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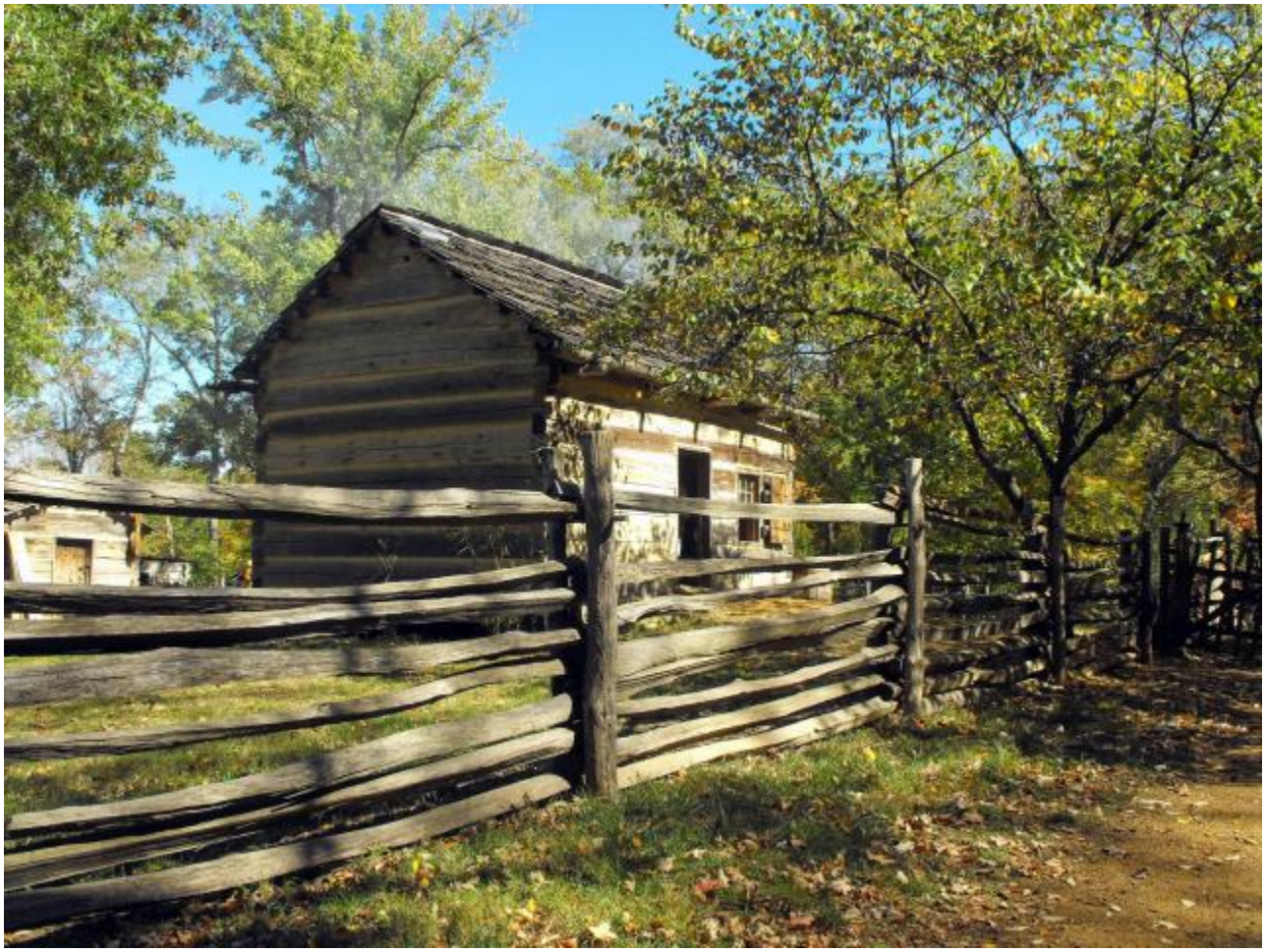
Natural Resource Stewardship and Science

Vegetation Classification and Mapping of Lincoln Boyhood National Memorial, Indiana

Project Report

Natural Resource Report NPS/LIBO/NRR—2014/798



ON THE COVER
Lincoln Boyhood Home
Photograph by: Amy Lyn, via www.nationalparks.org

NPS Vegetation Inventory Program
Lincoln Boyhood National Memorial

Vegetation Classification and Mapping of Lincoln Boyhood National Memorial, Indiana

Project Report

Natural Resource Report NPS/NPS/LIBO/NRR—2014/798

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National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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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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Abstract/Executive Summary

Lincoln Boyhood National Memorial (LIBO) is situated in southern Indiana, near the small town of Lincoln City and Lincoln State Park. It lies within a formerly forested landscape, but most of the park has been cleared in the past.

A vegetation classification and mapping project was initiated in 2011 and completed in 2013. Protocols and products were produced following National Park Service Vegetation Inventory Program guidelines. Classification was based on 30 field plots and 18 georeferenced observation points. Mapping was based on air photo interpretation and heads-up digitizing of polygons. Accuracy assessment points obtained during 2013 verified that the map is 100% accurate.

Five vegetation types were mapped and quantified. The most natural of these was a fairly mature Black Oak-White Oak-(Pignut, Shagbark) Hickory (*Quercus velutina - Quercus alba - Carya* (*glabra*, *ovata*) Forest association, which covered 10.2 acres (4.1 hectares). This type occurred as a single patch that surrounded the gravesite of Nancy Hanks Lincoln, and provided an aesthetically appealing backdrop. A Restored Deciduous Forest, which contained large sugar maples (*Acer saccharum*) and tuliptrees (*Liriodendron tulipifera*) partially surrounded the mature forest and covered another 49.4 acres (20.0 hectares). Ruderal Forest dominated by red maple (*Acer rubrum*) was the largest type, and covered 93.0 acres (37.6 hectares). Invasive species were abundant and sometimes dominant within this type, and no native canopy dominant trees were recorded in plots, so this type may persist as a ruderal forest without active management for many decades.

Introduction

Lincoln Boyhood National Memorial Vegetation Inventory Project

Lincoln Boyhood National Memorial (LIBO) Vegetation Inventory Project was a cooperative initiative involving the Missouri Resource Assessment Partnership (MoRAP) at the University of Missouri, the Heartland Inventory and Monitoring Program (HTLN) of the National Park Service (NPS), and park managers and resource specialists. MoRAP provided the classification and mapping and HTLN provided accuracy assessment and overall project coordination. All aspects of the project conform to overall requirements set forward by the NPS Vegetation Inventory Program (see http://science.nature.nps.gov/im/inventory/veg/index.cfm).

The project was initiated because accurate maps of existing vegetation facilitate natural and cultural resource management and interpretation. The natural landscapes also influenced Abraham Lincoln in his youth, and thus were significant in serving to help shape his character.

Each NPS Vegetation Inventory Project has three major components: classification, mapping, and map accuracy assessment. This report provides details on each of these fundamental elements.

NPS Vegetation Inventory Program

The National Vegetation Inventory Program (VIP) was established to map, classify, and describe vegetation in National Park units. It is administered by the NPS Biological Resources Management Division and provides baseline vegetation information to the NPS Natural Resource Inventory and Monitoring Program (I&M).

Vegetation Inventory Program scientists have developed procedures for classification, mapping, and accuracy assessment (Lea and Curtis 2010, Lea 2011). Use of the National Vegetation Classification System (NVCS) as the standard classification is central to fulfilling the goals of this national program. This system:

- is vegetation based;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing vegetation;
- uses a combined physiognomic-floristic hierarchy;
- identifies vegetation units based on both qualitative and quantitative data; and
- is appropriate for mapping at multiple scales.

The use of the NVCS and the establishment of classification and mapping standards facilitates effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs. In addition they can be used to provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental conditions and ecological processes across the landscape.

Before 1994, NVCS development was led by The Nature Conservancy (TNC), and further development was then passed on to the newly formed NatureServe organization. A network of state and regional ecologists involving dozens of individuals worked on the classification (TNC and ESRI 1994, Grossman et al. 1998). The NVCS is currently supported and endorsed by multiple federal agencies, the Federal Geographic Data Committee (FGDC 2008), NatureServe, state heritage programs, and the Ecological Society of America. Refinements to the classification have occurred in fits and spurts over the past decade, with funding from various federal and state agencies. A formal process for review of proposed revisions is in place (see Jennings et al. 2009), and the most accessible source for the NVCS is provided by NatureServe Explorer (http://www.natureserve.org/explorer/servlet/NatureServe?init=Ecol).

Vegetation Mapping Program Standards

The NPS I&M Program established guidance and standards for all vegetation mapping projects in a series of documents.

Protocols

- documenting a National Vegetation Classification System (TNC and ESRI 1994)
- standards for field methods and mapping procedures (Jennings et al. 2009, Lea 2011)
- producing rigorous and consistent accuracy assessment procedures (Lea and Curtis 2010)
- establishing standards for using existing vegetation data (TNC 1996)

Standards

- National Vegetation Classification Standard (FGDC 2008)
- Spatial Data Transfer Standard (FGDC 1998)
- Content Standard for Digital Geospatial Metadata (FGDC 1998)
- United States National Map Accuracy Standards (USGS 1999)
- Integrated Taxonomic Information System (http://www.itis.gov/)
- Program-defined standards for map attribute accuracy and minimum mapping unit

A 12-step guidance document provides details that cover the entire process with links to information extracted or summarized from publications described above (National Park Service 2011, available at http://science.nature.nps.gov/im/inventory/veg/docs/Veg_Inv_12step_Guidance_v1.1.pdf). Product specifications are also provided in a document (National Park Service 2011a, available at http://science.nature.nps.gov/im/inventory/veg/docs/Product_Specifications.pdf).

Lincoln Boyhood National Memorial

The memorial is located outside of Lincoln City, Indiana (Figure 1) and consists of 198.6 acres (80.4 hectares). According to the U.S. Environmental Protection Agency, the site lies within the Interior River Valleys and Hills Level III ecoregion, and the Green River-Southern Wabash Lowlands Level IV region (see http://www.epa.gov/wed/pages/ecoregions/ohin_eco.htm). This ecoregion, in general, was historically dominated by oak-hickory or mixed mesophytic forests prior to European settlement. Pavloic and White (1989) mapped eight current vegetation types, plus old home sites at LIBO. Most types were related to vegetation recovery from past human disturbance.

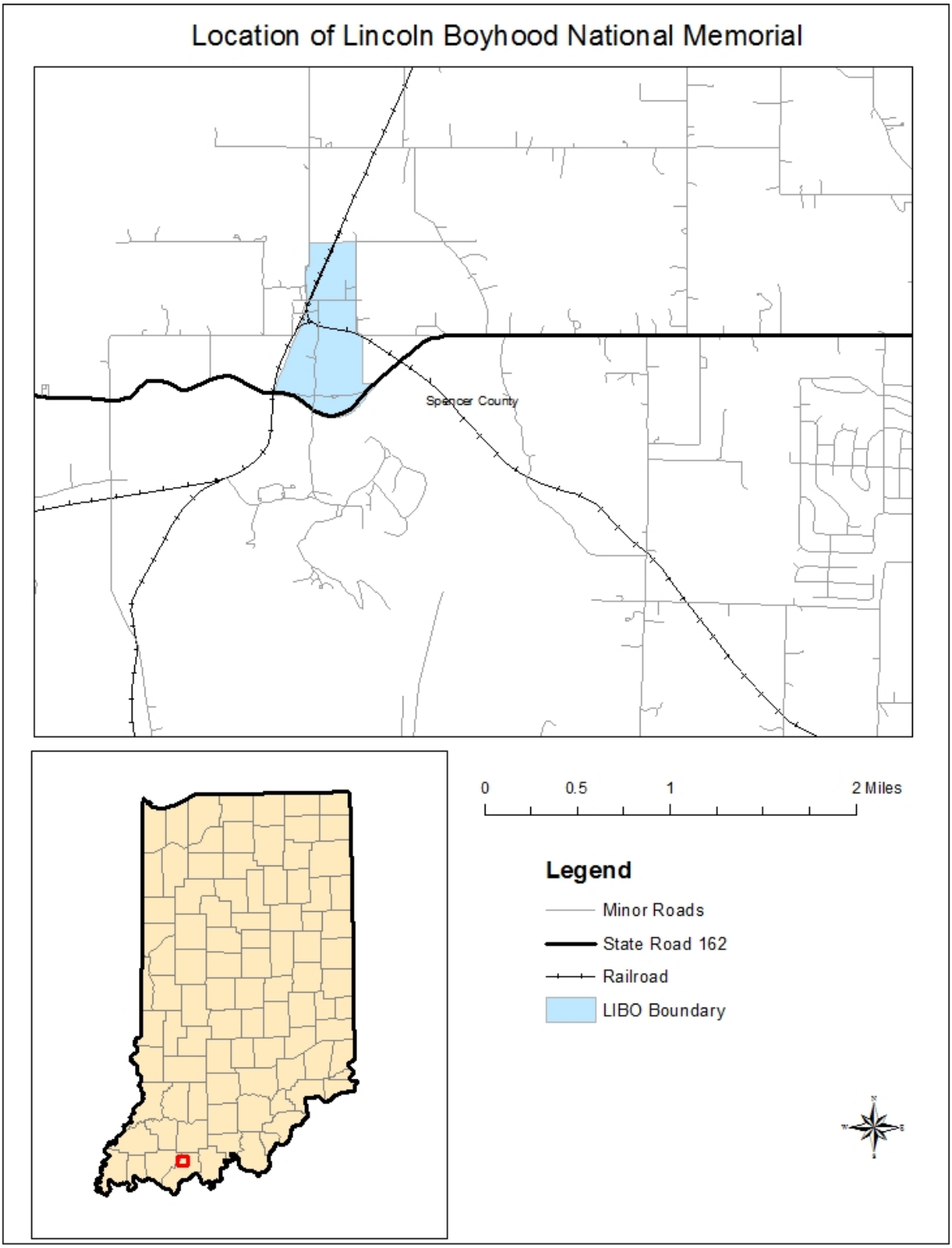


Figure 1. Location of Lincoln Boyhood National Memorial in Spencer County, Indiana.

