whereas amphibian diversity was predicted greatest in and near wetlands. Likewise, we predicted that heavily developed areas support the fewest number of species.

Limitations and Discussion

The species models created for this project the result of a first attempt to extend existing knowledge about the wildlife to an urban landscape. This is also the first attempt to conduct multi-species watershed level distribution modeling in Virginia. It is important to note that this technique is particularly suited to some species and insufficient for others. Many species require habitat features that could not be mapped, so their actual presence within predicted distributions likely is overestimated or underestimated. Structural characteristics of mapped habitats are not incorporated directly into these models. Thus, the distributions for species requiring habitat features such as high stem densities under a forest canopy (such as some small mammals), or the availability of vernal pools (some amphibians) or tree cavities (some birds/mammals) are likely overestimated. Similarly, highly mobile species and habitat generalists may be underestimated. We can better predict species occurrence with improvements in both species habitat data and tools for mapping habitat features.

It must be emphasized that one goal of this project was to identify areas that are likely to be rich in species, but not necessarily areas important to species at risk. Therefore, endangered, game, exotic, and common species receive equal, simple presence/absence designations. It may be of interest to future efforts to *a priori* select certain species for representation based on a non-biological or ecological criterion.

Overall, this project was successful in synthesizing useful, reasonably accurate information about the diversity of terrestrial vertebrates within an urban landscape. At minimum, we have exposed the need for more comprehensive work.

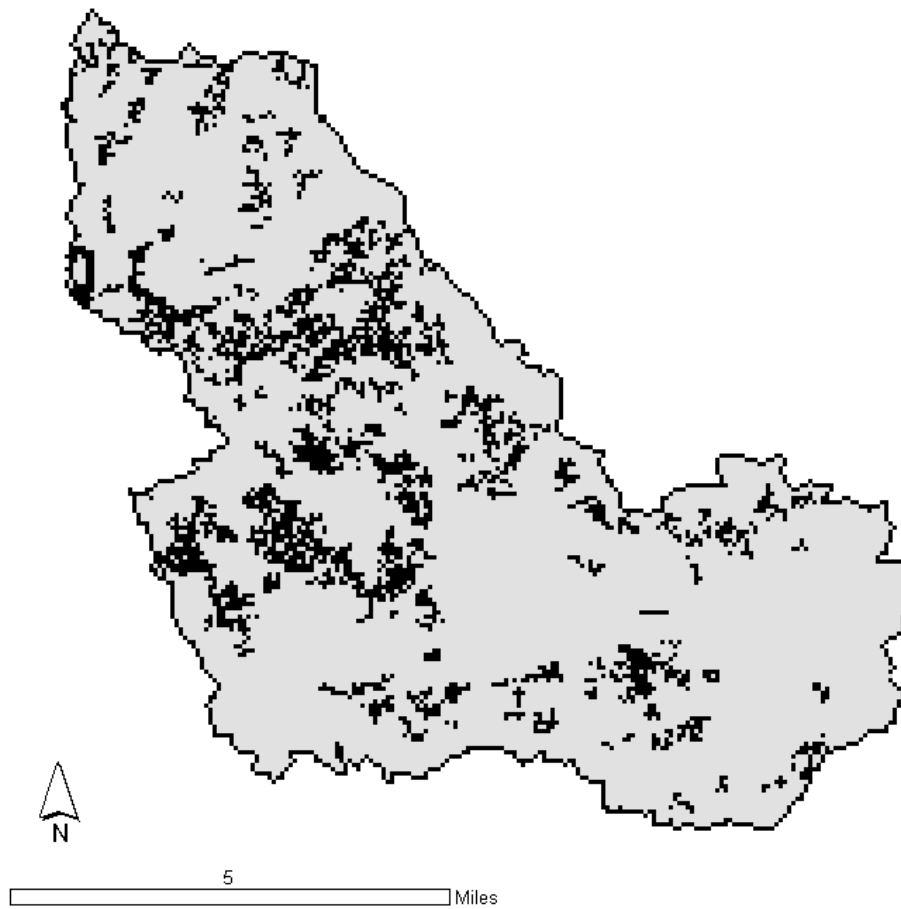


Figure 3-1. Sample predicted distribution of wood thrush (*Hylocichla mustelina*) within the watershed. The black area depicts the predicted distribution.

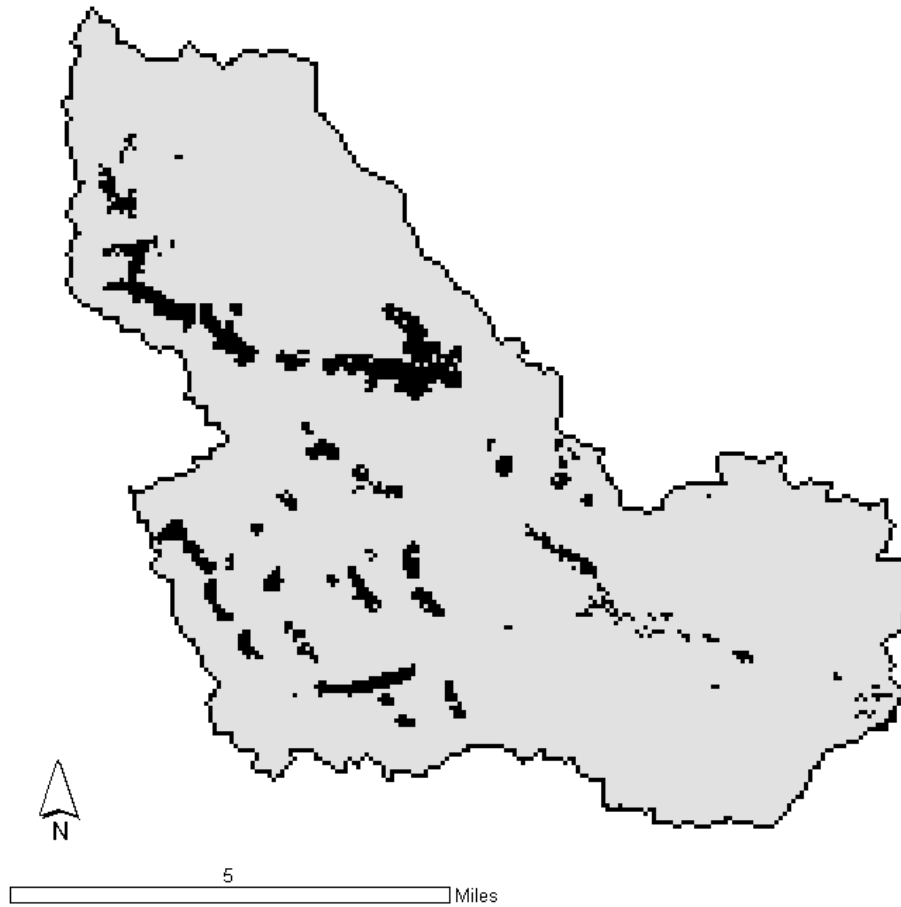


Figure 3-2. Sample distribution of the red-spotted newt (*Notophthalmus viridescens*) within the watershed. The black area depicts the predicted distribution.

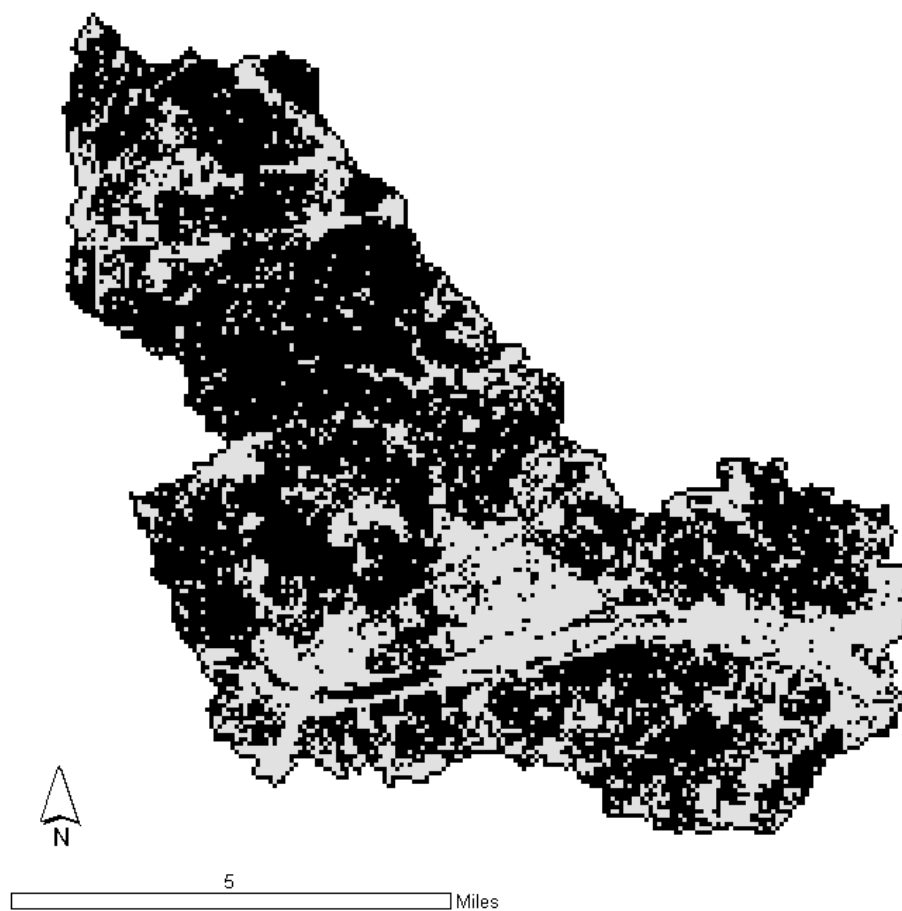


Figure 3-3. Sample distribution of the gray squirrel (*Sciurus carolinensis pennsylvanicus*) within the watershed. The black area depicts the predicted distribution.

Table 3-2. Description of variables used to creates species models. Individual models presented in Appendix C.

Variable	Description
LC_Code	Land cover. Values apply to final land cover map. 1 = Forested, 3 = Residential, 4 = Highly Developed, 5 = Field/Open
ForSize	A surrogate for minimum forest (land cover = 1) patch size, defined as the minimum number of contiguous (adjacent) forested pixels required to be potential habitat. 1 ha = 11 pixels.
ForEdge	Open areas (land cover = 5) adjacent to forested patches (land cover = 1) >1 ha (11 pixels).
ForBuff	Distance (m) from forest patches (ForSize).
ForMaj	Regions of high forest cover. Created using the ArcInfo command FOCALMAJORITY. Acceptable land cover codes within ForMaj regions are potential habitat.
OpenSize	A surrogate for minimum Open patch size. Defined as the minimum number of contiguous Open pixels (land cover = 5) required to be potential habitat. 1 ha = 11 pixels.
WetAreas	Suitable wetlands. Defined as suitable wetland type (from NWI) of the minimum size (m ²). Value from WetSize.
WetSize	Minimum wetland size (m ²).
ProxH2O	Distance (m) from suitable wetlands (defined by WetAreas), including wetland areas.
AdjH2O	Distance (m) from suitable wetlands (defined by WetAreas), not including wetland areas.
Industry	Regions of high development (land cover = 4). Created using the ArcInfo command FOCALMAJORITY.

4. LAND STEWARDSHIP

Introduction

To fulfill the analytical mission of GAP, it is necessary to compare the mapped distribution of elements of biodiversity with their representation in different categories of land ownership and management. As will be explained in the Analysis section, these comparisons do not measure viability, but are a start to assessing the likelihood of future threat to a biotic element through habitat conversion--the primary cause of biodiversity decline. We use the term "stewardship" in place of "ownership" in recognition that legal ownership does not necessarily equate to the entity charged with management of the resource, and that the mix of ownership and managing entities is a complex and rapidly changing condition not suitably mapped by GAP. At the same time, it is typically necessary to distinguish between stewardship and management status in that a single category of land stewardship such as a national forest may contain several degrees of management for biodiversity.

However, this project is unlike typical GAP projects in that the study area is almost entirely urbanized. Consequently, traditional GAP stewardship properties such as wilderness areas, national forests, and national parks, do not exist within the watershed. Furthermore, there are relatively few privately owned conservation lands within the study area, and the specific locations for these parcels could not be obtained. Undeveloped land is typically municipal parkland, sometimes including school ball fields, golf courses etc. Although some of these properties may be of questionable conservation value, local agencies have control over their future use, and thus they provide some measure of conservation potential. For these reasons, in this analysis, we used only two stewardship categories: parklands (referred to as Status 1) and other (referred to as Status 2). Status 2 properties are nearly always commercial or residential developments.

Methods

Stewardship Mapping:

Stewardship maps were compiled entirely from existing digital maps obtained from cooperators. A minimum scale of 1:24,000 was targeted. We identified parkland from GIS coverages obtained from each of municipalities (cities of Alexandria and Falls Church, and Fairfax county) within the study area. Coverages were merged into a single spatial database for the study area and then rasterized. This raster coverage was used in all subsequent analyses.

Results

The Homes/Tripp Run watershed has relatively little land protected in the form of parkland (Figure 4-1), and virtually none in the form of national forests, wilderness areas, or other federal or state protected designations. Less than 6% of the land area exists in

status 1. Although there may be a limited number of landowners currently participating in habitat incentive programs and in other land conservation initiatives, they were not included in stewardship lands, as specific locations for those tracts were not available.

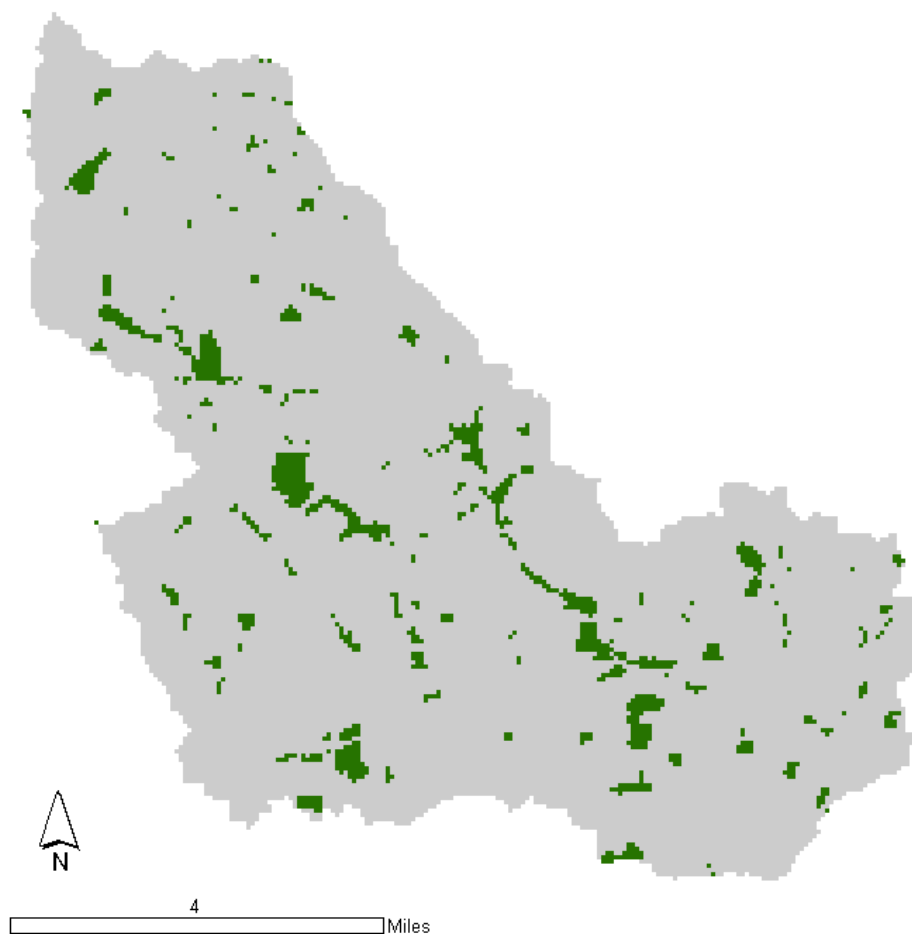


Figure 4-1. Map of status 1 areas (parklands) within the watershed. Approximately 6% of the watershed is composed of status 1 areas.

5. ANALYSIS BASED ON STEWARDSHIP AND MANAGEMENT STATUS

Introduction

This chapter describes the methods and results of the Gap Analysis as used by the Gap Analysis Program. As described in the general introduction to this report, the primary objective of GAP is to provide information on the distribution and status of several elements of biological diversity. Although GAP "seeks to identify habitat types and species not adequately represented in the current network of biodiversity management areas" (Gap Analysis Program 2000), it is unrealistic to create a standard definition of "adequate representation" for either land cover types or individual species (Noss et al. 1995). A practical solution to this problem is to report both percentages and absolute areas of each element in biodiversity management areas and allow the user to determine which types are adequately represented in natural areas. There are many other factors that should be considered in such determinations such as:

- 1) Historic loss or gain in distribution,
- 2) Nature of the spatial distribution,
- 3) Immediate versus long term risk, and
- 4) Degree of local adaptation among populations of the biotic elements that are worthy of individual conservation consideration.

Such analyses are beyond the scope of this project, but we encourage their application coupled with field confirmation of the mapped distributions.

Methods

The Gap Analysis is accomplished by first producing: maps of land cover ([Map 2-1](#)), predicted distributions for selected animal species (see example Figure 3-1), and land stewardship and management status (Figure 4-1). Intersecting the land stewardship map with the predicted species distributions result in tables that summarize the area and percent of total mapped distribution of each species in different land stewardship and management categories. From these data, we can make observations as to which area of the watershed species diversity is highest and which habitats are most important to biodiversity.

Results

Predicted Animal Species Distributions Analysis:

A summary table is not provided due to the large number of species analyzed, but some generalizations and examples of species results by the various thresholds are provided below. The complete Animal Species Distributions Analysis Table found in Appendix G provides the area (in hectares) of the species' mapped distribution by management status and the percent of the species' total distribution in each category. An example record is presented in Table 5-1.

Table 5-1. Example of species distribution by status category.

