Accuracy Assessment:
Ninety Six National Historic Site

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Executive Summary

This report presents an accuracy assessment of the digital vegetation map of the Ninety-Six National Historic Site (NISI). Vegetation as NISI was mapped by The University of Georgia Center for Remote Sensing and Mapping Science (UGA) with ecological consultation assistance from NatureServe. The mapping was conducted as part of the National Park Service vegetation mapping program.

The map accuracy was assessed by comparing the mapped vegetation type to the field-verified vegetation type at evaluation points chosen prior to field work to represent the full range of map classes in the park in a statistically valid manner. Accuracy was calculated for each individual map class as well as for all map classes combined.

It is very important to understand that the accuracy assessment process is not meant to judge the performance of the mapper or the ecologists on the project. Even the best mappers cannot tell the difference remotely between certain species of oaks or pines. It is also important to realize the sources of error include not just "remote sensing error" but also "ecologist error" caused by poor interpretation of the vegetation community concept and "field worker error" caused by mistakes made by fieldworkers while collecting the data (including misreading of the key). However, it is impossible to tease apart which of these errors is causing accuracy issues without more research. The accuracy assessment, therefore, should be used more as a tool to discern usability of map classes rather than a way to judge the performance of the mapmakers.

In an attempt to provide the most useful information possible to NPS, the University of Georgia (UGA) Team has made a strong effort to pull out the highest level of detail possible when mapping vegetation of parks. As a consequence, assessment of the finished project requires a two step approach: assessing the overall accuracy of the finest scale map produced and then combining the most "confused" map classes and determining the accuracy of the coarser scale but more pragmatic map. In this way, we are able to report our best approximation of how accurate each individual map class is *but also* suggest a way to combine certain map classes to produce a more reliable map at a coarser scale. We have summarized the two "steps" below:

1) The overall accuracy of the NISI map at its finest scale is 74%, with a kappa statistic of 0.70 (70%). This number compares favorably to map accuracies at other small parks, including Fort Necessity National Battlefield (70% accuracy), Carl Sandburg Home National Historic Site (71% accuracy), and Rock Creek Park (77% accuracy). A stricter interpretation of map classes at NISI, which considers only the dominant mapped vegetation, gives an overall accuracy of 66% with a kappa statistic of 0.62 (62%).
2) If some commonly confused map classes are combined, the overall accuracy of the map rises to 80% with a kappa statistic of 0.77 (77%). Eighty percent accuracy is achieved when interior southern red oak – white oak forest is grouped together with water oak forest and sweetgum forest is grouped together with southeastern coastal plain flat terrace forest.

Key finding:

For users interested in preserving the full detail of the map for the purpose of highly detailed studies or management of the landscape, we recommend use of the map as published by UGA. For all other users, we recommend combining map classes as specified above to allow for an overall map accuracy above 80%. These actions will allow for a map that is useful for the widest audience possible while not losing potentially important fine scale detail.

Introduction

In an effort to catalog and map the biodiversity of the United States, in 1994 the National Park Service (NPS) and the U.S. Geological Survey (USGS) embarked on a collaborative Vegetative Mapping project with the goal of mapping 230+ national park units (ESRI et al. 1994). As part of this national mapping initiative, a digital vegetation map of the Ninety-Six National Historic Site (NISI) was created in 2003 by the University of Georgia Center for Remote Sensing and Mapping Science in consultation with NatureServe.

NISI is located two miles south of the town of Ninety Six, South Carolina in Greenwood County. The park contains 989.14 acres (approximately 400 hectares) of land including forest, fields, and riparian areas. Vegetation at NISI was mapped and classified to the association level using the United States National Vegetation Classification (Grossman et al. 1998), following NPS guidelines. The minimum mapping unit (MMU) was 0.5 hectare. This document contains the results of an accuracy assessment performed on that map.

The accuracy assessment assigns a measure of validity to the map product and allows users to understand the reliability with which the mapped vegetation classes capture conditions on the ground. Knowing the accuracy of the map will enable potential users to determine the suitability of the map for any particular application (ESRI et al. 1994). This report describes the methods used in the accuracy assessment, and the results for each map class.

Methods

The thematic accuracy of the map was assessed by comparing the vegetation type shown on the map to the vegetation type identified on the ground for a representative sample of evaluation points. When polygons representing vegetation types are mapped and labeled with the correct community types, then the map has high thematic accuracy.

