Appendix C. Detailed Methods for Individual Landscape-level Models

Indiana Department of Natural Resources

Outline

A. Introduction

Landscape-level models (Chapter VIII) were used to objectively quantify current habitat conditions for wildlife in Indiana using GIS analysis.

The parameters built into the models included many different aspects of landscape composition and configuration – for example, how habitat cover types were interspersed, habitat patch sizes/degree of fragmentation, distance from one habitat feature to another, or density of roads or developed areas. The number and types of parameters used varied with each species (see below).

The models were set up to calculate individual suitability indices (SIs), which are denoted SI_1, SI_2, SI_3, etc. Each SI represented one parameter of habitat quality as it pertained to the focal species: for example, density of developed areas. Each SI produced a calculated value of relative habitat quality for the focal species ranging from 0 (unsuitable) to 1 (perfectly suitable) for each 30×30 m cell (i.e., map pixel) in a planning region. SIs were then combined in a final equation (habitat suitability index, or HSI), frequently using a geometric mean, to determine overall habitat quality given the values of each individual SI for each cell. To calculate the SIs, a variety of patch-definition and distance algorithms were used, depending on the requirements of the focal species. Frequently, a moving-window analysis was used to assess the proportion of different habitat requisites within a defined area (usually the species' average home range), and those proportions were compared to what was believed to be the ideal interspersion of habitat types and resources. In this way, these models took into account that habitat suitability of a species is a function of multiple cover types, and not simply an association with one cover type, as was a common assumption in the 2005 SWAP. These models incorporated spatial context into wildlife-habitat relationships.

Input Data

All of the models were built and run with the NLCD 2011 land cover data (Jin et al. 2013), and in a few cases (noted below), the Indiana GAP land cover data (US Geological Survey 2011). For some species, landscape-level models had already been published (references are noted below), and we used modified versions of these 'off-the-shelf' models applied to Indiana landscapes. The input data used in the published models varied, and many times, the input layers used to produce the published models were not readily accessible. Therefore, the published models were simplified to accommodate the data that was available and most useful for describing habitat conditions for the SWAP (land cover data). For species without published models, we developed models 'from scratch,' basing them on summaries of species' habitat requirements in published literature.

Model Results

After running a model (i.e., 1 species in 1 planning region), each cell contained in the region was assigned a particular value of habitat quality ranging from 0 to 1 (see maps in Regional Chapters). Because the models were landscape-level and did not necessarily take into account all possible local details that make a habitat of high or low quality for a species, they are not intended to serve as predictors of a species presence; although, they can give some overview of potential hotspot areas. For the purposes of the SWAP, when all the species in a region were taken together, they gave a good objective measure of current habitat condition. The original intent was to run the models with future conditions – alternative landscape scenarios that would be based on the outcome of different combinations of conservation actions, but as described in Chapter VIII, this endeavor was, at present, too abstract a question to be useful. We also considered running the models with landscapes simulated every decade out to 2050 by Tayyebi et al. (2013), which we would have used to represent a landscape of "no action" and a baseline against which to compare the alternative action scenarios. These maps simulate urban expansion in the US over the next 50 years, but not overall land use change, so their utility on their own for purposes of the SWAP may be limited.

Models were built for 14 representative species, and methods for each are detailed below. A total of 38 models were run, with six-seven species representing each region (a species could represent more than one region).

B. Species with Published Models

Northern Bobwhite

We used a habitat suitability model for the Northern Bobwhite published in Rittenhouse et al. (2007). The model was implemented exactly as described because there were no differences in available input data between their model and ours (only NLCD land cover data was used). Elements of the Northern Bobwhite habitat suitability model included the relative values of grassland, cropland, and woody edge as habitat, and the interspersion of these habitats.

<u>Suitability Indices</u>

- SI_1 – The first suitability index was used to identify grassland habitat, which would be used by bobwhites for nest sites, cover, and food. We evaluated land cover type in each cell and set $SI_1 = 0.50$ if the land cover type was grassland/herbaceous or hay/pasture and $SI_1 = 0.00$ otherwise using the Reclassify tool.

- SI_2 – The second suitability index was used to identify agricultural food sources. We evaluated land cover type in each cell and set $SI_2 = 0.40$ if land cover type was cultivated crops and $SI_2 = 0.00$ otherwise, using the Reclassify tool.

- SI_3 – The third suitability index was used to identify woody edges adjacent to grassland or agricultural habitat, which are often used for escape cover. We used a 60 m moving window to identify forest or shrubland within 30 m of grassland or agricultural land. This was accomplished by first identifying grassland and cropland as in the steps above. Then, we used the Focal Statistics tool to sum all grassland or cropland cells within a circle with a 2-cell (60-m) radius, using a moving window. If the center pixel in the moving window contained forest (deciduous, evergreen, and mixed forest) or shrubland, and the remaining cells contained either grassland or agricultural land, we set $SI_3 = 0.30$ for the center pixel. Otherwise, we set $SI_3 = 0.00$.

- SI_4 – The fourth suitability index was used to evaluate interspersion of grassland, cropland, and woody edge. We evaluated the proportion of grassland, cropland, and woody edge using a moving window with a 360 m radius (~40.7 ha, the maximum average bobwhite home range in this area). We evaluated the calculated interspersion of habitat types against "ideal" proportions: grassland = 0.22, cropland = 0.47, woody cover = 0.31. We set $SI_4 = 0.50$ if the observed proportion in the moving window equaled the ideal proportion. The SI value decreased toward 0 as a function of the difference between the observed proportion in the moving window and the ideal proportion: $SI_4 = 0.5 * ((1 - |\text{observed proportion grassland}-0.22|) * (1 - |\text{observed proportion cropland}-0.47|) * (1 - |\text{observed proportion woody cover}-0.31|))$.

- SI_5 – The fifth suitability index was used to zero out roads and urban areas (i.e., non-habitat) that were assigned a suitability value during calculations of SI_4. We set $SI_5 = 1.00$ for forest, shrubland, grassland, and cropland; otherwise, $SI_5 = 0.00$.

Overall HSI

The final habitat suitability value was the sum of (1) the maximum value of SI_1, SI_2, and SI_3 and (2) the product of SI_4 and SI_5: HSI = maximum (maximum (SI_1, SI_2), SI_3) + ($SI_4 \times SI_5$).

Henslow's Sparrow

We used a habitat suitability model for the Henslow's Sparrow published in Rittenhouse et al. (2007). The model was implemented exactly as described because there were no differences in available input data between their model and ours (only NLCD land cover data was used).

Elements of the Henslow's Sparrow habitat suitability model included the value of grasslands, grassland patch size requirements (a cell's value increased as patch size increased, with only patches ≥10 ha having a non-0 value), and the reduced value of grassland edges (grasslands within 30 m of edge were considered unsuitable).

Suitability Indices

- SI_1 – The first suitability index was used to identify grasslands as a breeding habitat. We set SI_1 = 1.00 if the land cover type was grassland/herbaceous or hay/pasture and SI_1 = 0.00 otherwise using the Reclassify tool.

- SI_2 – The second suitability index was used to address the Henslow's Sparrow's grassland area requirements (patch size). We calculated patch sizes of grasslands by first aggregating grassland cells into patches using the Region Group tool, then using Zonal Statistics to sum the number of cells contained in each of those patches and converting to ha. We assigned SI_2 = 0.01 for 10-ha patches, SI_2 = 0.50 for 55-ha patches, and SI_2 = 1.00 for 100-ha patches. Values for all other patches were fit using a sigmoid function: $SI_2 = 1.0090 / (1 + e^{(-1*(\text{patch size} - 55.1692)/9.5151))})$. SI_2 was assigned to all grassland cells (i.e., where SI_1 equaled 1) where patch size was >10 ha. For grassland patches ≤10 ha, SI_2 = 0.00.

- SI_3 – The third suitability index was used to reduce the value of grassland habitat adjacent to non-grassland habitat. We applied a moving window of 3×3 cells to grassland cells (i.e., where SI_1 equaled 1) using the Focal Statistics tool. The moving window assessed the land cover types within the window and assigned SI_3 = 0.00 to the center pixel if the window contained non-grassland habitat so that grassland immediately adjacent to edges would have no suitability value. Otherwise, the center pixel retained the value assigned in SI_1 (1.00).

Overall HSI

The final habitat suitability value was the geometric mean of SI_1 and SI_2, multiplied by SI_3 to impose the edge-sensitive penalty: HSI = $(\sqrt{SI_1 \times SI_2}) \times SI_3$.

Cerulean Warbler

We used a habitat suitability model for the Cerulean Warbler published in Rittenhouse et al. (2007). Because we did not have complete data on forest stand age, we modified the model so that the Indiana GAP land cover data could substitute for stand age data, with its more precise identification of early successional areas than the NLCD land cover data. We also did not have complete data on forest tree species composition, so we simplified the model to identify only deciduous and mixed forest cover rather than assigning values to various tree species.

Elements of the Cerulean Warbler habitat suitability model included identification of deciduous and mixed forest habitats, reduced value of early successional habitats relative to higher-quality mature forest habitats, and mature forest patch size (a cell's value increased as patch size increased).

Suitability Indices

- SI_1 – The first suitability index was used to identify a suitable breeding habitat. The published model identified specific tree species used for nesting; we simply identified deciduous and mixed forest cover as suitable for breeding. We set $SI_1 = 1.00$ if land cover type was deciduous forest or mixed forest, and $SI_1 = 0.00$ otherwise using the Reclassify tool.

- SI_2 – The second suitability index was used to identify mature forest within forest habitat identified in SI_1. The published model used a data layer of forest stand age and ecological land type, with values increasing as stand age increased. These layers were not available, so we used the Indiana GAP land cover data to identify and zero out early successional areas. First, we used the Reclassify tool to identify the following GAP land cover types: harvested-grass/forb, harvested-shrub, disturbed/successional-grass/forb, and disturbed/successional-shrub. We then combined this result with the output from SI_1 and set $SI_2 = 0.00$ if the breeding habitat identified in SI_1 was identified as an early successional area in SI_2. The remaining cells constituted areas of mature forest and were set $SI_2 = 1.00$.

- SI_3 – The third suitability index was used to address the Cerulean Warbler forest patch size requirements. We calculated patch sizes of mature forest by first aggregating mature forest cells into patches using the Region Group tool, then using Zonal Statistics to sum the number of cells contained in each of those patches and converting to ha. We assigned $SI_3 = 0.01$ for 100-ha patches, $SI_3 = 0.10$ for 700-ha patches, and $SI_3 = 1.00$ for patches ≥3000 ha. Values for all other patches were fit using a sigmoid function: $SI_3 = 1.002 / (1 + e^{(-1*(\text{patch size} - 1173.6472)/ 215.5805))})$. SI_3 was assigned to all mature forest cells (i.e., where SI_2 equaled 1) where patch size was ≥100 ha. For patches <100 ha, $SI_3 = 0.00$.

Overall HSI

The final habitat suitability value was the geometric mean of SI_2 and SI_3: $HSI = \sqrt{(SI_2 \times SI_3)}$.

American Woodcock

We used a habitat suitability model for the American Woodcock published in Rittenhouse et al. (2007). We simplified their model since we did not have complete data on tree species composition and forest stand age.

Elements of the American Woodcock habitat suitability model included the identification of habitats for diurnal cover, nesting, brood rearing, roosting, and display, as well as the interspersion of these habitats.

Suitability Indices

- SI_1 – The first suitability index was used to identify land cover types suitable for nest sites and diurnal cover. The published model used forest species composition data to identify these areas. Because we did not have this data, we simply identified cover as suitable for nest sites and diurnal cover. We set $SI_1 = 1.00$ if land cover type was deciduous forest, mixed forest, or shrubland, and SI_1 = 0.00 otherwise using the Reclassify tool on the NLCD data.

- SI_2 – The second suitability index was used to identify early successional areas for nest sites and brood-rearing habitat. The published model used forest stand age and ecological land type to identify these areas, with quality decreasing as stand age increased. Because we did not have this data, we substituted the Indiana GAP land cover data. We used the Reclassify tool to identify the following land cover types: harvested-shrub and disturbed/successional-shrub. We set SI_2 = 1.00 if the cell contained these cover types, otherwise SI_2 = 0.00.

- SI_3 – The third suitability index was used to identify open areas suitable for display and roosting. The published used forest stand age and ecological land type data, but we substituted the Indiana GAP land cover data. We used the Reclassify tool to identify the following land cover types: central tallgrass prairie, disturbed/successional-grass/forb, harvested-grass/forb, north-central interior sand/gravel tallgrass prairie, pasture/hay, and recently burned shrubland. We set SI_3 = 1.00 if the cell contained these cover types, otherwise SI_3 = 0.00.

- SI_4 – The fourth suitability index was used to evaluate the interspersion of nesting/foraging habitats and display habitats. We evaluated the proportion of early successional habitats (SI_2) and open habitats (SI_3) using a moving window with a 200-m radius (corresponds to the median distance between diurnal sites and singing grounds and average total home range size). The ideal proportions cited by Rittenhouse et al. (2007) were approximately 0.8 nesting/foraging habitat (early successional/forest) to 0.2 display habitat (open). The calculated proportions of these habitats were evaluated against the ideal proportions. We set SI_4 = 1.00 if the observed proportion in the moving window equaled the ideal proportion. The SI value declined toward 0 as a function of the difference between the observed proportion in the moving window and the ideal proportion: $SI_4 = 1.00 * ((1 - |\text{observed proportion early successional}-0.8|) * (1 - |\text{observed proportion open habitat}-0.2|))$.

<u>Overall HSI</u>

We added together SI_1, SI_2, and SI_3 to identify all potential suitable habitats and re-assigned all cells where habitats were present to a value of 1. The final habitat suitability value was the geometric mean of the resulting layer and SI_4: $HSI = \sqrt{(SI_{123} \times SI_4)}$.

Eastern Red Bat

We used a habitat suitability model for the Eastern Red Bat published in Larson et al. (2003). We simplified the published model where necessary to make up for the lack of forest stand age and ecological land type data. We also added a habitat interspersion variable because the simplified model was overly simplistic and unrealistic.

Elements of the red bat habitat suitability model included the identification of roosting habitats and foraging habitats, the distance to surface water from roosting habitats (value decreased as distance to surface water increased), and the interspersion of roosting habitats (forest) and foraging habitats (forest edges).

<u>Suitability Indices</u>

- SI_1 – The first suitability index was used to identify roosting habitats for red bats (forested habitats). We used the Reclassify tool on the NLCD data layer to set SI_1 = 1.00 if land cover type was deciduous forest, evergreen forest, or mixed forest, otherwise, SI_1 = 0.00.

- SI_2 – The second suitability index was used to identify foraging habitats for red bats (forest edges). We used the Focal Statistics tool on the resulting SI_1 layer to identify forest edges using a 3×3 cell rectangular moving window. We set SI_2 = 1.00 if the cell contained forest edge habitat, otherwise, SI_2 = 0.00.

- SI_3 – The third suitability index was used to evaluate the distance from the roosting habitat to surface water, and increase the value of roosting habitats closest to surface water. To accomplish this, we first identified surface water, including wetlands, using the Reclassify tool on the NLCD data layer (open water, woody wetlands, and emergent herbaceous wetlands). We then used the Euclidean Distance tool to determine the distance from every cell to the nearest surface water and converting to km. We took a subset of the resulting layer to create a new layer that contained only the distance from the roosting habitat (i.e., where SI_1 = 1.00) to surface water. Following the citations in Larson et al. (2003), we set SI_3 = 1.00 where the distance to surface water was <0.75 km and SI_3 = 0.00 where the distance was >1.5 km. To assign value to cells >0.75 km but <1.5 km from surface water, we applied an equation derived from Larson et al. (2003, Figure 24): $SI_3 = (-1.333 \times \text{distance}) + 2$.

- SI_4 – The fourth suitability index was used to evaluate the interspersion of roosting and foraging habitats. We evaluated the proportion of roosting habitats (SI_1) and foraging habitats (SI_2) using a moving window with a 16-cell radius (corresponds to average home range size in this region; Walters et al. 2007). We set the ideal proportions of roosting to foraging habitat at 0.7:0.3. The calculated proportions of these habitats were evaluated against the ideal proportions. We set SI_4 = 1.00 if the observed proportion in the moving window equaled the ideal proportion. The SI value decreased toward 0 as a function of the difference between the observed proportion in the moving window and the ideal proportion: $SI_4 = 1.00 * ((1 - |\text{observed proportion forest}-0.7|) * (1 - |\text{observed proportion forest edge}-0.3|))$.

Overall HSI

The final habitat suitability value was the geometric mean of SI_3 and SI_4: $HSI = \sqrt{(SI_3 \times SI_4)}$.

Prairie Warbler

We used a habitat suitability model for the Prairie Warbler published in Larson et al. (2003). We simplified the model because data layers were not available for forest stand age.
Elements of the Prairie Warbler habitat suitability model included the relative value of forest and early successional habitats, habitat patch size (value increased as patch size increased), and the reduced value of habitat edges for nesting.

Suitability Indices

- SI_1 – The first suitability index was used to define and assign value to suitable habitat patches. We used the Reclassify tool on the NLCD data layer to identify suitable habitats. We set SI_1 = 1.00 if the cell was classified as shrubland, SI_1 = 0.30 if the cell was deciduous forest, evergreen forest, or mixed forest, otherwise, SI_1 = 0.00. We also used the Indiana GAP data to identify early successional habitats. We set SI_1 = 1.00 if the cell was classified as harvested-shrub or disturbed/successional-shrub. We then combined the results from NLCD and GAP.

- SI_2 – The second suitability index was used to address Prairie Warbler habitat patch size requirements. We calculated patch sizes of habitat (forest, shrub, and early successional) by first aggregating habitat cells into patches using the Region Group tool, then using Zonal Statistics to sum the number of cells contained in the each of those patches and converting to ha. We assigned SI_2 = 1.00 for patches >3.51 ha and SI_2 = 0.00 for patches <0.36 ha. For patches <3.51 ha but >0.36 ha, we applied the equation $SI_2 = (0.32 \times \text{patch size}) - 0.13$ (Larson et al. 2003; Figure 11). SI_2 was assigned to all cells containing suitable habitat (i.e., where $SI_1>0$).

- SI_3 – The third suitability index was used to reduce the value of forest edges, as habitat quality for Prairie Warblers may be lower near edges, where they avoid nesting. First, we identified habitat edges using the Focal Statistics tool with a 3×3-cell rectangular moving window. We set SI_3 = 1.00 for habitat interior and SI_3 = 0.50 for habitat edges; otherwise, SI_3 = 0.00.

Overall HSI

The final habitat suitability value was the geometric mean of SI_1 and SI_2, multiplied by SI_3 to apply the edge-sensitive penalty: $HSI = (\sqrt{(SI_1 \times SI_2)}) \times SI_3$.

Ruffed Grouse

We used a habitat suitability model for the Ruffed Grouse published in Rittenhouse et al. (2007). We simplified the published model since GIS data was not available for mast production, forest stand age, or ecological land type.

Elements of the Ruffed Grouse habitat suitability model included the value of early successional and deciduous forest habitats, patch size of early successional habitats, minimum habitat area requirements, and interspersion of early successional and deciduous forest habitats.

Suitability Indices

- SI_1 – The first suitability index was used to identify suitable habitat for Ruffed Grouse. Grouse are associated with early successional habitats and forage for mast in deciduous forests. We used the Reclassify tool on the Indiana GAP land cover data to identify early successional habitats. We set SI_1 = 1.00 if the cell contained harvested-shrub or disturbed/successional-shrub. We also used the Reclassify tool on the NLCD land cover data to identify deciduous forest. We set SI_1 = 1.00 if the cell contained deciduous forest. The combination of the resulting layers from GAP and NLCD constituted SI_1, otherwise, SI_1 = 0.00.

- SI_2 – The second suitability index was used to address patch size requirements for early successional habitats. We calculated patch size of early successional habitats by first aggregating early successional cells (identified in SI_1) into patches using the Region Group tool, then using Zonal Statistics to sum the number of cells contained in each of those patches and converting to ha. We assigned SI_2 = 1.00 for patches >4 ha. For patches <4 ha, we applied the equation SI_2 = patch size / 4.

- SI_3 – The third suitability index was used to address the minimum forest area requirement for Ruffed Grouse. This included the combination of early successional habitats and surrounding deciduous forest (i.e., where $SI_1 = 1.00$). We calculated patch size of forest habitats by first aggregating habitat cells into patches using the Region Group tool, then using Zonal Statistics to sum the number of cells contained in each of those patches and converting to ha. We assigned $SI_3 = 0.00$ for patches ≤100 ha. For patches >100 ha, we applied a sigmoid function: $SI_3 = 1.000 / (1 + e^{(-1*(\text{patch size} - 277.118)/24.6569))})$ so that SI_3 for patches >400ha was assigned an approximate value of 1.

- SI_4 – The fourth suitability index was used to evaluate the interspersion of early successional and forest habitats. We evaluated the proportion of early successional habitats and deciduous forest habitats (identified in SI_1) using a moving window with a 6-cell radius (corresponding to average home range size of Ruffed Grouse). We set the ideal proportions of early successional and forest habitats to 0.4:0.6. The calculated proportions of these habitats were evaluated against the ideal proportions. We set SI_4 = 1.00 if the observed proportion in the moving window equaled the ideal proportion. The SI value decreased toward 0 as a function of the difference between the observed proportion in the moving window and the ideal proportion: $SI_4 = 1.00 * ((1 - |\text{observed proportion early successional}-0.4|) * (1 - |\text{observed proportion forest}-0.6|))$.

<u>Overall HSI</u>
The final habitat suitability value was the geometric mean of SI_2 and SI_4, multiplied by SI_3: $HSI = (\sqrt{(SI_2 \times SI_4)}) \times SI_3$.

Timber Rattlesnake

We used a habitat suitability model for the Timber Rattlesnake published in Rittenhouse et al. (2007). We simplified the model for use with only land cover data, as data layers for forest stand age, ecological land type, and den locations were not available.

Elements of the Timber Rattlesnake habitat suitability model included the identification of early successional and deciduous forest habitats, the interspersion of these habitat types, and the distance to roads (with habitat quality increasing as the distance from the nearest road increased).

<u>Suitability Indices</u>

- SI_1 – The first suitability index was used to identify suitable habitat for the Timber Rattlesnake. First, we used the Reclassify tool on the Indiana GAP land cover data layer to identify early successional habitats used for foraging and basking. We set $SI_1 = 1.00$ if the cell contained harvested-shrub or disturbed/successional-shrub. We also used the Reclassify tool on the NLCD land cover data layer to identify deciduous forests, which contain large coarse woody debris used by rattlesnakes. We set $SI_1 = 1.00$ if the cell contained deciduous forest. The combined results of these two layers constituted SI_1, otherwise, $SI_1 = 0.00$.

- SI_2 – The second suitability index was used to evaluate interspersion of early successional habitats and deciduous forest habitats. We used the Focal Statistics tool to evaluate the proportion of early successional habitat and deciduous forest habitat (identified in SI_1) using a moving window with a 28-cell (850-m) radius (corresponding to the maximum average home range size of Timber Rattlesnakes). The ideal proportions of early successional and forest habitats were set to 0.15:0.85. The calculated proportions of these habitats were evaluated against the ideal proportions. We set SI_2 = 1.00 if the observed proportion in the moving window equaled the ideal proportion. The SI value decreased toward 0 as a function of the difference between the observed proportion in the moving window and the ideal proportion: SI_2 = 1.00 * ((1 - |observed proportion early successional-0.15|) * (1 - |observed proportion forest-0.85|)).

- SI_3 – The third suitability index was used to reduce the value of habitats closest to roads and developed areas. First, we used the Reclassify tool on the NLCD land cover data layer to identify roads and developed lands (developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity). We then used the Euclidean Distance tool to determine the distance from all cells to the nearest developed lands and converted to km. We took a subset of the resulting layer to create a new layer that contained only the distance from habitats (i.e., where SI_1 = 1.00) to developed lands. Following the citations in Rittenhouse et al. (2007), we set SI_3 = 1.00 for habitat cells >100 m from developed lands. For habitat cells <100 m from developed lands, we applied the equation SI_3 = distance to road / 100.

<u>Overall HSI</u>
The final habitat suitability value was the product of SI_2 and SI_3, with SI_3 applying the road-sensitive penalty to the suitable habitat types identified in SI_1 and SI_2: HSI = $SI_2 \times SI_3$.

Red-headed Woodpecker

We used a habitat suitability model for the Red-headed Woodpecker published in Tirpak et al. (2009). We simplified the model to account for the fact that data layers for standing snag density and timber tree density were not available.

Elements of the Red-headed Woodpecker habitat suitability model included the relative value of land cover types that constituted suitable habitats, and the increased value of habitats that included transitions between habitats and open areas.

<u>Suitability Indices</u>

- SI_1 – The first suitability index was used to assign relative habitat quality values to land cover types that constitute suitable habitats for Red-headed Woodpeckers. We used the Reclassify tool on the NLCD land cover data layer and set SI_1 = 1.00 for evergreen forest, mixed forest, and woody wetlands, SI_1 = 0.75 for deciduous forest, and SI_1 = 0.25 for shrubland, otherwise SI_1 = 0.00.

- SI_2 – The second suitability index was used to increase the value of habitat edges (where habitats transitioned to open areas), since Red-headed Woodpeckers breed in relatively open habitats with widely spaced trees near openings. We used the Focal Statistics tool with a 7×7-cell rectangular moving window to identify edges of habitats identified in SI_1 (i.e., wherever SI_1>0). We set SI_2 = 1.00 wherever edge occurred within the moving window, otherwise, SI_2 = 0.10 (for non-habitat, SI_2 = 0.00).

<u>Overall HSI</u>
The final habitat suitability value was the product of SI_1 (relative value of cover types) and SI_2 (increased value of habitat near open areas): HSI = $SI_1 \times SI_2$.

C. Species without Published Models

Northern Leopard Frog

We constructed a habitat suitability model for the Northern Leopard Frog based on the following publications: Stevens et al. 2010, EPA Northern Leopard Frog Species Profile (and citations therein), UNH Extension Northern Leopard Frog Species Profile (and citations therein). Elements of the Northern Leopard Frog habitat suitability model included the identification of wetland and water-edge habitats, the identification of grassland habitats, the relative value of grassland habitats based on the distance to wetland habitats, and the decreased value of habitats in areas with high road density.

Suitability Indices

- SI_1 – The first suitability index was used to identify suitable wetland habitats for the Northern Leopard Frog. First, we used the Reclassify tool on the NLCD land cover data layer to identify wetland habitats (woody wetlands and emergent herbaceous wetlands). Northern Leopard Frogs may also use the edges of open water. We again used the Reclassify tool to identify open water. We then used the Focal Statistics tool with a 4×4-cell moving window on the resulting layer to identify open water edges. The combination of these two results constituted SI_1. If a cell contained wetlands or open water edges, $SI_1 = 1.00$, otherwise, $SI_1 = 0.00$.

- SI_2 – The second suitability index was used to increase the value of water habitats in close proximity to grasslands, since Northern Leopard Frogs will only travel up to 2 km from water to grassland/shrubland habitats. We used the Euclidean Distance tool to determine the distance from each cell to the nearest wetland habitat (identified in SI_1) and converted to km. We then identified grassland habitats using the Reclassify tool on the NLCD land cover data layer (grassland/herbaceous, hay/pasture, and shrubland). We took a subset of the resulting layer to create a new layer that contained only the distance from grassland habitats to wetlands. We set $SI_2 = 0.00$ for any grassland cells >2 km from wetlands. For grassland cells <2 km from wetlands, we applied the equation $SI_2 = (-0.5 \times \text{distance}) + 1$, so the value of the cell would increase as distance to wetland decreased.

- SI_3 – The third suitability index was used to decrease the value of habitats near areas with a high density of roads and developed lands, since Northern Leopard Frogs are sensitive to road mortality. We used the Reclassify tool on the NLCD land cover data layer to identify roads and developed lands (developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity). We determined the density of developed lands within a 50-cell radius circular moving window (based on maximum average distance travelled by leopard frogs) using the Focal Statistics tool. We applied the following equation (based on the maximum possible density of developed lands within the moving window) to habitat cells (i.e., wetlands and grasslands <2 km from wetlands identified in SI_1 and SI_2): $SI_3 = (-0.000127 \times \text{density}) + 1$, so the value of habitat cells with increasing densities of developed lands surrounding them was decreased.

Overall HSI

The final habitat suitability value was the geometric mean of (1) the combination of SI_1 (wetland habitats) and SI_2 (grassland habitats based on distance to wetlands) and (2) SI_3 (road-sensitive penalty): $HSI = \sqrt{(SI_1 + SI_2) \times SI_3}$.

Copper-bellied Water Snake

We constructed a habitat suitability model for the Copper-bellied Water Snake based on the following publications: Roe et al. (2004), Roe et al. (2006), Attum et al. (2007), Attum et al. (2009), and Center for Reptile and Amphibian Conservation and Management report– Copper-bellied Water Snake: Identification, Status, Ecology, and Conservation in the Midwest (and citations therein).

Elements of the Copper-bellied Water Snake habitat suitability model included the identification of wetland and upland habitats, the density of roads and developed areas (habitat quality decreased as road density increased), the density of vegetative buffers around wetlands (wetland habitat quality increased as upland habitat density increased), and the complexity of wetland mosaic habitat (the quality of habitat increased as the number of wetlands within the copper-belly's home range increased).

Suitability Indices

- SI_1 – The first suitability index was used to identify both wetland and upland habitat for the Copper-bellied Water Snake. For wetland habitats, we identified woody wetlands and emergent herbaceous wetlands in the NLCD land cover data. Copper-bellies may also use open water edges, so we identified open water in the NLCD land cover data and then used the Focal Statistics tool with a 3×3-cell rectangular moving window to identify edges of open water habitats. These two results were combined to define wetland habitats. For upland habitats, we identified shrubland in the NLCD data. Copper-bellies may also use forest edges or forest-field margins, so we identified forests (deciduous forest, evergreen forest, and mixed forest) in the NLCD data and then used the Focal Statistics tool with a 3×3-cell moving window to identify edges of forest habitats. These two results were combined to define upland habitat. We set $SI_1 = 1.00$ for any cell containing wetland or upland habitat, otherwise, $SI_1 = 0.00$.

- SI_2 – The second suitability index was used to decrease the value of habitats in areas with high densities of roads and developed lands, since copper-bellies are sensitive to road mortality, especially when roads bisect their travel routes between wetlands. First, we identified roads and developed lands using the Reclassify tool on the NLCD land cover data layer (developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity). We determined the density of developed lands within a 20-cell radius moving window (based on maximum average distance travelled by copper-bellies) using the Focal Statistics tool. We applied the following equation (based on the maximum possible density of developed lands within the moving window) to habitat cells (i.e., wetlands and uplands identified in SI_1): $SI_2 = (-0.000796 \times \text{developed density}) + 1$, so the value of habitat cells with increasing densities of developed lands surrounding them was decreased.

- SI_3 – The third suitability index was used to increase the value of wetland habitats in areas with high density of upland habitats since the most important habitat feature for copper-bellies is the presence of wetland complexes/mosaics in the landscape, and adequate vegetative buffers are needed around wetlands, with higher densities of vegetative buffers yielding higher-quality wetland habitat. We determined the density of upland habitats (identified in SI_1) within a 20-cell radius circular moving window using the Focal Statistics tool. We applied the following equation (based on the maximum possible density of upland habitats within the moving window) to habitat cells (i.e., wetlands and uplands identified in SI_1): $SI_2 = (0.000796 \times \text{upland density})$, so that the value of habitat cells with increasing densities of upland habitats surrounding them were increased.

- SI_4 – The fourth suitability index was used to increase the value of more "complex" wetland areas, since copper-bellies regularly move between 3-5 wetlands over the course of their active season. First, we aggregated wetland habitats into patches using the Region Group tool. Then, we counted the number of wetland patches within a 20-cell radius circular moving window using the Focal Statistics tool (output: 'Variety', rather than the usual 'Sum'). We then set the suitability value of SI_4 for each cell identified as a habitat in SI_1 based on the number of wetlands within the moving window: for 1 patch, SI_4= 0.00, 2 patches = 0.25, 3 patches = 0.50, 4 patches = 0.75, >4 patches = 1.00.

Overall HSI

The final habitat suitability value was the geometric mean of (1) the maximum of SI_2 (density of roads) and SI_3 (density of upland habitats) and (2) SI_4 (complexity of wetland mosaic): $HSI = \sqrt{(\max(SI_2, SI_3)) \times SI_4}$.

Eastern Box Turtle

We constructed a habitat suitability model for the Eastern Box Turtle based on the following publications: Williams and Parker 1987, Donaldson & Echternacht 2005, Luensmann 2006.

Elements of the Eastern Box Turtle habitat suitability model included the identification of suitable habitats, the distance from habitats to water (value increased as distance to water decreased), and density of roads (value decreased as density of roads increased).

Suitability Indices

- SI_1 – The first suitability index was used to identify suitable habitat for the Eastern Box Turtle based on land cover type. Box turtles use a wide variety of habitat types: forested habitats (both deciduous and evergreen), wetland and open water edges, forest-field ecotones, shrublands, and grasslands. We used the Reclassify tool on the NLCD land cover data to identify forests (deciduous forest, evergreen forest, and mixed forest), shrubland, and grasslands (grassland/herbaceous and hay/pasture). We set $SI_1 = 0.75$ if land cover type in a cell was forest or shrubland, 0.50 for herbaceous grassland, and 0.25 for hay/pasture (as mowing reduces quality of grassland habitats). We then used the Focal Statistics tool with a 3×3-cell rectangular moving window to identify forest edges. For any forest habitat identified in the previous step that was forest edge, we set $SI_1 = 1.00$. For non-habitat, $SI_1 = 0.00$.

- SI_2 – The second suitability index was used to increase the value of habitats closest to water. First, we identified open water using the Reclassify tool on the NLCD data. We then used the Euclidean Distance tool to determine the distance from each cell to water. We took a subset of the resulting layer to create a new layer that contained only the distance from habitat cells (identified in SI_1) to water. We set $SI_2 = 0.00$ for any habitat cells >200 m from water. For habitat cells <200 m from water, we applied the equation $SI_2 = (-0.005 \times \text{distance}) + 1$, so the value of the cell would increase as distance to water decreased.

- SI_3 – The third suitability index was used to decrease the value of habitats in areas with high densities of roads and developed lands, since box turtles are sensitive to road mortality as they travel. First, we identified roads and developed lands using the Reclassify tool on the NLCD land cover data layer (developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity). We determined the density of developed lands within a 3-cell radius moving window (based on average home range diameter) using the Focal Statistics tool. We applied the following equation (based on the maximum possible density of developed lands within the moving window) to habitat cells (i.e., habitat cells identified in SI_1): $SI_3 = (-0.0354 \times \text{developed density}) + 1$, so the value of habitat cells with increasing densities of developed lands surrounding them was decreased.

Overall HSI

The final habitat suitability value was the geometric mean of (1) the maximum of SI_2 and SI_3 and (2) SI_1: $HSI = \sqrt{(\max(SI_2, SI_3)) \times SI_1}$.

Blanding's Turtle

We constructed a habitat suitability model for the Blanding's Turtle based on the following publications: Hamernick 2001 and Wisconsin DNR Blanding's Turtle Species Guidance (and citations therein)

Elements of the Blanding's Turtle habitat suitability model included the identification of suitable habitats, distance to nesting habitats (with habitat quality increasing with decreasing distance to nesting habitats), wetland complexity (with habitat quality increasing with increasing number of wetlands within a home range), and density of roads (with habitat quality decreasing in areas with increasing density of roads).

Suitability Indices

- SI_1 – The first suitability index was used to identify suitable habitat for Blanding's Turtle. We used the Reclassify tool on the NLCD land cover data layer to identify grasslands (grassland/herbaceous and hay/pasture) and emergent herbaceous wetlands. We set $SI_1 = 1.00$ if a cell contained these cover types, otherwise, $SI_1 = 0.00$.

- SI_2 – The second suitability index was used to increase the value of habitats in close proximity to nesting habitats. First, we used the Reclassify tool on the Indiana GAP land cover data to identify nesting habitat (Central Tallgrass Prairie, North-Central Interior Oak Savanna, North-Central Interior Sand and Gravel Tallgrass Prairie, Great Lakes Dune, and Great Lakes Wet-Mesic Lakeplain Prairie). We then used the Euclidean Distance tool to determine the distance from habitat identified in SI_1 to suitable nesting habitat. We set $SI_2 = 0.00$ for habitat cells >275 m from nesting habitat (based on maximum average distance travelled). For cells <275 m from nesting habitat, we applied an equation to increase the value of habitat cells closest to nesting habitat: $SI_2 = (-0.0036 \times \text{distance}) + 1$.

- SI_3 – The third suitability index was used to increase the value of habitat with increasing complexity of wetland mosaics, since Blanding's Turtles regularly move between 3-6 wetlands over the course of their active season. First, we aggregated wetland habitats into patches using the Region Group tool. Then, we counted the number of wetland patches within a 33-cell radius moving window using the Focal Statistics tool (output:

‘Variety’, rather than the usual ‘Sum’). We then set the suitability value of SI_3 for each habitat cell based on the number of wetlands within the moving window: for 1 patch, SI_3 = 0.00, 2 patches = 0.25, 3 patches = 0.50, 4-5 patches = 0.75, >5 patches = 1.00.

- SI_4 – The fourth suitability index was used to decrease the value of habitat in areas with high densities of roads and developed lands, since Blanding’s Turtles are sensitive to road mortality as they travel. First, we identified roads and developed lands using the Reclassify tool on the NLCD land cover data layer (developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity). We determined the density of developed lands within a 33-cell radius moving window (based on average home range diameter) using the Focal Statistics tool. We applied the following equation (based on the maximum possible density of developed lands within the moving window) to habitat cells: $SI_4 = (-0.000292 \times \text{developed density}) + 1$, so the value of habitat cells with increasing densities of developed lands surrounding them was decreased.

Overall HSI

The final habitat suitability value was the maximum of SI_2 and SI_3, scaled by SI_4, and multiplied by SI_1 to zero out non-habitat: $HSI = SI_1 \times (SI_4 \times (\max(SI_2, SI_3)))$.

Swamp Rabbit

We constructed a habitat suitability model for the Swamp Rabbit based on the following publications: Terrel (1972), Allen (1985), Zollner et al. (2000), Whitaker and Mumford (2009), and Vale and Kissell (2010).

Elements of the Swamp Rabbit habitat suitability model included the relative value of wetland and upland habitats, proximity of wetland habitats to upland habitats (with value increasing with decreasing distance to upland), the density of agriculture and developed lands (with value decreasing in areas with increasing density of agriculture and developed lands), and wetland complex patch size (with value increasing as patch size increased).

Suitability Indices

- SI_1 – The first suitability index was used to identify suitable habitats for the Swamp Rabbit. We used the Reclassify tool with the NLCD land cover data layer to identify woody wetlands and emergent herbaceous wetlands. We also identified floodplain forests by using the Focal Statistics tool with an 8×8-cell moving window to identify edges of open water. Floodplain forests were identified as any cell containing forest (deciduous forest, evergreen forest, or mixed forest) that fell within the open water edge habitats. We also identified upland habitats used by Swamp Rabbits: deciduous forest, evergreen forest, mixed forest, shrubland, and herbaceous grassland. We set SI_1 = 1.00 if a cell contained wetland or floodplain forest habitat and 0.25 if a cell contained upland habitat.

- SI_2 – The second suitability index was used to increase the value of wetlands in close proximity to upland habitat. We used the Euclidean Distance tool to determine the distance from wetland habitat identified in SI_1 to upland habitat identified in SI_1 and converted to km. We set SI_2 = 0.00 for any wetland >2 km from upland. For cells <2 km from upland habitats, we applied the equation $(-0.0005 \times \text{distance}) + 1$, so a cell’s value increased with decreasing proximity to upland, and cells directly adjacent to upland were set to SI_2 = 1.00.

- SI_3 – The third suitability index was used to decrease the value of habitat in areas with high densities of agriculture and developed lands. First, we identified agriculture and developed lands using the Reclassify tool on the NLCD land cover data layer (cultivated crops, developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity). We determined the density of these cover types within a 4-cell radius moving window (based on average home range) using the Focal Statistics tool. We applied the following equation (based on the maximum possible density of agriculture and developed lands within the moving window) to habitat cells: SI_4 = (-0.02 × ag/developed density) + 1, so the value of habitat cells with increasing densities of developed lands surrounding them was decreased.

- SI_4 – The fourth suitability index was used to address Swamp Rabbit wetland patch size requirements. We calculated patch sizes of wetland habitats (wetlands and floodplains) by first aggregating habitat cells into patches using the Region Group tool, then using Zonal Statistics to sum the number of cells contained in the each of those patches and converting to ha. We assigned SI_4 = 1.00 for patches >100 ha. For patches <100 ha, we applied the equation SI_4 = (0.01 × patch size), so that a cell's value decreased with decreasing patch size.

Overall HSI
The final habitat suitability value was the geometric mean of (1) the combination of SI_2 and SI_4, multiplied by SI_1 to scale habitat values and zero out non-habitat and (2) SI_3: $HSI = \sqrt{((SI_2 + SI_4) \times SI_1) \times SI_3}$.

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E. Landscape-level Modeling Results

Great Lakes Region

Terrestrial Modeling Results

Technical experts participating in the Modeling Focus Group suggested the following terrestrial species as candidates for landscape-level modeling:

- **Amphibians:** Blue-spotted Salamander and Northern Leopard Frog
- **Birds:** Alder Flycatcher, Black Tern, Bobolink, Common Gallinule, Field Sparrow, Golden-winged Warbler, Least Flycatcher, Marsh Wren, Northern Bobwhite, Northern Waterthrush, Red-eyed Vireo, Red-headed Woodpecker, Sandhill Crane, Veery, and Wood Thrush
- **Mammals:** Bobcat, Franklin's Ground Squirrel, Eastern Red Bat, River Otter, Southern Bog Lemming, Star-nosed Mole, and White-tailed Deer
- **Reptiles:** Blanding's Turtle, Massasauga, and Racer

Respondents to the species survey voted for species from this initial list based on habitat types and were given space to suggest additional species. The top-ranked species were:

- **Forests:** Red-headed Woodpecker, Wood Thrush, Eastern Red Bat, Red-backed Salamander, and Spotted Salamander
- **Grasslands:** Northern Bobwhite, Henslow's Sparrow, Massasauga, Red-headed Woodpecker, and Northern Leopard Frog
- **Early Successional:** American Woodcock, Ruffed Grouse, and Whip-poor-will
- **Wetlands/Aquatic Systems**: Northern Leopard Frog, Blanding's Turtle, Massasauga, River Otter, and Mallard

Ultimately, the following species were chosen for landscape-level modeling (Chapter V): Northern Bobwhite, American Woodcock, Henslow's Sparrow, Red-headed Woodpecker, Blanding's Turtle, Northern Leopard Frog, and Eastern Red Bat.

Landscape-level models were built for each of the species above that estimated the quality of current habitat conditions (Chapter V). Figures C-1 through C-7 below show the resulting habitat suitability scores on maps for each representative species. To produce a map of average habitat suitability across all species tested, the scores for individual cells were averaged. Figure C-8 represents these cumulative suitability scores. For cleaner interpretation of the cumulative scores, an additional graph (Fig. C-9) is found below which groups the average scores into quartiles (0.00-2.25 - poor; 0.25-0.50 - fair; 0.50-0.75 - good; 0.75-1.00 - excellent). Because of the varying habitat needs of the species tested, no single area can represent an 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Habitat Suitability for the American Woodcock
in the Great Lakes Region

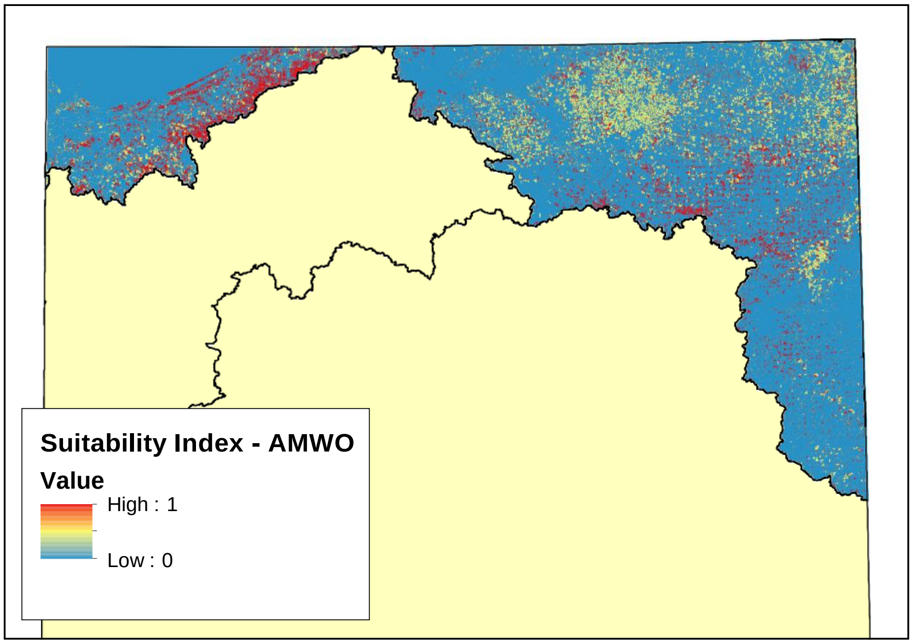

Figure C-1. Habitat suitability scores for the American Woodcock in the Great Lakes Region.