Num	Common Name	Scientific Name	Area (ha)	% in Gap 1	% in Gap 2
30002	Lizard, northern fence	<i>Sceloporus undulatus</i>	1978	12.6	87.4

A total of 228 species were cross-tabulated with the stewardship map to produce summaries of protection for each species (Appendix G). Species diversity for each group was calculated simultaneously with the individual distributions. About three-quarters (167/228) of the species have between 10% and 50% of their predicted distribution within status 1 lands (Table 5-2). Approximately 5% (11/228) of species have less than 1% of their predicted distribution within status 1 lands, and only 6% (13/228) of species have more than 50% of their predicted distribution within status 1 lands (Table 5-2).

Table 5-2. Percentage of each group with 0-1%, 1-10%, 10-50%, and >50% of their predicted distributions in Gap status 1 lands.

Group	Total species	0-1%		1-10%		10-50%		>50%	
		#	%	#	%	#	%	#	%
Amphibians	23	0	0.0	1	4.3	21	91.3	1	4.3
Reptiles	32	0	0.0	0	0.0	30	93.8	2	6.3
Mammals	25	0	0.0	9	36.0	12	48.0	2	8.0
Breeding birds	48	6	12.5	4	8.3	30	62.5	8	16.7
Resident birds	60	4	6.7	16	26.7	40	66.7	0	0.0
Wintering birds	16	1	6.3	5	31.3	10	62.5	0	0.0
Waterfowl	24	0	0.0	0	0.0	24	100.0	0	0.0

Breeding birds were the group best represented in status 1 lands, with 8 of 48 (16.7%) species distributions >50% protected, followed by mammals (8.0%), reptiles (6.3%) and amphibians (4.3). However, breeding birds were also the group with the greatest number of species with <1% of their distribution in status 1 lands. No resident birds, wintering birds, nor waterfowl had >50% of their distributions in status 1 lands.

In order to accurately identify those species that are truly in need of protection in the watershed we must consider the size of their predicted distributions within the watershed. Species that are relatively widespread in the watershed but are not represented on status 1 lands may not require immediate conservation attention. We consider species with a moderate or restricted distribution in the watershed and with low representation on status 1 lands to be at greater risk. In an effort to more readily identify species that meet these criteria, we plotted the predicted distribution of each species as a percentage of the whole watershed (i.e., a value of 100% indicates a species found on every pixel in the watershed) versus the portion of the predicted distribution found on status 1 land as a percentage of all status 1 lands (i.e., a value of 100% indicates a species found on all 1 lands in the watershed) (see Figure 5-1 to 5-4). An equal value (represented by the diagonal line in the graphs) indicates that a species is represented in proportion to its distribution for the watershed. Note this analysis presumes that both habitats and stewardship lands are distributed equally and evenly across the watershed, and this assumption may not be met. This analysis does, however, frame the protection of each species within the context of its overall distribution. We did not choose a specific threshold for determining a distribution large enough to eliminate a need for conservation consideration.

As we are displaying a ratio here, any value of under-representation (i.e., beneath the diagonal line) indicates a possible lack of habitat protection regardless of the size of the distribution. In addition, species with restricted distributions may warrant protection above this level of proportional representation. The concerns for those species with wide distributions may not be as immediate, but they are indeed real.

Individual species are displayed as points on the graphs (Figure 5-1 to 5-4). Species found on or near the diagonal line are found on status 1 lands in relative proportion to their overall distribution. Species found above the line are represented “more than expected” on status 1 lands. Species found below the line are under-represented and may warrant further investigation. We will represent this comparison repeatedly by referring to the species “status coordinate” given in an “X/Y” format where X is the percent of the watershed occupied by the species, and Y is the percent of status 1 areas on which the species is found.

An examination of Figures 5-1 to 5-4 illustrates that most species are represented more than expected on status 1 lands. No amphibians or reptiles, and only 2 mammals, are represented less than expected on status 1 lands. Most birds are also represented more than expected.

In a more typical, less developed landscape, these results might suggest that the current status 1 lands provide most species with a reasonable level of protection from future development. However, we feel that another interpretation is more appropriate within such a heavily urbanized landscape. We believe that these results suggest that many species are present within the watershed only because of the refuge that parks provide, and that many species probably had larger distributions prior to urbanization. In support of this, many species found in greater proportion on status 1 lands require larger areas of

contiguous forest or areas buffered from development, and within the study area only parks provide this requirement. With the exception of status 1 lands, nearly all developable lands have been utilized for residential or industrial purposes.

These results emphasize the importance that parks may play in species conservation within the watershed. Most of the status 1 areas within the watershed are managed for recreation rather than biodiversity. The potential for increasing biodiversity protection within the watershed is therefore great.

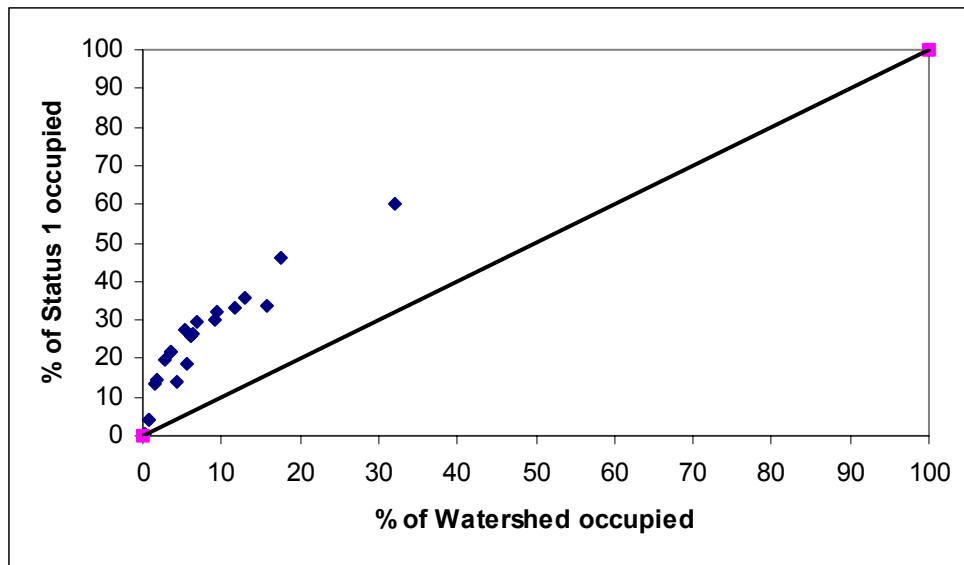


Figure 5-1. Distribution/protection status coordinates for amphibians.

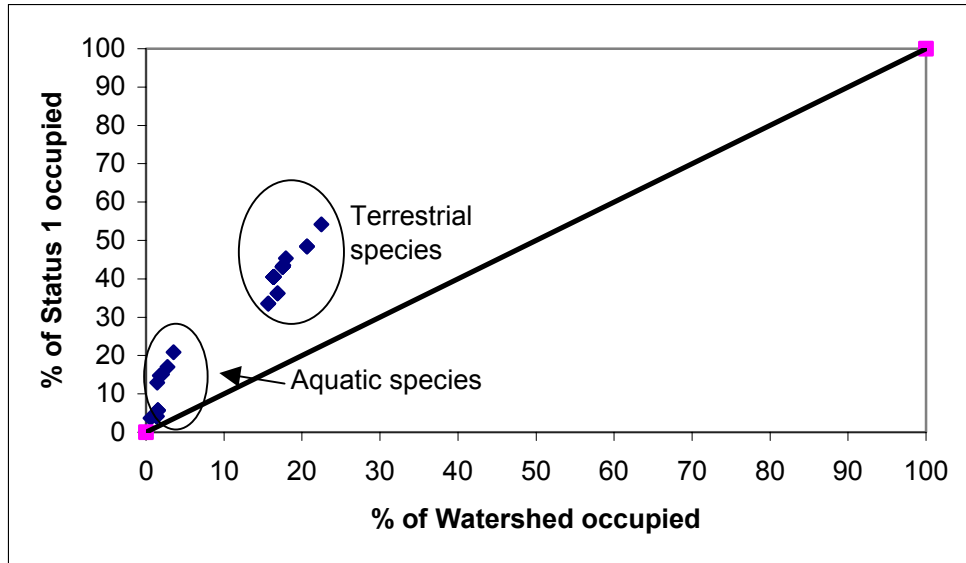


Figure 5-2. Distribution/protection status coordinates for reptiles.

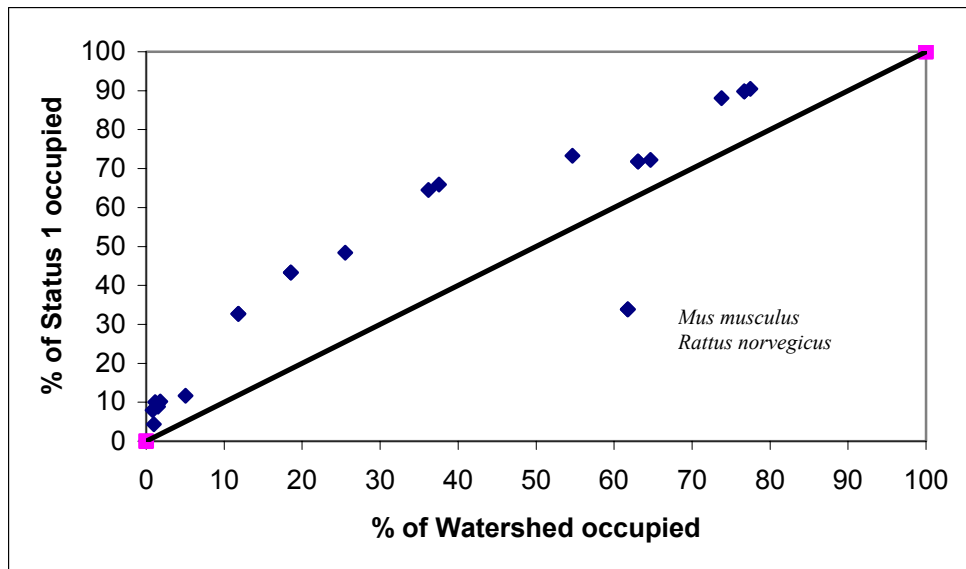


Figure 5-3. Distribution/protection status coordinates for mammals.

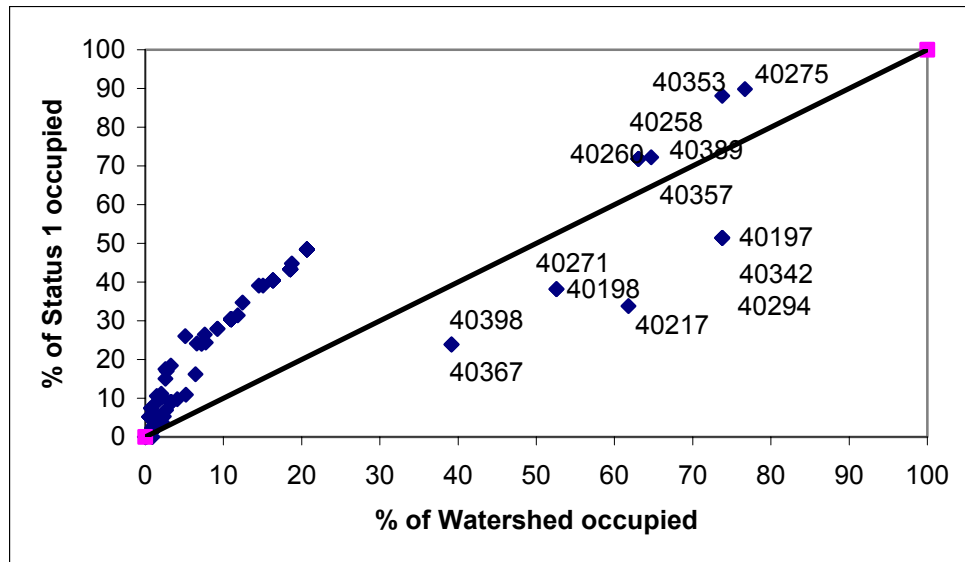


Figure 5-4. Distribution/protection status coordinates for birds (all groups combined). Numbers are species BOVA codes.

Limitations and Discussion

When applying the results of our analyses, it is critical that the following limitations are considered: 1) the limitations described for each of the component parts (land cover mapping, animal species mapping, stewardship mapping) of the analyses, 2) the spatial and thematic map accuracy of the components, and 3) the suitability of the results for the intended application.

Although individual species were modeled in this project, the compelling information appears within groups of species or taxa at the landscape level. Diversity measures treat each individual species equally, and some species models better represent actual distributions than others. Therefore, care should be taken in interpreting both individual species distributions and the community information that can be inferred from them. Landscape species diversity is likely to be more accurate than individual species distributions.

We also must stress that this project sought to map species distributions at the watershed-scale. Fine scale habitat characteristics, such as the presence of vernal breeding pools or suitable denning sites, will ultimately dictate whether or not a species occurs at any particular location. More study is needed on techniques to better identify these fine-scale habitat features on a landscape scale. It is also important to incorporate habitat structure, landscape pattern, and other abiotic factors (e.g., winter temperature, elevation) whenever possible.

6. CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The Hunting Creek watershed is home to a large number of terrestrial vertebrates and a diverse array of habitats. This is true despite the fact the watershed is heavily urbanized.

In this study, we created predicted species distribution models for 228 species of birds, mammals, amphibians and reptiles, and used the Gap Analysis approach to assess species conservation status within the watershed. Because traditional gap stewardship properties, such as national forest, national parks, etc., do not exist within the watershed, we used county and city parks as a surrogate for important conservation lands (status 1). Although some of these properties may be of questionable conservation value, local agencies have control over their future use, and thus they provide some measure of conservation potential.

We found that most species are represented more than expected on status 1 lands, and many species are nearly restricted to these lands. These results suggest that many species are present within the watershed only because of the refuge that parks provide. This emphasizes the importance that parks may play in species conservation within the watershed.

To the best of our knowledge most of the status 1 areas within the watershed are managed for recreation rather than biodiversity. The potential for increasing biodiversity protection within the watershed is therefore great.

Many areas of future investigation have been identified through this effort. More research is needed in the areas of species/habitat relationships, especially within an urban landscape, and fine-scale habitat delineations. Furthermore, urban stewardship mapping protocols should be developed.

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APPENDICES

Appendix A. Sample species profile. This section provides an example of a species account report from the Virginia fish and Wildlife Information Service. These data were used to supply information on the distribution and habitats used for predictive species modeling.

030046 Snake, rainbow

Report compiled 10 July 2000

Taxonomy

Taxonomy for (030046) Snake, rainbow (*Farancia erytrogramma erytrogramma*)

Category	03 Reptiles
Phylum	Chordata
SubPhylum	Vertebrata
Class	Reptilia
SubClass	
Order	Squamata
SubOrder	Serpentes
Family	Colubridae
SubFamily	
Genus	Farancia
SubGenus	
Species	erytrogramma
SubSpecies	erytrogramma
Authority	(Latreille)

Taxonomy Comments

Other common names include mud snake, hoop snake, horn snake, red swamp snake, sand snake and sand hog *1006*, striped horn snake*10760*

The genus *Farancia* is New Latin and is a coined name. The specific and subspecific name *erytrogramma* is from the Greek *erythro* meaning "red" and *gramma* meaning "writing," apparently in reference to the distribution of red pigmentation around the black scales on the head and to the red stripes.*10760*

Taxonomy References

- 3082 Collins, J.T., R. Conant, J.E. Huheey, J.L. Knight, E.M. Rundquist, H.M. Smith. 1982. Standard common and current scientific names for North American amphibians and reptiles. Herpetol. Circular No. 12. Society for the Study of Amphibians and Reptiles, Ohio Univ., Athens: 28.

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

Status

Status for (030046) Snake, rainbow (*Farancia erytrogramma erytrogramma*)

Status

223 Nongame-Protected
999 See Comments

Status Comments

This species appears secure in Va. despite the spotty occurrence of individual locality records. There is no information on loss of populations, but pollution of aquatic habitats is likely to have detrimental affects, especially if eels are affected. Protection of freshwater wetlands would increase the probability that this species will remain a part of our natural heritage for the long term.*10760*

Status References

Dept. Game and Inland Fisheries. 1990. 1990 Code of Virginia Section 29.1-100, Revised.
Nuisance species definition.: 1.

Life History

Life History for (030046) Snake, rainbow (*Farancia erythrogramma erythrogramma*)

Life History Comments

Physical description: This is a shiny iridescent snake with three red stripes on a bluish-black background. A broad reddish stripe bordered with black spots runs down the center of the belly and is flanked by yellow-orange coloration. The body is relatively stout and the head is barely distinct from the neck. The tail is short and ends in a spinelike tip. The juvenile is similar to the adult. The dorsal scales are smooth except above the anal region where they may be keeled. There are 19 scale rows and the anal plate is usually divided but is often single in Virginia. They are 8 inches or more at birth and they grow to between 36-44 inches with a maximum of 60 inches *1006*. In Virginia, maximum known SVL is 1518 mm (59.8 in.) and maximum total length is 1733 mm (68.2 in.).

