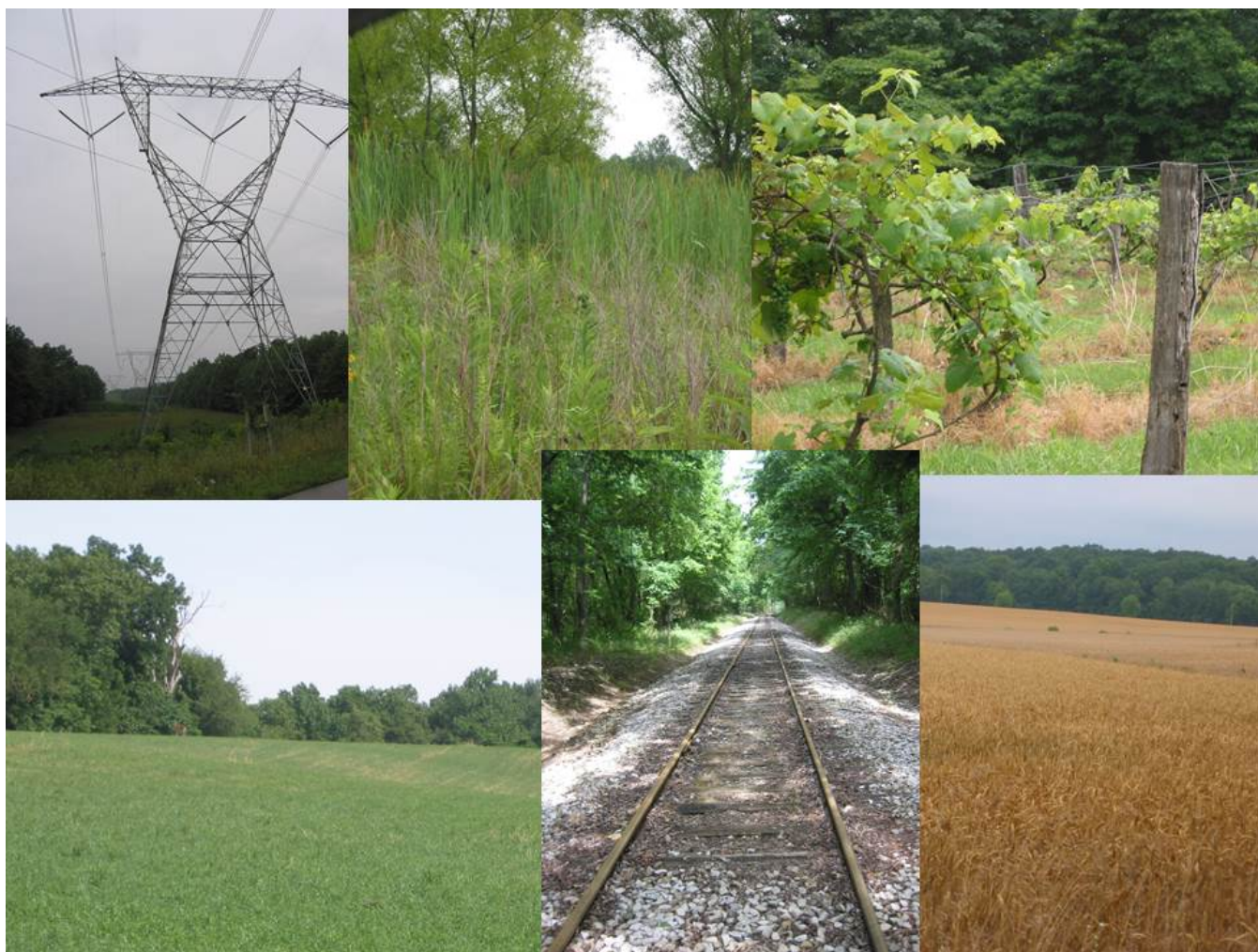




A Pilot Study

2007 Land Cover Baseline Report for Lincoln Boyhood National Memorial, Indiana

Natural Resource Data Series NPS/HTLN/NRDS—2014/735



ON THE COVER

Various photos representing the different land cover classes taken around the area of interest for this report.
Photograph by: Jennifer L. Haack-Gaynor

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Jennifer L. Haack-Gaynor

National Park Service
Heartland Network
6424 W Farm Rd 182
Republic, MO 65738

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Introduction

An underlying theme of the Heartland Network (HTLN) is the question of whether the species, communities and ecological processes comprising the natural resources of network parks are sustainable in the face of adjacent habitat loss and climate change. Potential impacts from adjacent land cover change on park natural resources include reduced water and air quality, increased invasive plant occurrence, altered animal populations associated with neighboring habitat loss, and diminished quality of viewshed. HTLN parks are bordered by adjacent lands with sometimes intensive agricultural practices and urban encroachment. Analysis of past and current land cover in the vicinity of network parks and analysis of land cover changes provide insight into the nature and change of the landscape shaping park natural resources.

Land cover is a distinct concept applied to the classification of the earth's land surface (Estes et al. 1982). Land cover is defined as visible features on the landscape. For this classification we are only considering land cover, because seldom can we see land use. Numerous uses exist for digital land cover classification maps. For example, land cover classification maps provide insight into a region's soils and geology (Ustin et al. 1999, Gupta 2003). Land cover classification maps are used extensively in conservation planning (Turner et al. 2003, Kerr and Ostrovsky 2003), informing land development decisions in metropolitan areas (Ridd 1995, Weber and Puissant 2003), planning and implementing large-scale inventories of natural resources (Anderson 1982, Volgelmann et al. 1998), and monitoring change in ecosystem/landscape condition over time (Frohn 1998, Lambin 1996, Weng 2002). Land cover data, particularly when used in conjunction with other data such as terrain maps and Digital Elevation Models (DEMs), can be useful in identifying areas more or less suited to specific land management practices and thereby aid in the assessment of appropriate practices for use in a specific area to attain certain goals (Bonner et al. 1982).

