Modeling Important Bird Habitat Using Multiple Alternative Land Cover Scenarios within the Chippewa River Watershed, Minnesota

U.S. Department of the Interior
U.S. Geological Survey

This study was supported by the National Institute of Food and Agriculture, USDA, under Agreement no. 2010-65615-20630. This project is part of the Chippewa 10% Project that is also funded by the Walton Family Foundation, Minnesota Environment and Natural Resources Trust Fund 2010 Chp 362, Sec 2 Subd3i and the National Fish and Wildlife Foundation and its partner the Natural Resources Conservation Service, USDA. Any opinions, conclusions or recommendations do not necessarily reflect the view of any funder.

Modeling Important Bird Habitat Using Multiple Alternative Land Cover Scenarios within the Chippewa River Watershed, Minnesota

by

Jason J. Rohweder
U.S. Geological Survey
Upper Midwest Environmental Sciences Center
2630 Fanta Reed Road
La Crosse, Wisconsin 54603

and

George Boody
Land Stewardship Project
821 East 35th Street
Suite 200
Minneapolis, Minnesota 55407

and

Sara Vacek
United States Fish and Wildlife Service
Morris Wetland Management District
43875 230th St.
Morris, MN 56267

Prepared for

Land Stewardship Project
October 2012

Contents

Figures

Tables

Introduction

The Chippewa River Watershed in Minnesota is an agricultural watershed with high-value ecosystem services. It is affected by sediment, nitrate nitrogen and other nutrients and habitat loss and degradation stressors. Analysis of sub-watershed monitoring in relation to water quality goals has led to an estimated need to convert approximately 9% of the watershed into perennials. Stakeholders are interested in identifying where investments of time and resources can be best applied to resolve water quality and wildlife habitat issues in the Chippewa River Watershed.

For the analyses described within this report we made hypothetical land use changes to the watershed in an attempt to determine how these proposed changes would affect important bird habitat. These scenarios involved the conversion of cultivated croplands to different perennial land use types within alternative areas of the watershed. We used these alternative scenarios within the Decision Support System LINK (Fox et al. 2004) to model and quantify the amount of important bird habitat within the watershed. Using the results from this tool we were able to compare alternative land use scenarios and determine how potential species occurrences for priority bird species were affected due to the proposed implementation of each. The GIS software used for these analyses was ArcGIS 9.3 (ESRI Inc.).

Spatial Datasets Used in Analyses

Many spatial datasets were used to complete the analyses. Data were given preference if they were the most current available, most accurate, had the highest spatial and thematic detail, were regionally available, and were relevant to the questions being asked. It is important to note that not all datasets used in each analysis were of the same spatial resolution as the outputs created using the models.

Study Area

All datasets were clipped to the study area defined as those areas within the Chippewa River watershed as outlined by the Watershed Boundary Dataset within the state of Minnesota (Figure 1). The study area accounts for an area in excess of 2,000 square miles.

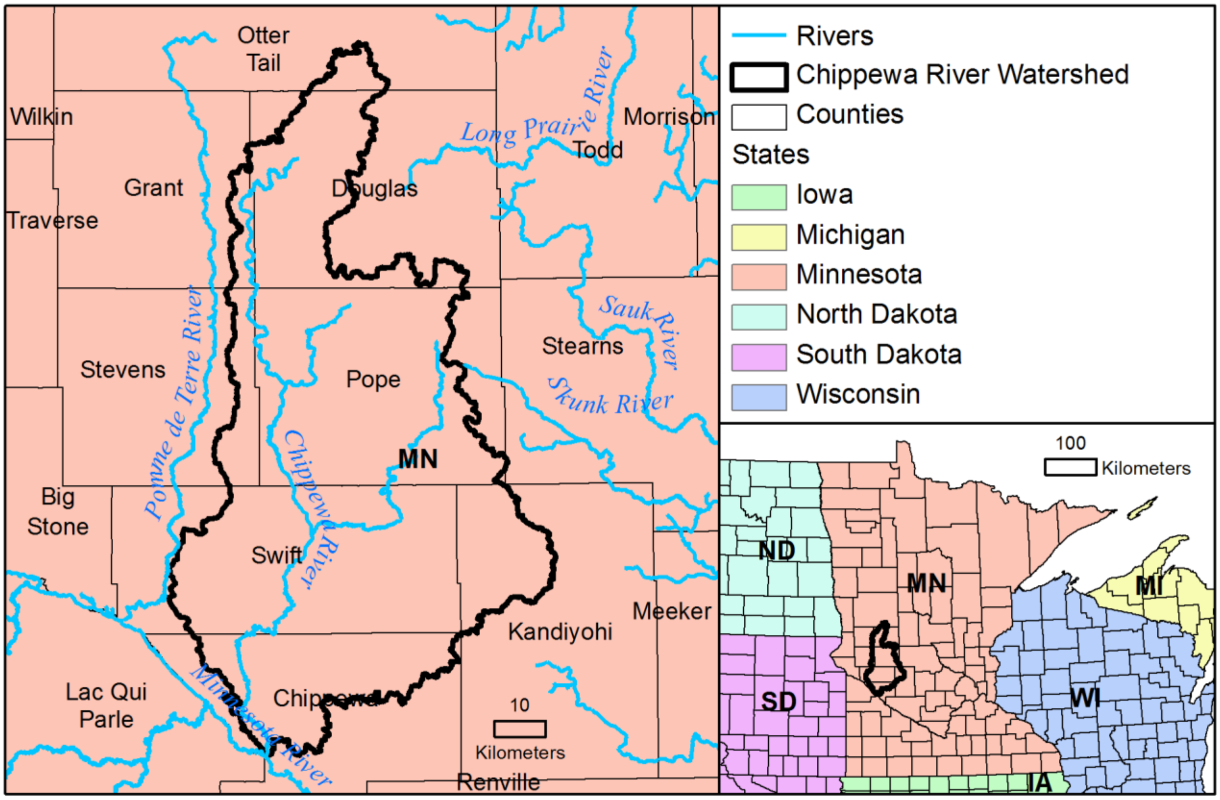

Figure 1. Study area

Land Cover

Land cover data were acquired from the National Land Cover Dataset (NLCD) produced for 2006 (Fry and others 2011). The United States Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (USEPA), has produced a land cover dataset for the conterminous United States on the basis of 2006 Landsat thematic mapper imagery and supplemental data (Figure 2). NLCD 2006 is a land cover database comprised of three elements: land cover, impervious surface and canopy density. NLCD 2006 uses improved classification algorithms, which have resulted in data with more precise rendering of spatial boundaries between the 16 classes. The seamless NLCD contains information suitable for a variety of state and regional applications, including landscape analysis, land management, and modeling nutrient and pesticide runoff. The NLCD is distributed by state as 30-meter resolution raster images in an Albers Equal-Area map projection. Classes of particular importance to the analyses performed for this report were cultivated crops, pasture/hay, and grassland/herbaceous. Cultivated crops are described as being areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. This class also includes all land being actively tilled. The pasture/hay class is described as being areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Finally, grassland/herbaceous areas are described as being areas dominated by gramanoid or herbaceous vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing (MRLC n.d.).

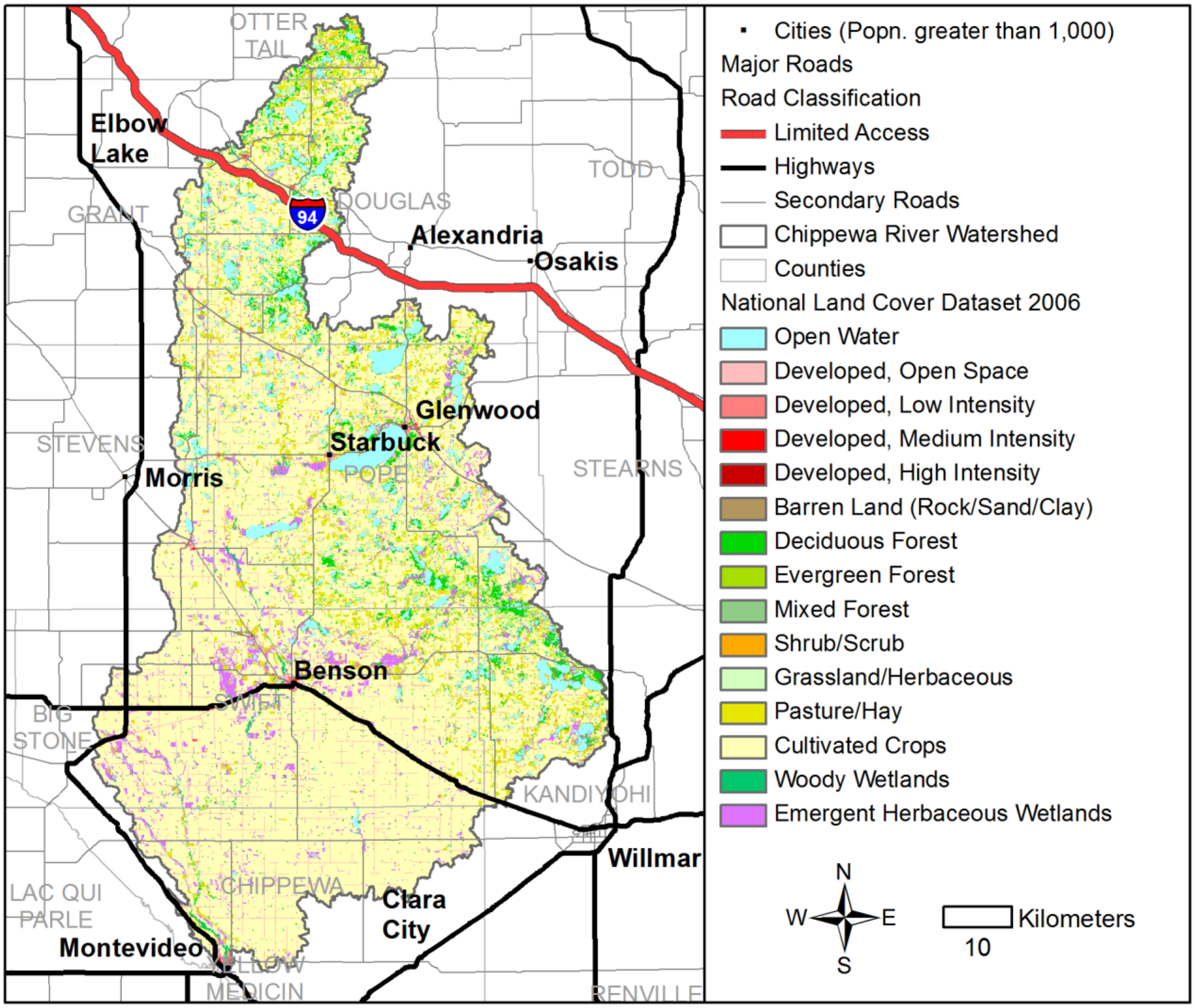

Figure 2. National Land Cover Dataset (NLCD; 2006)

When we look at the watershed as a whole we see it is dominated by cultivated crops with the other classes making up much less of the total land cover percentage (Table 1).