For each map class, both producers' and users' accuracy are evaluated. Users' accuracy indicates the probability that a sample point mapped as a given vegetation type will be shown to be of that type on the ground. Producers' accuracy indicates the probability that a sample point classified as a given vegetation type on the ground will have been assigned to that association on the map. In addition to the users' and producers' accuracy, measures of the overall map accuracy are calculated, and contingency tables showing the frequency of confusion (i.e. misclassification) between associations are presented.

Point Selection

A point-based approach was used to assess the accuracy of the map classes, with one or more evaluation points representing each map class. The map represents vegetation types using one or more polygons per type. Points were selected from within those polygons using a stratified random sampling design, so that points were distributed across all map classes with a higher number or points placed within map classes with large areas. Because representative points, not entire polygons, were evaluated, the assessment results should be interpreted as a measure of the accuracy of the overall map class, rather than an assessment of whether whole polygons were classified correctly.

In the mapping process, UGA assigned a dominant vegetation association for each polygon. Many polygons were also assigned secondary and/or tertiary association where ecotones, inclusions smaller than the minimum mapping unit, active succession, or blended vegetation types made assignment to one association unrepresentative of the situation on the ground. For the selection of evaluation points, only the dominant vegetation type was considered. The number of required points for each dominant vegetation type was determined based on differences in predominance and overall size of each type at the park (Environmental Systems Research Institute et al. 1994). The locations of the evaluation points were then selected using the GIS extension "Simple Random Sampling 1.0". Points were specifically excluded from a 12 meter internal buffer around the boundary of each polygon to avoid ecotones and potential misclassification due to GPS error in the field. Points were prevented from being placed in polygons smaller than 0.045 hectares (452 square meters) because of the potential that GPS error could lead field crews to record data for an area outside the mapped class. A distance of at least 80 meters was maintained between adjacent points to prevent overlap in the area evaluated around each point.

Field Data Collection

A field crew visited each evaluation point and assessed vegetation in a 15 meter radius surrounding each point. Points were located using either a WAAS enabled Garmin 5 GPS unit, or a Garmin 5 differential GPS unit. GPS accuracy recorded in the field ranged from 1 to 8 meters.

At each point, the field crew determined whether the association in which the point fell encompassed at least one MMU of 0.5 hectare. Unless the point had been flagged prior to sampling as one located in a polygon smaller than the MMU, if the area occupied by the association was smaller than the MMU, the point was understood to be in an inclusion. In these instances, the crew would shift their position so that they were within the closest community to the original point that occupied at least one MMU. The coordinates of this location were recorded as a new point and another form was filled out.

When collecting the data for the thematic accuracy points, the vegetation was considered in an approximately 15 meter radius circle around each point. The height range and percent cover of each stratum was collected. Only the dominant and diagnostic species were recorded in each stratum. The primary association type at that point was determined by the field crew using a key to the ecological and human influenced communities at NISI that was modified specifically for use in the accuracy assessment (Attachment A). At some points, a secondary association was also recorded, and notes were taken on any difficulties keying out the point. Environmental attributes of the area surrounding the point were also recorded.

A total of 137 data points with field data were used for the assessment of thematic accuracy. Data from three points was not included in the evaluation because the field crew attributed them to vegetation classes not included on the key.

Data Analysis

Data analysis for the accuracy assessment consisted of creation of contingency tables which summarize misclassification rates for each vegetation type, calculation of users and producers accuracy for each vegetation type, and evaluation of the overall accuracy of the map using the kappa statistic (Cohen 1960). The data was analyzed for two scenarios. The first scenario considered a point as correctly classified if the dominant, secondary, or tertiary vegetation type assigned to the map matched the observed value on the ground. The second scenario considered a point a match only if the dominant vegetation type assigned to the map matched the observed type. If questions arose with regard to the proper assignment of a point to a map class, the supplemental notes and environmental data recorded by the field crew were also considered.

A contingency table (also called a confusion matrix) was constructed for each scenario. This table lists sample data (i.e. mapped values) as rows and reference data (i.e. the type observed in the field) as columns. An example of a contingency table is presented below (Table 1). Cell values equal the number of points mapped or field-verified as belonging to that type, with numbers along the diagonal representing correctly classified points and all others cells representing misclassifications. In this example, four of the five evaluation points mapped as belonging to Class B were mapped correctly, while the fifth point was found to belong to Class D in the field. In addition, the field crew identified two evaluation points that were mapped as Class C but were shown to belong in Class B in the field. Examining the contingency table in this manner allows the users to discern patterns in misclassifications between classes.