Project Statistics

Field Work 2011 -2013:

Plot Sampling = 30
Plots sampled in May 2012 by MoRAP staff

Accuracy Assessment Points = 14
All collected in July 2013 by Heartland Inventory and Monitoring Network staff

Observation Points = 18
Collected in November 2011 and May 2012 by MoRAP staff

Classification:

2 NVC Plant Associations
3 Park Special Vegetation Classes
1 Non-Vegetated Land-Use Class

GIS Database 2011 - 2013:

Lincoln Boyhood National Memorial = 198.6 acres (80.4 hectares)

Base Imagery used for mapping (acquired by MoRAP):
2010, Spencer County, MO, leaf-on, true color, 1 m
2007, Spencer County, MO, true color, leaf-off, 1m

Additional Imagery acquired and viewed by MoRAP:
1937, Southern Indiana, black and white, TIFF
1966, Southern Indiana, black and white, TIFF
1984-1986, Southern Indiana, color infrared, 2m

Minimum Mapping Unit = 0.5 hectare
Minimum Patch Size=.004 hectares
Total Size = 27 Polygons
Average Polygon Size = 7.36 acres (2.98 hectares)
Overall Thematic Accuracy = 100%
Project Completion Date: 12/2013

Methods

Lincoln Boyhood National Memorial, at 198.6 acres, is a small park as defined by sampling design protocols (TNC and ESRI 1994), so most of the mapped vegetation polygons were visited for this study. Since access to private lands outside of the park was not ensured, the project boundary consisted of the boundary of the park itself (Figure 2). Five major tasks were identified and completed, including:

1. Plan, gather data, and coordinate tasks;

2. Survey LIBO to understand and sample the vegetation;

3. Classify the vegetation using the field data to NVC standard associations and alliances and crosswalk these to recognizable map units as far as possible;

4. Acquire current digital imagery and interpret the vegetation from these using the classification scheme and a map unit crosswalk; and

5. Assess the accuracy of the final map product.

All protocols for this project are outlined by NPS and important sections are summarized or linked at http://science.nature.nps.gov/im/inventory/veg/index.cfm. Drilling down to additional linked documents can be accomplished via the link to the National Park Service 12-step guidance document on that web site (National Park Service 2011). Important references include TNC and ESRI (1994), Jennings et al. (2009), Lea (2011), and Lea and Curtis (2010).

Planning, Data Gathering, and Coordination

The vegetation mapping project was discussed with appropriate park staff in coordination with Heartland Network staff and MoRAP staff. A proposal for vegetation mapping was subsequently completed and approved by NPS National Vegetation Inventory staff. Based on that proposal, MoRAP was responsible for classification, plot sampling, mapping, and development of digital databases. The Heartland Network was responsible for oversight of MoRAP activities in concert with NPS Vegetation Inventory Program staff, and coordinated Accuracy Assessment tasks. LIBO staff provided logistical and technical support, and helped coordinate field activities.

Field Survey

The field methods used in sampling and classifying the vegetation followed the methodology outlined by the NPS Vegetation Inventory Program team (see Jennings et al. 2009, Lea 2011, National Park Service 2011). A previous historic and current vegetation map had been generated for the site (Pavlovic and White 1989). Also, historic air photos were available. This information, together with an initial rapid field survey and collection of observation points in the fall of 2011, was used to inform the design of field surveys and ultimately vegetation classification and mapping. Observation points consisted of brief visits (fewer than 15 minutes) by ecologists from MoRAP where general information on vegetation structure and composition was noted (Figure 3).

Vegetation data were collected at 30 plots by MoRAP staff in May 2012 (Figure 4). In the lab, the locations of plots were randomly placed within the following general strata based on field observation points and viewing of air photos and digital soils surveys (available at http://soildatamart.nrcs.usda.gov/): young woodland, more mature forest, and a pasture. Young forest was further stratified based on apparent differences in forest age, based on viewing of historic air photos and rapid field surveys. Plots were located >30 m from an obvious land cover edge, and for each point there was at least one alternate, should the original point be determined unusable in the field (e.g. close to an un-mapped trail or road, stand too small). The stratified random plot location information was loaded into a GPS and workers navigated to the plot in the field for field sampling.

Woodlands and forests were sampled with a 10 m x 40 m plot (400 sq m), and herbaceous vegetation with a 5 m x 20 m plot (100 sq m). Minimal flagging was used to mark the plot. Data were collected using a plot survey form (Appendix B). The survey form includes sections for plot location and description, as well as vegetation and environmental information about the plot.

Vegetation sampling included information about structure and physiognomy, with leaf phenology, leaf type and physiognomic class recorded for the dominant vegetative stratum. Cover data was collected for the following strata, where applicable.

T1 = Emergent Tree (overstory) >30 m
T2 = Tree Canopy (overstory) 20-30 m
T3 = Tree Subcanopy (midstory) 5-20 m
S1 = Tall Shrub (understory woody species, tree and shrub) 1-5 m
S2 = Short Shrub (woody species, tree and shrub) <1 m
H = Herbaceous species, does not include S2

Additionally, cover was recorded in modified Daubenmire (1959) cover classes for each species by strata (Table 1).

Table 1. Canopy Cover used for quantitative sampling.

Cover Class Codes	Range of Cover (%)
7	95-100
6	75-95
5	50-75
4	25-50
3	5-25
2	1-5
1	0-0.99

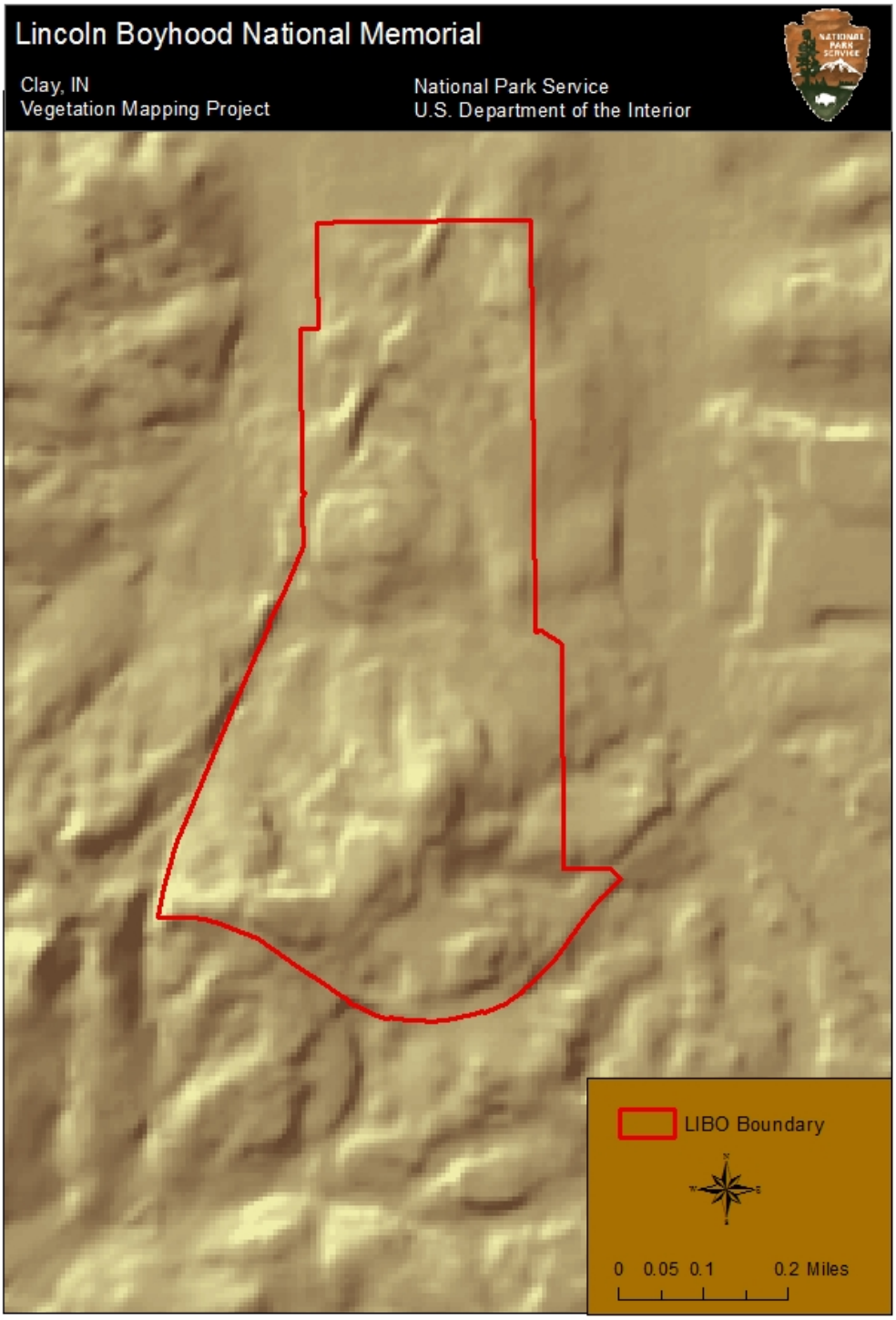


Figure 2. Map of Lincoln Boyhood National Memorial.

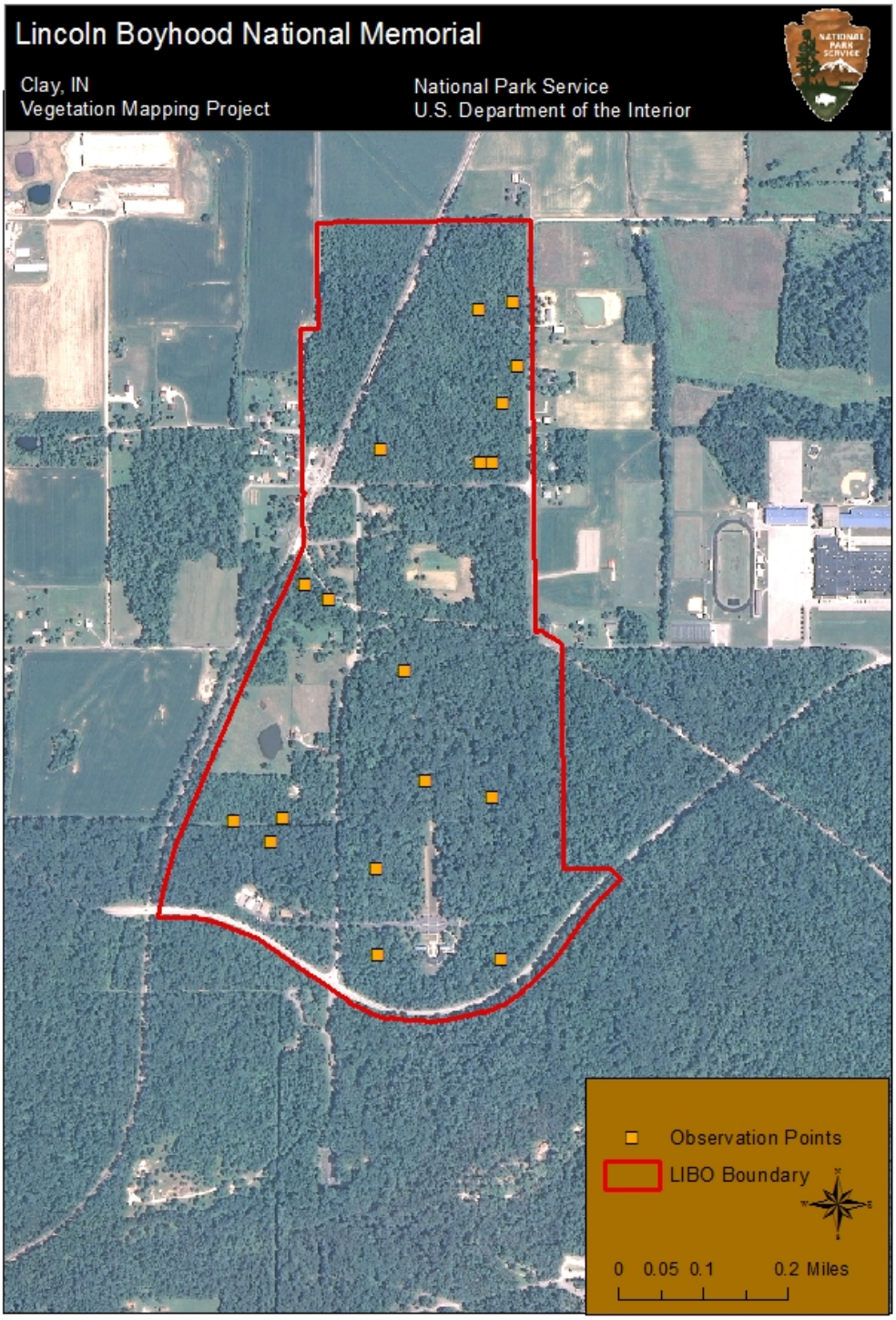


Figure 3. Location of 18 observation points collected in Lincoln Boyhood National Memorial.