Table 1. National Land Cover Data set 2006 area summary for the Chippewa River watershed in decreasing order of area percentage

Description	Percent
Cultivated Crops	68.71%
Pasture - Hay	7.85%
Open Water	5.87%
Emergent Herbaceous Wetlands	4.99%
Developed - Open Space	4.14%
Deciduous Forest	4.09%
Grasslands - Herbaceous	2.75%
Developed - Low Intensity	0.71%
Woody Wetlands	0.42%
Shrub - Scrub	0.17%
Evergreen Forest	0.09%
Developed - Medium Intensity	0.08%
Barren Land (Rock - Sand - Clay)	0.07%
Developed - High Intensity	0.03%
Mixed Forest	0.01%
TOTAL	100.00%

More information on the National Land Cover Dataset can be found at the following web address: http://www.mrlc.gov/.

Slope

Slope data were derived from 10-meter horizontal resolution digital elevation model (DEM) data courtesy of the USGS National Elevation Dataset (Figure 3). The DEMs consist of a 2-dimensional array (i.e. a raster) of elevations for ground positions at regularly spaced intervals.

Slope identifies the maximum rate of change in value from each cell to its neighbors. Slope can be calculated as percent rise or degree of slope. For these analyses, we calculated slope as percent rise. Conceptually, the slope function fits a plane to the z-values of a 3 x 3 cell neighborhood around the processing or center cell (Burrough and McDonell 1998). As the slope angle approaches vertical (90 degrees) the percent rise approaches infinity.

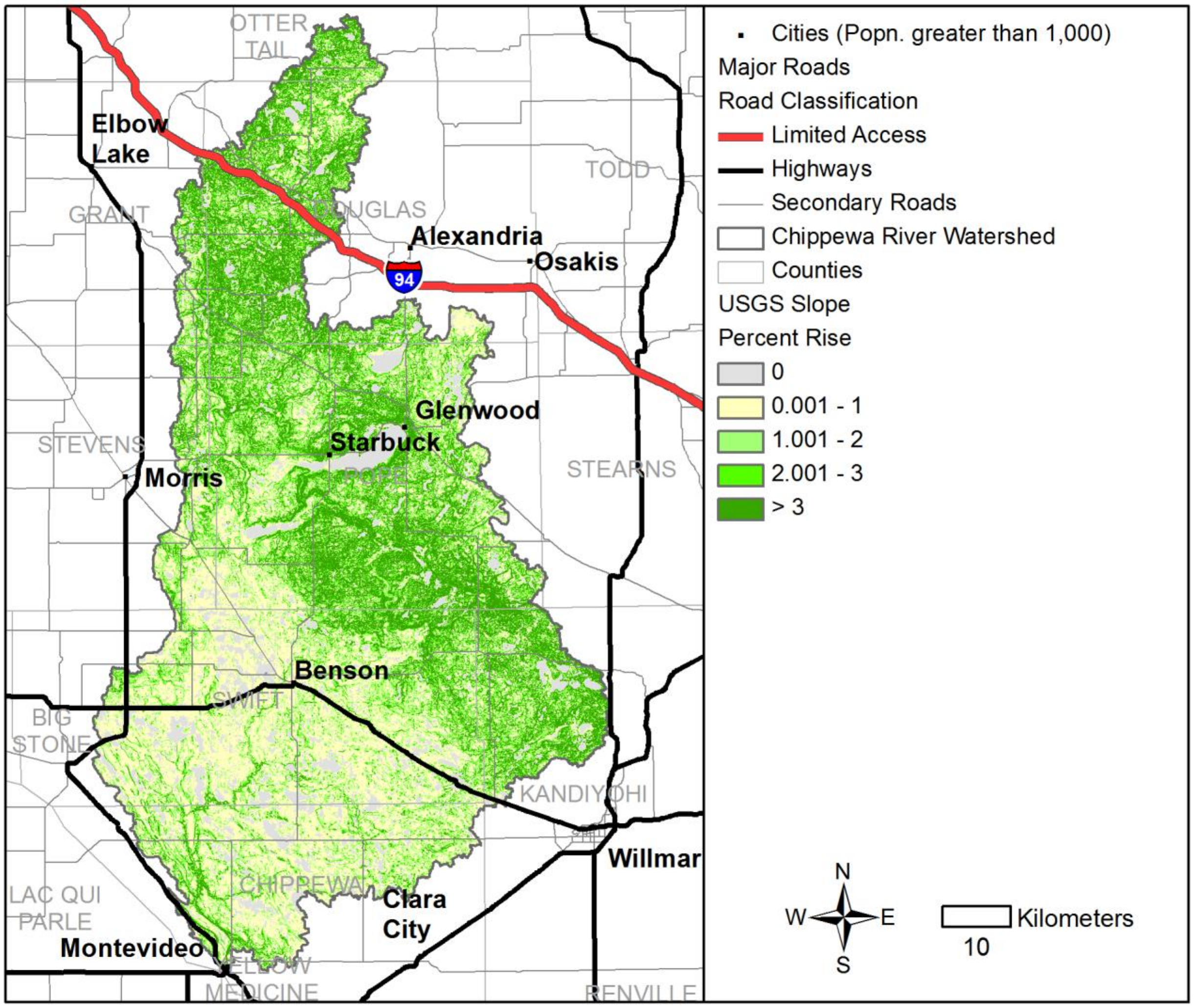

Figure 3. USGS slope depicted as percent rise

More information on the USGS National Elevation Dataset can be found at the following web address:
http://ned.usgs.gov/.

Soils

Soils data were acquired from the SSURGO database developed by the U.S. Department of Agriculture (NRCS n.d.*a*). Of particular importance from this database is the attribute "Non-irrigated capability class" (CLNIRR). CLNIRR is a rating for soil units that indicate a soil's relative capability to support non-irrigated agricultural use. As the number increases towards 8 the soil has more limitations and is less likely to be useable for non-irrigated agricultural use. Things that cause a soil unit to get a high ranking are related to erodibility, wetness, climate, and soil depth. Each SSURGO map unit is made up of several individual detailed soil components. Each of these components has a percentage applied to it that determines that component's contribution within the map unit. To calculate a unique value for each map unit, the CLNIRR for each respective component was multiplied by the components relative percentage within the map unit. These values were summed to create the “Average Land Capability Class” value for the entire map unit (Figure 4).

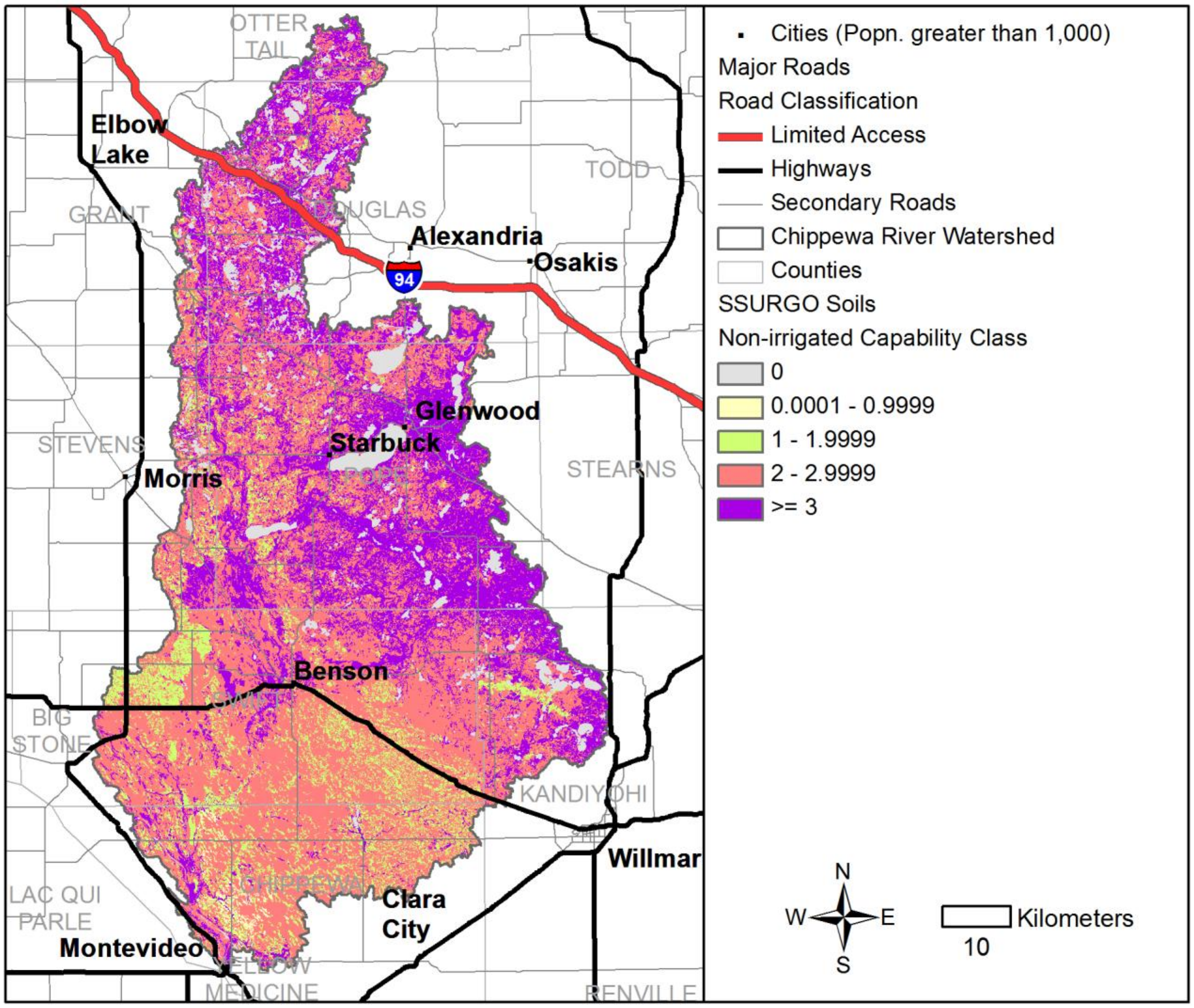

Figure 4. Non-irrigated capability class derived from SSURGO soils data

More information on USDA SSURGO can be found at the following web address: http://soils.usda.gov/survey/geography/ssurgo/.

Hydrography

The National Hydrography Dataset (NHD) courtesy of the USGS is a comprehensive set of digital spatial data that contains information about surface water features such as lakes, ponds, streams, rivers, springs and wells. High resolution (1:24,000) NHD data were available for the entire Chippewa River Watershed. Classes deemed relevant for these analyses were selected from the overall list of hydrographic classes. Linear features were limited to streams, canals, and ditches. Polygonal features were limited to lakes, ponds, reservoirs, swamps, and marshes (Figure 5).