This is a baseline report on the land cover in and around Lincoln Boyhood National Memorial (LIBO) during 2007. Land cover change analysis will be conducted after this report following about a ten year interval. Procedures in this report follow the steps put forth in Haack et al., 2014.

The monitoring objectives for this study are 1) to determine long-term trends in land cover change inside and adjacent to LIBO and 2) to determine the rate and distribution of urban expansion within the LIBO study area.

The study area for this report is a ten kilometer buffer around LIBO (Figure 1). The 10 km buffer area was chosen in order to exam land cover change adjacent to park boundaries. LIBO is a 200 acre National Park located in southern Indiana. Part of the ten kilometer buffer in the southwest corner was not processed because the imagery did not capture this area.

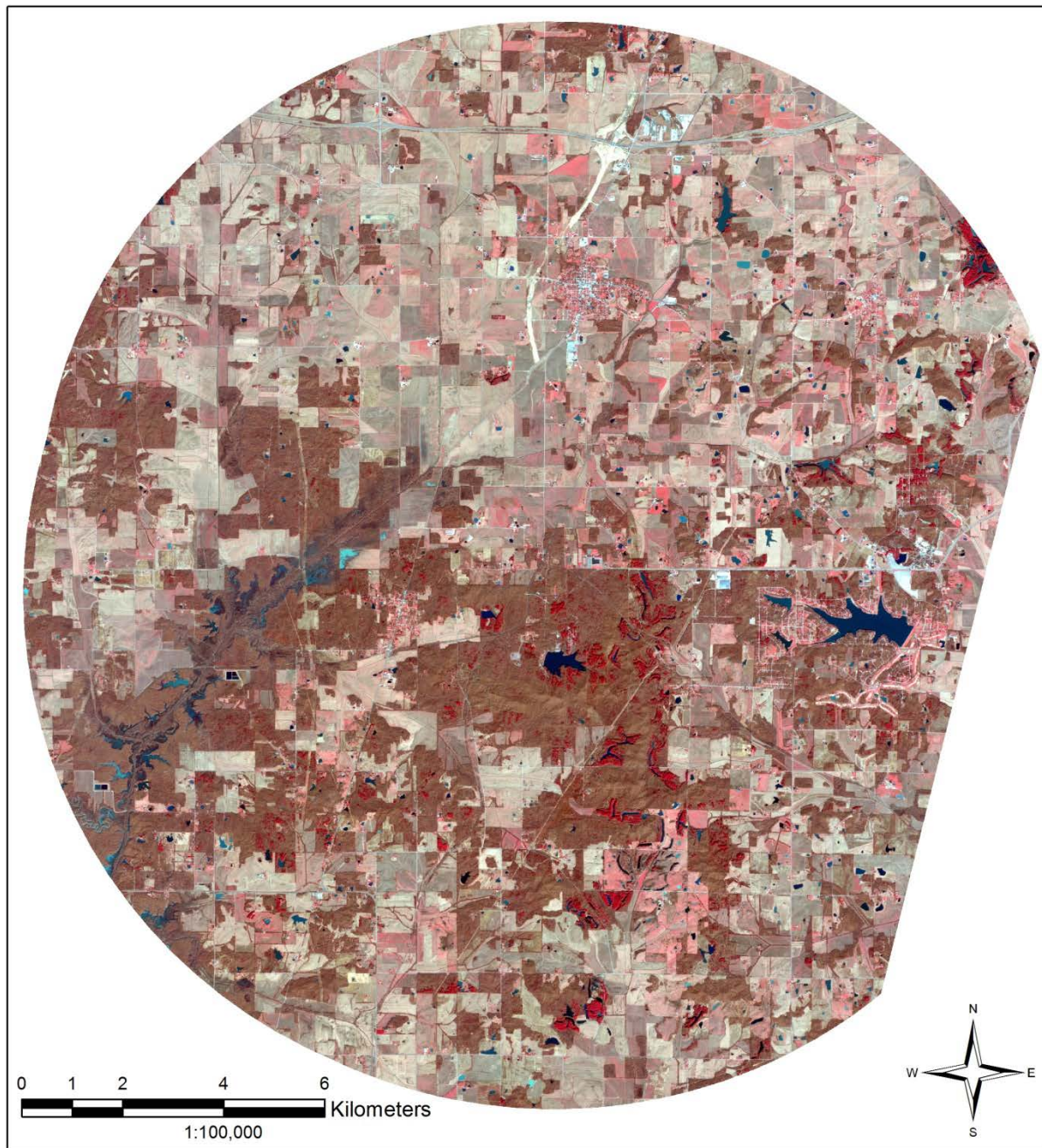


Figure 1. LISS image showing the land cover study area for Lincoln Boyhood National Memorial.

Methods

All spatial data in this study used the UTM NAD83, Zone 16 N coordinate system. For more specific information on the process steps, please refer to Haack et al., 2014. The first step in creating a land cover classification is acquiring the imagery. For this study one scene of LISS IV (Linear Imaging Self Scanning Sensor) imagery for two different time periods was purchased. The LISS imagery dates were 5 March 2007 (leaf-off) and 9 June 2007 (leaf-on). Imagery specifics include 5.8 meter pixel resolution; multispectral bands B2 (0.52 - 0.59 μm - green), B3 (0.62 - 0.68 μm - red), and B4 (0.77 - 0.86 μm - Near Infrared); incidence angle of $\pm 7.5^\circ$; less than 10% cloud cover; and less than 10% snow cover. The images were orthorectified by SAIC. The scenes were layer stacked to create a single 6 band multispectral image to be used for classification.

Next, training data was collected. Training data is location information used to develop classification spectral signatures. The training dataset documents the land cover classes present at specific locations. The LIBO training data was collected two different ways. Initially GPS (Global Positioning System) points were captured in the field between June 18 – 20, 2007. Then later, extra points were collected by photo interpretation on the LISS and 2005 aerial imagery.