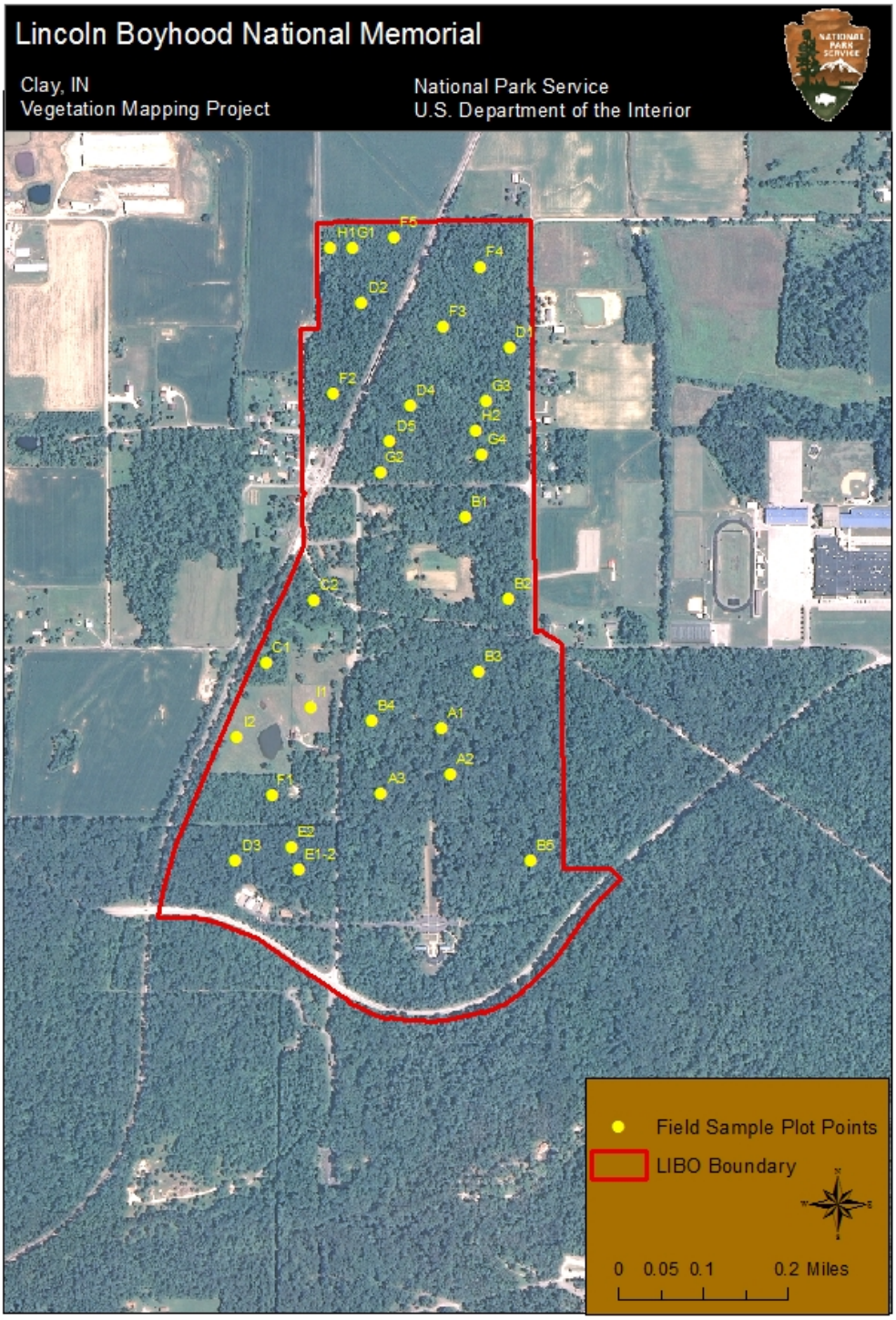


Figure 4. Location of 30 sampled plots within Lincoln Boyhood National Memorial.

Vegetation Classification

All recorded data were entered into the NPS PLOTS v3 database (available at http://science.nature.nps.gov/im/inventory/veg/plots.cfm), a Microsoft Access-derived program. The PLOTS database was developed for the NPS National Vegetation Inventory Program so that data entry fields mirror the standard field form. Data entry was facilitated by assigning each plant taxon a unique, standardized code and name based on the PLANTS database developed by Natural Resources Conservation Service in cooperation with the Biota of North America Program (USDA and NRCS 2009, available at http://plants.usda.gov/java/). Data were thoroughly proofed after entry to minimize errors.

Plot data were subject to cluster analysis and ordination in order to help inform classification. Species-specific data were collected in multiple strata using cover classes, but for the purpose of analysis, the cover values for each species were combined into a single value using the midpoint of the cover class. The formula for percent overlap used to combine the strata cover values for each species was

$$1 - \prod(1 - \frac{\%cover}{100}).$$

Use of this formula reduces the effects of overlapping cover in various strata. We used a log transformation to standardize cover values using the formula log(cover + 1). Bray-Curtis dissimilarity was used as the distance metric for the cluster and ordination analyses (Legendre and Legendre 1998). Clustering was performed using the hierarchical clustering algorithm known as flexible Beta with a $\beta = -0.25$ (Lance and Williams 1967, Maechler et al. 2011). Non-metric multidimensional scaling was used to develop the ordination (Legendre and Legendre 1998, Roberts 2010).

Descriptive information on NVC community composition concepts and classification were obtained from the NatureServe Explorer (2012) website available at http://www.natureserve.org/explorer/servlet/NatureServe?init=Ecol. Where the observed LIBO vegetation did not fit descriptions of natural associations described for Indiana, ruderal types were assigned.

Once the classification was finalized, a dichotomous key was developed by MoRAP for use during the Accuracy Assessment (Appendix C). For types with an NVC assignment, the full NVC hierarchical classification and global descriptions are available in the results section. In addition, the final described types were linked to map classes for use in the photo-interpretation and mapping portions of the project.

In the future, LIBO classification plot data may be used by NatureServe to update and improve worldwide (i.e., global) descriptions of the NVC plant associations, especially for ruderal types which are generally lacking for the Midwest. LIBO specific (i.e., local) descriptions were written based on LIBO plot, observation, and accuracy assessment data.

Digital Imagery and Interpretation

The mapping component was produced by identifying land cover on air photos and hand digitizing on-screen. Heads-up digitizing was accomplished at a display scale of not more than

1:1,000 against a back-drop of air photos. Imagery was the most recent available from the National Agriculture Imagery Program (NAIP; see http://www.fsa.usda.gov/Internet/FSA_File/naip_2009_info_final.pdf). This include 2010, 1 meter resolution leaf-off, and 2007, 1 meter resolution leaf on imagery (Figure 5).

Figure 5. Digitization of hand drawn objects.

Accuracy Assessment

Thematic accuracy assessment (AA) was conducted by the HTLN. Methods and analysis for the accuracy assessment of vegetation mapping at LIBO were based on NPS standards (Lea and Curtis 2010). Thematic or attribute accuracy of mapped vegetation classes were assessed independently following the completion of the vegetation mapping inventory by the lead authors. Representative sites were identified and visited in the field to determine if interpreted mapped classes were correctly assigned by field observers using the dichotomous key to mapped current vegetation types (Appendix C). Identifying the degree of correspondence between field observations and mapped attributes provides a measure of the maps suitability for different applications.

Accuracy assessment consisted of first evaluating the spatial pattern (total area and number of polygons) of each mapped vegetation class. The number of samples in each class was selected from five possible scenarios (Table 2). Accuracy assessment was restricted to natural vegetation map classes, thus omitting developed areas and standing water. Once the appropriate sampling scenario for each map class was determined, site selection was performed using a geographical information system (ArcGIS 10.0).

Table 2. Target number of Accuracy Assessment samples per map class based on number of polygons and area.

Scenario	Description	Polygons in class	Area occupied by class	Recommended number of samples in class
Scenario A:	The class is abundant. It covers more than 50 hectares of the total area and consists of at least 30 polygons. In this case, the recommended sample size is 30.	>30	>50 ha	30
Scenario B:	The class is relatively abundant. It covers more than 50 hectares of the total area but consists of fewer than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size for this type of class is that sample sites are more difficult to find because of the lower frequency of the class.	<30	>50 ha	20
Scenario C:	The class is relatively rare. It covers less than 50 hectares of the total area but consists of more than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size is that the class occupies a small area. At the same time, however, the class consists of a considerable number of distinct polygons that are possibly widely distributed. The number of samples therefore remains relatively high because of the high frequency of the class.	>30	<50 ha	20
Scenario D:	The class is rare. It has more than 5 but fewer than 30 polygons and covers less than 50 hectares of the area. In this case, the recommended number of samples is 5. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than 5 sample sites will therefore probably	5 - 30	<50 ha	5

Scenario	Description	Polygons in class	Area occupied by class	Recommended number of samples in class
	result in multiple sample sites within the same (small) polygon. Collecting 5 sample sites will allow an accuracy estimate to be computed, although it will not be very precise.			
Scenario E:	The class is very rare. It has fewer than 5 polygons and occupies less than 50 hectares of the total area. In this case, it is recommended that the existence of the class be confirmed by a visit to each sample site. The rationale for the recommendation is that with fewer than 5 sample sites (assuming 1 site per polygon) no estimate of level of confidence can be established for the sample (the existence of the class can only be confirmed through field checking).	<5	<50 ha	Visit all and confirm

Random sample points were generated in ArcGIS. Points were buffered 40 meters from the park boundary and 80 meters from another point. The minimum mapping unit used in delineating vegetation polygons was 0.5 hectare. All random points were selected within the park boundary to avoid any private land issues.

Randomly selected site locations were loaded onto a Garmin GPS unit for field navigation (Figure 6). All AA field work was completed on June 26, 2012. Field staff was provided with a GPS unit, dichotomous key for mapping vegetation map classes, and vegetation class definitions.

Plot shape and size varied according to the extent of the vegetation class patch containing the sample point. Circular 0.25 hectare (28 m radius) plots were used for larger patches while circular 0.1 hectare (18 m radius) plots were used for small patches approaching the minimum mapping unit. A circular plot size of 0.5 hectare (40 m radius) was used to capture information for a single large homogenous patch. In all cases, plot size exceeded the minimum patch size for LIBO.

Field staff recorded plot size and shape, positional accuracy and vegetation classification at each point (Accuracy Assessment field form, Appendix D). In addition, comments regarding the plot location, plot size and vegetation were recorded on the field form. Field data from the 14 points were entered into to the PLOTS database and underwent quality assurance/quality control (QA/QC) verification. In addition, the associated project geodatabase was updated in ArcGIS to reflect any changes to the point location due to offsets made in the field. All classification and spatial field observations were compared with the vegetation map and AA point locations for any differences.

Upon completion of QA/QC, the accuracy assessment analysis was performed. All analysis and evaluation of producer and user accuracy was conducted using the AA Contingency Table Calculation Spreadsheet (http://science.nature.nps.gov/im/inventory/veg/guidance.cfm). Statistics and calculations performed in the spreadsheet are presented in Table 3.

Table 3. Summary of the Accuracy Assessment statistics used at Lincoln Boyhood National Memorial.

Statistic	Description
User's Accuracy	The fraction of the accuracy assessment observations in a map class that were found to have the correct vegetation class in the field.
Producer's Accuracy	The fraction of the accuracy assessment observations in a vegetation class in the field that were found to be mapped correctly.
Overall Accuracy	The fraction of accuracy assessment observations within all map classes that were correctly mapped.
Kappa Index	Another measure of overall accuracy, which takes into account the probability that mapped polygons will be correct due to random chance.