Coloration and Pattern: iridescent with 3 red stripes on a black dorsum; middorsal stripe extends only to base of tail, whereas the lateral stripes on scale row 6 (counting from the ventrals on each side) extend onto dorsum of the tail; coloration below the 6th scale row is usually black; venter yellow with 2 primary rows of black spots - there may be a shorter, 3rd midventral row in some specimens; dorsum of head black to slate blue with some of the scales edged in red, forming an artistic pattern; throat, chin, infralabials, and supralabials yellow; each supralabial and some of the infralabials and chin shields have distinct black spots; yellow and red coloration fades to white in preservative. These are stout, cylindrical snakes with no difference in the width of the head and neck. The tail has a sharp spine.*10760*

Sexual dimorphism: Sexual dimorphism is exhibited in size, pattern, and scutellation. Adult females reach longer snout vent lengths (781-1518 mm, avg. = 1051.1+/-220.9, n=16) than males (722-730 mm, avg. = 726, n=2). Sexual dimorphism index is 1.45. However, tail length/total length ratio in males is higher (17.0-17.4%, avg. = 17.2, n=2) than in females (10.5-15.8%, avg. = 12.3+/-1.3%, n=16). Females have a higher number of ventrals (avg. - 170.8+/-2.3, 167-175, n=31) than males (159.2+/-1.5, 157-161, n=6). Counts of ventrals + subcaudals for males (204-210 avg. = 208.8+/-3.0, n=28). The midventral spots are usually more distinct in males than in females.*10760* Richmond reported that hatchlings from New Kent Co. were sexually dimorphic in number of ventrals (females 170-175, avg. = 172.0+/-1.2, n=39;; males 155-162, avg. = 159.3+/-1.5, n=46) and number of subcaudals (females 35-42, avg. = 37.6+/-1.3; males 44-49, avg. = 46.5+/-1.0) and ventrals + subcaudals (females 207-215, avg. = 209.7+/-1.6; males 202-210, avg. = 205.8+/-1.8). The midventral row of black spots is more pronounced in male hatchlings than females. However, these are statistical differences and cannot be used to assign gender to single individuals. *10760*

Juveniles: Juveniles are colored and patterned as adults. Hatchlings averaged 196.3+/-3.0 mm SVL (170-222, n=81), 231.3 +/-13.6 mm total length (197-270, n=81), and 5.9+/-1.1 g body mass (3.6-8.7, n=68).*10760*

Confusing Species: No other Virginia snake is as multicolored as *F. erytrogramma*. Mud snakes (*F. abacura*) have stout bodies and are shiny, but are uniformly black dorsally and red ventrally with some overlap on the sides. *10760*

Geographic Variation: There is no geographic variation in pattern, color, or scutellation in Va. *10760*

Reproduction: This species lays up to 52 eggs in an underground cavity in sandy soil, usually during July. The leathery white eggs are deposited from to 18 inches below the surface in exposed, dry, sandy fields. *1006* Females remain with their eggs in the nest, presumably to confer some protection against predation. *10760* The young hatch in the fall and overwinter on land, probably in a burrow near the nest, and move overland to an aquatic area in early spring. The males may reach sexual maturity by the end of their second or the beginning of their third year. The female probably reach maturity by the end of the third year, possibly the second *1006*.

Behavior: These snakes are both aquatic and burrowers. They are excellent swimmers but usually prowl along stream or swamp bottoms. At times they burrow into muck or mud. They have been found in dry sand at depths of up to 10 feet. The young have been found beneath boards logs and other debris. They may use their sharp tipped tail to probe. They have no definite period of hibernation since active specimens have been reported during every month. The main food of this species is eels. After catching an eel the snake usually climbs out of the water where the prey is swallowed head first. They may often rest with the tail dangling from its mouth *1006*.

Aquatic/terrestrial associations: This species is preyed on by aquatic turtles, raccoons, opossums, skunks, kingsnakes and hawks *1006*.

Nothing is known of the population ecology of this species anywhere in its range. Richmond plowed up 20 rainbow snakes in a 10 ac. field on one day in New Kent Co. Rainbow snakes will not bite, but will thrash about vigorously when picked up and attempt to scratch or poke the handler with the spine on the tail (it will not pierce the skin). These snakes appear to be oblivious to humans unless picked up. *10760*

Life History References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

County Distribution Map

Commonwealth of Virginia

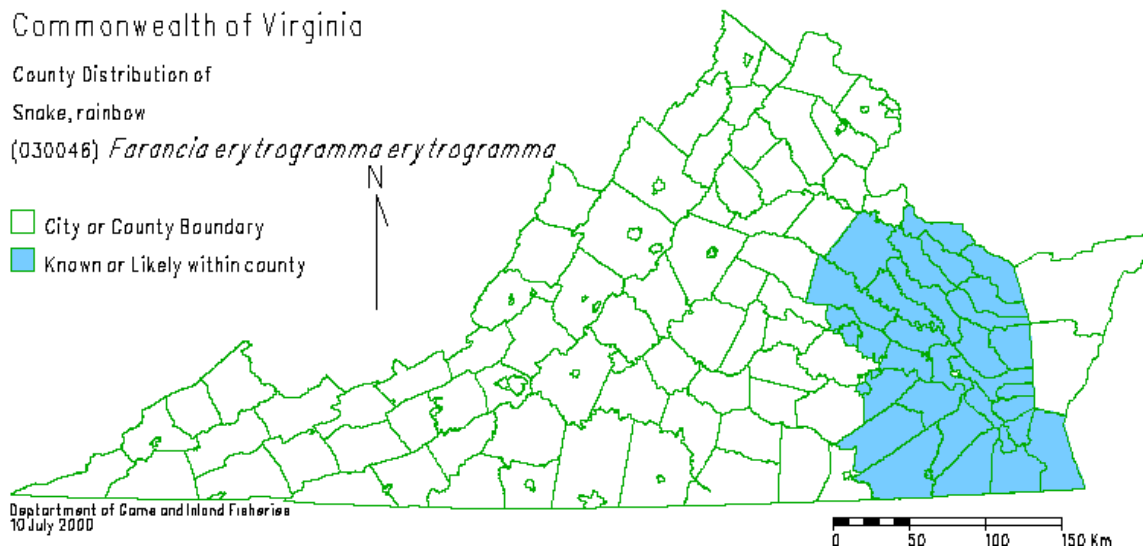
County Distribution of

Snake, rainbow

(030046) *Farancia erytrogramma erytrogramma*

□ City or County Boundary

■ Known or Likely within county



County Distribution

County Distribution for (030046) Snake, rainbow *Farancia erythrogramma erythrogramma*

General Occurrence	City/County	References
1 Known	033 Caroline	11332
1 Known	036 Charles City	11332
1 Known	095 James City	11332
1 Known	101 King William	11332
1 Known	127 New Kent	4206
1 Known	149 Prince George	4206
1 Known	175 Southampton	4206
1 Known	181 Surry	11332
1 Known	183 Sussex	11332
1 Known	620 Franklin	4206
1 Known	760 Richmond	4206
1 Known	810 Virginia Beach	4206
2 Likely	057 Essex	
2 Likely	073 Gloucester	
2 Likely	085 Hanover	
2 Likely	087 Henrico	
2 Likely	093 Isle of Wight	
2 Likely	097 King and Queen	
2 Likely	103 Lancaster	
2 Likely	115 Mathews	
2 Likely	119 Middlesex	
2 Likely	133 Northumberland	
2 Likely	149 Prince George	
2 Likely	159 Richmond	
2 Likely	193 Westmoreland	
2 Likely	199 York	
2 Likely	550 Chesapeake	
2 Likely	650 Hampton	
2 Likely	670 Hopewell	4206
2 Likely	700 Newport News	
2 Likely	710 Norfolk	
2 Likely	730 Petersburg	4206
2 Likely	735 Poquoson	
2 Likely	740 Portsmouth	
2 Likely	800 Suffolk	

General Occurrence Comments

This species appears secure in Va. despite the spotty occurrence of individual locality records. There is no information on loss of populations, but pollution of aquatic habitats is likely to have detrimental effects, especially if eels are affected. Protection of freshwater wetlands would increase the probability that this species will remain a part of our natural heritage for the long term.*10760*

General Occurrence References

Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.
 11332 Reay, Karen K., and Mitchell, Joseph C. 1999. Atlas of Amphibians and Reptiles in Virginia. (1). Virginia Department of Game and Inland Fisheries, Richmond, VA: 122.

Resident Occurrence	City/County	References
1 Known	033 Caroline	11332

1 Known	036 Charles City	11332
1 Known	095 James City	11332
1 Known	101 King William	11332
1 Known	127 New Kent	4206
1 Known	149 Prince George	4206
1 Known	175 Southampton	4206
1 Known	181 Surry	
1 Known	183 Sussex	11332
1 Known	760 Richmond	4206
1 Known	810 Virginia Beach	4206

Resident Occurrence Comments

Unvouchered Va. literature records are:

Chesterfield Co. - 4.8 km SW Chesterfield C.H.; Hanover Co. - Ellerson, Surry Co.
- Hog Island, Va. Beach City - Pungo.*10760*

Resident Occurrence References

4206 Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.
11332 Reay, Karen K., and Mitchell, Joseph C. 1999. Atlas of Amphibians and Reptiles in Virginia. (1).
Virginia Department of Game and Inland Fisheries, Richmond, VA: 122.

Seasonal Occurrence - Not available

Seasonal Occurrence Comments

In Virginia, active specimens have been recorded in every month of the year. Museum records are about evenly spread over all months.*10760*

Seasonal Occurrence References

4206 Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.
11332 Reay, Karen K., and Mitchell, Joseph C. 1999. Atlas of Amphibians and Reptiles in Virginia. (1).
Virginia Department of Game and Inland Fisheries, Richmond, VA: 122.

County Distribution for (030046) Snake, rainbow (*Farancia erythrogramma erythrogramma*)

Other Distribution for (030046) Snake, rainbow (*Farancia erythrogramma erythrogramma*)

USFWS Refuges

51510 Back Bay
51620 Presquile
51520 Mackay Island

USFWS Refuge References

4206 Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.

NPS Park and Recreation Areas

367 Richmond National Battlefield Park

NPS Parks and Recreation Area References

4206 Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.

USFS Ranger Districts - Not available

USFS Ranger District References - Not available

VDGIF Wildlife Management Areas

- 007 Chickahominy
- 008 Princess Anne
- 006 Kittewan

VDGIF Wildlife Management Area References

- 4206 Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.

Administrative Units Comments - Not available

USGS Topographic Quadrangles

- 5009 Bon Air
- 5509 New Kent
- 5502 Franklin
- 5206 Prince George
- 6301 Knotts Island

USGS Topographic Quadrangle References

- 4206 Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.

USGS Hydrologic Units

- 02080105 Mid Atlantic Region: Mattaponi River
- 02080203 Mid Atlantic Region: Middle James-Buffalo River
- 02080206 Mid Atlantic Region: Lower James River
- 03010201 South Atlantic-Gulf Region: Nottoway River
- 03010205 South Atlantic-Gulf Region: Albemarle River

USGS Hydrologic Unit References

- 10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Ecoregions

- 232012 Southeastern Mixed Forest: Flat Plains
- 232013 Southeastern Mixed Forest: Irregular Plains

Ecoregion References

- 10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Potential Natural Vegetation

- 065 Northern Cordgrass Prairie
- 101 Oak-Hickory-Pine Forest
- 103 Southern Floodplain Forest

Potential Natural Vegetation References

- 10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Physiographic Provinces

- 1 Coastal Plain

Physiographic Province References

- 10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Site Distribution Comments

Unvouchered Va. literature records are: Chesterfield Co. - 4.8 km SW Chesterfield C.H.; Hanover Co. - Ellerson, Surry Co.
- Hog Island, Va. Beach City - Pungo.*10760*

General Distribution Comments

Distribution: Coastal Plain of Va. The northern distributional limit of this species is in Charles Co., Maryland. This species is confined entirely to the N.A. Coastal Plain from Maryland south through peninsula Florida and eastern Louisiana.*10760*

County Abundance

County Abundance for (030046) Snake, rainbow *Farancia erythrogramma erythrogramma*

Relative Distribution Within County City/County - Not available

Distribution Within County Comments - Not available

Distribution Within County References - Not available

Relative Abundance within County City/County - Not available

Relative Abundance Within County Comments - Not available

Relative Abundance Within County References - Not available

Average Annual Population for Last 5 Years City/County - Not available

Average Annual Population for Last 5 Years Comments - Not available

Average Annual Population for Last 5 Years Referances - Not available

Average Annual Harvest for Last 5 Years City/County - Not available

Average Annual Harvest for Last 5 Years Comments - Not available

Average Annual Harvest for Last 5 Years References - Not available

Management Practices

Management Practices for (030046) Snake, rainbow *Farancia erythrogramma erythrogramma*

B	Beneficial	108	Maintaining unique or special habitat features (wetlands, caves, etc.)
B	Beneficial	118	Developing/maintaining water holes, ponds, potholes, etc.
B	Beneficial	130	Maintaining dead/downed woody materials
B	Beneficial	140	Maintaining woodlots
B	Beneficial	141	Developing/maintaining green space (wildlife corridors)
B	Beneficial	225	Maintaining/protecting riparian habitats
B	Beneficial	301	Developing/maintaining brackish marsh
B	Beneficial	303	Developing/maintaining freshwater marsh
A	Adverse	306	Draining wetlands, marshes, ponds, lakes
B	Beneficial	307	Developing/maintaining/protecting wetlands
B	Beneficial	417	Controlling pollution (thermal, chemical, physical)
B	Beneficial	506	Reforestations
B	Beneficial	999	Other management practices (specified in comments)

Beneficial Management References

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Adverse Management References

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Existing Management References - Not available

Management Comments

Rainbow snakes are generally considered highly aquatic, but Richmond found numerous adults and juveniles buried in sandy soil in floodplain farm fields in New Kent Co. they can also be found in freshwater creeks, ditches, and marshes and in brackish water marshes, rivers, and ditches. Adults and juveniles are terrestrial for unknown periods of time and have been found in pine woods, mixed hardwood and pine woods, and open fields. Juveniles have been found under all manner of surface objects. Rainbow snakes are active on the surface during rains. In Virginia, active specimens have been recorded in every month of the year. Museum records are about evenly spread over all months.*10760* This species appears secure in Va. despite the spotty occurrence of individual locality records. There is no information on loss of populations, but pollution of aquatic habitats is likely to have detrimental effects, especially if eels are affected. Protection of freshwater wetlands would increase the probability that this species will remain a part of our natural heritage for the long term.*10760* Nothing is known about the population ecology of this species anywhere in its range. Richmond plowed up to 20 rainbow snakes in a 10 acre field on one day in New Kent Co.*10760*

Food Habits

Food Habits for (030046) Snake, rainbow (*Farancia erytrogramma erytrogramma*)

Trophic Carnivore

Trophic References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

Food Utilized by Life Stage

Life Stage	Food	Part	
I Important	7340 Anguilliformes	S	See Comments
G General	7630 Caudata	X	Not Specified
G General	7660 Salientia	X	Not Specified

Food (General) Comments

The major food item for this species is eels. The young eat tadpoles and small frogs in addition to eels and salamanders *1006*. Richmond observed rainbow snakes eating eels in and out of water. Prey are eaten alive and usually swallowed headfirst. Enlarged posterior teeth occur on bones of the upper jaw in *F. erytrogramma*, presumably for holding on to slippery prey. Active foraging has been observed between 21-2300 hrs. *10760

Food (General) References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Food (Important) References - Not available

Food (Adults) Comments

Adults consume mostly eels *1006*.

Food (Adult) References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

Food (Juvenile) Comments

The juveniles eat tadpoles and small frogs in addition to salamanders *1006*.

Food (Juvenile) References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

Food (Larval) Comments - Not available

Food (Larval) References - Not available

Habitat Associations

Habitat for (030046) Snake, rainbow (*Farancia erythrogramma erythrogramma*)

Habitat Terrestrial

Habitat References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

Forest Size Class - Not available

Forest Size References - Not available

SAF Type - Not available

SAF Type References - Not available

Land Use

- 20 Agricultural Land
- 21 Cropland and Pasture
- 50 Water
- 51 Streams and Canals
- 60 Wetland
- 61 Forested Wetland
- 62 Nonforested Wetland

Land Use References

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

USFWS National Wetland Inventory

- R1 Riverine, tidal
- E2 Estuarine, intertidal
- R1 Riverine, tidal
- E2 Estuarine, intertidal

USFWS National Wetland Inventory References

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Habitat Association

This species is found in swamps, marshes (fresh and brackish), or slow moving streams and adjacent sandy soils generally under 100 feet in elevation. The habitat includes suitable muck and sand for burrowing and eels for food *1006*. Rainbow snakes are generally considered highly aquatic, but Richmond found numerous adults and juveniles buried in sandy soil in floodplain farm fields in New Kent Co. they can also be found in freshwater creeks, ditches, and marshes and in brackish water marshes, rivers, and ditches. Adults and juveniles are terrestrial for unknown periods of time and have been found in pine woods, mixed hardwood and pine woods, and open fields. Juveniles have been found under all manner of surface objects. Rainbow snakes are active on the surface during rains. In Virginia, active specimens have been recorded in every month of the year. Museum records are about evenly spread over all months.*10760*

Animal or Plant Associations - Not available

Animal or Plant Association Comments - Not available

Animal or Plant Association References - Not available

USFWS Habitat Evaluation Procedures - Not available

USFWS Habitat Evaluation Procedure Comments - Not available

USFWS Habitat Evaluation Procedure References - Not available

Potential Natural Vegetation

065 Northern Cordgrass Prairie
101 Oak-Hickory-Pine Forest
103 Southern Floodplain Forest

Potential Natural Vegetation References

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Environmental Association by Lifestage

Lifestage Environmental Associations for (030046) Snake, rainbow *Farancia erytrogramma erytrogramma*

General	00320C	Soil Needs: Sand
General	00360D	Soil Drainage: Imperfectly and poorly drained
General	00650S	Coniferous Forest: Specified in Comments
General	00660S	Hardwood Forest: Specified in Comments

Environmental Associations Comments

They are found in brackish and freshwater marshes and swamps or in slow moving streams and the adjacent sandy soil *1006*. Rainbow snakes are generally considered highly aquatic, but Richmond found numerous adults and juveniles buried in sandy soil in floodplain farm fields in New Kent Co. They can also be found in freshwater creeks, ditches, and marshes and in brackish water marshes, rivers, and ditches. Adults and juveniles are terrestrial for unknown periods of time and have been found in pine woods, mixed hardwood and pine woods, and open fields. Juveniles have been found under all manner of surface objects. Rainbow snakes are active on the surface during rains. In Virginia, active specimens have been recorded in every month of the year. Museum records are about evenly spread over all months.*10760*

Environmental Associations References

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Environmental Associations (Limiting) References - Not available

Environmental Associations (Feeding Adults) Comments - Not available

Environmental Associations (Feeding Adults) References - Not available

Environmental Associations (Resting Adults) Comments - Not available

Environmental Associations (Resting Adults) References - Not available

Environmental Associations (Breeding Adults) Comments - Not available

Environmental Associations (Breeding Adults) References - Not available

Environmental Associations (Feeding Juvenile) Comments - Not available

Environmental Associations (Feeding Juvenile) References - Not available

Environmental Associations (Resting Juvenile) Comments - Not available

Environmental Associations (Resting Juvenile) References - Not available

Environmental Associations (Feeding Larvae) Comments - Not available

Environmental Associations (Feeding Larvae) References - Not available

Environmental Associations (Rest Larvae) Comments - Not available

Environmental Associations (Resting Larvae) References - Not available

Environmental Associations (Pupa) Comments - Not available

Environmental Associations (Pupa) References - Not available

Environmental Associations (Egg) Comments - Not available

Environmental Associations (Egg) References - Not available

References

References for (030046) Snake, rainbow (*Farancia erytrogramma erytrogramma*)

Collins, J.T., R. Conant, J.E. Huheey, J.L. Knight, E.M. Rundquist, H.M. Smith. 1982. Standard common and current scientific names for North American amphibians and reptiles. Herpetol. Circular No. 12. Society for the Study of Amphibians and Reptiles, Ohio Univ., Athens: 28.