Habitat Suitability for the Blanding's Turtle
in the Great Lakes Region

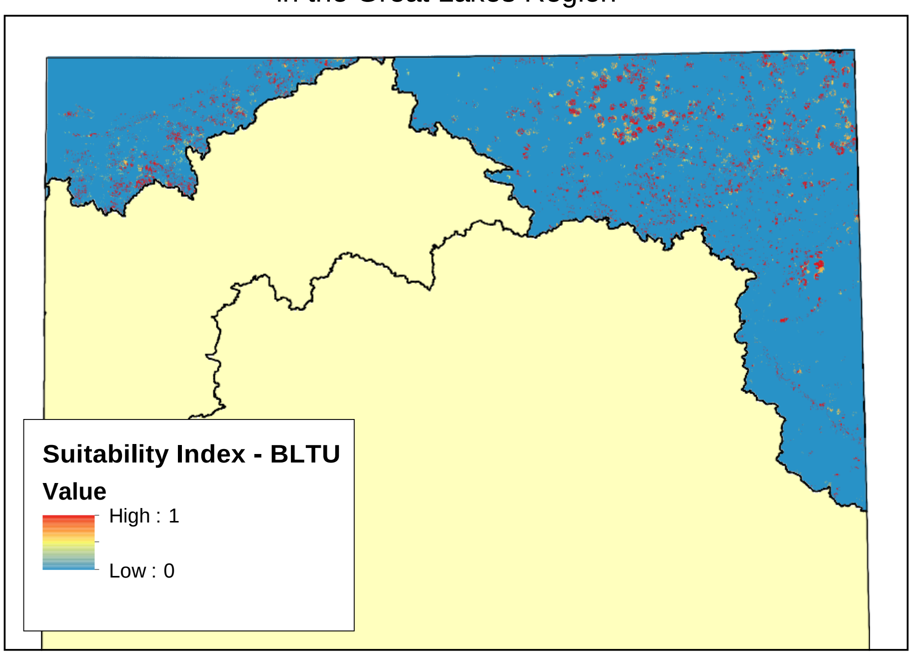

Figure C-2. Habitat suitability scores for the Blanding’s Turtle in the Great Lakes Region.

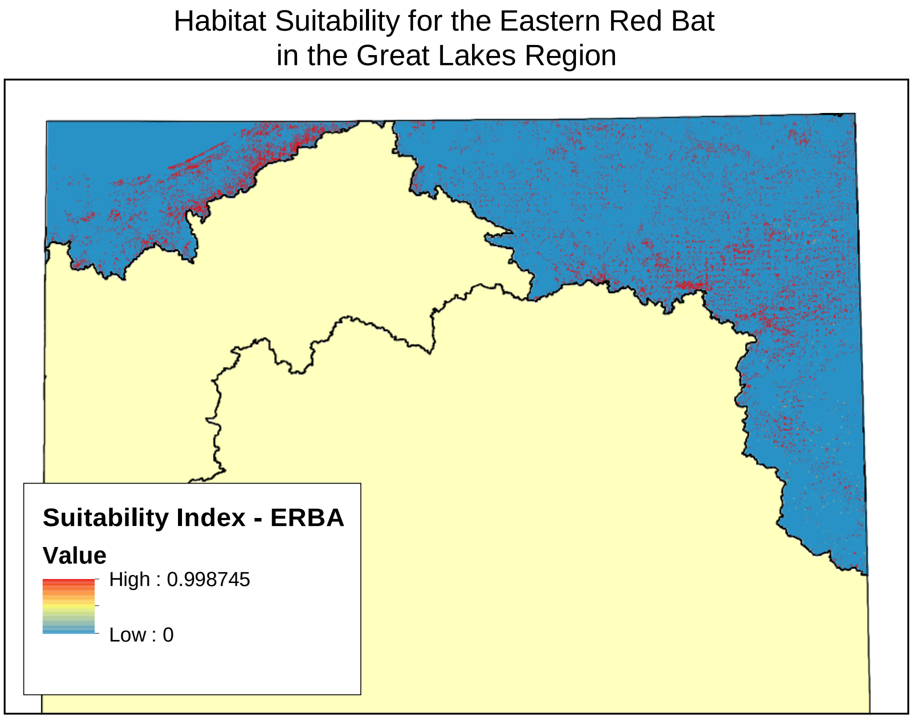

Figure C-3. Habitat suitability scores for the Eastern Red Bat in the Great Lakes Region.

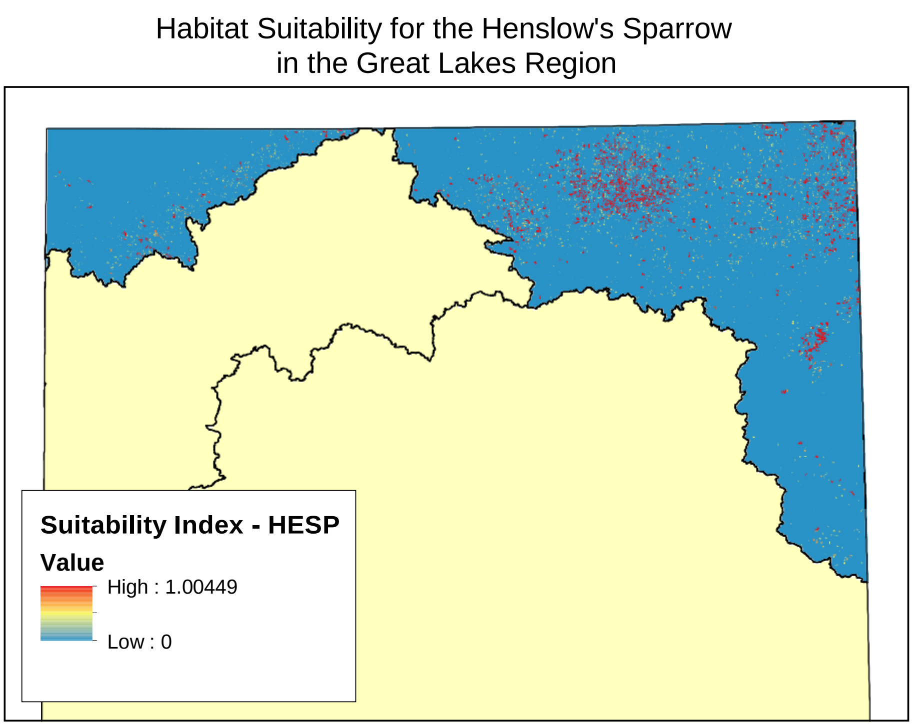

Figure C-4. Habitat suitability scores for the Henslow’s Sparrow in the Great Lakes Region.

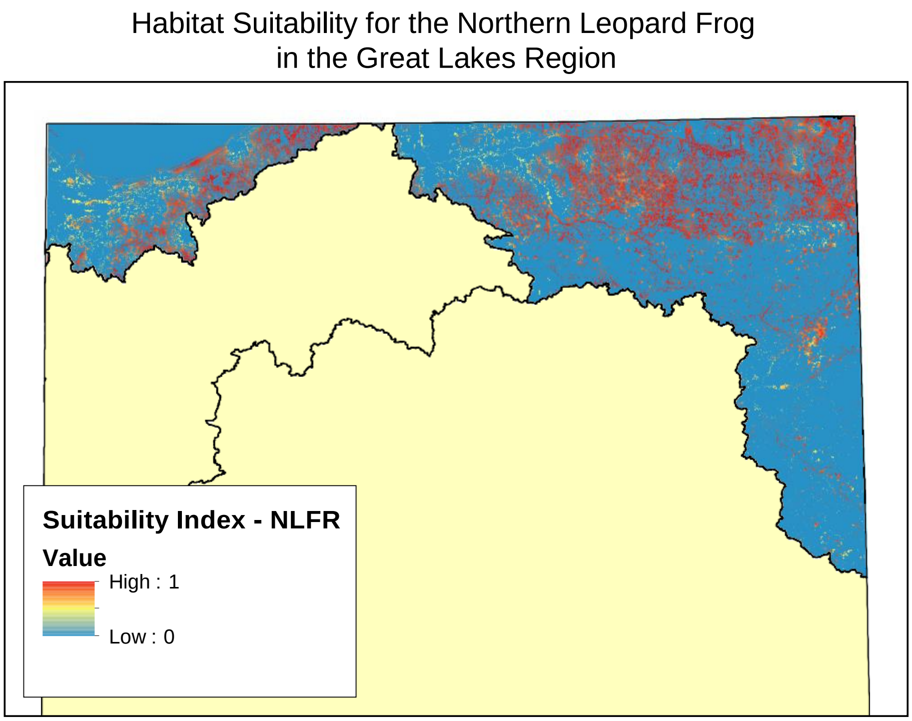

Figure C-5. Habitat suitability scores for the Northern Leopard Frog in the Great Lakes Region.

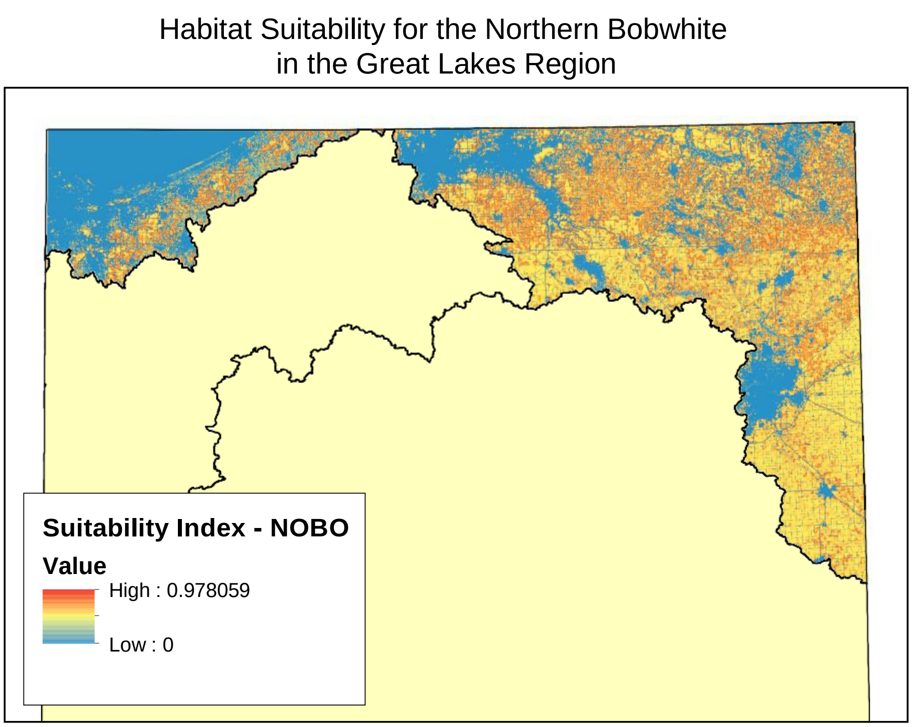

Figure C-6. Habitat suitability scores for the Northern Bobwhite in the Great Lakes Region.

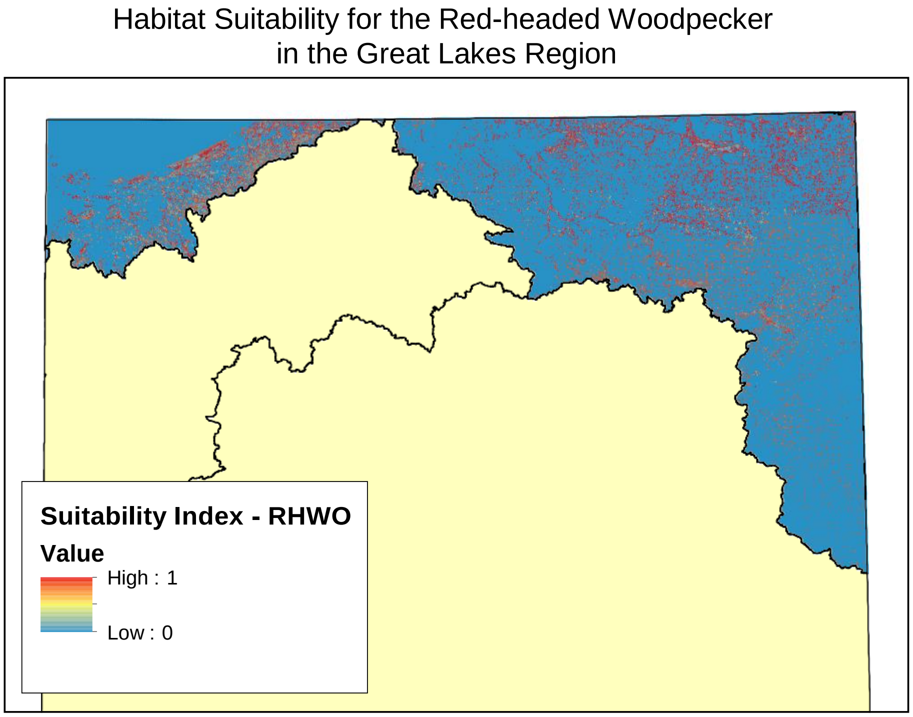

Figure C-7. Habitat suitability scores for the Red-headed Woodpecker in the Great Lakes Region.

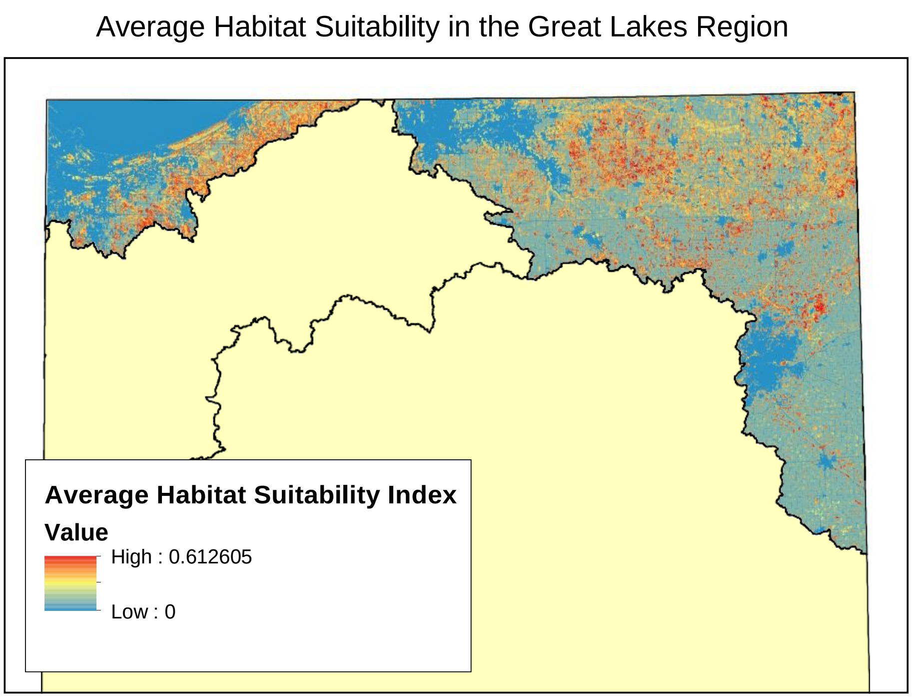

Figure C-8. Average habitat suitability in the Great Lakes Region for all representative species.

Habitat Suitability Quartiles in the Great Lakes Region

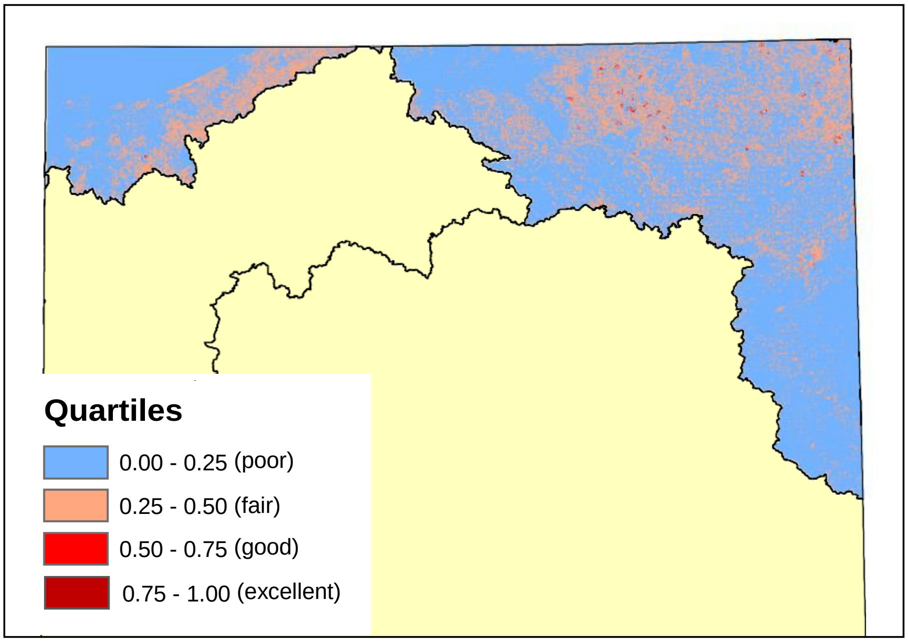

Figure C-9. Habitat suitability quartiles for cumulative scores across all species tested in the Great Lakes Region. Scores ranging from 0.00-1.00 were grouped into quartiles (0.00-0.25 - poor, 0.25-0.50 - fair, 0.50-0.75 - good, 0.75-1.00 - excellent) to produce this map. Note that because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Table C-1. Acres assigned to each habitat suitability quartile for each species chosen for landscape-level modeling in the Great Lakes Region. Note that "cumulative habitat suitability", in the last column, does not represent average number of acres in each quartile, but rather the number of acres assigned to each quartile when scores for individual cells were averaged, as in Figure # above. Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent."

Quartile	**Red-headed Woodpecker**	**Eastern Red Bat**	**Northern Bobwhite**	**Henslow's Sparrow**	**American Woodcock**	**Blanding's Turtle**	**Northern Leopard Frog**	**Cumulative Habitat Suitability**
Poor (0.00-0.25)	2,120,342	2,261,234	939,919	2,382,878	1,979,529	2,361,774	1,954,459	1,859,742
Fair (0.25-0.50)	20,129	6,036	52,752	16,766	226,509	26,703	11,366	580,840
Good (0.50-0.75)	0	137,322	1,324,921	11,347	150,262	28,929	43,072	3,891
Excellent (0.75-1.00)	306,934	42,813	129,813	36,414	88,173	29,998	438,508	0

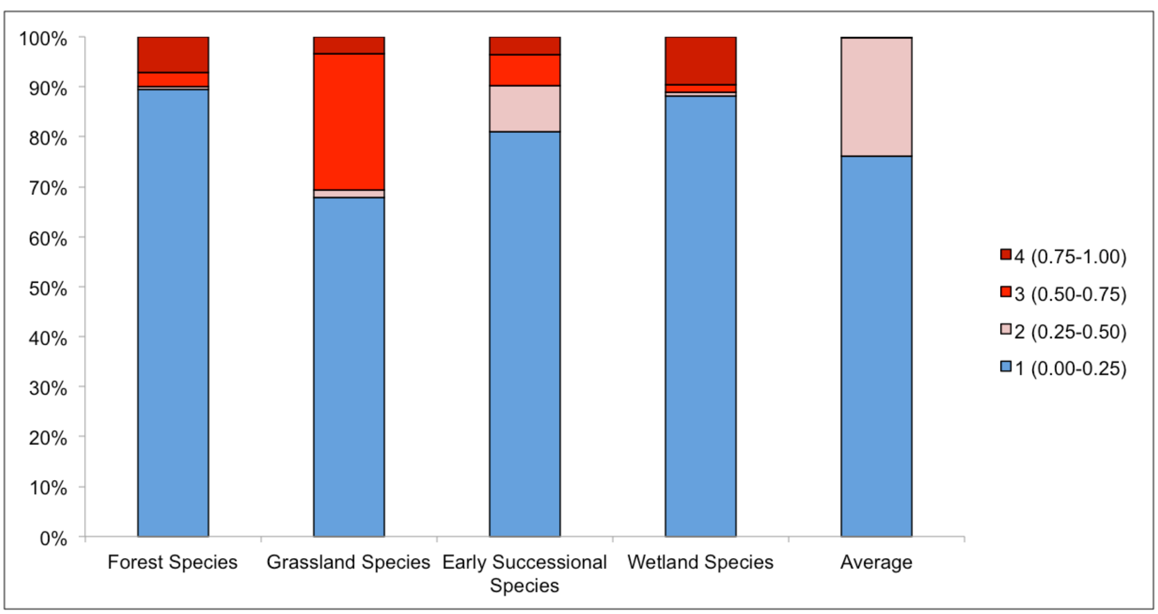

Figure C-10. Percentage of total acreage in the Great Lakes Region assigned to each habitat suitability quartile for species representing forest, grassland, early successional, and wetland habitats. “Average” represents cumulative scores across all species.

Aquatic Modeling Results
Within the Great Lakes Region, the landscape level aquatic modeling predictions broke rankings for QHEI into five categories and rankings for IBI into six categories.

For QHEI within this region, the model estimated 87.9 miles in the excellent condition, 681.8 miles in good condition, 2,381 miles in fair condition, 456 miles in poor condition, and 7 miles in very poor condition. Figure C-11 displays the linear miles of streams from within this region predicted to be in each QHEI category.

For IBI within this region, the model estimated 18.1 miles in the excellent condition, 83.8 miles in good condition, 658.6 miles in fair condition, 2,711.5 miles in poor condition, 142.6 miles in very poor condition, and 0 miles in fish absent condition. Figure C-12 displays the linear miles of streams from within this region predicted to be in each IBI category.

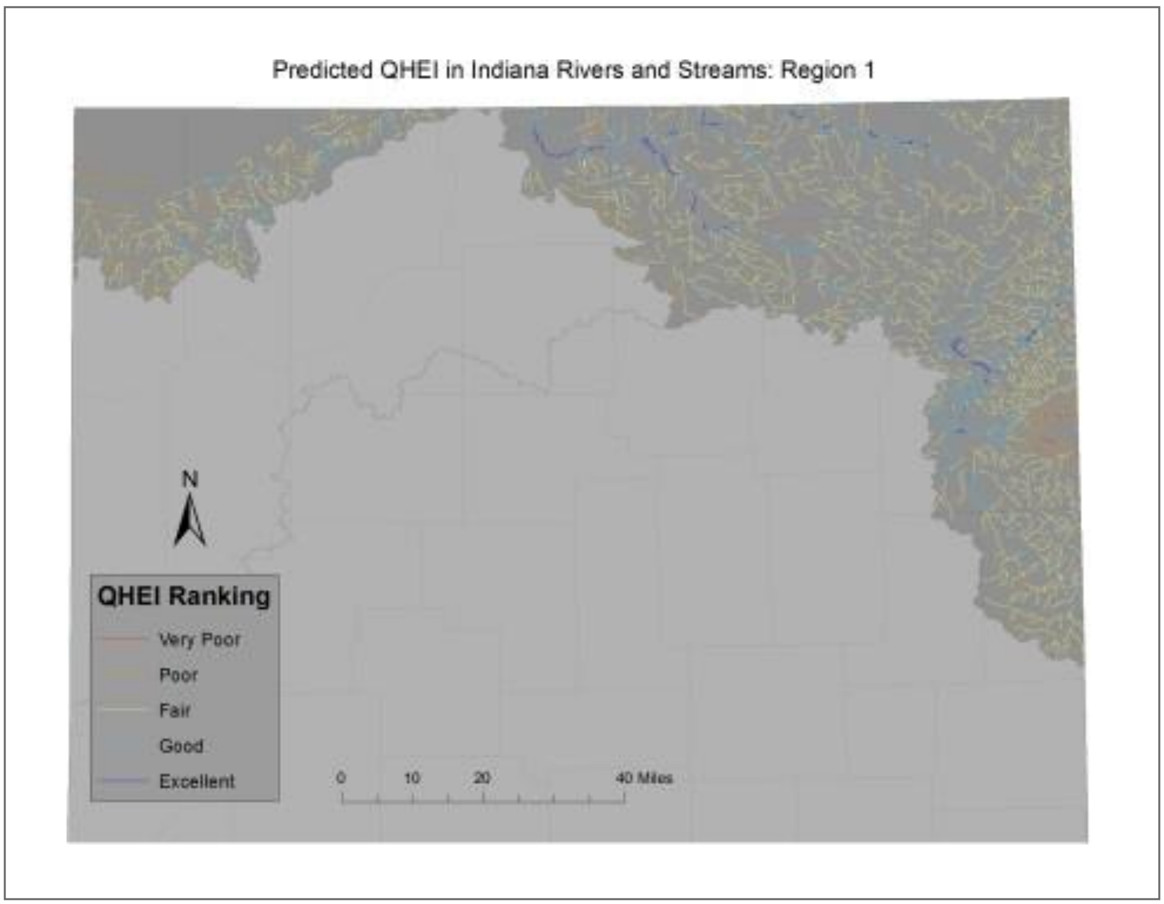

Figure C-11. Streams in the Great Lakes Region predicted to be in each QHEI category.

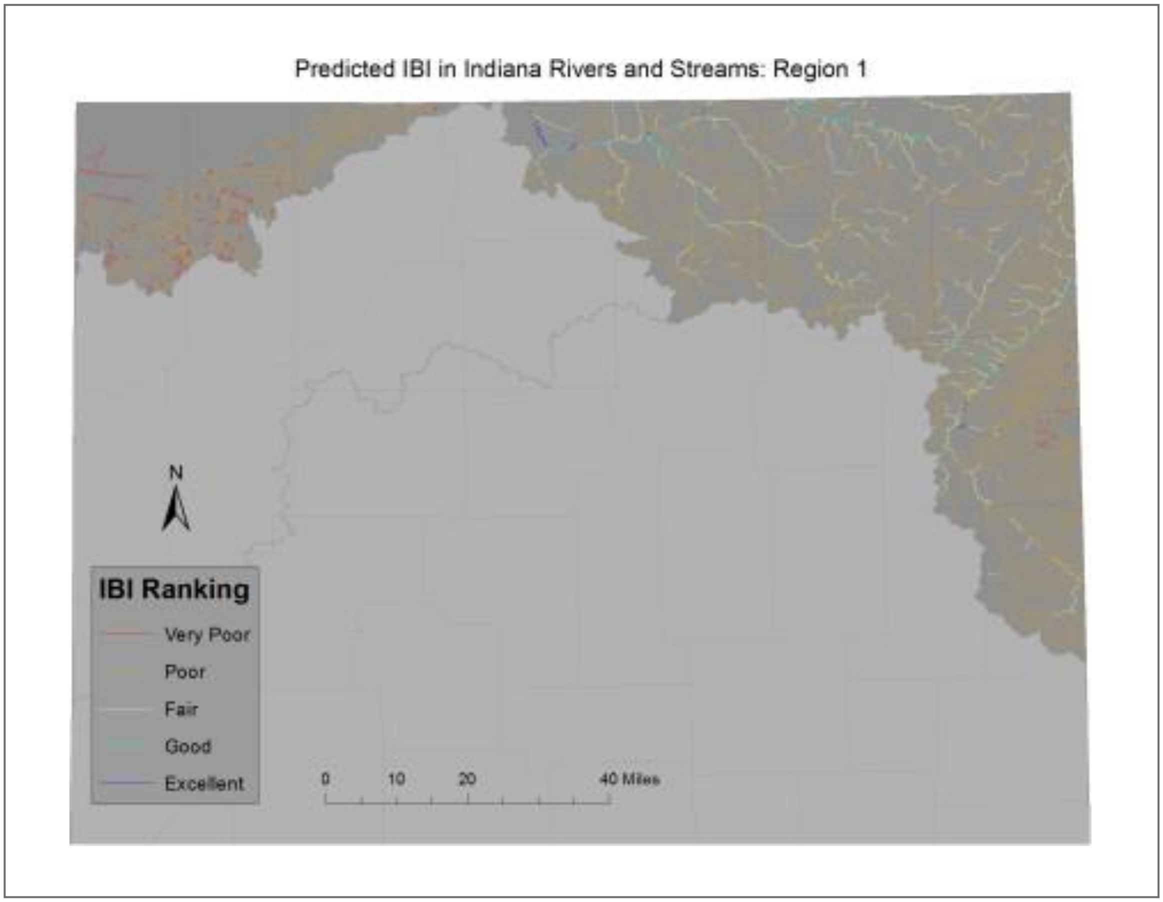

Figure C-12. Streams in the Great Lakes Region predicted to be in each IBI category.

<u>Conservation Action Scenarios</u>

Survey respondents were also asked to assign 100 points of effort to actions that make a difference 'on-the-ground' (such as protection, restoration, or improvement in the quality of existing habitats). Scores for these actions were ranked, and the actions were assembled into three different scenarios for application to a landscape in a GIS environment (Chapter V). The 'baseline' scenario represented the average distribution of effort among 'on-the-ground' actions recommended by survey respondents. The 'focused' and 'distributed' scenarios represented how effort would be distributed if it were focused only on the top-priority actions, or spread out evenly among most of the actions that were considered important, respectively.

Unlike most other regions, aquatic systems in the Great Lakes Region were emphasized heavily by respondents to the Habitat Survey. Protection of aquatic systems was the top-ranked action in every scenario, and other actions that focused on aquatic systems, such as controlling invasive species, restoring aquatic habitat, creating buffer/riparian zones, and improving water quality, were also in the top ten.

Although transformation of landscapes in a GIS environment was not possible with current knowledge of how Indiana landscapes change, in the future, managers may find the following results useful in simulating landscape changes under alternative conservation action scenarios.

Table C-2. Percent effort to be devoted to 'on-the-ground' conservation actions (habitat protection, restoration, or improvement) under alternative future conservation action scenarios (see above).

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect aquatic systems	12%	14%	11%
Protect forests	8%	4%	6%
Protect wetlands	7%	9%	7%
Control invasive species in aquatic systems	7%	8%	6%
Restore aquatic systems	6%	7%	5%
Protect buffer zones around aquatic systems	6%	7%	5%
Restore riparian zones around aquatic systems	6%	7%	5%
Improve water quality in aquatic systems	6%	6%	5%
Improve drainage management to benefit aquatic systems	5%	6%	4%
Restore wetlands	4%	5%	3%
Control invasive species in wetlands	4%	4%	2%
Control invasive species in forests	4%	4%	2%
Preserve/create corridors between habitat - agriculture	3%	4%	3%
Utilize CRP partnerships to convert cropland to habitat	3%	0%	2%
Preserve/create corridors between habitat - barren lands	3%	3%	3%
Preserve/create corridors between habitat - forests	3%	3%	3%
Improve water quality in wetlands	3%	3%	2%
Improve drainage management to benefit wetlands	3%	0%	2%
Preserve/create corridors between habitat - grasslands	2%	2%	2%
Control forest pests	2%	0%	1%
Protect grasslands	2%	3%	4%
Reduce conversion of habitat to human land uses	2%	0%	2%
Enhance wetland connectivity	1%	0%	1%
Restrict recreational overuse in aquatic systems	0%	0%	2%
Enhance Classified Forest Program	0%	0%	2%
Restore forests	0%	0%	2%
Create buffers around wetlands	0%	0%	2%
Create new wetlands	0%	0%	2%
Actively manage wetland habitat quality	0%	0%	1%
Control invasive species in grasslands	0%	0%	1%
Control invasive species in agricultural systems	0%	0%	1%
Manage nuisance wildlife in wetlands	0%	0%	1%
Manage nuisance wildlife in forests	0%	0%	1%
Manage nuisance wildlife in agriculture	0%	0%	0%
Control invasive species in barren lands	0%	0%	0%
Manage nuisance wildlife in barren lands	0%	0%	0%

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Enhance pastures and haylands for wildlife	0%	0%	0%
Improve soil health	0%	0%	0%
Modify drainage management on agricultural lands	0%	0%	0%
Reduce hay mowing during nesting season	0%	0%	0%
Reestablish fire regimes in barrens and glades	0%	0%	0%
Diversify forest types	0%	0%	0%
Reestablish fire regimes in forests	0%	0%	0%
Restrict recreational overuse in forests	0%	0%	0%
Implement fire regimes in grasslands	0%	0%	0%
Protect barren lands	0%	0%	0%
Restore wildlife habitat with agricultural matrix	0%	0%	0%
Restore barren lands	0%	0%	0%
Restore grasslands	0%	0%	0%

Kankakee Region

Terrestrial Modeling Results
Technical experts participating in the Modeling Focus Group suggested the following terrestrial species as candidates for landscape-level modeling:

- **Birds:** Bell's Vireo, Grasshopper Sparrow, Henslow's Sparrow, Lark Sparrow, Northern Bobwhite, Northern Harrier, Red-headed Woodpecker, Sandhill Crane, Sedge Wren, Short-eared Owl, Virginia Rail, Wilson's Snipe, and Wood Duck
- **Mammals:** American Badger, Eastern Red Bat, Franklin's Ground Squirrel, Indiana Bat, Little Brown Bat, Northern Long-eared Bat, Plains Pocket Gopher, and River Otter
- **Amphibians:** Plains Leopard Frog and Northern Leopard Frog
- **Reptiles:** Blanding's Turtle, Bullsnake, Eastern Massasauga, and Racer

Respondents to the species survey voted for species from this initial list based on habitat types and were given space to suggest additional species. The top-ranked species were:

- **Forests:** Red-headed Woodpecker, Eastern Red Bat, and Wood Duck
- **Grasslands:** Northern Bobwhite, Henslow's Sparrow, Massasauga, and Red-headed Woodpecker
- **Early Successional:** American Woodcock and Ruffed Grouse
- **Wetlands/Aquatic Systems:** Northern Leopard Frog, Wood Duck, Blanding's Turtle, Massasauga, and River Otter

Ultimately, the following species were chosen for landscape-level modeling (Chapter V): Red-headed Woodpecker, Henslow's Sparrow, Eastern Red Bat, Blanding's Turtle, Northern Bobwhite, American Woodcock, and Northern Leopard Frog.

Landscape-level models were built for each of the species above that estimated the quality of current habitat conditions (Chapter V). Figures C-13 through C-19 below show the resulting habitat suitability scores on maps for each representative species. To produce a map of average habitat suitability across all species tested, the scores for individual cells were averaged. Figure C-20 represents these cumulative suitability scores. For cleaner interpretation of the cumulative scores, an additional figure (Fig. C-21) is found below which groups the average scores into quartiles (0.00-2.25 - poor; 0.25-0.50 - fair; 0.50-0.75 - good; 0.75-1.00 - excellent). Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Habitat Suitability for the American Woodcock
in the Kankakee Region

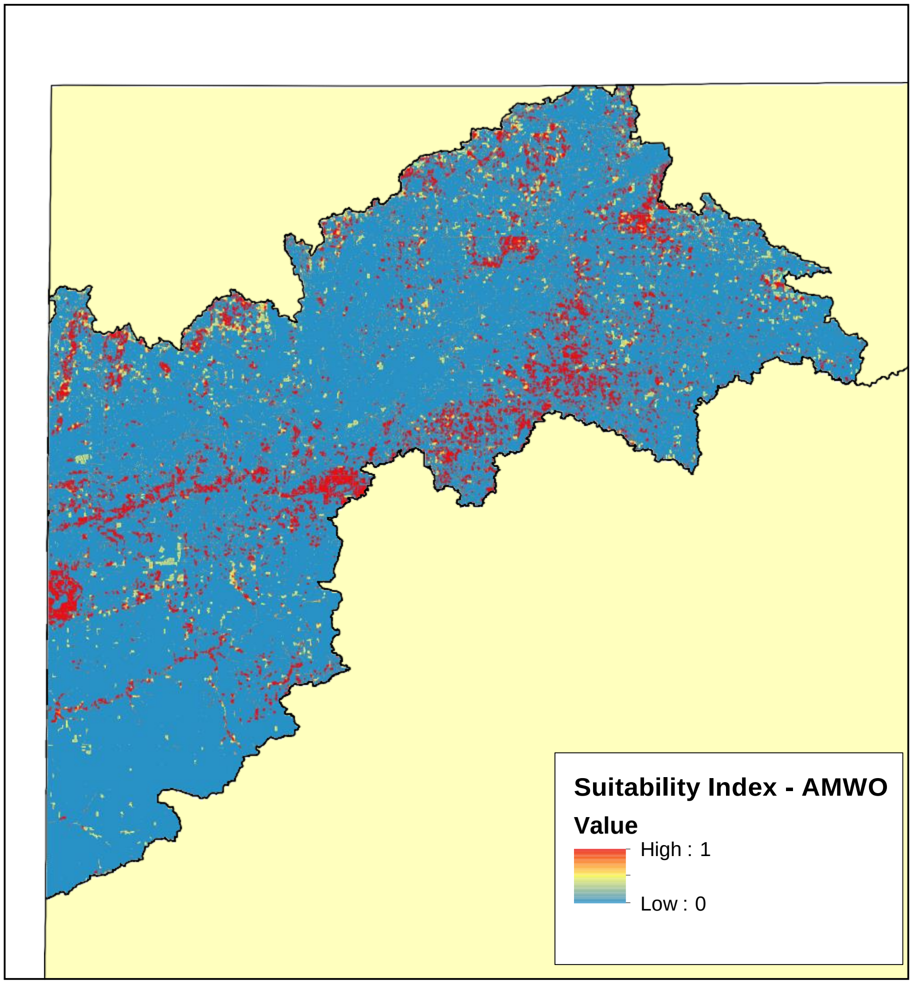

Figure C-13. Habitat suitability scores for the American Woodcock in the Kankakee Region.

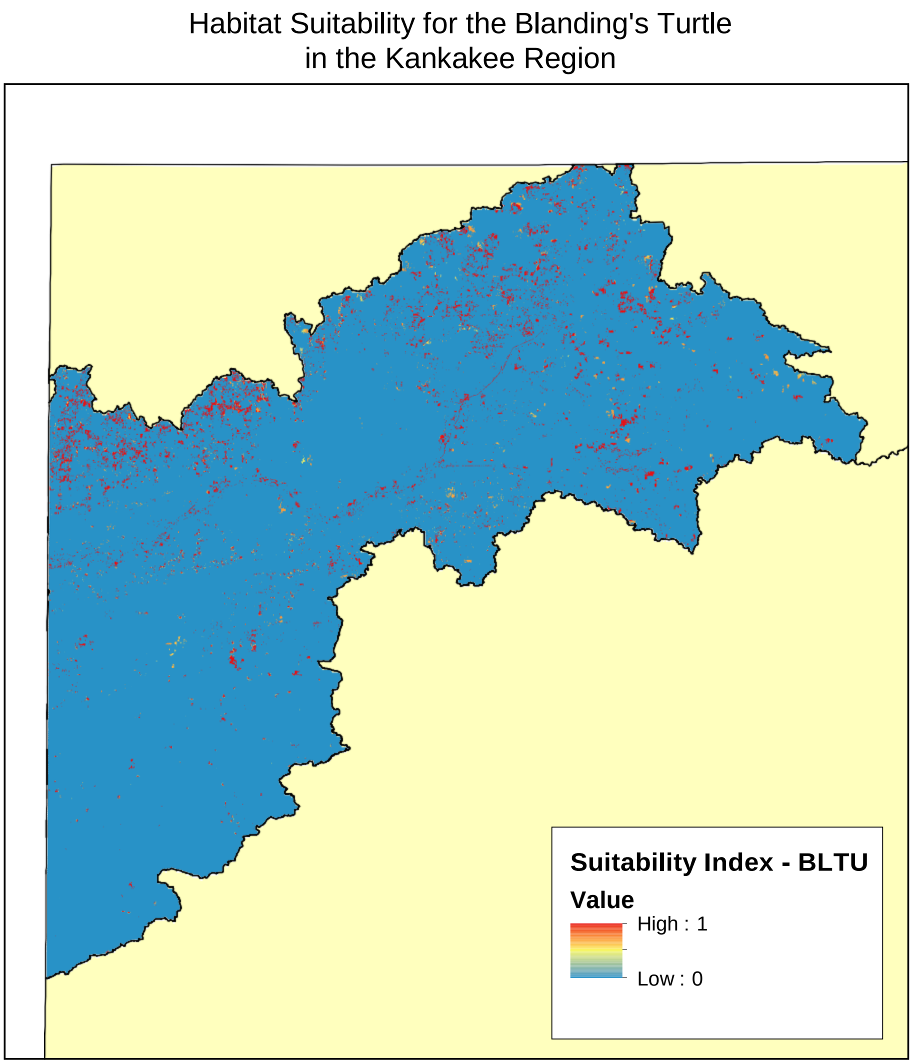

Figure C-14. Habitat suitability scores for the Blanding's Turtle in the Kankakee Region.

Habitat Suitability for the Eastern Red Bat
in the Kankakee Region

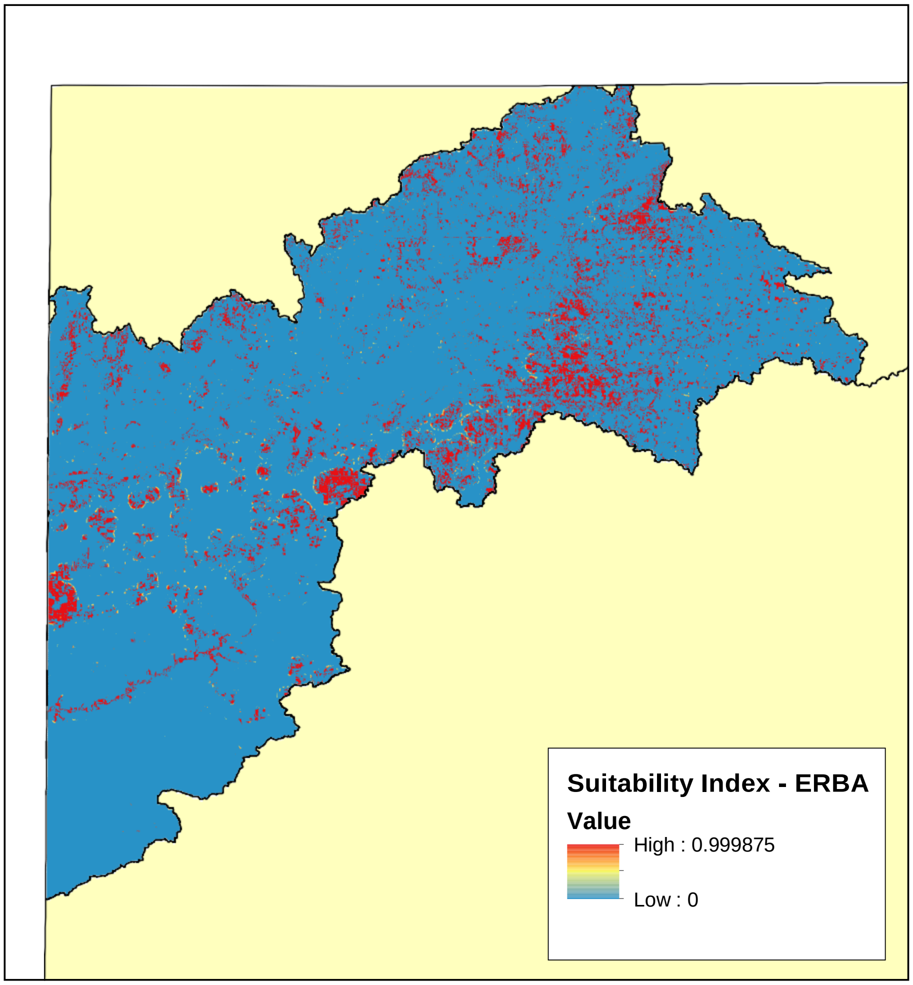

Figure C-15. Habitat suitability scores for the Eastern Red Bat in the Kankakee Region.