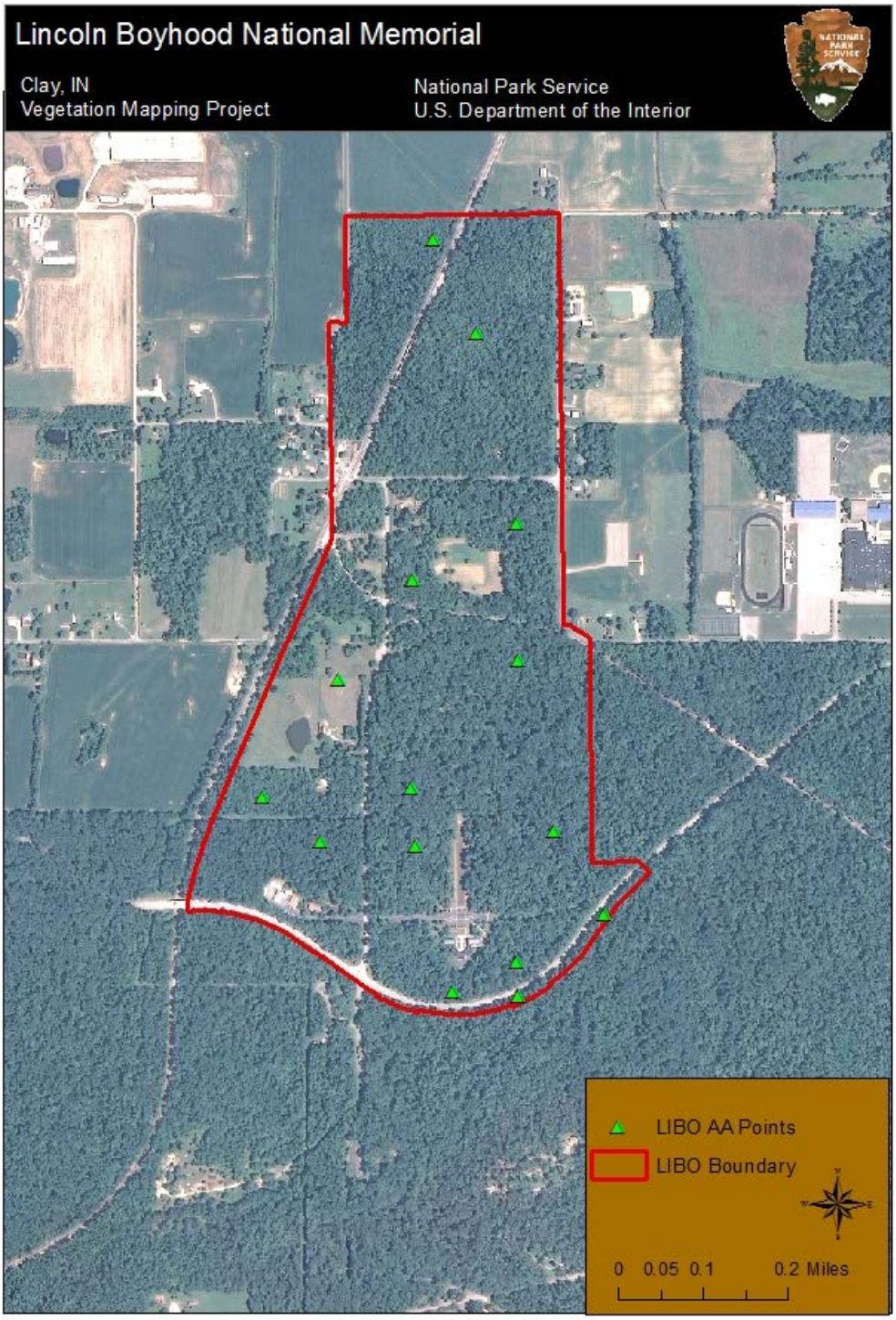


Figure 6. Accuracy Assessment points for Lincoln Boyhood National Memorial.

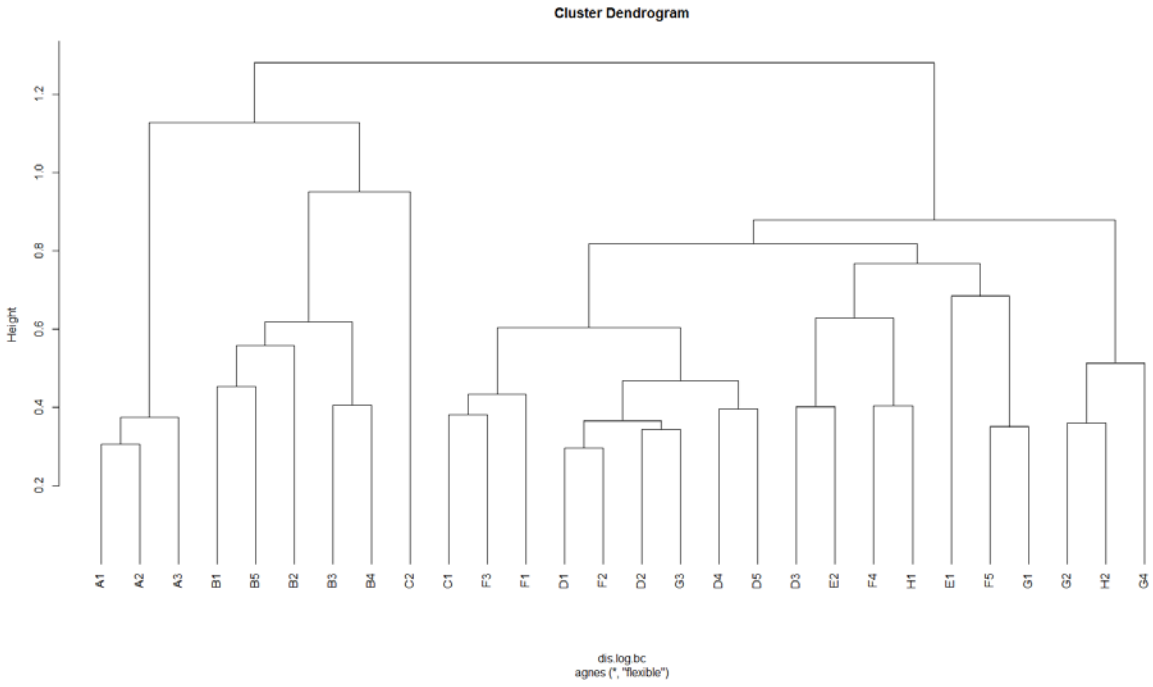
Results

Vegetation Classification

Five vegetation types were identified at LIBO based on ordination and cluster analysis results (Figure 7). Developed land, undivided by type, made up a sixth class. Two plots that represented the Ruderal Grassland vegetation type were removed from ordination and cluster analysis after initial analyses, and the remaining 28 plots, which all represented forested types, were classified into three types. Types depicted on the ordination (Figure 7) were as follows:

Blue (three plots) – Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest
Orange (five plots) – Restored Deciduous Forest
Green (20 plots) – Ruderal Forest

A relatively large number of plots represented Ruderal Forest. This type had a fairly diverse understory, but all plots contained red maple (*Acer rubrum*) among the dominant tree species.



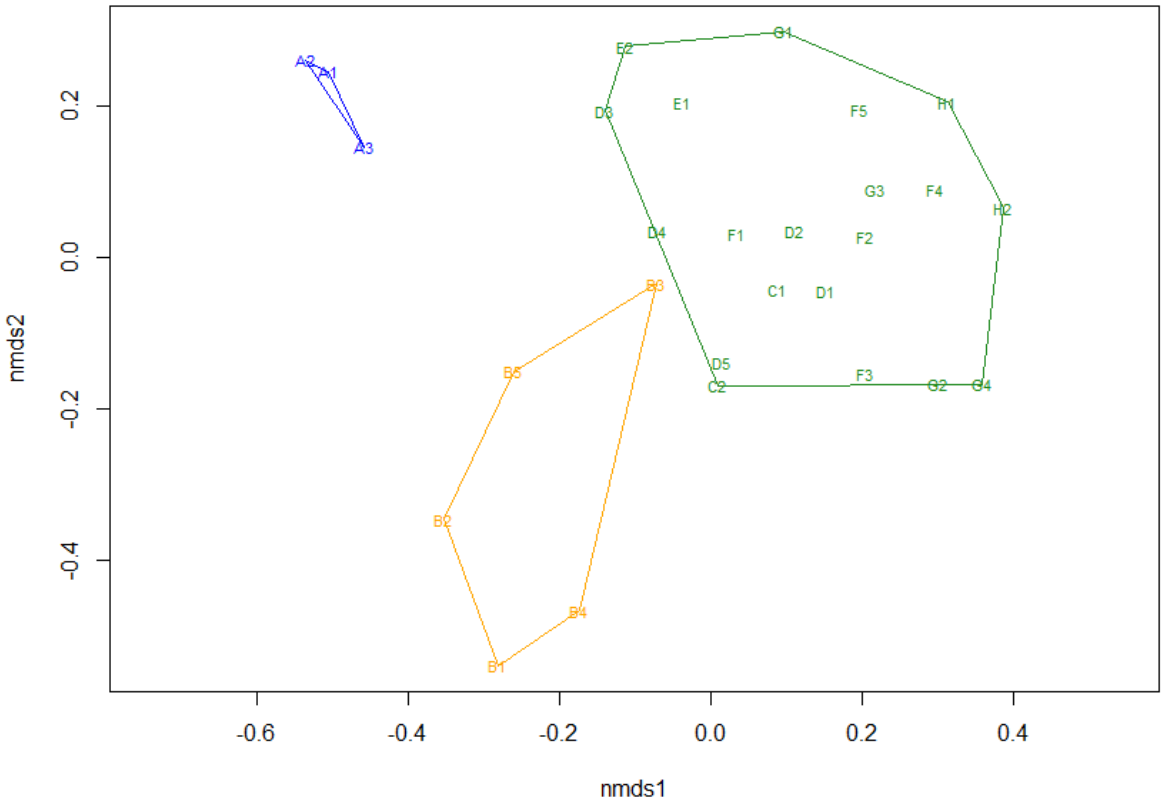


Figure 7. Ordination analysis and cluster dendogram of 30 plots sampled in LIBO.

Digital Imagery and Interpretation

Five map units that corresponded directly with the classified vegetation plus developed land were defined (Table 4). The developed land map class was a catch-all that included all areas without semi-natural vegetation.

Vegetation Map

A total of 198.6 acres (80.4 hectares) are within the accepted boundaries of LIBO (Figure 8). The standard minimum mapping unit for NPS vegetation mapping projects is defined as 0.5 hectare, although several mapped polygons were smaller for LIBO. Ruderal forest was the predominant type, accounting for 93 acres (37.6 hectares), or 56.5% of the non-developed land. Restored Deciduous Forest was the next largest type, accounting for 49.4 acres (20.0 hectares, 30.0%). The Ruderal Grassland and Black Oak-White Oak-(Pignut, Shagbark) Hickory types accounted for just over 10 acres (4 hectares, 6.2%) each. Developed land accounts for 33.5 acres (13.6 hectares) of the park.

Accuracy Assessment

The 2013 accuracy assessment for LIBO was limited to the 198.6 acres (80.4 hectares) of natural and semi-natural vegetation within the park boundary. A total of 14 points were required to

accurately evaluate the five natural and semi-natural mapped vegetation types identified in the park (Table 4). Navigational error (positional accuracy) of the GPS unit was 4 meters for the 14 accuracy assessment points.

Table 4. Mapped types identified at Lincoln Boyhood National Memorial.

NVC Identifier	Mapped Type Name	Scientific Name / Description	Number of Polygons	Acres	Hectares
Forest and Woodlands					
CEGL002076	Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest	*Quercus velutina - Quercus alba - Carya (glabra, ovata)* Forest	1	10.2	4.1
None assigned	Restored Deciduous Forest	*Acer saccharum - Liriodendron tulipifera - Liquidambar styraciflua* Forest	4	49.4	20
None assigned	Ruderal Forest	*Acer rubrum - Liquidambar styraciflua* Forest	14	93	37.6
CEGL006313	Ruderal White Pine Woodland	*Pinus strobus* Woodland	3	10.3	4.1
Herbaceous Vegetation					
None assigned	Ruderal Grassland	*Schedonorus pratensis - Trifolium* spp. Herbaceous Vegetation	1	10.3	4.2
Land Use/Land Cover					
None assigned	Developed Land	buildings, parking lots, roads	3	33.5	13.6
	Water		1	.58	0.23
Total Land Use/Land Cover			4	34	13.7
Total Natural Vegetation			23	164.6	66.6
Totals			27	198.6	80.4

Overall accuracy of the final error matrix was 100.0% (the 90% confidence interval was between 100.0 and 100.0%) for the natural and semi-natural mapped vegetation types at LIBO (Appendix A). Both omission accuracy (map producer's error) and commission accuracy (user's error) was 100% for all map classes. All 14 accuracy assessment points assigned correctly. Kappa Index, or the random chance polygons were assigned correctly, was 100.0% (Appendix A).

