Historic Vegetation Assessment

Sam D. Hamilton Noxubee National Wildlife Refuge

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Timothy A. Fotinos
U.S. Fish and Wildlife Service
National Wildlife Refuge System
Inventory and Monitoring - Gulf Network
Red River NWR
150 Eagle Bend Point
Bossier City, LA 71112
timothy_fotinos@fws.gov

Janet Ertel
U.S. Fish and Wildlife Service
National Wildlife Refuge System
Inventory and Monitoring - Gulf Network
P.O. Box 9627
Mississippi State, MS 39762
janet_ertel@fws.gov

Summary

Sam D. Hamilton Noxubee National Wildlife Refuge is currently developing a new Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP) for the refuge. The refuge requested support defining historic habitat condition from the Inventory and Monitoring network (I&M) in order to aid in decision making.

I&M provided two types of valuable data to SDH Noxubee NWR, 1) historic accounts of vegetation communities on the refuge from primary and gray literature and 2) spatial data from models predicting vegetation community distributions prior to major European settlement and logging. Spatial data from an available regional/national modeling effort were provided and tested using refuge specific, historic tree data to confirm local applicability of the regional level data.

Methods

The initial stages of this project were exploratory and consisted of finding all available information about vegetation communities on SDH Noxubee NWR prior to the major changes to the landscape caused by human settlement, agriculture, logging and subsequent silviculture. The primary literature was searched using several database sources from NCTC and local universities. Gray literature such as county land survey records and NRCS soil surveys was also searched for historic descriptions. The search turned up five applicable documents that were provided to the refuge (McLendon and Hurst 1907, Smith et al. 1910, Crabb and Hightower 1913, Leidolf et al. 2002, Campbell and Seymour 2011).

In order to provide spatial data to the refuge, I&M identified previously produced historic vegetation maps that cover the entire refuge and surrounding region. These regional scale maps were produced by LANDFIRE in a nationwide, collaborative modeling effort in 2001 and have since been updated and refined for ease of use. The LANDFIRE model results represent the potential distribution of vegetation communities given the current environmental conditions and a natural (pre-European) disturbance regime.

The problem with using such data for management decisions is lack of validation. This is particularly true of data that represent a landscape condition that theoretically existed 200 years ago and has since been highly modified. I&M pursued a unique approach to providing site specific support for the LANDFIRE model results.

The opportunity to validate the LANDFIRE model came from a recent academic paper, published by researchers at Mississippi State University, that was identified by the refuge. It presented a project in which they sought to demonstrate how General Land Office (GLO) survey data can be used to reconstruct historic vegetation communities using ordination analysis (Schauwecker et al. 2011). The project was conducted using GLO data from a portion of Winston County, Mississippi that largely falls within refuge boundaries. The GLO survey records from original county surveys in 1830 include a witness tree at every corner and midpoint of a survey line. The trees are identified to species, or as close as possible, and data such as trunk diameter are collected so the tree can be more easily identified on future surveys. Schauwecker et al. took these data and translated the survey coordinates to UTM coordinates and then related the location of the trees to environmental data such as elevation, slope, and soil type. The species X environment matrix was used in an ordination analysis to recreate the tree community associations that may have been present historically.

Refuge I&M was given these GLO data and used it to create a tree species distribution model for SDH Noxubee NWR. The environmental data layers used by Schauwecker et al. to generate the matrix were reproduced by I&M in An ArcGIS project. These layers included elevation, slope, roughness, and distance to nearest stream or water body. A historic mean fire return interval layer acquired from LANDFIRE was also added to the project (LANDFIRE 2008). Tree species that occurred fewer than six times or that clearly did not include the full range of environmental conditions under which the species is observed to occur were removed from the matrix. Five tree species remained, which happen to be the dominants across much of the landscape, and were used in the model. These species were pine, red oak, post oak, hickory, and white oak. The tree species X environment matrix was reduced to minimum and maximum values for each variable. These values served as boundary parameters that defined the range of suitable physical conditions for the five tree species. Minimum and maximum parameter values for fire return interval were acquired from LANDFIRE, the Fire Effects Information System (FEIS), and NatureServe vegetation community definitions. The parameter values for each species used in the model often represented the mean values from these sources because they typically differed slightly.

An environmental suitability model was created from these data for each tree species. Five new raster layers, representing the five environmental variables used in the model, were created for each tree species. These layers identified the areas of the refuge that were within the range of suitable conditions identified for that species in the GLO data. The layers were created using map algebra calculations that examined each cell of the environmental data layer and gave the spatially corresponding cell of the new raster a value of one if the environmental data value was within the range of parameter values and assigned a zero if it was outside the range. Another map algebra calculation was done to identify the potential distribution for each tree species. The spatially corresponding cells of the five suitability layers were multiplied together and the resulting value was assigned to the cell of a new raster layer (Figure 1). Those cells where all five values were one resulted in a suitable value of one in the new raster layer. All other cells were assigned zero values because at least one suitability layer had a zero value at that cell.