Habitat Suitability for the Henslow's Sparrow
in the Kankakee Region

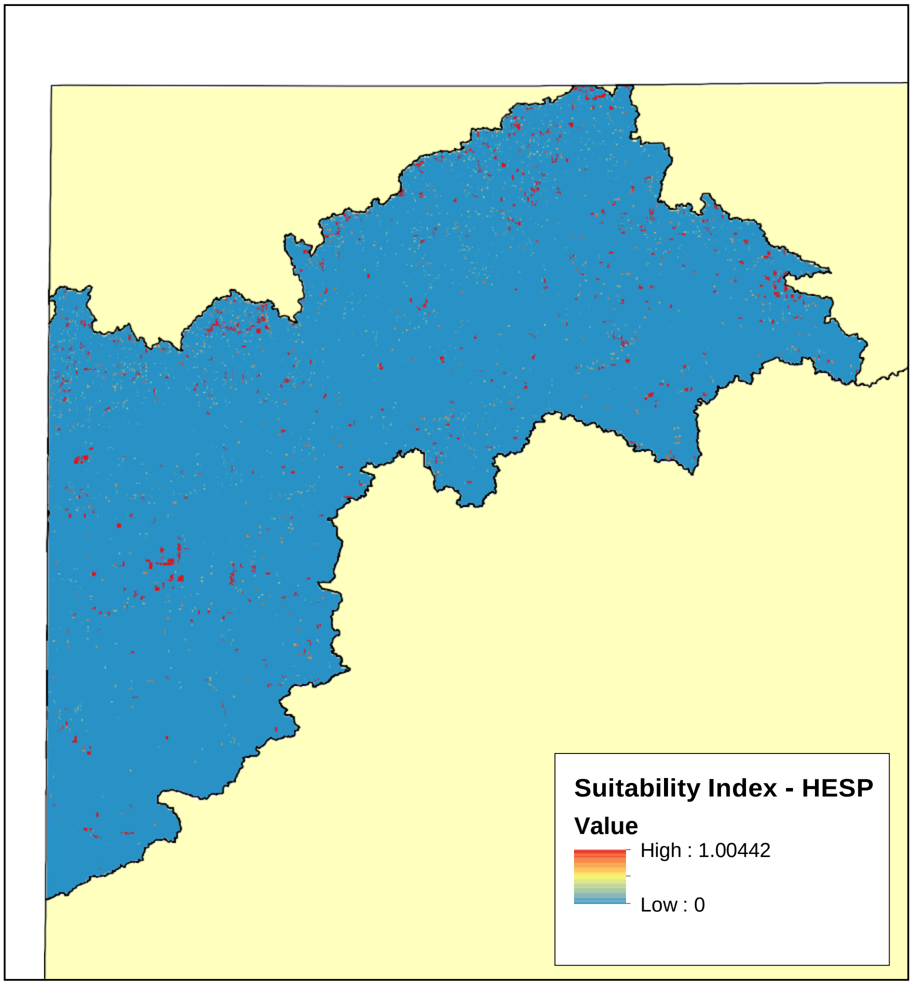

Figure C-16. Habitat suitability scores for the Henslow's Sparrow in the Kankakee Region.

Habitat Suitability for the Northern Leopard Frog
in the Kankakee Region

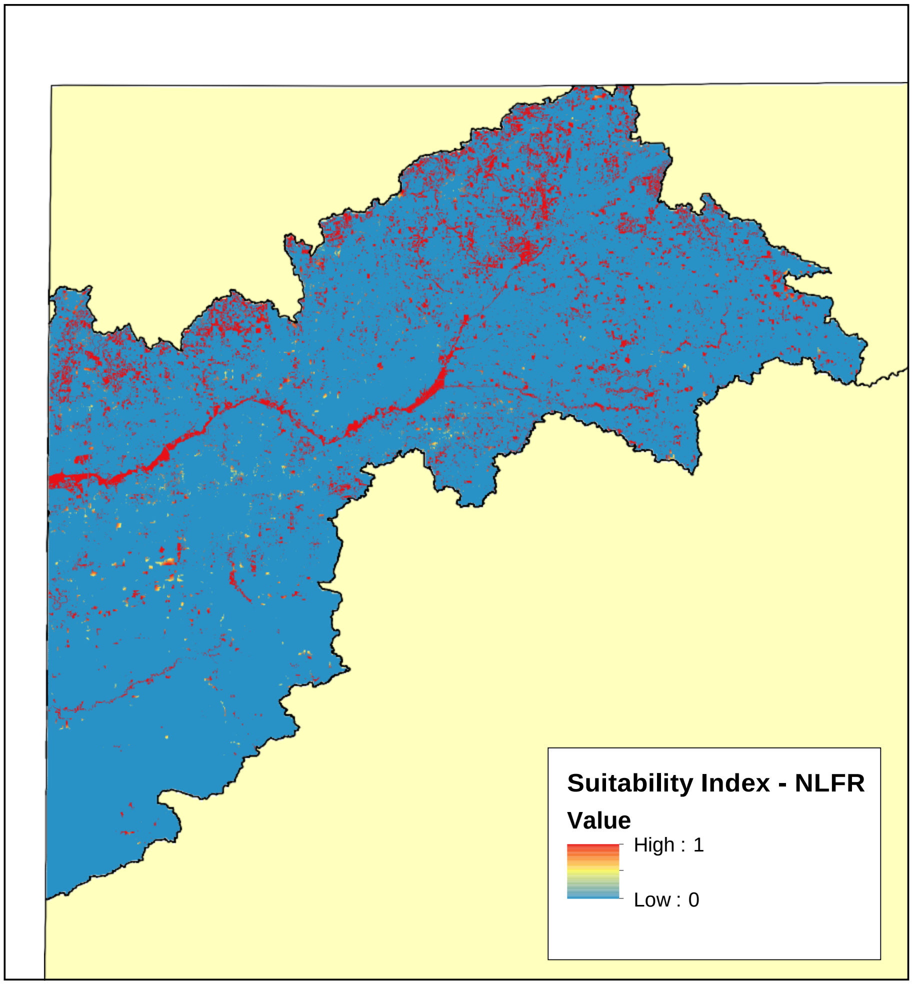

Figure C-17. Habitat suitability scores for the Northern Leopard Frog in the Kankakee Region.

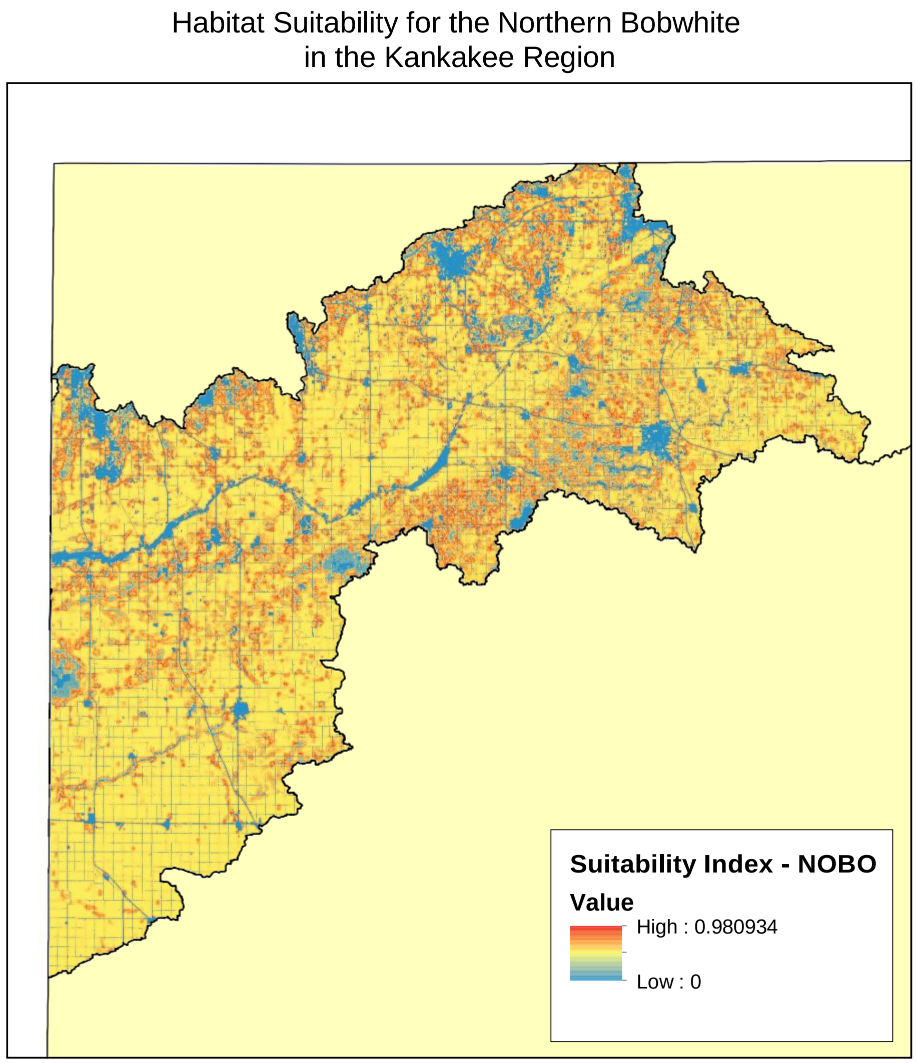

Figure C-18. Habitat suitability scores for the Northern Bobwhite in the Kankakee Region.

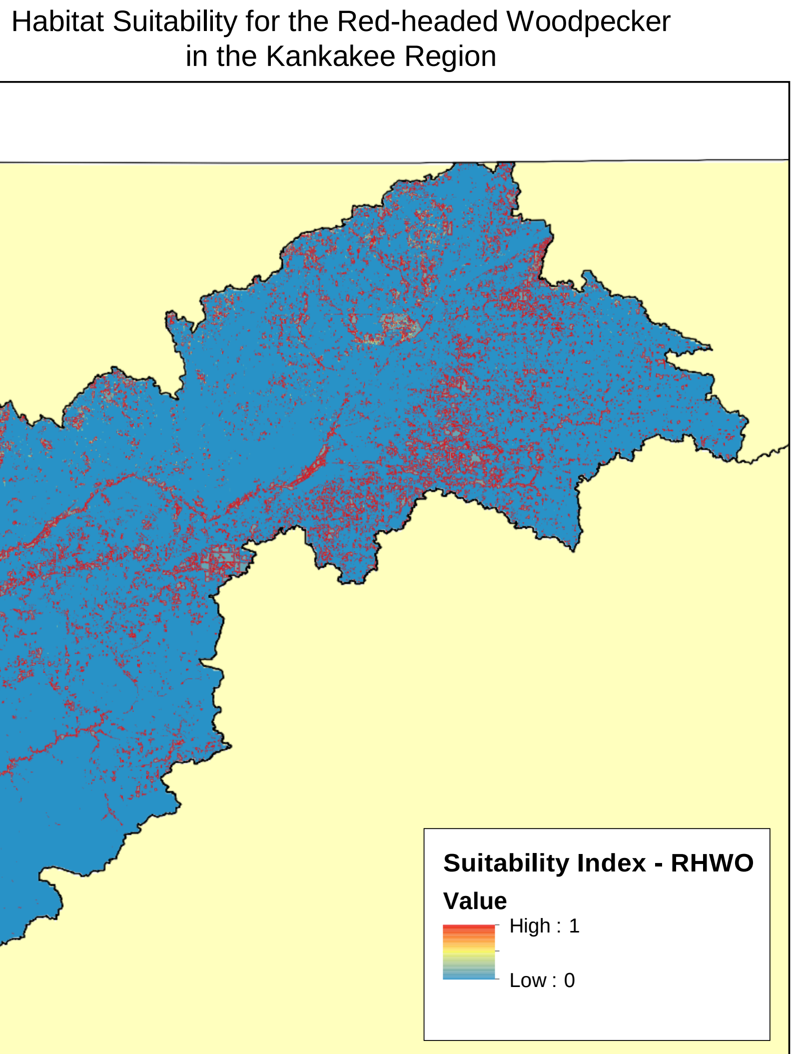

Figure C-19. Habitat suitability scores for the Red-headed Woodpecker in the Kankakee Region.

Average Habitat Suitability in the Kankakee Region

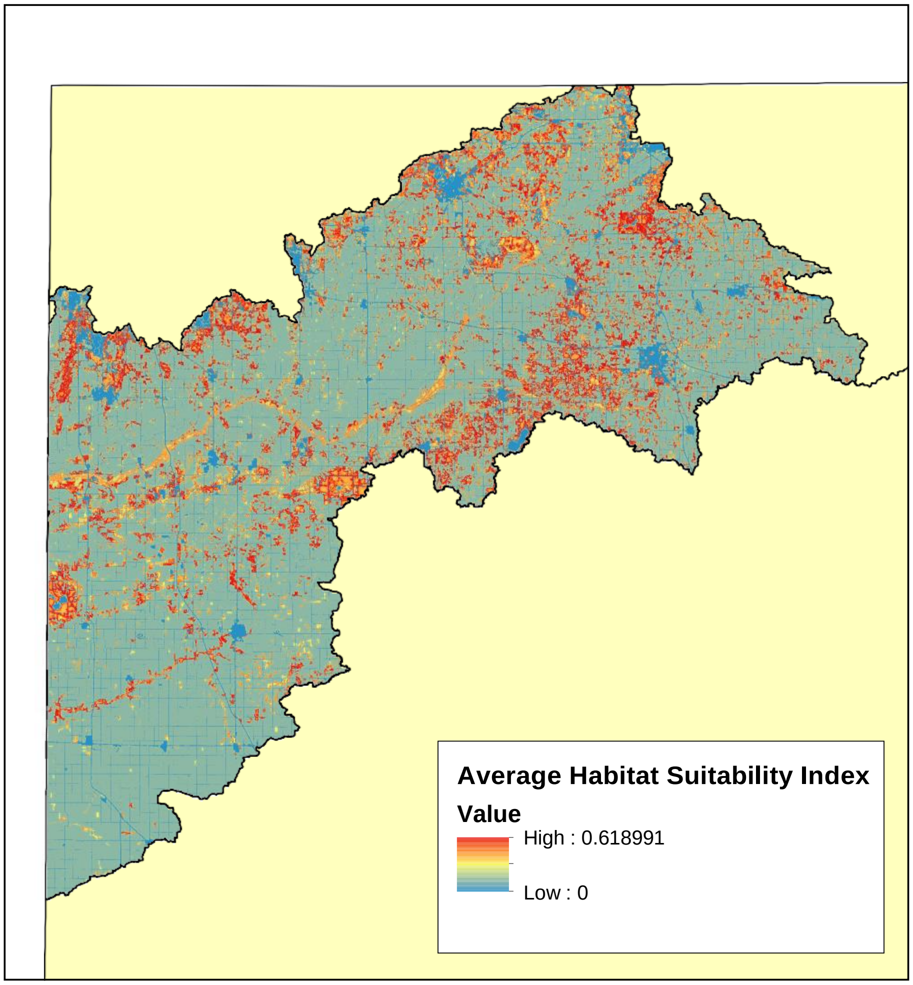

Figure C-20. Cumulative (average) habitat suitability across all the representative species.

Habitat Suitability Quartiles in the Kankakee Region

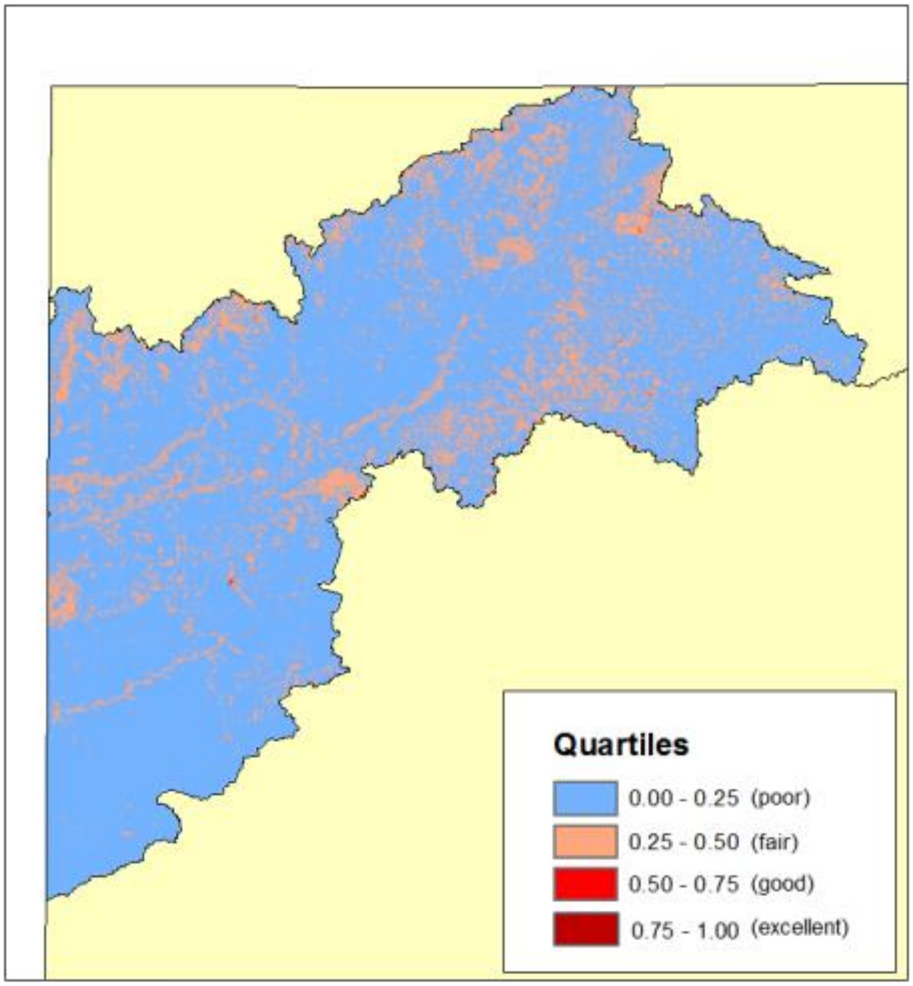

Figure C-21. Habitat suitability quartiles for cumulative scores across all species tested in the Kankakee Region. Scores ranging from 0.00-1.00 were grouped into quartiles (0.00-0.25 - poor, 0.25-0.50 - fair, 0.50-0.75 - good, 0.75-1.00 - excellent) to produce this map. Note that because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Table C-3. Acres assigned to each habitat suitability quartile for each species chosen for landscape-level modeling in the Kankakee Region. Note that "cumulative habitat suitability", in the last column, does not represent average number of acres in each quartile but rather the number of acres assigned to each quartile when scores for individual cells were averaged, as in Figure C-21 above. Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent".

Quartile	Red-headed Woodpecker	Eastern Red Bat	Northern Bobwhite	Henslow's Sparrow	American Woodcock	Blanding's Turtle	Northern Leopard Frog	Cumulative Habitat Suitability
Poor (0.00-0.25)	1,702,383	1,746,633	272,510	1,899,002	1,627,313	1,858,399	1,736,413	1,585,567
Fair (0.25-0.50)	10,866	11,502	58,415	5,559	68,347	11,583	5,500	325,110
Good (0.50-0.75)	0	89,919	1,484,913	2,661	103,463	17,207	25,221	890
Excellent (0.75-1.00)	198,989	64,183	96,399	5,016	112,444	25,048	145,104	0

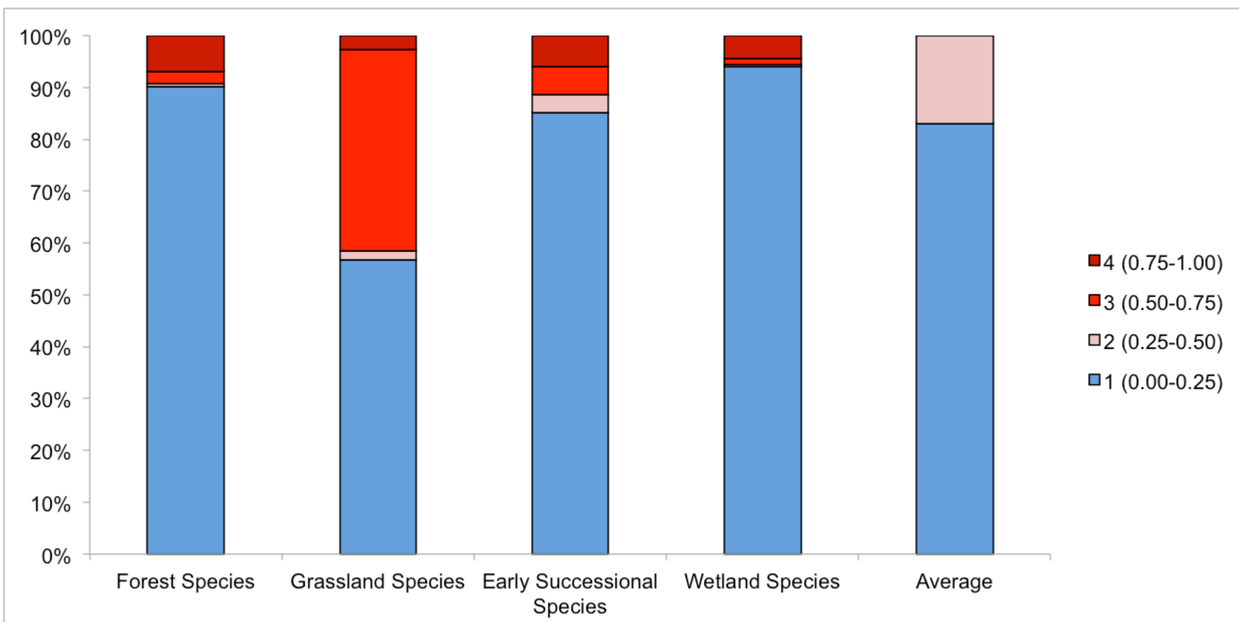

Figure C-22. Percentage of total acreage in the Kankakee Region assigned to each habitat suitability quartile for species representing forest, grassland, early successional, and wetland habitats. "Average" represents cumulative scores across all species.

Aquatic Modeling Results
Within the Kankakee Region, the landscape level aquatic modeling predictions broke rankings for QHEI into five categories and rankings for IBI into six categories. For QHEI within this region, the model estimated 23.4 miles in excellent condition, 301.8 miles in good condition, 1,523.1 miles in fair condition, 1,557.3 miles in poor condition, and 119.0 miles in very poor condition.

Figure C-23 displays the linear miles of streams from within this region predicted to be in each QHEI category. For IBI within this region the model estimated 2.5 miles in excellent condition, 96.4 miles in good condition, 1,113.7 miles in fair condition, 2,241.5 miles in poor condition, 70.5 miles in very poor condition, and 0 miles in fish absent condition.

Figure C-24 displays the linear miles of streams from within this region predicted to be in each IBI category.

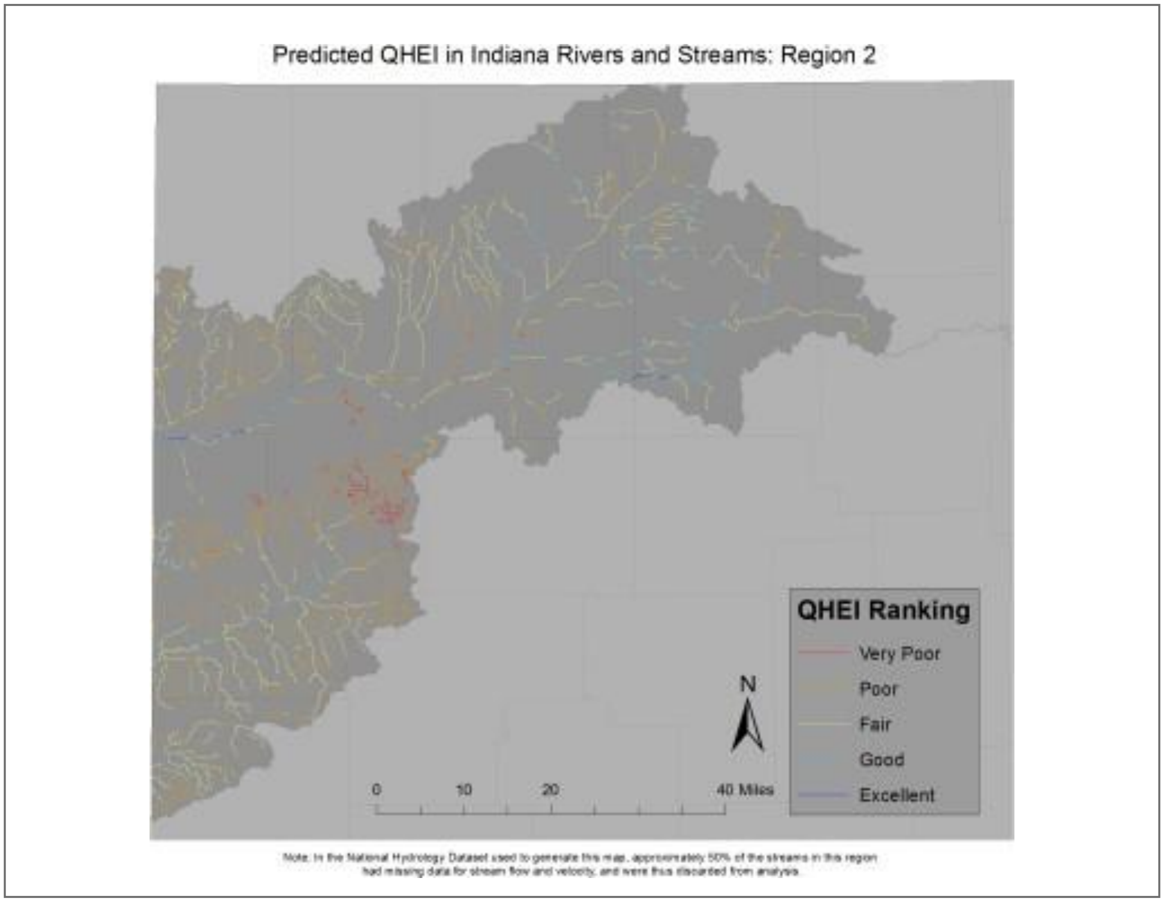

Figure C-23. Streams in the Kankakee Region predicted to be in each QHEI category.

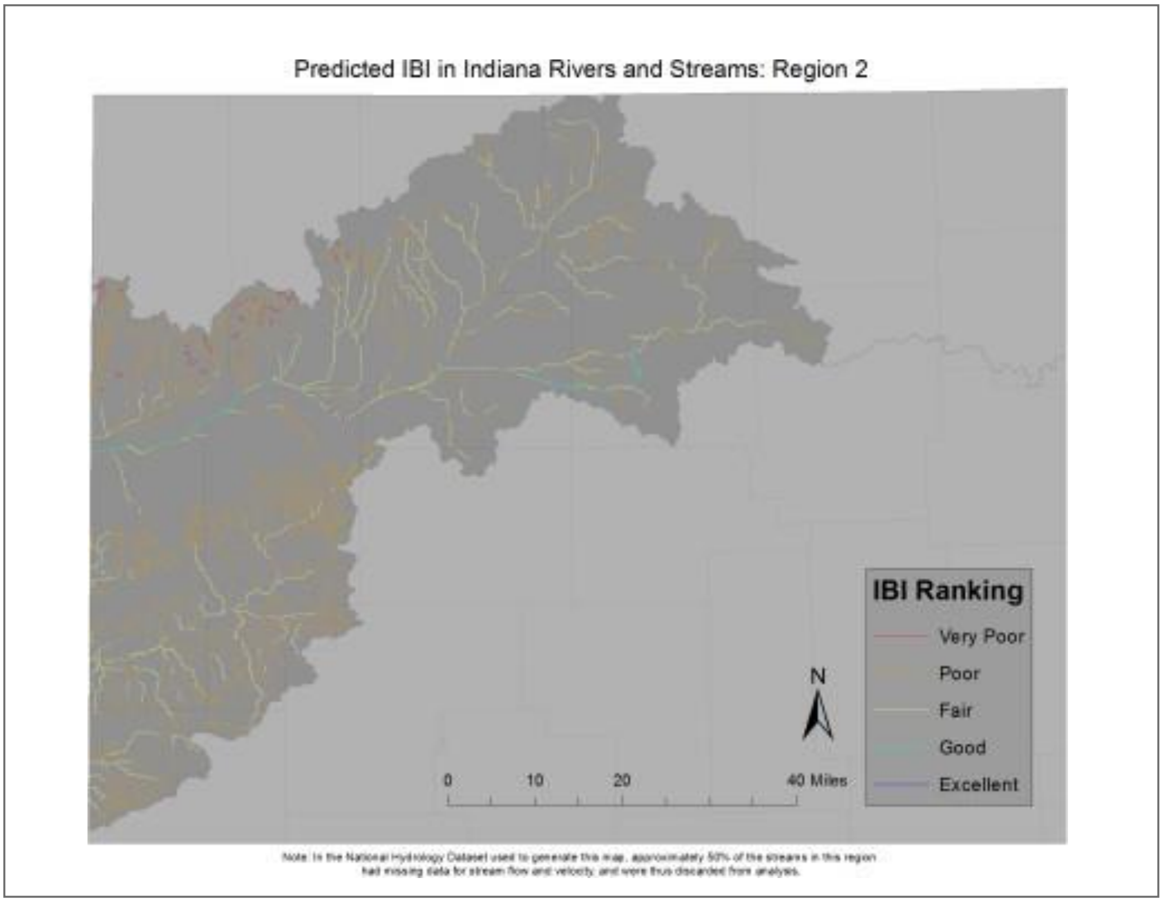

Figure C-24. Streams in the Kankakee Region predicted to be in each IBI category.

Conservation Action Scenarios

Survey respondents were also asked to assign 100 points of effort to actions that make a difference 'on-the-ground' (such as protection, restoration, or improvement in the quality of existing habitat). Scores for these actions were ranked, and the actions were assembled into three different scenarios for application to a landscape in a GIS environment (Chapter V). The 'baseline' scenario represented the average distribution of effort among 'on-the-ground' actions recommended by survey respondents. The 'focused' and 'distributed' scenarios represented how effort would be distributed if it were focused only on the top-priority actions, or spread out evenly among most of the actions that were considered important, respectively.

Grassland habitats in the Kankakee Region were emphasized heavily by respondents to the Habitat Survey. Protection of grasslands was the top-ranked action in every scenario, and other actions that focused on grasslands, such as linking grasslands, restoring grasslands, controlling invasive species in grasslands, and implementing fire regimes, were also in the top ten.

Although transformation of landscapes in a GIS environment was not possible with current knowledge of how Indiana landscapes change, in the future, managers may find the following results useful in simulating landscape changes under alternative conservation action scenarios.

Table C-4. Percent effort to be devoted to 'on-the-ground' conservation actions (habitat protection, restoration, or improvement) under alternative future conservation action scenarios (see above).

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect grasslands	15%	17%	14%
Protect wetlands	13%	8%	11%
Preserve/create corridors between habitat - grasslands	9%	12%	8%
Preserve/create corridors between habitat - agriculture	7%	10%	5%
Restore grasslands	7%	10%	6%
Enhance wetland connectivity	6%	0%	6%
Restore wetlands	6%	9%	5%
Control invasive species in grasslands	5%	7%	4%
Utilize CRP partnerships to convert cropland to habitat	5%	0%	4%
Implement fire regimes in grasslands	5%	7%	4%
Control invasive species in wetlands	5%	7%	4%
Reduce conversion of wildlife habitat to cropland	5%	7%	3%
Actively manage wetlands for habitat quality	4%	0%	3%
Improve quality of water that drains into wetlands	4%	6%	3%
Control invasive species in forests	4%	0%	2%
Create new wetlands	0%	0%	3%
Preserve/create corridors between habitat - forests	0%	0%	3%
Reduce mowing of hay and pasture - grasslands	0%	0%	3%
Protect forests	0%	0%	3%
Control invasive species in agricultural lands	0%	0%	2%
Increase acres enrolled in the Classified Forest Program	0%	0%	2%
Manage nuisance wildlife populations in wetlands	0%	0%	1%

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Control forest pests	0%	0%	1%
Manage nuisance wildlife populations in agricultural lands	0%	0%	0%
Control invasive species in aquatic systems	0%	0%	0%
Manage nuisance wildlife populations in forests	0%	0%	0%
Enhance pastures and haylands for wildlife	0%	0%	0%
Improve soil health in agricultural lands	0%	0%	0%
Modify drainage management - agricultural lands	0%	0%	0%
Reduce mowing of hay and pasture - agricultural lands	0%	0%	0%
Modify drainage management - aquatic systems	0%	0%	0%
Improve water quality in aquatic systems	0%	0%	0%
Restrict recreational overuse in aquatic systems	0%	0%	0%
Diversify forest types (e.g., create forest openings)	0%	0%	0%
Reestablish fire regimes in forests	0%	0%	0%
Restrict recreational overuse in forests	0%	0%	0%
Improve drainage management to improve wetlands	0%	0%	0%
Protect aquatic systems	0%	0%	0%
Protect buffer zones adjacent to aquatic systems	0%	0%	0%
Restore wildlife habitat within agricultural matrix	0%	0%	0%
Restore aquatic systems	0%	0%	0%
Restore riparian zones	0%	0%	0%
Restore forests	0%	0%	0%
Create adequate vegetative buffers around wetlands	0%	0%	0%

Corn Belt Region

<u>Terrestrial Modeling Results</u>
Technical experts participating in the Modeling Focus Group suggested the following terrestrial species as candidates for landscape-level modeling:

- **Birds:** American Golden-plover, Henslow's Sparrow, Northern Bobwhite, Peregrine Falcon, Smith's Longspur, Cerulean Warbler, Kentucky Warbler, and Ruffed Grouse
- **Mammals:** Eastern Gray Squirrel, Franklin's Ground Squirrel, Indiana Myotis, Little Brown Myotis, Northern Long-eared Myotis, Eastern Red Bat, and Southern Flying Squirrel
- **Amphibians:** Northern Cricket Frog, Northern Leopard Frog, and Wood Frog
- **Reptiles:** Black Rat Snake, Kirtland's Snake, and Racer

Respondents to the species survey voted for species from this initial list based on habitat types and were given space to suggest additional species. The top-ranked species were:

- **Forests:** Southern Flying Squirrel, Eastern Gray Squirrel, Eastern Red Bat, Pileated Woodpecker, Wood Thrush, Cerulean Warbler, Eastern Box Turtle, and Northern Leopard Frog
- **Grasslands:** Northern Bobwhite, Henslow's Sparrow, and Northern Leopard Frog
- **Early Successional:** American Woodcock and Ruffed Grouse
- **Wetlands/Aquatic Systems:** Northern Leopard Frog

Ultimately, the following species were chosen for landscape-level modeling (Chapter V): Northern Bobwhite, Eastern Red Bat, Northern Leopard Frog, Henslow's Sparrow, American Woodcock, and Cerulean Warbler.

Landscape-level models were built for each of the species above that estimated the quality of current habitat conditions (Chapter V). Figures C-25 through C-30 below shows the resulting habitat suitability scores on maps for each representative species. To produce a map of average habitat suitability across all species tested, the scores for individual cells were averaged. Figure C-31 represents these cumulative suitability scores. For cleaner interpretation of the cumulative scores, an additional figure (Fig. C-32) is found below which groups the average scores into quartiles (0.00-2.25 - poor; 0.25-0.50 - fair; 0.50-0.75 - good; 0.75-1.00 - excellent). Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

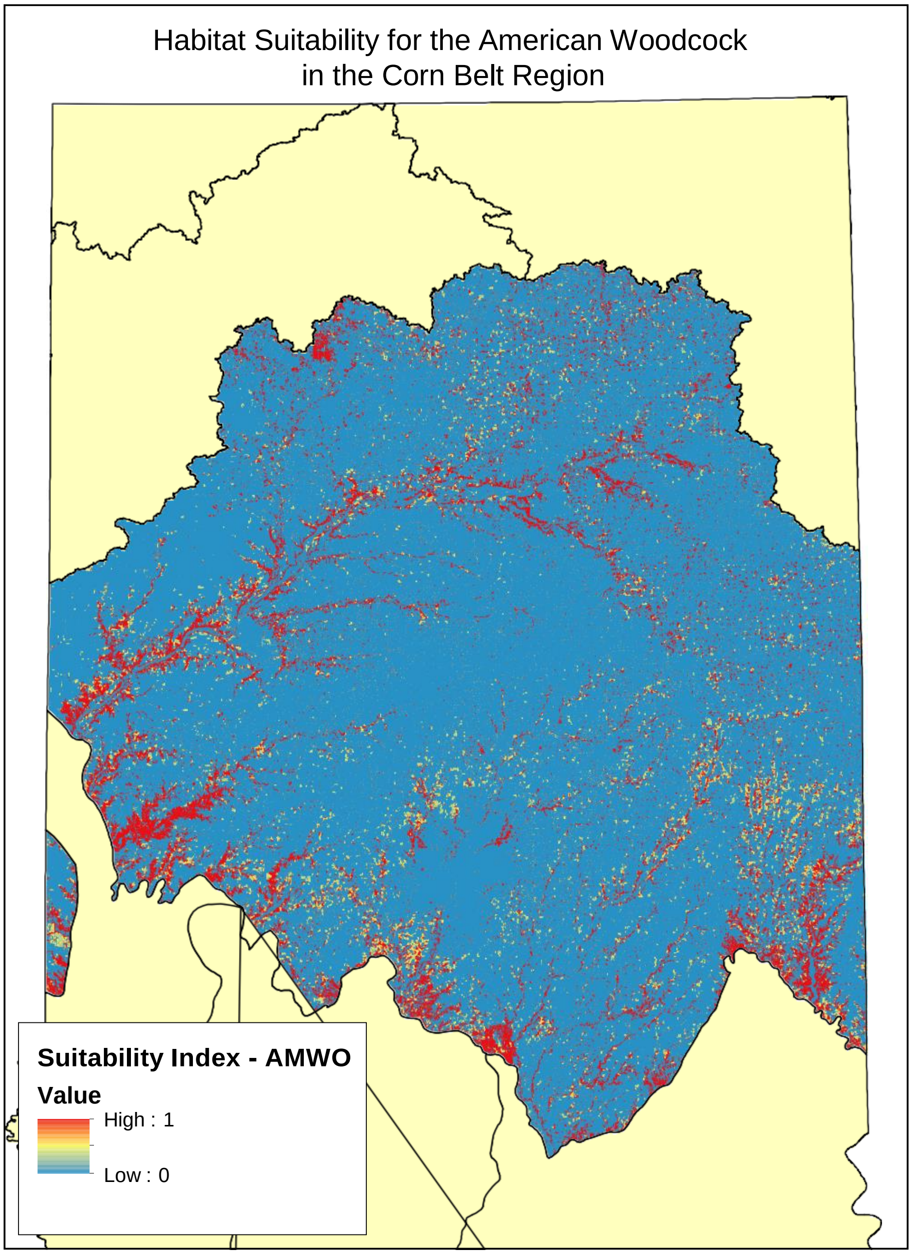

Figure C-25. Habitat suitability scores for the American Woodcock in the Corn Belt Region.

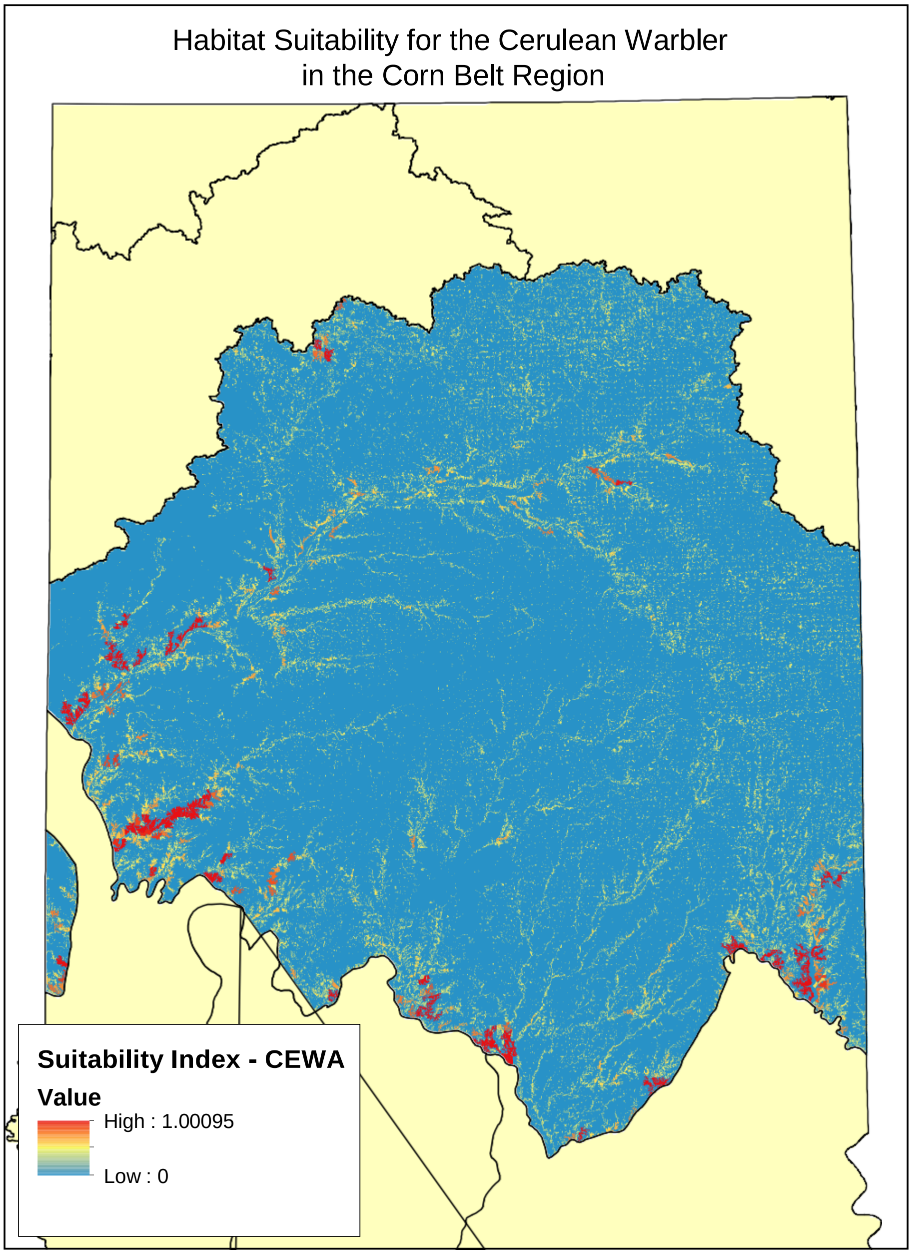

Figure C-26. Habitat suitability scores for the Cerulean Warbler in the Corn Belt Region.

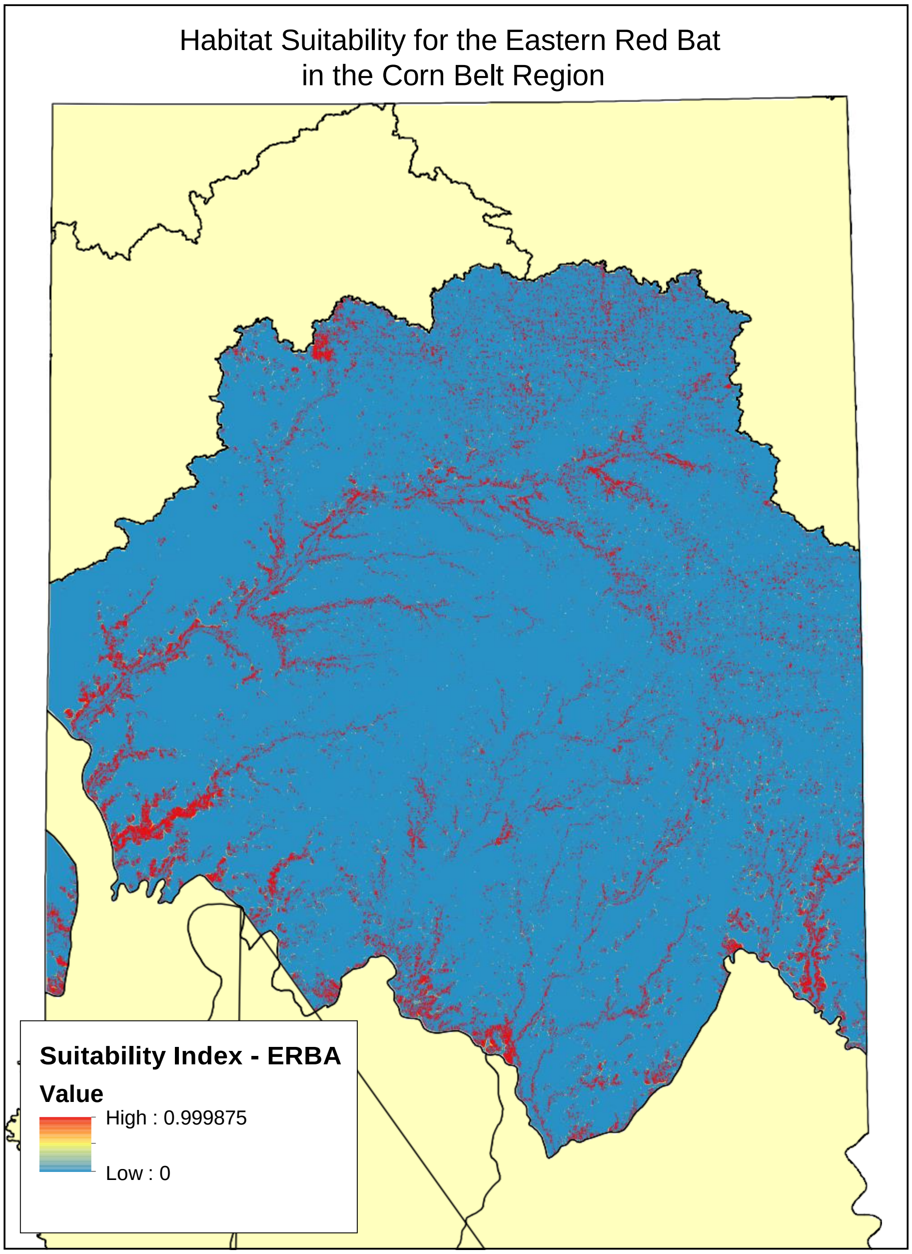

Figure C-27. Habitat suitability scores for the Eastern Red Bat in the Corn Belt Region.