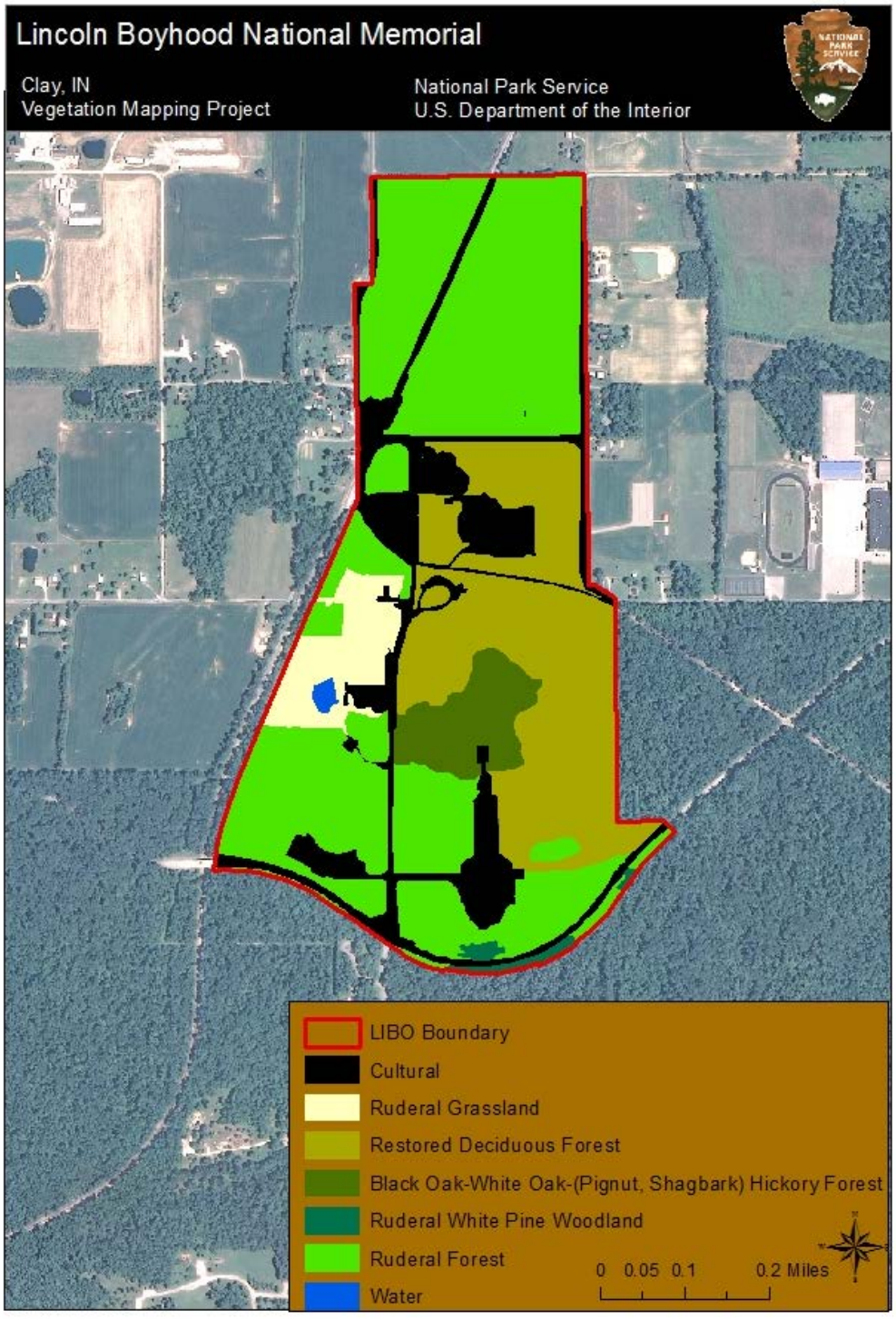


Figure 8. Vegetation map of Lincoln Boyhood National Memorial.

Vegetation Associations

Mapped Type Name: Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest

Macrogroup: M012. Central Oak-Hardwood & Pine Forest
Group: G158. Northeastern & North-Central Oak-Hickory Forest Group
Association: CEGL002076
Type Common Name: Black Oak - White Oak - (Pignut, Shagbark) Hickory Forest
Type Scientific Name: *Quercus velutina - Quercus alba - Carya (glabra, ovata)* Forest

Figure 9. Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest at Lincoln Boyhood National Memorial.

Global Summary: This group is found throughout the glaciated regions of the Midwest, typically in rolling uplands. It forms a mosaic with tallgrass prairie communities in some landscapes. The type ranges from dry-mesic to dry, which distinguishes it from more mesic forest types in the Midwest. Common dominant species include white oak (*Quercus alba*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), pignut hickory (*Carya glabra*), and shagbark hickory (*Carya ovata*) (Figure 9). Bur oak (*Quercus macrocarpa*) is a common component in the upper Midwest. American chestnut (*Castanea dentata*) was a common dominant before chestnut blight eliminated this species as a canopy component.

Environmental Description: At LIBO, this type occurred as a single patch on dissected uplands with some fairly steep slopes. The soils are generally well-drained, and this type occupied relatively high hills in the local landscape.

Vegetation Description: Black oak and white oak dominated this fairly mature forest type with a generally open understory. Shagbark hickory , sugar maple (*Acer saccharum*), and northern red oak also occurred as common canopy species (Table 5). Important shrubs included eastern redbud (*Cercis canadensis*), common persimmon (*Diospyros virginiana*), and sassafras (*Sassafras albidum*). Common herbaceous species included whitetinge sedge (*Carex albicans*), common yellow oxalis (*Oxalis stricta*), mayapple (*Podophyllum peltatum*), and jumpseed (*Polygonum virginianum*). Weedy invasive shrubs and herbaceous species had relatively low importance within this forest patch.

Most Abundant Species:

Table 5. Species found in one or more of three plots representing the Black Oak-White Oak-(Pignut, Shagbark) Hickory vegetation type.

Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Tree Layer			
Acer saccharum	sugar maple	33%	15.0
Carya ovata	shagbark hickory	67%	9.0
Fraxinus americana	white ash	33%	15.0
Quercus alba	white oak	100%	26.0
Quercus rubra	northern red oak	33%	15.0
Quercus velutina	black oak	100%	54.2
Shrub Layer			
Acer negundo	boxelder	33%	0.5
Acer rubrum	red maple	33%	0.5
Acer saccharum	sugar maple	67%	9.0
Aralia spinosa	devil's walkingstick	33%	0.5
Carya alba	mockernut hickory	33%	0.5
Celastrus scandens	American bittersweet	33%	0.5
Cercis canadensis	eastern redbud	100%	57.7
Cornus florida	flowering dogwood	100%	5.3
Diospyros virginiana	common persimmon	67%	0.5
Fraxinus americana	white ash	100%	6.2
Juglans nigra	black walnut	33%	0.5
Juniperus virginiana	eastern redcedar	33%	0.5
Ligustrum vulgare	European privet	33%	3.0
Lindera benzoin	northern spicebush	67%	7.8
Liriodendron tulipifera	tuliptree	67%	0.5
Morus rubra	red mulberry	33%	0.5
Nyssa sylvatica	blackgum	33%	0.5
Parthenocissus quinquefolia	Virginia creeper	100%	46.7
Prunus serotina	black cherry	67%	1.8
Quercus alba	white oak	67%	0.5

Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Quercus velutina	black oak	33%	0.5
Rubus argutus	sawtooth blackberry	100%	26.0
Rubus occidentalis	black raspberry	33%	0.5
Sassafras albidum	sassafras	100%	11.0
Smilax glauca	cat greenbrier	33%	0.5
Symphoricarpos orbiculatus	coralberry	33%	15.0
Toxicodendron radicans	eastern poison ivy	33%	0.5
Ulmus rubra	slippery elm	33%	0.5
Vinca minor	common periwinkle	33%	0.5
Vitis aestivalis	summer grape	67%	9.0
Vitis vulpina	frost grape	33%	0.5
Herbaceous Layer			
Acalypha rhomboidea	common threeseed mercury	33%	0.5
Acalypha virginica	Virginia threeseed mercury	33%	0.5
Agastache nepetoides	yellow giant hyssop	33%	0.5
Ageratina altissima	white snakeroot	33%	0.5
Arisaema dracontium	green dragon	33%	0.5
Arisaema triphyllum	Jack in the pulpit	33%	0.5
Aristolochia serpentaria	Virginia snakeroot	33%	0.5
Boehmeria cylindrica	smallspike false nettle	33%	0.5
Carex albicans	whitetinge sedge	67%	0.5
Carex hirsutella	fuzzy wuzzy sedge	33%	0.5
Carex squarrosa	squarrose sedge	33%	0.5
Erigeron strigosus	prairie fleabane	33%	0.5
Galium circaezans	licorice bedstraw	33%	0.5
Oxalis stricta	common yellow oxalis	67%	0.5
Phryma leptostachya	American lopseed	33%	0.5
Phytolacca americana	American pokeweed	33%	0.5
Podophyllum peltatum	mayapple	67%	0.5
Polygonum sp.	knotweed	33%	0.5
Polygonum virginianum	jumpseed	67%	0.5
Sanicula canadensis	Canadian blacksnakeroot	33%	0.5
Solanum carolinense	Carolina horsenettle	33%	0.5
Thalictrum thalictroides	rue anemone	33%	0.5
Verbesina alternifolia	wingstem	33%	0.5
Viola sororia	common blue violet	33%	3.0

Mapped Type Name: Restored Deciduous Forest

Macrogroup: None
Group: None
Association: None
Type Common Name: Restored Deciduous Forest
Type Scientific Name: *Acer saccharum - Liriodenron tulipifera-Liquidambar styraciflua* Forest

Figure 10. Restored Deciduous Forest Lincoln Boyhood National Memorial.

Global Summary: This type is unique to LIBO. The combination of species that were planted and the success of establishment are not known to be duplicated elsewhere, and hence this type does not fit within a hierarchical natural community classification. An unusual combination of mesic forest trees are mixed with early successional trees within this type at LIBO.

Environmental Description: This type occurred in a variety of land positions at LIBO. Most of the area was rolling and fairly well-drained but moist, although some upland headwater riparian zones were included.

Vegetation Description: Sugar maple was the prevailing dominant of this type, and tuliptree (*Liriodendron tulipifera*) was a visually striking component. Early successional species such as sweetgum (*Liquidambar styraciflua*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), and shingle oak (*Quercus imbricaria*) were also tree components (Figure 10). Common small tree and shrub components included sugar maple, bitternut hickory (*Carya cordiformis*), white ash, and northern spicebush (*Lindera benzoin*). Vines such as Japanese honeysuckle (*Lonicera japonica*), Virginia creeper (*Parthenocissus quinquefolia*), and eastern poison ivy (*Toxicodendron radicans*) were common. A number of non-native invasive species,

including Japanese honeysuckle, burning bush (*Euonymus alatus*), and European privet (*Ligustrum vulgare*) were among the shrub components. Common herbaceous species included rattlesnake fern (*Botrychium virginianum*), eastern woodland sedge (*Carex blanda*), and American lopseed (*Phryma leptostachya*)(Table 6).

Most Abundant Species:

Table 6. Species found within two or more of five plots representing the Restored Deciduous Forest vegetation type.

Restored Deciduous Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Tree Layer			
Acer saccharum	sugar maple	100%	45.6
Fraxinus americana	white ash	40%	9.0
Liquidambar styraciflua	sweetgum	60%	11.0
Liriodendron tulipifera	tuliptree	60%	14.5
Nyssa sylvatica	blackgum	40%	15.0
Prunus serotina	black cherry	40%	9.0
Quercus imbricaria	shingle oak	40%	26.3
Shrub Layer			
Acer saccharum	sugar maple	100%	40.6
Carya alba	mockernut hickory	40%	0.5
Carya cordiformis	bitternut hickory	100%	1.5
Carya ovata	shagbark hickory	40%	0.5
Celastrus scandens	American bittersweet	60%	0.5
Cercis canadensis	eastern redbud	80%	10.4
Cornus florida	flowering dogwood	80%	1.1
Euonymus alatus	burningbush	40%	1.8
Euonymus fortunei	winter creeper	40%	0.5
Fraxinus americana	white ash	100%	1.5
Ligustrum vulgare	European privet	40%	0.5
Lindera benzoin	northern spicebush	100%	2.0
Liquidambar styraciflua	sweetgum	60%	0.5
Lonicera japonica	Japanese honeysuckle	80%	14.6
Morus rubra	red mulberry	60%	0.5
Nyssa sylvatica	blackgum	80%	0.5
Parthenocissus quinquefolia	Virginia creeper	80%	23.9
Prunus serotina	black cherry	80%	0.5
Rubus argutus	sawtooth blackberry	60%	12.8
Sassafras albidum	sassafras	60%	1.3
Smilax glauca	cat greenbrier	80%	0.5
Symphoricarpos orbiculatus	coralberry	40%	1.8
Toxicodendron radicans	eastern poison ivy	80%	5.4

Restored Deciduous Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Ulmus rubra	slippery elm	40%	0.5
Viburnum prunifolium	blackhaw	40%	0.5
Vinca minor	common periwinkle	40%	1.8
Herbaceous Layer			
Ageratina altissima	white snakeroot	60%	1.3
Asplenium platyneuron	ebony spleenwort	40%	0.5
Boehmeria cylindrica	smallspike false nettle	40%	0.5
Botrychium virginianum	rattlesnake fern	100%	0.5
Carex albicans	whitetinge sedge	40%	0.5
Carex blanda	eastern woodland sedge	80%	0.5
Carex retroflexa	reflexed sedge	40%	1.8
Elymus virginicus	Virginia wildrye	40%	0.5
Galium circaezans	licorice bedstraw	40%	0.5
Galium triflorum	fragrant bedstraw	40%	0.5
Geum canadense	white avens	60%	0.5
Impatiens spp.	touch-me-not	40%	0.5
Phryma leptostachya	American lopseed	80%	0.5
Podophyllum peltatum	mayapple	40%	3.0
Polygonum virginianum	jumpseed	40%	0.5
Sanicula canadensis	Canadian blacksnakeroot	40%	0.5
Verbena urticifolia	white vervain	60%	0.5
Verbesina alternifolia	wingstem	40%	0.5
Viola pubescens var. *pubescens*	downy yellow violet	40%	0.5
Viola sororia	common blue violet	60%	0.5

Mapped Type Name: Ruderal Forest

Macrogroup: **M013. Eastern North American Ruderal Forest & Plantation**
Group: G030. Northern & Central Hardwood & Conifer Ruderal Forest Group
Association: None
Type Common Name: Ruderal Forest
Type Scientific Name: *Acer rubrum - Liquidambar styraciflua* Forest

Figure 11. Ruderal Forest at Lincoln Boyhood National Memorial.