The software used to process the land cover classification was ERDAS Imagine (Version 2010) [Hexagon Geospatial]. The training data was used to create signature classes which are collections of image pixels of known classification type and known spectral values. Signature classes were used to process the supervised classification on the 6 band LISS image. The supervised classification rules that were used were 1) non-parametric: *none* and 2) parametric: *maximum likelihood*. Once the classification was found to be over 80% accurate, therefore the classification was manually recoded to decrease pixel speckling (remove noise in the output image).

The final step was to calculate the accuracy of the classification. For the eight land cover classes 486 stratified random points (SRP) were created. Photo interpretation of 2007 and 2006 NAIP (National Agriculture Imagery Program) imagery was used to designate the reference class for the SRP. The SRP and land cover classification were then used to produce an error matrix and KHAT value. The kappa value measures the difference between the observed agreement (error matrix's overall accuracy) and agreement that could be produced by chance (Congalton and Green 1999, Campbell 2002). Kappa or KHAT (K^2) values range from -1 to 1. When the K^2 value is greater than 0 this signifies that the produced classification is better than a random classification (Congalton and Green 1999).

Results and Discussion

Eight different land cover types were classified for the LIBO study area. These classes were Barren, Cropland, Deciduous Forest, Evergreen Forest, Mixed Forest, Grassland, Urban, and Water. The description of these classes can be found in Appendix A, at the end of this document.

The overall study area consisted of 33,681.36 hectares (ha). The dominant land cover for the study area was cropland with 12,587.40 ha (Table 1). Followed by the next largest classes of deciduous forest at 8,726.25 ha and grassland at 7,588.58 ha. The other five land covers combined was 4,779.14 ha with none of the classes covering more than 5 % (Figure 2) of the total study area. The barren class, which covered the least amount of land at 94.58 ha (Figure 4) was mostly due to new road construction.

Figure 3 shows the dominant land cover type for LIBO is deciduous forest. This is similar to what is found in the central and western parts of the overall study area.

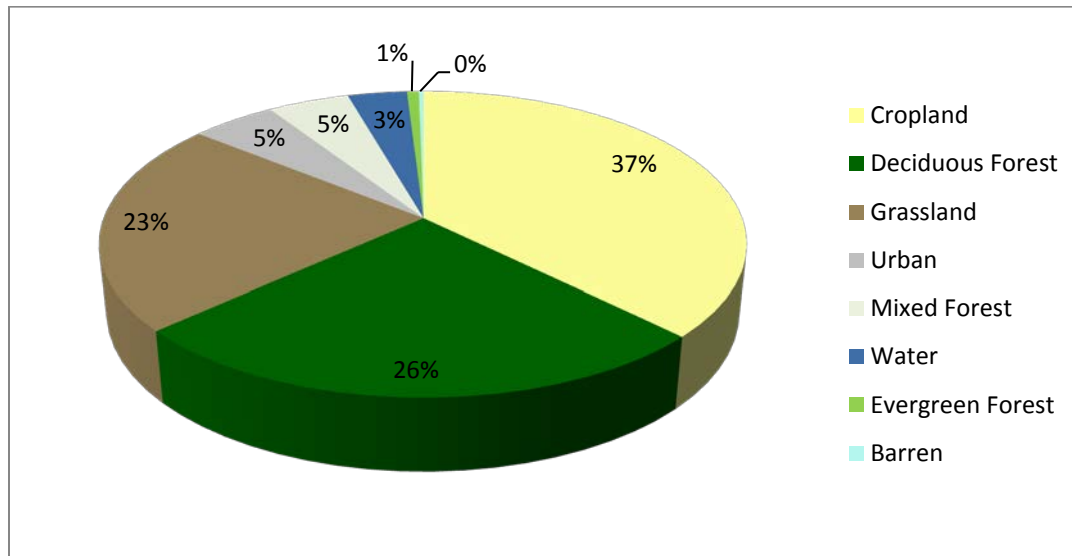


Figure 2. Pie chart of land cover class percentages.

Table 1. Land cover class amount totals.

Land cover	Acres	Hectares
Evergreen Forest	580.04	234.74
Deciduous Forest	21563.03	8726.25
Mixed Forest	3975.01	1608.63
Grassland	18751.79	7588.58
Cropland	31104.15	12587.40
Water	2890.40	1169.71
Urban	4130.34	1671.49
Barren	233.71	94.58
Totals	83228.47	33681.37