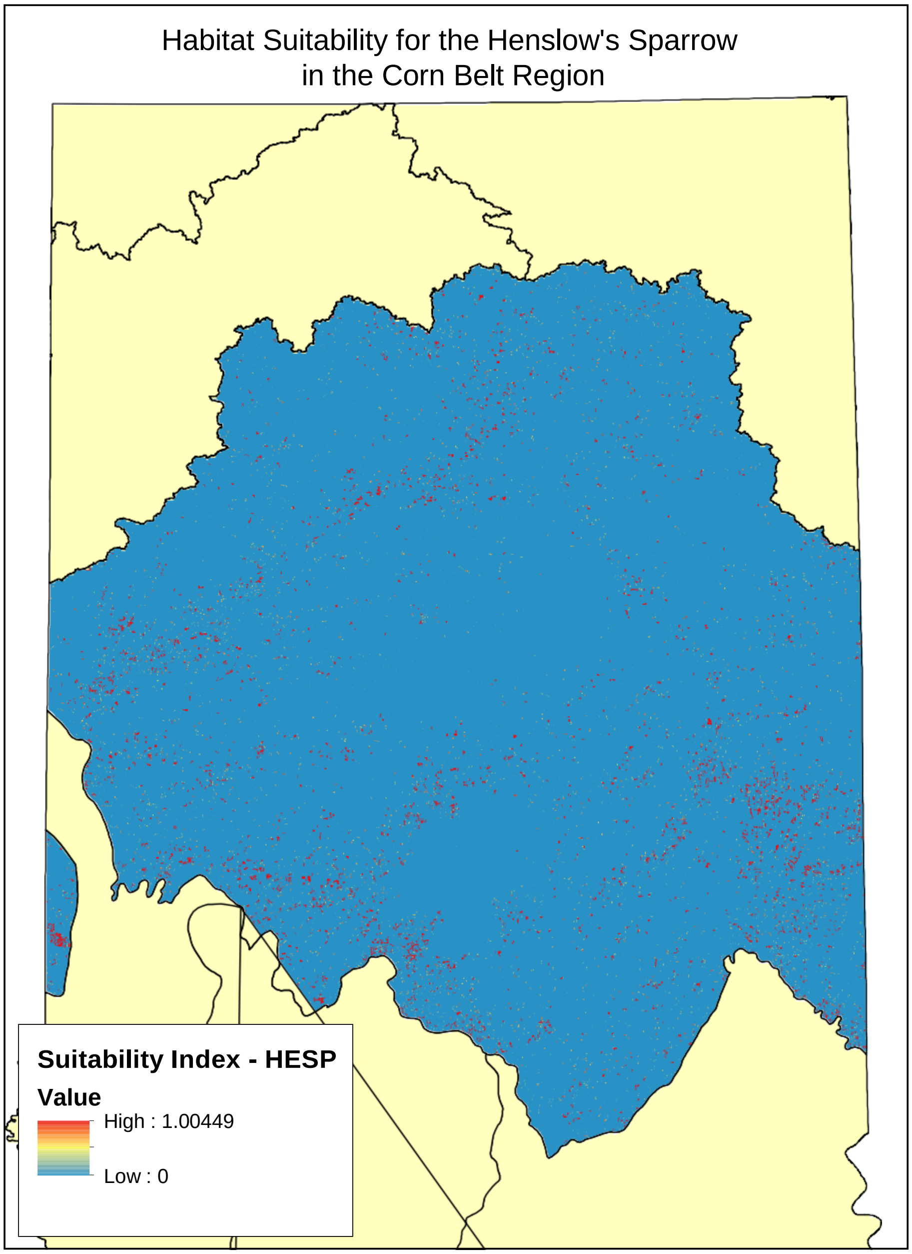

Figure C-28. Habitat suitability scores for the Henslow’s Sparrow in the Corn Belt Region.

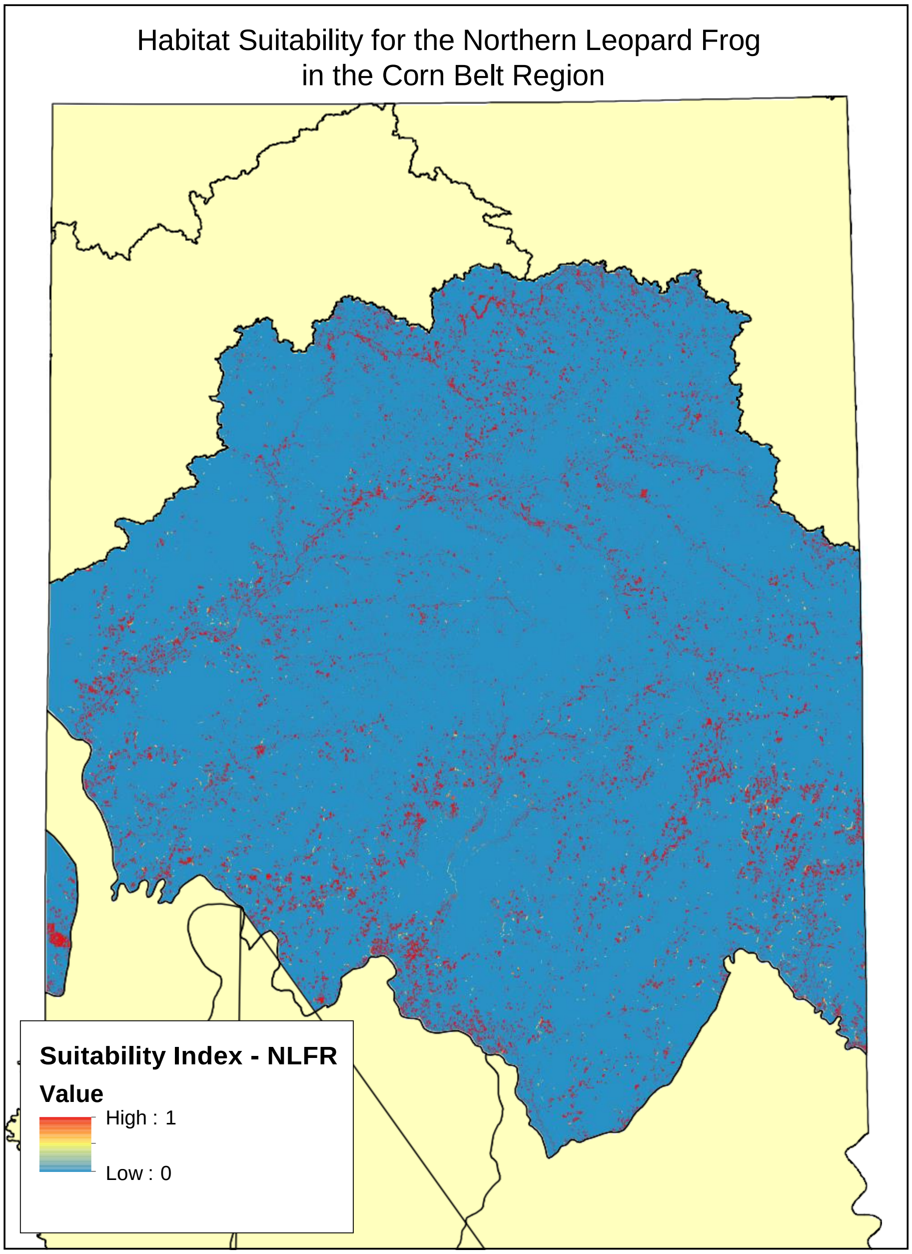

Figure C-29. Habitat suitability scores for the Northern Leopard Frog in the Corn Belt Region.

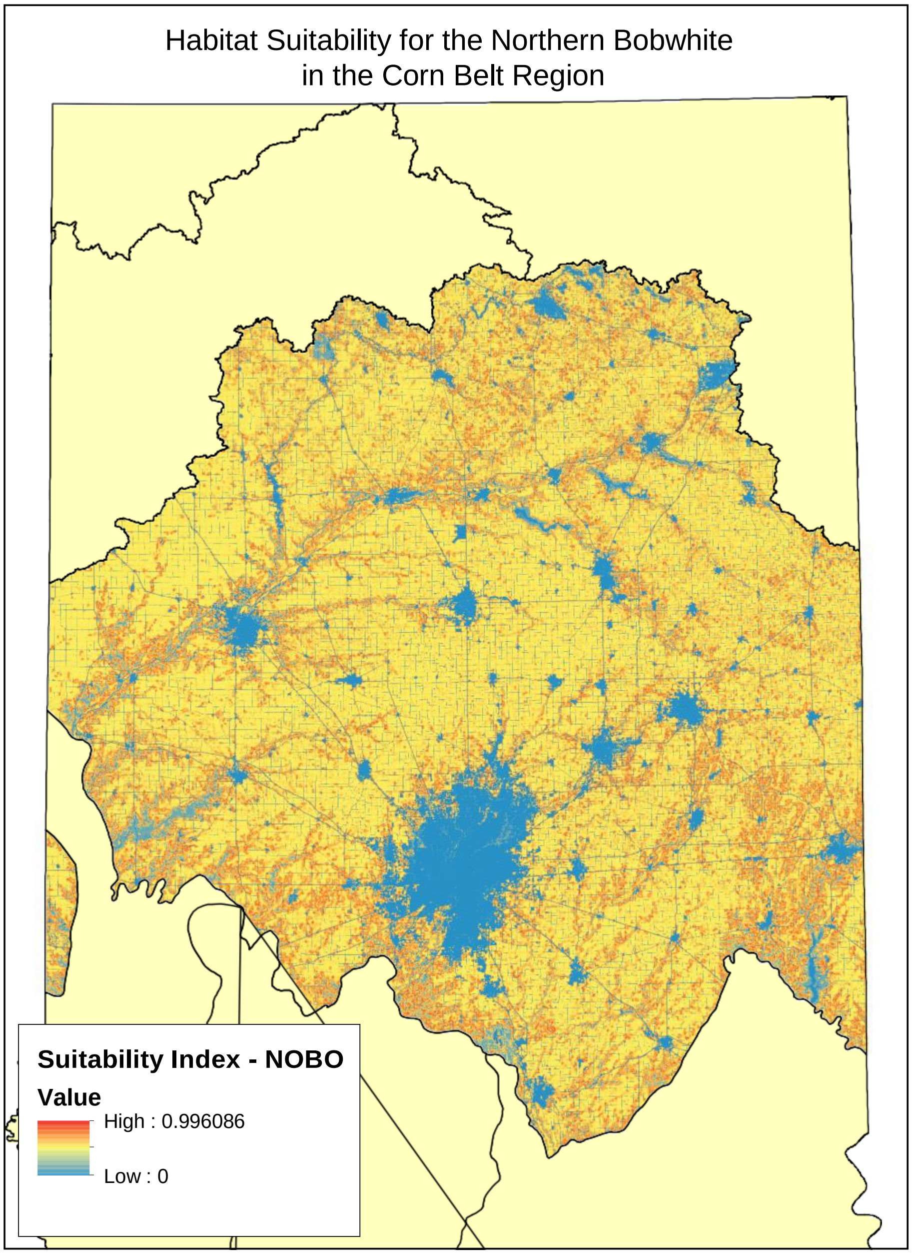

Figure C-30. Habitat suitability scores for the Northern Bobwhite in the Corn Belt Region.

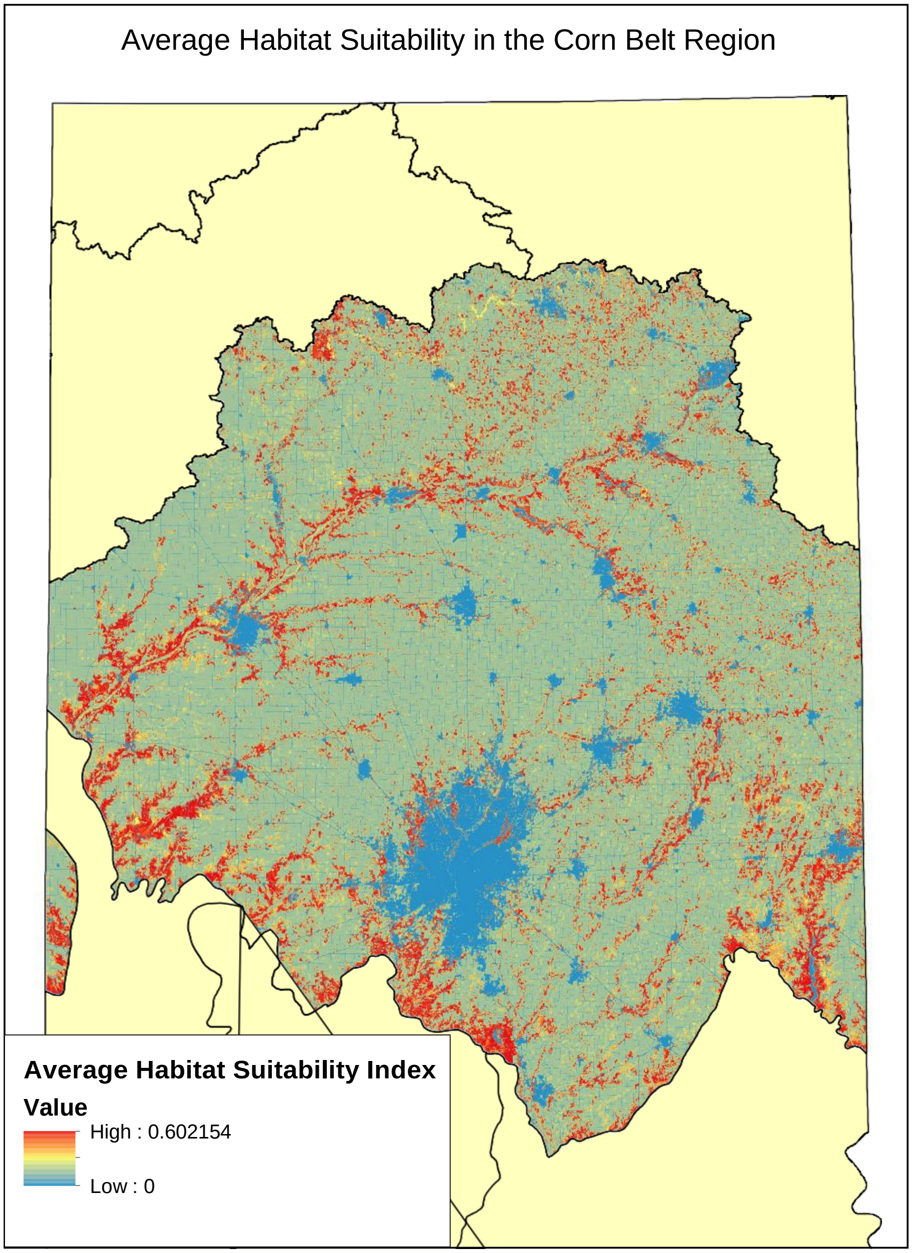

Figure C-31. Cumulative (average) habitat suitability across all the representative species.

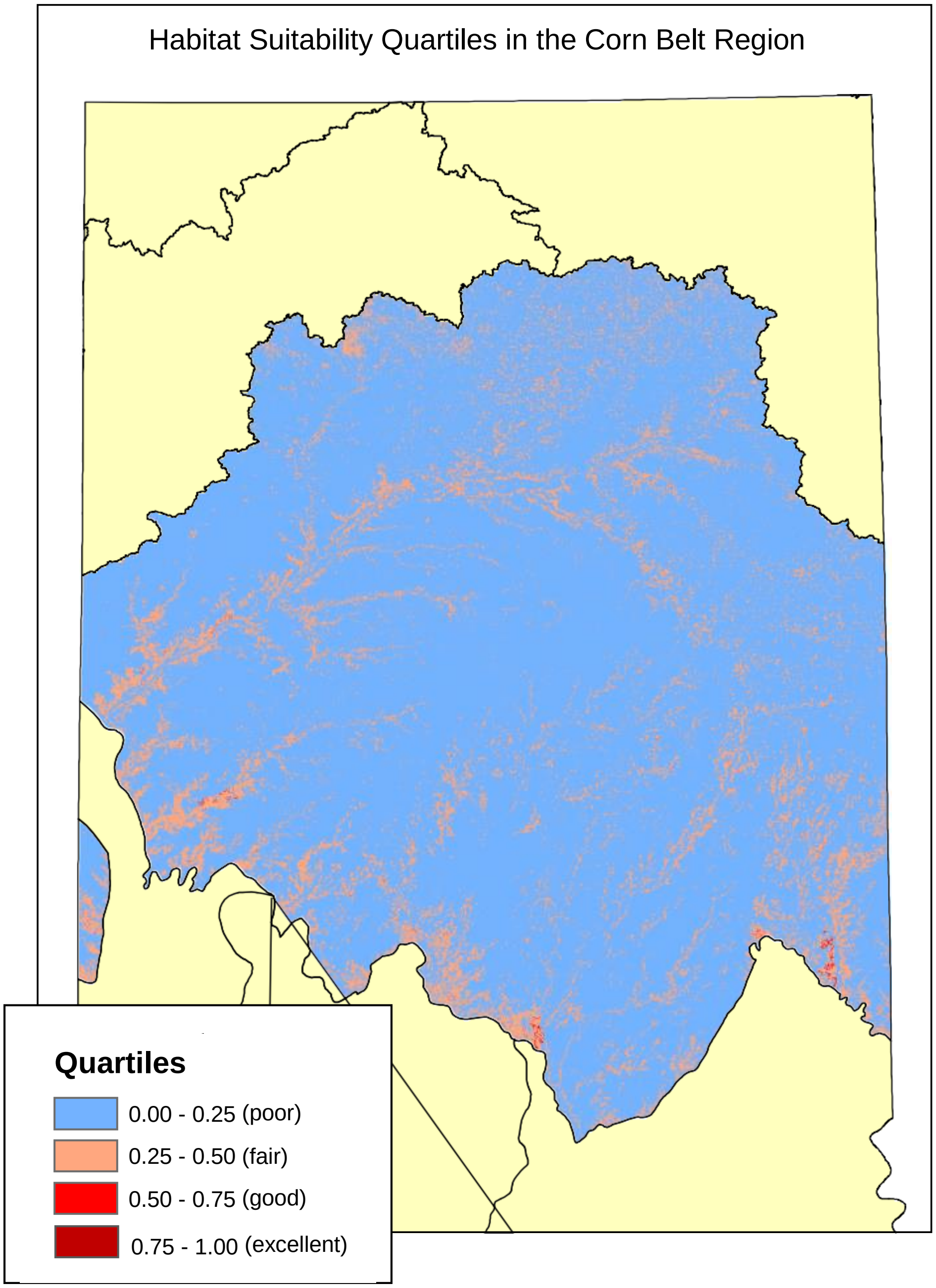

Figure C-32. Habitat suitability quartiles for cumulative scores across all species tested. Scores ranging from 0.00-1.00 were grouped into quartiles (0.00-0.25 - poor, 0.25-0.50 - fair, 0.50-0.75 - good, 0.75-1.00 - excellent) to produce this map. Note that because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Table C-5. Acres assigned to each habitat suitability quartile for each species chosen for landscape-level modeling in the Corn Belt Region. Note that "cumulative habitat suitability," in the last column, does not represent average number of acres in each quartile, but rather the number of acres assigned to each quartile when scores for individual cells were averaged, as in Figure C-32 above. Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent."

Quartile	**Cerulean Warbler**	**Eastern Red Bat**	**Henslow's Sparrow**	**Northern Bobwhite**	**American Woodcock**	**Northern Leopard Frog**	**Cumulative Habitat Suitability**
Poor (0.00-0.25)	10,005,431	9,257,446	9,966,148	1,557,657	8,606,366	9,488,641	8,809,321
Fair (0.25-0.50)	23,261	85,101	42,186	301,638	373,923	51,734	1,246,788
Good (0.50-0.75)	14,260	413,201	18,786	7,802,619	541,974	165,573	7,324
Excellent (0.75-1.00)	20,481	309,221	37,659	402,865	541,170	358,831	0

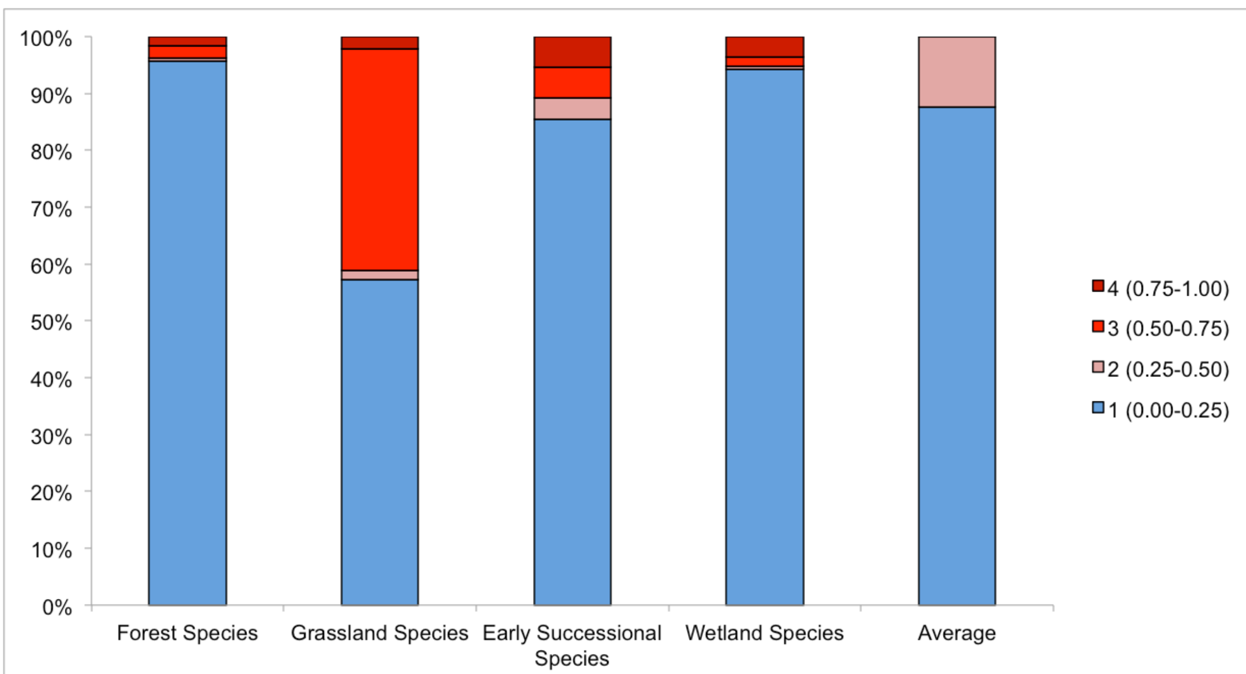

Figure C-33. Percentage of total acreage in the Corn Belt Region assigned to each habitat suitability quartile for species representing forest, grassland, early successional, and wetland habitats. "Average" represents cumulative scores across all species.

Aquatic Modeling Results

Within the Corn Belt Region, the landscape level aquatic modeling predictions broke rankings for QHEI into five categories and rankings for IBI into six categories. For QHEI within this region, the model estimated 885.9 miles in the excellent condition, 4,693.7 miles in good condition, 6,669.8 miles in fair condition, 1,130.9 miles in poor condition, and 35.0 miles in very poor condition.

Figure C-34 displays the linear miles of streams from within this region predicted to be in each QHEI category. For IBI within this region, the model estimated 91.2 miles in the excellent condition, 846.2 miles in good condition, 5,372.3 miles in fair condition, 7,089.3 miles in poor condition, 15.1 miles in very poor condition, and 1.1 miles in fish absent condition. Figure C-35 displays the linear miles of streams from within this region predicted to be in each IBI category.

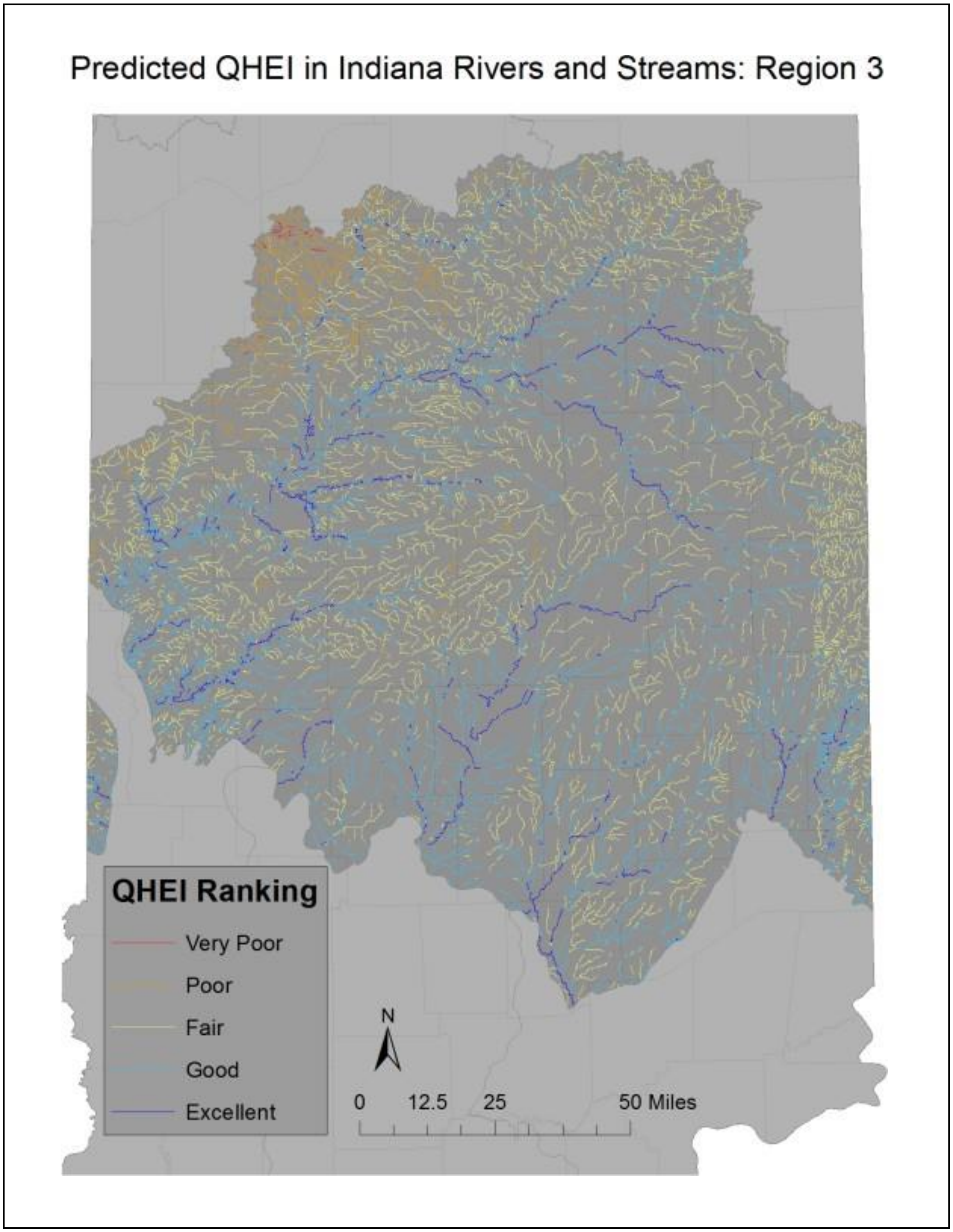

Figure C-34. Streams in the Corn Belt Region predicted to be in each QHEI category.

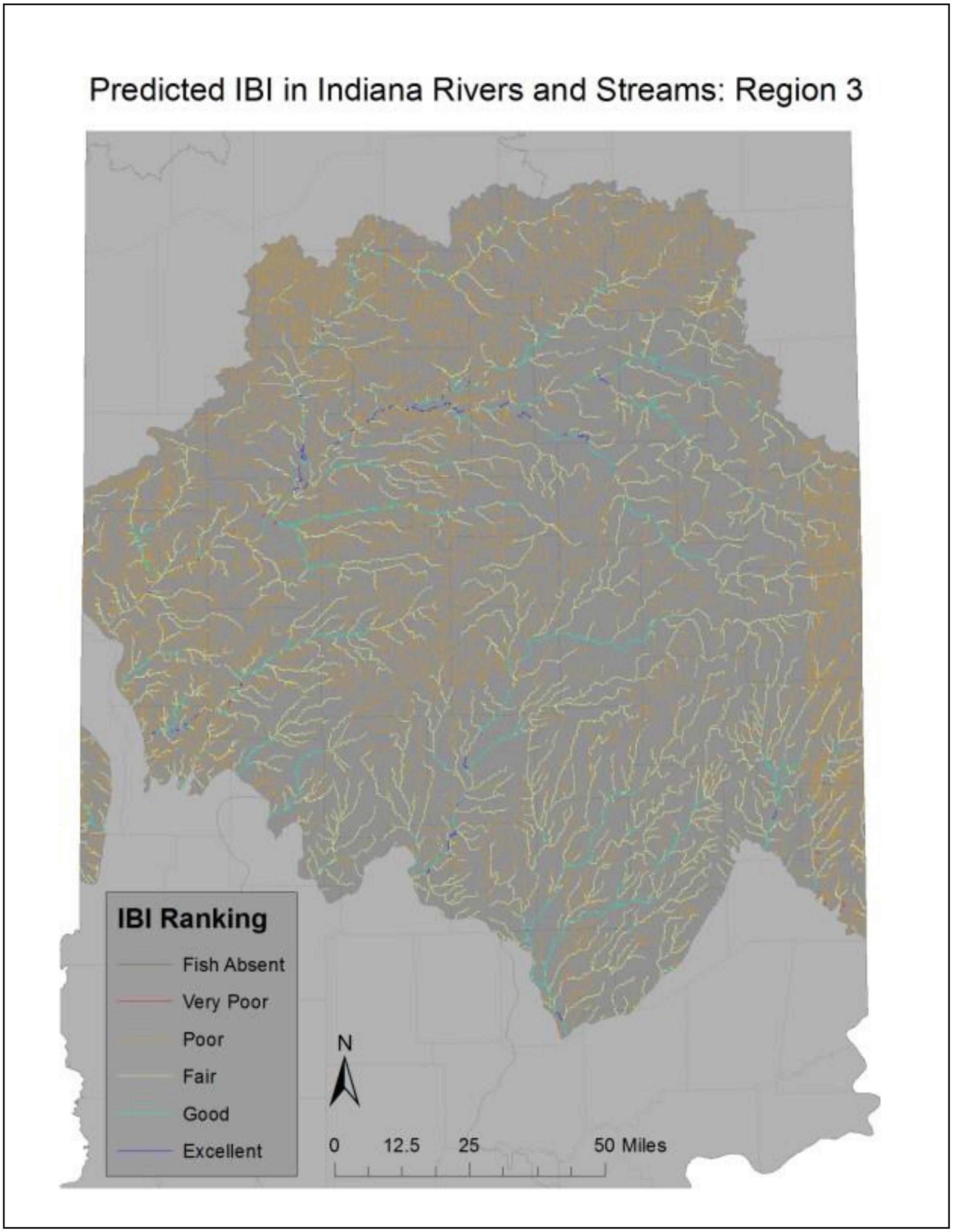

Figure C-35. Streams in the Corn Belt Region predicted to be in each IBI category.

Conservation Action Scenarios

Survey respondents were also asked to assign 100 points of effort to actions that make a difference 'on-the-ground' (such as protection, restoration, or improvement in the quality of existing habitat). Scores for these actions were ranked, and the actions were assembled into three different scenarios for application to a landscape in a GIS environment (Chapter V). The 'baseline' scenario represented the average distribution of effort among 'on-the-ground' actions recommended by survey respondents. The 'focused' and 'distributed' scenarios represented how effort would be distributed if it were focused only on the top-priority actions, or spread out evenly among most of the actions that were considered important, respectively.

Respondents to the Habitat Survey emphasized forests and aquatic systems in this exercise. Protection of forests and aquatic systems were the top-ranked actions in every scenario, and other related actions, such as improving water quality, restoring riparian zones, controlling invasive species, and connecting forest patches, were also in the top ten.

Although transformation of landscapes in a GIS environment was not possible with current knowledge of how Indiana landscapes change, in the future managers may find the following results useful in simulating landscape changes under alternative conservation action scenarios.

Table C-6. Percent effort to be devoted to 'on-the-ground' conservation actions (habitat protection, restoration, or improvement) under alternative future conservation action scenarios (see above).

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect forests	13%	12%	10%
Protect aquatic systems	9%	11%	7%
Improve water quality in aquatic systems	5%	6%	5%
Restore riparian zones	5%	6%	5%
Protect buffer zones adjacent to aquatic systems	5%	6%	4%
Preserve/create corridors between habitat within agricultural matrix	5%	5%	5%
Control invasive species in forests	5%	6%	4%
Control invasive species in aquatic systems	5%	6%	4%
Restore aquatic systems	5%	6%	4%
Preserve/create corridors between forest habitats	5%	5%	5%
Reduce conversion of wildlife habitat to cropland	5%	6%	6%
Improve drainage management for aquatic systems	4%	5%	4%
Use CRP partnerships to convert marginal cropland to habitat	4%	6%	4%
Increase acres enrolled in the Classified Forest Program	4%	0%	3%
Control forest pests	3%	4%	3%
Restore wildlife habitat within agricultural matrix	3%	0%	3%
Improve soil health in agricultural lands	3%	4%	3%
Control invasive species in agricultural lands	3%	0%	2%
Modify drainage management in agricultural lands	3%	0%	2%
Preserve/create corridors between grassland habitats	3%	3%	3%
Enhance wetland connectivity	2%	2%	2%
Preserve/create corridors between barren lands habitat	1%	0%	0%

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect grasslands	0%	0%	4%
Restore forests	0%	0%	2%
Diversify forest types (create forest openings)	0%	0%	2%
Manage nuisance wildlife populations in forests	0%	0%	2%
Protect wetlands	0%	0%	2%
Manage nuisance wildlife populations in agricultural lands	0%	0%	2%
Protect barren lands	0%	0%	0%
Control invasive species in barren lands	0%	0%	0%
Manage nuisance wildlife populations in barren lands	0%	0%	0%
Control invasive species in grasslands	0%	0%	0%
Control invasive species in wetlands	0%	0%	0%
Manage nuisance wildlife populations in wetlands	0%	0%	0%
Enhance pastures and haylands for wildlife in agricultural lands	0%	0%	0%
Reduce mowing of hay and pasture in agricultural lands	0%	0%	0%
Restrict recreational overuse in aquatic systems	0%	0%	0%
Reestablish fire regimes in barrens and glades	0%	0%	0%
Reestablish fire regimes in forests	0%	0%	0%
Restrict recreational overuse in forests	0%	0%	0%
Implement fire regimes in grasslands	0%	0%	0%
Reduce mowing of hay and pasture in grasslands	0%	0%	0%
Actively manage wetlands for habitat quality	0%	0%	0%
Improve quality of water that drains into wetlands	0%	0%	0%
Reduce negative impacts of drainage management on wetlands	0%	0%	0%
Restore barren lands	0%	0%	0%
Restore grasslands	0%	0%	0%
Create adequate vegetative buffers around wetlands	0%	0%	0%
Create new wetlands	0%	0%	0%
Restore wetlands	0%	0%	0%

Valleys & Hills Region

Terrestrial Modeling Results

Technical experts participating in the Modeling Focus Group suggested the following terrestrial species as candidates for landscape-level modeling:

- **Birds:** Northern Bobwhite, Cerulean Warbler, Northern Harrier, American Woodcock, Dickcissel, Hooded Warbler, King Rail, Least Tern, Loggerhead Shrike, Northern Parula, Pileated Woodpecker, Wood Thrush, and Yellow-throated Warbler
- **Mammals:** Indiana Myotis, Little Brown Myotis, Northern Long-eared Myotis, Eastern Red Bat, Southern Flying Squirrel, American Beaver, Bobcat, Swamp Rabbit, and Tri-colored Bat
- **Amphibians:** Northern Cricket Frog, Wood Frog, Crawfish Frog, Eastern Spadefoot, and Spotted Salamander
- **Reptiles:** Racer, Copper-bellied Water Snake, Eastern Box Turtle, and Six-lined Racerunner

Respondents to the species survey voted for species from this initial list based on habitat types and were given space to suggest additional species. The top-ranked species were:

- **Forests:** Swamp Rabbit, Pileated Woodpecker, Cerulean Warbler, Wood Thrush, Eastern Box Turtle, Southern Flying Squirrel, Copper-bellied Water Snake, Spotted Salamander, and Eastern Red Bat
- **Grasslands:** Northern Bobwhite, Eastern Box Turtle, and Henslow’s Sparrow
- **Early Successional:** American Woodcock and Ruffed Grouse
- **Wetlands/Aquatic Systems:** Copper-bellied Water Snake, Swamp Rabbit, and Wood Duck

Ultimately, the following species were chosen for landscape-level modeling (Chapter V): Northern Bobwhite, Henslow’s Sparrow, Cerulean Warbler, American Woodcock, Swamp Rabbit, and Copper-bellied Water Snake.

Landscape-level models were built for each of the species above that estimated the quality of current habitat conditions (Chapter V). Figure C-36 through Figure C-40 below shows the resulting habitat suitability scores on maps for each representative species. To produce a map of average habitat suitability across all species tested, the scores for individual cells were averaged. Figure C-41 represents these cumulative suitability scores. For cleaner interpretation of the cumulative scores, an additional figure (Figure C-42) is found below which groups the average scores into quartiles (0.00-2.25 - poor; 0.25-0.50 - fair; 0.50-0.75 - good; 0.75-1.00 - excellent). Because of the varying habitat needs of the species tested, no single area can represent ‘excellent’ habitat for all of them. Therefore, no areas received a habitat suitability quartile score of “excellent”. Areas which resulted in a “good” score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

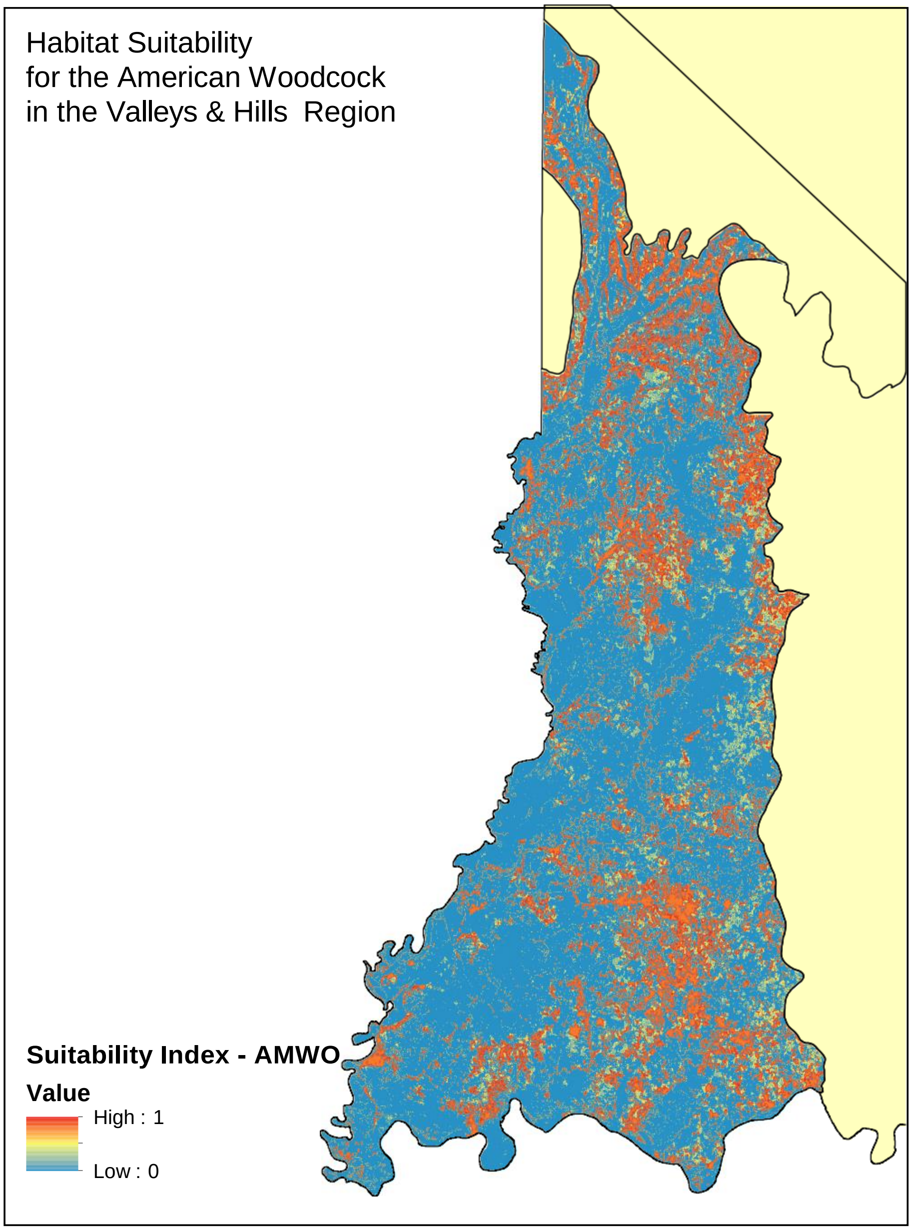

Figure C-36. Habitat suitability scores for the American Woodcock in the Valleys & Hills Region.

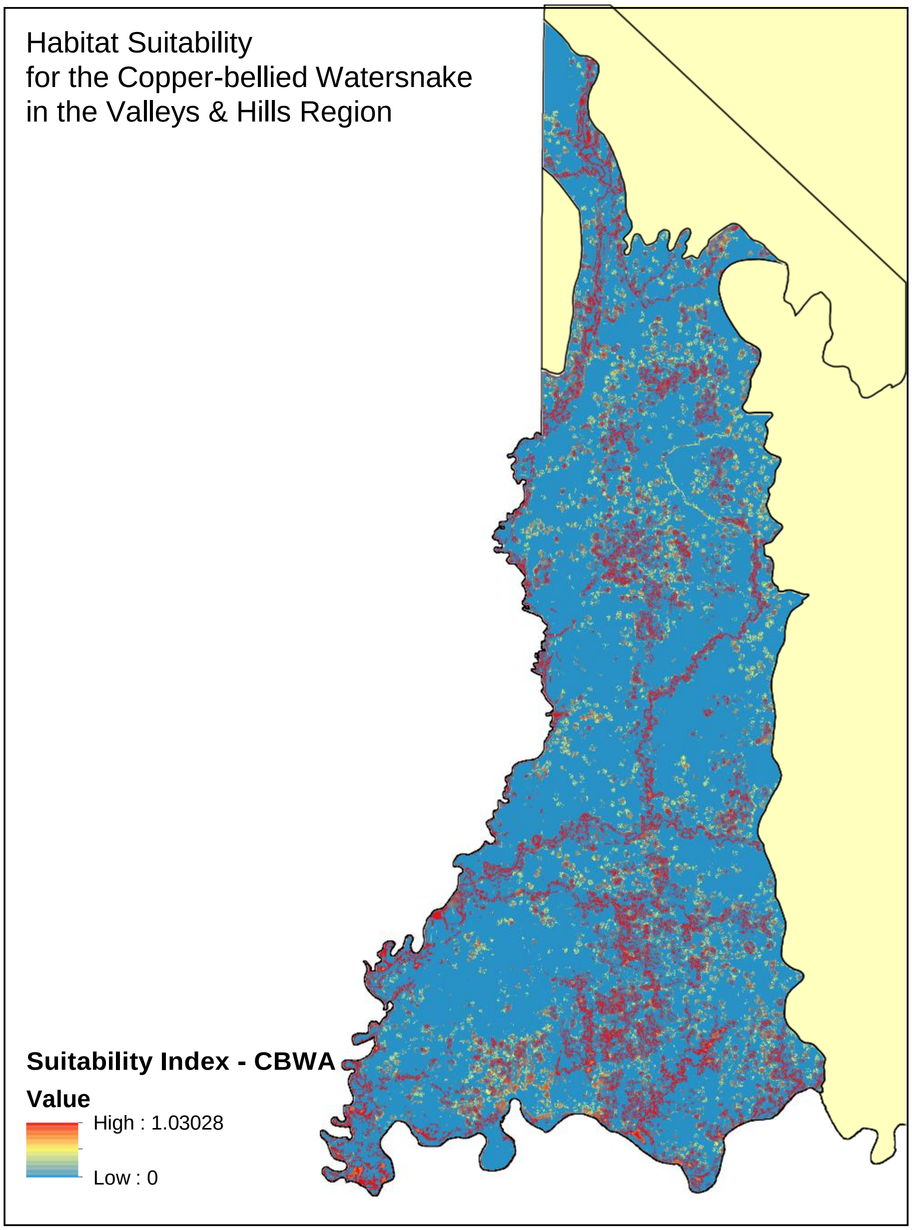

Figure C-37. Habitat suitability scores for the Copper-bellied Water Snake in the Valleys & Hills Region.