Dept. Game and Inland Fisheries. 1990. 1990 Code of Virginia Section 29.1-100, Revised. Nuisance species definition.: 1.

Linzey, D.W., M.J. Clifford. 1981. Snakes of Virginia. Univ. of Virginia Press, Charlottesville, VA.

10760 Mitchell, J. C. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington, DC: 352.

Mitchell, J., Pague, C. 1991. Amphibians and reptiles of Virginia -in prep.
11332 Reay, Karen K., and Mitchell, Joseph C. 1999. Atlas of Amphibians and Reptiles in Virginia. (1).
Virginia Department of Game and Inland Fisheries, Richmond, VA: 122.

Report compiled 10 July 2000

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Appendix B. Species included in BOVA that were not modeled in this study. Reason not modeled: H = Very little or none of this habitat exists within the study area, M = Habitat that does exist could not be accurately modeled at the scale of the study, A = accidental.

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Group</u>	<u>Habitat</u>	<u>Reason</u>
050124	Mouse, prairie deer	<i>Peromyscus maniculatus</i>	Mammals	Open habitat such as pasture, meadows, and crop fields.	H/M
050125	Coyote	<i>Canis latrans</i>	Mammals	Brushy areas, forests, fields and meadows; prefer open land.	A
020062	Toad, Fowler's	<i>Bufo fowleri</i>	Amphibians	Sandy open areas, such as sand dunes and shorelines.	M
030024	Snake, eastern hognose	<i>Heterodon platirhinos</i>	Reptiles	Sandy open areas.	M
040204	Owl, barn	<i>Tyto alba</i>	Resident Birds	Open country, such as lightly-grazed pasture and hay fields.	H
040224	Woodpecker, red-headed	<i>Melanerpes erythrocephalus</i>	Resident Birds	Savannah-like grasslands with scattered trees.	H
040254	Raven, common	<i>Corvus corax</i>	Resident Birds	Mountainous areas and nests in areas of rock and remote cliffs.	H
040293	Shrike, loggerhead	<i>Lanius ludovicianus</i>	Resident Birds	Open grassland with an abundance of perching sites.	H
040173	Gull, laughing	<i>Larus atricilla</i>	Breeding Birds	Sandy islands, tufts of grass or reeds in saltwater marshes, beaches.	M
040181	Tern, common	<i>Sterna hirundo</i>	Breeding Birds	Relatively undisturbed sandy beaches.	H/M
040186	Tern, least	<i>Sterna antillarum</i>	Breeding Birds	Relatively undisturbed, broad, flat open sand beaches.	H/M
040216	Nighthawk, common	<i>Chordeiles minor</i>	Breeding Birds	Plowed fields, gravel beaches, barren areas with rocky soil.	H/M
040328	Warbler, prairie	<i>Dendroica discolor</i>	Breeding Birds	Pine scrub, abandoned fields with scattered saplings.	M
040337	Chat, yellow-breasted	<i>Icteria virens</i>	Breeding Birds	Brushy pastures, thickets or briar patches, usually near water.	M
040347	Oriole, orchard	<i>Icterus spurius</i>	Breeding Birds	Orchards, woodland margins, open woodlands.	H
040361	Bunting, indigo	<i>Passerina cyanea</i>	Breeding Birds	Edges of woods, old burns, open brushy fields, roadside thickets.	M
040371	Goldfinch, American	<i>Carduelis tristis</i>	Breeding Birds	Open weedy fields, farms, forest edges, open swamps.	M
040378	Sparrow, grasshopper	<i>Ammodramus savannarum</i>	Breeding Birds	Hayfields, weedy fallow fields, prairies.	H
040391	Sparrow, field	<i>Spizella pusilla</i>	Breeding Birds	Old fields with scattered woody vegetation, abandoned hayfields.	H/M

Appendix C. List of species and the operations used to model habitat. Descriptions of variables are presented in Table 3-2.

Amphibians

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Operation</u>
20004	Bullfrog	<i>Rana catesbeiana</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20006	Treefrog, Cope's gray	<i>Hyla chrysoscelis</i>	(ProxH2O AND ForSize) OR WetAreas NOT Industry
20007	Treefrog, gray	<i>Hyla versicolor</i>	(ProxH2O AND ForSize) OR WetAreas NOT Industry
20008	Frog, northern green	<i>Rana clamitans</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20009	Treefrog, green	<i>Hyla cinerea</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20012	Frog, eastern cricket	<i>Acris crepitans</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20013	Frog, pickerel	<i>Rana palustris</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20016	Frog, southern leopard	<i>Rana sphenoccephala</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20018	Frog, southeastern chorus	<i>Pseudacris feriarum</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20019	Frog, wood	<i>Rana sylvatica</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20029	Salamander, four-toed	<i>Hemidactylum scutatum</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20035	Salamander, marbled	<i>Ambystoma opacum</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20038	Salamander, northern dusky	<i>Desmognathus fuscus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20043	Salamander, northern red-backed	<i>Plethodon cinereus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20049	Salamander, spotted	<i>Ambystoma maculatum</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20051	Salamander, three-lined	<i>Eurycea guttolineata</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20053	Salamander, northern two-lined	<i>Eurycea bislineata</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20059	Toad, American	<i>Bufo americanus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20065	Newt, red-spotted	<i>Notophthalmus viridescens</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20069	Salamander, eastern mud	<i>Pseudotriton montanus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20070	Salamander, northern red	<i>Pseudotriton ruber</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20071	Peeper, northern spring	<i>Pseudacris crucifer</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
20080	Salamander, white-spotted slimy	<i>Plethodon cylindraceus</i>	ForSize NOT WetAreas NOT Industry

Reptiles

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Operation</u>
30002	Lizard, northern fence	<i>Sceloporus undulatus</i>	((ForSize or ForEdge) Not WetAreas) NOT Industry
30004	Skink, five-lined	<i>Eumeces fasciatus</i>	AdjH2O AND ForSize NOT Industry
30005	Skink, southeastern five-lined	<i>Eumeces inexpectatus</i>	(ForSize OR ForEdge) NOT Industry
30006	Skink, broadhead	<i>Eumeces laticeps</i>	ForSize NOT WetAreas NOT Industry
30007	Skink, little brown	<i>Scincella lateralis</i>	ForSize NOT Industry
30016	Copperhead, northern	<i>Agkistrodon contortrix</i>	(WetAreas OR ForSize OR ForEdge) NOT Industry
30018	Racer, northern black	<i>Coluber constrictor</i>	((ForSize or ForEdge) Not WetAreas) NOT Industry
30019	Snake, eastern worm	<i>Carphophis amoenus</i>	ForSize NOT Industry
30020	Snake, northern ringneck	<i>Diadophis punctatus</i>	ForSize NOT Industry
30022	Snake, corn	<i>Elaphe guttata</i>	(ForSize OR ForEdge) NOT Industry
30023	Snake, black rat	<i>Elaphe obsoleta</i>	(ForSize or ForEdge) NOT Industry
30026	Kingsnake, eastern	<i>Lampropeltis getula</i>	((AdjH2O AND LC_Code) OR ForSize OR ForEdge) NOT Industry
30027	Kingsnake, mole	<i>Lampropeltis calligaster</i>	(ForSize NOT WetAreas) NOT Industry
30029	Snake, eastern milk	<i>Lampropeltis triangulum</i>	ForSize NOT Industry
30033	Snake, queen	<i>Regina septemvittata</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30034	Snake, northern water	<i>Nerodia sipedon</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30038	Snake, rough green	<i>Opheodrys aestivus</i>	ForMaj NOT Industry
30041	Snake, northern brown	<i>Storeria dekayi</i>	ForMaj NOT Industry
30042	Snake, northern red-bellied	<i>Storeria occipitomaculata</i>	((AdjH2O AND LC_Code) OR ForSize) NOT Industry
30044	Snake, eastern garter	<i>Thamnophis sirtalis</i>	((AdjH2O AND LC_Code) OR ForMaj OR ForEdge) NOT Industry
30045	Snake, eastern ribbon	<i>Thamnophis sauritus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30049	Earthsake, eastern smooth	<i>Virginia valeriae</i>	ForSize OR ForEdge NOT Industry
30050	Turtle, eastern snapping	<i>Chelydra serpentina</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30051	Turtle, eastern mud	<i>Kinosternon subrubrum</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30052	Turtle, eastern musk	<i>Sternotherus odoratus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30057	Cooter, northern red-bellied	<i>Pseudemys rubriventris</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30058	Slider, yellowbellied	<i>Trachemys scripta</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30060	Turtle, eastern painted	<i>Chrysemys picta</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30062	Turtle, wood	<i>Clemmys insculpta</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30063	Turtle, spotted	<i>Clemmys guttata</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
30068	Turtle, eastern box	<i>Terrapene carolina</i>	ForSize NOT Industry
30077	Slider, red-eared	<i>Trachemys scripta</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry

Mammals

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Operation</u>
50001	Opossum, Virginia	<i>Didelphis virginiana virginiana</i>	LC_Code
50007	Shrew, southeastern	<i>Sorex longirostris longirostris</i>	LC_Code
50013	Shrew, Kirtland's short-tailed	<i>Blarina brevicauda kirtlandi</i>	WetAreas NOT Industry
50017	Mole, eastern	<i>Scalopus aquaticus aquaticus</i>	LC_Code NOT Industry
50019	Mole, star-nosed	<i>Condylura cristata cristata</i>	WetAreas NOT Industry
50028	Bat, big brown	<i>Eptesicus fuscus fuscus</i>	LC_Code OR WetAreas
50029	Bat, eastern red	<i>Lasiurus borealis borealis</i>	LC_Code
50038	Raccoon	<i>Procyon lotor lotor</i>	LC_Code
50042	Mink, common	<i>Mustela vison mink</i>	WetAreas NOT Industry
50047	Skunk, striped	<i>Mephitis mephitis nigra</i>	LC_Code
50049	Fox, red	<i>Vulpes vulpes fulva</i>	ForSize OR OpenSize
50050	Fox, eastern gray	<i>Urocyon cinereoargenteus c.</i>	ForSize OR OpenSize
50054	Woodchuck	<i>Marmota monax monax</i>	OpenSize
50055	Chipmunk, Fisher's eastern	<i>Tamias striatus fisheri</i>	LC_Code NOT Industry
50058	Squirrel, northern gray	<i>Sciurus carolinensis pennsylvanicus</i>	LC_Code NOT Industry
50065	Squirrel, southern flying	<i>Glaucomys volans volans</i>	ForSize NOT Industry
50069	Beaver	<i>Castor canadensis</i>	WetAreas NOT Industry
50073	Mouse, northern white-footed	<i>Peromyscus leucopus noveboracensis</i>	ForSize NOT Industry
50082	Vole, meadow	<i>Microtus pennsylvanicus p.</i>	WetAreas NOT Industry
50092	Muskrat, common	<i>Ondatra zibethicus zibethicus</i>	WetAreas NOT Industry
50095	Rat, Norway	<i>Rattus norvegicus norvegicus</i>	LC_Code
50098	Mouse, house	<i>Mus musculus musculus</i>	LC_Code
50099	Mouse, meadow jumping	<i>Zapus hudsonius americanus</i>	(AdjH2O AND LC_Code) NOT Industry
50103	Cottontail, eastern	<i>Sylvilagus floridanus mallurus</i>	LC_Code NOT Industry
50108	Deer, white-tailed	<i>Odocoileus virginianus</i>	((ForBuff AND LC_Code) OR ForSize) NOT Industry

Breeding Birds

<u>Num</u>	<u>Name</u>	<u>Scientific Name</u>	<u>Operation</u>
40028	Heron, green	<i>Butorides virescens</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40032	Egret, great	<i>Ardea alba</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40036	Night-heron, yellow-crowned	<i>Nyctanassa violacea</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40037	Bittern, least	<i>Ixobrychus exilis</i>	WetAreas NOT Industry
40038	Bittern, American	<i>Botaurus lentiginosus</i>	WetAreas NOT Industry
40095	Osprey	<i>Pandion haliaetus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40112	Moorhen, common	<i>Gallinula chloropus</i>	WetAreas NOT Industry
40134	Sandpiper, spotted	<i>Actitis macularia</i>	WetAreas NOT Industry
40202	Cuckoo, yellow-billed	<i>Coccyzus americanus</i>	ForSize NOT Industry
40214	Chuck-will's-widow	<i>Caprimulgus carolinensis</i>	ForSize NOT Industry
40215	Whip-poor-will	<i>Caprimulgus vociferus</i>	ForSize NOT Industry
40217	Swift, chimney	<i>Chaetura pelagica</i>	LC_Code
40218	Hummingbird, ruby-throated	<i>Archilochus colubris</i>	ForSize NOT Industry
40229	Kingbird, eastern	<i>Tyrannus tyrannus</i>	OpenSize NOT Industry
40234	Flycatcher, great crested	<i>Myiarchus crinitus</i>	(WetAreas OR ForSize) NOT Industry
40239	Flycatcher, Acadian	<i>Empidonax virescens</i>	ForSize NOT Industry
40240	Flycatcher, willow	<i>Empidonax traillii</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40243	Pewee, eastern wood	<i>Contopus virens</i>	ForSize NOT Industry
40246	Swallow, tree	<i>Tachycineta bicolor</i>	(ProxH2O AND OpenSize) OR WetAreas NOT Industry
40248	Swallow, northern rough-winged	<i>Stelgidopteryx serripennis</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40249	Swallow, barn	<i>Hirundo rustica</i>	WetAreas OR OpenSize NOT Industry
40251	Martin, purple	<i>Progne subis</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40272	Catbird, gray	<i>Dumetella carolinensis</i>	ForMaj NOT Industry
40277	Thrush, wood	<i>Hylocichla mustelina</i>	ForSize NOT Industry
40281	Veery	<i>Catharus fuscescens</i>	ForSize NOT Industry
40284	Gnatcatcher, blue-gray	<i>Poliophtila caerulea</i>	WetAreas NOT Industry
40295	Vireo, white-eyed	<i>Vireo griseus</i>	WetAreas NOT Industry
40297	Vireo, yellow-throated	<i>Vireo flavifrons</i>	AdjH2O AND LC_Code AND ForSize NOT Industry
40299	Vireo, red-eyed	<i>Vireo olivaceus</i>	ForSize NOT Industry
40301	Vireo, warbling	<i>Vireo gilvus</i>	AdjH2O AND ForSize NOT Industry
40302	Warbler, black-and-white	<i>Mniotilta varia</i>	WetAreas NOT Industry
40303	Warbler, prothonotary	<i>Protonotaria citrea</i>	WetAreas NOT Industry
40305	Warbler, worm-eating	<i>Helmitheros vermivorus</i>	WetAreas NOT Industry

<u>Num</u>	<u>Name</u>	<u>Scientific Name</u>	<u>Operation</u>
40312	Parula, northern	<i>Parula americana</i>	WetAreas NOT Industry
40313	Warbler, yellow	<i>Dendroica petechia</i>	AdjH2O AND LC_Code NOT Industry
40320	Warbler, cerulean	<i>Dendroica cerulea</i>	WetAreas NOT Industry
40322	Warbler, yellow-throated	<i>Dendroica dominica</i>	WetAreas NOT Industry
40326	Warbler, pine	<i>Dendroica pinus</i>	ForSize NOT Industry
40330	Ovenbird	<i>Seiurus aurocapillus</i>	ForSize NOT Industry
40332	Waterthrush, Louisiana	<i>Seiurus motacilla</i>	AdjH2O AND ForSize NOT Industry
40333	Warbler, Kentucky	<i>Oporornis formosus</i>	WetAreas NOT Industry
40336	Yellowthroat, common	<i>Geothlypis trichas</i>	WetAreas NOT Industry
40338	Warbler, hooded	<i>Wilsonia citrina</i>	ForSize NOT Industry
40341	Redstart, American	<i>Setophaga ruticilla</i>	WetAreas NOT Industry
40348	Oriole, Baltimore	<i>Icterus galbula</i>	ForMaj NOT Industry
40355	Tanager, scarlet	<i>Piranga olivacea</i>	ForSize NOT Industry
40360	Grosbeak, blue	<i>Guiraca caerulea</i>	OpenSize NOT Industry
40389	Sparrow, chipping	<i>Spizella passerina</i>	LC_Code NOT Industry

Resident Birds

<u>Num</u>	<u>Name</u>	<u>Scientific Name</u>	<u>Operation</u>
40027	Heron, great blue	<i>Ardea herodias</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40035	Night-heron, black-crowned	<i>Nycticorax nycticorax</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40045	Goose, Canada	<i>Branta canadensis</i>	(ProxH2O AND OpenSize) OR WetAreas NOT Industry
40051	Mallard	<i>Anas platyrhynchos</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40052	Duck, American black	<i>Anas rubripes</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40057	Teal, blue-winged	<i>Anas discors</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40061	Duck, wood	<i>Aix sponsa</i>	(ProxH2O AND ForSize) OR WetAreas NOT Industry
40077	Merganser, hooded	<i>Lophodytes cucullatus</i>	(ProxH2O AND ForSize) OR WetAreas NOT Industry
40080	Vulture, turkey	<i>Cathartes aura</i>	ForSize NOT Industry
40081	Vulture, black	<i>Coragyps atratus</i>	ForSize NOT Industry
40085	Hawk, sharp-shinned	<i>Accipiter striatus</i>	ForSize NOT Industry
40087	Hawk, red-tailed	<i>Buteo jamaicensis</i>	ForSize NOT Industry
40088	Hawk, red-shouldered	<i>Buteo lineatus</i>	WetAreas NOT Industry
40093	Eagle, bald	<i>Haliaeetus leucocephalus</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40098	Kestrel, American	<i>Falco sparverius</i>	OpenSize NOT Industry
40100	Bobwhite, northern	<i>Colinus virginianus</i>	ForSize NOT Industry
40102	Turkey, wild	<i>Meleagris gallopavo</i>	ForSize NOT Industry
40105	Rail, king	<i>Rallus elegans</i>	WetAreas NOT Industry
40107	Rail, Virginia	<i>Rallus limicola</i>	WetAreas NOT Industry
40113	Coot, American	<i>Fulica americana</i>	WetAreas
40119	Killdeer	<i>Charadrius vociferus</i>	WetAreas OR OpenSize NOT Industry
40140	Woodcock, American	<i>Scolopax minor</i>	ForSize NOT Industry
40173	Gull, laughing	<i>Larus atricilla</i>	WetAreas
40197	Dove, rock	<i>Columba livia</i>	LC_Code
40198	Dove, mourning	<i>Zenaidura macroura</i>	LC_Code NOT ForMaj NOT Industry
40205	Screech-owl, eastern	<i>Otus asio</i>	ForSize NOT Industry
40206	Owl, great horned	<i>Bubo virginianus</i>	ForSize NOT Industry
40209	Owl, barred	<i>Strix varia</i>	ForSize NOT Industry
40220	Kingfisher, belted	<i>Ceryle alcyon</i>	(ProxH2O AND LC_Code) OR WetAreas NOT Industry
40221	Flicker, northern	<i>Colaptes auratus</i>	ForSize NOT Industry
40222	Woodpecker, pileated	<i>Dryocopus pileatus</i>	ForSize NOT Industry
40223	Woodpecker, red-bellied	<i>Melanerpes carolinus</i>	ForSize NOT Industry
40226	Woodpecker, hairy	<i>Picoides villosus</i>	ForSize NOT Industry