Global Summary: This group includes communities that show evidence of heavy human use (clearing, plowing) in the past. Woody species volunteer into these cleared areas more or less spontaneously, and vegetation is dominated (>80% cover) by ruderal or exotic species. A wide variety of woody species may be present, and these species may occur in monodominant or mixed stands. Some typical woody dominates include eastern redcedar (*Juniperus virginiana*), pines (*Pinus* spp.), hawthorns (*Crataegus* spp.), red maple, honey locust (*Gleditsia triacanthos*), and black walnut (*Juglans nigra*) (Figure 11). Other associated shrubs and herbaceous species are generalist or ruderal species.

Environmental Description: At LIBO, this type occurred on a variety of land positions and slopes, although most areas were very gently sloping. All areas had been cleared in the past, and some small patches within this type represent old home sites and associated former yards and driveways with heavily disturbed soils.

Vegetation Description: This type represented early successional and ruderal woodlands and forests in a variety of stages of recovery from different types of disturbance. As a result, the shrub and herbaceous layers were quite diverse. Trees were generally immature and often rather

dense, and red maple was the dominant both in cover and in visual aspect within most of the mapped patches of this type. Other important trees included white ash, sweetgum, and tuliptree. American sycamore (*Platanus occidentalis*) and boxelder (*Acer negundo*) were also noticeable in the canopy, but occurred in localized patches. Common shrubs and small trees included bitternut hickory, flowering dogwood (*Cornus florida*), white ash, sweetgum, black cherry, shingle oak, coralberry (*Symphoricarpos orbiculatus*), and slippery elm (*Ulmus rubra*). Japanese honeysuckle was an important non-native invasive vine that was dominant across large areas. Common herbaceous species included white snakeroot (*Ageratina altissima*), ebony spleenwort (*Asplenium platyneuron*), eastern woodland sedge, white avens (*Geum canadense*), and jumpseed (Table 7).

Most Abundant Species:

Table 7. Species found within six or more of twenty plots representing the Ruderal Forest vegetation type.

Ruderal Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Tree Layer			
Acer negundo	boxelder	30%	4.6
Acer rubrum	red maple	80%	29.4
Fraxinus americana	white ash	50%	15.9
Juglans nigra	black walnut	40%	16.0
Liquidambar styraciflua	sweetgum	55%	19.9
Liriodendron tulipifera	tuliptree	55%	13.8
Platanus occidentalis	American sycamore	30%	16.3
Prunus serotina	black cherry	45%	10.7
Ulmus rubra	slippery elm	35%	8.1
Shrub Layer			
Acer negundo	boxelder	45%	0.8
Acer rubrum	red maple	55%	18.4
Acer saccharum	sugar maple	50%	2.7
Campsis radicans	trumpet creeper	55%	1.4
Carya alba	mockernut hickory	35%	3.3
Carya cordiformis	bitternut hickory	75%	2.3
Celtis occidentalis	common hackberry	30%	1.8
Cercis canadensis	eastern redbud	35%	7.8
Cornus florida	flowering dogwood	60%	8.6
Diospyros virginiana	common persimmon	40%	1.4
Elaeagnus umbellata	autumn olive	35%	2.9
Euonymus fortunei	winter creeper	30%	15.7
Fraxinus americana	white ash	85%	7.1
Juglans nigra	black walnut	40%	2.9
Juniperus virginiana	eastern redcedar	30%	0.9
Ligustrum vulgare	European privet	55%	6.5

Ruderal Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Lindera benzoin	northern spicebush	50%	3.9
Liquidambar styraciflua	sweetgum	60%	7.4
Liriodendron tulipifera	tuliptree	55%	4.7
Lonicera japonica	Japanese honeysuckle	90%	14.2
Morus rubra	red mulberry	40%	1.1
Nyssa sylvatica	blackgum	30%	3.8
Parthenocissus quinquefolia	Virginia creeper	95%	35.9
Prunus serotina	black cherry	65%	1.1
Quercus imbricaria	shingle oak	70%	0.7
Rosa multiflora	multiflora rose	75%	10.0
Rubus argutus	sawtooth blackberry	85%	14.6
Rubus occidentalis	black raspberry	30%	9.1
Sassafras albidum	sassafras	55%	3.0
Symphoricarpos orbiculatus	coralberry	85%	7.6
Toxicodendron radicans	eastern poison ivy	85%	17.6
Ulmus americana	American elm	50%	2.7
Ulmus rubra	slippery elm	60%	3.0
Vitis vulpina	frost grape	70%	1.0
Herbaceous Layer			
Ageratina altissima	white snakeroot	85%	1.4
Allium spp.	onion	50%	0.8
Ambrosia artemisiifolia	annual ragweed	30%	0.5
Ambrosia trifida	great ragweed	30%	0.5
Asplenium platyneuron	ebony spleenwort	80%	0.5
Barbarea vulgaris	garden yellowrocket	35%	0.5
Boehmeria cylindrica	smallspike false nettle	65%	1.1
Botrychium virginianum	rattlesnake fern	35%	0.5
Carex albicans	whitetinge sedge	30%	0.5
Carex blanda	eastern woodland sedge	85%	0.5
Carex hirsutella	fuzzy wuzzy sedge	65%	0.5
Clematis virginiana	devil's darning needles	65%	5.6
Commelina communis	Asiatic dayflower	40%	0.5
Desmodium paniculatum	panicledleaf ticktrefoil	55%	0.5
Elymus virginicus	Virginia wildrye	70%	0.9
Erigeron philadelphicus	Philadelphia fleabane	30%	0.5
Festuca subverticillata	nodding fescue	40%	1.4
Galium aparine	stickywilly	75%	1.8
Geum canadense	white avens	90%	4.0
Glyceria striata	fowl mannagrass	50%	0.8

Ruderal Forest			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Hackelia virginiana	beggarslice	40%	0.8
Impatiens spp.	touch-me-not	85%	1.8
Lactuca floridana	woodland lettuce	45%	0.5
Leersia virginica	whitegrass	60%	0.9
Microstegium vimineum	Nepalese browntop	40%	2.1
Muhlenbergia sobolifera	rock muhly	30%	0.9
Myosotis verna	spring forget-me-not	35%	0.5
Oxalis stricta	common yellow oxalis	45%	0.5
Phryma leptostachya	American lopseed	70%	0.5
Phytolacca americana	American pokeweed	50%	1.0
Pilea pumila	Canadian clearweed	60%	0.9
Poa pratensis	Kentucky bluegrass	30%	3.3
Polygonum cespitosum	Oriental lady's thumb	35%	2.9
Polygonum virginianum	jumpseed	90%	3.8
Polystichum acrostichoides	Christmas fern	40%	0.8
Pycnanthemum tenuifolium	narrowleaf mountainmint	45%	0.5
Ranunculus harveyi	Harvey's buttercup	30%	0.5
Sanicula canadensis	Canadian blacksnakeroot	60%	0.5
Solidago canadensis	Canada goldenrod	55%	1.0
Stellaria media	common chickweed	60%	2.1
Symphyotrichum lateriflorum	calico aster	40%	0.5
Verbena urticifolia	white vervain	65%	0.5
Verbesina alternifolia	wingstem	70%	0.5
Viola sororia	common blue violet	50%	0.5

Mapped Type Name: Ruderal Grassland

Macrogroup: M123. Eastern North American Ruderal Shrubland & Grassland
Group: G059. Northern & Central Ruderal Meadow & Shrubland Group
Association: None
Type Common Name: Ruderal Grassland
Type Scientific Name: *Schedonorus pratensis* - *Trifolium* spp. Herbaceous Vegetation

Figure 12. Ruderal Grassland at Lincoln Boyhood National Memorial.

Global Summary: This group circumscribes a wide variety of shrub or herb meadows in the northern and central regions of the eastern United States. Introduced grasses that have been planted or volunteer into old fields dominate this type, typically with goldenrod species (*Solidago* spp.) a major components. Shrubs may or may not be present, and generally account for less than 25% of the total cover. Common shrubs include dogwood species (*Cornus* spp.), sumac species (*Rhus* spp.), blackberries (*Rubus* spp.), and eastern redcedar. Non-native shrubs commonly include multiflora rose (*Rosa multiflora*), Japanese honeysuckle, and Russian olive (*Elaeagnus angustifolia*)(Figure 12).

Environmental Description: At LIBO, this type occupied a single, well-defined, fenced pasture that contained a small artificial pond. The land use rather than environmental variables controlled the distribution of the type.

Vegetation Description: This type was an open pasture dominated by two non-native species, meadow fescue (*Schedonorus pratensis*) and buffalo clover (*Trifolium reflexum*). Grazing tolerant species such as hairy woodland brome (*Bromus pubescens*), prairie fleabane (*Erigeron strigosus*), and blackseed plantain (*Plantago rugelii*) were also present (Table 8). The presence of small trees, including red maple and white ash, hint that, without continued active management, this patch would be invaded by woody species.

Most Abundant Species:

Table 8. Species that occurred in one or both plots within the Ruderal Grassland vegetation type.

Ruderal Grassland			
Scientific Name	**Common Name**	**Frequency**	**%Cover**
Shrub Layer			
Acer rubrum	red maple	50%	0.5
Fraxinus americana	white ash	50%	0.5
Rosa multiflora	multiflora rose	50%	0.5
Herbaceous Layer			
Achillea millefolium	yarrow	50%	0.5
Ambrosia artemisiifolia	annual ragweed	50%	3.0
Ambrosia bidentata	lanceleaf ragweed	50%	0.5
Andropogon virginicus	broomsedge bluestem	50%	3.0
Bromus pubescens	hairy woodland brome	100%	0.5
Carex squarrosa	squarrose sedge	50%	0.5
Dactylis glomerata	orchardgrass	50%	0.5
Erigeron strigosus	prairie fleabane	100%	0.5
Ipomoea pandurata	man of the earth	50%	0.5
Juncus tenuis	poverty rush	50%	3.0
Lactuca floridana	woodland lettuce	50%	0.5
Paspalum laeve	field paspalum	50%	0.5
Plantago rugelii	blackseed plantain	100%	1.8
Potentilla simplex	common cinquefoil	50%	3.0
Prunella vulgaris	common selfheal	100%	0.5
Schedonorus pratensis	meadow fescue	100%	50.0
Solanum carolinense	Carolina horsenettle	50%	0.5
Solidago canadensis	Canada goldenrod	50%	0.5
Trifolium pratense	red clover	100%	15.0
Trifolium reflexum	buffalo clover	100%	50.0
Verbena urticifolia	white vervain	50%	0.5
Vernonia gigantea	giant ironweed	100%	3.0

Mapped Type Name: Ruderal White Pine Woodland

Macrogroup: M013. Eastern North American Ruderal Forest & Plantation
Group: G032. Northern & Central Conifer & Hardwood Plantation Group
Association: CEGL006313
Type Common Name: Ruderal White Pine Woodland
Type Scientific Name: *Pinus strobus* Woodland

Global Summary: This group circumscribes a variety of plantations of all kinds. It includes uplands and wetlands, and conifer as well has hardwood plantations that are used for pulp or timber production. Commonly planted species include eastern white pine (*Pinus strobus*), jack pine (*Pinus banksiana*), red pine (*Pinus resinosa*), and Virginia pine (*Pinus virginiana*).

Environmental Description: At LIBO, this type was restricted to areas near the road on the southern boundary of the site. Human management determined the distribution of this type.