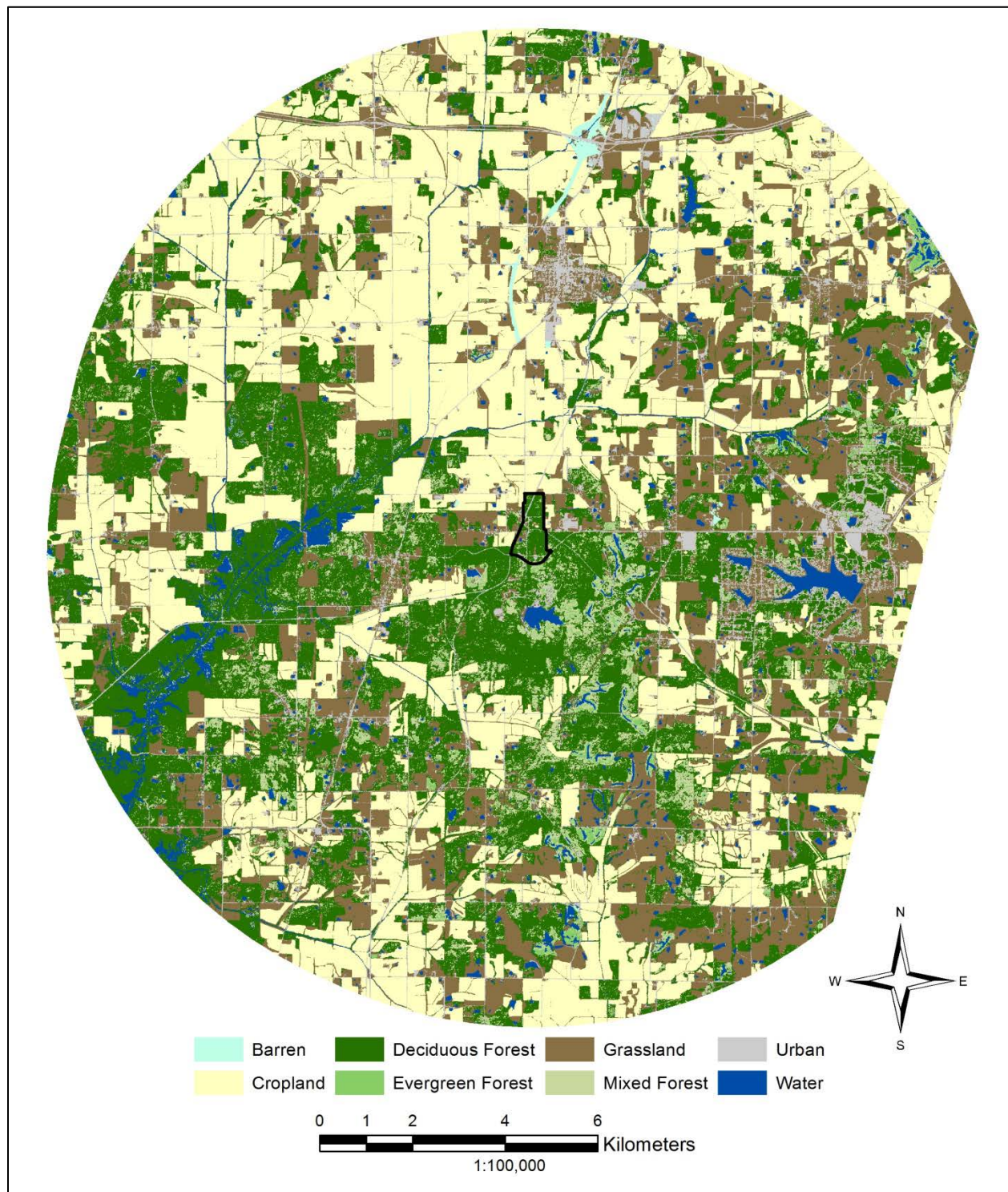


Figure 3. Land cover output for Lincoln Boyhood National Memorial in 2007. The park boundary is outlined in black.

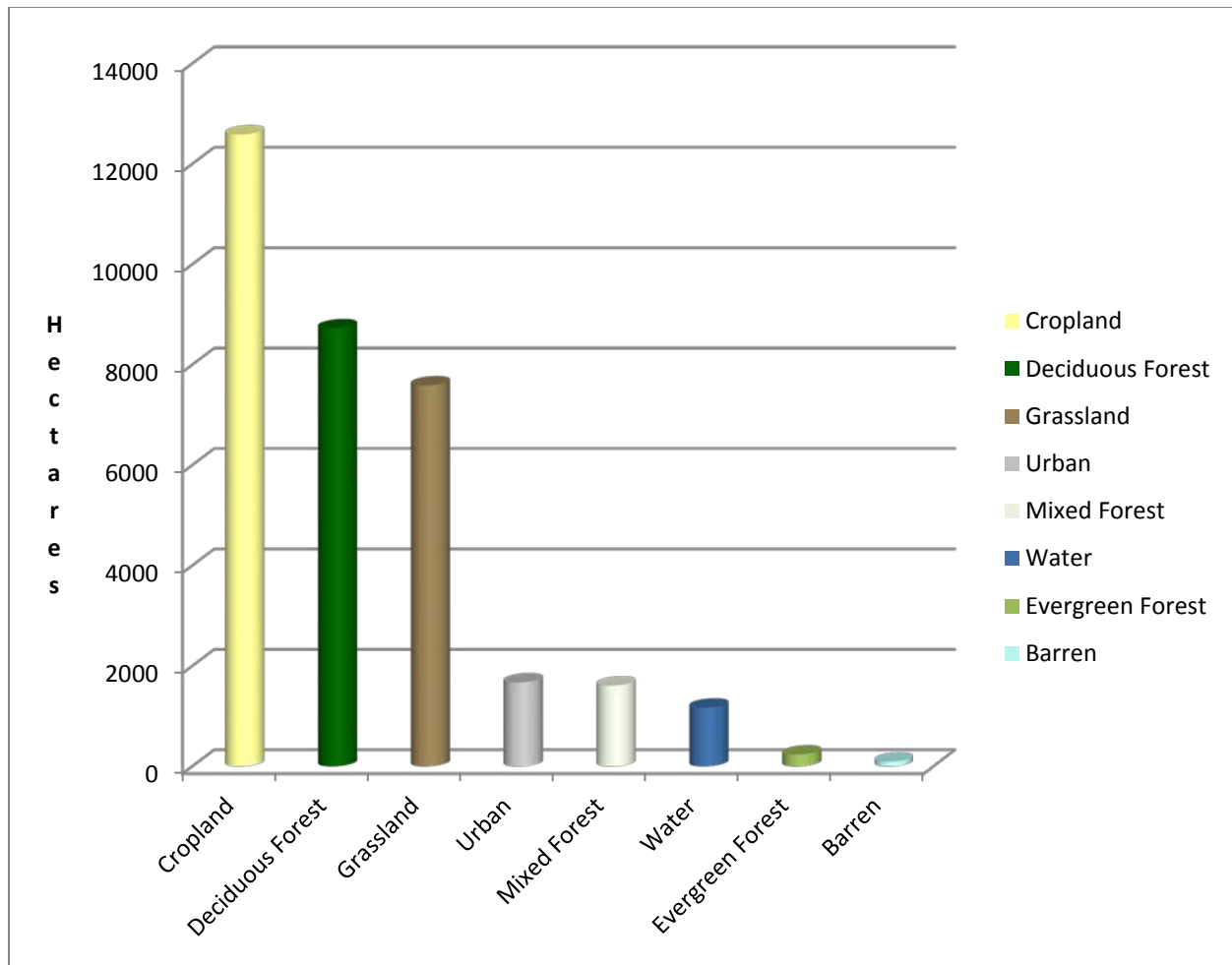


Figure 4. Bar chart of land cover classes total hectares.