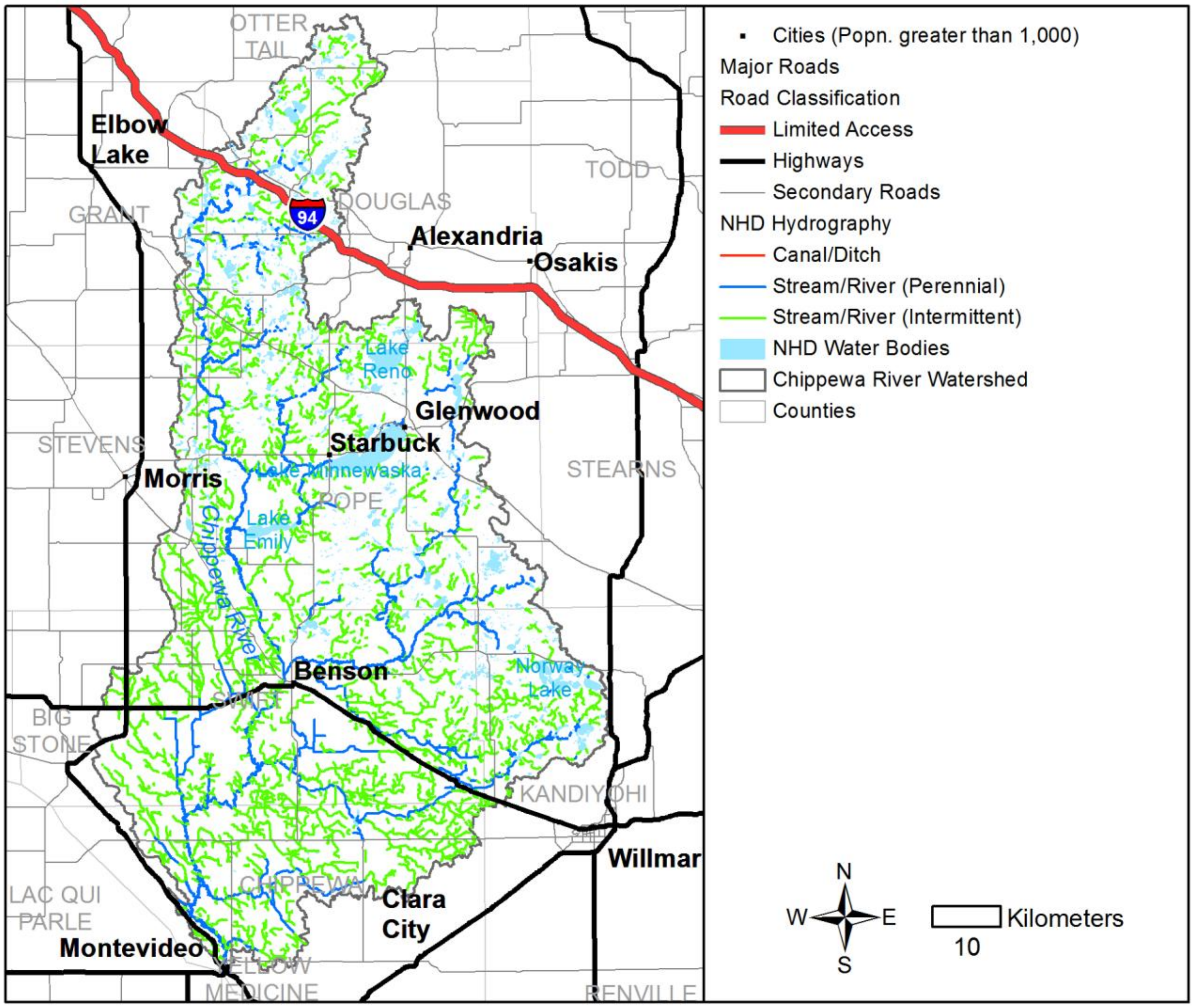

Figure 5. Hydrography for the watershed

Existing hydrography was buffered 100 feet to create a dataset that would depict a 100-foot corridor around water bodies (Figure 5).

More information on the USGS National Hydrography Dataset can be found at the following web address:
http://nhd.usgs.gov/

Watershed Boundary Dataset

Watershed boundaries developed by the Natural Resources Conservation Service (NRCS) define the aerial extent of surface water drainage to a point. The intent of defining hydrologic units for the Watershed Boundary Dataset (WBD) is to establish a base-line drainage boundary framework, accounting for all land and surface areas. The selection and delineation of hydrologic boundaries are determined solely upon science-based hydrologic principles, not favoring any administrative or special projects nor particular program or agency. At a minimum, they are being delineated and georeferenced to the USGS 1:24,000 scale topographic base map meeting National Map Accuracy Standards (NMAS). A hydrologic unit has a single flow outlet except in coastal or lakefront areas.

As stated by the Federal Standard for Delineation of Hydrologic Unit Boundaries (NRCS n.d.*b*) (Figure 6).

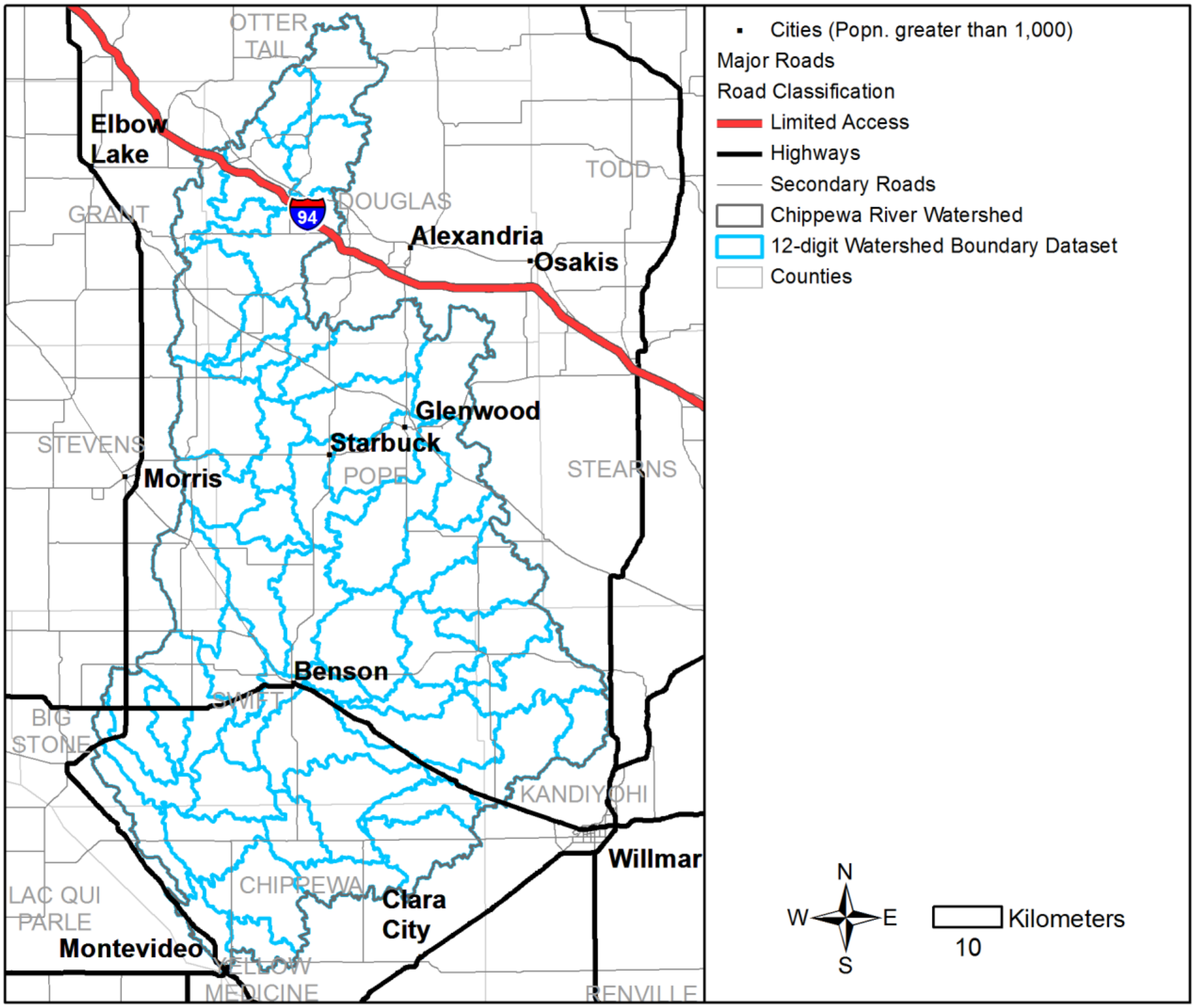

Figure 6. 12-digit watershed boundary dataset produced by the USDA-NRCS

More information on the Watershed Boundary Dataset can be found at the following web address: http://www.nrcs.usda.gov/wps/portal/nrcs/main/?ss=16&navtype=SUBNAVIGATION&navid=850150000000000&pnavid=850000000000000&recid=null&actid=null&groupid=null&ttype=main&pname=Watershed Boundary Dataset | NRCS

Methods

LINK Analysis

The analyses of important bird habitat relied upon LINK. The following information describes LINK and was taken from the tool's online documentation (Fox, T. J. 2004) and from Thogmartin et al. (2006).

LINK is a set of ArcGIS tools designed to map species-habitat patterns across a landscape. LINK uses species-habitat matrices to model potential species habitat and habitat diversity. These species-habitat matrices are user contributed and typically are created through expert opinion regarding species-habitat associations. What sets LINK apart from its predecessors is that it relates these user-contributed species/habitat matrices to raster data sources such as land cover. Raster data allows LINK to model habitat associations over a much larger spatial extent (e.g., counties, states, regions) than that of its vector-based antecedents.

Three main data sources are needed to run a LINK query: a species-habitat matrix, source layers, and (optionally) zonal layers.

A species-habitat matrix relates, for each habitat type within the raster source layer, a score representing species-habitat suitability. Species habitat suitability ranges from 0 (little to no value as habitat) to 100 (prime habitat). The source layer is a raster spatial data layer containing landscape information for species listed in the matrix. A zonal layer is a vector (polygonal) spatial data layer used to divide the landscape into units of comparison (i.e., Counties, Management Units).

LINK relates values contained in the species-habitat matrix to the source layer to generate several indices of potential habitat. These indices include mean potential species occurrence (PSO) and potential species richness (PSR), and may be calculated for an individual species or a group of species. Mean PSO is described as the average matrix score of the species queried for each source layer class. The maximum value for Mean PSO is 100. PSR is described as the potential number of species that may be found in a given area. The maximum value for PSR is equal to the total number of species queried. The Simpson's Diversity Index measures the diversity of habitats in each zone of a zonal layer. Only source layer classes with a PSO score > 0 are used to calculate Simpson's Diversity Index (SDI). SDI values range from 0 to less than 1. The SDI is positively influenced by the number of different habitat types and the relative equality of their areas.

If the user chooses, the program can summarize these indices for each zone within a zonal layer. A zonal layer is not required to run a LINK query, but summarizing habitat information by zone helps to illustrate the distribution of habitats across a region; the use of a zonal layer provides a unit-by-unit evaluation of potential habitat within the area of interest.