Table 1. A sample contingency table with shaded cells representing correctly classified points.

		Observed as:				Row Totals
		A	B	C	D	
Mapped as:	A	5	0	0	0	5
	B	0	4	0	1	5
	C	0	2	8	0	10
	D	0	0	3	2	5
Column Totals		5	6	11	3	25

Users' and producers' accuracy were derived from the values in the contingency table. Producers' accuracy, or (1 - errors of omission), is calculated by dividing the number of correctly classified points for a map class by the total number of points determined to belong to that class in the field (i.e. the column total). In our example, the producers' accuracy for Class B is 4 divided by 6, or 67 percent.

Users' accuracy is determined by dividing the number of correctly classified points in one map class by the total number of evaluation points originally generated for that class (i.e. the row total). In our example, the users' accuracy for Class B is 4 divided by 5, or 80 percent. The users' accuracy is equal to (1 - errors or commission).
Ninety percent confidence intervals for both producers' and users' accuracy were determined for each map class with the use of the binomial distribution equation:

$$p \pm \left\{ t_{(\alpha,\, n-1)} \sqrt{\frac{p(1-p)}{n}} + \frac{1}{(2n)} \right\}$$

where p is either the users' or producers' accuracy, t is the t-score for α, which is 0.1 for a 90% confidence interval, and n is the sample size. Confidence intervals were only generated for map units with a sample size greater than two because one or two samples do not provide enough information to produce meaningful intervals.

Overall map accuracy was determined by dividing the number of correct points by the total number of points assessed. A Kappa index, which takes into account that some polygons are correctly classified by chance (Environmental Systems Research Institute et al. 1994, Foody 1992), was also calculated.

Results

The overall accuracy of the map when a match with either the dominant vegetation, secondary vegetation, or tertiary vegetation attribute is considered correct is 74%, with a kappa statistic of 0.70. The contingency table for this scenario, along with a tabulation of users' and producers' accuracy, is provided in Appendix B. Users' and producers' accuracy, with 90 percent upper confidence intervals, is summarized on Figure 2.

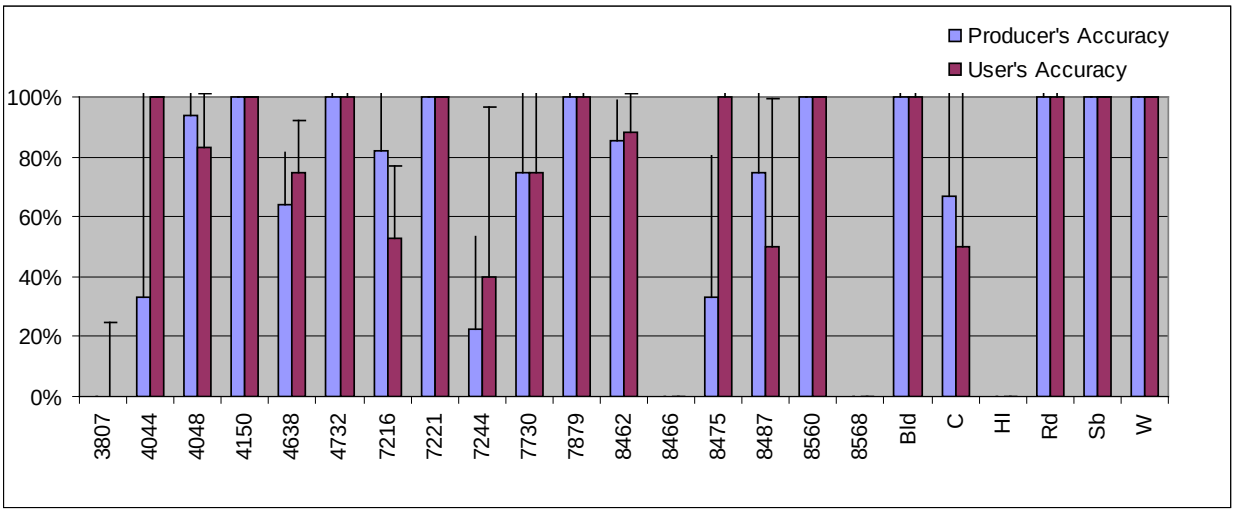

Figure 1. Users' and producers' accuracy when an evaluation point is considered correct if the association identified on the ground matches either the dominant vegetation, secondary vegetation, or tertiary vegetation map attribute. Error bars show the upper 90 percent confidence interval. The four digit codes are derived from the last four digits of the NatureServe global database codes for the U.S. National Vegetation Classification associations that begin with "CEGL00…".