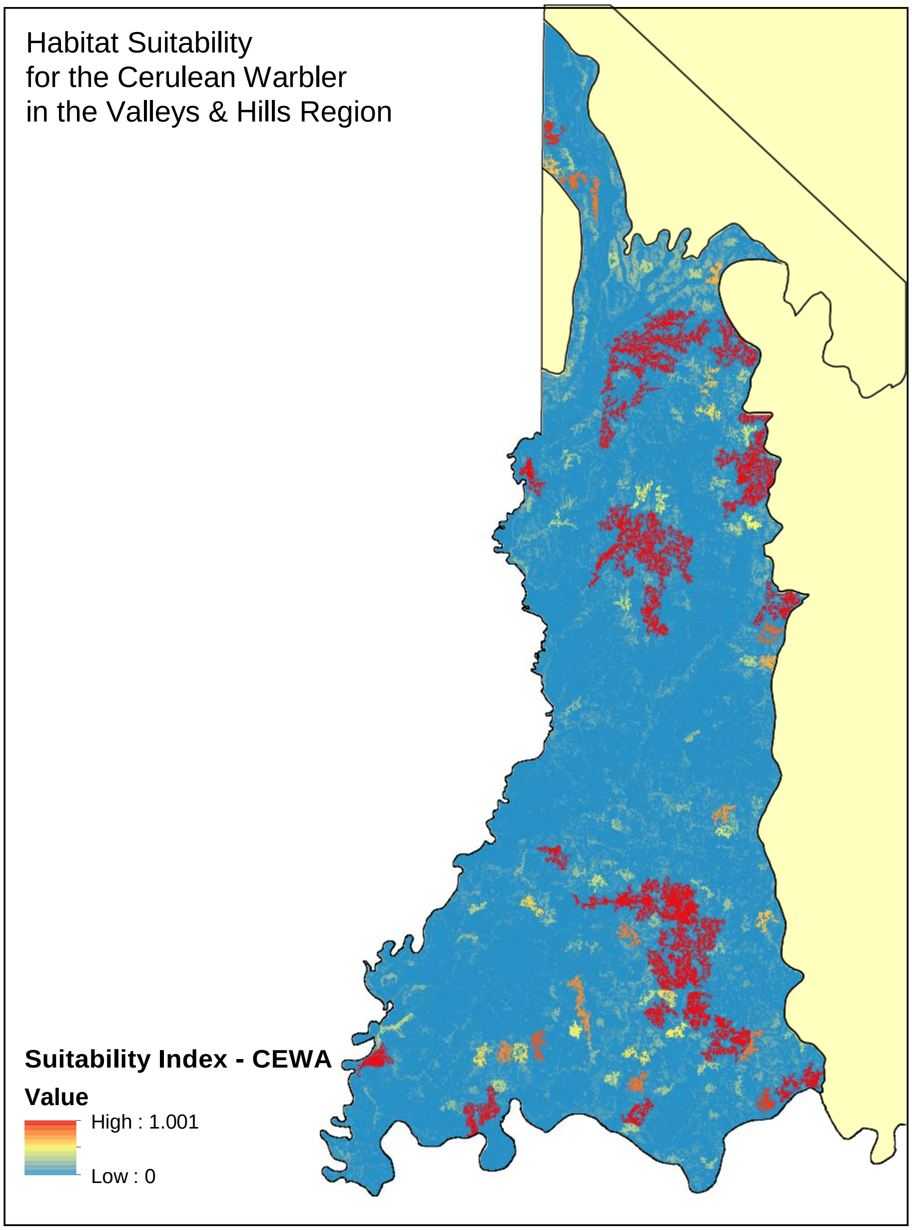

Figure C-38. Habitat suitability scores for the Cerulean Warbler in the Valleys & Hills Region.

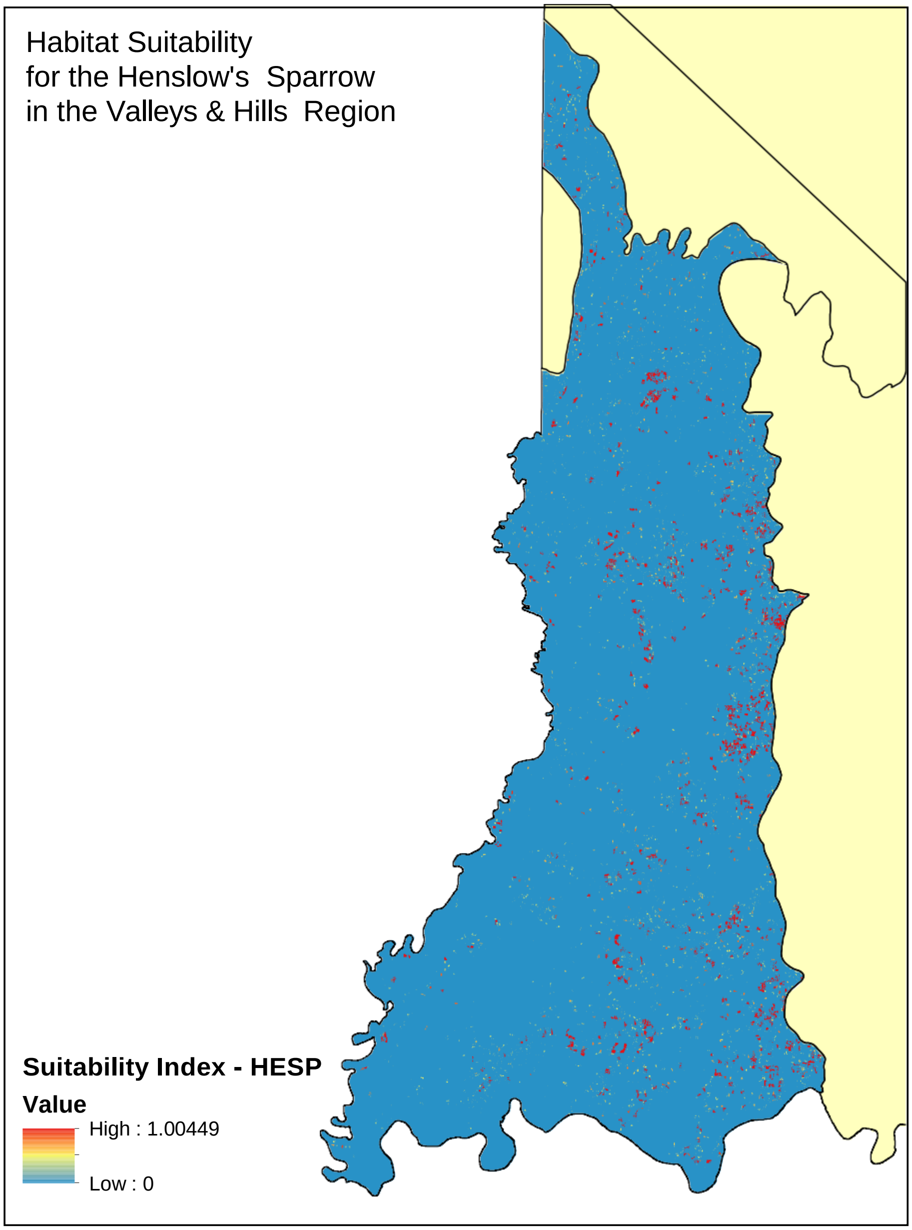

Figure C-38. Habitat suitability scores for the Henslow’s Sparrow in the Valleys & Hills Region.

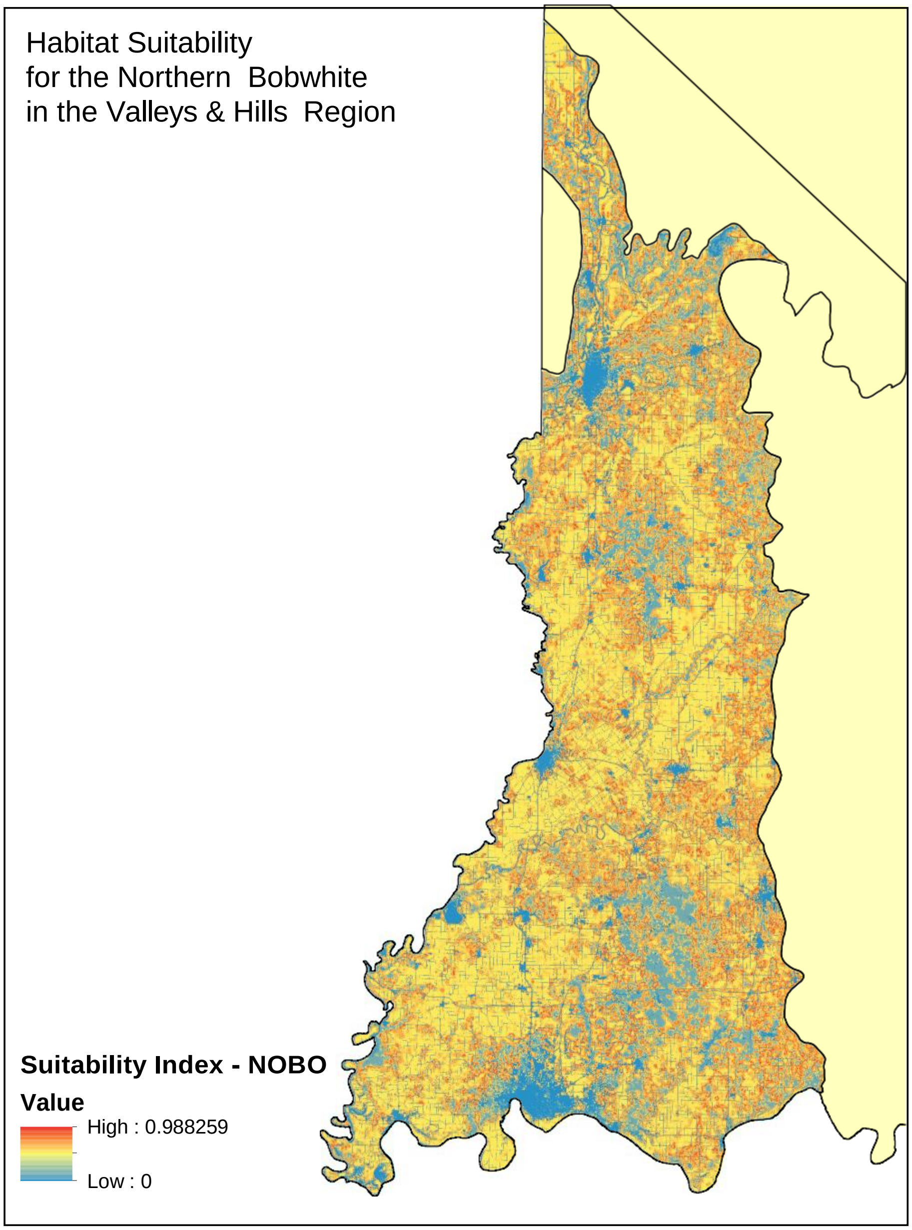

Figure C-39. Habitat suitability scores for the Northern Bobwhite in the Valleys & Hills Region.

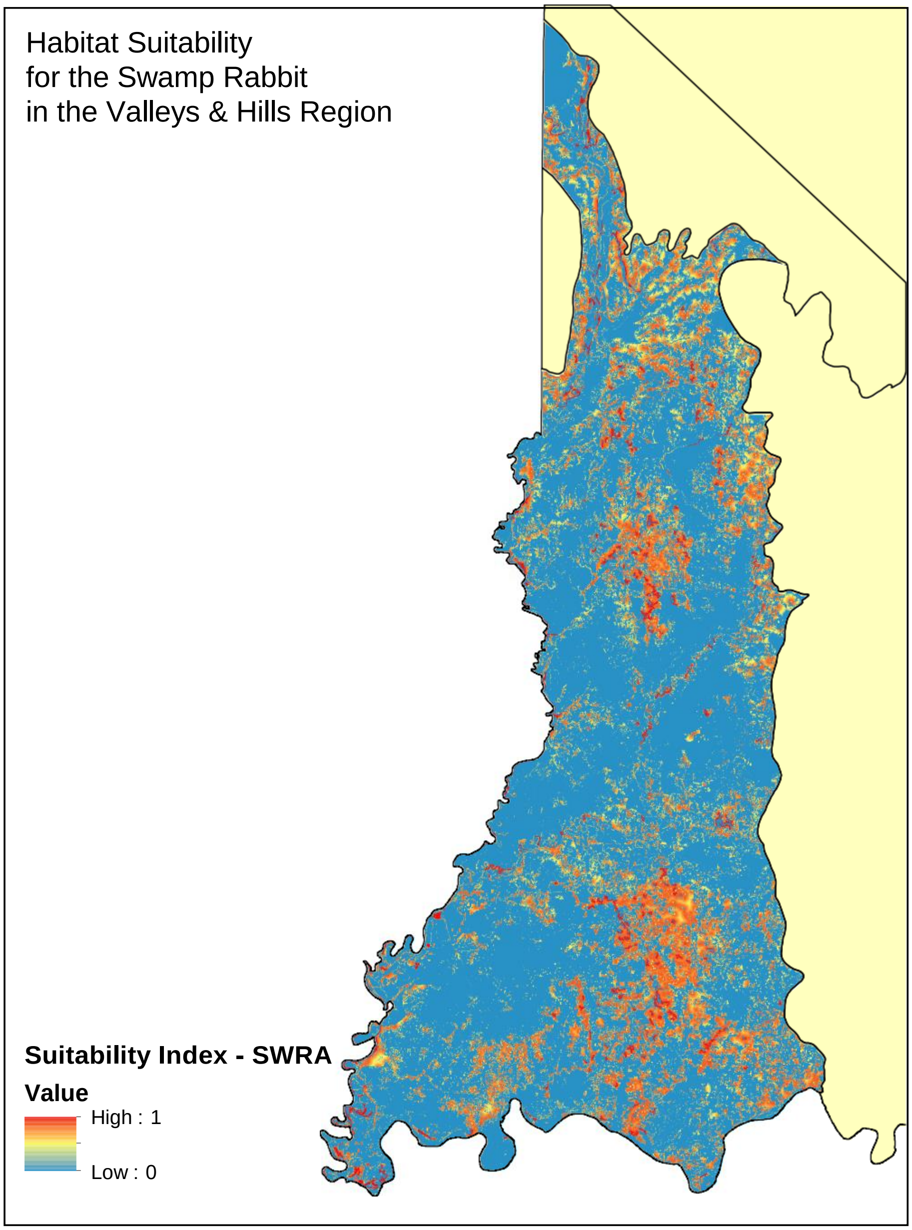

Figure C-40. Habitat suitability scores for the Swamp Rabbit in the Valleys & Hills Region.

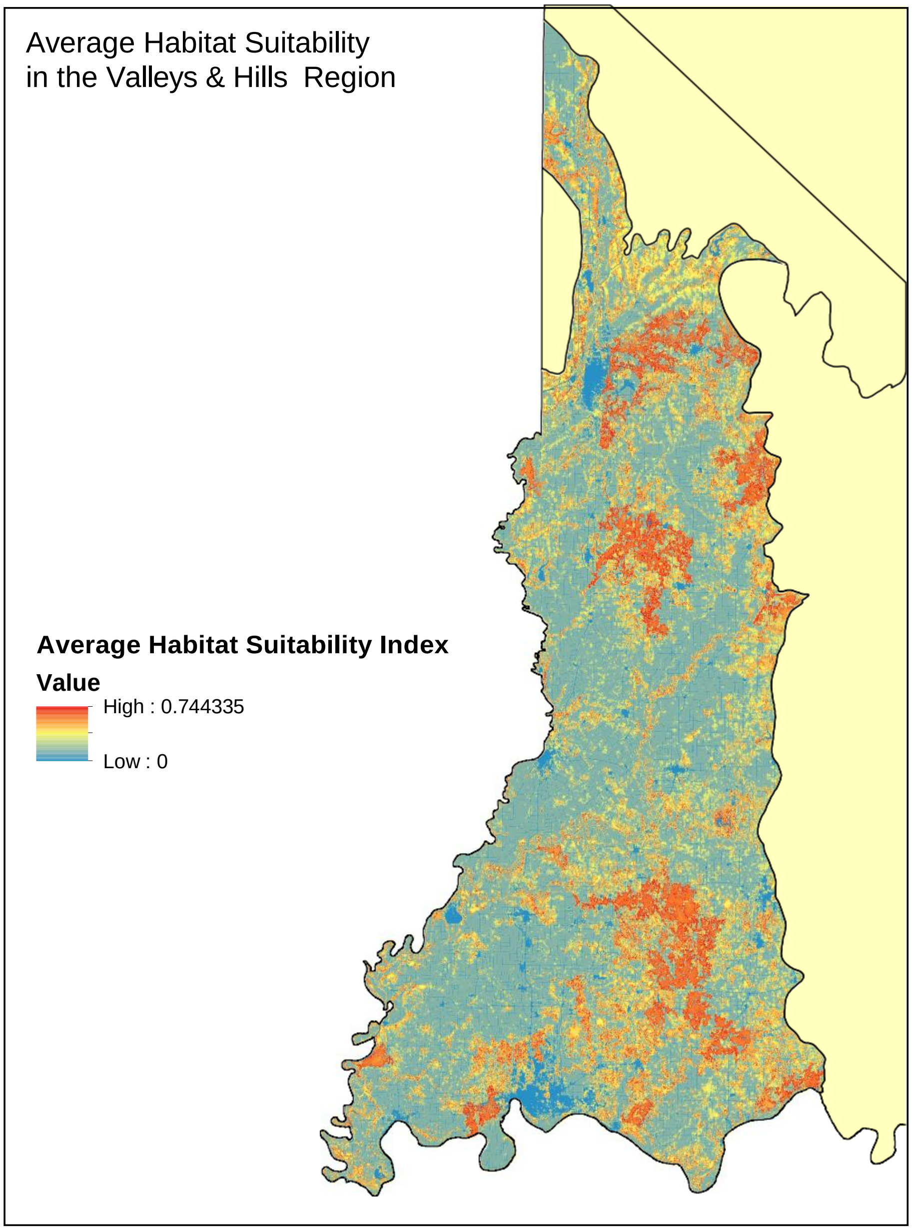

Figure C-41. Cumulative (average) habitat suitability across all the representative species.

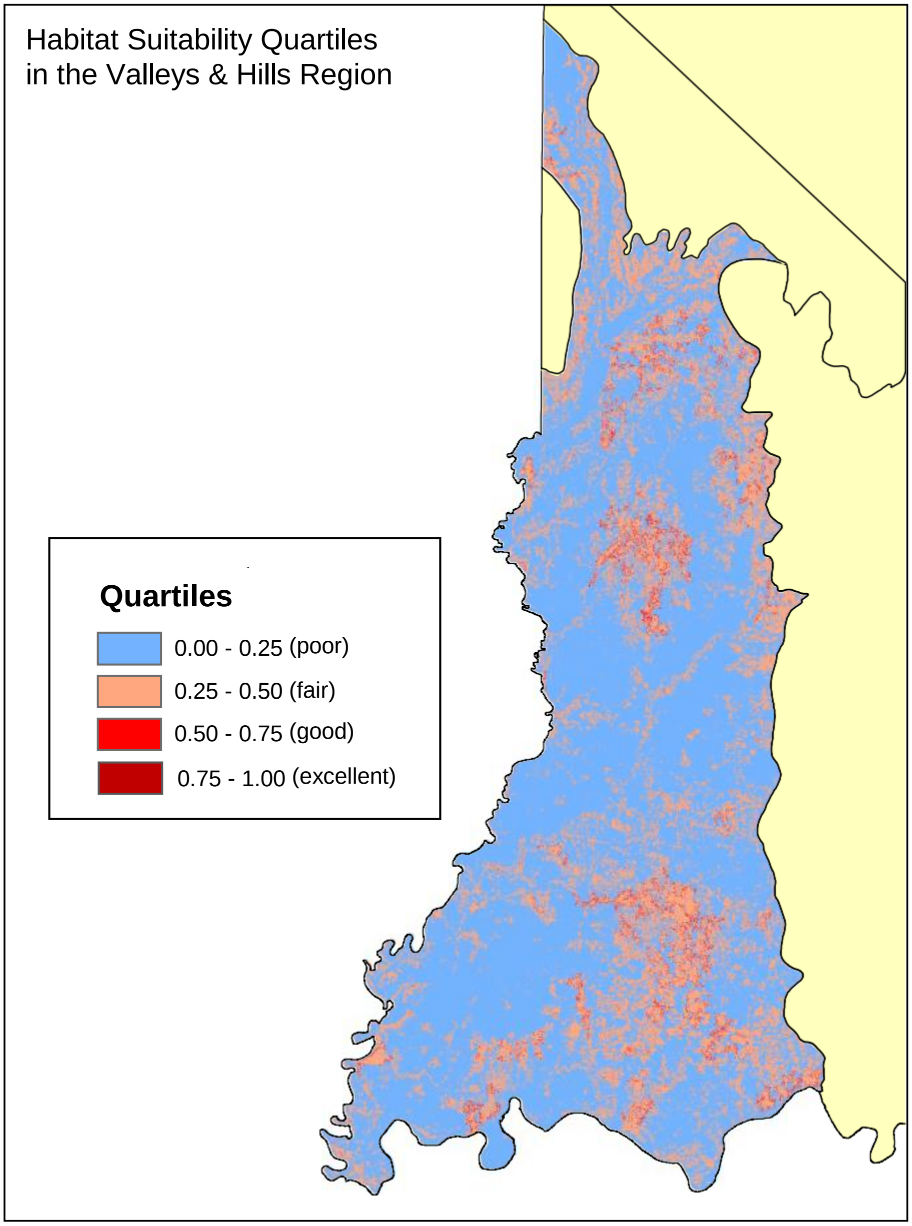

Figure C-42. Habitat suitability quartiles for cumulative scores across all species tested. Scores ranging from 0.00-1.00 were grouped into quartiles (0.00-0.25 - poor, 0.25-0.50 - fair, 0.50-0.75 - good, 0.75-1.00 - excellent) to produce this map. Note that because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent". Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Table C-7. Acres assigned to each habitat suitability quartile for each species chosen for landscape-level modeling in the Valleys & Hills Region. Note that "cumulative habitat suitability", in the last column, does not represent average number of acres in each quartile, but rather the number of acres assigned to each quartile when scores for individual cells were averaged, as in Figure C-42 above. Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent."

Quartile	Cerulean Warbler	Henslow's Sparrow	Northern Bobwhite	American Woodcock	Copper-bellied Water Snake	Swamp Rabbit	Cumulative Habitat Suitability
Poor (0.00-0.25)	3,218,301	3,457,159	772,869	2,470,826	2,907,380	2,710,815	2,536,859
Fair (0.25-0.50)	44,709	15,759	219,133	124,410	121,860	757,424	923,345
Good (0.50-0.75)	33,161	9,031	2,314,949	291,371	101,405	23,667	49,735
Excellent (0.75-1.00)	213,767	29,995	204,992	623,331	381,299	20,037	0

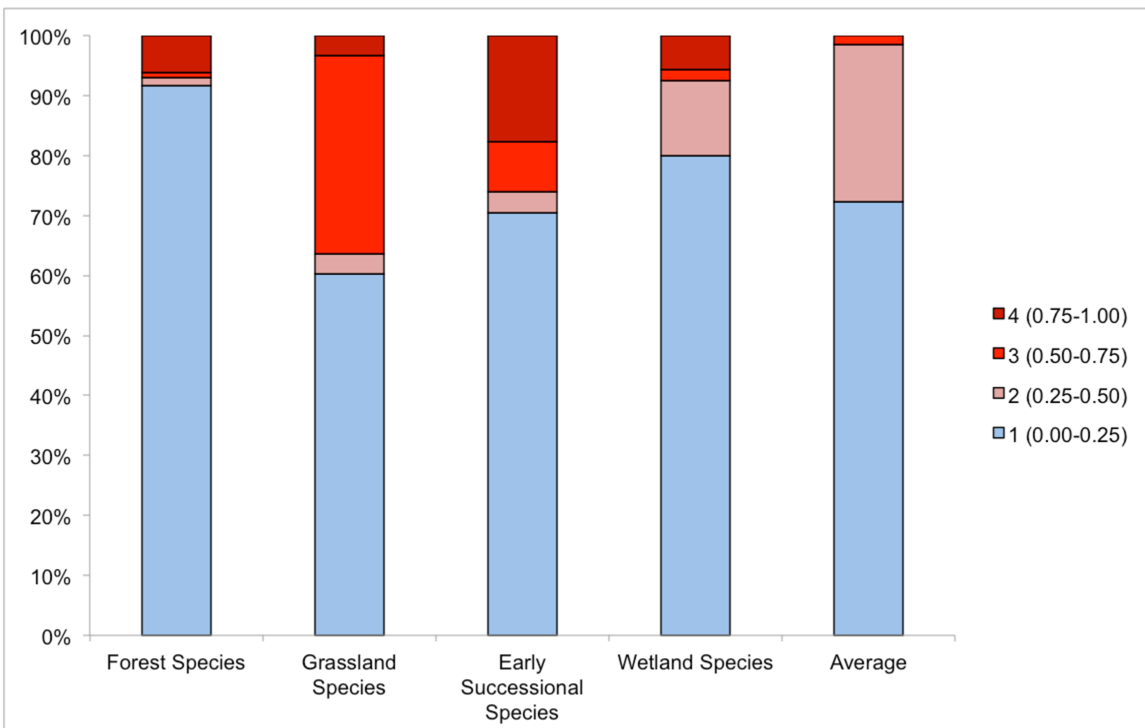

Figure C-43. Percentage of total acreage in the Valleys & Hills Region assigned to each habitat suitability quartile for species representing forest, grassland, early successional, and wetland habitats. "Average" represents cumulative scores across all species.

Results

Within the Valley and Hills Region, the landscape level aquatic modeling predictions broke rankings for QHEI into 5 categories and rankings for IBI into 6 categories. For QHEI within this region, the model estimated 123.3 miles in the excellent condition, 734.2 miles in good condition, 1,885.1 miles in fair condition, 1,604.9 miles in poor condition and 101.6 miles in very poor condition.

Figure C-44 displays the linear miles of streams from within this region predicted to be in each QHEI category. For IBI within this region, the model estimated 25.2 miles in the excellent condition, 124.6 miles in good condition, 911.5 miles in fair condition, 3,315.5 miles in poor condition, 69.7 miles in very poor condition and 2.5 miles in fish absent condition. Figure C-35 displays the linear miles of streams from within this region predicted to be in each IBI category.

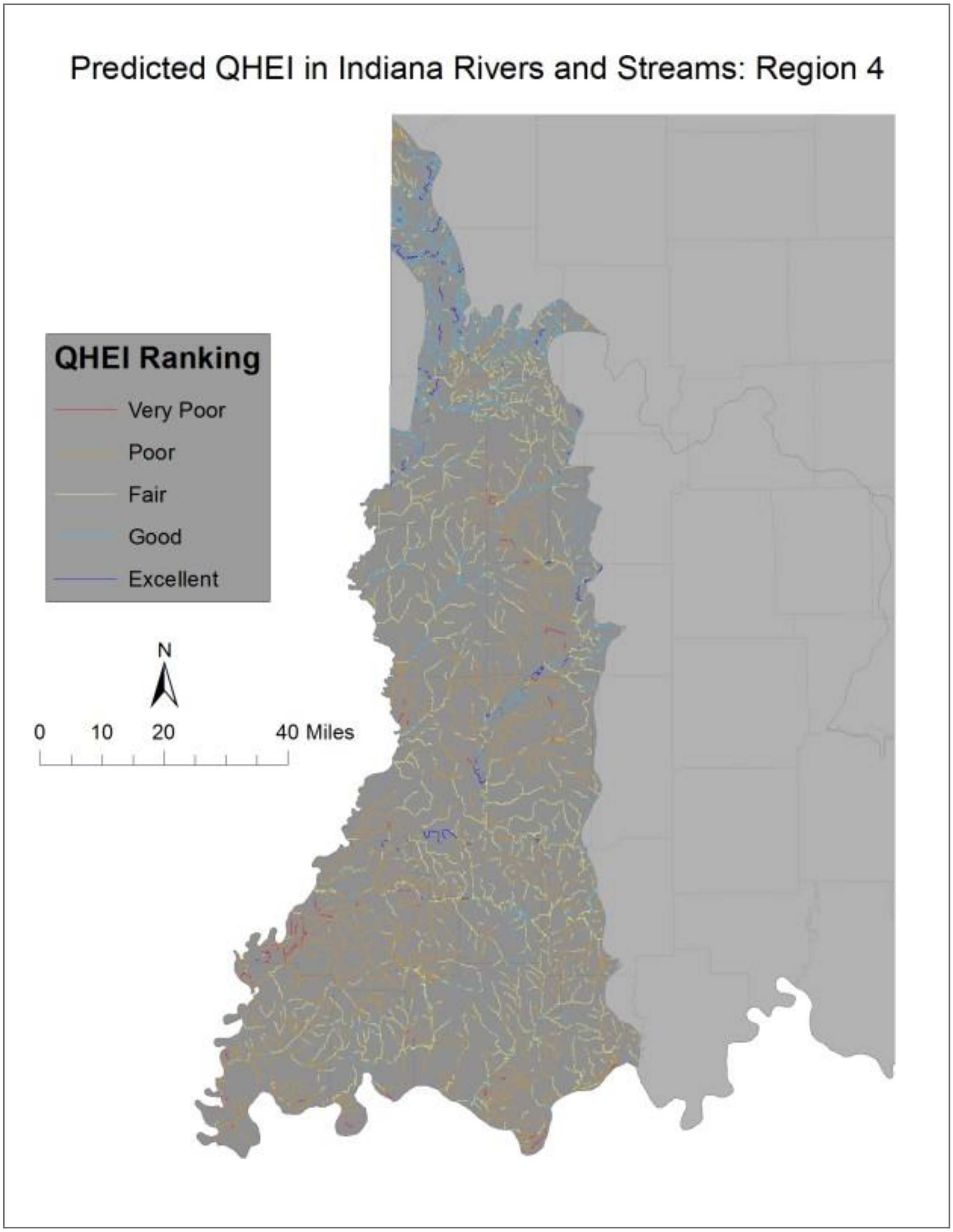

Figure C-44. Streams in the Valleys & Hills Region predicted to be in each QHEI category.

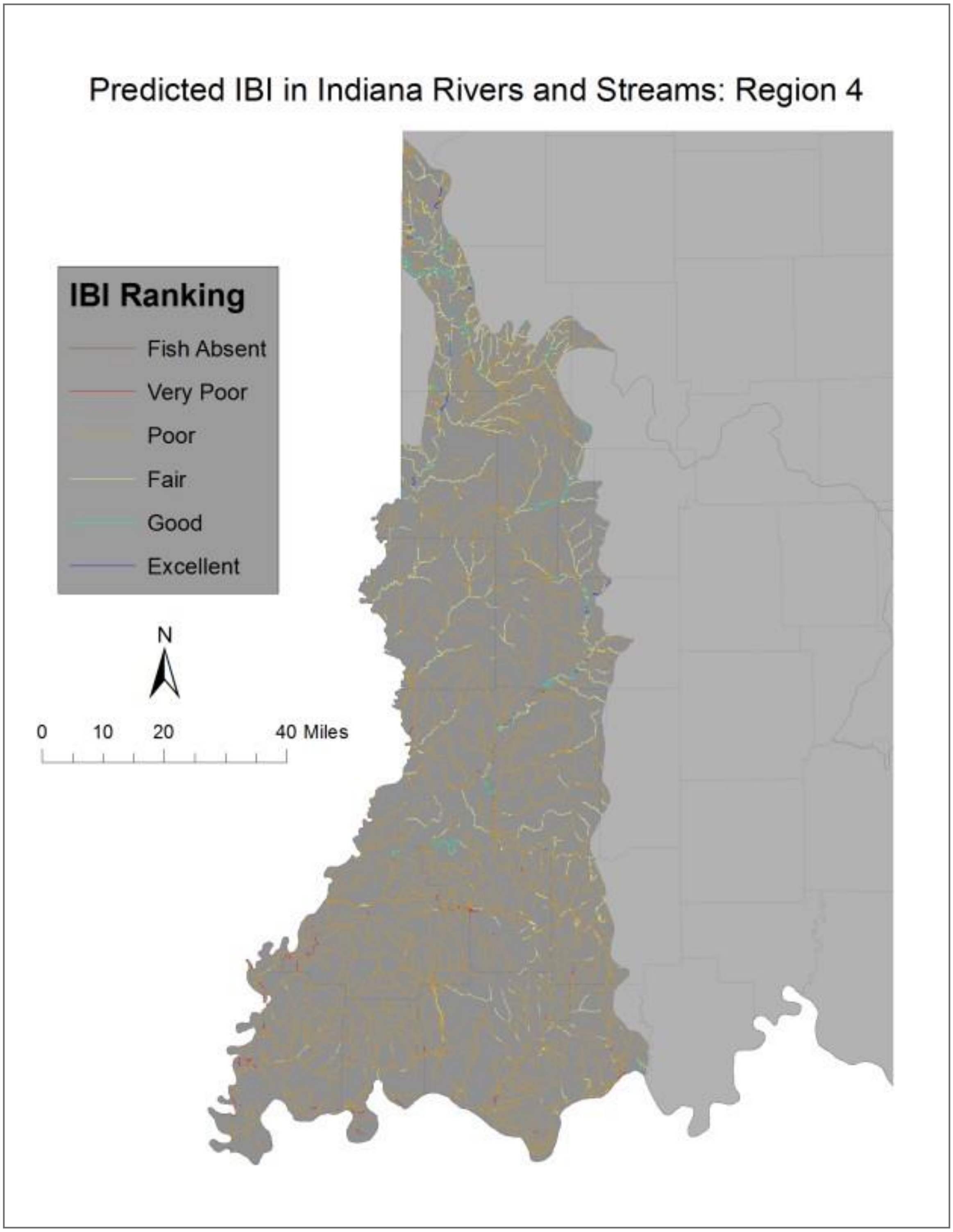

Figure C-45. Streams in the Valleys & Hills Region predicted to be in each IBI category.

Conservation Action Scenarios

Survey respondents were also asked to assign 100 points of effort to actions that make a difference 'on-the-ground' (such as protection, restoration, or improvement in the quality of existing habitat). Scores for these actions were ranked, and the actions were assembled into three different scenarios for application to a landscape in a GIS environment (Chapter V).

The 'baseline' scenario represented the average distribution of effort among 'on-the-ground' actions recommended by survey respondents. The 'focused' and 'distributed' scenarios represented how effort would be distributed if it were focused only on the top-priority actions, or spread out evenly among most of the actions that were considered important, respectively.

Respondents to the Habitat Survey heavily emphasized protection and restoration of habitats in this exercise, especially wetlands, forests, and grasslands. The three top-ranked actions in every scenario were the protection of wetlands, forests, and grasslands. Other actions focusing on these habitat types were also ranked in the top 10 actions, including enhancing connectivity of wetland, forest, and grassland habitats, restoration of riparian zones, and creating new wetlands.

Although transformation of landscapes in a GIS environment was not possible with current knowledge of how Indiana landscapes change, in the future, managers may find the following results useful in simulating landscape changes under alternative conservation action scenarios.

Table C-8. Percent effort to be devoted to 'on-the-ground' conservation actions (habitat protection, restoration, or improvement) under alternative future conservation action scenarios (see above).

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect wetlands	11%	12%	8%
Protect forests	11%	12%	9%
Protect grasslands	10%	7%	7%
Restore grasslands	5%	7%	3%
Restore riparian zones	5%	6%	3%
Restore wetlands	5%	6%	3%
Preserve/create corridors between forest habitats	5%	6%	5%
Enhance wetland connectivity	4%	5%	4%
Preserve/create corridors between grassland habitats	4%	5%	4%
Create new wetlands	4%	0%	2%
Reduce conversion of wildlife habitat to cropland	4%	5%	3%
Implement fire regimes in grasslands	4%	5%	2%
Improve water quality in aquatic systems	4%	5%	2%
Diversify forest types (e.g., create forest openings)	4%	5%	2%
Actively manage wetlands for habitat quality	3%	0%	2%
Control invasive species in forests	3%	5%	2%
Preserve/create corridors between habitat within agricultural matrix	3%	0%	3%
Control invasive species in aquatic systems	3%	4%	2%
Manage nuisance species in forests	2%	4%	2%

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Control invasive species in wetlands	2%	0%	2%
Control forest pests	2%	0%	2%
Preserve/create corridors between barren lands habitat	0%	0%	0%
Protect aquatic systems	0%	0%	5%
Increase acres enrolled in Classified Forest Program	0%	0%	3%
Create adequate vegetative buffers around wetlands	0%	0%	3%
Restore forests	0%	0%	2%
Restore aquatic systems	0%	0%	2%
Protect buffer zones around aquatic systems	0%	0%	2%
Improve drainage management to benefit aquatic systems	0%	0%	2%
Improve water quality in wetlands	0%	0%	2%
Reduce mowing during nesting season in grasslands	0%	0%	2%
Reestablish fire regimes in forests	0%	0%	1%
Control invasive species in grasslands	0%	0%	1%
Control invasive species in agricultural lands	0%	0%	1%
Manage nuisance wildlife populations in wetlands	0%	0%	1%
Manage nuisance wildlife populations in agricultural lands	0%	0%	1%
Control invasive species in barren lands	0%	0%	0%
Manage nuisance wildlife populations in barren lands	0%	0%	0%
Enhance pastures and haylands for wildlife	0%	0%	0%
Improve soil health in agricultural lands	0%	0%	0%
Modify drainage management in agricultural lands	0%	0%	0%
Reduce mowing during nesting season in agricultural lands	0%	0%	0%
Restrict recreational overuse in aquatic systems	0%	0%	0%
Reestablish fire regimes in barrens and glades	0%	0%	0%
Restrict recreational overuse in forests	0%	0%	0%
Reduce negative impacts of drainage management on wetlands	0%	0%	0%
Protect barren lands	0%	0%	0%
Convert marginal cropland to wildlife habitat	0%	0%	0%
Restore wildlife habitat within agricultural matrix	0%	0%	0%
Restore barren lands	0%	0%	0%

Interior Plateau Region

Terrestrial Modeling Results

Technical experts participating in the Modeling Focus Group suggested the following terrestrial species as candidates for landscape-level modeling:

- **Birds:** Northern Bobwhite, Cerulean Warbler, Hooded Warbler, Pileated Woodpecker, Wood Thrush, Ruffed Grouse, Bald Eagle, Eastern Whip-poor-will, Louisiana Waterthrush, Ovenbird, Prairie Warbler, Red-shouldered Hawk, Wild Turkey, Worm-eating Warbler
- **Mammals:** Indiana Myotis, Little Brown Myotis, Northern Long-eared Myotis, Eastern Red Bat, American Beaver, Tri-colored Bat, River Otter, Allegheny Woodrat, Eastern Chipmunk, Pygmy Shrew, Smoky Shrew
- **Amphibians:** Wood Frog, Eastern Spadefoot, Cave Salamander, Green Salamander, Hellbender, Longtail Salamander, Northern Slimy Salamander
- **Reptiles:** Racer, Eastern Box Turtle, Northern Copperhead, Timber Rattlesnake

Respondents to the species survey voted for species from this initial list based on habitat types and were given space to suggest additional species. The top-ranked species were:

- **Forests:** Cerulean Warbler, Pileated Woodpecker, Timber Rattlesnake, Eastern Box Turtle, Ovenbird, Eastern Red Bat, Southern Flying Squirrel
- **Grasslands:** Northern Bobwhite, Prairie Warbler, Eastern Box Turtle, Prairie Warbler, American Woodcock
- **Early Successional:** Ruffed Grouse, American Woodcock, Prairie Warbler, Hooded Warbler
- **Wetlands/Aquatic Systems:** Eastern Box Turtle, River Otter

Ultimately, the following species were chosen for landscape-level modeling (Chapter V): Cerulean Warbler, Ruffed Grouse, Northern Bobwhite, Eastern Box Turtle, Timber Rattlesnake, and Prairie Warbler.

Landscape-level models were built for each of the species above that estimated the quality of current habitat conditions (Chapter V). Figure 46 though Figure 51 below shows the resulting habitat suitability scores on maps for each representative species. To produce a map of average habitat suitability across all species tested, the scores for individual cells were averaged. Figure 52 represents these cumulative suitability scores. For cleaner interpretation of the cumulative scores, an additional figure (Figure 53) is found below which groups the average scores into quartiles (0.00-2.25 - poor; 0.25-0.50 - fair; 0.50-0.75 - good; 0.75-1.00 - excellent). Because of the varying habitat needs of the species tested, no single area can represent ‘excellent’ habitat for all of them. Therefore, no areas received a habitat suitability quartile score of “excellent.” Areas which resulted in a “good” score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

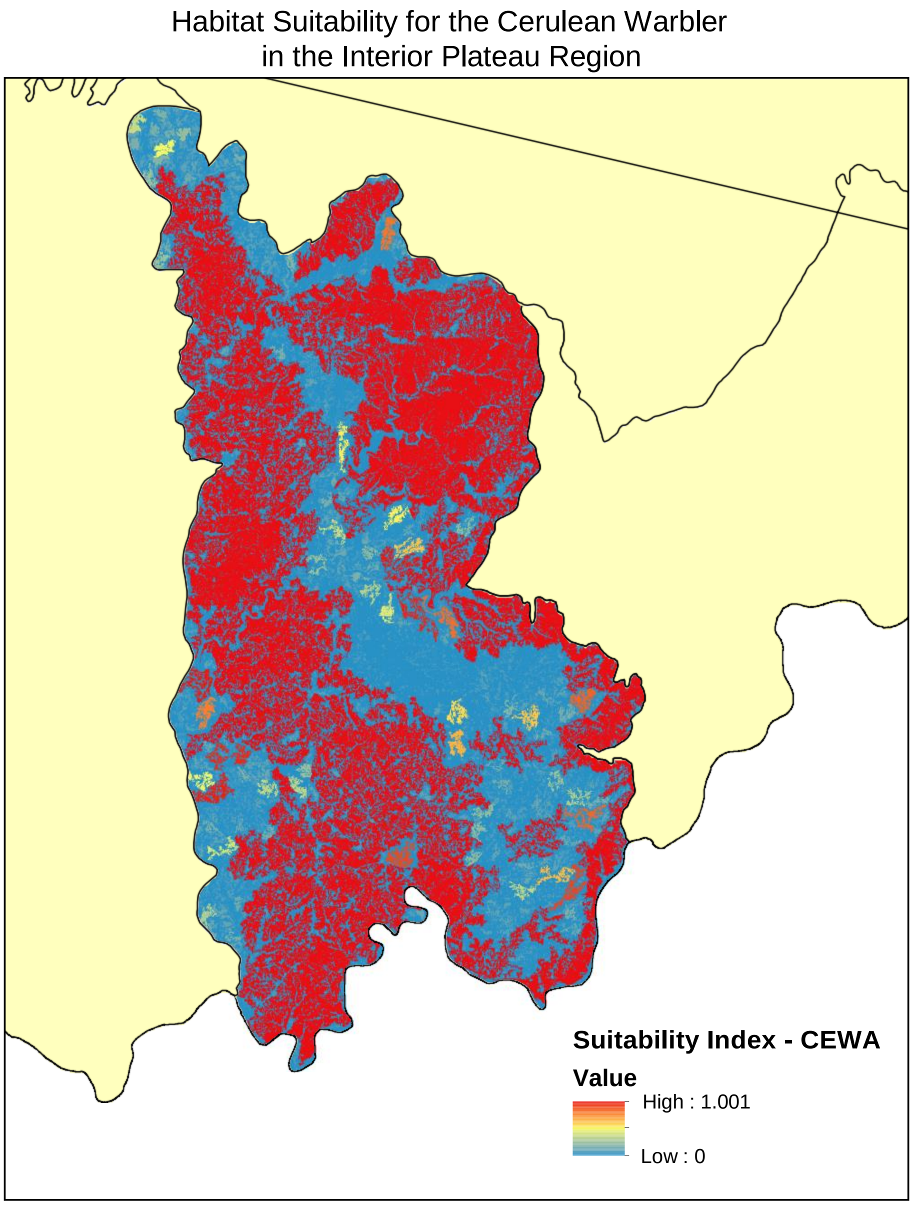

Figure C-46. Habitat suitability scores for the Cerulean Warbler in the Interior Plateau Region.