An extension was developed to the LINK tool that incorporates bird species ranges into models of habitat suitability; in this way, species are modeled only for those areas in their range for which they are believed to exist. This range limitation emphasizes that the LINK tool models potential rather than occupied habitat. As part of this extension, we incorporated ranges for all birds in the Western Hemisphere as provided in the collection of digital distribution maps by NatureServe, and the Breeding Bird Survey. The NatureServe ranges act as a 0/1 binary mask of the predictions, allowing predicted habitat to show only for areas within the range of the species, whereas the Breeding Bird Survey ranges act as weights to the predictions, weighing predicted species occurrence by the scaled species relative abundance.

Three separate LINK queries were run within the Chippewa River Watershed based upon three different bird/habitat guilds. A guild is a way to group species according to similar ecological resource requirements. The guilds used for this analysis were game birds, grassland passerines, and waterfowl. The individual species, listed in Table 2, were selected based on their inclusion on one of several lists including the Bird Conservation Region (BCR) 11 Audubon Watch List, the BCR23 Audubon Watch List, and the U.S. Fish and Wildlife Service (USFWS) Prairie Plan. Many of these species are also listed in the USFWS's "Birds of Conservation Concern, 2002" (USFWS 2002).

Table 2. Important bird guilds used in the analyses

Game Birds	Grassland Passerines	Waterfowl
Ring-necked Pheasant	Bobolink	American Black Duck
	Clay-colored Sparrow	Blue-winged Teal
	Dickcissel	Gadwall
	Grasshopper Sparrow	Mallard
	Le Conte's Sparrow	Northern Pintail
	Savannah Sparrow	Northern Shoveler
	Sedge Wren	Wood Duck
	Western Meadowlark	

The source layer used for the current land cover analysis was the NLCD2006. The zonal layer used within the analysis was the 12-digit WBD (USDA n.d.*b*). The range maps used for the analysis were obtained from the Breeding Bird Survey (Sauer and others 2011). Figure 7 displays an example range map for the black-billed cuckoo. The large blocks generated by the breeding bird survey were converted to a smaller cell size using ArcGIS' Focal Statistics command. This was done to create a smoother surface at the watershed scale. The larger values (red cells) denote areas with higher relative abundance probabilities according to the surveys.

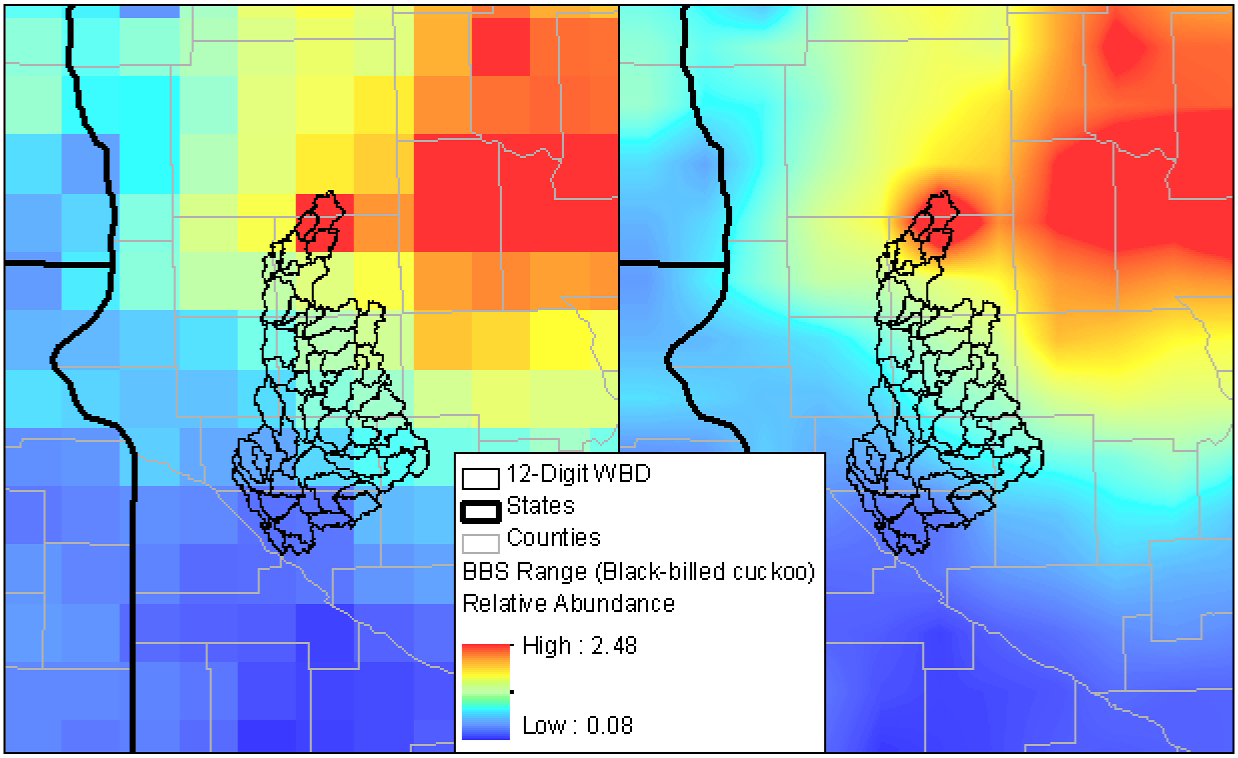

Figure 7. Example of Breeding Bird Survey range map revision

Alternative Land Cover Scenario Development

In order to project how changes to the landscape may affect important bird habitat we re-ran the various LINK models using alternative land management scenarios developed using specific rules applied to various input layers. These rules, when applied to the landscape, will highlight areas of optional land use change related to topography and habitat considerations. (Table 3). These changes will be directly applied to the input source layer, the NLCD 2006. For Scenarios 1 and 2 the analysis was performed on both the entire watershed as well as a subset of focal HUCs.

The first criterion we used was to identify areas within the watershed where slopes were calculated to be greater than 3%. We used the USGS 10-meter DEM as a source for the calculated slope represented as percent rise. Higher sloped areas are deemed less fit for agricultural land use. Figure 8 shows an example of the juxtaposition of these areas within a portion of the watershed. The second criterion, non-irrigated land capability class values greater than or equal to 3, was developed using the USDA, SSURGO soils data base for the watershed. These areas represent lands less appropriate for agricultural use according to their soil types. The next two criteria identified whether converted cropland would be proposed to be altered to either pasture/hay or grassland/herbaceous. Both options for Scenario 1 would be converted to pasture/hay. Scenario 1 represents a shift in cultivated cropland within somewhat marginal areas in the watershed due to slope, soil types, and distance to water to a land use type more suited to pastured livestock, in essence a working lands approach. Both Scenario 2 options would be converted to grassland/herbaceous, a land use type more suited to that associated with easements and set-aside. Scenario 3 would be converted to grassland/herbaceous as well. The next criterion identified the models where only cropland would be converted within the 18 identified focal HUCs. Focal areas were identified based on results of long-term monitoring by Chippewa River Watershed Project compared to water quality goals, current land-use, environmental sensitivity, and in conjunction with the Minnesota Prairie Plan. The final criterion identified the models where only areas within 100 feet of a stream or other waterbody (riparian area) would be converted. These riparian areas are integral in preventing erosion, providing habitat corridors, protecting water quality, and maintaining stream health. Scenario 3 was the only alternative that used this criterion (Table 3). An alternative land cover scenario was not developed limiting to the focal HUCs for scenario 3 due to the relative lack of acreage within the watershed that met this criterion.

Table 3. Criteria used in the alternative land cover scenario models

Criteria	Scenario 1 (Entire Watershed)	Scenario 1 (Focal HUCs)	Scenario 2 (Entire Watershed)	Scenario 2 (Focal HUCs)	Scenario 3 (Entire Watershed)
Slope > 3 %	X	X	X	X	X
Land Capability Class >= 3	X	X	X	X	X
Cultivated Crops converted to Pasture/Hay	X	X			
Cultivated Crops converted to Grassland/Herbaceous			X	X	X
Identified Focal HUC		X		X	
Within 100-foot Riparian Buffer					X
Total Acres Proposed Converted	106,735	54,637	106,735	54,637	3,410
Percentage of Chippewa River Watershed Converted	8.0%	4.1%	8.0%	4.1%	0.3%

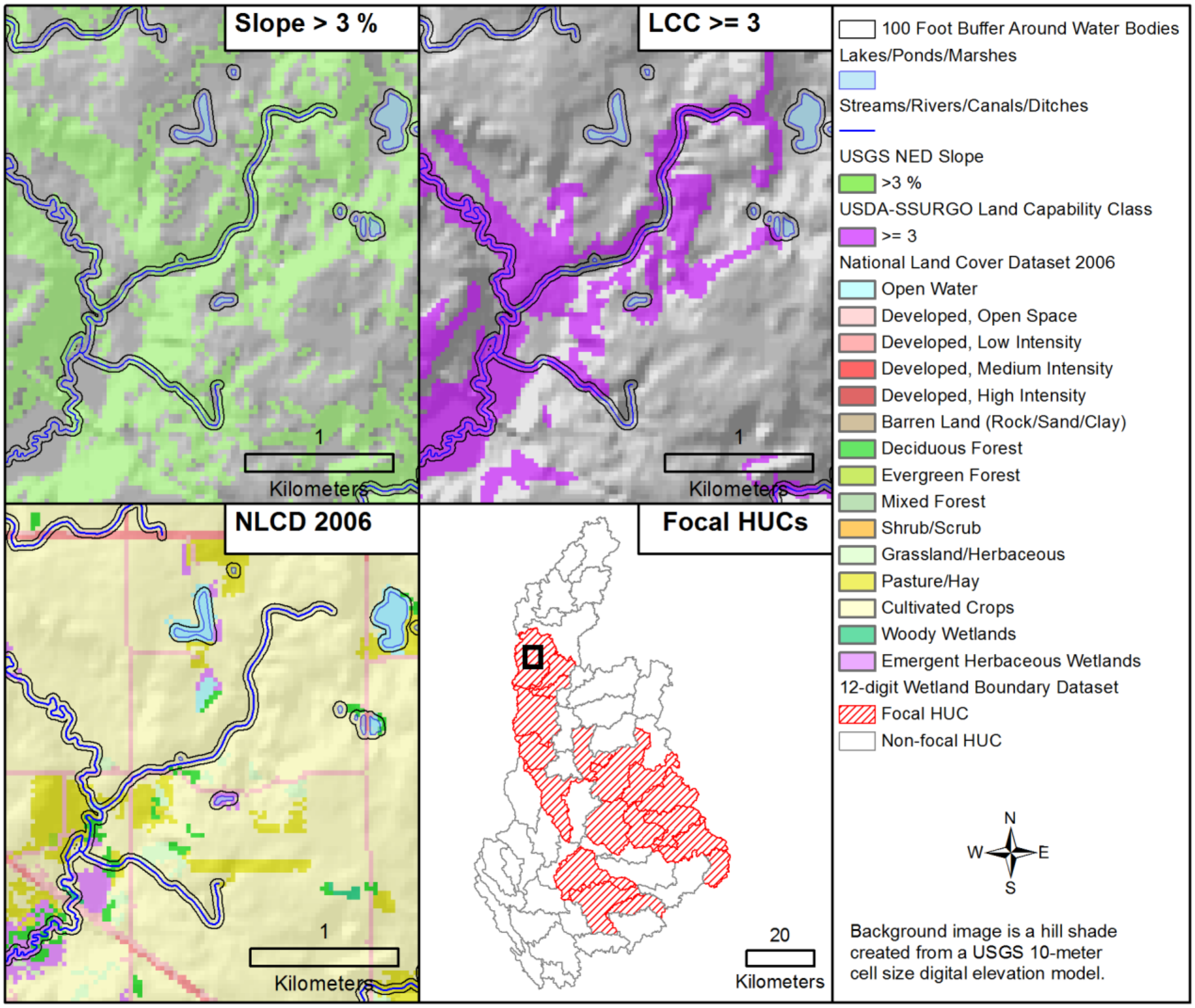

Figure 8. Map displays of the input criteria used to develop alternative land cover scenarios. Dark outline in the bottom-right map panel represents the area within the Chippewa River Watershed depicted in the other panels.