Of a total of 486 accuracy assessment points (Figure 5), 456 were correctly classified. That translates to an overall accuracy value of 93.83%. The error matrix output (Table 2) shows how many accuracy points were classified correctly (the bolded values in the highlighted color cell) and the frequency and type of misclassifications. All classes were interpreted reasonably well. Water was the least accurate being confused with multiple classes.

Table 3 lists producer's and user's accuracies by cover class. Producer's accuracy gives an indication of how accurately a particular class has been classified by the producer of that classification. While user's accuracy gives an indication of how accurate the areas assigned to a given class on the land cover classification actually belong to that class 'on the ground'. This accuracy is of greater importance to the users of the classification because it indicates how true the classified image is to the actual situation on the ground. For this study the KHAT statistic was = 0.92. This value indicates that the classification is better than a random one and also that there is a positive correlation between the land cover classification and the LISS image used to produce it.

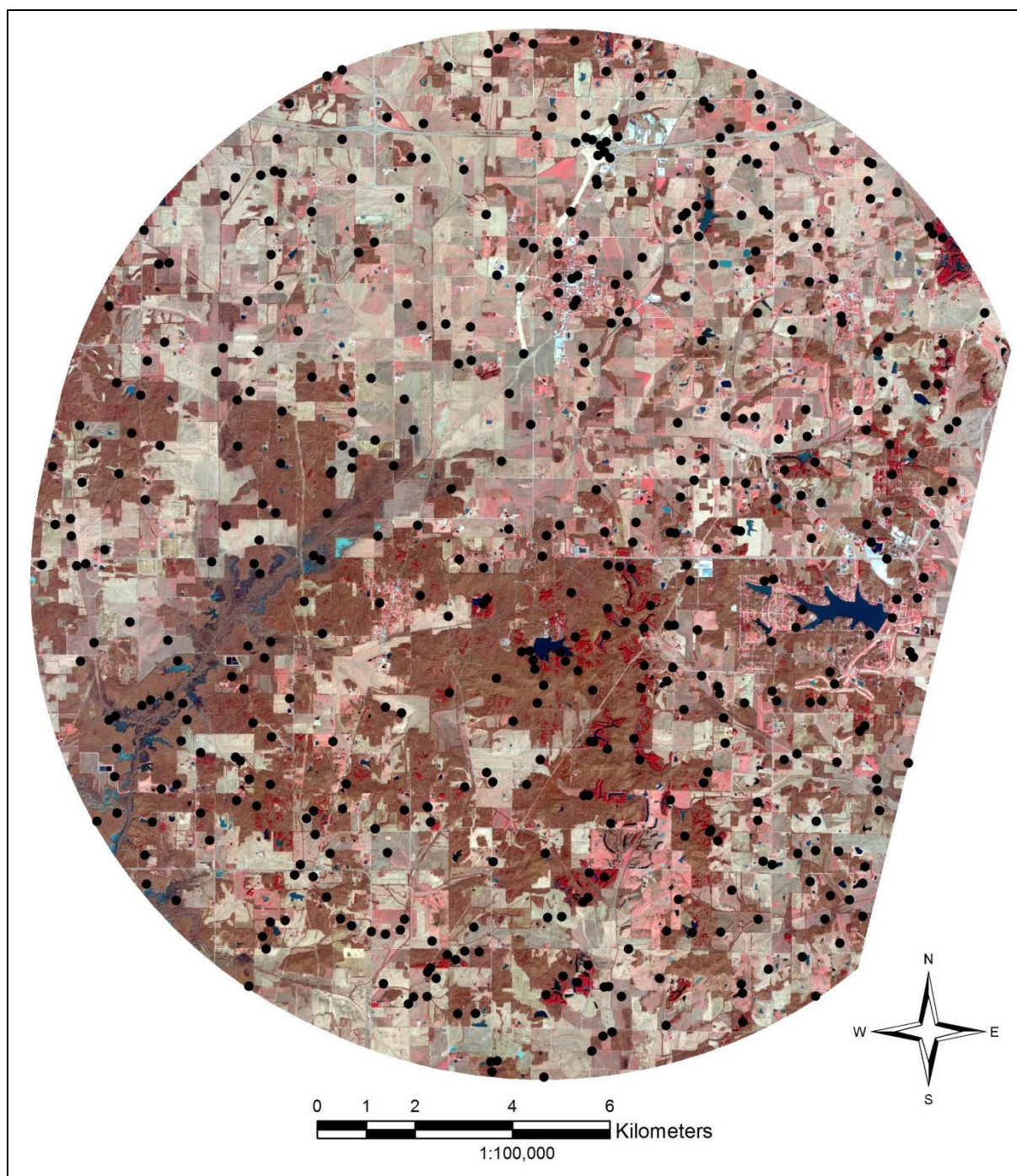


Figure 5. Map of accuracy point (black dots) locations.

Table 2. Error matrix output of the accuracy assessment.

Classified Data	Reference Data								Classified Totals
	Barren	Urban	Grassland	Water	Cropland	Evergreen Forest	Mixed Forest	Deciduous Forest	
Barren	18		1	1	0	0	0	0	20
Urban	0	34	1	0	0	0	0	1	36
Grassland	0	0	89	0	3	0	1	1	94
Water	0	0	2	26	0	0	0	3	31
Cropland	0	1	4	0	138	0	0	1	144
Evergreen Forest	0	0	1	0	0	20	0	0	21
Mixed Forest	0	0	0	1	0	0	31	3	35
Deciduous Forest	0	0	1	2	1	0	1	100	105
Reference Totals	18	35	99	30	142	20	33	109	486

Table 3. Accuracy totals derived from the error matrix.