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Figure 1. Example of map algebra where two suitability layers are multiplied together in order to create a combined suitability layer. Corresponding cells are multiplied together and the resulting value is assigned to the corresponding cell of the new raster layer.

Results

The LANDFIRE 2008 model results for SDH Noxubee NWR are presented below and shows the modeled distribution of vegetation communities as it may have occurred in approximately 1800 (Figure 2).

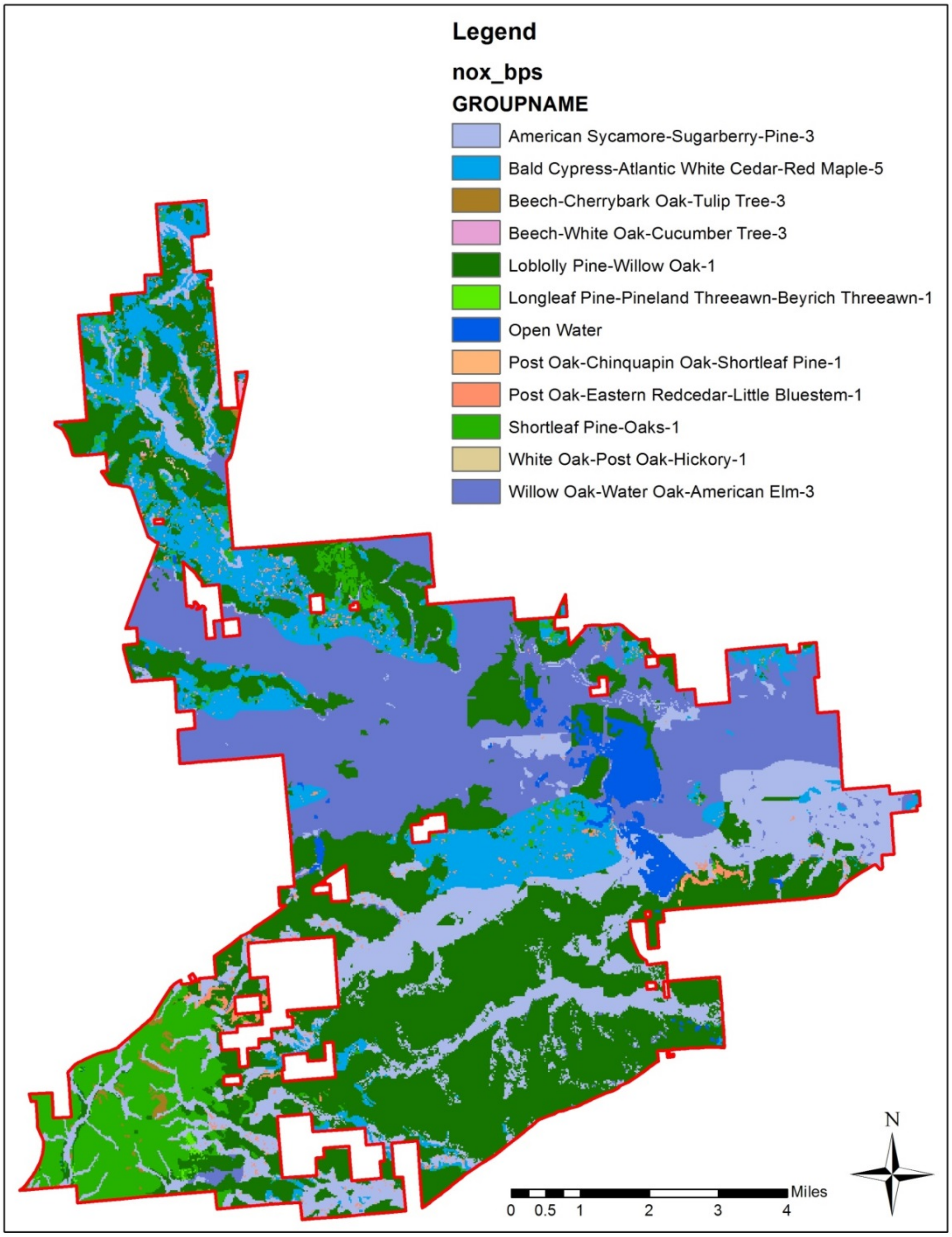
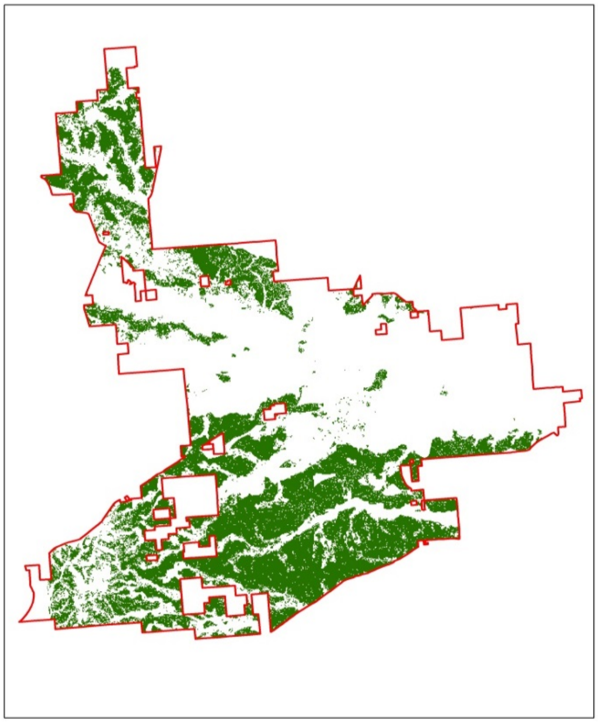