The overall accuracy when only the dominant vegetation attribute of the vegetation map is considered is 66%, with a kappa statistic of 0.62. The contingency table for this scenario, along with a tabulation of users' and producers' accuracy, is provided in Appendix B. Users' and producers' accuracy, with 90 percent upper confidence intervals, is summarized on Figure 1. Several map classes, including CEGL003807 (Chinese Privet Upland Shrubland), CEGL008466 (Piedmont Basic Mesic Mixed Hardwood Forest), CEGL008568 (Wisteria Vineland), and HI (Human Influenced: old or present homesite) had zero percent accuracy because no vegetation of that type was observed at the evaluation points in the field. For each of these map classes, fewer than three points mapped as the class were visited; it is likely that all three types occur as inclusions less than the size of minimum mapping unit.

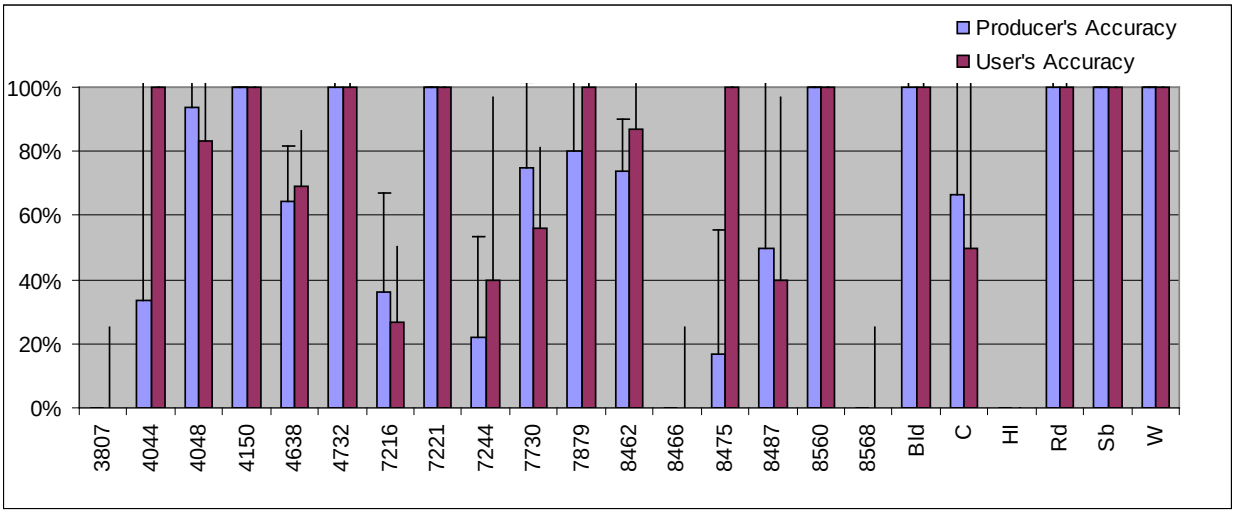

Figure 2. Users' and producers' accuracy when only the mapped dominant vegetation is considered. Error bars represent the upper 90 percent confidence interval.

It is apparent from a comparison of figures 1 and 2 that the users' and producers' accuracy of several classes is considerable higher when the secondary and tertiary vegetation is considered in addition to the dominant mapped vegetation. These include CEGL007216 (Sweetgum Forest), CEGL007330 (Southeastern Coastal Plain Flat Terrace Forest), CEGL007879 (Successional Black Walnut Forest), CEGL008462 (Successional Loblolly Pine – Sweetgum Forest), and CEGL008487 (Southern Piedmont Oak Bottomland Forest).

The accuracy of the map is higher still, with an overall 80% accuracy rate (kappa = 0.77), when some commonly confused classes are combined. Eighty percent accuracy is achieved when CEGL007244 (Interior Southern Red Oak – White Oak Forest) is grouped together with CEGL004638 (Water Oak Forest) and CEGL007216 (Sweetgum Forest) is grouped together with CEGL007730 (Southeastern Coastal Plain Flat Terrace Forest). Table B-5 of Appendix B shows the users' and producers' accuracy under this combined scenario.