Vegetation Description**:** These were plantations of close-grown white pines in essentially mono-dominant stands.

Most Abundant Species:

No quantitative data were taken within this mapped type.

Discussion

Pavlovic and White (1989) found that LIBO was probably dominated by white oak and black oak prior to intensive clearing, based on examination of General Land Office survey notes. James (2011) found that sugar maple and red maple were canopy dominants, and flowering dogwood was the primary understory dominant based on sampling at four monitoring sites centered in the southeastern portion of the park. Peitz (2011) found 12 bird species of continental importance breeding within the park based on systematic surveys.

Using information from earlier workers, a rapid field survey, and historic air photos, we stratified samples across the park based largely on perceived forest age and, to a lesser extent, on perceived composition. Twenty plots placed in different aged successional or ruderal forests proved to be inseparable based on quantitative analysis of plot data. Composition differences between this Ruderal Forest versus the Restored Deciduous Forest and the more natural Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest were made apparent via the quantitative analyses. The latter two forests were composed of fairly large, tall, trees and had a generally open understory, which offers an aesthetically appealing aspect.

During the sampling efforts, a total of 216 taxa were recorded (Appendix E). Invasive species were abundant, especially within the Ruderal Forest vegetation type, and these have been documented by Cribbs et al. (2007). Japanese honeysuckle and multiflora rose were especially widespread and dominant in patches.

Field Survey

The Ruderal Forest vegetation type at LIBO will be quite dynamic over time. The successional path of this type over time is of interest, and monitoring seems appropriate.

NVC Classification

Quantitative data from the park may help in the description of ruderal types. The Ruderal Forest vegetation association at LIBO is not currently described in the National Vegetation Classification, nor is the Ruderal Grassland. These types may be a result of the unique history of the park, and may not represent often-encountered plant associations. Data on the Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest type simply adds to the information available on this association.

Digital Imagery and Interpretation

Both leaf-on and leaf-off imagery were available for the park and were used to develop map polygons. The use of leaf-on and leaf-off data helped ensure high quality results. Because the park was small, heads up digitizing was used to circumscribe polygons.

Accuracy Assessment

The high degree of thematic accuracy was made possible in part by the small size of LIBO and the limited number of natural vegetation classes identified within the park. The overall accuracy assessment, as well as the accuracy assessment of each mapped class exceeded the 80% level required by the NPS Vegetation Inventory Program. Further, the lower limit of the 90% confidence interval exceeded the programmatic requirement of 80% for each individual map

class accuracy assessment. All map classes were sampled according to Scenario E. Field staff was able to visit all polygons and assess thematic accuracy of all five mapped vegetation classes. For all vegetation map classes, the dichotomous key allowed for clear identification at the majority of points.

Future Recommendations

The largest type at LIBO is Ruderal Forest. The future composition of this type is not clear. Many native invasive species are contained within the type. Seedlings and saplings of native dominant oaks (e.g. black oak, white oak, northern red oak) were not recorded in plots. Thus, active management may be required for this type to succeed to a more natural forest type. Likewise, the Restored Deciduous Forest type may need active management to reduce invasive species and promote native trees. Native oaks were also not recorded in the shrub layer of this type. In contrast, the Black Oak-White Oak-(Pignut, Shagbark) Hickory Forest type has few non-native invasive species, and does have canopy oaks in the shrub layer. Active management to keep invasive species out of this forest patch seems appropriate.

Research Opportunities

Restoration of the Ruderal Forest type seems to offer the best opportunity for research. Establishment of native canopy trees and elimination of non-native invasive species will be a management challenge.

Literature Cited

Cribbs, J. T., C. C. Young, J. L. Haack, and H. J. Etheridge. 2007. Invasive exotic plant monitoring at Lincoln Boyhood National Memorial: Year 1 (2006). Natural Resource Technical Report NPS/HTLN/NRTR—2007/021. National Park Service, Fort Collins, Colorado.

Daubenmire, R. F. 1959. Canopy coverage method of vegetation analysis. Northwest Science 33:43-64.

Federal Geographic Data Committee (FGDC). 1998. Spatial data transfer standard, FGDC-STD-002 (modified version ANSI NCITS 20:1998). Available at http://www.fgdc.gov/standards/.

Federal Geographic Data Committee. 2008. National vegetation classification standards. FGDC-STD-005-2008. Available at http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/index_html.

Grossman D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, and others. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I, The National Vegetation Classification System: development, status, and applications. The Nature Conservancy: Arlington, VA. Available at http://www.natureserve.org/publications/library.jsp#nspubs.

James, K. M. 2011. Vegetation community monitoring at Lincoln Boyhood National Memorial, Indiana. Natural Resource Data Series NPS/HTLN/NRDS—2011/194. National Park Service, Fort Collins, Colorado.

Jennings, M. D., D. Faber-Langendoen, O. L. Loucks, R. K. Peet, and D. Roberts. 2009. Standards for Associations and alliances of the U.S. National Vegetation Classification. Ecological Monographs 79:173-199.

Lance, G. N., and W. T. Williams. 1967. A general theory of classificatory sorting strategies, 1. Hierarchical Systems. The Computer Journal 9: 373-380.

Lea, C. 2011. Vegetation classification guidelines: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/NRPC/NRR-2011/374. National Park Service, Fort Collins, Colorado.

Lea, C., and A. C. Curtis. 2010. Thematic accuracy assessment procedures: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/2010/NRR—2010/204. National Park Service, Fort Collins, Colorado.

Legendre, P., and L. Legendre. 1998. Numerical Ecology. 2nd English Edition. Elsevier Science B. V., Amsterdam. 853 pp.

Maechler, M., P. Rousseeuw, A. Struyf, M. Hubert, and K. Hornik. 2011. cluster: Cluster Analysis Basics and Extensions. R package version 1.14.1. http://CRAN.R-project.org/package=cluster

National Park Service. 2011. 12-step guidance for NPS vegetation inventories. Available at http://science.nature.nps.gov/im/inventory/veg/docs/Veg_Inv_12step_Guidance_v1.1.pdf.

National Park Service. 2011a. NPS vegetation inventory program final product specifications. Guidelines for creating final products. Available at http://science.nature.nps.gov/im/inventory/veg/docs/Product_Specifications.pdf

Natureserve. 2013. NatureServe Web Service. Arlington, VA. U.S.A. Available http://services.natureserve.org.

Pavlovic, N. B., and M. White. 1989. Forest restoration on Lincoln Boyhood National Memorial: Presettlement, existing vegetation, and restoration management recommendations. Research/Resources Management Report MWR-15. United States Department of the Interior, National Park Service, Midwest Region.

Peitz, D. G. 2011. Bird Community Monitoring at Lincoln Boyhood National Memorial, Indiana: Status report. Natural Resource Data Series NPS/HTLN/NRDS-2011/210. National Park Service, Fort Collins, Colorado.

Roberts, D. W. 2010. labdsv: Ordination and Multivariate Analysis for Ecology. R package version 1.4-1. http://CRAN.R-project.org/package=labdsv

The Nature Conservancy (TNC) and Environmental Systems Research Institute (ESRI). 1994. NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System. Prepared for the U.S. Department of the Interior, National Biological Survey and National Park Service. Washington, D.C.

The Nature Conservancy (TNC). 1996. Methodology for Assessing the Utility of Existing Data for Vegetation Mapping. Arlington, VA.

USDA and NRCS. 2009. The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Available at http://plants.usda.gov/java/.

U.S. Geological Survey (USGS). 1999. Map accuracy standards. Fact sheet FS-171-99 (November 1999). Web address: http://nationalmap.gov/standards/nmas.html.

Appendix A: Contingency Table for Vegetation Mapping of Lincoln Boyhood National Memorial.

	Reference Data (Accuracy Assessment Field Data)						User's Error			
Sample Data (Polygon Map Data)	Map Units	Ruderal Grassland	Restored Deciduous Forest	Black Oak - White Oak - Shagbark Hickory Forest	Ruderal White Pine Woodland	Ruderal Forest	Totals	Commission Accuracy	90% Conf. Interval	
									-	+
	Ruderal Grassland	**1**					1	100.0%	50.0%	100.0%
	Restored Deciduous Forest		**4**				4	100.0%	87.5%	100.0%
	Black Oak - White Oak - Shagbark Hickory Forest			**1**			1	100.0%	50.0%	100.0%
	Ruderal White Pine Woodland				**3**		3	100.0%	83.3%	100.0%
	Ruderal Forest					**5**	5	100.0%	90.0%	100.0%
	Totals	1	4	1	3	5				
Producer's Error	Omission Accuracy	100.0%	100.0%	100.0%	100.0%	100.0%	**14 Total Correct Points**			
	90% Conf. -	100.0%	100.0%	100.0%	100.0%	100.0%	**14 Total Points**			
	Level +	100.0%	100.0%	100.0%	100.0%	100.0%				
Overall Total Accuracy = 100%	**Overall Kappa Index =100%**			**Overall 90% Upper and Lower Confidence Interval =100% and 100%**						

Accuracy Assessment Contingency Table:

The contingency table combines the sample contingency and population contingency tables in which rows represent the map classes from the vegetation map and columns are the map classes determined in the field. The shaded areas display the number of accuracy assessment points where the field determination of the map class agrees with the vegetation map. Disagreement between field data (columns) and map data result in producer's error (omission error). Conversely, disagreement between map data (rows) and field data reflect user's error (errors of commission). Both types of error are reported in terms of accuracy (100% indicates no errors) and a corresponding 90% confidence interval. The total number of correct points out of the total number of accuracy assessment points (shaded diagonal values) provides the degree to which map classes were interpreted correctly. The Kappa Index is an index that accounts for chance agreement in the contingency table.

Appendix B: Example of Plot Survey Form

NPS VEGETATION MAPPING PROGRAM – PLOT SURVEY FORM
PLOT LOCATION AND DESCRIPTION

Plot Code _____ Surveyors _____
Date _____

Plot Directions

_____

Plot Dimensions _____ by _____ m Photos (y/n) _____
Provisional Community Name

_____

Relative Stand Size extensive (>100x plot), large (>10-100x plot), small (3-10x plot), very small (1-3x plot), unknown
Representativeness

_____
_____
_____

Landform (circle) interfluve, gap/saddle, side slope, terrace/bench flat plain

Topographic Position (circle) crest, upper slope, middle slope, lower slope, toe slope, plain/level/bottom, basin/depression

Hydrologic Regime ___Upland ___Permanently flooded ___Semipermanently flooded ___Seasonally/Temporarily flooded ___Unknown

Plot Shape (circle) concave convex flat irregular
General Comments

_____
_____
_____

Plot Code _____

NPS VEGETATION MAPPING PROGRAM – PLOT SURVEY FORM
VEGETATION SAMPLING

Leaf Phenology	Leaf type	Physiognomic Class
____Deciduous (<25% evergreen)	____Broadleaf	____Forest
____Evergreen (<25% deciduous)	____Needleleaf	____Woodland
____Mixed deciduous/evergreen	____Mixed	____Sparse woodland
____Perennial graminoid	____Graminoid	____Shrubland
____Perennial forb	____Forb	____Sparse shrubland
____Perennial mixed	____Pteridophyte	____Herbaceous
____Annual herbaceous	____Non-vascular	____Sparse vegetation

Strata	%Cover (1=<1%, 2=1-5%, 3=5-25%, 4=25-50%, 5=50-75%, 6=75-95%, 7=95-100%)
T1 Emergent >30m	_____
T2 Tree Canopy 20-30m	_____
T3 Tree Subcanopy 5-20m	_____
S1 Tall Shrub 1-5m	_____
S2 Short Shrub <1m	_____
H Herbaceous	_____

SPECIES COMPOSITION AND COVER CLASS BY STRATUM
%Cover (1=<1%, 2=1-5%, 3=5-25%, 4=25-50%, 5=50-75%, 6=75-95%, 7=95-100%)

T1	T2	T3	S1	S2	H	Species	Comments

Plot Code ___________

T1	T2	T3	S1	S2	H	Species	Comments

Appendix C: Lincoln Boyhood National Memorial Dichotomous Key to Mapped Current Vegetation Types

1a. Vegetation dominated by grasses and forbs, without a tree canopy >3 m tall ....**Ruderal Grassland**

1b. Vegetation dominated by trees >3 m tall **2**

2a. White pine (*Pinus strobus*) among the important trees.....**Ruderal White Pine Woodland**

2b. White pine (*Pinus strobus*) not among the important trees **3**

3a. Vegetation dominated by a combination of mature black oak (*Quercus velutina*) and white oak (*Quercus alba*) trees..... **Black Oak – White Oak – Shagbark Hickory Forest**

3b. Vegetation not dominated by a combination of mature black oak (*Quercus velutina*) and white oak (*Quercus alba*) trees..... **4**

4a. Vegetation dominated by sugar maple (*Acer saccharum*), or if not, neither red maple (*Acer rubrum*) nor American sycamore (*Platanus occidentalis*) among the dominant trees..... **Restored Deciduous Forest**