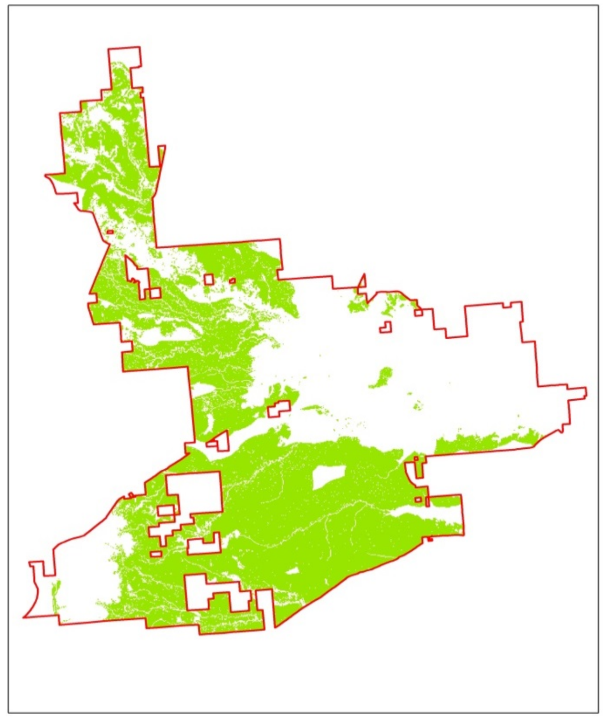
Figure 2. Modeled historic vegetation community distribution map from LANDFIRE 1.1.0 (2008). Community types are adapted from the NatureServe Ecological classification system.

The I&M environmental suitability models produced a potential distribution for each of the five tree species (Figure 3). Pines are restricted to the upland areas of the refuge (Figure 3A). Post oak and white oak overlap almost entirely with pine, but their distribution extends further in to the bottoms (Figure 3B, 3C). Hickories and red oaks are predominantly in the low lying areas of the refuge (Figure 3D, 3E).

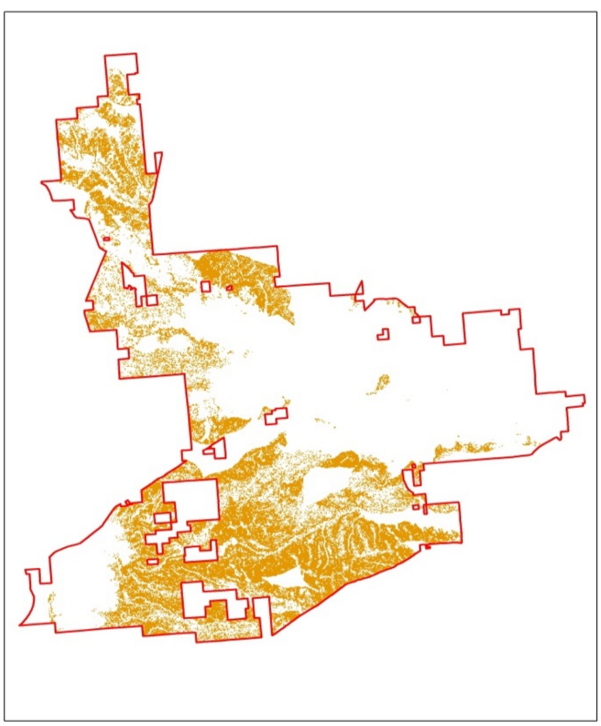
A)