Discussion

Overall, accuracy of the NISI vegetation map was within acceptable limits and common vegetation classes had high users' and producers' accuracy. When the dominant, secondary, and

tertiary vegetation attributes were considered, the 90 percent confidence interval for producers' accuracy was above the 80 percent threshold for18 of the 23 map classes. The results for users' accuracy were similar. The confidence intervals were often large due to the small sample sizes, so some caution is warranted in considering the results of this assessment. However, the high overall map accuracy lends credence to the validity of the results.

Several classes had zero percent accuracy, and thus users should be very cautious in interpreting areas mapped as belonging to those classes. It should be noted however, that all classes with very low accuracy occupied only a small area of the total park, and the low accuracy recorded may be an artifact of the small sample size (≤ 2) for these map classes, as well as the inherent difficulty of mapping types that often occur in patches smaller than the minimum mapping unit. Two of the four map classes with low accuracy are communities dominated by exotic species (CEGL008568 and GEGL003807) and it is possible that management activities altered the groundcover between mapping and ground-truthing. These classes reduced the overall accuracy of the map.

While the accuracy assessment is intended to provide a measure of the reliability of the map classes, the reader should be aware that error is also inherent in the field assessment of evaluation points. The recorded overall accuracy and users' and producers' accuracy of individual map classes may be affected by GPS error, data collection error by the field crew, poorly built classification keys, poor ecological community concepts, and inconsistent interpretation of the classification key. Two or more community types could be similar enough that one could be mistakenly assigned by a field crew to a particular community type when another community type was assigned by the map producers (Townsend 2000). Points may fall into ecotones or into inclusions within the larger community type and the resulting classification in the field may not be the same as that on the map. While measures were taken to reduce these errors, they are not altogether avoidable and it is not within the scope of this project to discern what mistakes led to errors. **However, it is important to note that mapping error is but one of many types of error that combine to create accuracy issues with any given map.**

Users of the NISI digital vegetation map should familiarize themselves with the results of this accuracy assessment, and particularly the contingency tables provided in Appendix B. When interested in using the map to locate a particular association, it is useful to know what other map classes have been shown to contain points matching that association, and what other vegetation types the mapped association of interest in likely to contain.

We recommend that natural resource managers consider lumping some commonly confused map classes together for display or other purposes. The results of the accuracy assessment indicate that CEGL007244 (Interior Southern Red Oak – White Oak Forest) and CEGL004638 (Water Oak Forest) were difficult for the mappers to distinguish from one another and may best be displayed as a combined mapped class. Likewise, CEGL007216 (Sweetgum Forest) and CEGL007730 (Southeastern Coastal Plain Flat Terrace Forest) were often confused, and may best be displayed as a combined class. For casual map users and general display purposes, use of the higher-accuracy map which includes these lumped classes will be most useful.
For researchers and managers interested in fine-scale detail and rare vegetation types, a version of the map that preserves the full detail as published by UGA should be maintained. This more detailed version of the map, while less accurate for some map classes, contains valuable

information for those interested in locating vegetation types that are inherently difficult to map. Used in conjunction with the results of this accuracy assessment, the original map provides the best tool available for understanding the spatial distribution of vegetation types at NISI.

Key Findings:

For users interested in preserving the full detail of the map for the purpose of highly detailed studies or management of the landscape, we recommend use of the NISI map as published by UGA. The overall accuracy of the this map at its finest scale is 74%, with a kappa statistic of 0.70 (70%). A stricter interpretation of this map, which considers only the dominant mapped vegetation, gives an overall accuracy of 66% with a kappa statistic of 0.62 (62%).

For all other users, we recommend combining the following map classes to allow for an overall map accuracy above 80%. These actions will allow for a map that is useful for the widest audience possible while not losing potentially important fine scale detail.

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Appendix A
Classification Key for Field Identification of Evaluation Points

Ninety-Six National Historic Park
Accuracy Assessment

Key to Ecological and Human Influenced Communities of Ninety-six: Modified for AA

A. Area is clearly influenced by human activity
   a. physical artifacts usually present
      i. old or present homesite
         Human influence (HI)
      ii. old fort
         Fort (F)
      iii. building
         Building (Bld)
      iv. road
         Road (Rd)
      v. well
         Well (Well)
      vi. pond or lake (also see wetlands system part of key below- may contain association)
         Water (W)
   b. vegetation previously planted
      a. may be fencerow or hedges or pecan orchards (*Carya illinoinensis)*. Commonly contains *Celtis laevigata* (hackberry/sugarberry)
         Culturally Modified Vegetation (C)
   c. Vegetation otherwise – See below

A. Early successional or exotic species dominated forests, shrublands, and fields (<50 years since last major disturbance). These communities are generally dominated by one or two species in the dominant strata (for instance, all loblolly pine) and are generally not very species diverse. Most of the trees or shrubs in the stands are even aged, evidence that they all were generated from one stand-destroying event in the past, such as plowing and agriculture or clear cutting.