Land Cover	Producers Accuracy	Users Accuracy
Barren	100.00%	90.00%
Urban	97.14%	94.44%
Grassland	89.90%	94.68%
Water	86.67%	83.87%
Cropland	97.18%	95.83%
Evergreen Forest	100.00%	95.24%
Mixed Forest	93.94%	88.57%
Deciduous Forest	91.74%	95.24%

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Appendix A: Land Cover Definitions

Table 4. Land cover class names and definitions.

Code	HTLN Class Name	HTLN Definition
B	Barren	Land that supports very little vegetation, and is not part of the Urban/Built up class. Examples are gravel bars, beaches, bare exposed rock, sand dunes, gravel pits, quarries, strip mines, and wasteland.
C	Cropland	Cultivated land for the purpose of row or close grown crops. Examples are corn, soybean, rice, cotton, small grains, sunflowers, and truck crops.
FD	Deciduous Forest	Land that is dominated by types of deciduous trees. The deciduous trees must cover 75% or greater area.
FE	Evergreen Forest	Land that is dominated by types of evergreen trees. The evergreen trees must cover 75% or greater area.
FM	Mixed Forest	Land that is covered with trees of both deciduous and evergreen types. Neither deciduous or evergreen trees cover 75% or more of the total area.
G	Grassland	Land that is dominated by the presence of grasses, grass-like, or forb vegetation. Examples are pastures, hayland, lawn, grass road right-of-ways, rangeland, prairies, cropland that has been left fallow for a number of years, etc.
U	Urban/Built-up	Any structure or surface that was built by humans that is not part of the natural system. This class includes, but is not limited to the following: buildings, houses, farmsteads, barns, roads, railroad, parking lots, dams, electrical substations, industrial areas, poultry facilities, and other impervious surfaces.
W	Water	Land covered with permanent open water. This class includes: rivers/streams, ponds, lakes, reservoirs, bayous, etc.

Appendix B: Wetland Analysis

Due to the amount of wetlands in the vicinity of LIBO, a side wetland analysis was performed on the land cover classification. The wetland analysis was processed from the LIBO 2007 land cover classification. Two different outputs were processed, but the same methodology was used for both. The definitions for the wetland classes are:

Forested Wetlands: Wetlands dominated by forest.

Non-Forested Wetlands: Wetlands dominated by any vegetation class except forest.

Methods

The first step was to heads-up digitized the wetland areas from the LISS imagery used for the land cover classification. In figure 6 the area outlined in yellow is an example of what was heads-up digitized as wetlands (areas that were darker in pixel color indicating possible soil moisture). This polygon feature is called the HTLN wetland layer. This layer was then union-ed to the LIBO 2007 land cover layer. If the HTLN wetland layer overlapped forest cover classes then it was labeled as Forested Wetland. If the HTLN wetland layer overlapped grassland or cropland classes then it was labeled as Non-Forested Wetland. All other classes, such as, Barren, Urban, and Water were not labeled as a wetland even if it fell within the HTLN wetland polygons.

As a second analysis the NWI (National Wetland Inventory) dataset (USFWS 2006) was downloaded and also union-ed with the LIBO 2007 land cover classification layer. The wetland classes were then labeled the same way as above.

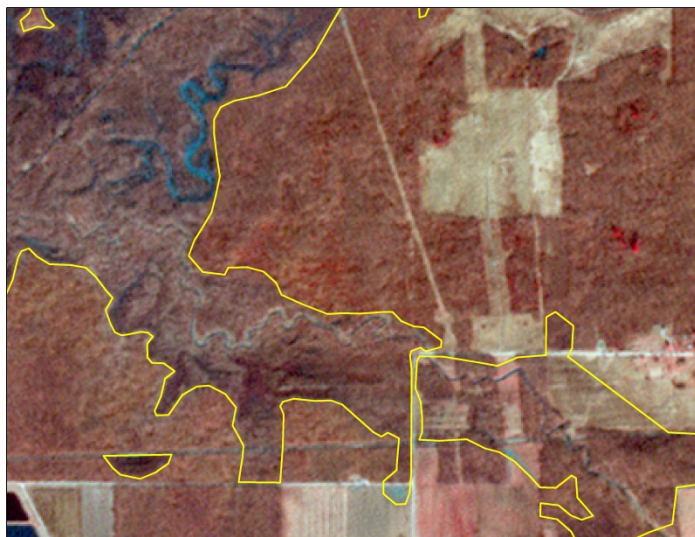


Figure 6. Example of HTLN wetland layer as digitized from the LISS imagery.

Results

Both wetland land cover classifications were very similar. The NWI wetland layer broke out slightly higher amounts of forested (1166.67 verses 838.06 ha) and non-forested (169.57 verses 128.17 ha) wetland, than the HTLN wetland layer. For full results see the below tables and figures.

Table 5. Land cover breakdown with the HTLN wetland layer.

Land cover (HTLN Wetland)	Acres	Hectares
Barren	233.71	94.58
Cropland	30923.10	12514.13
Deciduous Forest	19680.07	7964.24
Evergreen Forest	580.03	234.73
Forested Wetland	2070.88	838.06
Grassland	18616.13	7533.68
Mixed Forest	3787.10	1532.58
Non-Forested Wetland	316.71	128.17
Urban	4130.34	1671.49
Water	2890.40	1169.71
Totals	83228.47	33681.36