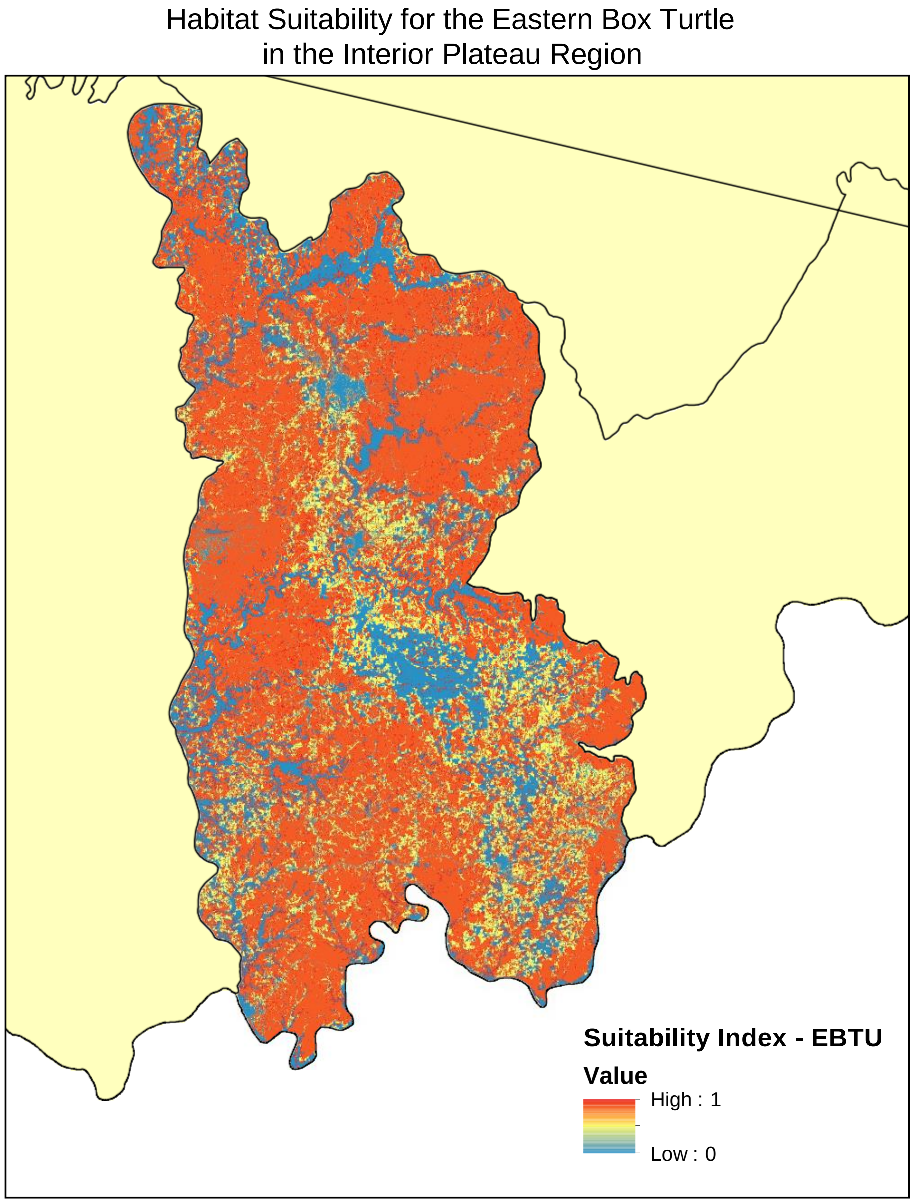

Figure C-47. Habitat suitability scores for the Eastern Box Turtle in the Interior Plateau Region.

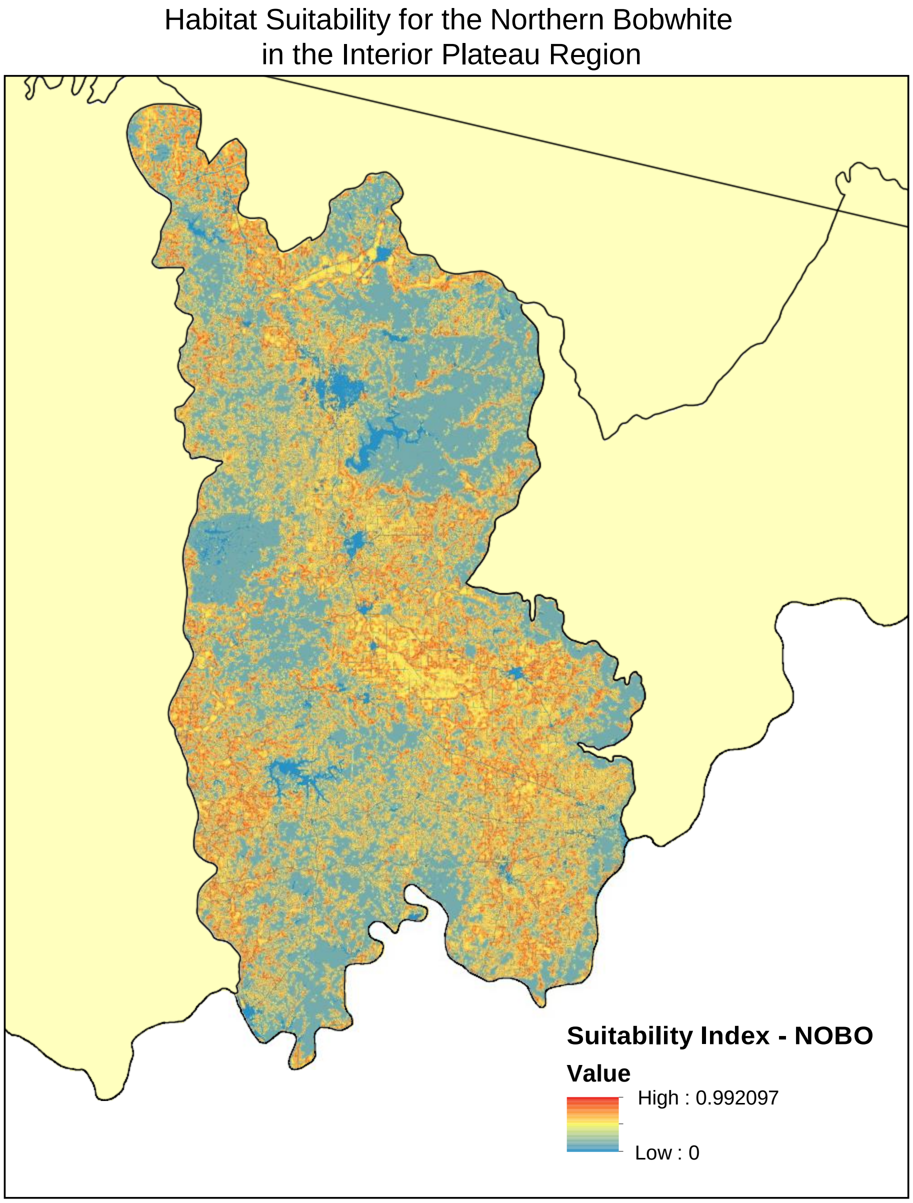

Figure C-48. Habitat suitability scores for the Northern Bobwhite in the Interior Plateau Region.

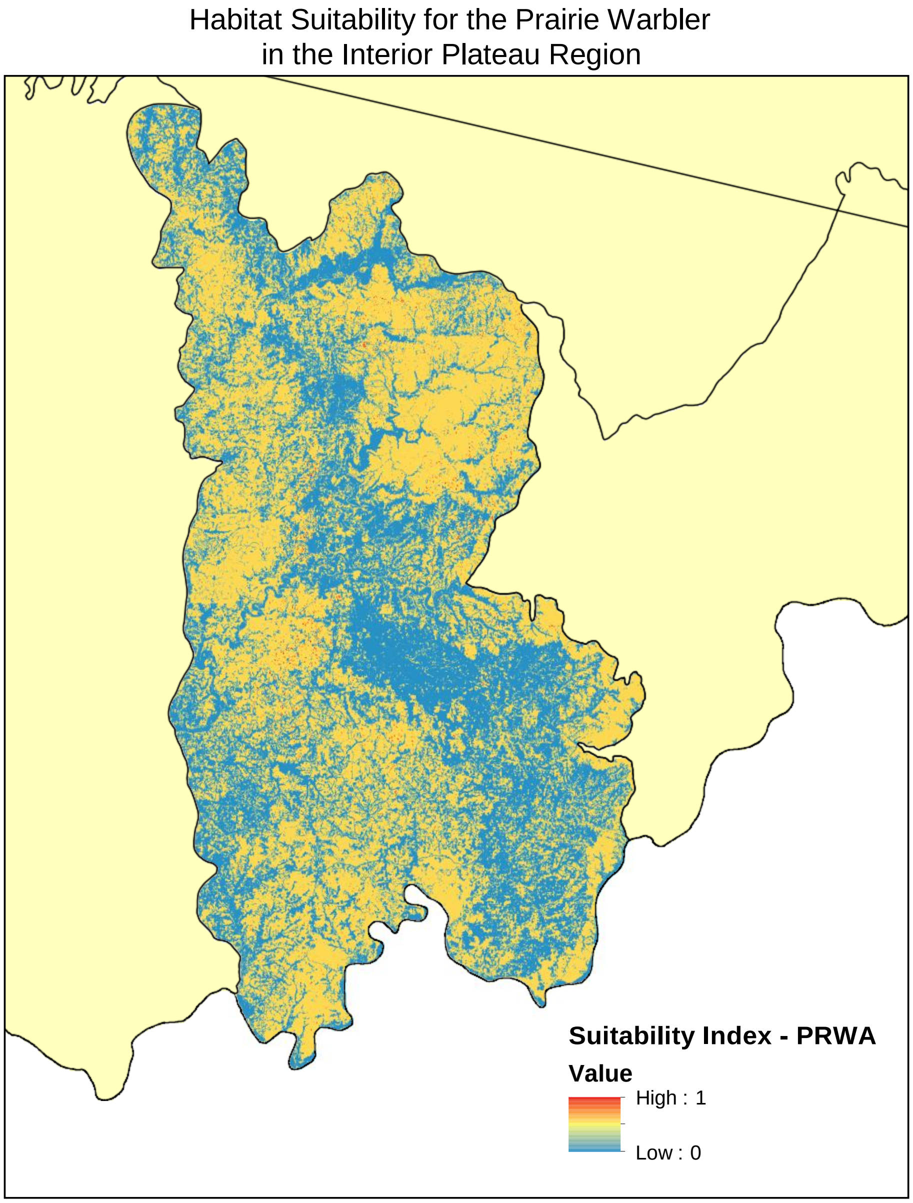

Figure C-49. Habitat suitability scores for the Prairie Warbler in the Interior Plateau Region.

Habitat Suitability for the Ruffed Grouse
in the Interior Plateau Region

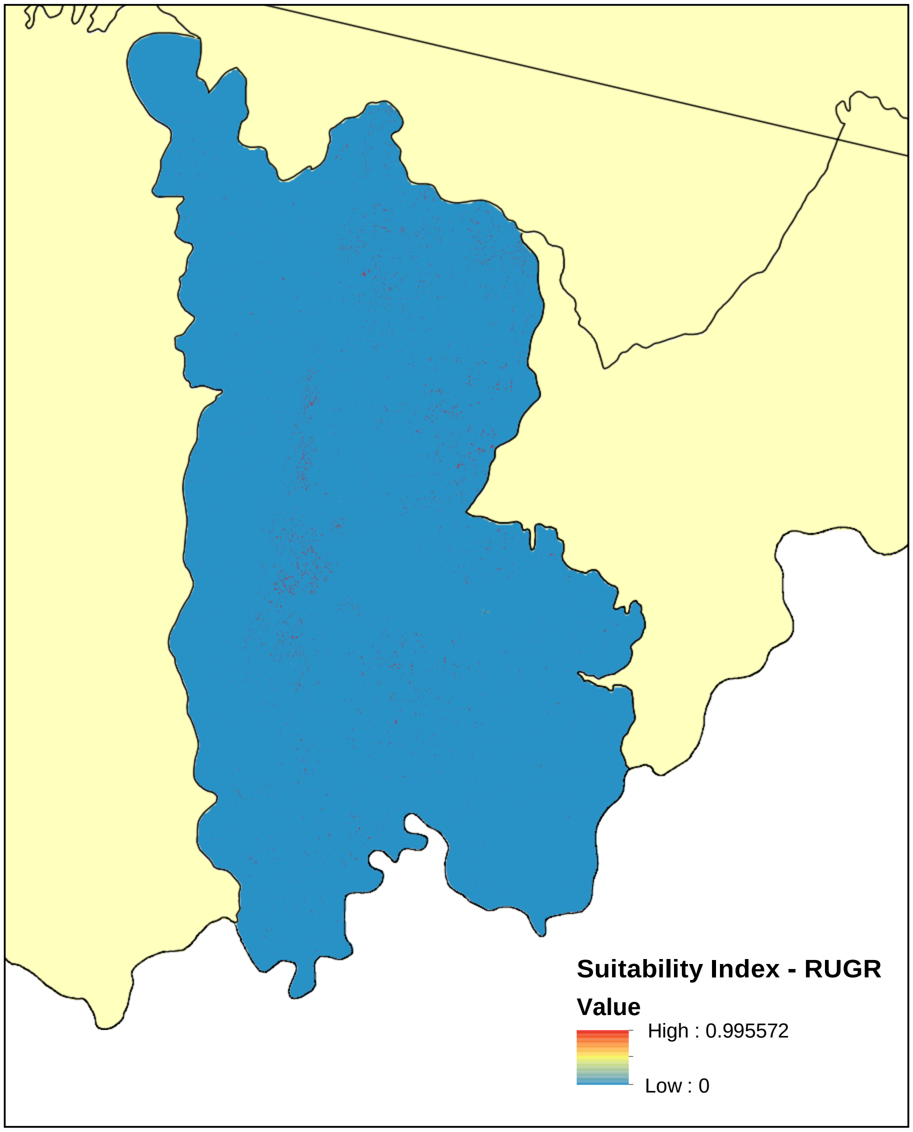

Figure C-50. Habitat suitability scores for the Ruffed Grouse in the Interior Plateau Region.

Habitat Suitability for the Timber Rattlesnake
in the Interior Plateau Region

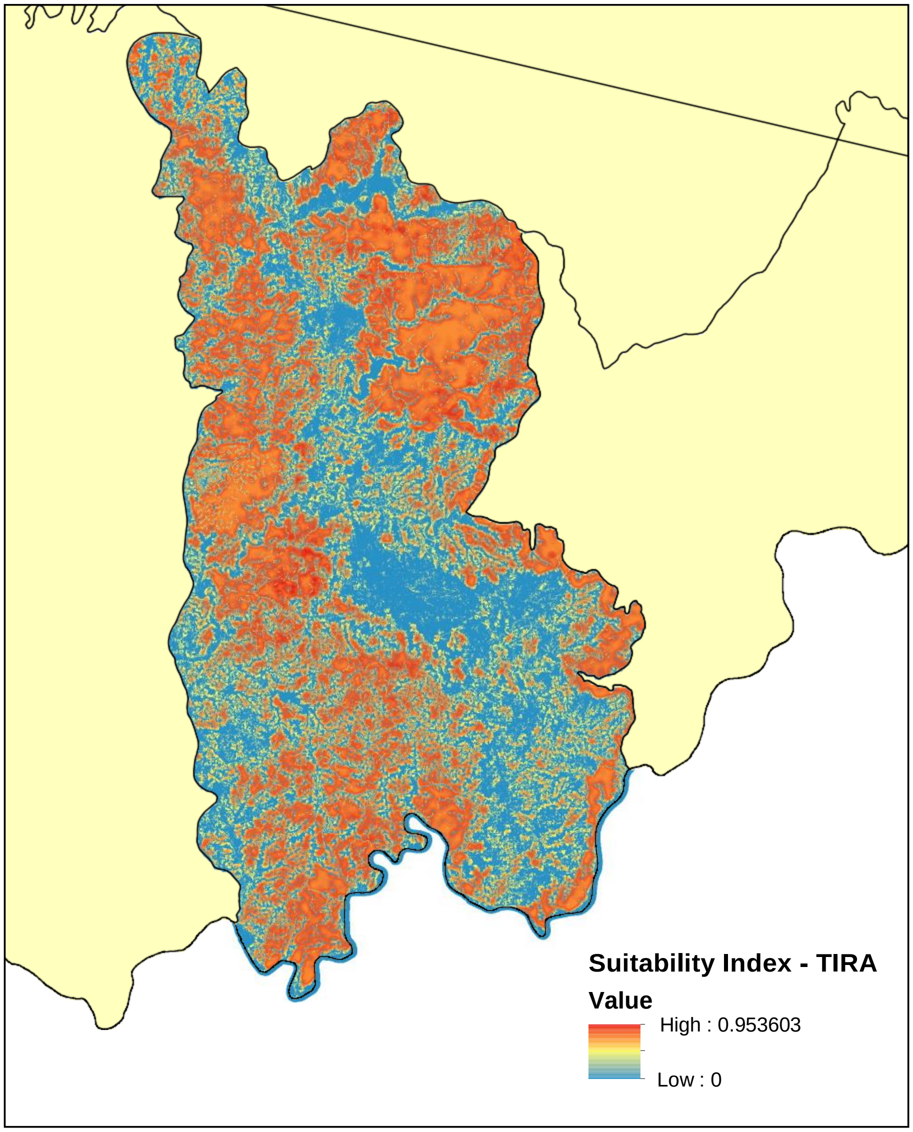

Figure C-51. Habitat suitability scores for the Timber Rattlesnake in the Interior Plateau Region.

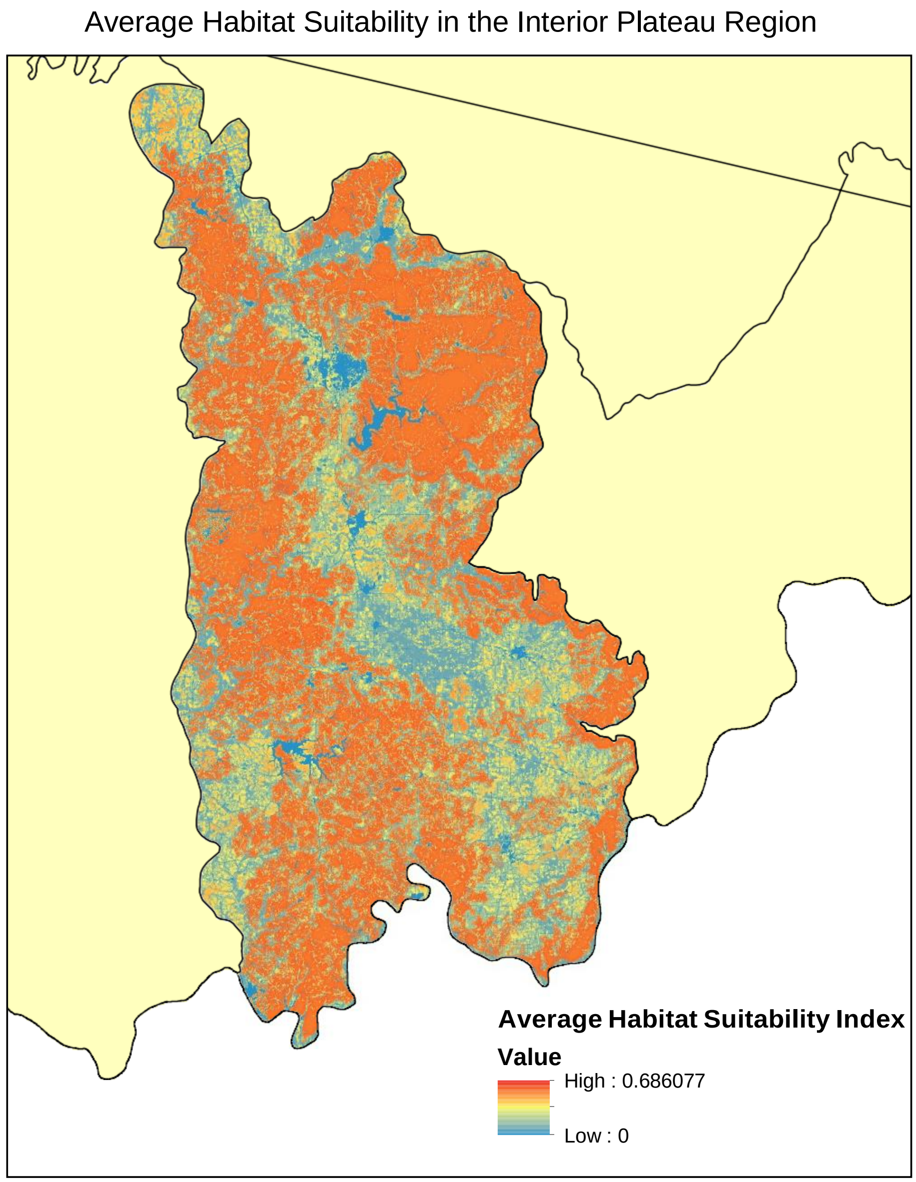

Figure C-52. Cumulative (average) habitat suitability across all the representative species.

Habitat Suitability Quartiles in the Interior Plateau Region

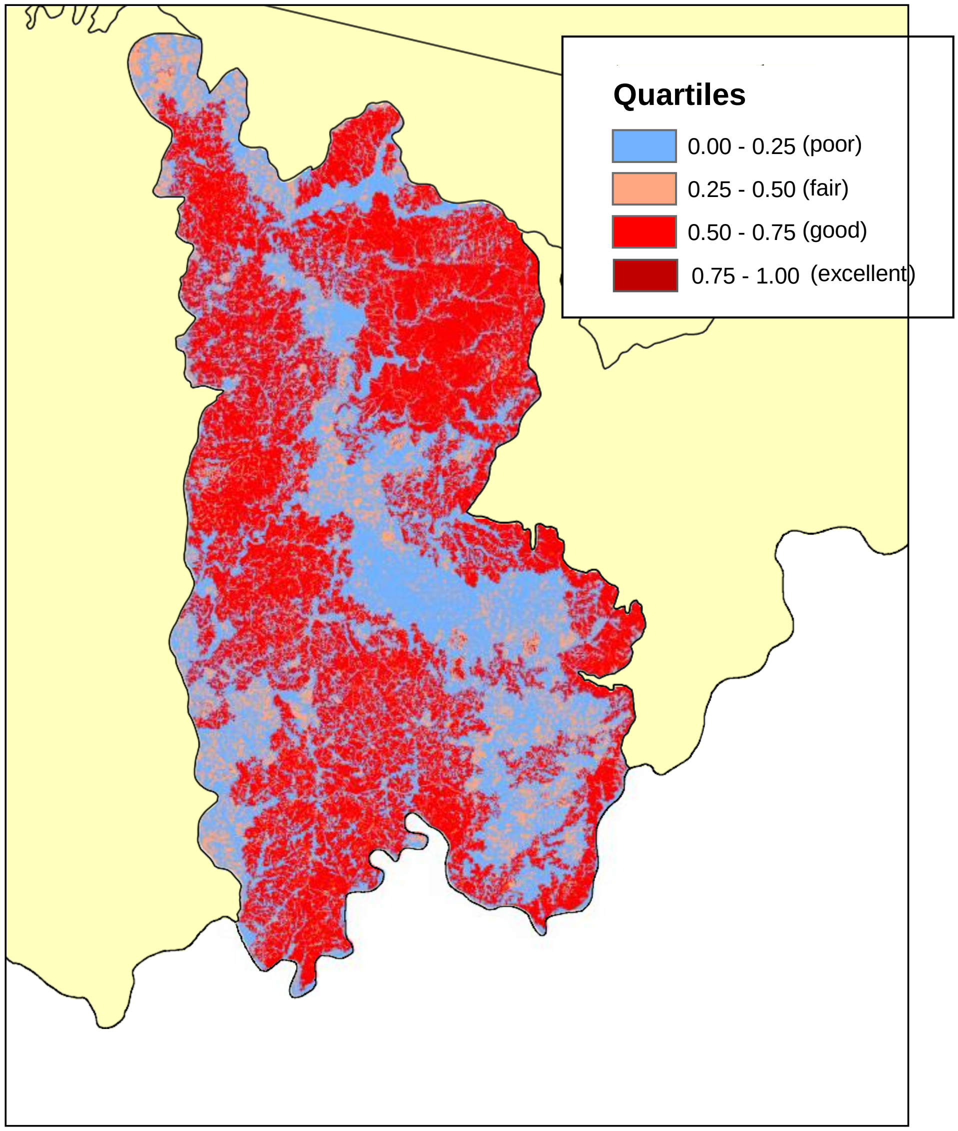

Figure C-53. Habitat suitability quartiles for cumulative scores across all species tested. Scores ranging from 0.00-1.00 were grouped into quartiles (0.00-0.25 - poor, 0.25-0.50 - fair, 0.50-0.75 - good, 0.75-1.00 - excellent) to produce this map. Note that because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent." Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Table C-9. Acres assigned to each habitat suitability quartile for each species chosen for landscape-level modeling in the Interior Plateau Region. Note that "cumulative habitat suitability", in the last column, does not represent average number of acres in each quartile, but rather the number of acres assigned to each quartile when scores for individual cells were averaged, as in Figure C-53 above. Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent."

Quartile	Cerulean Warbler	Timber Rattlesnake	Eastern Box Turtle	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Cumulative Habitat Suitability
Poor (0.00-0.25)	1,664,799	1,412,479	659,502	1,607,313	1,309,186	3,316,573	1,276,004
Fair (0.25-0.50)	24,445	247,109	508,507	275,210	425,465	5,691	495,812
Good (0.50-0.75)	18,121	751,928	119,302	1,249,078	1,578,882	1,728	1,553,576
Excellent (0.75-1.00)	1,618,027	915,025	2,039,226	194,936	11,859	1,400	0

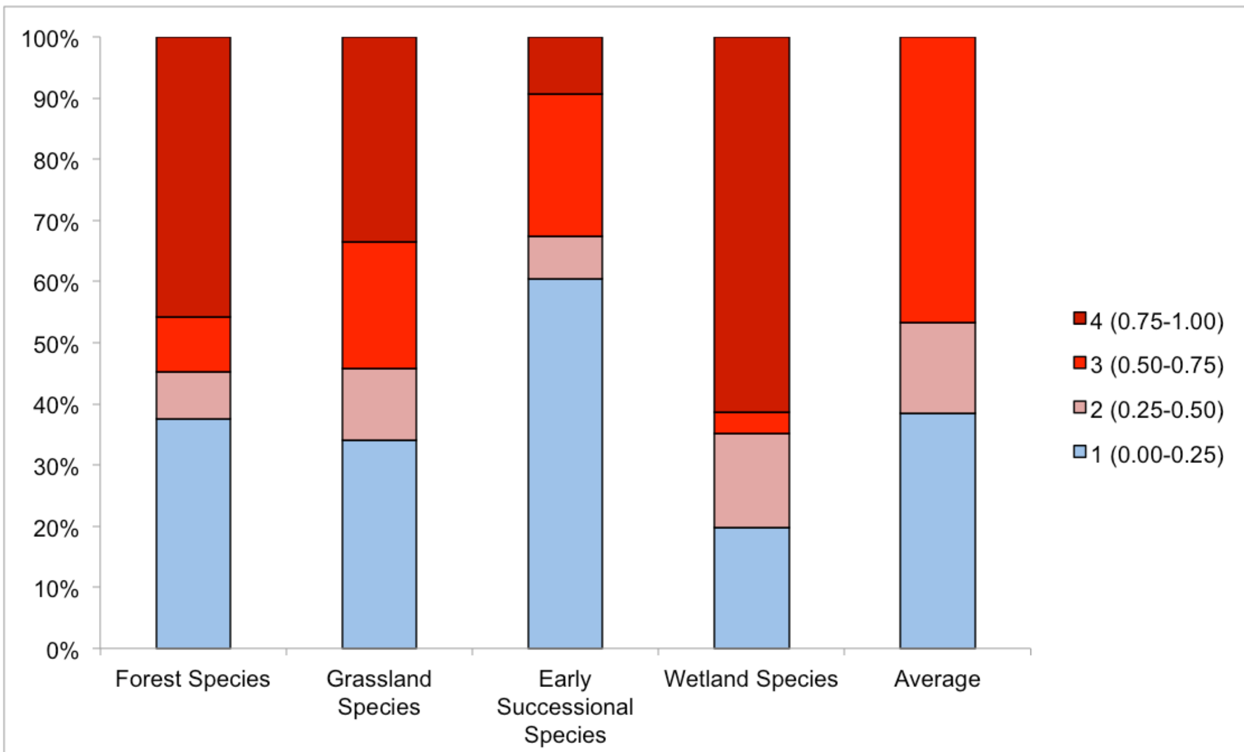

Figure C-54. Percentage of total acreage in the Interior Plateau Region assigned to each habitat suitability quartile for species representing forest, grassland, early successional, and wetland habitat. "Average" represents cumulative scores across all species.

Aquatic Modeling Results

Within the Interior Plateau Region, the landscape level aquatic modeling predictions broke rankings for QHEI into 5 categories and rankings for IBI into 6 categories. For QHEI within this region, the model estimated 249.0 miles in the excellent condition, 2,700.0 miles in good condition, 668.6 miles in fair condition, 38.4 miles in poor condition and 0.0 miles in very poor condition.

Figure C-55 displays the linear miles of streams from within this region predicted to be in each QHEI category. For IBI within this region, the model estimated 33.4 miles in the excellent condition, 328.9 miles in good condition, 2,407.0 miles in fair condition, 878.8 miles in poor condition, 7.6 miles in very poor condition, and 0.4 miles in fish absent condition. Figure C-56 displays the linear miles of streams from within this region predicted to be in each IBI category.

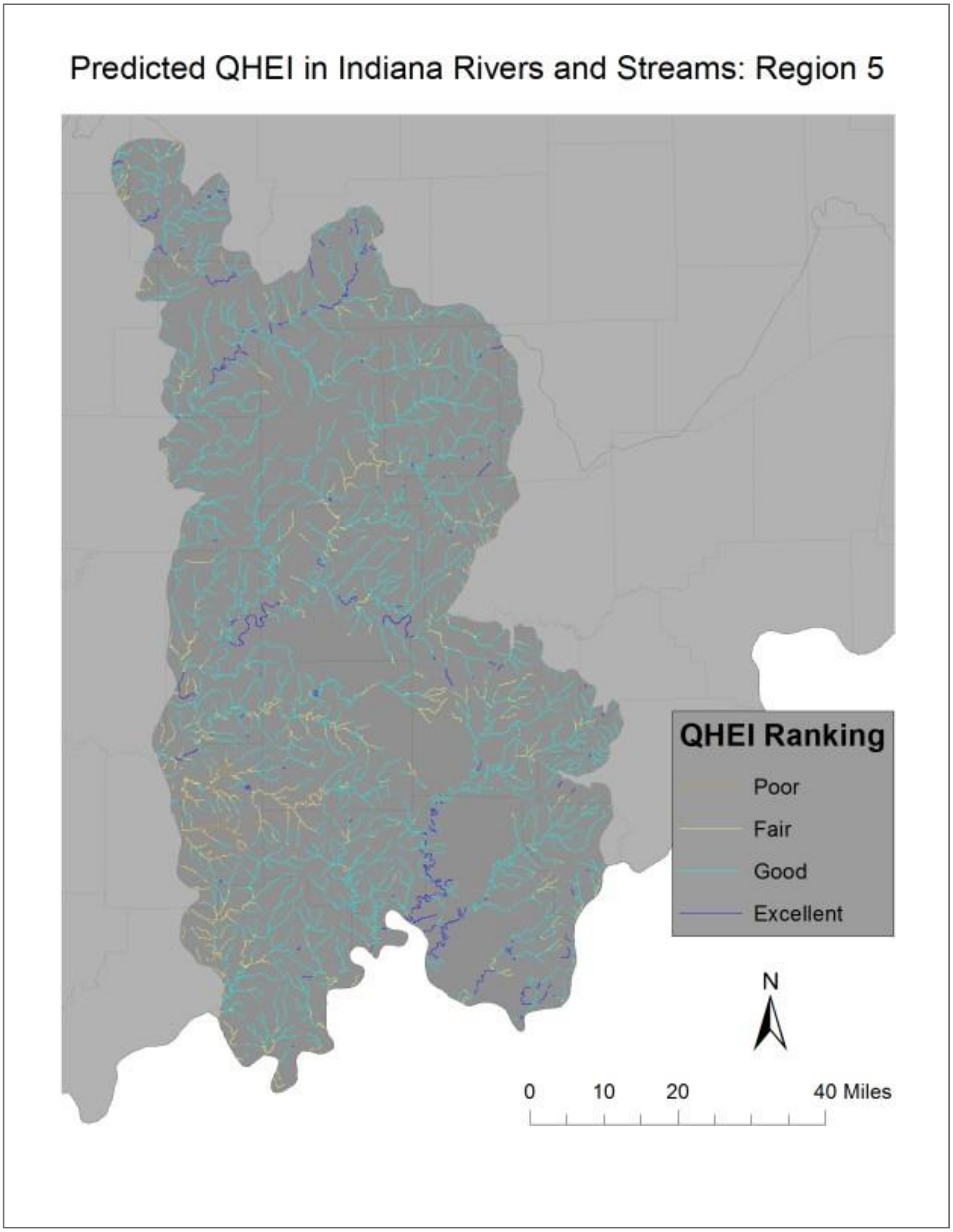

Figure C-55. Streams in the Interior Plateau Region predicted to be in each QHEI category.

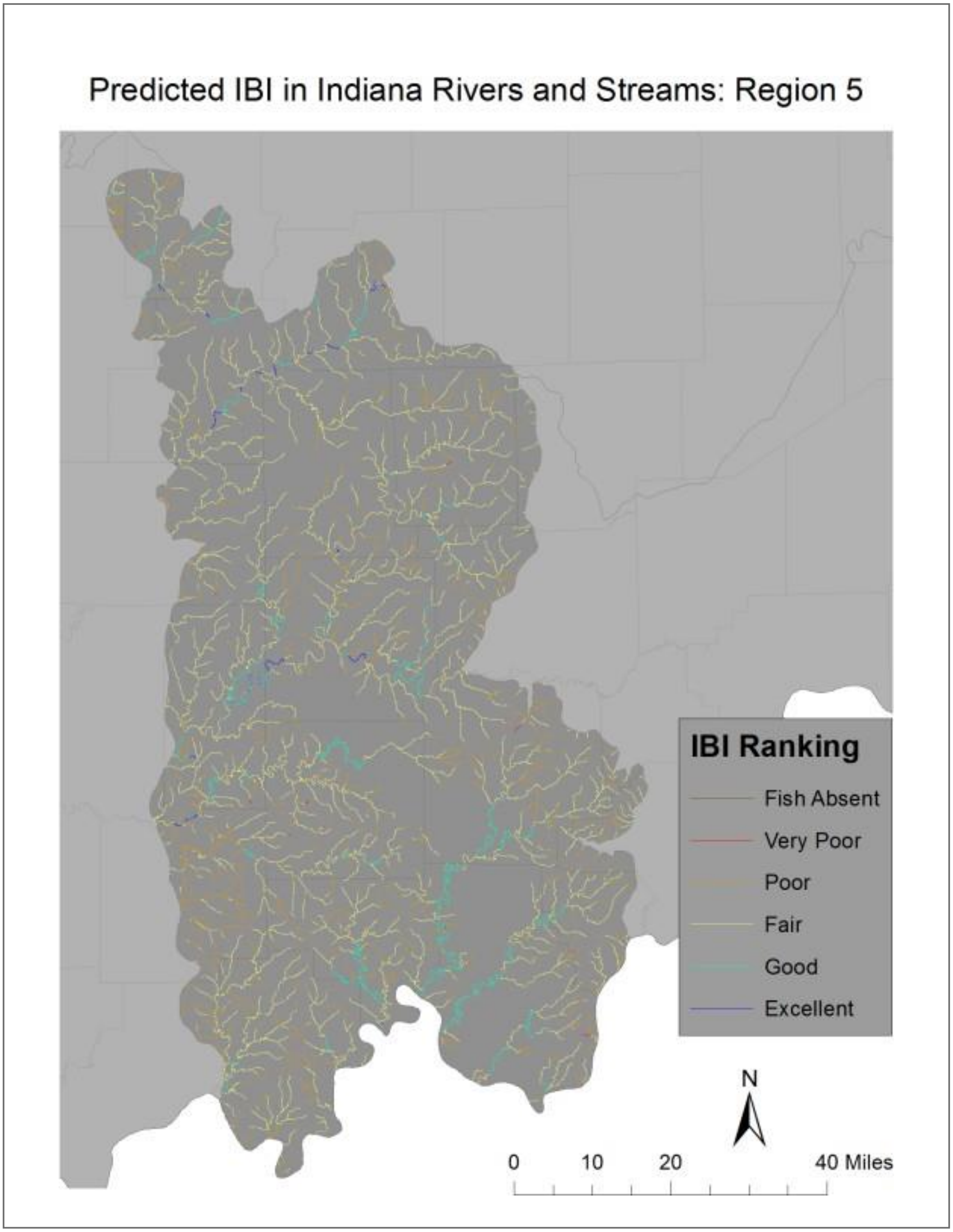

Figure C-56. Streams in the Interior Plateau Region predicted to be in each IBI category.

Conservation Action Scenarios

Survey respondents were also asked to assign 100 points of effort to actions that make a difference 'on-the-ground' (such as protection, restoration, or improvement in the quality of existing habitat). Scores for these actions were ranked, and the actions were assembled into three different scenarios for application to a landscape in a GIS environment (Chapter V).

The 'baseline' scenario represented the average distribution of effort among 'on-the-ground' actions recommended by survey respondents. The 'focused' and 'distributed' scenarios represented how effort would be distributed if it were focused only on the top-priority actions, or spread out evenly among most of the actions that were considered important, respectively. Respondents to the Habitat Survey heavily emphasized actions for conservation of forest habitats in this exercise. Protection of forests was the top-ranked action by a large margin in every scenario. Other actions focusing on forests were also ranked in the top 10 actions, including controlling invasive species, enhancing forest connectivity, enrollment in the Classified Forest Program, diversifying forest types, controlling forest pests, and restoring forests.

Although transformation of landscapes in a GIS environment was not possible with current knowledge of how Indiana landscapes change, in the future managers may find the following results useful in simulating landscape changes under alternative conservation action scenarios.

Table C-10. Percent effort to be devoted to 'on-the-ground' conservation actions (habitat protection, restoration, or improvement) under alternative future conservation action scenarios (see above).

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect forests	18%	20%	14%
Protect aquatic systems	9%	10%	5%
Control invasive species in forests	8%	11%	7%
Preserve/create corridors between forest habitats	7%	7%	9%
Increase acres enrolled in the Classified Forest Program	7%	7%	5%
Diversify forest types (e.g., create forest openings)	6%	6%	5%
Control forest pests	6%	8%	5%
Restore forests	5%	5%	4%
Control invasive species in aquatic systems	5%	0%	3%
Restore riparian zones	4%	6%	3%
Reestablish fire regimes in forests	4%	4%	3%
Restore aquatic systems	4%	5%	3%
Improve water quality in aquatic systems	3%	4%	2%
Convert marginal cropland to wildlife habitat	3%	0%	2%
Preserve/create corridors between habitat within agricultural matrix	3%	4%	3%
Reduce conversion of wildlife habitat to cropland	3%	0%	3%
Preserve/create corridors between barren lands habitat	2%	3%	1%
Enhance wetland connectivity	2%	3%	1%
Preserve/create corridors between grassland habitat	1%	0%	1%
Manage nuisance species in forests	0%	0%	3%
Protect buffer zones around aquatic systems	0%	0%	3%

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect wetlands	0%	0%	3%
Restrict recreational overuse in forests	0%	0%	2%
Protect barren lands	0%	0%	2%
Improve drainage management to benefit aquatic systems	0%	0%	2%
Restore wildlife habitat within agricultural matrix	0%	0%	1%
Protect grasslands	0%	0%	1%
Create new wetlands	0%	0%	1%
Restore wetlands	0%	0%	1%
Create adequate vegetative buffers around wetlands	0%	0%	1%
Restore barren lands	0%	0%	1%
Restore grasslands	0%	0%	1%
Control invasive species in agricultural lands	0%	0%	0%
Manage nuisance wildlife populations in agricultural lands	0%	0%	0%
Control invasive species in barren lands	0%	0%	0%
Manage nuisance wildlife populations in barren lands	0%	0%	0%
Control invasive species in grasslands	0%	0%	0%
Control invasive species in wetlands	0%	0%	0%
Manage nuisance wildlife populations in wetlands	0%	0%	0%
Enhance pastures and haylands for wildlife	0%	0%	0%
Improve soil health in agricultural lands	0%	0%	0%
Modify drainage management in agricultural lands	0%	0%	0%
Reduce mowing during nesting season in agricultural lands	0%	0%	0%
Restrict recreational overuse in aquatic systems	0%	0%	0%
Reestablish fire regimes in barrens and glades	0%	0%	0%
Implement fire regimes in grasslands	0%	0%	0%
Reduce mowing during nesting season in grasslands	0%	0%	0%
Actively manage wetlands for habitat quality	0%	0%	0%
Improve water quality in wetlands	0%	0%	0%
Reduce negative impacts of drainage management on wetlands	0%	0%	0%

Drift Plains Region

<u>Terrestrial Modeling Results</u>
Technical experts participating in the Modeling Focus Group suggested the following terrestrial species as candidates for landscape-level modeling:

- Birds: Cerulean Warbler, Henslow's Sparrow, Kentucky Warbler, Northern Bobwhite, Ruffed Grouse, Prairie Warbler, American Woodcock
- Mammals: Eastern Gray Squirrel, Southern Flying Squirrel, Indiana Myotis, Little Brown Myotis, Northern Long-eared Myotis, Eastern Red Bat
- Amphibians: Northern Cricket Frog, Wood Frog, Two-lined Salamander, Eastern Red-backed Salamander, Spotted Salamander
- Reptiles: Black Ratsnake, Copper-bellied Water Snake, Kirtland's Snake, Racer

Respondents to the species survey voted for species from this initial list based on habitat types and were given space to suggest additional species. The top-ranked species were:

- Forests: Cerulean Warbler, Eastern Red-backed Salamander, Southern Flying Squirrel
- Grasslands: Northern Bobwhite, Henslow's Sparrow
- Early successional: Ruffed Grouse, Prairie Warbler, American Woodcock
- Wetlands/aquatic systems: Copper-bellied Water Snake, Spotted Salamander

Ultimately, the following species were chosen for landscape-level modeling (Chapter V): Cerulean Warbler, Ruffed Grouse, Henslow's Sparrow, Copper-bellied Water Snake, Northern Bobwhite, and Prairie Warbler.

Landscape-level models were built for each of the species above that estimated the quality of current habitat conditions (Chapter V). Figure C-57 through Figure C-62 below shows the resulting habitat suitability scores on maps for each representative species. To produce a map of average habitat suitability across all species tested, the scores for individual cells were averaged. Figure C-63 represents these cumulative suitability scores. For cleaner interpretation of the cumulative scores, an additional figure (Figure C-64) is found below which groups the average scores into quartiles (0.00-2.25 - poor; 0.25-0.50 - fair; 0.50-0.75 - good; 0.75-1.00 - excellent). Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent." Areas which resulted in a "good" score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Habitat Suitability for the Copper-bellied Watersnake
in the Drift Plains Region

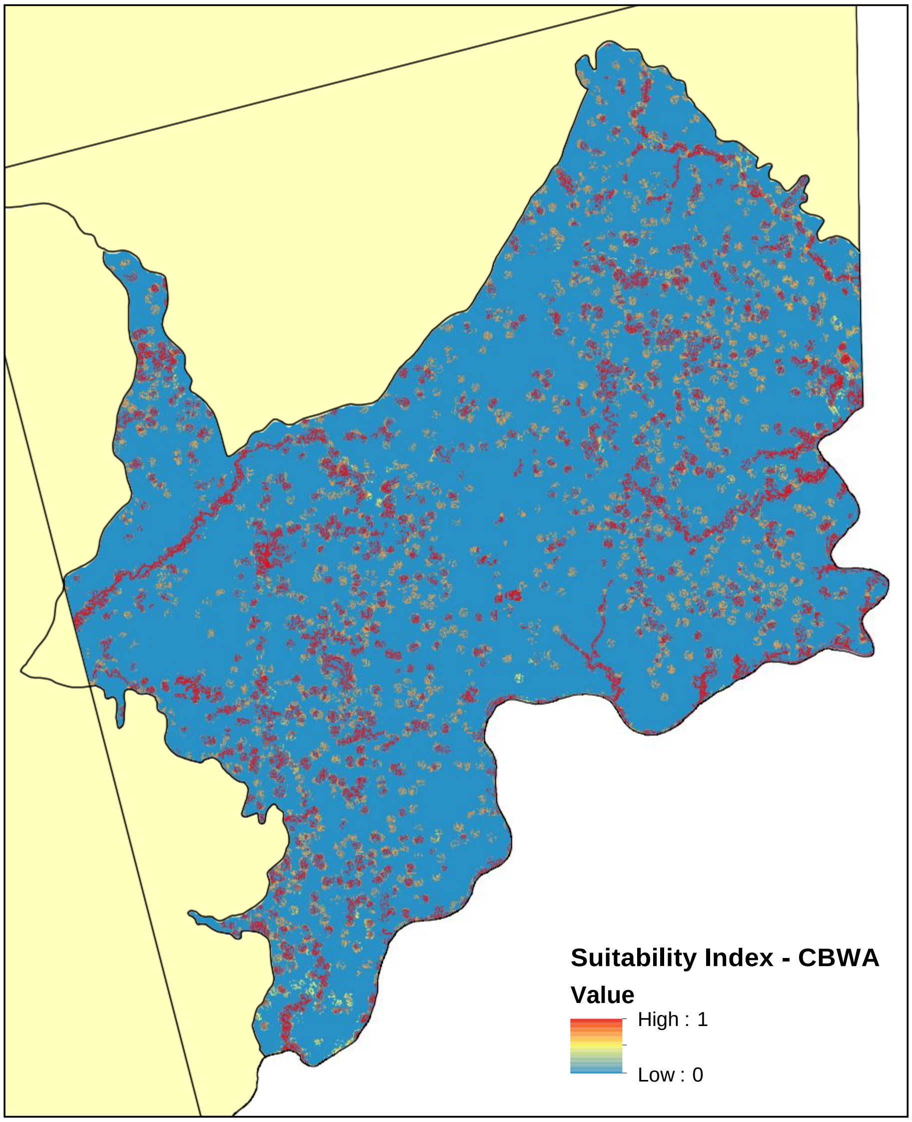

Figure C-57. Habitat suitability scores for Copper-bellied Water Snake in the Drift Plains Region.