<u>Num</u>	<u>Name</u>	<u>Scientific Name</u>	<u>Operation</u>
40227	Woodpecker, downy	<i>Picoides pubescens</i>	ForMaj NOT Industry
40236	Phoebe, eastern	<i>Sayornis phoebe</i>	OpenSize NOT Industry
40252	Jay, blue	<i>Cyanocitta cristata</i>	ForMaj NOT Industry
40255	Crow, American	<i>Corvus brachyrhynchos</i>	ForSize
40256	Crow, fish	<i>Corvus ossifragus</i>	(AdjH2O AND ForSize)
40258	Chickadee, Carolina	<i>Poecile carolinensis</i>	LC_Code NOT Industry
40260	Titmouse, tufted	<i>Baeolophus bicolor</i>	LC_Code NOT Industry
40261	Nuthatch, white-breasted	<i>Sitta carolinensis</i>	ForSize NOT Industry
40265	Wren, house	<i>Troglodytes aedon</i>	ForMaj NOT Industry
40268	Wren, Carolina	<i>Thryothorus ludovicianus</i>	ForMaj NOT Industry
40269	Wren, marsh	<i>Cistothorus palustris</i>	WetAreas NOT Industry
40271	Mockingbird, northern	<i>Mimus polyglottos</i>	LC_Code NOT ForMaj NOT Industry
40273	Thrasher, brown	<i>Toxostoma rufum</i>	ForMaj NOT Industry
40275	Robin, American	<i>Turdus migratorius</i>	LC_Code NOT Industry
40282	Bluebird, eastern	<i>Sialia sialis</i>	OpenSize NOT Industry
40290	Waxwing, cedar	<i>Bombycilla cedrorum</i>	ForMaj NOT Industry
40294	Starling, European	<i>Sturnus vulgaris</i>	LC_Code
40342	Sparrow, house	<i>Passer domesticus</i>	LC_Code
40344	Meadowlark, eastern	<i>Sturnella magna</i>	OpenSize NOT Industry
40346	Blackbird, red-winged	<i>Agelaius phoeniceus</i>	WetAreas NOT Industry
40352	Grackle, common	<i>Quiscalus quiscula</i>	ForSize
40353	Cowbird, brown-headed	<i>Molothrus ater</i>	LC_Code
40357	Cardinal, northern	<i>Cardinalis cardinalis</i>	LC_Code
40367	Finch, house	<i>Carpodacus mexicanus</i>	LC_Code
40375	Towhee, eastern	<i>Pipilo erythrophthalmus</i>	ForMaj NOT Industry
40397	Sparrow, swamp	<i>Melospiza georgiana</i>	WetAreas NOT Industry
40398	Sparrow, song	<i>Melospiza melodia</i>	LC_Code

Wintering Birds

<u>Num</u>	<u>Name</u>	<u>Scientific Name</u>	<u>Operation</u>
40141	Snipe, common	<i>Gallinago gallinago</i>	WetAreas NOT Industry
40165	Gull, great black-backed	<i>Larus marinus</i>	WetAreas
40166	Gull, lesser black-backed	<i>Larus fuscus</i>	WetAreas
40167	Gull, herring	<i>Larus argentatus</i>	WetAreas
40170	Gull, ring-billed	<i>Larus delawarensis</i>	WetAreas
40175	Gull, Bonaparte's	<i>Larus philadelphia</i>	WetAreas
40213	Owl, northern saw-whet	<i>Aegolius acadicus</i>	ForSize NOT Industry
40225	Sapsucker, yellow-bellied	<i>Sphyrapicus varius</i>	ForSize NOT Industry
40262	Nuthatch, red-breasted	<i>Sitta canadensis</i>	ForSize NOT Industry
40264	Creeper, brown	<i>Certhia americana</i>	ForSize NOT Industry
40266	Wren, winter	<i>Troglodytes troglodytes</i>	ForSize NOT Industry
40278	Thrush, hermit	<i>Catharus guttatus</i>	ForSize NOT Industry
40285	Kinglet, golden-crowned	<i>Regulus satrapa</i>	ForSize NOT Industry
40286	Kinglet, ruby-crowned	<i>Regulus calendula</i>	ForSize NOT Industry
40287	Pipit, American	<i>Anthus rubescens</i>	OpenSize NOT Industry
40317	Warbler, yellow-rumped	<i>Dendroica coronata</i>	ForMaj AND LC_Code NOT Industry

Waterfowl

<u>Num</u>	<u>Name</u>	<u>Scientific Name</u>	<u>Operation</u>
40001	Loon, common	<i>Gavia immer</i>	WetAreas NOT Industry
40008	Grebe, pied-billed	<i>Podilymbus podiceps</i>	WetAreas NOT Industry
40024	Cormorant, double-crested	<i>Phalacrocorax auritus</i>	WetAreas NOT Industry
40044	Swan, tundra	<i>Cygnus columbianus</i>	WetAreas NOT Industry
40049	Goose, lesser snow	<i>Chen caerulescens</i>	WetAreas NOT Industry
40053	Gadwall	<i>Anas strepera</i>	WetAreas NOT Industry
40054	Pintail, northern	<i>Anas acuta</i>	WetAreas NOT Industry
40056	Teal, green-winged	<i>Anas crecca</i>	WetAreas NOT Industry
40059	Wigeon, American	<i>Anas americana</i>	WetAreas NOT Industry
40060	Shoveler, northern	<i>Anas clypeata</i>	WetAreas NOT Industry
40062	Redhead	<i>Aythya americana</i>	WetAreas NOT Industry
40063	Duck, ring-necked	<i>Aythya collaris</i>	WetAreas NOT Industry
40064	Canvasback	<i>Aythya valisineria</i>	WetAreas NOT Industry
40065	Scaup, greater	<i>Aythya marila</i>	WetAreas NOT Industry
40066	Scaup, lesser	<i>Aythya affinis</i>	WetAreas NOT Industry
40067	Goldeneye, common	<i>Bucephala clangula</i>	WetAreas NOT Industry
40068	Bufflehead	<i>Bucephala albeola</i>	WetAreas NOT Industry
40069	Oldsquaw	<i>Clangula hyemalis</i>	WetAreas NOT Industry
40073	Scoter, white-winged	<i>Melanitta fusca</i>	WetAreas NOT Industry
40074	Scoter, surf	<i>Melanitta perspicillata</i>	WetAreas NOT Industry
40075	Scoter, black	<i>Melanitta nigra</i>	WetAreas NOT Industry
40076	Duck, ruddy	<i>Oxyura jamaicensis</i>	WetAreas NOT Industry
40078	Merganser, common	<i>Mergus merganser</i>	WetAreas NOT Industry
40079	Merganser, red-breasted	<i>Mergus serrator</i>	WetAreas NOT Industry

Appendix D. Parameters for species models, not including land cover or wetland type. No data indicates that variable was not used to create model. Operations to create species models are presented in Appendix C. Parameters for suitable land cover are presented in Appendix E. Parameters for suitable wetlands are presented in Appendix F.

Amphibians

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff</u> (m)	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O</u> (m)
20004	Bullfrog	<i>Rana catesbeiana</i>				2500	100	
20006	Treefrog, Cope's gray	<i>Hyla chrysoscelis</i>	11				500	
20007	Treefrog, gray	<i>Hyla versicolor</i>	11				500	
20008	Frog, northern green	<i>Rana clamitans</i>					100	
20009	Treefrog, green	<i>Hyla cinerea</i>					500	
20012	Frog, eastern cricket	<i>Acris crepitans</i>					100	
20013	Frog, pickerel	<i>Rana palustris</i>					500	
20016	Frog, southern leopard	<i>Rana sphenocephala</i>					500	
20018	Frog, southeastern chorus	<i>Pseudacris feriarum</i>					100	
20019	Frog, wood	<i>Rana sylvatica</i>					500	
20029	Salamander, four-toed	<i>Hemidactylium scutatum</i>					250	
20035	Salamander, marbled	<i>Ambystoma opacum</i>					250	
20038	Salamander, northern dusky	<i>Desmognathus fuscus</i>					100	
20043	Salamander, northern red-backed	<i>Plethodon cinereus</i>					250	
20049	Salamander, spotted	<i>Ambystoma maculatum</i>					250	
20051	Salamander, three-lined	<i>Eurycea guttolineata</i>					100	
20053	Salamander, northern two-lined	<i>Eurycea bislineata</i>					25	
20059	Toad, American	<i>Bufo americanus</i>					500	
20065	Newt, red-spotted	<i>Notophthalmus viridescens</i>					100	
20069	Salamander, eastern mud	<i>Pseudotriton montanus</i>					25	
20070	Salamander, northern red	<i>Pseudotriton ruber</i>					100	
20071	Peeper, northern spring	<i>Pseudacris crucifer</i>					100	
20080	Salamander, white-spotted slimy	<i>Plethodon cylindraceus</i>	22					

Reptiles

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff (m)</u>	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O (m)</u>
30002	Lizard, northern fence	<i>Sceloporus undulatus</i>	22					
30004	Skink, five-lined	<i>Eumeces fasciatus</i>	22				200	
30005	Skink, southeastern five-lined	<i>Eumeces inexpectatus</i>	22					
30006	Skink, broadhead	<i>Eumeces laticeps</i>	22					
30007	Skink, little brown	<i>Scincella lateralis</i>	22					
30016	Copperhead, northern	<i>Agkistrodon contortrix</i>	22					
30018	Racer, northern black	<i>Coluber constrictor</i>	22					
30019	Snake, eastern worm	<i>Carphophis amoenus</i>	22					
30020	Snake, northern ringneck	<i>Diadophis punctatus</i>	22					
30022	Snake, corn	<i>Elaphe guttata</i>	22					
30023	Snake, black rat	<i>Elaphe obsoleta</i>	22					
30026	Kingsnake, eastern	<i>Lampropeltis getula</i>	22				25	
30027	Kingsnake, mole	<i>Lampropeltis calligaster</i>	22					
30029	Snake, eastern milk	<i>Lampropeltis triangulum</i>	22					
30033	Snake, queen	<i>Regina septemvittata</i>				25		
30034	Snake, northern water	<i>Nerodia sipedon</i>				25		
30038	Snake, rough green	<i>Opheodrys aestivus</i>						
30041	Snake, northern brown	<i>Storeria dekayi</i>						
30042	Snake, northern red-bellied	<i>Storeria occipitomaculata</i>	22				25	
30044	Snake, eastern garter	<i>Thamnophis sirtalis</i>					25	
30045	Snake, eastern ribbon	<i>Thamnophis sauritus</i>				25		
30049	Earthsnake, eastern smooth	<i>Virginia valeriae</i>	22					
30050	Turtle, eastern snapping	<i>Chelydra serpentina</i>				25		
30051	Turtle, eastern mud	<i>Kinosternon subrubrum</i>				25		
30052	Turtle, eastern musk	<i>Sternotherus odoratus</i>				25		
30057	Cooter, northern red-bellied	<i>Pseudemys rubriventris</i>				25		

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff (m)</u>	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O (m)</u>
30058	Slider, yellowbellied	<i>Trachemys scripta</i>				25		
30060	Turtle, eastern painted	<i>Chrysemys picta</i>				25		
30062	Turtle, wood	<i>Clemmys insculpta</i>				25		
30063	Turtle, spotted	<i>Clemmys guttata</i>				25		
30068	Turtle, eastern box	<i>Terrapene carolina</i>	22					
30077	Slider, red-eared	<i>Trachemys scripta</i>				25		

Mammals

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff</u> (m)	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O</u> (m)
50001	Opossum, Virginia	<i>Didelphis virginiana virginiana</i>						
50007	Shrew, southeastern	<i>Sorex longirostris longirostris</i>						
50013	Shrew, Kirtland's short-tailed	<i>Blarina brevicauda kirtlandi</i>						
50017	Mole, eastern	<i>Scalopus aquaticus aquaticus</i>						
50019	Mole, star-nosed	<i>Condylura cristata cristata</i>						
50028	Bat, big brown	<i>Eptesicus fuscus fuscus</i>						
50029	Bat, eastern red	<i>Lasiurus borealis borealis</i>						
50038	Raccoon	<i>Procyon lotor lotor</i>						
50042	Mink, common	<i>Mustela vison mink</i>						
50047	Skunk, striped	<i>Mephitis mephitis nigra</i>						
50049	Fox, red	<i>Vulpes vulpes fulva</i>	111	111				
50050	Fox, eastern gray	<i>Urocyon cinereoargenteus cinereoargenteus</i>	111	111				
50054	Woodchuck	<i>Marmota monax monax</i>		11				
50055	Chipmunk, Fisher's eastern	<i>Tamias striatus fisheri</i>						
50058	Squirrel, northern gray	<i>Sciurus carolinensis pennsylvanicus</i>						
50065	Squirrel, southern flying	<i>Glaucomys volans volans</i>	11					
50069	Beaver	<i>Castor canadensis</i>				10000		
50073	Mouse, northern white-footed	<i>Peromyscus leucopus noveboracensis</i>	11					
50082	Vole, meadow	<i>Microtus pennsylvanicus pennsylvanicus</i>						
50092	Muskrat, common	<i>Ondatra zibethicus zibethicus</i>						
50095	Rat, Norway	<i>Rattus norvegicus norvegicus</i>						
50098	Mouse, house	<i>Mus musculus musculus</i>						
50099	Mouse, meadow jumping	<i>Zapus hudsonius americanus</i>						100
50103	Cottontail, eastern	<i>Sylvilagus floridanus mallurus</i>						
50108	Deer, white-tailed	<i>Odocoileus virginianus</i>	111		500			

Breeding Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff (m)</u>	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O (m)</u>
40028	Heron, green	<i>Butorides virescens</i>				10000	25	
40032	Egret, great	<i>Ardea alba</i>					25	
40036	Night-heron, yellow-crowned	<i>Nyctanassa violacea</i>				10000	25	
40037	Bittern, least	<i>Ixobrychus exilis</i>				10000		
40038	Bittern, American	<i>Botaurus lentiginosus</i>				10000		
40095	Osprey	<i>Pandion haliaetus</i>				10000	100	
40112	Moorhen, common	<i>Gallinula chloropus</i>				10000		
40134	Sandpiper, spotted	<i>Actitis macularia</i>				10000		
40202	Cuckoo, yellow-billed	<i>Coccyzus americanus</i>	111					
40214	Chuck-will's-widow	<i>Caprimulgus carolinensis</i>	111					
40215	Whip-poor-will	<i>Caprimulgus vociferus</i>	111					
40217	Swift, chimney	<i>Chaetura pelagica</i>						
40218	Hummingbird, ruby-throated	<i>Archilochus colubris</i>	111					
40229	Kingbird, eastern	<i>Tyrannus tyrannus</i>		22				
40234	Flycatcher, great crested	<i>Myiarchus crinitus</i>	11					
40239	Flycatcher, Acadian	<i>Empidonax virescens</i>	411					
40240	Flycatcher, willow	<i>Empidonax traillii</i>					100	
40243	Pewee, eastern wood	<i>Contopus virens</i>	11					
40246	Swallow, tree	<i>Tachycineta bicolor</i>		22			200	
40248	Swallow, northern rough-winged	<i>Stelgidopteryx serripennis</i>					100	
40249	Swallow, barn	<i>Hirundo rustica</i>		22				
40251	Martin, purple	<i>Progne subis</i>					200	
40272	Catbird, gray	<i>Dumetella carolinensis</i>						
40277	Thrush, wood	<i>Hylocichla mustelina</i>	33					
40281	Veery	<i>Catharus fuscescens</i>	556					
40284	Gnatcatcher, blue-gray	<i>Polioptila caerulea</i>				370000		
40295	Vireo, white-eyed	<i>Vireo griseus</i>				10000		
40297	Vireo, yellow-throated	<i>Vireo flavifrons</i>	111					100
40299	Vireo, red-eyed	<i>Vireo olivaceus</i>	78					
40301	Vireo, warbling	<i>Vireo gilvus</i>	2					100
40302	Warbler, black-and-white	<i>Mniotilta varia</i>				100000		
40303	Warbler, prothonotary	<i>Protonotaria citrea</i>				100000		

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize (cells)</u>	<u>OpenSize (cells)</u>	<u>ForBuff (m)</u>	<u>WetSize (m²)</u>	<u>ProxH2O (m)</u>	<u>AdjH2O (m)</u>
40305	Warbler, worm-eating	<i>Helmitheros vermivorus</i>				100000		
40312	Parula, northern	<i>Parula americana</i>				100000		
40313	Warbler, yellow	<i>Dendroica petechia</i>						200
40320	Warbler, cerulean	<i>Dendroica cerulea</i>				100000		
40322	Warbler, yellow-throated	<i>Dendroica dominica</i>				10000		
40326	Warbler, pine	<i>Dendroica pinus</i>	111					
40330	Ovenbird	<i>Seiurus aurocapillus</i>	167					
40332	Waterthrush, Louisiana	<i>Seiurus motacilla</i>	1111					200
40333	Warbler, Kentucky	<i>Oporornis formosus</i>				450000		
40336	Yellowthroat, common	<i>Geothlypis trichas</i>						
40338	Warbler, hooded	<i>Wilsonia citrina</i>	111					
40341	Redstart, American	<i>Setophaga ruticilla</i>				100000		
40348	Oriole, Baltimore	<i>Icterus galbula</i>						
40355	Tanager, scarlet	<i>Piranga olivacea</i>	333					
40360	Grosbeak, blue	<i>Guiraca caerulea</i>		22				
40389	Sparrow, chipping	<i>Spizella passerina</i>						