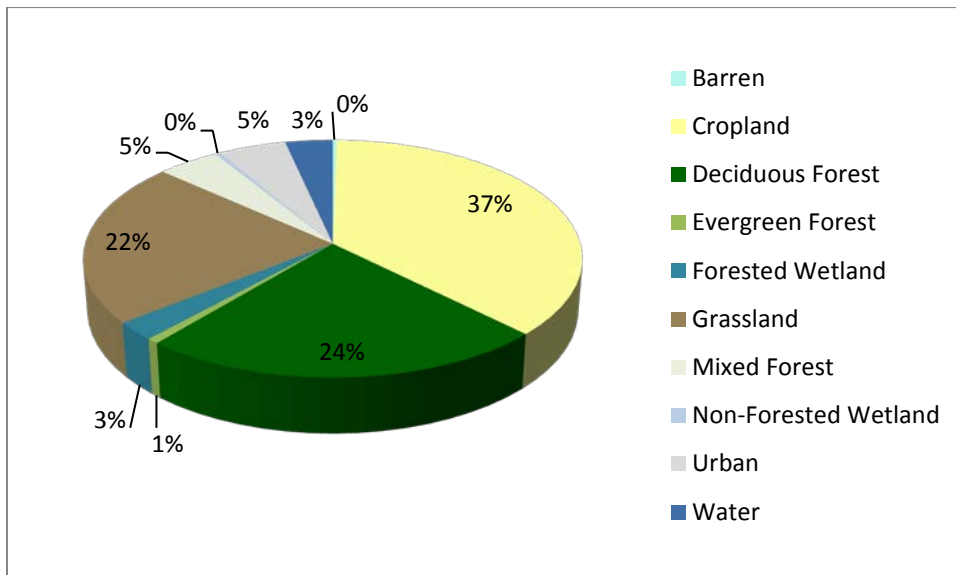


Figure 7. Land cover pie graph breakdown of the HTLN wetland layer.

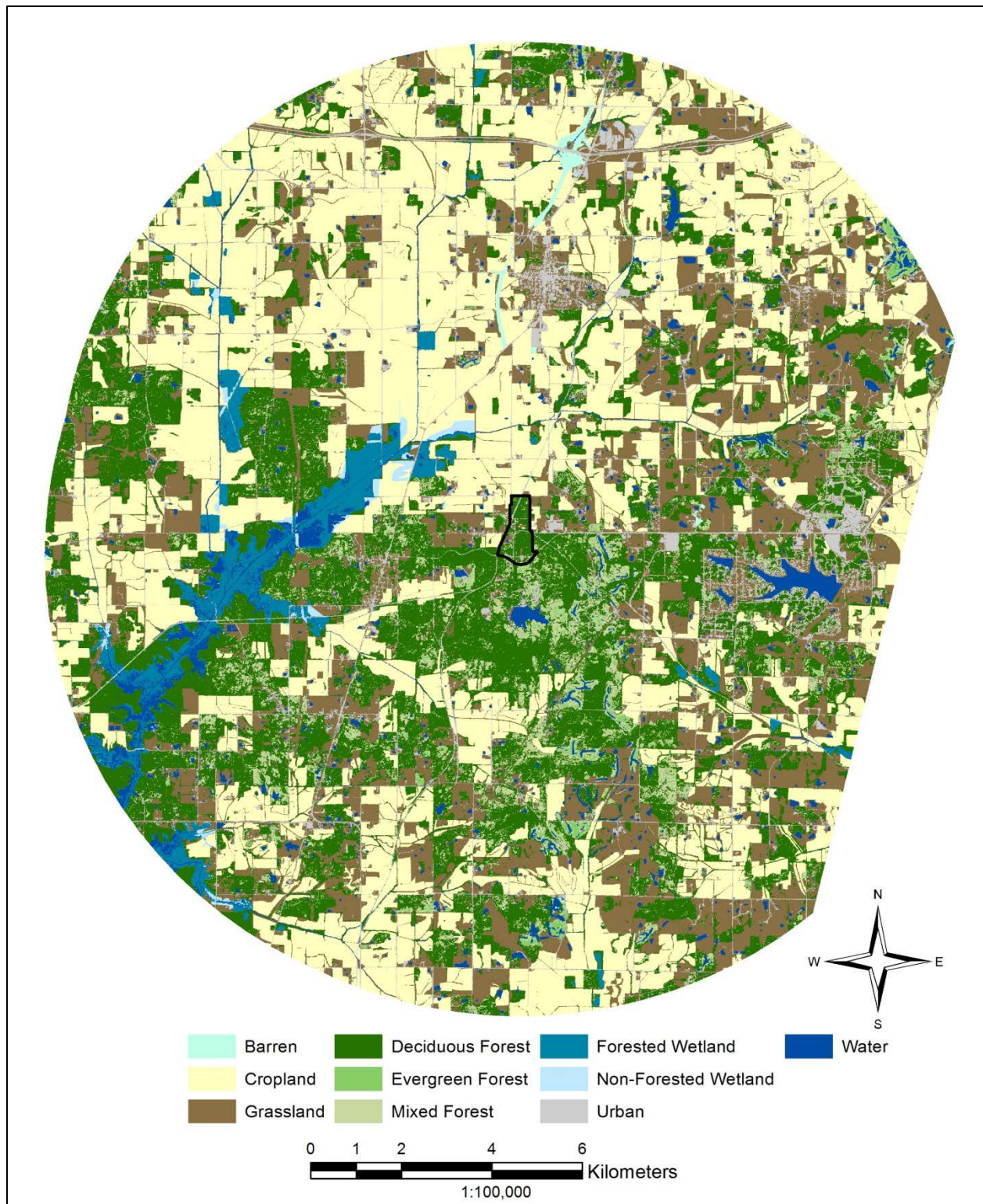


Figure 8. Map output of HTLN wetland land cover classifications. The park boundary is outlined in black.

Table 6. Land cover breakdown with the NWI wetland layer.