Habitat Suitability for the Cerulean Warbler
in the Drift Plains Region

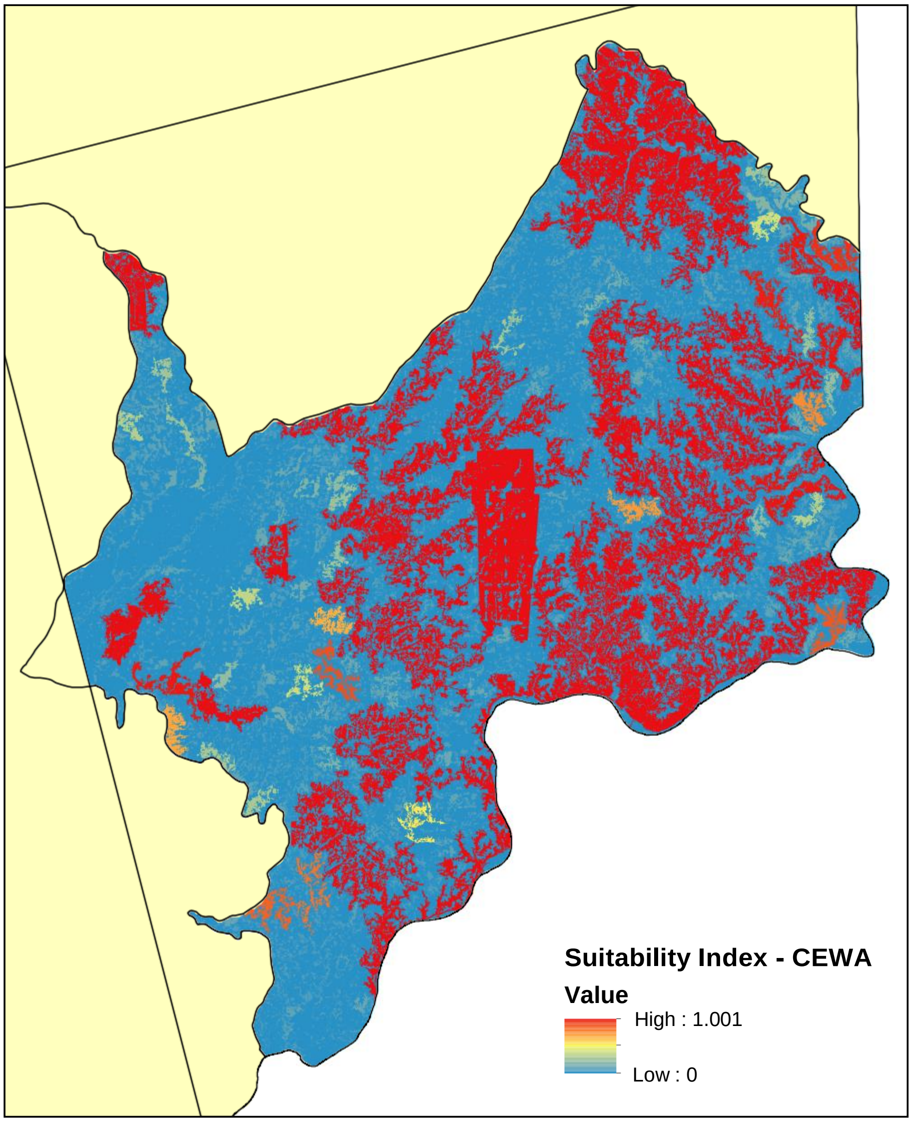

Figure C-58. Habitat suitability scores for Cerulean Warbler in the Drift Plains Region.

Habitat Suitability for the Henslow's Sparrow
in the Drift Plains Region

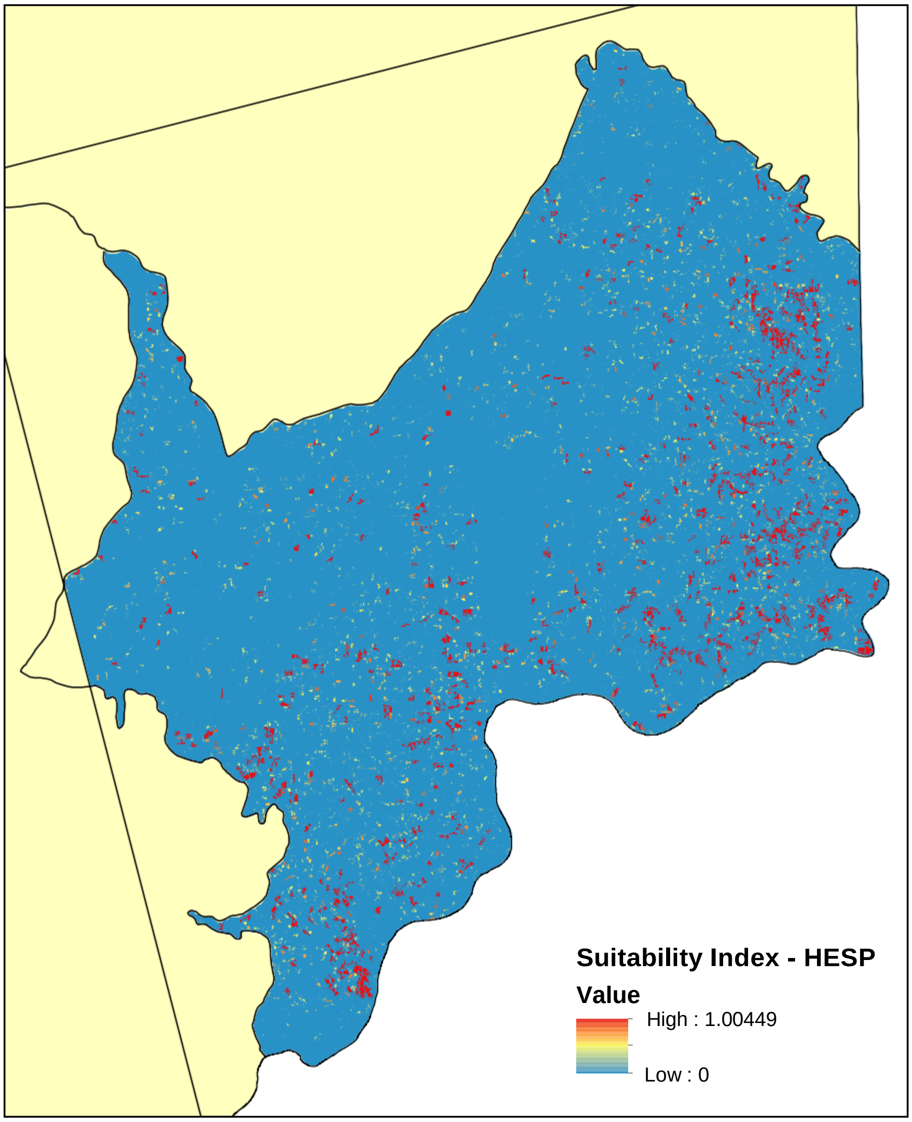

Figure C-59. Habitat suitability scores for Henslow's Sparrow in the Drift Plains Region.

Habitat Suitability for the Northern Bobwhite
in the Drift Plains Region

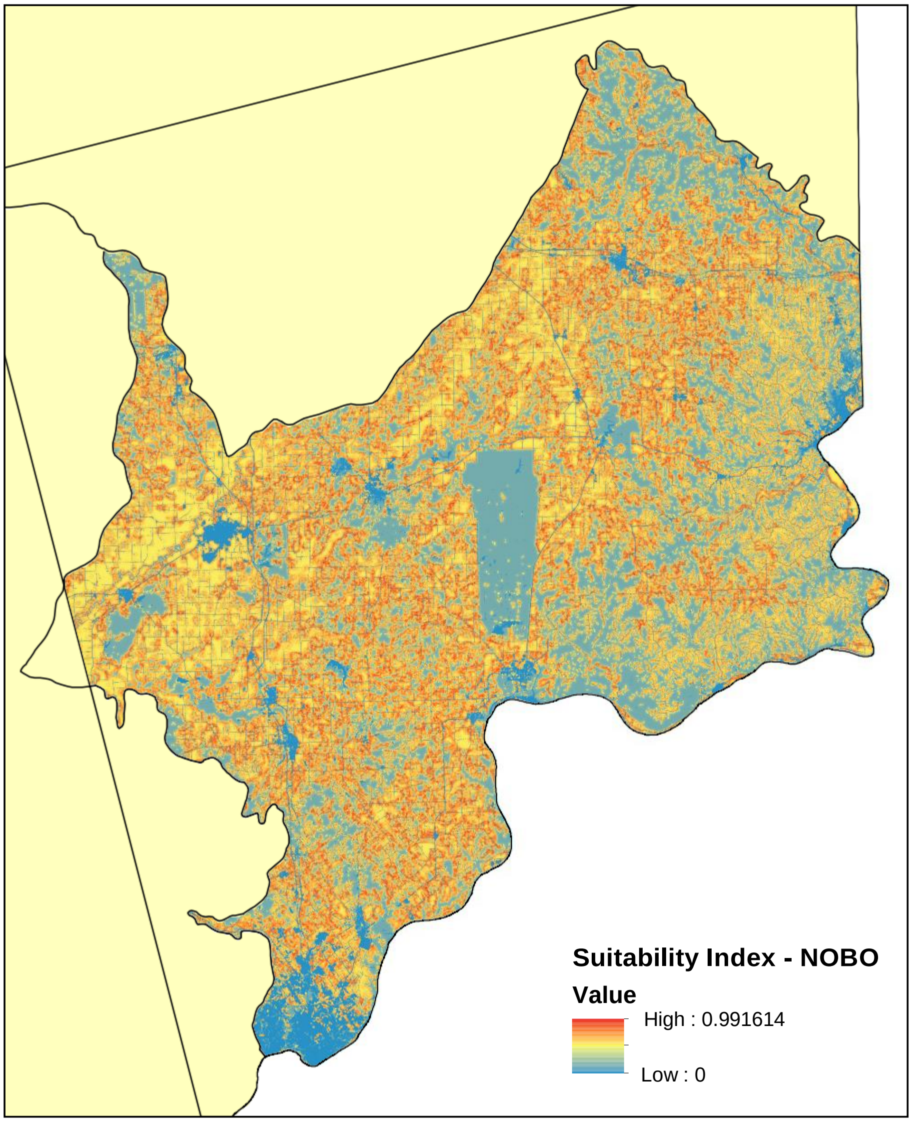

Figure C-60. Habitat suitability scores for Northern Bobwhite in the Drift Plains Region.

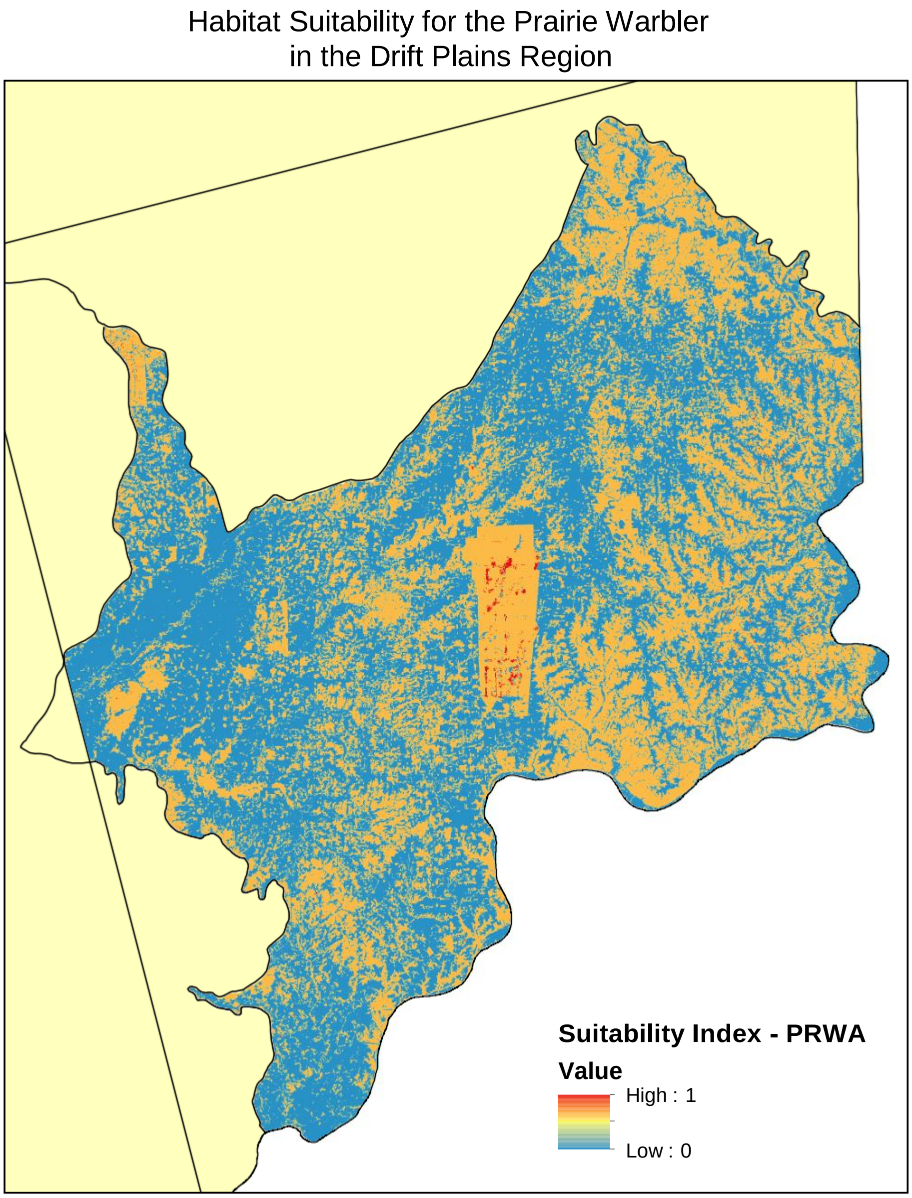

Figure C-61. Habitat suitability scores for Prairie Warbler in the Drift Plains Region.

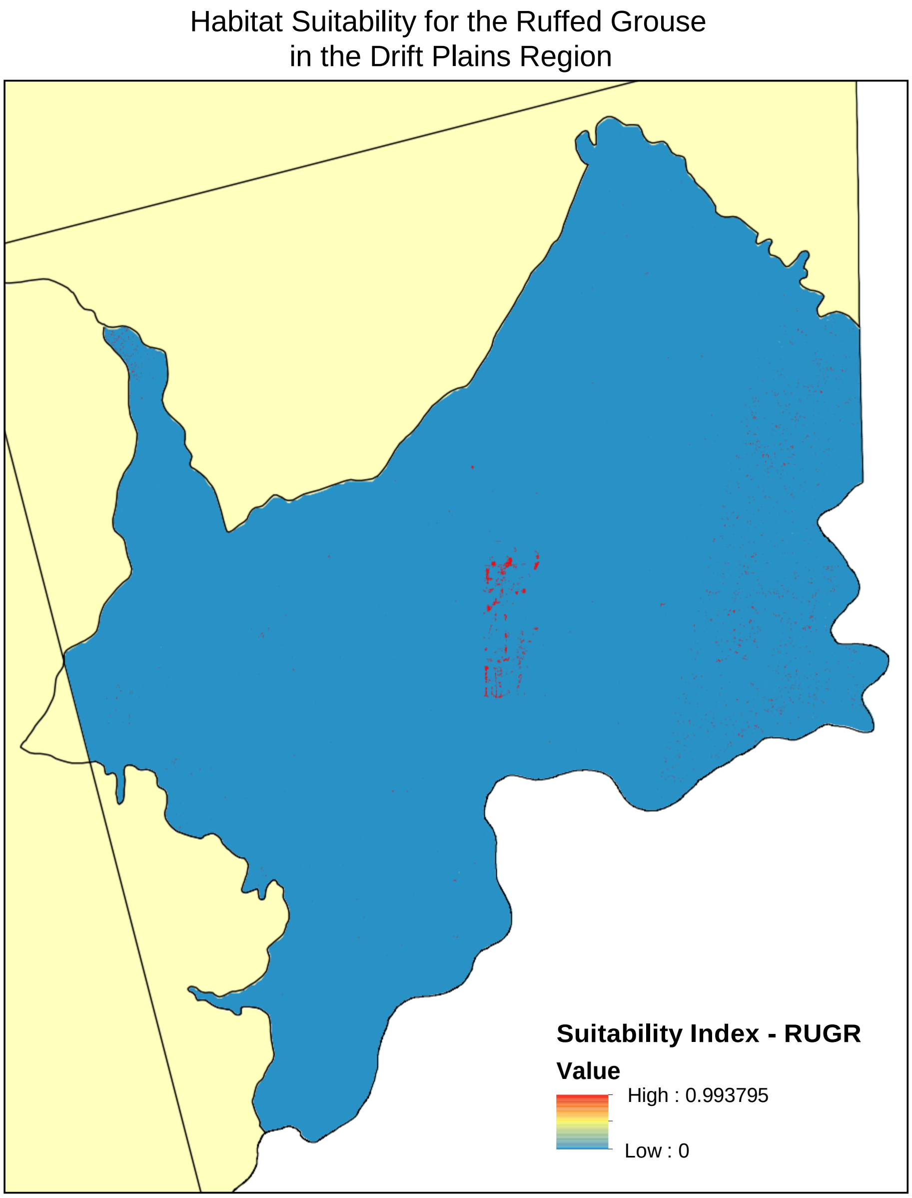

Figure C-62. Habitat suitability scores for Ruffed Grouse in the Drift Plains Region.

Average Habitat Suitability in the Drift Plains Region

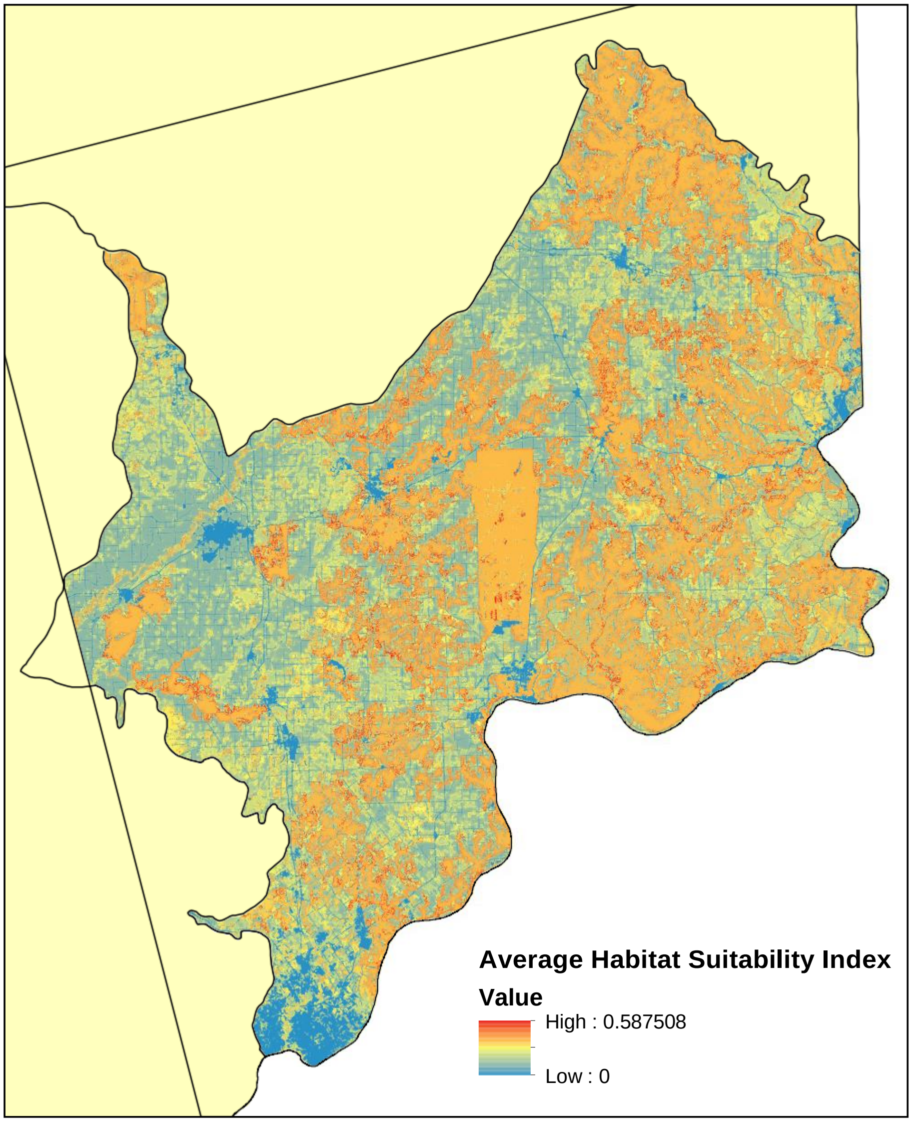

Figure C-63. Cumulative (average) habitat suitability across all the representative species.

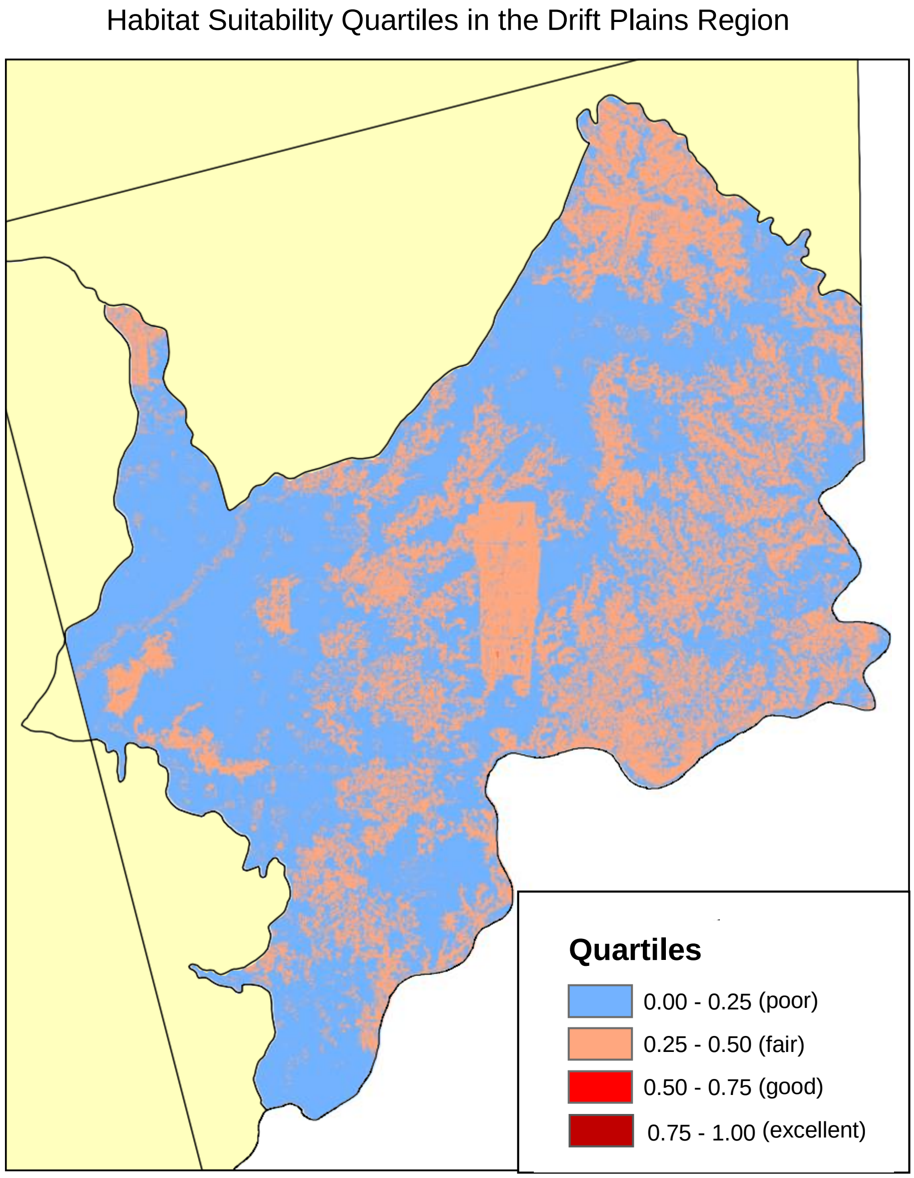

Figure C-64. Habitat suitability quartiles for cumulative scores across all species tested. Scores ranging from 0.00-1.00 were grouped into quartiles (0.00-0.25 - poor, 0.25-0.50 - fair, 0.50-0.75 - good, 0.75-1.00 - excellent) to produce this map. Note that because of the varying habitat needs of the species tested, no single area can represent ‘excellent’ habitat for all of them. Therefore, no areas received a habitat suitability quartile score of “excellent”. Areas which resulted in a “good” score overall represent the areas with the best habitat for the widest variety of species and a valuable mix of habitat types.

Table C-11. Acres assigned to each habitat suitability quartile for each species chosen for landscape-level modeling in the Drift Plains Region. Note that "cumulative habitat suitability", in the last column, does not represent average number of acres in each quartile, but rather the number of acres assigned to each quartile when scores for individual cells were averaged, as in Figure C-64 above. Because of the varying habitat needs of the species tested, no single area can represent 'excellent' habitat for all of them. Therefore, no areas received a habitat suitability quartile score of "excellent."

Quartile	Cerulean Warbler	Henslow's Sparrow	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Copper-bellied Water Snake	Cumulative Habitat Suitability
Poor (0.00-0.25)	1,390,128	1,982,450	667,206	1,111,648	2,040,789	1,775,500	1,327,721
Fair (0.25-0.50)	18,492	19,561	193,387	261,880	1,912	119,573	717,236
Good (0.50-0.75)	11,035	10,776	1,001,808	666,011	1,198	68,341	56
Excellent (0.75-1.00)	625,359	33,472	183,859	5,474	1,114	82,845	0

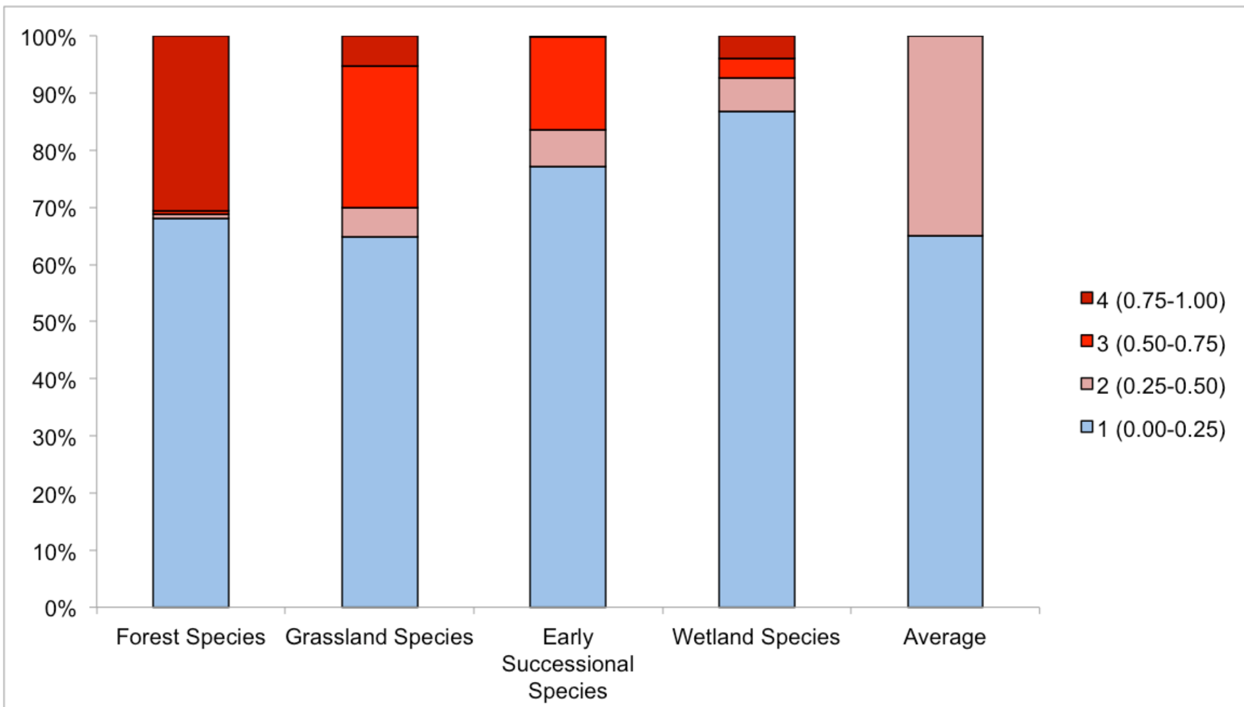

Figure C-65. Percentage of total acreage in the Drift Plains Region assigned to each habitat suitability quartile for species representing forest, grassland, early successional, and wetland habitats. "Average" represents cumulative scores across all species.

Aquatic Modeling Results

Within the Drift Plains Region, the landscape level aquatic modeling predictions broke rankings for QHEI into 5 categories and rankings for IBI into 6 categories. For QHEI within this region, the model estimated 271.0 miles in the excellent condition, 1,922.1 miles in good condition, 633.0 miles in fair condition, 41.7 miles in poor condition, and 0.1 miles in very poor condition.

Figure C-66 displays the linear miles of streams from within this region predicted to be in each QHEI category. For IBI within this region, the model estimated 29.9 miles in the excellent condition, 316.6 miles in good condition, 1,600.0 miles in fair condition, 846.1 miles in poor condition, 67.9 miles in very poor condition and 7.5 miles in fish absent condition. Figure C-67 displays the linear miles of streams from within this region predicted to be in each IBI category.

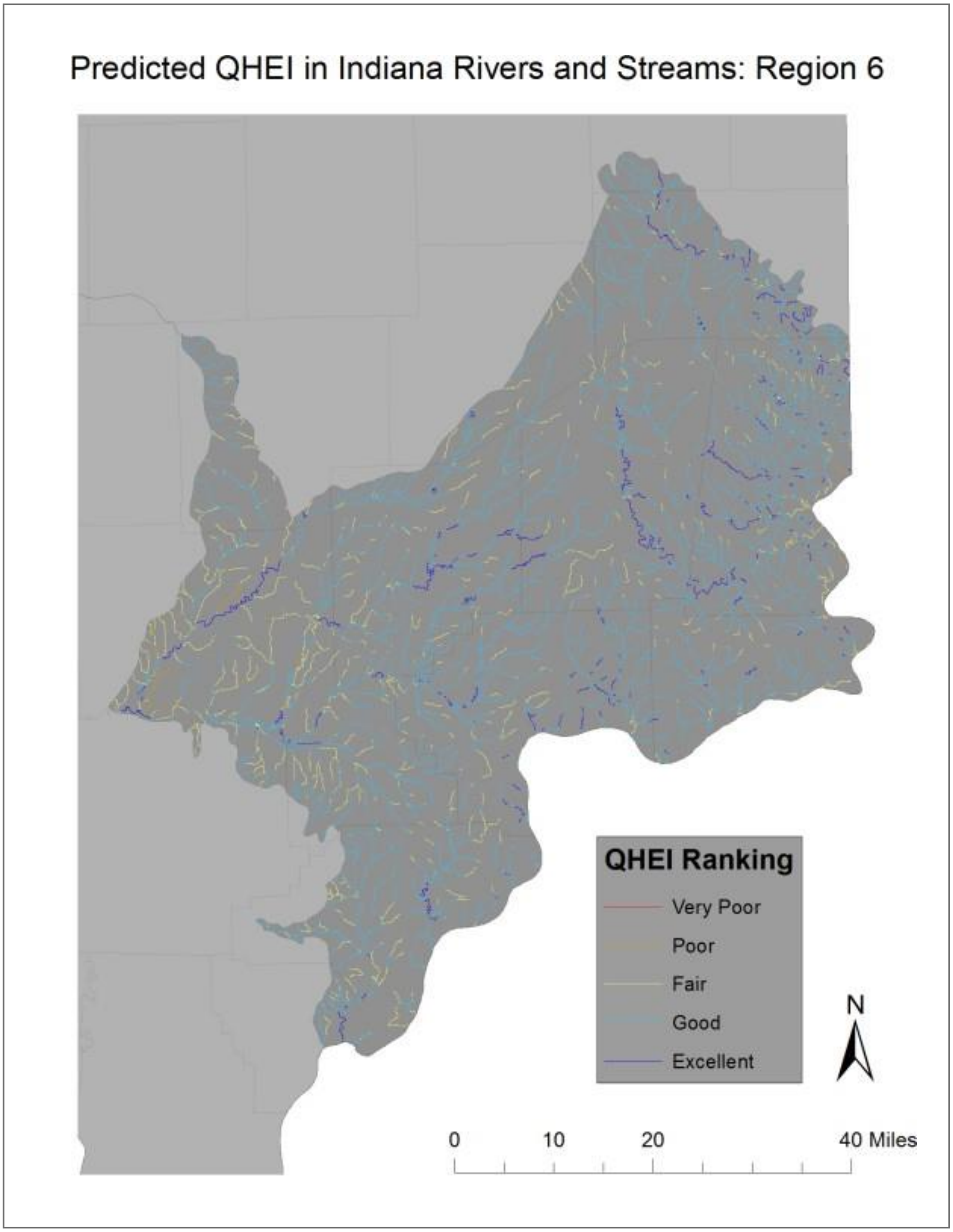

Figure C-66. Streams in the Drift Plains Region predicted to be in each QHEI category.

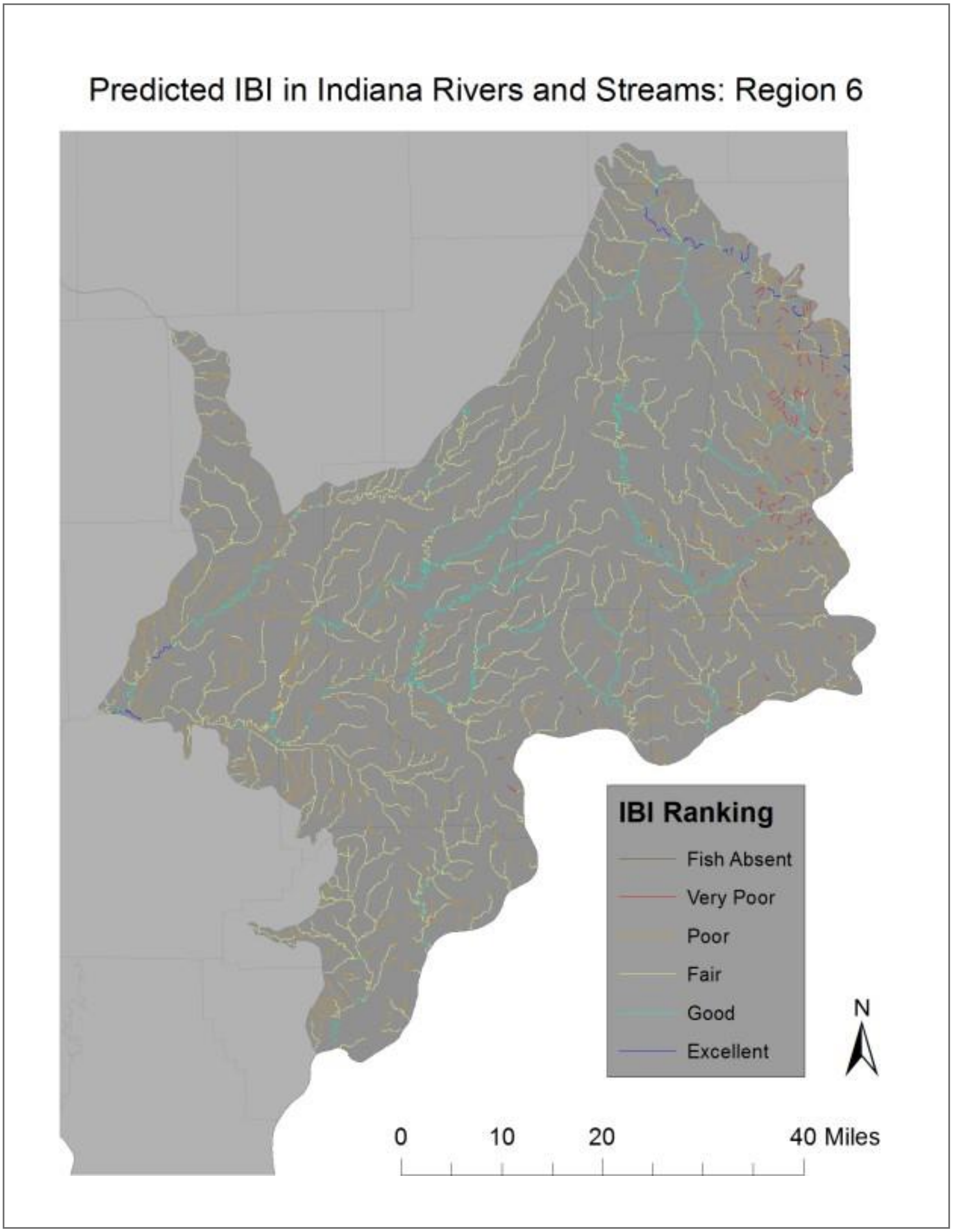

Figure C-67. Streams in the Drift Plains Region predicted to be in each IBI category.

Conservation Action Scenarios
Survey respondents were also asked to assign 100 points of effort to actions that make a difference 'on-the-ground' (such as protection, restoration, or improvement in the quality of existing habitat). Scores for these actions were ranked, and the actions were assembled into three different scenarios for application to a landscape in a GIS environment (Chapter V). The 'baseline' scenario represented the average distribution of effort among 'on-the-ground' actions recommended by survey respondents. The 'focused' and 'distributed' scenarios represented how effort would be distributed if it were focused only on the top-priority actions, or spread out evenly among most of the actions that were considered important, respectively.

Respondents to the Habitat Survey heavily emphasized actions for conservation of forest habitats in this exercise. Protection of forests was the top-ranked action by a large margin in every scenario. Other actions focusing on forests were also ranked in the top 10 actions, including enhancing forest connectivity, controlling invasive species, enrollment in the Classified Forest Program, controlling forest pests, restoring forests, and diversifying forest types. Respondents also emphasized protection and restoration of grasslands and wetlands.

Although transformation of landscapes in a GIS environment was not possible with current knowledge of how Indiana landscapes change, in the future managers may find the following results useful in simulating landscape changes under alternative conservation action scenarios.

Table C-12. Percent effort to be devoted to 'on-the-ground' conservation actions (habitat protection, restoration, or improvement) under alternative future conservation action scenarios (see above).

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect forests	18%	19%	15%
Preserve/create corridors between forest habitats	8%	8%	11%
Control invasive species in forests	8%	10%	6%
Increase acres enrolled in the Classified Forest Program	6%	7%	5%
Control forest pests	5%	7%	4%
Restore forests	5%	6%	5%
Diversify forest types (e.g., create forest openings)	5%	6%	4%
Protect grasslands	5%	5%	5%
Protect wetlands	4%	6%	4%
Preserve/create corridors between grassland habitat	4%	5%	3%
Restore grasslands	4%	5%	2%
Protect aquatic systems	4%	0%	3%
Manage nuisance species in forests	4%	0%	3%
Reestablish fire regimes in forests	4%	4%	3%
Restore riparian zones in aquatic systems	4%	5%	2%
Restore wetlands	3%	0%	2%
Enhance wetland connectivity	3%	4%	2%
Implement fire regimes in grasslands	3%	4%	2%
Restrict recreational overuse in forests	3%	0%	2%
Preserve/create corridors between habitat within agricultural matrix	2%	0%	1%

Action	Baseline Scenario	Focused Scenario	Distributed Scenario
Protect buffer zones around aquatic systems	0%	0%	2%
Control invasive species in grasslands	0%	0%	2%
Create new wetlands	0%	0%	1%
Control invasive species in aquatic systems	0%	0%	1%
Create adequate vegetative buffers around wetlands	0%	0%	1%
Improve water quality in aquatic systems	0%	0%	1%
Convert marginal cropland to wildlife habitat	0%	0%	1%
Restore aquatic systems	0%	0%	1%
Reduce conversion of wildlife habitat to cropland	0%	0%	1%
Reduce mowing during nesting season in grasslands	0%	0%	1%
Improve drainage management to benefit aquatic systems	0%	0%	1%
Improve water quality in wetlands	0%	0%	1%
Control invasive species in wetlands	0%	0%	1%
Control invasive species in agricultural lands	0%	0%	1%
Manage nuisance species in wetlands	0%	0%	1%
Restore wildlife habitat within agricultural matrix	0%	0%	0%
Manage nuisance species in agricultural lands	0%	0%	0%
Enhance pastures and haylands for wildlife	0%	0%	0%
Improve soil health in agricultural lands	0%	0%	0%
Modify drainage management in agricultural lands	0%	0%	0%
Reduce mowing during nesting season in agricultural lands	0%	0%	0%
Restrict recreational overuse in aquatic systems	0%	0%	0%
Actively manage wetlands for habitat quality	0%	0%	0%
Reduce negative impacts of drainage management on wetlands	0%	0%	0%

F. Full Landscape-level Modeling Results

Table C-13. Raw landscape-level modeling scores for seven species representing the Great Lakes Region (number of cells assigned to each score ranging from 1-100).