1.Dominated by exotic species in dominant strata
EXOTIC SPECIES DOMINATED SYSTEM
a.Community dominated by herbaceous vegetation
Cultivated meadow – 4048

b.Shrubland or vineland
1.Community dominated by an exotic species of vine (wisteria), with some areas approaching a shrubland where vines have toppled canopy trees and created large gaps
Wisteria Vineland - 8568

2.Community dominated by shrub or bamboo.
a.Nearly 100% dominated by golden bamboo (*Phyllostachys aurea*)
Golden Bamboo Shrubland - 8560

b.Nearly 100% dominated by privet with <10% overtopping canopy trees
Chinese Privet Upland Shrubland – 3807 (*Ligustrum sinense*)

2. Dominated by native species in dominant strata

EARLY SUCCESSIONAL SYSTEM

a. Not forested

1.Community dominated by herbaceous vegetation with mostly native old field species, especially broomsedge (*Andropogon virginicus* or *Carex scoparia*)
Successional Broomsedge Vegetation - 4044

2.Community dominated by shrubs – mainly blackberry and greenbrier
Blackberry – Greenbrier Successional Shrubland Thicket - 4732

3. Shrubland – formerly cleared field that does not contain mainly blackberry and greenbrier
Successional Shrubland, formerly cleared field – Sb

b. Forested

1.Forest located in flat area near creek or wet flat area near ponds or upland nutrient rich old homesites.

a.Canopy dominated by *Juglans nigra* (black walnut) (at least 50%) often with hackberry
Successional black walnut forest – 7879

b.Canopy dominated by sweetgum (at least 50%) and red maple
Sweetgum Forest – 7216

2.Forest located in uplands or on slopes along creek

a.Canopy dominated by conifers, specifically loblolly pine (at least 50% of canopy)
Successional Loblolly Pine – Sweetgum Forest – 8462

b.Canopy dominated by hardwoods

1.Canopy dominated by water oak (*Quercus nigra*) (usually at least 50% of canopy) as well as willow oak (*Quercus phellos*) and sweetgum
Water Oak Forest - 4638

2.Canopy dominated by tulip poplar (at least 50%) with red maple and oak species
Successional Tuliptree – Hardwood Forest - 7221

B. Later successional forest and/or wetland not dominated by exotic species in the dominant stratum. These communities are generally more species diverse than early successional communities. In addition, their structure is generally more complex (not even-aged) and they don't have obvious signs of recent human disturbance.

1.Wetlands and communities within floodplains of creeks

a.Standing water for most of year

POND SYSTEM

Southern Cattail (Typha or Carex typhina) *Marsh* – 4150

b.Temporarily flooded

1.Shrubland

SOUTHERN PIEDMONT SMALL FLOODPLAIN AND RIPARIAN FOREST

Floodplain Canebrake – 3836 – only exists in small isolated patches under new tree blowdowns in floodplain

2.Forested

a.Community dominated by various oaks (at least 50% of canopy)

SOUTHERN PIEDMONT LARGE FLOODPLAIN FOREST

Southern Piedmont Oak Bottomland Forest - 8487

b.Community not dominated by oaks (< 50% oak dominance)

Canopy dominated by a combination of ash (25-75%), boxelder (*Acer negundo*) (10-50%), and often sycamore (*Platanus occidentalis*), walnut (*Juglans*), and cottonwood (*Populus*).

ATLANTIC COASTAL PLAIN SMALL BROWNWATER RIVER FLOODPLAIN FOREST

Southeastern Coastal Plain Flat Terrace Forest - 7730

2.Upland communities – including those of slopes adjacent to creeks

a.Community restricted to north facing slopes along creek banks; this community type is mesic with basic soil tendencies, beech and maple in understory.

SOUTHERN PIEDMONT MESIC FOREST

Piedmont Basic Mesic Mixed Hardwood Forest - 8466

b.Community, for the most part, on upland areas except for steep north facing slopes along creek banks. Acidic and low diversity, with sourwood and dogwood in understory.