When we apply these model scenarios to the NLCD 2006 within the Chippewa River Watershed between 3,410 and 106,735 acres of cultivated crops would be identified for conversion to either pasture/hay or grassland/herbaceous cover types (Table 3). When we look at the breakdown by 12-digit HUC we see which HUCs have the greatest acreage increase in perennial cover types from the current land cover scenario and their location within the entire watershed (Figure 9).

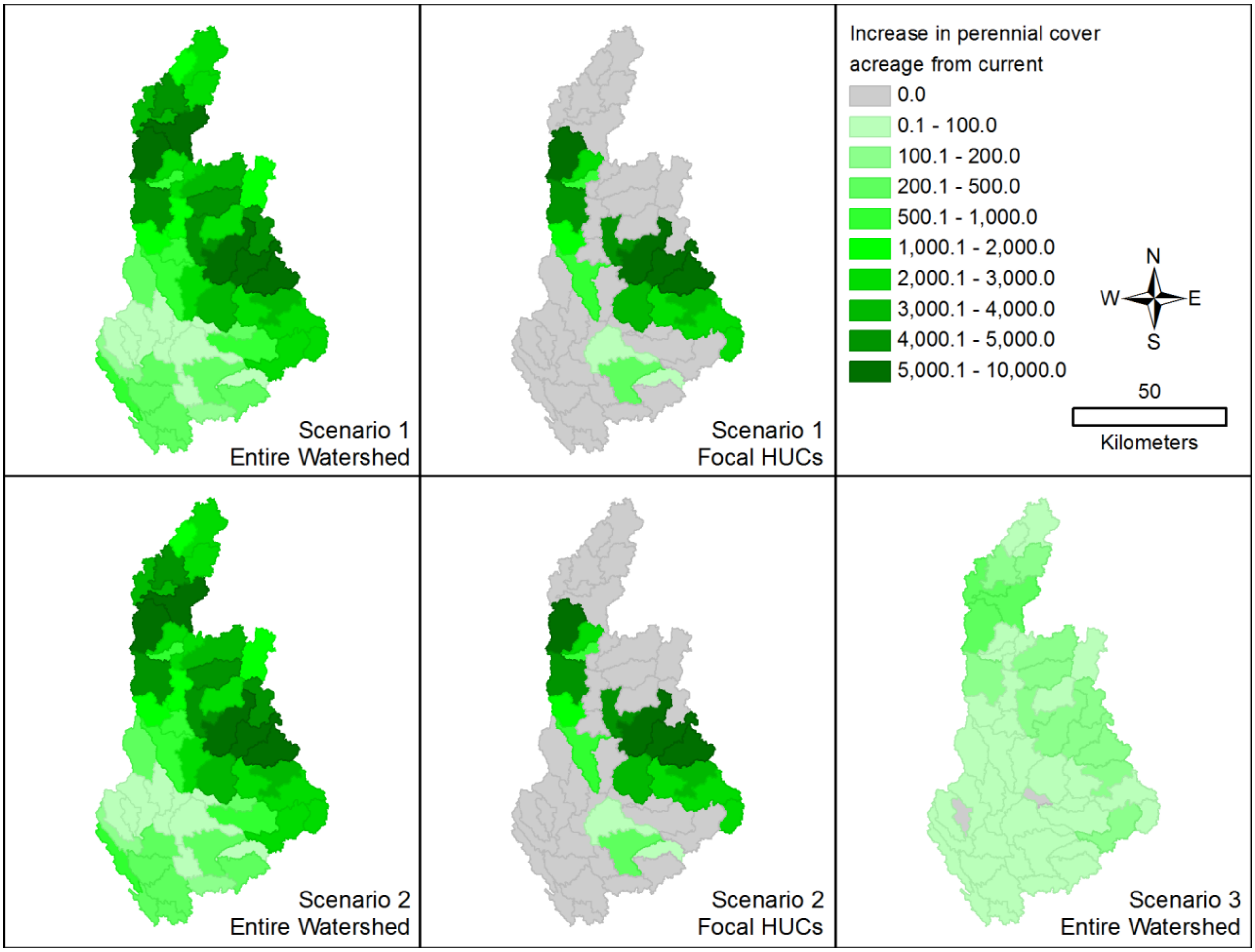

Figure 9. Increases in perennial cover types for each of the five scenarios. For scenario 1 the proposed conversion is to pasture/hay, whereas in scenarios 2 and 3 the proposed land cover conversion would be to grassland/herbaceous.

We then used these models as alternative source layers within LINK using the same species/habitat matrix, zonal layer, and range maps that were used to generate the current land cover scenario results.

Results

Current Land Cover Scenario LINK Results

We ran the LINK models using the current (as of 2006) land cover as the base input layer for each of the three bird guilds.

Game Bird LINK Output

There was one species used to define the game birds guild, the Ring-necked Pheasant. Table 4 shows the individual potential species occurrence scores for each NLCD land cover type. The poorest habitat type is scored zero and the best is 100. It is important to note that the matrix was scored to indicate the relative affinity of each bird species for each land cover type for any potential use (i.e., breeding, nesting, feeding, etc). If we were just looking at modeling nesting habitat, for instance, the matrix would most likely look markedly different.

Table 4. Bird guild matrix

Common Name	Open Water	Developed - Open Space	Developed - Low Intensity	Developed - Medium Intensity	Developed - High Intensity	Barren Land (Rock - Sand - Clay)	Deciduous Forest	Evergreen Forest	Mixed Forest	Shrub - Scrub	Grasslands - Herbaceous	Pasture - Hay	Cultivated Crops	Woody Wetlands	Emergent Herbaceous Wetlands
Game Birds															
Ring-necked Pheasant	0	0	40	0	0	23	0	0	0	60	100	100	99	60	80
Grassland Passerines															
Bobolink	0	20	0	0	0	11	0	0	0	0	100	100	0	0	20
Clay-colored Sparrow	0	0	0	0	0	41	0	0	0	100	40	40	0	20	0
Dickcissel	0	0	0	0	0	0	0	0	0	0	100	80	20	0	0
Grasshopper Sparrow	0	20	0	0	0	0	0	0	0	0	100	80	0	0	0
Le Conte's Sparrow	0	0	0	0	0	0	0	0	0	0	60	40	0	0	100
Savannah Sparrow	0	20	20	0	0	7	0	0	0	40	100	100	20	0	0
Sedge Wren	0	0	0	0	0	0	0	0	0	0	60	40	0	40	100
Western Meadowlark	0	0	0	0	20	20	0	0	0	20	100	100	20	0	0
Waterfowl															
American Black Duck	20	0	0	0	0	0	0	0	40	0	0	0	0	100	60
Blue-winged Teal	60	0	0	0	0	0	0	0	0	0	100	60	0	40	100
Gadwall	60	0	0	0	0	0	0	0	0	0	100	0	0	0	100
Mallard	100	40	60	0	0	10	40	0	40	60	100	60	60	80	100
Northern Pintail	40	0	0	0	0	0	0	0	0	0	40	100	0	0	100
Northern Shoveler	100	0	0	0	20	0	0	0	0	0	80	40	0	40	100
Wood Duck	20	0	80	0	0	0	60	0	40	0	0	0	0	100	60

Once the analysis is completed using LINK, one of the products created is a raster dataset depicting mean potential species occurrence. Figure 10 shows this output for game birds. The figure also includes separate maps for mean potential species occurrence, potential species richness, and Simpson’s Diversity Index by zone. The zones for these analyses are derived from the 12-digit WBD.

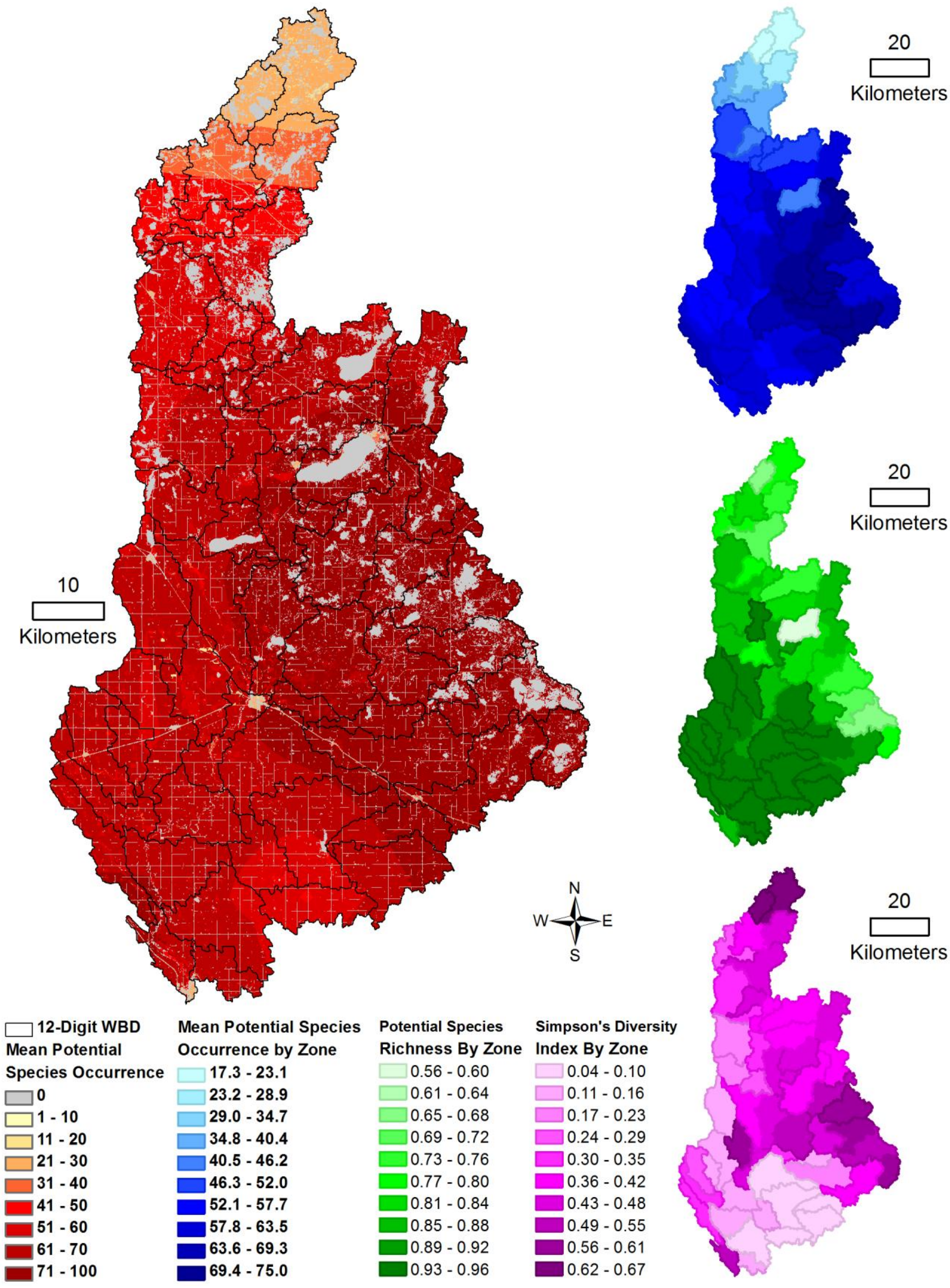

Figure 10. Game bird LINK output for current land cover scenario

The Area-Weighted Mean PSO score (AWMPSO) is calculated each time a LINK query is initiated. This score is created by multiplying the area of each land cover class by the average PSO value for all species using that land cover class, summing this value for all land cover types, then dividing by the total area.