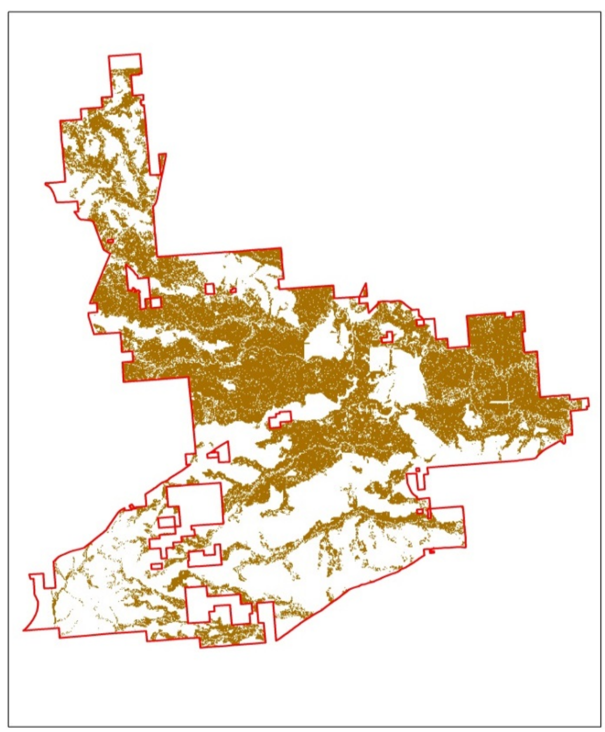
B)



C)



D)



E)

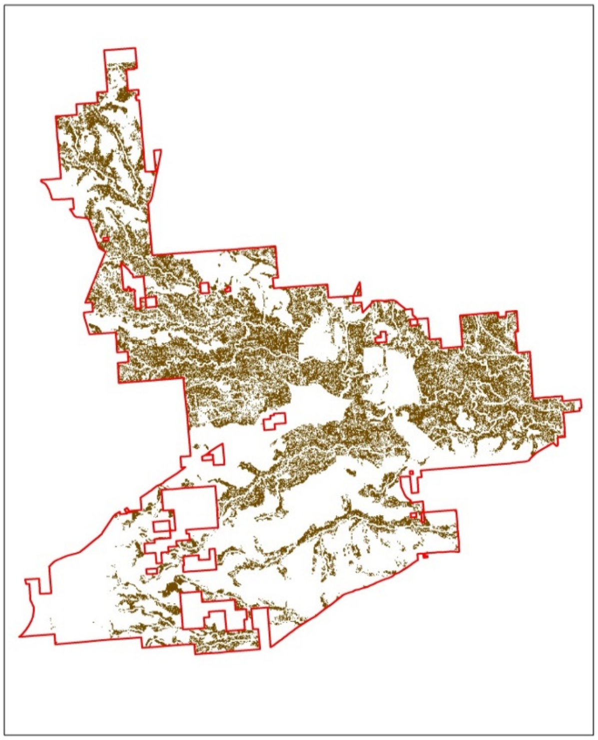


Figure 3. Potential distribution maps for A) pine, B) post oak, C) white oak, D) red oak, and E) hickory on SDH/Noxubee NWR. Data is from I&M environmental suitability models.

Discussion

Whenever applying the results of a model it is important to understand the assumptions and limitations of the model. Any model is only as good as its input data. The LANDFIRE model and the community definitions used have been extensively worked on and refined by regional and national experts and represent the best available knowledge. The refuge I&M model was limited by the GLO data used to create the tree species parameter values. Only 189 tree records existed in the dataset which covered only a third of the refuge. These data were further reduced to include only five species with between 16 and 51 records from which to generate parameter values for the model. The refuge I&M model was particularly weak in the eastern and southwest portions of the refuge where the communities were not completely represented in the data or the landscape structure was most different from the remainder of the refuge. Another important consideration when using the refuge I&M model results is remembering to treat the data as the potential distribution of the tree species. The tree species were modeled individually so it did not take in to account species interactions (e.g. competition) or any proxy for this limit on distribution or abundance.

The similarity of the distribution of tree species/communities between the two models is good support for them being reasonable representations of the historic distribution of natural communities. The LANDFIRE model is derived from vegetation community definitions from the NatureServe vegetation classification system. The model created by refuge I&M uses actual tree data collected on and around the refuge by land surveyors in 1830. Both models generated similar distributions for upland and lowland communities, although the LANDFIRE model is more detailed and has complete coverage of the refuge because of the more comprehensive dataset. Corroboration of the two models using data from different sources supports the use of these data for refuge management.

These data can be used to guide management of the refuge in many ways. The primary motivation for this work was to better understand the historic distribution and condition of habitats on the refuge. These models give likely the best insight possible as to the location and structure of refuge habitats prior to agriculture, logging, and replanting of the current loblolly forest. These data can also provide location and areal extent of different natural fire regimes for fire management planning. It can be used to compare to current vegetation patterns and quantify deviation from the “natural” historic condition. These data can also serve as a guide for restoration of refuge land from an undesired state.

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