SOUTHERN PIEDMONT DRY OAK – (PINE) FOREST

1.Dominated by a combination of white oak, northern red oak, and hickory – usually just upslope from 8466

Piedmont Dry – Mesic Oak – Hickory Forest - 8475

2.Dominated by a combination of southern red oak, black oak, and white oak – drier than 8475

Interior Southern Red Oak – White Oak Forest - 7244

Appendix B
Contingency Matrices and Error Tables

Ninety-Six National Historic Park
Accuracy Assessment

Table B-1
Confusion Matrix Using Mapped Dominant, Secondary, or Tertiary Vegetation (Best Match)
Ninety-Six National Historic Park Accuracy Assessment

		Observed as:																							
		3807	4044	4048	4150	4638	4732	7216	7221	7244	7730	7879	8462	8466	8475	8487	8560	8568	Bld	C	HI	Rd	Sb	W	*Total:*
Mapped as:	3807	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	*2*
	4044	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	4048	0	1	15	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*18*
	4150	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	4638	0	0	0	0	18	0	0	0	4	0	0	1	0	1	0	0	0	0	0	0	0	0	0	*24*
	4732	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*2*
	7216	0	0	0	0	2	0	9	0	1	2	0	1	0	0	1	0	0	0	1	0	0	0	0	*17*
	7221	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	7244	0	0	0	0	2	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	*5*
	7730	0	0	0	0	1	0	1	0	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	*12*
	7879	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	*5*
	8462	0	0	0	0	2	0	1	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	*26*
	8466	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	*1*
	8475	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	*2*
	8487	0	0	0	0	2	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	*6*
	8560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	*1*
	8568	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	*1*
	Bld	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	*3*
	C	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	*4*
	HI	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	*2*
	Sb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	*1*
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*1*
	Total:	*0*	*3*	*16*	*1*	*28*	*2*	*11*	*1*	*9*	*12*	*5*	*27*	*1*	*6*	*4*	*1*	*0*	*3*	*3*	*0*	*2*	*1*	*1*	*137*

Number correct:	101
Overall Accuracy:	74%
Kappa Statistic:	0.74

Table B-2
Confusion Matrix Using Mapped Dominant Vegetation Only
Ninety-Six National Historic Park Accuracy Assessment

		Observed as:																							
		3807	4044	4048	4150	4638	4732	7216	7221	7244	7730	7879	8462	8466	8475	8487	8560	8568	Bld	C	HI	Rd	Sb	W	*Total:*
Mapped as:	3807	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	*2*
	4044	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	4048	0	1	15	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*18*
	4150	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	4638	0	0	0	0	18	0	2	0	4	0	0	1	0	1	0	0	0	0	0	0	0	0	0	*26*
	4732	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*2*
	7216	0	0	0	0	2	0	4	0	1	2	0	4	0	0	1	0	0	0	1	0	0	0	0	*15*
	7221	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	7244	0	0	0	0	2	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	*5*
	7730	0	0	0	0	1	0	4	0	0	9	0	1	0	0	1	0	0	0	0	0	0	0	0	*16*
	7879	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	*4*
	8462	0	0	0	0	2	0	1	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	*23*
	8466	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	*2*
	8475	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	*1*
	8487	0	0	0	0	2	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	*5*
	8560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	*1*
	8568	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	*2*
	Bld	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	*3*
	C	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	*4*
	HI	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
	Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	*2*
	Sb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	*1*
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*1*
	Total:	*0*	*3*	*16*	*1*	*28*	*2*	*11*	*1*	*9*	*12*	*5*	*27*	*1*	*6*	*4*	*1*	*0*	*3*	*3*	*0*	*2*	*1*	*1*	*137*

Number correct:	90
Overall Accuracy:	66%
Kappa Statistic:	0.62

Table B-3
Accuracy Calculations Using the Mapped Dominant Vegetation Type Only
Ninety-Six National Historic Park