$$AWMPSO = \frac{\sum(Area\ of\ each\ habitat\ type\ *\ PSO\ value\ for\ each\ habitat\ type)}{Total\ Area}$$

In practical terms, the higher the AWMPSO score, the more useful that particular area of interest is for the species queried (based on the land cover used, the range maps used, the species selected, and the matrix used). This score does not take into account things such as edge effects, patch size or other landscape patterns. It only looks at land cover composition. The number itself doesn't reveal a lot, but comparing this score to scores calculated for a different area, an alternative land cover, or using different species allows you to make general comparisons. The AWMPSO score for game birds was calculated to be **57.02**.

Grassland Passerine Birds LINK Output

The grassland passerine bird guild is made up of eight representative species. Table 4 shows each of the species along with the individual potential species occurrence scores for each NLCD land cover type. Figure 11 shows the output maps. The AWMPSO score was calculated to be **7.69**.

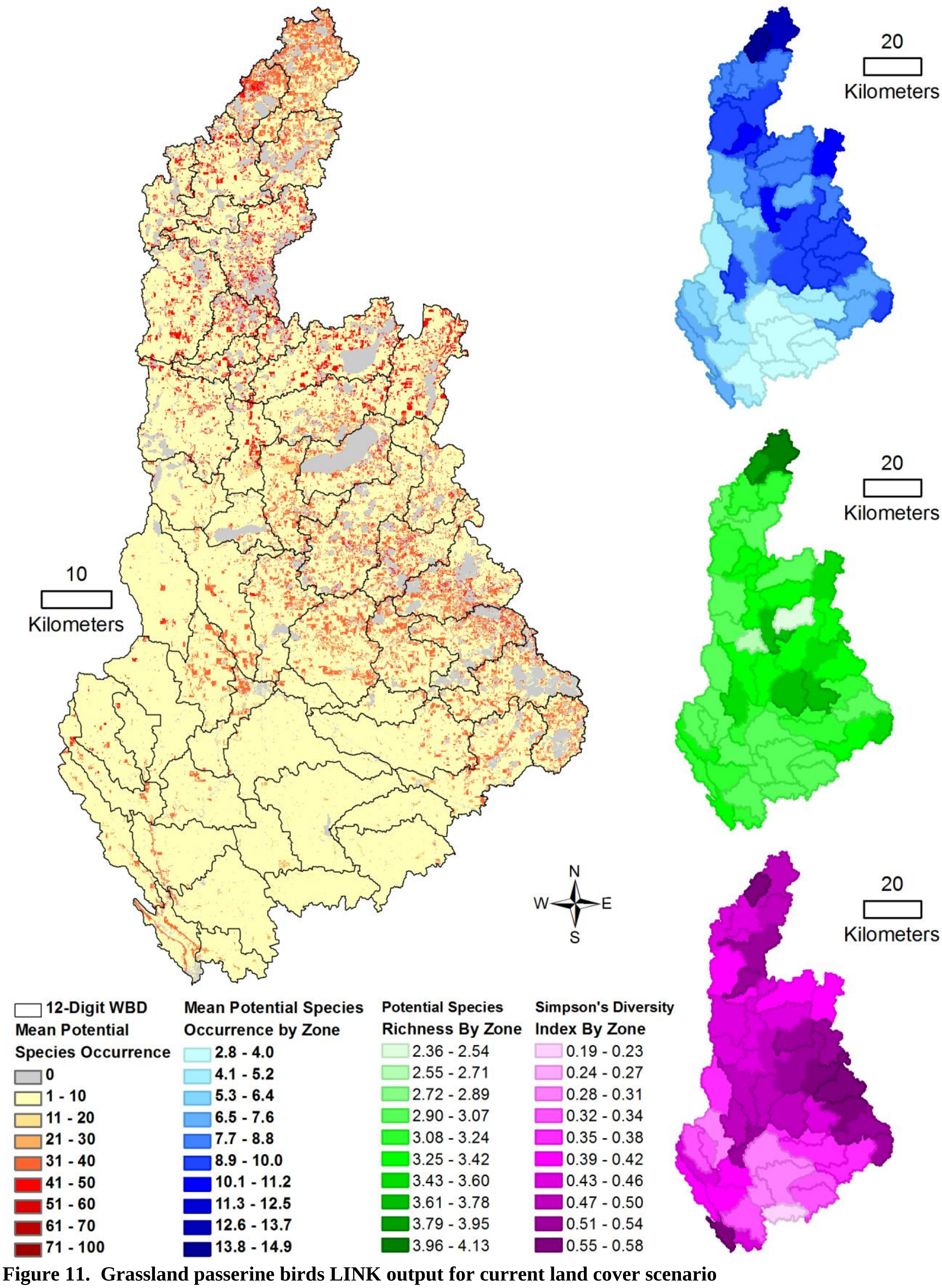

Figure 11. Grassland passerine birds LINK output for current land cover scenario

Waterfowl LINK Output

There were seven species aggregated to form the waterfowl guild. Table 4 shows each of the species along with the individual potential species occurrence scores for each NLCD land cover type. Figure 12 shows the output maps. The AWMPSO score was calculated to be **12.12**.

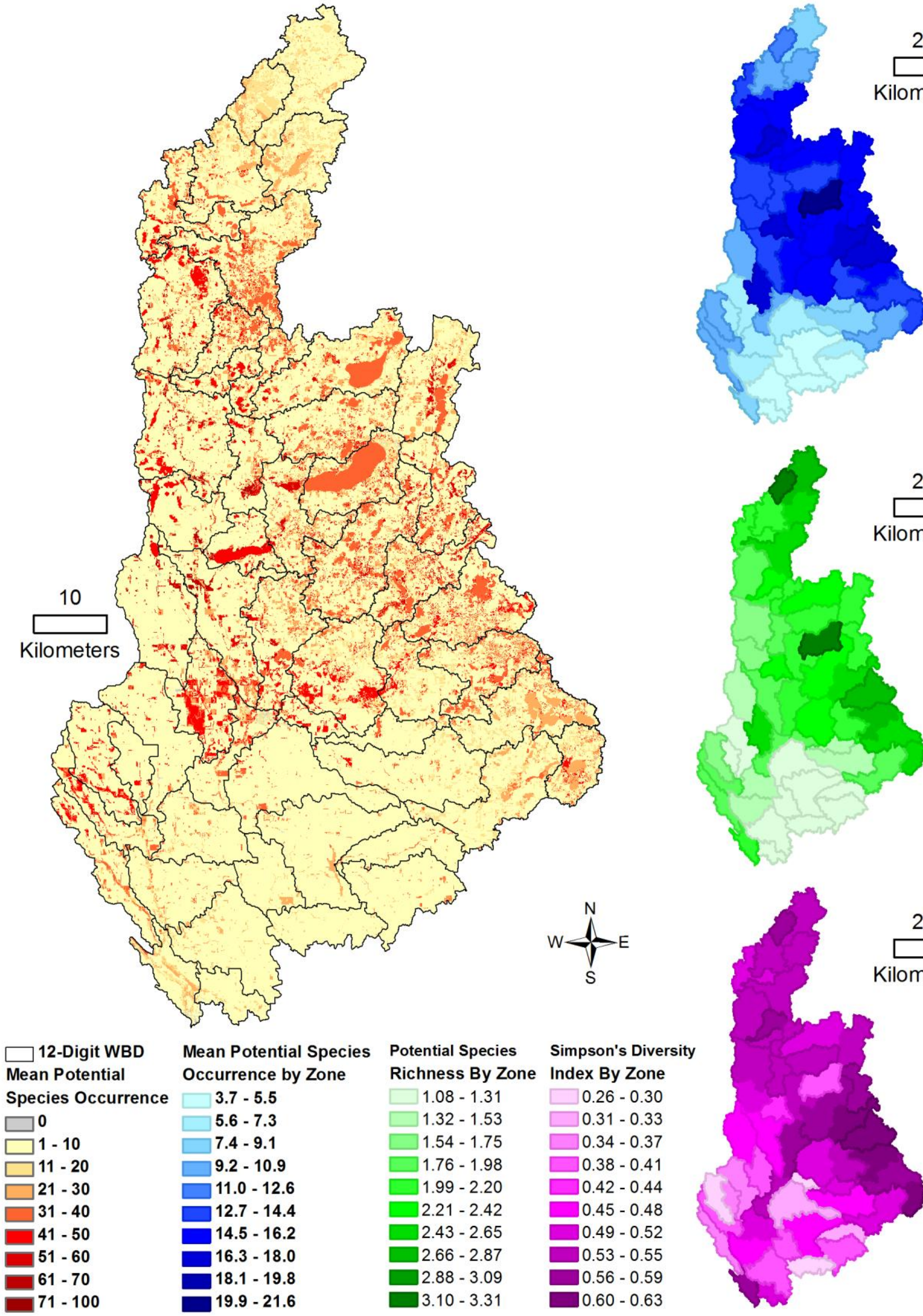

Figure 12. Waterfowl LINK output for current land cover scenario

The AWMPSO scores for the three bird guilds range from a low of 7.69 to a high of 57.02 when we analyze the current land cover condition. Low scores represent that the watershed is less suited for that bird guild when just looking at land cover, whereas high scores tell us that the watershed is better suited for that particular guild.

Alternative Land Cover Scenario LINK Results

Next, we ran the LINK models again for each of the three bird guilds, this time using the alternative land cover scenarios. When we did this we saw an increase in AWMPSO score for each alternative. Table 5 gives a summary of the AWMPSO scores for each scenario and the percent increase in AWMPSO score for each new scenario when compared to current land cover conditions (2006). These percent increases are also displayed in graphical form in Figure 13.

Table 5. Area-weighted mean potential species occurrence by bird guild. Percent increase values reflect the percent increase from current conditions.