Resident Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff</u> (m)	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O</u> (m)
40027	Heron, great blue	<i>Ardea herodias</i>					25	
40035	Night-heron, black-crowned	<i>Nycticorax nycticorax</i>				10000	25	
40045	Goose, Canada	<i>Branta canadensis</i>		4		5000	500	
40051	Mallard	<i>Anas platyrhynchos</i>					25	
40052	Duck, American black	<i>Anas rubripes</i>				10000	25	
40057	Teal, blue-winged	<i>Anas discors</i>				10000	25	
40061	Duck, wood	<i>Aix sponsa</i>	111			10000	1000	
40077	Merganser, hooded	<i>Lophodytes cucullatus</i>	111			10000	500	
40080	Vulture, turkey	<i>Cathartes aura</i>	22					
40081	Vulture, black	<i>Coragyps atratus</i>	22					
40085	Hawk, sharp-shinned	<i>Accipiter striatus</i>	111					
40087	Hawk, red-tailed	<i>Buteo jamaicensis</i>	22					
40088	Hawk, red-shouldered	<i>Buteo lineatus</i>				1000000		
40093	Eagle, bald	<i>Haliaeetus leucocephalus</i>				300000	100	
40098	Kestrel, American	<i>Falco sparverius</i>		22				
40100	Bobwhite, northern	<i>Colinus virginianus</i>	111					
40102	Turkey, wild	<i>Meleagris gallopavo</i>	111					
40105	Rail, king	<i>Rallus elegans</i>				10000		
40107	Rail, Virginia	<i>Rallus limicola</i>				10000		
40113	Coot, American	<i>Fulica americana</i>						
40119	Killdeer	<i>Charadrius vociferus</i>		22				
40140	Woodcock, American	<i>Scolopax minor</i>	111					
40197	Dove, rock	<i>Larus atricilla</i>						
40198	Dove, mourning	<i>Columba livia</i>						
40204	Owl, barn	<i>Zenaidra macroura</i>						
40205	Screech-owl, eastern	<i>Otus asio</i>	111					
40206	Owl, great horned	<i>Bubo virginianus</i>	11					
40209	Owl, barred	<i>Strix varia</i>	11					
40220	Kingfisher, belted	<i>Ceryle alcyon</i>					100	
40221	Flicker, northern	<i>Colaptes auratus</i>	111					
40222	Woodpecker, pileated	<i>Dryocopus pileatus</i>	1111					
40223	Woodpecker, red-bellied	<i>Melanerpes carolinus</i>	11					

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff (m)</u>	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O (m)</u>
40226	Woodpecker, hairy	<i>Picoides villosus</i>	200					
40227	Woodpecker, downy	<i>Picoides pubescens</i>						
40236	Phoebe, eastern	<i>Sayornis phoebe</i>		22				
40252	Jay, blue	<i>Cyanocitta cristata</i>						
40255	Crow, American	<i>Corvus brachyrhynchos</i>	22					
40256	Crow, fish	<i>Corvus ossifragus</i>	11					500
40258	Chickadee, Carolina	<i>Poecile carolinensis</i>						
40260	Titmouse, tufted	<i>Baeolophus bicolor</i>						
40261	Nuthatch, white-breasted	<i>Sitta carolinensis</i>	89					
40265	Wren, house	<i>Troglodytes aedon</i>						
40268	Wren, Carolina	<i>Thryothorus ludovicianus</i>						
40269	Wren, marsh	<i>Cistothorus palustris</i>						
40271	Mockingbird, northern	<i>Mimus polyglottos</i>						
40273	Thrasher, brown	<i>Toxostoma rufum</i>						
40275	Robin, American	<i>Turdus migratorius</i>						
40282	Bluebird, eastern	<i>Sialia sialis</i>		22				
40290	Waxwing, cedar	<i>Bombycilla cedrorum</i>						
40294	Starling, European	<i>Sturnus vulgaris</i>						
40342	Sparrow, house	<i>Passer domesticus</i>						
40344	Meadowlark, eastern	<i>Sturnella magna</i>		22				
40346	Blackbird, red-winged	<i>Agelaius phoeniceus</i>						200
40352	Grackle, common	<i>Quiscalus quiscula</i>	11					
40353	Cowbird, brown-headed	<i>Molothrus ater</i>						
40357	Cardinal, northern	<i>Cardinalis cardinalis</i>						
40367	Finch, house	<i>Carpodacus mexicanus</i>						
40375	Towhee, eastern	<i>Pipilo erythrophthalmus</i>						
40397	Sparrow, swamp	<i>Melospiza georgiana</i>						
40398	Sparrow, song	<i>Melospiza melodia</i>						

Wintering Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff</u> (m)	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O</u> (m)
40141	Snipe, common	<i>Gallinago gallinago</i>				30000		
40165	Gull, great black-backed	<i>Larus marinus</i>						
40166	Gull, lesser black-backed	<i>Larus fuscus</i>						
40167	Gull, herring	<i>Larus argentatus</i>						
40170	Gull, ring-billed	<i>Larus delawarensis</i>						
40175	Gull, Bonaparte's	<i>Larus philadelphia</i>						
40213	Owl, northern saw-whet	<i>Aegolius acadicus</i>	111					
40225	Sapsucker, yellow-bellied	<i>Sphyrapicus varius</i>	11					
40262	Nuthatch, red-breasted	<i>Sitta canadensis</i>	11					
40264	Creeper, brown	<i>Certhia americana</i>	111					
40266	Wren, winter	<i>Troglodytes troglodytes</i>	111					
40278	Thrush, hermit	<i>Catharus guttatus</i>	111					
40285	Kinglet, golden-crowned	<i>Regulus satrapa</i>	111					
40286	Kinglet, ruby-crowned	<i>Regulus calendula</i>	22					
40287	Pipit, American	<i>Anthus rubescens</i>		55				
40317	Warbler, yellow-rumped	<i>Dendroica coronata</i>						

Waterfowl

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>ForSize</u> <u>(cells)</u>	<u>OpenSize</u> <u>(cells)</u>	<u>ForBuff</u> (m)	<u>WetSize</u> <u>(m²)</u>	<u>ProxH2O</u> <u>(m)</u>	<u>AdjH2O</u> (m)
40001	Loon, common	<i>Gavia immer</i>				10000		
40008	Grebe, pied-billed	<i>Podilymbus podiceps</i>				5000		
40024	Cormorant, double-crested	<i>Phalacrocorax auritus</i>				5000		
40044	Swan, tundra	<i>Cygnus columbianus</i>				5000		
40049	Goose, lesser snow	<i>Chen caerulescens</i>				5000		
40053	Gadwall	<i>Anas strepera</i>				5000		
40054	Pintail, northern	<i>Anas acuta</i>				5000		
40056	Teal, green-winged	<i>Anas crecca</i>				5000		
40059	Wigeon, American	<i>Anas americana</i>				5000		
40060	Shoveler, northern	<i>Anas clypeata</i>				5000		
40062	Redhead	<i>Aythya americana</i>				5000		
40063	Duck, ring-necked	<i>Aythya collaris</i>				5000		
40064	Canvasback	<i>Aythya valisineria</i>				10000		
40065	Scaup, greater	<i>Aythya marila</i>				10000		
40066	Scaup, lesser	<i>Aythya affinis</i>				5000		
40067	Goldeneye, common	<i>Bucephala clangula</i>				10000		
40068	Bufflehead	<i>Bucephala albeola</i>				5000		
40069	Oldsquaw	<i>Clangula hyemalis</i>				10000		
40073	Scoter, white-winged	<i>Melanitta fusca</i>				10000		
40074	Scoter, surf	<i>Melanitta perspicillata</i>				5000		
40075	Scoter, black	<i>Melanitta nigra</i>				10000		
40076	Duck, ruddy	<i>Oxyura jamaicensis</i>				5000		
40078	Merganser, common	<i>Mergus merganser</i>				5000		
40079	Merganser, red-breasted	<i>Mergus serrator</i>				5000		

Appendix E. Suitable land cover codes for species models. 1 = suitable; 0 = not suitable. No data indicates that land cover was not a variable used to create species model. Operations to create species models are presented in Appendix C.

Amphibians

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>LC1</u>	<u>LC3</u>	<u>LC4</u>	<u>LC5</u>
20004	Bullfrog	<i>Rana catesbeiana</i>	1	1	0	1
20006	Treefrog, Cope's gray	<i>Hyla chrysoscelis</i>				
20007	Treefrog, gray	<i>Hyla versicolor</i>				
20008	Frog, northern green	<i>Rana clamitans</i>	0	0	0	1
20009	Treefrog, green	<i>Hyla cinerea</i>	1	0	0	0
20012	Frog, eastern cricket	<i>Acris crepitans</i>	0	0	0	1
20013	Frog, pickerel	<i>Rana palustris</i>	0	0	0	1
20016	Frog, southern leopard	<i>Rana sphenocephala</i>	1	0	0	1
20018	Frog, southeastern chorus	<i>Pseudacris feriarum</i>	0	0	0	1
20019	Frog, wood	<i>Rana sylvatica</i>	1	0	0	0
20029	Salamander, four-toed	<i>Hemidactylium scutatum</i>	1	0	0	0
20035	Salamander, marbled	<i>Ambystoma opacum</i>	1	0	0	0
20038	Salamander, northern dusky	<i>Desmognathus fuscus</i>	1	0	0	0
20043	Salamander, northern red-backed	<i>Plethodon cinereus</i>	1	0	0	0
20049	Salamander, spotted	<i>Ambystoma maculatum</i>	1	0	0	0
20051	Salamander, three-lined	<i>Eurycea guttolineata</i>	1	0	0	0
20053	Salamander, northern two-lined	<i>Eurycea bislineata</i>	1	0	0	0
20059	Toad, American	<i>Bufo americanus</i>	1	1	0	1
20065	Newt, red-spotted	<i>Notophthalmus viridescens</i>	1	1	0	0
20069	Salamander, eastern mud	<i>Pseudotriton montanus</i>	1	0	0	0
20070	Salamander, northern red	<i>Pseudotriton ruber</i>	1	0	0	0
20071	Peeper, northern spring	<i>Pseudacris crucifer</i>	1	1	0	1
20080	Salamander, white-spotted slimy	<i>Plethodon cylindraceus</i>				

Reptiles

Num	Common Name	Scientific Name	LC1	LC3	LC4	LC5
30002	Lizard, northern fence	<i>Sceloporus undulatus</i>				
30004	Skink, five-lined	<i>Eumeces fasciatus</i>				
30005	Skink, southeastern five-lined	<i>Eumeces inexpectatus</i>				
30006	Skink, broadhead	<i>Eumeces laticeps</i>				
30007	Skink, little brown	<i>Scincella lateralis</i>				
30016	Copperhead, northern	<i>Agkistrodon contortrix</i>				
30018	Racer, northern black	<i>Coluber constrictor</i>				
30019	Snake, eastern worm	<i>Carphophis amoenus</i>				
30020	Snake, northern ringneck	<i>Diadophis punctatus</i>				
30022	Snake, corn	<i>Elaphe guttata</i>				
30023	Snake, black rat	<i>Elaphe obsoleta</i>				
30026	Kingsnake, eastern	<i>Lampropeltis getula</i>	1	0	0	1
30027	Kingsnake, mole	<i>Lampropeltis calligaster</i>				
30029	Snake, eastern milk	<i>Lampropeltis triangulum</i>				
30033	Snake, queen	<i>Regina septemvittata</i>	1	0	0	1
30034	Snake, northern water	<i>Nerodia sipedon</i>	1	0	0	1
30038	Snake, rough green	<i>Opheodrys aestivus</i>	1	1	0	0
30041	Snake, northern brown	<i>Storeria dekayi</i>	1	1	0	0
30042	Snake, northern red-bellied	<i>Storeria occipitomaculata</i>	1	0	0	1
30044	Snake, eastern garter	<i>Thamnophis sirtalis</i>	1	1	0	1
30045	Snake, eastern ribbon	<i>Thamnophis sauritus</i>	1	0	0	1
30049	Earthsnake, eastern smooth	<i>Virginia valeriae</i>				
30050	Turtle, eastern snapping	<i>Chelydra serpentina</i>	1	0	0	1
30051	Turtle, eastern mud	<i>Kinosternon subrubrum</i>	1	0	0	1
30052	Turtle, eastern musk	<i>Sternotherus odoratus</i>	1	0	0	1
30057	Cooter, northern red-bellied	<i>Pseudemys rubriventris</i>	1	0	0	1
30058	Slider, yellowbellied	<i>Trachemys scripta</i>	1	0	0	1
30060	Turtle, eastern painted	<i>Chrysemys picta</i>	1	0	0	1
30062	Turtle, wood	<i>Clemmys insculpta</i>	1	0	0	0
30063	Turtle, spotted	<i>Clemmys guttata</i>	1	0	0	1
30068	Turtle, eastern box	<i>Terrapene carolina</i>				
30077	Slider, red-eared	<i>Trachemys scripta</i>	1	0	0	1

Mammals

Num	Common Name	Scientific Name	LC1	LC3	LC4	LC5
50001	Opossum, Virginia	<i>Didelphis virginiana virginiana</i>	1	1	0	1
50007	Shrew, southeastern	<i>Sorex longirostris longirostris</i>	1	0	0	1
50013	Shrew, Kirtland's short-tailed	<i>Blarina brevicauda kirtlandi</i>				
50017	Mole, eastern	<i>Scalopus aquaticus aquaticus</i>	1	0	0	1
50019	Mole, star-nosed	<i>Condylura cristata cristata</i>				
50028	Bat, big brown	<i>Eptesicus fuscus fuscus</i>	1	1	0	1
50029	Bat, eastern red	<i>Lasiurus borealis borealis</i>	1	0	0	0
50038	Raccoon	<i>Procyon lotor lotor</i>	1	1	0	0
50042	Mink, common	<i>Mustela vison mink</i>				
50047	Skunk, striped	<i>Mephitis mephitis nigra</i>	1	1	0	1
50049	Fox, red	<i>Vulpes vulpes fulva</i>				
50050	Fox, eastern gray	<i>Urocyon cinereoargenteus cinereoargenteus</i>				
50054	Woodchuck	<i>Marmota monax monax</i>				
50055	Chipmunk, Fisher's eastern	<i>Tamias striatus fisheri</i>	1	1	0	0
50058	Squirrel, northern gray	<i>Sciurus carolinensis pennsylvanicus</i>	1	1	0	0
50065	Squirrel, southern flying	<i>Glaucomys volans volans</i>				
50069	Beaver	<i>Castor canadensis</i>				
50073	Mouse, northern white-footed	<i>Peromyscus leucopus noveboracensis</i>				
50082	Vole, meadow	<i>Microtus pennsylvanicus pennsylvanicus</i>				
50092	Muskrat, common	<i>Ondatra zibethicus zibethicus</i>				
50095	Rat, Norway	<i>Rattus norvegicus norvegicus</i>	0	1	1	0
50098	Mouse, house	<i>Mus musculus musculus</i>	0	1	1	0
50099	Mouse, meadow jumping	<i>Zapus hudsonius americanus</i>	1	0	0	1
50103	Cottontail, eastern	<i>Sylvilagus floridanus mallurus</i>	1	1	0	1
50108	Deer, white-tailed	<i>Odocoileus virginianus</i>	1	1	0	1

Breeding Birds

Num	Common Name	Scientific Name	LC1	LC3	LC4	LC5
40028	Heron, green	<i>Butorides virescens</i>	1	0	0	1
40032	Egret, great	<i>Ardea alba</i>	1	0	0	1
40036	Night-heron, yellow-crowned	<i>Nyctanassa violacea</i>	1	0	0	1
40037	Bittern, least	<i>Ixobrychus exilis</i>				
40038	Bittern, American	<i>Botaurus lentiginosus</i>				
40095	Osprey	<i>Pandion haliaetus</i>	1	0	0	0
40112	Moorhen, common	<i>Gallinula chloropus</i>				
40134	Sandpiper, spotted	<i>Actitis macularia</i>				
40202	Cuckoo, yellow-billed	<i>Coccyzus americanus</i>				
40214	Chuck-will's-widow	<i>Caprimulgus carolinensis</i>				
40215	Whip-poor-will	<i>Caprimulgus vociferus</i>				
40217	Swift, chimney	<i>Chaetura pelagica</i>	0	1	1	0
40218	Hummingbird, ruby-throated	<i>Archilochus colubris</i>				
40229	Kingbird, eastern	<i>Tyrannus tyrannus</i>				
40234	Flycatcher, great crested	<i>Myiarchus crinitus</i>				
40239	Flycatcher, Acadian	<i>Empidonax virescens</i>				
40240	Flycatcher, willow	<i>Empidonax traillii</i>	1	0	0	1
40243	Pewee, eastern wood	<i>Contopus virens</i>				
40246	Swallow, tree	<i>Tachycineta bicolor</i>				
40248	Swallow, northern rough-winged	<i>Stelgidopteryx serripennis</i>	0	0	0	1
40249	Swallow, barn	<i>Hirundo rustica</i>				
40251	Martin, purple	<i>Progne subis</i>	0	1	0	1
40272	Catbird, gray	<i>Dumetella carolinensis</i>	1	1	0	0
40277	Thrush, wood	<i>Hylocichla mustelina</i>				
40281	Veery	<i>Catharus fuscescens</i>				
40284	Gnatcatcher, blue-gray	<i>Polioptila caerulea</i>				
40295	Vireo, white-eyed	<i>Vireo griseus</i>				
40297	Vireo, yellow-throated	<i>Vireo flavifrons</i>	1	0	0	0
40299	Vireo, red-eyed	<i>Vireo olivaceus</i>				
40301	Vireo, warbling	<i>Vireo gilvus</i>				
40302	Warbler, black-and-white	<i>Mniotilta varia</i>				
40303	Warbler, prothonotary	<i>Protonotaria citrea</i>				
40305	Warbler, worm-eating	<i>Helmitheros vermivorus</i>				