Score	Blanding's Turtle	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	Red-headed Woodpecker	American Woodcock	Average
0	10450432	10459380	8782898	3917684	10164267	9278963	8847544	2925628
1	18	0	11	0	20	0	0	40
2	100	0	12	0	11	9492	0	869
3	157	0	13	0	13	0	0	3320
4	181	0	8	0	14	0	0	7682
5	249	81465	26	1	43	0	0	22800
6	420	0	30	0	77	0	0	25557
7	577	0	88	7	70	114755	0	1295950
8	672	0	84	6	86	0	0	1800930
9	807	16510	87	30	81	0	0	1266709
10	950	18281	154	63	93	130916	0	475362
11	862	20052	157	51	124	0	0	61835
12	851	16036	125	107	133	0	0	21425
13	1090	13542	178	179	132	0	0	70460
14	1623	9850	208	70329	139	0	0	47560
15	1816	12985	161	29765	185	0	0	93583
16	2000	8797	162	26561	164	0	0	16937
17	2281	10481	237	25523	187	0	0	13944
18	3295	7746	299	24690	210	0	0	12116
19	5040	7015	489	24634	218	0	5878	13994
20	6348	7814	410	24492	232	0	6370	19737
21	10690	7467	397	23296	270	0	6604	26163
22	26295	5121	663	21393	287	0	8298	37402
23	77281	7256	447	19530	281	0	13175	46758
24	25693	4824	888	18007	311	0	13091	55576
25	778	7088	859	16858	312	90510	17813	69299
26	667	5162	719	16388	355	0	20765	110910
27	812	6201	662	16206	346	0	22565	288639
28	908	5172	715	15752	372	0	25162	430193
29	1092	2773	626	14902	387	0	33174	135003
30	1076	2720	868	14246	403	0	29888	136067
31	1134	3418	807	13318	439	0	37669	131591
32	1070	4118	1074	11721	419	0	40951	127073

Score	Blanding's Turtle	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	Red-headed Woodpecker	American Woodcock	Average
33	1180	2685	1399	10316	432	0	43731	128194
34	1369	2579	1243	8854	510	0	46554	128467
35	1332	4324	1383	6816	520	0	47500	127591
36	1584	2199	1563	5118	566	0	55305	127230
37	1837	1352	1666	3684	603	0	50264	121925
38	1944	3218	1952	2745	671	0	53721	114760
39	2000	2646	2347	1949	729	0	52739	102216
40	2739	1726	2424	1894	825	0	55266	85937
41	3045	2822	2621	1657	824	0	59494	68034
42	3222	2205	2773	1568	849	0	57536	52226
43	4577	2061	3085	2144	849	0	63512	40362
44	6451	1410	2948	3539	911	0	51367	29187
45	9160	506	3070	7137	931	0	31530	19718
46	17366	3722	3676	10040	1034	0	31703	13717
47	32852	2794	4355	13430	3045	0	31214	10376
48	19273	1403	4334	16673	4343	0	29843	7335
49	2603	1083	3937	20243	6467	0	29234	5699
50	991	3703	4055	23252	7618	0	29450	4699
51	1013	2038	3985	25523	9419	0	28042	3862
52	1007	965	4166	200311	10804	0	27990	3228
53	1167	599	4434	289853	12004	0	27560	2202
54	1280	2644	4845	464154	13548	0	26883	1481
55	1307	2542	4855	437732	14256	0	26420	1032
56	1605	1705	5254	373471	15724	0	26793	579
57	1595	3277	5631	334384	16847	0	27054	268
58	1610	1693	6274	314253	17524	0	28009	105
59	1819	512	6817	295599	18351	0	28091	31
60	2119	2973	6950	276035	18837	0	26100	8
61	2269	1383	7142	265783	22063	0	26980	1
62	2485	3489	7260	253690	28310	0	28713	0
63	2625	1766	7476	248092	36045	0	26789	0
64	3027	2837	7732	253240	39861	0	26594	0
65	4431	683	8031	261280	41119	0	27799	0
66	4896	2794	8705	269296	41762	0	26819	0
67	6711	1669	8946	251077	39256	0	26931	0
68	9667	1678	9514	227230	38118	0	26206	0
69	13275	1948	10172	200236	36021	0	27122	0

Score	Blanding's Turtle	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	Red-headed Woodpecker	American Woodcock	Average
70	18638	1379	10406	177550	33184	0	27244	0
71	24957	2467	11260	155449	30311	0	24783	0
72	15258	2249	12322	136148	27553	0	26924	0
73	4639	2206	13494	118413	25988	0	25876	0
74	1689	1821	13949	105463	22946	0	24482	0
75	1635	1944	15363	96431	19695	714398	24747	0
76	1359	3518	17116	92691	17838	0	24065	0
77	1340	2287	19018	79639	16197	0	23117	0
78	1567	1888	21481	66209	15121	0	23062	0
79	1719	2316	23960	55324	14078	0	22904	0
80	2049	377	26636	45684	12384	0	26368	0
81	2042	3039	29771	38416	11590	0	24378	0
82	2170	2096	32860	30457	10549	0	23791	0
83	2675	1272	37404	23137	9435	0	23081	0
84	3014	2323	44354	17147	8127	0	22694	0
85	3399	2357	52221	12065	7152	0	22428	0
86	3503	2742	60059	8486	6663	0	22356	0
87	4075	3219	67132	6101	6473	0	22829	0
88	4602	1452	76204	4285	6195	0	21891	0
89	5202	2991	86395	3052	6182	0	19408	0
90	6208	3395	99748	1886	5864	0	13747	0
91	6977	4706	113497	1160	5179	0	10139	0
92	8787	1862	126690	721	4076	0	7661	0
93	11517	4724	145984	415	3145	0	5652	0
94	15331	2647	164285	238	2437	0	4207	0
95	19827	4227	188407	92	1725	0	3157	0
96	15529	5676	213261	65	1165	0	2194	0
97	7368	3861	215641	5	685	0	1462	0
98	2348	8280	87679	0	406	0	844	0
99	440	11649	4450	0	146	0	284	0
100	204	78889	2137	0	0	665732	2	0

Figure C-68. Landscape-level modeling scores for the Great Lakes Region averaged across species.

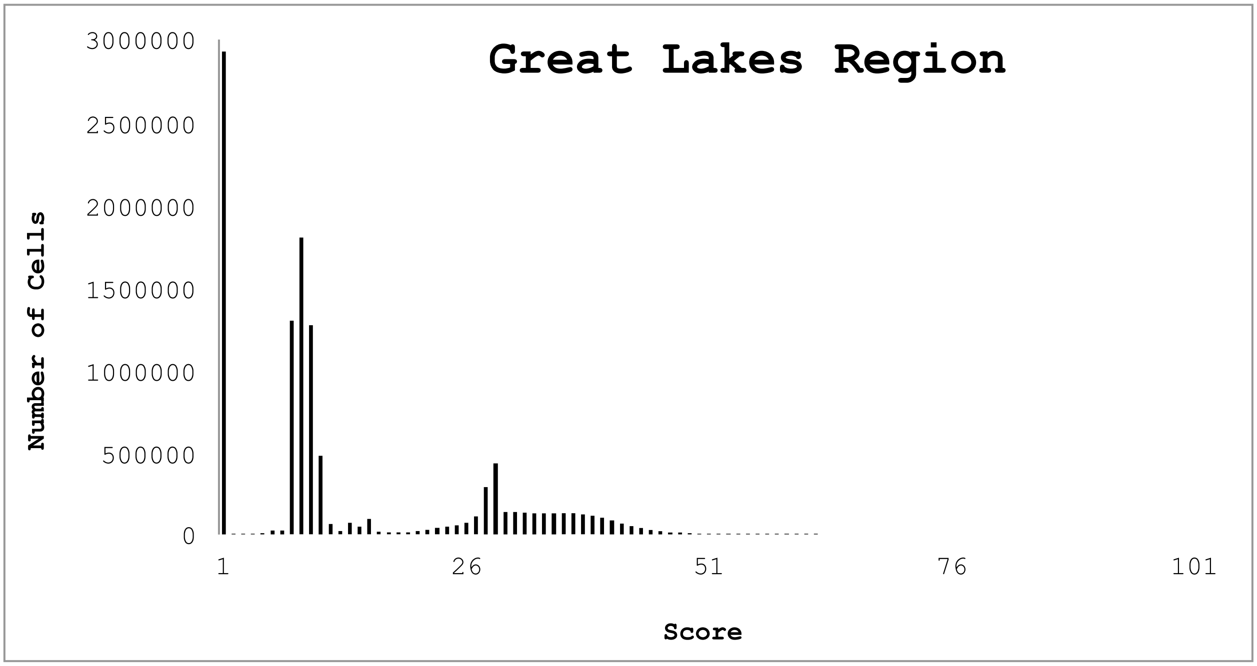

Table C-14. Raw landscape-level modeling scores for seven species representing the Kankakee Region (number of cells assigned to each score ranging from 1-100).

Score	Blanding's Turtle	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	Red-headed Woodpecker	American Woodcock	Average
0	8300265	8415002	7802846	1026040	7842789	7485722	7303060	727858
1	337	0	43	0	33	0	0	0
2	1353	0	47	0	62	5451	0	57
3	760	0	29	0	48	0	0	687
4	59	0	40	0	43	0	0	2208
5	181	40452	92	0	97	0	0	4987
6	1109	0	72	0	163	0	0	4616
7	1115	0	118	0	269	122243	0	3097530
8	325	0	134	0	348	0	0	1764732
9	422	8338	177	0	305	0	0	850159
10	1035	10929	117	8	367	41357	0	370569
11	847	10279	181	27	369	0	0	82458
12	1697	9054	143	56	427	0	0	8092
13	543	6208	189	54	509	0	0	22793
14	965	6025	264	38216	536	0	0	17378
15	704	4866	294	13916	598	0	0	39382
16	1077	3701	192	15307	563	0	0	13895
17	908	4551	288	15298	657	0	0	12432
18	1283	3822	287	15047	672	0	0	10681
19	1938	3393	394	16371	701	0	2230	9479
20	3495	2650	284	16707	753	0	1958	10169
21	4559	3282	335	17032	807	0	1530	12571
22	7190	1864	464	16962	826	0	2133	16181
23	15452	2532	351	17197	880	0	3259	21741
24	8678	1921	406	17105	920	0	3049	28855
25	776	1690	518	17272	1016	48857	3836	38349
26	988	2072	435	17348	1032	0	4377	56055
27	733	896	481	17769	1124	0	4871	106992
28	1074	1702	576	18247	1112	0	5278	187106
29	1494	1311	539	18097	1236	0	7300	69688
30	1239	1612	676	18072	1286	0	6549	65029
31	991	1761	538	18206	1341	0	8421	59992
32	1332	1654	732	17233	1428	0	9384	60937
33	1366	882	666	15457	1489	0	10511	64719

Score	Blanding's Turtle	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	Red-headed Woodpecker	American Woodcock	Average
34	1212	1234	767	13142	1570	0	11612	72747
35	1270	673	813	11260	1654	0	12049	78573
36	1072	963	907	9102	1728	0	14788	84900
37	1142	1031	930	6787	1781	0	13801	91184
38	1074	279	1033	4620	1914	0	15083	92061
39	1362	235	1098	3101	1899	0	14522	85580
40	1608	1002	1152	2159	2131	0	19319	68822
41	1611	447	1160	1630	2152	0	22215	50973
42	2177	238	1261	1157	2238	0	18798	41555
43	2655	591	1286	1748	2320	0	20256	34070
44	2768	1453	1393	3155	2497	0	17486	22398
45	3586	567	1484	5203	2629	0	13052	11750
46	3902	637	1477	7625	2719	0	13435	6960
47	7907	314	1578	9343	3849	0	13273	5156
48	6694	523	1618	11467	4418	0	13446	3948
49	2051	1229	1612	13464	5157	0	13661	2314
50	1553	1017	1852	16110	5787	0	14049	1362
51	1640	984	1890	17624	6380	0	13985	812
52	1746	330	2025	899240	7344	0	14581	498
53	1664	301	2103	786860	7688	0	14952	374
54	1586	926	2194	892258	8414	0	15157	297
55	1325	295	2419	603637	8737	0	15826	243
56	1383	1034	2628	420801	8986	0	16123	170
57	1521	807	2870	344049	9690	0	16745	161
58	1848	0	3127	302166	10370	0	17250	59
59	1843	358	3365	262463	11039	0	18613	19
60	1701	403	3534	233786	11292	0	17376	6
61	2011	349	3570	213841	11773	0	18593	2
62	2238	0	3841	194897	13331	0	18881	0
63	2240	289	4279	181531	16761	0	19121	0
64	2442	425	4443	177671	20522	0	19441	0
65	2385	0	4692	168097	23265	0	20467	0
66	2801	416	5204	157947	23604	0	20788	0
67	3445	1627	5596	138728	26161	0	20382	0
68	4157	1227	6194	124513	26092	0	21011	0
69	4719	0	6580	111104	26758	0	21732	0
70	6314	0	7156	101960	25723	0	22024	0

Score	Blanding's Turtle	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	Red-headed Woodpecker	American Woodcock	Average
71	10831	467	7684	93506	25062	0	20975	0
72	9435	451	8199	84543	24747	0	22610	0
73	4340	259	8609	75364	23130	0	22583	0
74	2205	0	9351	74223	21667	0	21959	0
75	1836	560	10240	67920	21273	695699	22965	0
76	1524	874	11336	63031	20187	0	22484	0
77	1350	904	12092	54592	18456	0	22472	0
78	1628	0	12923	45251	17582	0	22716	0
79	1743	0	13473	37364	16803	0	22851	0
80	2129	476	14778	31078	16191	0	31350	0
81	2175	868	15793	26961	15553	0	28977	0
82	2141	0	16205	22584	14282	0	29311	0
83	2438	0	16964	18343	13744	0	28806	0
84	2134	545	18068	14959	12977	0	29586	0
85	2598	1018	19182	12201	12479	0	30146	0
86	2669	299	20733	9710	11912	0	30368	0
87	2668	577	23095	8342	11704	0	31066	0
88	3017	1558	25571	6455	11954	0	30518	0
89	3119	1079	26773	5089	12234	0	28333	0
90	4055	589	28176	3618	11232	0	22821	0
91	5894	503	27976	2553	10027	0	18017	0
92	7005	464	30059	1704	9013	0	14402	0
93	8038	666	30602	933	8200	0	11430	0
94	10312	1213	31300	489	7027	0	8691	0
95	13618	1108	38996	193	5870	0	7080	0
96	14542	2308	57643	62	4411	0	5064	0
97	8967	1305	73807	22	3125	0	3535	0
98	4579	649	62395	3	1797	0	1978	0
99	1867	1482	14207	0	565	0	637	0
100	583	3508	74	0	0	199054	1	0

Figure C-69. Landscape-level modeling scores for the Kankakee Region averaged across species.

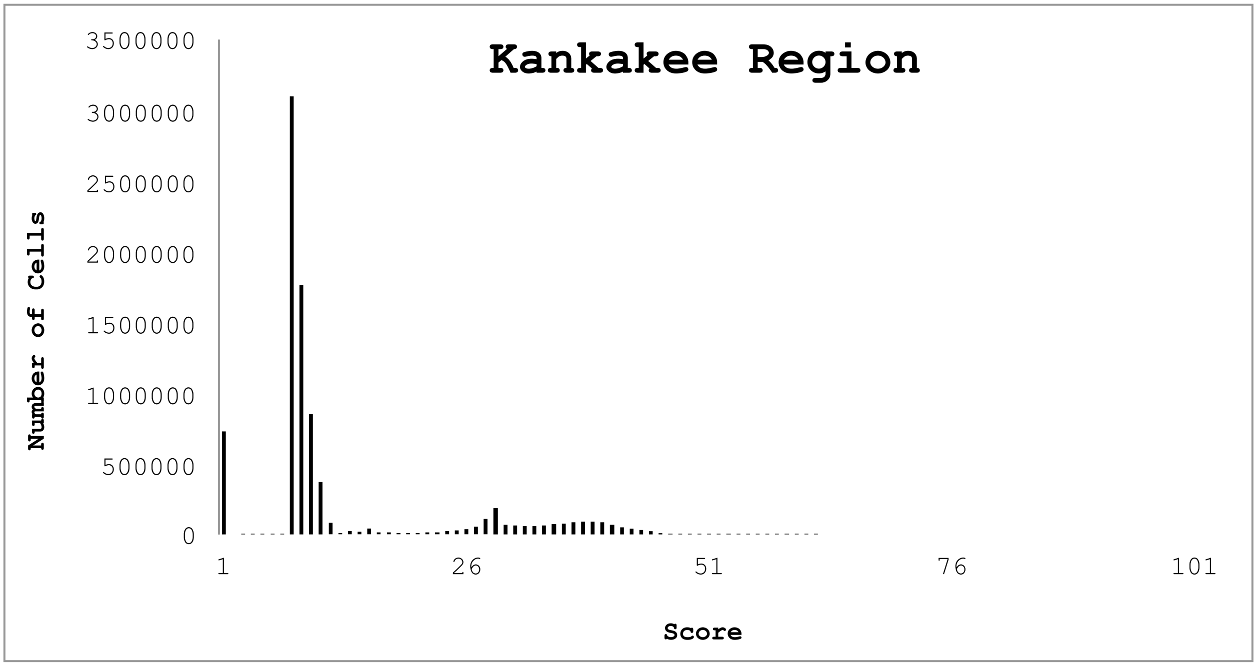

Table C-15. Raw landscape-level modeling scores for six species representing the Corn Belt Region (number of cells assigned to each score ranging from 1-100).

Score	Cerulean Warbler	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	American Woodcock	Average
0	40953022	44261677	42616119	6057971	41533184	38594719	5506190
1	0	0	339	0	340	0	121
2	0	0	444	0	462	0	908
3	0	0	248	0	334	0	4666
4	0	0	394	0	496	0	9382
5	0	93700	827	0	930	0	14059
6	3246088	0	733	1	1639	0	20205
7	0	0	1195	2	2149	0	19506
8	207527	0	1288	12	2531	0	6778231
9	133862	33172	1677	30	2775	0	16699503
10	100589	51316	1194	46	3176	0	5032353
11	88561	50637	1811	123	3321	0	2602024
12	56517	39940	1514	203	3500	0	1077043
13	45266	37678	1880	357	4166	0	279538
14	34512	38348	2504	226518	4499	0	53620
15	16453	29869	2666	62215	4658	0	144072
16	4391	27401	2079	59993	4975	0	284373
17	4895	24806	2953	61998	5239	0	71182
18	10233	25139	2880	66456	5642	0	110212
19	10497	19926	3538	71445	6212	13210	138527
20	16607	14947	3243	75568	6422	13510	155195
21	22975	18923	3405	79425	6679	12571	157585
22	11861	14560	4707	80312	7047	17162	143618
23	6147	17006	3742	80794	7709	24095	144703
24	19455	13779	4333	80544	8057	23293	164330
25	19850	12498	5216	80216	8562	29276	192636
26	0	15905	4565	80911	8882	33658	217059
27	14040	11916	5125	81589	9214	34495	242000
28	7300	9513	5926	82808	9638	37762	280142
29	0	7797	5281	82613	10113	48192	321840
30	0	7901	6577	81775	10585	43703	370299
31	0	9675	5812	80985	10923	53797	424285
32	0	9105	6833	77344	11654	58612	480912
33	8115	5661	6846	72253	11994	63110	530985
34	8215	9346	7218	65487	12488	69042	538554

Score	Cerulean Warbler	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	American Woodcock	Average
35	0	9525	7584	55293	13034	71261	473879
36	8549	5532	8224	43997	13488	84237	370375
37	0	5895	8603	31278	14188	77081	284116
38	0	5982	9143	21700	14968	81050	222030
39	0	7243	9372	15578	15265	78320	170509
40	0	6869	10580	11690	15978	103233	123580
41	0	5934	10353	9706	16499	115105	85015
42	9473	8074	11543	8105	17615	95653	59066
43	9539	4499	11726	12236	18161	95721	45260
44	9733	4671	12355	23267	18706	78888	41830
45	9779	6146	13836	39848	19667	63311	35194
46	0	7921	13877	56263	20357	66358	31667
47	0	5546	14981	70221	24067	66336	25869
48	0	3565	15547	80892	26916	63418	21595
49	0	2969	15498	90261	29694	69727	17488
50	0	5909	16274	98878	33059	73299	11811
51	0	4578	16964	106234	35943	74687	7032
52	0	6171	17403	3356899	39002	77701	3911
53	0	4109	18069	3633321	40714	78931	2749
54	0	3215	19282	5168386	43815	81237	2850
55	0	2375	20488	4018507	44925	82163	2572
56	0	3445	21879	2845142	48172	85035	1516
57	0	3462	22546	2166698	49624	87530	422
58	0	3205	23530	1797319	50653	99227	65
59	0	5430	24708	1503430	52389	95681	4
60	0	2711	25455	1277264	55572	92024	1
61	11806	4288	26813	1120886	58143	98829	0
62	0	3265	28150	989973	63049	110553	0
63	0	2806	29591	899928	69262	99738	0
64	0	3403	31060	860186	78852	100863	0
65	0	3998	32575	821557	88251	112386	0
66	0	2280	34415	777352	99121	105602	0
67	0	2964	36267	669884	106113	112114	0
68	0	1887	37845	583054	114236	104732	0
69	0	2864	39657	511965	116605	113682	0
70	25954	4650	40808	456881	119902	116338	0
71	13140	2038	42204	408885	116485	99993	0

Score	Cerulean Warbler	Henslow's Sparrow	Northern Leopard Frog	Northern Bobwhite	Eastern Red Bat	American Woodcock	Average
72	13219	1079	44478	365854	117132	116041	0
73	0	2267	46018	327973	111277	115236	0
74	0	2071	48019	318051	105666	103364	0
75	0	2780	49745	294831	100086	111582	0
76	0	2004	51656	281479	93800	109631	0
77	0	3600	53080	236463	89197	108645	0
78	0	3116	54692	190417	84443	108634	0
79	0	3935	56476	156551	80513	107776	0
80	0	3215	57688	130935	77234	221098	0
81	0	2243	59642	109400	72291	152280	0
82	0	2005	61241	89004	67349	143163	0
83	0	1848	61629	72410	63663	141969	0
84	0	4108	62995	57243	60444	141635	0
85	0	4238	64439	45139	58222	142810	0
86	0	4271	65941	36721	56812	147523	0
87	0	3710	67044	29457	54969	151905	0
88	0	4761	68342	23152	54225	146186	0
89	0	3665	69303	18028	53030	123608	0
90	16627	4918	69771	14102	52146	83311	0
91	0	4966	69780	10133	50338	64076	0
92	17196	4981	70109	6967	47805	53068	0
93	0	4511	71815	4422	43600	44326	0
94	0	5384	73785	2531	38481	37276	0
95	0	8382	76877	1354	32588	31582	0
96	0	3694	96471	542	25664	25089	0
97	0	7517	128476	174	18735	18898	0
98	0	7618	48991	26	11088	12492	0
99	23359	25621	3402	1	3689	4808	0
100	34912	42245	96	0	0	1	0

Figure C-70. Landscape-level modeling scores for the Corn Belt Region averaged across species.

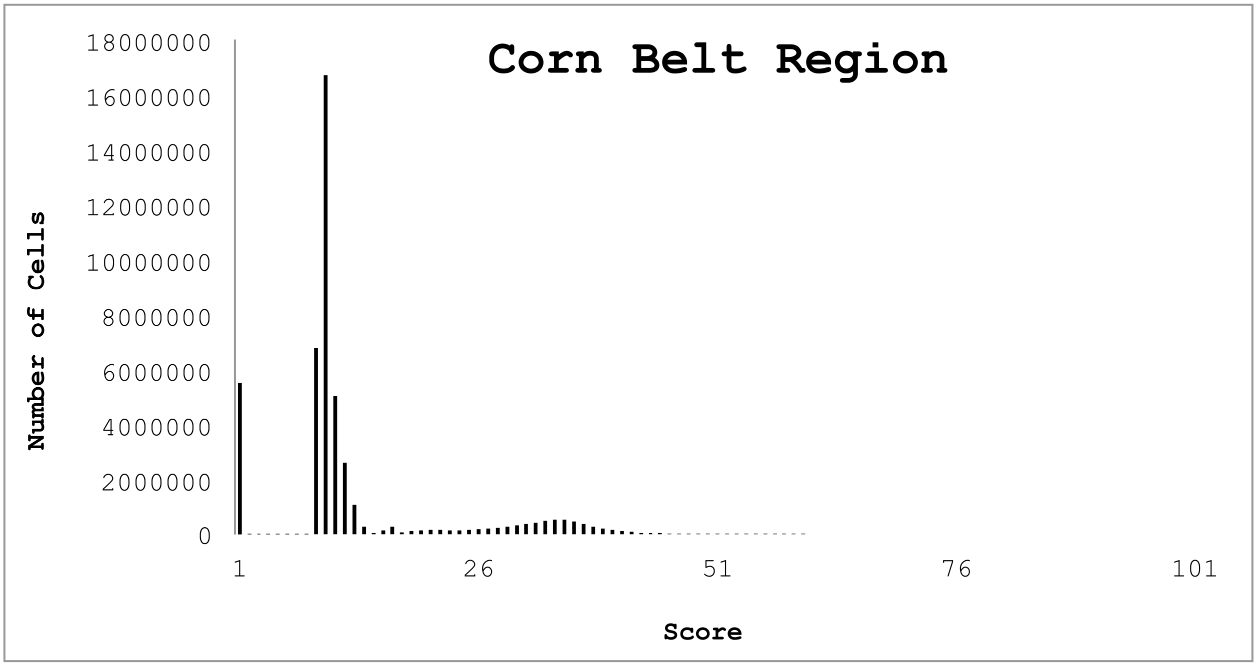

Table C-16. Raw landscape-level modeling scores for six species representing the Valleys & Hills Region (number of cells assigned to each score ranging from 1-100).

Score	Cerulean Warbler	Copper-bellied Water Snake	Henslow's Sparrow	Northern Bobwhite	Swamp Rabbit	American Woodcock	Average
0	12056439	13071754	15331831	2016412	11594681	11064538	1301771
1	0	0	0	0	3280	0	17
2	0	0	0	0	10657	0	170
3	0	0	0	0	12608	0	1033
4	0	0	0	0	13756	0	5405
5	0	1	65892	0	14876	0	11898
6	1487841	9	0	0	17630	0	21109
7	0	3	0	5	17227	0	38638
8	127835	2	0	9	14819	0	1143906
9	151899	2	12577	17	17987	0	3760718
10	119935	3	16463	44	16904	0	1602104
11	80999	7	15745	106	17164	0	1067929
12	82924	39	12119	203	20043	0	603686
13	46103	17	11762	355	21338	0	198727
14	34812	19	10108	304123	23005	0	75397
15	33320	23	8394	122792	24890	0	87296
16	58247	34	9834	118053	27558	0	201542
17	42691	33	8822	117682	29186	0	95766
18	29977	70	7499	117445	31804	0	123615
19	10624	92	7132	118091	35353	8420	153469
20	22085	122	5326	118296	38471	6459	174103
21	17347	157	6159	117693	41437	5953	163717
22	36142	158	4925	113993	43749	6879	167834
23	6194	227	6097	108508	48380	8758	193339
24	25691	273	4442	101381	52389	9072	213807
25	26298	305	3220	93867	55369	12466	274486
26	0	391	3932	85526	61190	13344	358230
27	6946	529	4568	81732	67876	13853	416490
28	14433	766	4208	77655	73457	14756	368421
29	0	775	3167	72764	79082	17834	244733
30	7572	883	4752	68328	84373	16082	179843
31	0	1083	5100	64182	89398	18260	158413
32	7862	1199	2248	58876	97978	19437	148299

Score	Cerulean Warbler	Copper-bellied Water Snake	Henslow’s Sparrow	Northern Bobwhite	Swamp Rabbit	American Woodcock	Average
33	0	1626	2425	53087	102627	20195	140354
34	8203	1775	2685	44921	110571	21376	109311
35	8451	2112	2275	36048	119276	21485	96427
36	0	2637	1838	28294	125807	24355	93822
37	8679	2854	3228	20790	136127	23509	96777
38	26563	3232	2248	13500	139441	23979	109877
39	18011	3509	2008	8659	150791	23922	158820
40	9128	4350	1784	6699	159680	23985	220424
41	0	5465	2129	5490	159337	24595	221328
42	0	6504	2270	4947	170001	24692	190375
43	19049	8493	3314	6012	177629	29224	150892
44	9650	11383	1862	8415	191282	25960	110988
45	0	18805	3876	13728	186964	27520	84409
46	19802	34762	1860	20257	212929	28891	74954
47	0	90667	2993	28886	199177	29718	63720
48	0	211732	1147	36602	246250	27270	47348
49	10387	132107	1724	46068	209148	32701	33082
50	0	18261	2612	53211	3930	33621	24455
51	10578	1415	1690	61705	5595	34662	17294
52	21389	1673	2186	635286	4888	35572	14344
53	0	1839	1967	611270	3705	37333	14143
54	10910	2056	1430	1010147	3687	38039	14894
55	22169	2351	679	932093	4539	39674	15347
56	11242	2635	1968	766293	5810	40747	15630
57	22754	2878	1740	617540	4475	42350	16886
58	0	3451	992	544360	3894	51117	18448
59	0	4115	2851	492702	5810	45287	13959
60	0	4902	2307	453558	4720	45267	12083
61	11813	5567	706	425658	7192	47198	10950
62	0	7219	1239	397455	4195	57734	10739
63	0	8626	1177	380764	3747	49705	9908
64	0	13210	1439	365543	4398	50753	6767
65	12300	18724	1438	347217	4920	62519	4146
66	0	28621	1261	336198	3809	54786	2181
67	12579	59692	726	312470	5186	65564	768
68	0	95631	933	291220	5840	56879	272

Score	Cerulean Warbler	Copper-bellied Water Snake	Henslow's Sparrow	Northern Bobwhite	Swamp Rabbit	American Woodcock	Average
69	0	93395	1301	270007	3362	70033	182
70	0	54711	3373	254501	2709	71472	98
71	0	5467	2171	238929	2927	60513	75
72	0	6344	568	221123	1827	75504	44
73	13374	6082	3196	203904	2182	77220	18
74	0	7103	657	186025	3074	66604	2
75	13710	7050	858	163018	3289	80509	0
76	0	7648	2089	142097	2571	83413	0
77	14008	8869	1216	118744	4042	83803	0
78	0	10605	2001	95365	2324	86874	0
79	0	12965	507	75654	2300	89181	0
80	0	15626	2065	62195	1512	342777	0
81	0	21725	1555	50536	2659	192319	0
82	0	33251	1969	41950	1329	173680	0
83	0	53902	2103	34675	895	171031	0
84	0	62898	1677	28112	2463	173713	0
85	0	54195	2227	23837	834	177532	0
86	0	34247	2418	19740	2351	190964	0
87	0	7992	1018	16480	2860	195066	0
88	16004	9755	3381	13488	2127	182877	0
89	0	12372	2400	11119	1513	141841	0
90	0	15065	1454	8480	1642	88462	0
91	16951	20207	3328	6237	2291	73677	0
92	0	28237	2872	4192	3251	63815	0
93	0	39698	1545	2787	2025	54333	0
94	18267	66992	3825	1682	1994	45964	0
95	0	109431	1560	881	1793	39247	0
96	0	176588	4840	353	2692	31200	0
97	20428	255279	5398	113	2378	22374	0
98	0	255717	7171	13	1922	13755	0
99	0	228715	14763	0	0	4403	0
100	861837	165482	60633	0	37038	1	0

Figure C-71. Landscape-level modeling scores for the Valleys & Hills Region averaged across species.

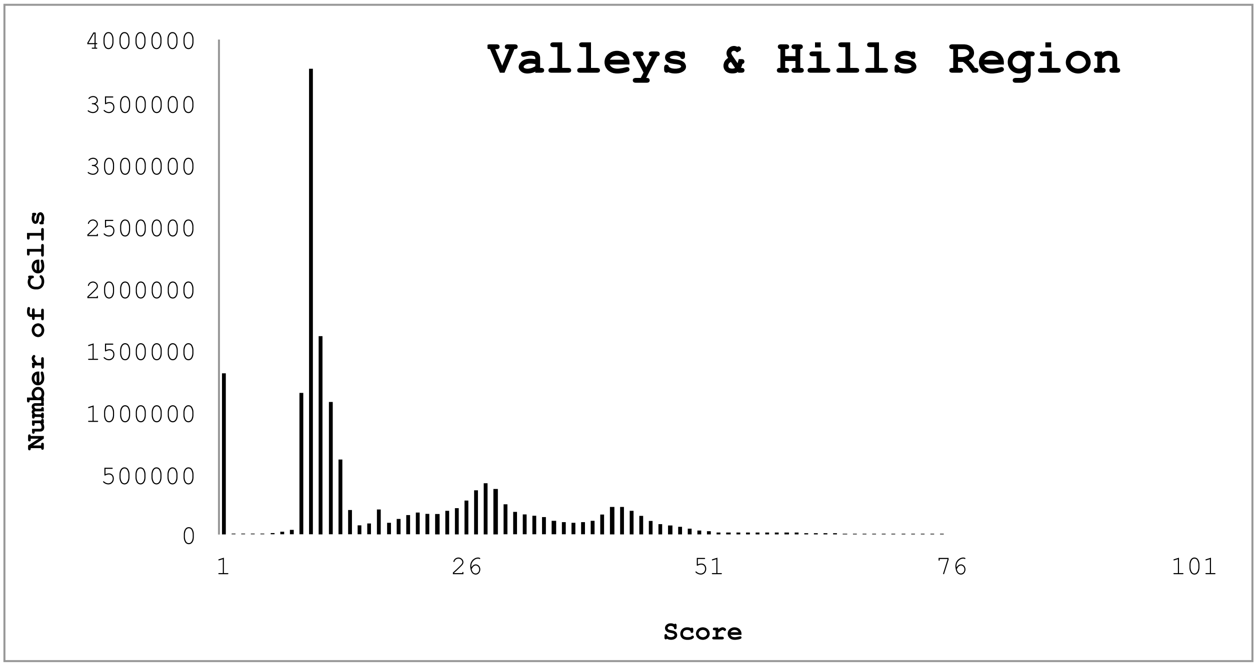

Table C-17. Raw landscape-level modeling scores for six species representing the Interior Plateau Region (number of cells assigned to each score ranging from 1-100).

Score	Cerulean Warbler	Eastern Box Turtle	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Timber Rattlesnake	Average
0	6232432	2964799	1010160	5764895	14884016	5984872	1005398
1	0	0	0	0	136	0	2
2	0	0	0	0	82	0	15
3	0	0	0	9938	43	8	17
4	0	0	0	0	66	496	2
5	0	0	0	8333	58	1047	6
6	749351	0	4	0	70	1632	14
7	0	0	30	8024	32	3044	74
8	81108	0	81	6933	23	4256	68006
9	74558	0	181	6002	707	5760	339083
10	58017	0	362	5982	1952	7214	389778
11	58477	0	662	5024	2422	9101	532432
12	30722	0	1149	4853	1229	10776	452591
13	24467	0	2075	4761	765	13468	160735
14	34585	2	2216903	4807	991	15445	12538
15	20858	0	559028	7560	1137	18352	3267
16	35202	20	494148	3694	1531	21198	37013
17	9347	0	442497	6666	1401	22786	231796
18	10034	0	420033	6275	1245	24231	547636
19	0	39	404522	6832	2769	25824	683798
20	11060	0	394837	2938	2458	28865	508615
21	11495	91	383169	5337	2134	31572	202486
22	6088	0	348767	7579	2774	36171	158751
23	18506	174	303605	5200	2657	41738	256949
24	19470	3	245077	5126	2284	43362	146553
25	0	326	175671	4033	1918	36665	85909
26	6763	0	105954	6274	1862	21159	83133
27	0	486	82089	1897201	1881	21868	44659
28	7313	799	69925	136	1512	23842	21265
29	0	0	58740	15	1777	25494	23687
30	0	1160	50752	114	1399	27190	26880
31	0	1690	42958	164	1307	30125	36784
32	23704	2474	36163	152	1247	33892	45058
33	8107	142	29582	11	1089	36647	68367

Score	Cerulean Warbler	Eastern Box Turtle	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Timber Rattlesnake	Average
34	8187	3667	24303	201	1162	39052	79083
35	8410	6291	19654	207	1153	40953	89055
36	8612	8880	15709	224	1038	37601	107767
37	0	12578	12879	216	928	37406	132750
38	0	354	11191	266	838	39391	149793
39	0	20782	10131	298	739	41919	156019
40	0	27685	10690	15	769	44916	155458
41	18529	37131	12093	299	642	49163	155301
42	0	68516	14619	336	680	52041	169451
43	0	78495	18657	317	599	55928	150472
44	0	92301	23705	273	582	59744	105239
45	0	108413	38580	687	567	63034	73339
46	0	55454	57669	325	514	67367	57046
47	10084	54822	79416	456	465	71140	56804
48	10207	55859	104738	440	455	75666	68724
49	0	136804	131614	445	466	78925	87379
50	0	1511720	157416	15286	427	83683	102792
51	0	549	180757	351	457	82849	118421
52	10733	12	224883	715	445	85898	173817
53	10804	959	224905	497	413	87579	312355
54	0	910	235624	7082588	358	91454	773263
55	0	1922	211057	0	277	95638	1748670
56	0	2985	176657	0	306	99192	2004118
57	11394	1237	174018	2	304	96738	930770
58	0	4678	182002	0	328	99220	286117
59	0	9142	189682	0	327	103147	215566
60	0	1459	196562	0	342	106448	163838
61	11847	12308	206225	0	288	110288	82847
62	11955	14953	212192	0	337	115578	54183
63	0	2083	219449	0	332	119906	16306
64	12266	18176	228352	2	287	123800	2001
65	0	15502	238356	0	317	129515	516
66	12481	11871	253301	0	269	134129	62
67	0	407	259804	0	257	138860	9
68	0	14873	266162	2	266	146028	8
69	0	23110	271483	0	226	150062	0
70	0	367525	275937	6	262	155255	0

Score	Cerulean Warbler	Eastern Box Turtle	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Timber Rattlesnake	Average
71	0	6517	278665	0	269	156687	0
72	0	66	273340	0	258	247477	0
73	0	9545	255538	0	213	295971	0
74	0	62	224115	0	206	325643	0
75	0	15591	178390	0	244	348006	0
76	0	18008	130235	0	274	367393	0
77	0	0	107990	0	256	373193	0
78	14124	49664	90357	0	271	373008	0
79	0	5	75686	0	278	377584	0
80	14452	60594	62445	2	321	388219	0
81	0	55811	50572	0	294	389459	0
82	14885	28027	40155	0	325	391468	0
83	0	73962	31746	1	305	393900	0
84	15181	44219	25198	0	266	404792	0
85	15387	144565	19944	0	313	159811	0
86	0	6720349	15878	0	327	66929	0
87	0	0	12598	3	332	35244	0
88	0	72236	10012	0	361	19223	0
89	0	0	7852	0	347	11533	0
90	16733	81055	5976	3	384	6691	0
91	0	0	4324	0	348	3932	0
92	17240	66985	2941	0	338	2371	0
93	0	0	2034	4	253	1403	0
94	0	61113	1236	0	183	235	0
95	0	0	613	4	149	19	0
96	0	52060	259	3	70	0	0
97	40054	0	83	0	32	0	0
98	42131	81043	6	1	18	0	0
99	22586	0	2	0	5	0	0
100	7062690	1559691	0	53302	0	0	0

Figure C-72. Landscape-level modeling scores for the Interior Plateau Region averaged across species.

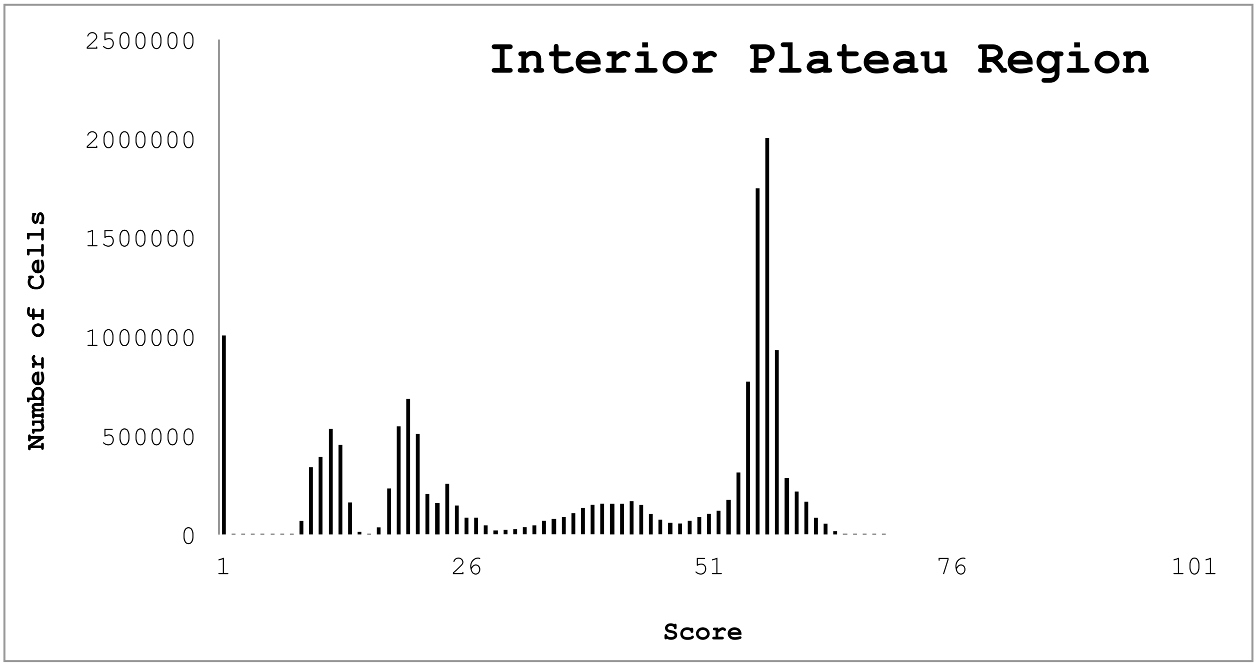

Table C-18. Raw landscape-level modeling scores for six species representing the Drift Plains Region (number of cells assigned to each score ranging from 1-100).

Score	Cerulean Warbler	Copper-bellied Water Snake	Henslow's Sparrow	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Average
0	5163628	7982440	8647394	823623	4901441	9169623	645392
1	0	0	0	0	0	54	63
2	0	16	0	0	0	18	160
3	0	1	0	0	7340	17	1054
4	0	3	0	0	0	13	2462
5	0	0	81630	0	6289	11	4722
6	723610	9	0	0	0	45	5580
7	0	5	0	4	5956	20	20000
8	56652	11	0	13	5405	30	151779
9	71136	8	14621	25	4700	143	680199
10	40017	10	19304	76	4539	346	653851
11	39131	19	19971	176	4402	665	801228
12	21392	20	16091	361	3963	318	746368
13	27613	16	12770	696	4068	169	452591
14	23059	17	12655	506612	3675	162	332212
15	12293	17	12604	177759	6648	268	293500
16	0	28	13180	175803	3118	377	236939
17	19019	54	8755	173729	5645	289	123592
18	5026	63	10415	174207	4591	302	102783
19	5329	82	8523	174196	5325	526	133946
20	5540	94	7565	172759	2257	640	156140
21	11661	94	9241	172054	5077	523	112168
22	0	100	5766	166450	5618	584	87896
23	6169	167	7983	153240	4337	696	111163
24	19439	268	5626	128312	4135	576	114314
25	13389	242	6646	100774	4011	485	99659
26	6848	357	3435	73181	5142	608	130224
27	7071	421	5199	63760	1163165	497	116566
28	14482	600	5876	58636	119	457	1062129
29	0	663	5546	54610	61	470	770158
30	7652	832	4859	50463	74	404	344139
31	7750	1065	4360	48115	168	419	184083
32	0	1115	4497	44243	185	389	75653

Score	Cerulean Warbler	Copper-bellied Water Snake	Henslow's Sparrow	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Average
33	0	1246	3688	39516	43	317	32352
34	8205	1362	3044	35241	210	333	70850
35	0	1359	3007	29555	216	296	51289
36	0	1604	3607	23733	203	310	43917
37	8764	1632	3684	17509	242	280	34742
38	0	1646	3132	12095	261	275	39590
39	8988	2041	3661	8924	272	414	31147
40	0	2486	2271	7606	71	302	33569
41	0	2854	2603	7098	296	291	22613
42	0	3463	1835	6948	312	272	15682
43	0	4722	2658	8027	334	294	15658
44	0	7906	2498	10151	243	261	11321
45	0	11281	1365	14592	518	245	11478
46	0	22246	2672	22042	421	292	13842
47	0	73141	3008	31448	316	226	8294
48	0	211140	1441	44249	326	247	4999
49	0	182237	3364	57049	337	215	1100
50	0	23870	3236	70553	17679	231	109
51	0	903	1615	82189	371	198	102
52	0	995	2091	140294	681	195	14
53	0	1326	1326	152263	529	204	6
54	11027	1299	1967	195875	2975435	220	10
55	0	1411	2514	196809	0	233	8
56	0	1441	2153	181771	0	199	3
57	0	1481	3363	178134	2	190	0
58	0	1778	526	181179	0	138	2
59	0	1919	1432	187489	0	172	0
60	0	2464	1848	191233	0	201	0
61	0	3270	2068	194558	0	187	0
62	0	3187	1366	197433	3	225	0
63	0	3798	1326	200329	0	228	0
64	0	5476	1758	202766	0	196	0
65	0	8290	2180	203431	0	221	0
66	0	15003	1537	206731	2	245	0
67	12554	34903	3171	203913	0	237	0

Score	Cerulean Warbler	Copper-bellied Water Snake	Henslow's Sparrow	Northern Bobwhite	Prairie Warbler	Ruffed Grouse	Average
68	0	63129	1957	202167	0	236	0
69	12871	77669	1637	198935	0	227	0
70	0	46667	2694	197942	0	234	0
71	13167	1438	1308	196273	0	246	0
72	0	1711	2214	192082	12	228	0
73	0	1786	1785	182946	0	255	0
74	0	2081	1382	167337	8	241	0
75	13642	2311	3202	143007	0	261	0
76	0	2433	1643	119658	2	282	0
77	0	2697	2504	102928	0	246	0
78	0	3082	3009	85334	4	253	0
79	0	3608	2270	71375	0	204	0
80	0	4562	2452	59652	3	217	0
81	14586	7114	1130	49426	0	232	0
82	0	11305	1339	40196	0	246	0
83	0	20466	1192	32290	2	223	0
84	15312	31461	2365	25705	0	234	0
85	0	30935	1731	21120	0	229	0
86	0	19222	338	16942	0	230	0
87	15800	2196	2100	14376	0	229	0
88	16194	2710	1170	11967	0	247	0
89	0	3177	2537	9857	0	288	0
90	0	3342	3150	7798	8	275	0
91	0	4303	1518	5710	0	241	0
92	0	4979	4639	4215	1	203	0
93	0	6895	3945	2509	2	185	0
94	0	11362	4184	1519	0	130	0
95	18691	19050	4508	716	0	133	0
96	0	28552	7604	316	0	106	0
97	0	43423	6586	87	0	69	0
98	64483	42174	9403	17	0	39	0
99	173015	38021	17617	1	0	7	0
100	2480205	23135	58373	0	24591	0	0

Figure C-73. Landscape-level modeling scores for the Drift Plains Region averaged across species.