Land cover (NWI Wetland)	Acres	Hectares
Barren	233.71	94.58
Cropland	30926.18	12515.38
Deciduous Forest	18940.30	7664.87
Evergreen Forest	560.76	226.93
Forested Wetland	2882.91	1166.67
Grassland	18510.74	7491.03
Mixed Forest	3734.11	1511.14
Non-Forested Wetland	419.01	169.57
Urban	4130.34	1671.49
Water	2890.40	1169.70
Totals	83228.47	33681.36

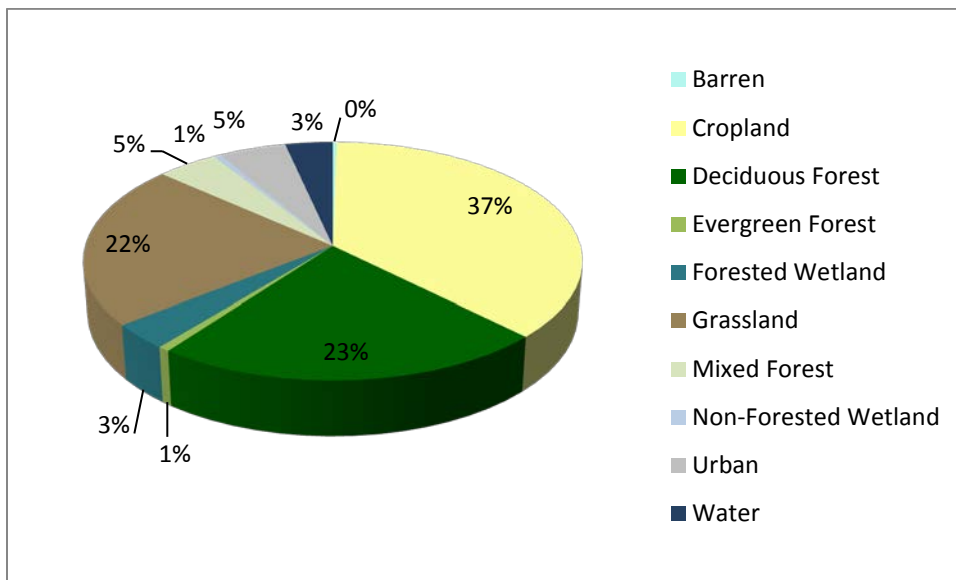


Figure 9. Land cover pie graph breakdown of the NWI wetland layer.

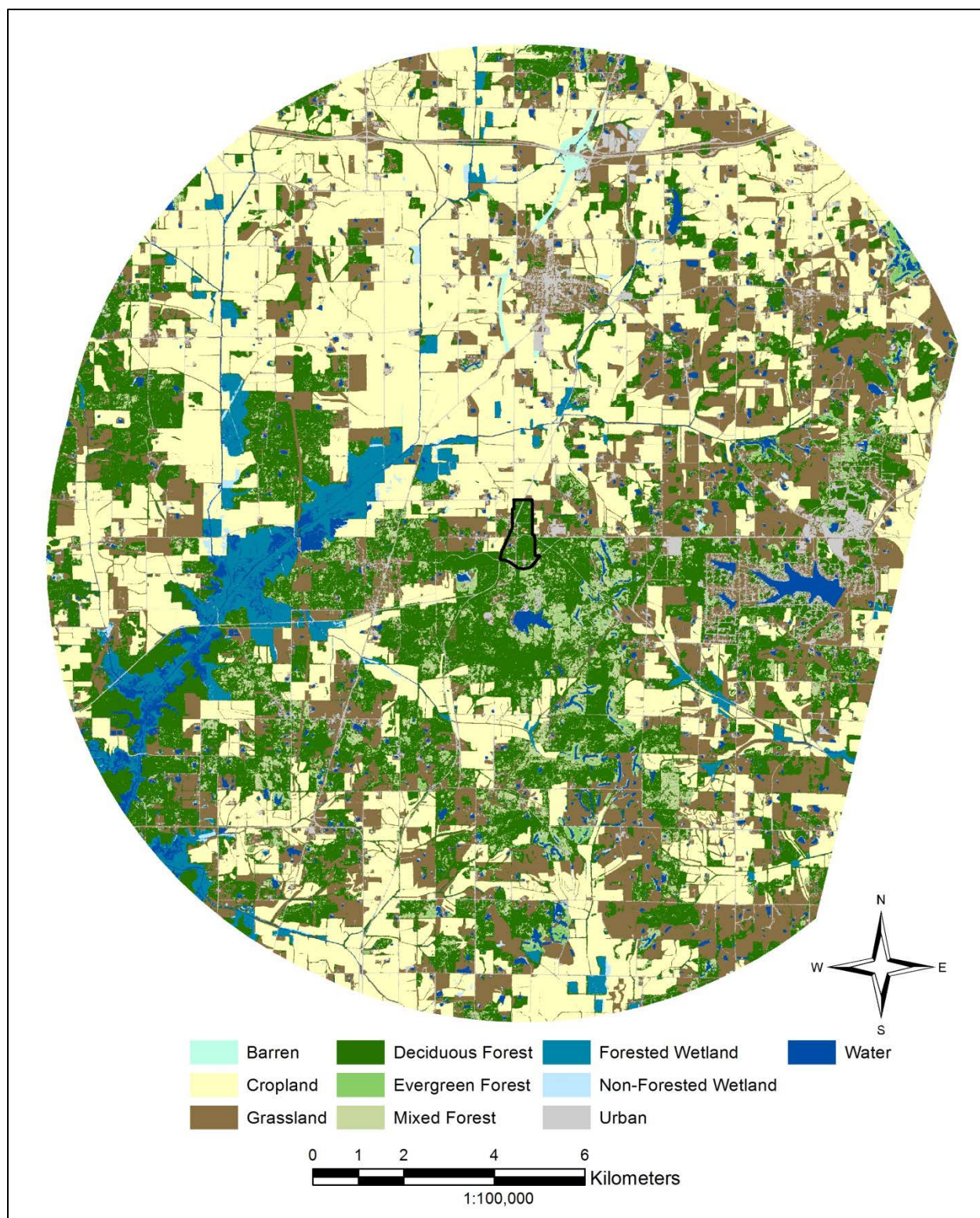


Figure 10. Map output of NWI wetland land cover classifications. The park boundary is outlined in black.

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