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>LC1</u>	<u>LC3</u>	<u>LC4</u>	<u>LC5</u>
40312	Parula, northern	<i>Parula americana</i>				
40313	Warbler, yellow	<i>Dendroica petechia</i>	1	0	0	0
40320	Warbler, cerulean	<i>Dendroica cerulea</i>				
40322	Warbler, yellow-throated	<i>Dendroica dominica</i>				
40326	Warbler, pine	<i>Dendroica pinus</i>				
40330	Ovenbird	<i>Seiurus aurocapillus</i>				
40332	Waterthrush, Louisiana	<i>Seiurus motacilla</i>				
40333	Warbler, Kentucky	<i>Oporornis formosus</i>				
40336	Yellowthroat, common	<i>Geothlypis trichas</i>				
40338	Warbler, hooded	<i>Wilsonia citrina</i>				
40341	Redstart, American	<i>Setophaga ruticilla</i>				
40348	Oriole, Baltimore	<i>Icterus galbula</i>	1	0	0	0
40355	Tanager, scarlet	<i>Piranga olivacea</i>				
40360	Grosbeak, blue	<i>Guiraca caerulea</i>				
40389	Sparrow, chipping	<i>Spizella passerina</i>	1	1	0	0

Resident Birds

Num	Common Name	Scientific Name	LC1	LC3	LC4	LC5
40027	Heron, great blue	<i>Ardea herodias</i>	1	0	0	1
40035	Night-heron, black-crowned	<i>Nycticorax nycticorax</i>	1	0	0	1
40045	Goose, Canada	<i>Branta canadensis</i>				
40051	Mallard	<i>Anas platyrhynchos</i>	0	0	0	1
40052	Duck, American black	<i>Anas rubripes</i>	0	0	0	1
40057	Teal, blue-winged	<i>Anas discors</i>	0	0	0	1
40061	Duck, wood	<i>Aix sponsa</i>				
40077	Merganser, hooded	<i>Lophodytes cucullatus</i>				
40080	Vulture, turkey	<i>Cathartes aura</i>				
40081	Vulture, black	<i>Coragyps atratus</i>				
40085	Hawk, sharp-shinned	<i>Accipiter striatus</i>				
40087	Hawk, red-tailed	<i>Buteo jamaicensis</i>				
40088	Hawk, red-shouldered	<i>Buteo lineatus</i>				
40093	Eagle, bald	<i>Haliaeetus leucocephalus</i>	1	0	0	0
40098	Kestrel, American	<i>Falco sparverius</i>				
40100	Bobwhite, northern	<i>Colinus virginianus</i>				
40102	Turkey, wild	<i>Meleagris gallopavo</i>				
40105	Rail, king	<i>Rallus elegans</i>				
40107	Rail, Virginia	<i>Rallus limicola</i>				
40113	Coot, American	<i>Fulica americana</i>				
40119	Killdeer	<i>Charadrius vociferus</i>				
40140	Woodcock, American	<i>Scolopax minor</i>				
40197	Dove, rock	<i>Larus atricilla</i>	0	1	1	1
40198	Dove, mourning	<i>Columba livia</i>	1	1	0	1
40205	Screech-owl, eastern	<i>Zenaida macroura</i>				
40206	Owl, great horned	<i>Otus asio</i>				
40209	Owl, barred	<i>Bubo virginianus</i>				
40220	Kingfisher, belted	<i>Strix varia</i>	1	0	0	1
40221	Flicker, northern	<i>Ceryle alcyon</i>				
40222	Woodpecker, pileated	<i>Colaptes auratus</i>				
40223	Woodpecker, red-bellied	<i>Dryocopus pileatus</i>				
40224	Woodpecker, red-headed	<i>Melanerpes carolinus</i>				
40226	Woodpecker, hairy	<i>Picoides villosus</i>				

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>LC1</u>	<u>LC3</u>	<u>LC4</u>	<u>LC5</u>
40227	Woodpecker, downy	<i>Picoides pubescens</i>	1	1	0	0
40236	Phoebe, eastern	<i>Sayornis phoebe</i>				
40252	Jay, blue	<i>Cyanocitta cristata</i>	1	1	0	0
40255	Crow, American	<i>Corvus brachyrhynchos</i>				
40256	Crow, fish	<i>Corvus ossifragus</i>				
40258	Chickadee, Carolina	<i>Poecile carolinensis</i>	1	1	0	0
40260	Titmouse, tufted	<i>Baeolophus bicolor</i>	1	1	0	0
40261	Nuthatch, white-breasted	<i>Sitta carolinensis</i>				
40265	Wren, house	<i>Troglodytes aedon</i>	1	1	0	0
40268	Wren, Carolina	<i>Thryothorus ludovicianus</i>	1	1	0	0
40269	Wren, marsh	<i>Cistothorus palustris</i>				
40271	Mockingbird, northern	<i>Mimus polyglottos</i>	1	1	0	1
40273	Thrasher, brown	<i>Toxostoma rufum</i>	1	1	0	0
40275	Robin, American	<i>Turdus migratorius</i>	1	1	0	1
40282	Bluebird, eastern	<i>Sialia sialis</i>				
40290	Waxwing, cedar	<i>Bombycilla cedrorum</i>	1	1	0	0
40294	Starling, European	<i>Sturnus vulgaris</i>	0	1	1	1
40342	Sparrow, house	<i>Passer domesticus</i>	0	1	1	1
40344	Meadowlark, eastern	<i>Sturnella magna</i>				
40346	Blackbird, red-winged	<i>Agelaius phoeniceus</i>				
40352	Grackle, common	<i>Quiscalus quiscula</i>				
40353	Cowbird, brown-headed	<i>Molothrus ater</i>	1	1	0	1
40357	Cardinal, northern	<i>Cardinalis cardinalis</i>	1	1	0	0
40367	Finch, house	<i>Carpodacus mexicanus</i>	0	1	0	0
40375	Towhee, eastern	<i>Pipilo erythrophthalmus</i>	1	1	0	0
40397	Sparrow, swamp	<i>Melospiza georgiana</i>				
40398	Sparrow, song	<i>Melospiza melodia</i>	0	1	0	0

Wintering Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>LC1</u>	<u>LC3</u>	<u>LC4</u>	<u>LC5</u>
40141	Snipe, common	<i>Snipe, common</i>				
40165	Gull, great black-backed	<i>Gull, great black-backed</i>				
40166	Gull, lesser black-backed	<i>Gull, lesser black-backed</i>				
40167	Gull, herring	<i>Gull, herring</i>				
40170	Gull, ring-billed	<i>Gull, ring-billed</i>				
40175	Gull, Bonaparte's	<i>Gull, Bonaparte's</i>				
40213	Owl, northern saw-whet	<i>Owl, northern saw-whet</i>				
40225	Sapsucker, yellow-bellied	<i>Sapsucker, yellow-bellied</i>				
40262	Nuthatch, red-breasted	<i>Nuthatch, red-breasted</i>				
40264	Creeper, brown	<i>Creeper, brown</i>				
40266	Wren, winter	<i>Wren, winter</i>				
40278	Thrush, hermit	<i>Thrush, hermit</i>				
40285	Kinglet, golden-crowned	<i>Kinglet, golden-crowned</i>				
40286	Kinglet, ruby-crowned	<i>Kinglet, ruby-crowned</i>				
40287	Pipit, American	<i>Pipit, American</i>				
40317	Warbler, yellow-rumped	<i>Warbler, yellow-rumped</i>	1	1	0	0

Waterfowl

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>LC1</u>	<u>LC3</u>	<u>LC4</u>	<u>LC5</u>
40001	Loon, common	<i>Gavia immer</i>				
40008	Grebe, pied-billed	<i>Podilymbus podiceps</i>				
40024	Cormorant, double-crested	<i>Phalacrocorax auritus</i>				
40044	Swan, tundra	<i>Cygnus columbianus</i>				
40049	Goose, lesser snow	<i>Chen caerulescens</i>				
40053	Gadwall	<i>Anas strepera</i>				
40054	Pintail, northern	<i>Anas acuta</i>				
40056	Teal, green-winged	<i>Anas crecca</i>				
40059	Wigeon, American	<i>Anas americana</i>				
40060	Shoveler, northern	<i>Anas clypeata</i>				
40062	Redhead	<i>Aythya americana</i>				
40063	Duck, ring-necked	<i>Aythya collaris</i>				
40064	Canvasback	<i>Aythya valisineria</i>				
40065	Scaup, greater	<i>Aythya marila</i>				
40066	Scaup, lesser	<i>Aythya affinis</i>				
40067	Goldeneye, common	<i>Bucephala clangula</i>				
40068	Bufflehead	<i>Bucephala albeola</i>				
40069	Oldsquaw	<i>Clangula hyemalis</i>				
40073	Scoter, white-winged	<i>Melanitta fusca</i>				
40074	Scoter, surf	<i>Melanitta perspicillata</i>				
40075	Scoter, black	<i>Melanitta nigra</i>				
40076	Duck, ruddy	<i>Oxyura jamaicensis</i>				
40078	Merganser, common	<i>Mergus merganser</i>				
40079	Merganser, red-breasted	<i>Mergus serrator</i>				

Reptiles

Num	Common Name	Scientific Name	L1UB	L2US	P0EM	P0FO	P0SS	P0UB	P0US	R1EM	R1UB	R1US	R2US	R3RS	R3US	RXXX
30002	Lizard, northern fence	<i>Sceloporus undulatus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30004	Skink, five-lined	<i>Eumeces fasciatus</i>	0	0	0	1	1	0	1	0	0	0	0	1	1	1
30005	Skink, southeastern five-lined	<i>Eumeces inexpectatus</i>														
30006	Skink, broadhead	<i>Eumeces laticeps</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30007	Skink, little brown	<i>Scincella lateralis</i>														
30016	Copperhead, northern	<i>Agkistrodon contortrix</i>	0	0	1	1	1	1	1	0	0	0	0	0	0	0
30018	Racer, northern black	<i>Coluber constrictor</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30019	Snake, eastern worm	<i>Carphophis amoenus</i>														
30020	Snake, northern ringneck	<i>Diadophis punctatus</i>														
30022	Snake, corn	<i>Elaphe guttata</i>														
30023	Snake, black rat	<i>Elaphe obsoleta</i>														
30026	Kingsnake, eastern	<i>Lampropeltis getula</i>	0	0	1	1	1	0	0	0	0	0	0	0	0	1
30027	Kingsnake, mole	<i>Lampropeltis calligaster</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30029	Snake, eastern milk	<i>Lampropeltis triangulum</i>														
30033	Snake, queen	<i>Regina septemvittata</i>	0	0	0	0	0	0	0	0	0	0	0	1	0	0
30034	Snake, northern water	<i>Nerodia sipedon</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30038	Snake, rough green	<i>Ophedrys aestivus</i>														
30041	Snake, northern brown	<i>Storeria dekayi</i>														
30042	Snake, northern red-bellied	<i>Storeria occipitomaculata</i>	0	0	1	1	1	0	0	0	0	0	0	0	0	0
30044	Snake, eastern garter	<i>Thamnophis sirtalis</i>	0	0	1	1	1	1	1	0	0	0	0	0	0	1
30045	Snake, eastern ribbon	<i>Thamnophis sauritus</i>	0	0	1	0	0	1	1	0	0	0	0	1	1	1
30049	Earthsake, eastern smooth	<i>Virginia valeriae</i>														
30050	Turtle, eastern snapping	<i>Chelydra serpentina</i>	1	1	1	0	0	1	1	1	1	1	1	1	1	1
30051	Turtle, eastern mud	<i>Kinosternon subrubrum</i>	0	0	1	1	0	1	1	0	0	0	0	0	0	1
30052	Turtle, eastern musk	<i>Sternotherus odoratus</i>	1	1	1	0	0	1	1	1	1	1	1	0	1	1
30057	Cooter, northern red-bellied	<i>Pseudemys rubriventris</i>	1	1	1	0	0	1	1	1	1	1	1	1	1	0
30058	Slider, yellowbellied	<i>Trachemys scripta</i>	1	1	1	0	1	1	1	1	1	1	1	0	0	0
30060	Turtle, eastern painted	<i>Chrysemys picta</i>	1	1	1	0	0	1	1	1	1	1	1	0	1	1
30062	Turtle, wood	<i>Clemmys insculpta</i>	0	0	1	1	0	0	0	0	0	0	0	1	1	1
30063	Turtle, spotted	<i>Clemmys guttata</i>	0	0	1	1	1	1	1	1	1	1	1	1	1	1
30068	Turtle, eastern box	<i>Terrapene carolina</i>	0	0	2	1	2	0	0	0	0	0	0	0	0	0
30077	Slider, red-eared	<i>Trachemys scripta</i>	1	1	1	0	0	1	1	1	1	1	1	0	0	0

Waterfowl

Num	Name	Scientific Name	L1UB	L2US	P0EM	P0FO	P0SS	P0UB	P0US	R1EM	R1UB	R1US	R2US	R3RS	R3US	RXXX
40001	Loon, common	<i>Gavia immer</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40008	Grebe, pied-billed	<i>Podilymbus podiceps</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40024	Cormorant, double-crested	<i>Phalacrocorax auritus</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40044	Swan, tundra	<i>Cygnus columbianus</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40049	Goose, lesser snow	<i>Chen caerulescens</i>	1	1	0	0	0	0	1	1	1	1	0	0	0	0
40053	Gadwall	<i>Anas strepera</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40054	Pintail, northern	<i>Anas acuta</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40056	Teal, green-winged	<i>Anas crecca</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40059	Wigeon, American	<i>Anas americana</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40060	Shoveler, northern	<i>Anas clypeata</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40062	Redhead	<i>Aythya americana</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40063	Duck, ring-necked	<i>Aythya collaris</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40064	Canvasback	<i>Aythya valisineria</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40065	Scaup, greater	<i>Aythya marila</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40066	Scaup, lesser	<i>Aythya affinis</i>	1	1	0	0	0	1	0	1	1	1	0	0	0	0
40067	Goldeneye, common	<i>Bucephala clangula</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40068	Bufflehead	<i>Bucephala albeola</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40069	Oldsquaw	<i>Clangula hyemalis</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40073	Scoter, white-winged	<i>Melanitta fusca</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40074	Scoter, surf	<i>Melanitta perspicillata</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40075	Scoter, black	<i>Melanitta nigra</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40076	Duck, ruddy	<i>Oxyura jamaicensis</i>	1	1	0	0	0	1	1	1	1	1	1	0	0	0
40078	Merganser, common	<i>Mergus merganser</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0
40079	Merganser, red-breasted	<i>Mergus serrator</i>	1	1	0	0	0	0	0	1	1	1	0	0	0	0

Appendix G. Species modeled by protection status. Status 1 = parklands; status 2 = all other land, mostly residential and commercial.

Amphibians

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
20004	Bullfrog	<i>Rana catesbeiana</i>	505	19.3	80.7
20006	Treefrog, Cope's gray	<i>Hyla chrysoscelis</i>	1105	19.9	80.1
20007	Treefrog, gray	<i>Hyla versicolor</i>	1070	19.3	80.7
20008	Frog, northern green	<i>Rana clamitans</i>	82	34.9	65.1
20009	Treefrog, green	<i>Hyla cinerea</i>	1361	16.8	83.2
20012	Frog, eastern cricket	<i>Acris crepitans</i>	23	9.8	90.2
20013	Frog, pickerel	<i>Rana palustris</i>	651	19.8	80.2
20016	Frog, southern leopard	<i>Rana sphenocephala</i>	2058	15.3	84.7
20018	Frog, southeastern chorus	<i>Pseudacris feriarum</i>	78	36.4	63.6
20019	Frog, wood	<i>Rana sylvatica</i>	1529	16.1	83.9
20029	Salamander, four-toed	<i>Hemidactylium scutatum</i>	703	25.1	74.9
20035	Salamander, marbled	<i>Ambystoma opacum</i>	712	24.9	75.1
20038	Salamander, northern dusky	<i>Desmognathus fuscus</i>	409	36.6	63.4
20043	Salamander, northern red-backed	<i>Plethodon cinereus</i>	703	25.1	74.9
20049	Salamander, spotted	<i>Ambystoma maculatum</i>	812	24.8	75.2
20051	Salamander, three-lined	<i>Eurycea guttolineata</i>	409	36.6	63.4
20053	Salamander, northern two-lined	<i>Eurycea bislineata</i>	205	48.0	52.0
20059	Toad, American	<i>Bufo americanus</i>	3760	10.9	89.1
20065	Newt, red-spotted	<i>Notophthalmus viridescens</i>	747	24.4	75.6
20069	Salamander, eastern mud	<i>Pseudotriton montanus</i>	172	52.6	47.4
20070	Salamander, northern red	<i>Pseudotriton ruber</i>	333	40.4	59.6
20071	Peeper, northern spring	<i>Pseudacris crucifer</i>	628	29.7	70.3
20080	Salamander, white-spotted slimy	<i>Plethodon cylindraceus</i>	1840	12.5	87.5