4b. Vegetation with some combination of red maple (*Acer rubrum*), American elm (*Ulmus americana*), sweetgum (*Liquidambar styraciflua*), or American sycamore (*Platanus occidentalis*) among the dominant trees; lacking sugar maple (*Acer saccharum*) among the dominants.....**Ruderal Forest**

Appendix D: Example of Accuracy Assessment Form

Accuracy Assessment Form

NPS Vegetation Inventory

PLOT (WAYPOINT) #:_____ 2. DATE:_____

OBSERVER (DETERMING ASSOCIATION) _____

Observer (assisting) _____

ACCURACY OF NAVIGATION (METERS) _____

How Determined: _____

UTM EASTING: _____ 8. UTM: _____

9. UTM Zone: _____ 10. Datum: _____

11. If GPS Position is an intentional offset from the waypoint, circle the explanation:

a.) Mosaicing scenario (too heterogeneous to key because of two or more clearly distinct types within observation area)

b.) Physical constraints in reaching waypoint

c.) Other (explain as needed):_____

_____

_____

12. VEGETATION ASSOCIATION (Primary call): _____

_____

13. Other possible associations (complexing scenario) (if applicable): _____

_____

14. Explanation for # 13 (if applicable): _____

_____

Appendix E: Species List for Lincoln Boyhood National Memorial

Family	Scientific Name	Common Name
Acanthaceae	*Ruellia caroliniensis*	Carolina wild petunia
Aceraceae	*Acer negundo*	boxelder
	Acer rubrum	red maple
	Acer saccharum	sugar maple
Anacardiaceae	*Toxicodendron radicans*	eastern poison ivy
Apiaceae	*Cryptotaenia canadensis*	Canadian honewort
	Osmorhiza claytonii	Clayton's sweetroot
	Sanicula canadensis	Canadian blacksnakeroot
Apocynaceae	*Apocynum cannabinum*	Indianhemp
	Vinca minor	common periwinkle
Araceae	*Arisaema dracontium*	green dragon
	Arisaema triphyllum	Jack in the pulpit
Araliaceae	*Aralia spinosa*	devil's walkingstick
Aristolochiaceae	*Aristolochia serpentaria*	Virginia snakeroot
Asclepiadaceae	*Asclepias syriaca*	common milkweed
Aspleniaceae	*Asplenium platyneuron*	ebony spleenwort
Asteraceae	*Achillea millefolium*	common yarrow
	Ageratina altissima	white snakeroot
	Ambrosia artemisiifolia	annual ragweed
	Ambrosia bidentata	lanceleaf ragweed
	Ambrosia trifida	great ragweed
	Antennaria neglecta	field pussytoes
	Arnoglossum atriplicifolium	pale Indian plantain
	Bidens bipinnata	Spanish needles
	Elephantopus carolinianus	Carolina elephantsfoot
	Erechtites hieraciifolia	American burnweed
	Erigeron philadelphicus	Philadelphia fleabane
	Erigeron strigosus	prairie fleabane
	Eupatorium perfoliatum	common boneset
	Eupatorium serotinum	lateflowering thoroughwort
	Lactuca floridana	woodland lettuce
	Packera aurea	golden ragwort
	Solidago canadensis	Canada goldenrod
	Solidago hispida	hairy goldenrod
	Solidago ulmifolia	elmleaf goldenrod
	Symphyotrichum laeve	smooth blue aster
	Symphyotrichum lateriflorum var. lateriflorum	calico aster

Family	Scientific Name	Common Name
Asteraceae	*Taraxacum officinale*	common dandelion
	Verbesina alternifolia	wingstem
	Vernonia gigantea	giant ironweed
Berberidaceae	*Podophyllum peltatum*	mayapple
Betulaceae	*Betula nigra*	river birch
	Corylus americana	American hazelnut
	Ostrya virginiana	hophornbeam
Bignoniaceae	*Campsis radicans*	trumpet creeper
	Catalpa speciosa	northern catalpa
Boraginaceae	*Hackelia virginiana*	beggarslice
	Myosotis verna	spring forget-me-not
Brassicaceae	*Arabis laevigata*	smooth rockcress
	Barbarea vulgaris	garden yellowrocket
Campanulaceae	*Campanulastrum americanum*	American bellflower
	Lobelia inflata	Indian-tobacco
	Triodanis perfoliata	clasping Venus' looking-glass
Caprifoliaceae	*Lonicera japonica*	Japanese honeysuckle
	Lonicera maackii	Amur honeysuckle
	Sambucus nigra ssp. canadensis	American black elderberry
	Symphoricarpos orbiculatus	coralberry
	Triosteum perfoliatum	feverwort
	Viburnum dentatum	southern arrowwood
	Viburnum prunifolium	blackhaw
Caryophyllaceae	*Stellaria media*	common chickweed
Celastraceae	*Celastrus scandens*	American bittersweet
	Euonymus alatus	burningbush
	Euonymus americanus	bursting-heart
	Euonymus fortunei	winter creeper
Clusiaceae	*Hypericum prolificum*	shrubby St. Johnswort
	Hypericum punctatum	spotted St. Johnswort
	Hypericum virgatum	sharpleaf St. Johnswort
Commelinaceae	*Commelina communis*	Asiatic dayflower
Convolvulaceae	*Ipomoea pandurata*	man of the earth
Cornaceae	*Cornus florida*	flowering dogwood
	Nyssa sylvatica	blackgum
Cupressaceae	*Juniperus virginiana*	eastern redcedar
Cyperaceae	*Carex*	sedge
	Carex albicans var. albicans	whitetinge sedge
	Carex amphibola	eastern narrowleaf sedge
	Carex blanda	eastern woodland sedge

Family	Scientific Name	Common Name
Cyperaceae	*Carex cephalophora*	oval-leaf sedge
	Carex hirsutella	fuzzy wuzzy sedge
	Carex jamesii	James' sedge
	Carex retroflexa	reflexed sedge
	Carex rosea	rosy sedge
	Carex squarrosa	squarrose sedge
	Scirpus atrovirens	green bulrush
Dioscoreaceae	*Dioscorea quaternata*	fourleaf yam
Dryopteridaceae	*Onoclea sensibilis*	sensitive fern
	Polystichum acrostichoides	Christmas fern
	Woodsia obtusa	bluntlobe cliff fern
Ebenaceae	*Diospyros virginiana*	common persimmon
Elaeagnaceae	*Elaeagnus umbellata*	autumn olive
Euphorbiaceae	*Acalypha rhomboidea*	common threeseed mercury
	Acalypha virginica	Virginia threeseed mercury
Fabaceae	*Amphicarpaea bracteata*	American hogpeanut
	Cercis canadensis	eastern redbud
	Desmodium canescens	hoary ticktrefoil
	Desmodium glabellum	Dillenius' ticktrefoil
	Desmodium paniculatum	panicledleaf ticktrefoil
	Gleditsia triacanthos	honeylocust
	Lespedeza cuneata	sericea lespedeza
	Melilotus officinalis	sweetclover
	Robinia pseudoacacia	black locust
	Trifolium pratense	red clover
	Trifolium reflexum	buffalo clover
Fagaceae	*Quercus alba*	white oak
	Quercus bicolor	swamp white oak
	Quercus imbricaria	shingle oak
	Quercus muehlenbergii	chinkapin oak
	Quercus rubra	northern red oak
	Quercus velutina	black oak
Fumariaceae	*Corydalis flavula*	yellow fumewort
Geraniaceae	*Geranium carolinianum*	Carolina geranium
Hamamelidaceae	*Liquidambar styraciflua*	sweetgum
Iridaceae	*Iris cristata*	dwarf crested iris
	Sisyrinchium albidum	white blue-eyed grass
Juglandaceae	*Carya alba*	mockernut hickory
	Carya cordiformis	bitternut hickory
	Carya glabra	pignut hickory

Family	Scientific Name	Common Name
Juglandaceae	*Carya illinoinensis*	pecan
	Carya laciniosa	shellbark hickory
	Carya ovata	shagbark hickory
	Juglans nigra	black walnut
Juncaceae	*Juncus tenuis*	poverty rush
Lamiaceae	*Agastache nepetoides*	yellow giant hyssop
	Perilla frutescens	beefsteakplant
	Prunella vulgaris	common selfheal
	Pycnanthemum tenuifolium	narrowleaf mountainmint
	Salvia lyrata	lyreleaf sage
Lauraceae	*Lindera benzoin*	northern spicebush
	Sassafras albidum	sassafras
Liliaceae	*Hemerocallis fulva*	orange daylily
	Maianthemum racemosum ssp. racemosum	feathery false lily of the valley
	Narcissus	daffodil
Magnoliaceae	*Liriodendron tulipifera*	tuliptree
Malvaceae	*Hibiscus syriacus*	rose of Sharon
Moraceae	*Morus rubra*	red mulberry
Oleaceae	*Fraxinus americana*	white ash
	Ligustrum vulgare	European privet
Onagraceae	*Circaea lutetiana ssp. canadensis*	broadleaf enchanter's nightshade
Ophioglossaceae	*Botrychium virginianum*	rattlesnake fern
Orchidaceae	*Liparis liliifolia*	brown widelip orchid
Oxalidaceae	*Oxalis stricta*	common yellow oxalis
Passifloraceae	*Passiflora lutea*	yellow passionflower
Phytolaccaceae	*Phytolacca americana*	American pokeweed
Pinaceae	*Pinus strobus*	eastern white pine
Plantaginaceae	*Plantago rugelii*	blackseed plantain
Platanaceae	*Platanus occidentalis*	American sycamore
Poaceae	*Andropogon virginicus*	broomsedge bluestem
	Bromus pubescens	hairy woodland brome
	Chasmanthium latifolium	Indian woodoats
	Cinna arundinacea	sweet woodreed
	Dactylis glomerata	orchardgrass
	Danthonia spicata	poverty oatgrass
	Diarrhena americana	American beakgrain
	Dichanthelium clandestinum	deertongue
	Dichanthelium dichotomum	cypress panicgrass

Family	Scientific Name	Common Name
Poaceae	*Elymus virginicus*	Virginia wildrye
	Festuca subverticillata	nodding fescue
	Glyceria striata	fowl mannagrass
	Leersia virginica	whitegrass
	Microstegium vimineum	Nepalese browntop
	Muhlenbergia schreberi	nimblewill
	Muhlenbergia sobolifera	rock muhly
	Paspalum laeve	field paspalum
	Poa pratensis	Kentucky bluegrass
	Poa sylvestris	woodland bluegrass
	Schedonorus pratensis	meadow fescue
Polemoniaceae	*Phlox paniculata*	fall phlox
Polygonaceae	*Polygonum cespitosum*	Oriental lady's thumb
	Polygonum virginianum	jumpseed
	Rumex crispus	curly dock
Portulacaceae	*Claytonia virginica*	Virginia springbeauty
Primulaceae	*Lysimachia nummularia*	creeping jenny
Ranunculaceae	*Anemone virginiana*	tall thimbleweed
	Clematis virginiana	devil's darning needles
	Ranunculus harveyi	Harvey's buttercup
	Ranunculus recurvatus	blisterwort
	Thalictrum thalictroides	rue anemone
Rosaceae	*Agrimonia parviflora*	harvestlice
	Agrimonia rostellata	beaked agrimony
	Crataegus	hawthorn
	Geum canadense	white avens
	Geum vernum	spring avens
	Malus coronaria	sweet crab apple
	Potentilla simplex	common cinquefoil
	Prunus serotina	black cherry
	Prunus virginiana	chokecherry
	Rosa multiflora	multiflora rose
	Rubus argutus	sawtooth blackberry
	Rubus occidentalis	black raspberry
Rubiaceae	*Galium aparine*	stickywilly
	Galium circaezans	licorice bedstraw
	Galium triflorum	fragrant bedstraw
Scrophulariaceae	*Veronica arvensis*	corn speedwell
Smilacaceae	*Smilax glauca*	cat greenbrier
	Smilax tamnoides	bristly greenbrier

Family	Scientific Name	Common Name
Solanaceae	*Physalis virginiana*	Virginia groundcherry
	Solanum carolinense	Carolina horsenettle
Thelypteridaceae	*Phegopteris hexagonoptera*	broad beechfern
Tiliaceae	*Tilia americana*	American basswood
Ulmaceae	*Celtis laevigata*	sugarberry
	Celtis occidentalis	common hackberry
	Ulmus alata	winged elm
	Ulmus americana	American elm
	Ulmus rubra	slippery elm
Urticaceae	*Boehmeria cylindrica*	smallspike false nettle
	Parietaria pensylvanica	Pennsylvania pellitory
	Pilea pumila	Canadian clearweed
Valerianaceae	*Valerianella radiata*	beaked cornsalad
Verbenaceae	*Phryma leptostachya*	American lopseed
	Verbena urticifolia	white vervain
Violaceae	*Viola pubescens var. pubescens*	downy yellow violet
	Viola sororia	common blue violet
Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper
	Vitis aestivalis	summer grape
	Vitis vulpina	frost grape

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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