Bird Guild	Current Scenario (Entire Watershed)	Scenario 1 (Entire Watershed)	Scenario 1 (Focal HUCs)	Scenario 2 (Entire Watershed)	Scenario 2 (Focal HUCs)	Scenario 3 (Entire Watershed)
Game Birds (AWMPSO)	57.02	57.09	57.06	57.09	57.06	57.02
Grassland Birds (AWMPSO)	7.69	10.52	9.11	10.88	9.30	7.79
Waterfowl (AWMPSO)	12.12	13.24	12.72	14.87	13.63	12.21
Game Birds (% increase)		0.11%	0.07%	0.11%	0.07%	0.00%
Grassland Birds (% increase)		36.84%	18.47%	41.50%	20.88%	1.28%
Waterfowl (% increase)		9.28%	4.96%	22.67%	12.48%	0.74%

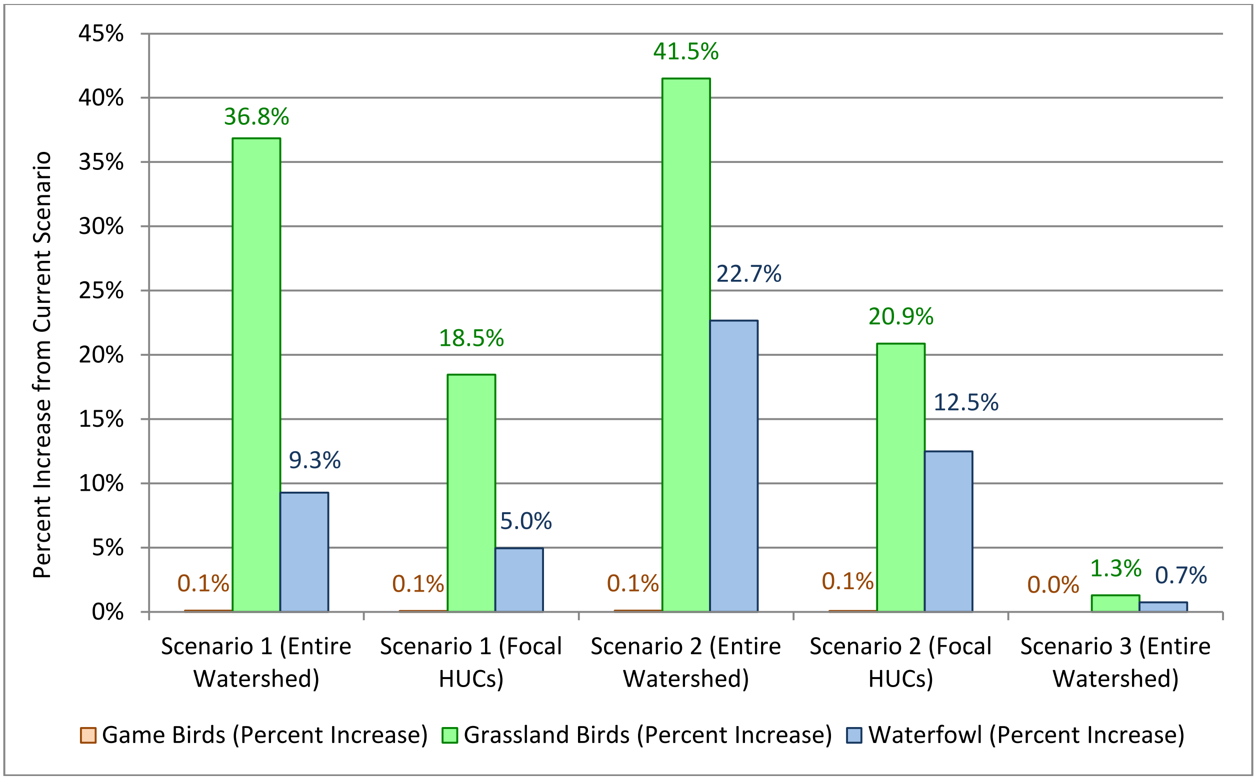

Figure 13. Graph depicting percent increases in Area Weighted Mean Potential Species Occurrence Score for alternative land cover scenarios when compared to current conditions for each bird guild

The individual species AWMPSO values are displayed in Table 6. The values are sorted (in descending order) for each guild by AWMPSO and include both those values calculated using the current land cover scenario and also those for each alternative land cover scenario. This table identifies the individual species from each guild with the highest area-weighted mean PSO value.

Table 6. Area-weighted mean potential species occurrence by bird species.

Guild	Bird Species	Current Scenario (Entire Watershed)	Scenario 1 (Entire Watershed)	Scenario 1 (Focal HUCs)	Scenario 2 (Entire Watershed)	Scenario 2 (Focal HUCs)	Scenario 3 (Entire Watershed)
		Area-weighted mean potential species occurrence score					
Game Birds	Ring-necked Pheasant	57.02	57.09	57.06	57.09	57.06	57.02
Grassland Passerines	Western Meadowlark	14.46	18.50	16.53	18.50	16.53	14.60
	Dickcissel	14.40	17.27	16.01	18.22	16.54	14.52
	Savannah Sparrow	10.55	13.57	11.96	13.57	11.96	10.65
	Bobolink	8.01	13.57	10.69	13.57	10.69	8.19
	Sedge Wren	5.74	7.73	6.70	8.73	7.18	5.84
	Grasshopper Sparrow	4.17	6.86	5.67	7.53	6.04	4.27
	Clay-colored Sparrow	2.83	4.86	3.80	4.86	3.80	2.89
	Le Conte's Sparrow	1.33	1.82	1.52	2.07	1.61	1.35
Waterfowl	Mallard	47.26	47.27	47.27	49.94	48.73	47.35
	Blue-winged Teal	12.04	15.85	14.07	18.39	15.43	12.25
	Northern Shoveler	7.91	9.57	8.80	11.23	9.69	8.02
	Gadwall	7.73	7.73	7.73	13.66	11.18	7.92
	Wood Duck	5.19	5.19	5.19	5.19	5.19	5.19
	Northern Pintail	4.66	7.06	5.94	5.62	5.17	4.69
	American Black Duck	0.05	0.05	0.05	0.05	0.05	0.05

Figures 14, 15, and 16 display the breakdown of percent increase in AWMPSO score by 12-digit HUC for each alternative land cover scenario and also for each guild. We see similar patterns of where AWMPSO scores are increasing for each species guild, but the degree (percentage) to which they are increased varies greatly between guilds.

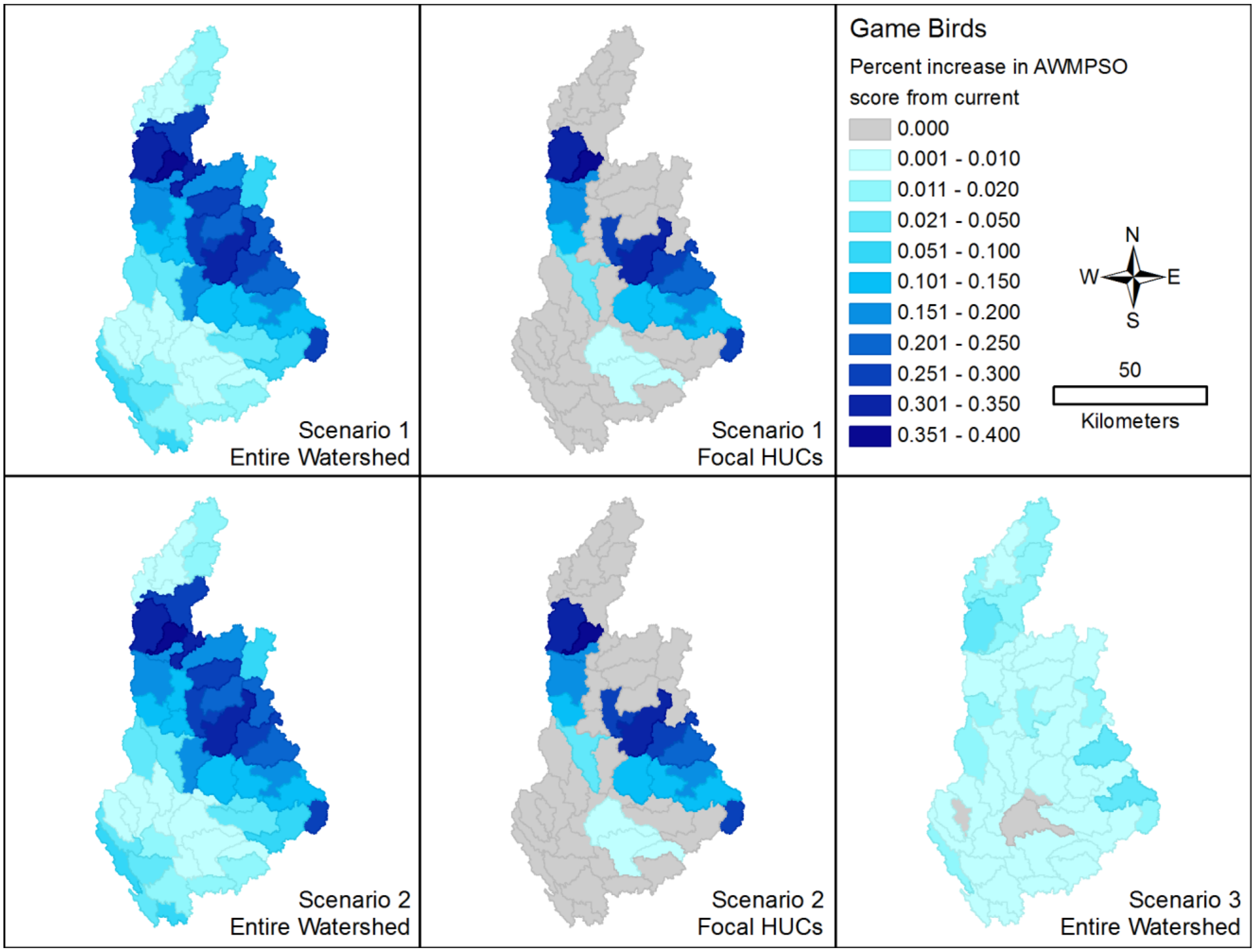

Figure 14. Percent increase in area weighted mean potential species occurrence score from current land cover conditions to each alternative land cover scenario for game birds