Class	Producers'			Users'		
	Accuracy	CI	n	Accuracy	CI	n
3807	NA	--	0	0.00	0.25	2
4044	0.33	0.96	3	1.00	--	1
4048	0.94	0.14	16	0.83	0.18	18
4150	1.00	--	1	1.00	--	1
4638	0.64	0.17	28	0.69	0.17	26
4732	1.00	0.25	2	1.00	0.25	2
7216	0.36	0.31	11	0.27	0.23	15
7221	1.00	--	1	1.00	--	1
7244	0.22	0.31	9	0.40	0.57	5
7730	0.75	0.27	12	0.56	0.25	16
7879	0.80	0.48	5	1.00	0.13	4
8462	0.74	0.16	27	0.87	0.14	23
8466	0.00	--	1	0.00	0.25	2
8475	0.17	0.39	6	1.00	--	1
8487	0.50	0.71	4	0.40	0.57	5
8560	1.00	--	1	1.00	--	1
8568	NA	--	0	0.00	0.25	2
Bld	1.00	0.17	3	1.00	0.17	3
C	0.67	0.96	3	0.50	0.71	4
HI	NA	--	0	0.00	--	1
Rd	1.00	0.25	2	1.00	0.25	2
Sb	1.00	--	1	1.00	--	1
W	1.00	--	1	1.00	--	1

CI The 90% confidence interval.

n The sample size. For users' accuracy, this is the number of points mapped in this class. For producers' accuracy, it is the number of points assigned to that class in the field.

NA Not applicable. No evaluation points were assigned to that association in the field.

-- A confidence interval could not be calculated due to the small sample size.

Table B-4
Accuracy Calculations Using the Mapped Dominant, 2nd, or 3rd Vegetation Type
Ninety-Six National Historic Park

Class	Producers'			Users'		
	Accuracy	CI	n	Accuracy	CI	n
3807	NA	--	0	0.00	0.25	2
4044	0.33	0.96	3	1.00	--	1
4048	0.94	0.14	16	0.83	0.18	18
4150	1.00	--	1	1.00	--	1
4638	0.64	0.17	28	0.75	0.17	24
4732	1.00	0.25	2	1.00	0.25	2
7216	0.82	0.26	11	0.53	0.24	17
7221	1.00	--	1	1.00	--	1
7244	0.22	0.31	9	0.40	0.57	5
7730	0.75	0.27	12	0.75	0.27	12
7879	1.00	0.10	5	1.00	0.10	5
8462	0.85	0.14	27	0.88	0.13	26
8466	0.00	--	1	0.00	--	1
8475	0.33	0.47	6	1.00	0.25	2
8487	0.75	0.63	4	0.50	0.49	6
8560	1.00	--	1	1.00	--	1
8568	NA	--	0	0.00	--	1
Bld	1.00	0.17	3	1.00	0.17	3
C	0.67	0.96	3	0.50	0.71	4
HI	NA	--	0	0.00	--	1
Rd	1.00	0.25	2	1.00	0.25	2
Sb	1.00	--	1	1.00	--	1
W	1.00	--	1	1.00	--	1

CI The 90% confidence interval.

n The sample size. For users' accuracy, this is the number of points mapped in this class. For producers' accuracy, it is the number of points assigned to that class in the field.

NA Not applicable. No evaluation points were assigned to that association in the field.

-- A confidence interval could not be calculated due to the small sample size.

Table B-5
Accuracy Calculations with Recommended Groupings
Ninety-Six National Historic Park

Class	Producers'			Users'		
	Accuracy	CI	n	Accuracy	CI	n
3807	NA	--	0	0.00	0.25	2
4044	0.33	0.96	3	1.00	--	1
4048	0.94	0.14	16	0.83	0.18	18
4150	1.00	--	1	1.00	--	1
4638/7244	0.70	0.14	37	0.90	0.11	29
4732	1.00	0.25	2	1.00	0.25	2
7221	1.00	--	1	1.00	--	1
7730/7216	0.91	0.12	23	0.72	0.16	29
7879	1.00	0.10	5	1.00	0.10	5
8462	0.85	0.14	27	0.88	0.13	26
8466	0.00	--	1	0.00	--	1
8475	0.33	0.47	6	1.00	0.25	2
8487	0.75	0.63	4	0.50	0.49	6
8560	1.00	--	1	1.00	--	1
8568	NA	--	0	0.00	--	1
Bld	1.00	0.17	3	1.00	0.17	3
C	0.67	0.96	3	0.50	0.71	4
HI	NA	--	0	0.00	--	1
Rd	1.00	0.25	2	1.00	0.25	2
Sb	1.00	--	1	1.00	--	1
W	1.00	--	1	1.00	--	1

CI The 90% confidence interval.

n The sample size. For users' accuracy, this is the number of points mapped in this class. For producers' accuracy, it is the number of points assigned to that class in the field.

NA Not applicable. No evaluation points were assigned to that association in the field.

-- A confidence interval could not be calculated due to the small sample size.