Reptiles

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
30002	Lizard, northern fence	<i>Sceloporus undulatus</i>	1978	12.6	87.4
30004	Skink, five-lined	<i>Eumeces fasciatus</i>	414	34.6	65.4
30005	Skink, southeastern five-lined	<i>Eumeces inexpectatus</i>	2054	14.4	85.6
30006	Skink, broadhead	<i>Eumeces laticeps</i>	1840	12.5	87.5
30007	Skink, little brown	<i>Scincella lateralis</i>	1915	14.5	85.5
30016	Copperhead, northern	<i>Agkistrodon contortrix</i>	2102	14.8	85.2
30018	Racer, northern black	<i>Coluber constrictor</i>	1978	12.6	87.4
30019	Snake, eastern worm	<i>Carphophis amoenus</i>	1915	14.5	85.5
30020	Snake, northern ringneck	<i>Diadophis punctatus</i>	1915	14.5	85.5
30022	Snake, corn	<i>Elaphe guttata</i>	2054	14.4	85.6
30023	Snake, black rat	<i>Elaphe obsoleta</i>	2054	14.4	85.6
30026	Kingsnake, eastern	<i>Lampropeltis getula</i>	2067	14.4	85.6
30027	Kingsnake, mole	<i>Lampropeltis calligaster</i>	1840	12.5	87.5
30029	Snake, eastern milk	<i>Lampropeltis triangulum</i>	1915	14.5	85.5
30033	Snake, queen	<i>Regina septemvittata</i>	1	69.2	30.8
30034	Snake, northern water	<i>Nerodia sipedon</i>	323	36.1	63.9
30038	Snake, rough green	<i>Opheodrys aestivus</i>	2422	13.7	86.3
30041	Snake, northern brown	<i>Storeria dekayi</i>	2422	13.7	86.3
30042	Snake, northern red-bellied	<i>Storeria occipitomaculata</i>	1928	14.5	85.5
30044	Snake, eastern garter	<i>Thamnophis sirtalis</i>	2637	14.1	85.9
30045	Snake, eastern ribbon	<i>Thamnophis sauritus</i>	65	38.8	61.2
30049	Earthsnake, eastern smooth	<i>Virginia valeriae</i>	2054	14.4	85.6
30050	Turtle, eastern snapping	<i>Chelydra serpentina</i>	178	22.2	77.8
30051	Turtle, eastern mud	<i>Kinosternon subrubrum</i>	209	48.4	51.6
30052	Turtle, eastern musk	<i>Sternotherus odoratus</i>	177	22.0	78.0
30057	Cooter, northern red-bellied	<i>Pseudemys rubriventris</i>	159	18.1	81.9
30058	Slider, yellowbellied	<i>Trachemys scripta</i>	160	17.9	82.1
30060	Turtle, eastern painted	<i>Chrysemys picta</i>	177	22.0	78.0
30062	Turtle, wood	<i>Clemmys insculpta</i>	169	52.6	47.4
30063	Turtle, spotted	<i>Clemmys guttata</i>	240	43.1	56.9
30068	Turtle, eastern box	<i>Terrapene carolina</i>	1915	14.5	85.5
30077	Slider, red-eared	<i>Trachemys scripta</i>	158	17.7	82.3

Mammals

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
50001	Opossum, Virginia	<i>Didelphis virginiana virginiana</i>	8998	6.9	93.1
50007	Shrew, southeastern	<i>Sorex longirostris longirostris</i>	4405	10.3	89.7
50013	Shrew, Kirtland's short-tailed	<i>Blarina brevicauda kirtlandi</i>	95	57.8	42.2
50017	Mole, eastern	<i>Scalopus aquaticus aquaticus</i>	4247	10.4	89.6
50019	Mole, star-nosed	<i>Condylura cristata cristata</i>	135	51.1	48.9
50028	Bat, big brown	<i>Eptesicus fuscus fuscus</i>	9092	6.8	93.2
50029	Bat, eastern red	<i>Lasiurus borealis borealis</i>	2997	11.1	88.9
50038	Raccoon	<i>Procyon lotor lotor</i>	7590	6.5	93.5
50042	Mink, common	<i>Mustela vison mink</i>	175	37.4	62.6
50047	Skunk, striped	<i>Mephitis mephitis nigra</i>	8998	6.9	93.1
50049	Fox, red	<i>Vulpes vulpes fulva</i>	1385	16.2	83.8
50050	Fox, eastern gray	<i>Urocyon cinereoargenteus .c</i>	1385	16.2	83.8
50054	Woodchuck	<i>Marmota monax monax</i>	594	13.5	86.5
50055	Chipmunk, Fisher's eastern	<i>Tamias striatus fisheri</i>	7399	6.7	93.3
50058	Squirrel, northern gray	<i>Sciurus carolinensis pennsylvanicus</i>	7399	6.7	93.3
50065	Squirrel, southern flying	<i>Glaucomys volans volans</i>	2176	13.7	86.3
50069	Beaver	<i>Castor canadensis</i>	178	34.1	65.9
50073	Mouse, northern white-footed	<i>Peromyscus leucopus noveboracensis</i>	2176	13.7	86.3
50082	Vole, meadow	<i>Microtus pennsylvanicus p</i>	1	31.3	68.8
50092	Muskrat, common	<i>Ondatra zibethicus zibethicus</i>	211	33.2	66.8
50095	Rat, Norway	<i>Rattus norvegicus norvegicus</i>	7249	3.2	96.8
50098	Mouse, house	<i>Mus musculus musculus</i>	7249	3.2	96.8
50099	Mouse, meadow jumping	<i>Zapus hudsonius americanus</i>	116	25.8	74.2
50103	Cottontail, eastern	<i>Sylvilagus floridanus mallurus</i>	8657	7.0	93.0
50108	Deer, white-tailed	<i>Odocoileus virginianus</i>	6413	7.8	92.2

Breeding Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
40028	Heron, green	<i>Butorides virescens</i>	239	32.2	67.8
40032	Egret, great	<i>Ardea alba</i>	300	34.4	65.6
40036	Night-heron, yellow-crowned	<i>Nyctanassa violacea</i>	171	42.5	57.5
40037	Bittern, least	<i>Ixobrychus exilis</i>	8	0.0	100.0
40038	Bittern, American	<i>Botaurus lentiginosus</i>	8	0.0	100.0
40095	Osprey	<i>Pandion haliaetus</i>	100	0.2	99.8
40112	Moorhen, common	<i>Gallinula chloropus</i>	8	0.0	100.0
40134	Sandpiper, spotted	<i>Actitis macularia</i>	82	2.4	97.6
40202	Cuckoo, yellow	<i>Coccyzus americanus</i>	1287	16.2	83.8
40214	Chuck-will's-widow	<i>Caprimulgus carolinensis</i>	1287	16.2	83.8
40215	Whip-poor-will	<i>Caprimulgus vociferus</i>	1287	16.2	83.8
40217	Swift, chimney	<i>Chaetura pelagica</i>	7249	3.2	96.8
40218	Hummingbird, ruby-throated	<i>Archilochus colubris</i>	1287	16.2	83.8
40229	Kingbird, eastern	<i>Tyrannus tyrannus</i>	382	16.2	83.8
40234	Flycatcher, great-crested	<i>Myiarchus crinitus</i>	2200	14.0	86.0
40239	Flycatcher, Acadian	<i>Empidonax virescens</i>	843	19.6	80.4
40240	Flycatcher, willow	<i>Empidonax traillii</i>	249	28.6	71.4
40243	Pewee, eastern	<i>Contopus virens</i>	2176	13.7	86.3
40246	Swallow, tree	<i>Tachycineta bicolor</i>	169	17.7	82.3
40248	Swallow, north	<i>Stelgidopteryx serripennis</i>	162	18.3	81.7
40249	Swallow, barn	<i>Hirundo rustica</i>	479	14.0	86.0
40251	Martin, purple	<i>Progne subis</i>	610	12.3	87.7
40272	Catbird, gray	<i>Dumetella carolinensis</i>	2422	13.7	86.3
40277	Thrush, wood	<i>Hylocichla mustelina</i>	1765	15.2	84.8
40281	Veery	<i>Catharus fuscescens</i>	752	14.8	85.2
40284	Gnatcatcher, blue-gray	<i>Poliophtila caerulea</i>	0	0.0	100.0
40295	Vireo, white-eyed	<i>Vireo griseus</i>	87	58.7	41.3
40297	Vireo, yellow-throated	<i>Vireo flavifrons</i>	300	40.1	59.9
40299	Vireo, red-eyed	<i>Vireo olivaceus</i>	1459	16.3	83.7
40301	Vireo, warbling	<i>Vireo gilvus</i>	9	14.1	85.9
40302	Warbler, black-and-white	<i>Mniotilta varia</i>	61	59.0	41.0
40303	Warbler, prothonotary	<i>Protonotaria citrea</i>	61	59.0	41.0
40305	Warbler, worm-eating	<i>Helmitheros vermivorus</i>	61	59.0	41.0
40312	Parula, northern	<i>Parula americana</i>	61	59.0	41.0
40313	Warbler, yellow	<i>Dendroica petechia</i>	382	33.1	66.9
40320	Warbler, cerulean	<i>Dendroica cerulea</i>	61	59.0	41.0

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
40322	Warbler, yellow-throated	<i>Dendroica dominica</i>	87	58.7	41.3
40326	Warbler, pine	<i>Dendroica pinus</i>	1287	16.2	83.8
40330	Ovenbird	<i>Seiurus aurocapillus</i>	1085	17.7	82.3
40332	Waterthrush, Louisiana	<i>Seiurus motacilla</i>	116	36.9	63.1
40333	Warbler, Kentucky	<i>Oporornis formosus</i>	0	0.0	100.0
40336	Yellowthroat,	<i>Geothlypis trichas</i>	12	6.8	93.2
40338	Warbler, hooded	<i>Wilsonia citrina</i>	1287	16.2	83.8
40341	Redstart, American	<i>Setophaga ruticilla</i>	61	59.0	41.0
40348	Oriole, Baltimore	<i>Icterus galbula</i>	1706	15.7	84.3
40355	Tanager, scarlet	<i>Piranga olivacea</i>	908	18.4	81.6
40360	Grosbeak, blue	<i>Guiraca caerulea</i>	382	16.2	83.8
40389	Sparrow, chipping	<i>Spizella passerina</i>	7399	6.7	93.3

Resident Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
40027	Heron, great blue	<i>Ardea herodias</i>	323	36.1	63.9
40035	Night-heron, black-crowned	<i>Nycticorax nycticorax</i>	103	15.5	84.5
40045	Goose, Canada	<i>Branta canadensis</i>	277	13.1	86.9
40051	Mallard	<i>Anas platyrhynchos</i>	129	16.2	83.8
40052	Duck, American black	<i>Anas rubripes</i>	200	32.5	67.5
40057	Teal, blue-winged	<i>Anas discors</i>	112	12.3	87.7
40061	Duck, wood	<i>Aix sponsa</i>	894	20.3	79.7
40077	Merganser, hooded	<i>Lophodytes cucullatus</i>	773	21.4	78.6
40080	Vulture, turkey	<i>Cathartes aura</i>	1915	14.5	85.5
40081	Vulture, black	<i>Coragyps atratus</i>	1915	14.5	85.5
40085	Hawk, sharp-shinned	<i>Accipiter striatus</i>	1287	16.2	83.8
40087	Hawk, red-tailed	<i>Buteo jamaicensis</i>	1915	14.5	85.5
40088	Hawk, red-shouldered	<i>Buteo lineatus</i>	0	0.0	100.0
40093	Eagle, bald	<i>Haliaeetus leucocephalus</i>	106	0.2	99.8
40098	Kestrel, American	<i>Falco sparverius</i>	382	16.2	83.8
40100	Bobwhite, northern	<i>Colinus virginianus</i>	1287	16.2	83.8
40102	Turkey, wild	<i>Meleagris gallopavo</i>	1287	16.2	83.8
40105	Rail, king	<i>Rallus elegans</i>	8	0.0	100.0
40107	Rail, Virginia	<i>Rallus limicola</i>	8	0.0	100.0
40113	Coot, American	<i>Fulica americana</i>	140	11.8	88.2
40119	Killdeer	<i>Charadrius vociferus</i>	392	15.9	84.1
40140	Woodcock, American	<i>Scolopax minor</i>	1287	16.2	83.8
40173	Gull, laughing	<i>Larus atricilla</i>	113	9.3	90.7
40197	Dove, rock	<i>Columba livia</i>	8657	4.1	95.9
40198	Dove, mourning	<i>Zenaida macroura</i>	6171	4.2	95.8
40205	Screech-owl, eastern	<i>Otus asio</i>	1287	16.2	83.8
40206	Owl, great horned	<i>Bubo virginianus</i>	2176	13.7	86.3
40209	Owl, barred	<i>Strix varia</i>	2176	13.7	86.3
40220	Kingfisher, belted	<i>Ceryle alcyon</i>	599	29.9	70.1
40221	Flicker, northern	<i>Colaptes auratus</i>	1287	16.2	83.8
40222	Woodpecker, pileated	<i>Dryocopus pileatus</i>	313	15.3	84.7
40223	Woodpecker, red-bellied	<i>Melanerpes carolinus</i>	2176	13.7	86.3
40226	Woodpecker, hairy	<i>Picoides villosus</i>	1081	17.7	82.3
40227	Woodpecker, downy	<i>Picoides pubescens</i>	2422	13.7	86.3
40236	Phoebe, eastern	<i>Sayornis phoebe</i>	382	16.2	83.8
40252	Jay, blue	<i>Cyanocitta cristata</i>	2422	13.7	86.3

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
40255	Crow, American	<i>Corvus brachyrhynchos</i>	1916	14.5	85.5
40256	Crow, fish	<i>Corvus ossifragus</i>	252	10.4	89.6
40258	Chickadee, Carolina	<i>Poecile carolinensis</i>	7399	6.7	93.3
40260	Titmouse, tufted	<i>Baeolophus bicolor</i>	7399	6.7	93.3
40261	Nuthatch, white-breasted	<i>Sitta carolinensis</i>	1388	15.6	84.4
40265	Wren, house	<i>Troglodytes aedon</i>	2422	13.7	86.3
40268	Wren, Carolina	<i>Thryothorus ludovicianus</i>	2422	13.7	86.3
40269	Wren, marsh	<i>Cistothorus palustris</i>	10	3.4	96.6
40271	Mockingbird, northern	<i>Mimus polyglottos</i>	6171	4.2	95.8
40273	Thrasher, brown	<i>Toxostoma rufum</i>	2422	13.7	86.3
40275	Robin, American	<i>Turdus migratorius</i>	8657	7.0	93.0
40282	Bluebird, eastern	<i>Sialia sialis</i>	382	16.2	83.8
40290	Waxwing, cedar	<i>Bombycilla cedrorum</i>	2422	13.7	86.3
40294	Starling, European	<i>Sturnus vulgaris</i>	8657	4.1	95.9
40342	Sparrow, house	<i>Passer domesticus</i>	8657	4.1	95.9
40344	Meadowlark, eastern	<i>Sturnella magna</i>	382	16.2	83.8
40346	Blackbird, red-winged	<i>Agelaius phoeniceus</i>	12	6.8	93.2
40352	Grackle, common	<i>Quiscalus quiscula</i>	2178	13.7	86.3
40353	Cowbird, brown-headed	<i>Molothrus ater</i>	8998	6.9	93.1
40357	Cardinal, northern	<i>Cardinalis cardinalis</i>	7590	6.5	93.5
40367	Finch, house	<i>Carpodacus mexicanus</i>	4593	3.6	96.4
40375	Towhee, eastern	<i>Pipilo erythrophthalmus</i>	2422	13.7	86.3
40397	Sparrow, swamp	<i>Melospiza georgiana</i>	12	6.8	93.2
40398	Sparrow, song	<i>Melospiza melodia</i>	4593	3.6	96.4

Wintering Birds

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
40141	Snipe, common	<i>Gallinago gallinago</i>	6	0.0	100.0
40165	Gull, great black-backed	<i>Larus marinus</i>	107	9.4	90.6
40166	Gull, lesser black-backed	<i>Larus fuscus</i>	107	9.4	90.6
40167	Gull, herring	<i>Larus argentatus</i>	107	9.4	90.6
40170	Gull, ring-billed	<i>Larus delawarensis</i>	107	9.4	90.6
40175	Gull, Bonaparte's	<i>Larus philadelphia</i>	107	9.4	90.6
40213	Owl, northern saw-whet	<i>Aegolius acadicus</i>	1287	16.2	83.8
40225	Sapsucker, yellow-bellied	<i>Sphyrapicus varius</i>	2176	13.7	86.3
40262	Nuthatch, red-breasted	<i>Sitta canadensis</i>	2176	13.7	86.3
40264	Creepers, brown	<i>Certhia americana</i>	1287	16.2	83.8
40266	Wren, winter	<i>Troglodytes troglodytes</i>	1287	16.2	83.8
40278	Thrush, hermit	<i>Catharus guttatus</i>	1287	16.2	83.8
40285	Kinglet, golden-crowned	<i>Regulus satrapa</i>	1287	16.2	83.8
40286	Kinglet, ruby-crowned	<i>Regulus calendula</i>	1915	14.5	85.5
40287	Pipit, American	<i>Anthus rubescens</i>	181	20.1	79.9
40317	Warbler, yellow-rumped	<i>Dendroica coronata</i>	2422	13.7	86.3

Waterfowl

<u>Num</u>	<u>Common Name</u>	<u>Scientific Name</u>	<u>Area (ha)</u>	<u>% Status 1</u>	<u>% Status 2</u>
40001	Loon, common	<i>Gavia immer</i>	87	10.0	90.0
40008	Grebe, pied-billed	<i>Podilymbus podiceps</i>	106	10.7	89.3
40024	Cormorant, double-crested	<i>Phalacrocorax auritus</i>	106	10.7	89.3
40044	Swan, tundra	<i>Cygnus columbianus</i>	87	10.0	90.0
40049	Goose, lesser snow	<i>Chen caerulescens</i>	87	10.0	90.0
40053	Gadwall	<i>Anas strepera</i>	106	10.7	89.3
40054	Pintail, northern	<i>Anas acuta</i>	106	10.7	89.3
40056	Teal, green-winged	<i>Anas crecca</i>	106	10.7	89.3
40059	Wigeon, American	<i>Anas americana</i>	106	10.7	89.3
40060	Shoveler, northern	<i>Anas clypeata</i>	106	10.7	89.3
40062	Redhead	<i>Aythya americana</i>	87	10.0	90.0
40063	Duck, ring-necked	<i>Aythya collaris</i>	87	10.0	90.0
40064	Canvasback	<i>Aythya valisineria</i>	87	10.0	90.0
40065	Scaup, greater	<i>Aythya marila</i>	87	10.0	90.0
40066	Scaup, lesser	<i>Aythya affinis</i>	104	10.8	89.2
40067	Goldeneye, common	<i>Bucephala clangula</i>	87	10.0	90.0
40068	Bufflehead	<i>Bucephala albeola</i>	87	10.0	90.0
40069	Oldsquaw	<i>Clangula hyemalis</i>	87	10.0	90.0
40073	Scoter, white-winged	<i>Melanitta fusca</i>	87	10.0	90.0
40074	Scoter, surf	<i>Melanitta perspicillata</i>	87	10.0	90.0
40075	Scoter, black	<i>Melanitta nigra</i>	87	10.0	90.0
40076	Duck, ruddy	<i>Oxyura jamaicensis</i>	106	10.7	89.3
40078	Merganser, common	<i>Mergus merganser</i>	87	10.0	90.0
40079	Merganser, red-breasted	<i>Mergus serrator</i>	83	10.5	89.5