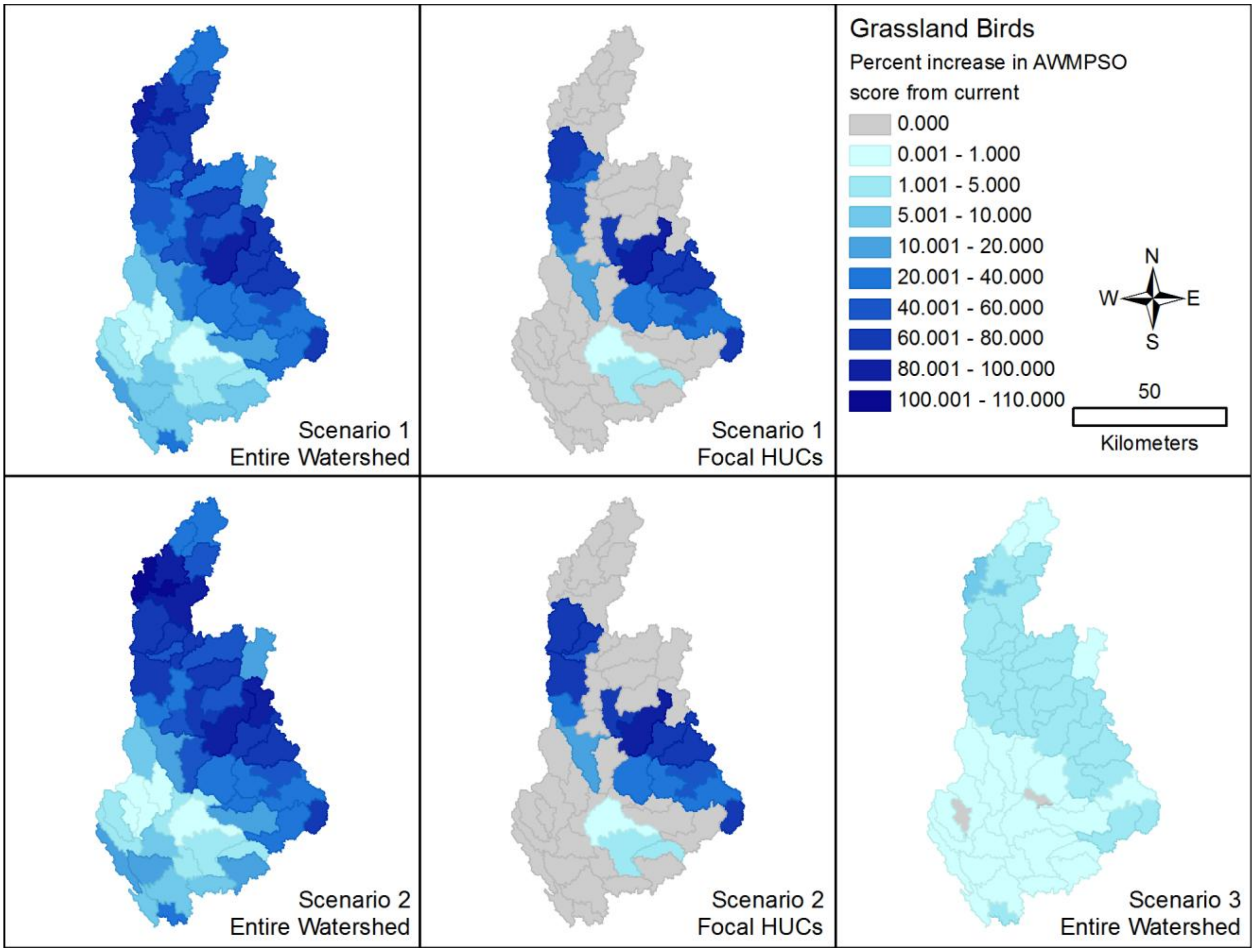

Figure 15. Percent increase in area weighted mean potential species occurrence score from current land cover conditions to each alternative land cover scenario for grassland birds

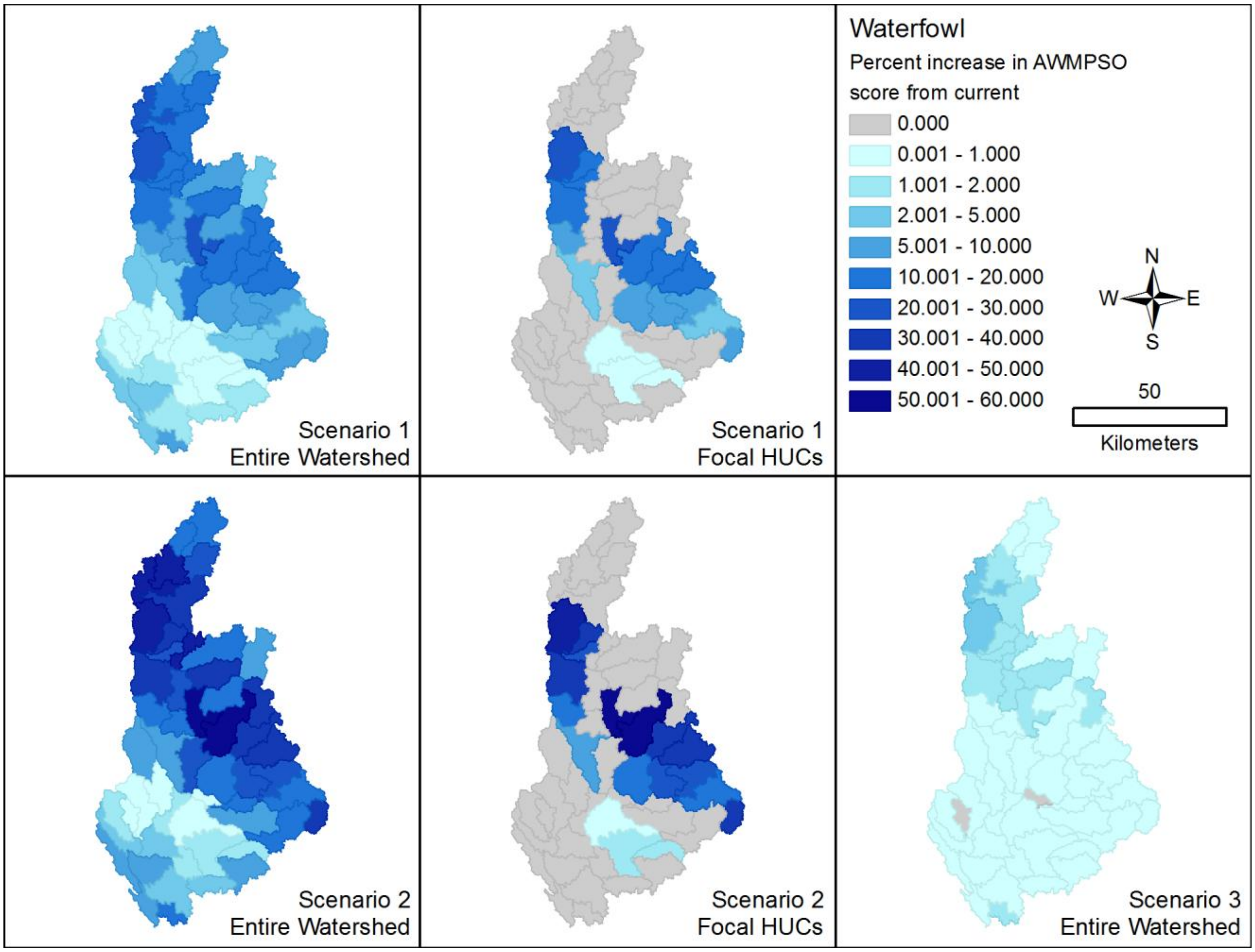

Figure 16. Percent increase in area weighted mean potential species occurrence score from current land cover conditions to each alternative land cover scenario for waterfowl

Discussion

As a result of making hypothetical land cover conversions within the Chippewa River Watershed to perennial cover types we see an increase in potential species occurrences for all bird guilds analyzed using the LINK model. When we look specifically at game birds, the watershed is already prime habitat, with the highest AWMPSO scores of all the guilds, due to the current abundance of favorable habitat types such as cultivated crops and pasture/hay. Converting cultivated crops to perennial cover types has very little effect due to the similar scores for these land cover types within the species/habitat matrix used in the LINK analyses. Grassland birds have the lowest AWMPSO scores of the three guilds but display the largest increase in AWMPSO with conversion of cultivated crops to a perennial cover type. With waterfowl, the watershed has higher AWMPSO scores than that of grassland birds but we see a smaller percent increase in AWMPSO with cultivated crop conversion to perennial cover types than we calculated for grassland birds (Figure 13). In summary, according to the LINK models, the watershed is currently best suited to game birds, then waterfowl, and finally grassland birds. The hypothetical conversion of cultivated croplands planted on less than ideal areas due to their soil type, slope, and distance to water bodies will benefit all bird guilds, but will benefit grassland birds the most followed by waterfowl and finally game birds. Scenario 1 could be viewed as an agricultural working lands approach and Scenario 2 could be taken as a purchase of easement or set-aside approach. A significant potential increase in passerine and waterfowl bird habitat could likely be achieved for less cost to the public under a working lands approach.

Since this analysis used the NLCD 2006 as a source land cover layer, the model output will only be as accurate as this data set. An accuracy assessment has not been completed for the NLCD 2006, but for the NLCD 2001 which the NLCD 2006 was modeled after, there was an overall national accuracy of 78.7% at classification level II which was used for our analyses. When the assessment looked at grassland/herbaceous, pasture/hay, and cultivated crop classes individually, the cover types were 61%, 69%, and 82% accurate, respectively (Wickham and others 2010).

References Cited

Burrough, P. A., and R. A. McDonnell. 1998. Principals of Geographical Information Systems. Oxford University Press.

Fox, T. J. 2004. LINK: ArcGIS Tools for Conservation Planning. Computer software program produced by the author at the U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. Available online at http://www.umesc.usgs.gov/management/dss/bird_conservation_tools_link.html.

Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PE&RS, Vol. 77(9):858-864.

Multi-Resolution Land Characteristics Consortium (MRLC). (n.d.), Multi-Resolution Land Characteristics Consortium (MRLC), National Land Cover Database 2006 (NLCD 2006). Available online at http://www.mrlc.gov/nlcd06_leg.php. Accessed March 11, 2011

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. The North American Breeding Bird Survey, Results and Analysis 1966 - 2010. Version 12.07.2011 USGS Patuxent Wildlife Research Center, Laurel, MD

Thogmartin, W. E., T. J. Fox, J. J. Rohweder, M. G. Knutson, and T. C. Will. 2006. Emerging Technologies: LINK: a land conservation decision support tool. Bulletin of the Ecological Society of America 87(3). Available online at http://esapubs.org/bulletin/current/web_pdfs_july/emergingjul06bulletin.pdf.

USDA Natural Resources Conservation Service (NRCS). (n.d.*a*), United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for MN. Available online at http://soildatamart.nrcs.usda.gov . Accessed September 8, 2011.

USDA Natural Resource Conservation Service (NRCS). (n.d.*b*). Watershed Boundary Dataset. U.S. Department of Agriculture, Natural Resource Conservation Service, Accessed September 8, 2011, from http://www.nrcs.usda.gov/wps/portal/nrcs/main/?ss=16&navtype=SUBNAVIGATION&navid=850150000000000&pnavid=850000000000000&recid=null&actid=null&groupid=null&ttype=main&pname=Watershed%20Boundary%20Dataset%20|%20NRCS.

U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99 pp. [Online version available at http://migratorybirds.fws.gov/reports/bcc2002.pdf.]

Wickham, J. D., Stehman S. V., Fry, J. A., Smith, J. H., & Homer, C. G., (2010), Thematic accuracy of the NLCD 2001 land cover for the conterminous United States, Remote Sensing of Environment, 114, 1286 - 1296.