

## Expert-based Model Guidance and Documentation (Version 1)

### Project Information

- Species: Red-cockaded Woodpecker (*Picoides borealis*)
- Lead modeler: Katie Talavera ([katie.talavera@terracon.com](mailto:katie.talavera@terracon.com)), 919-602-4430
- Date started: June 2018
- Date completed: October 2021

### Species Information

#### **NCDOT NRTR Habitat Description**

USFWS Optimal Survey Window: year-round; November to early March (optimal)

The red-cockaded woodpecker (RCW) typically occupies open, mature stands of southern pines, particularly longleaf pine (*Pinus palustris*), for foraging and nesting/roosting habitat. The RCW excavates cavities for nesting and roosting in living pine trees, aged 60 years or older, which are contiguous with pine stands at least 30 years of age to provide foraging habitat. The foraging range of the RCW is normally no more than 0.5 miles. They are currently found in the sandhills and piedmont ecoregions, as well as coastal communities where old growth pines are prevalent.

Longleaf pine is the preferred species for nesting, while loblolly, shortleaf, slash and pond pines are also used dependent on availability.

#### **Additional Information**

There is a total of 347 element occurrences (EO's) tracked by NCNHP within the piedmont and coastal regions of North Carolina: 95 current occurrences; 251 historic occurrences; and one obscure record occurring just south of other Sandhill Game Land occurrences in Scotland County (NCNHP 2021).

### County Information

- As of September 2021, IPAC ECOS contains 35 counties, Anson, Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chatham, Columbus, Craven, Cumberland, Currituck, Dare, Duplin, Gates, Greene, Harnett, Hertford, Hoke, Hyde, Johnston, Jones, Moore, New Hanover, Onslow, Pamlico, Pender, Richmond, Robeson, Sampson, Scotland, Tyrrell, Wake, Washington, and Wayne.
- As of July 2021, historic counties are no longer tracked by USFWS but were modeled at the start of the modeling process.
- As of April 2021, NHP and FWS listed 45 counties which are included in the modeling process. Anson, Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chatham,

Columbus, Craven, Cumberland, Currituck, Dare, Duplin, Edgecombe, Gates, Greene, Halifax, Harnett, Hertford, Hoke, Hyde, Johnston, Jones, Lee, Lenoir, Montgomery, Moore, Nash, New Hanover, Northampton, Onslow, Pamlico, Pender, Pitt, Richmond, Robeson, Sampson, Scotland, Tyrrell, Wake, Washington, Wayne, and Wilson.

- Edgecombe, Halifax, Lee, Lenoir, Montgomery, Nash, Northampton, Orange, Pitt and Wilson are not currently identified in IPAC but initially modeled and are available in needed.

### Environmental Data Information

The RCW model was separated into four different regions to account for habitat preferences and availability across various southern pine forest types including Pine Savannas, Sandhill Xeric Scrub, Pine-Scrub Oak Sandhill, or Pond Pine Woodlands. Thresholds were adjusted along the coast to account for bay or high pocosin habitat of stunted pine trees and to account for optimum habitat of the sandhills. All spatial data are in NAD 1983 State Plane North Carolina FIPS 3200 (US feet). Table of all environmental data layers available via DOT ATLAS project server.

All data were derived to identify potential foraging and nesting habitat and were categorized as high, medium and low potential habitat using a weighted overlay approach. The model approach left non-habitat areas not mapped. The final shapefiles provide RCW Potential Habitat broken into high, medium, and low habitats, where low potential was combined with the initially identified medium potential habitats and the remaining county coverage previously not identified as habitat was then identified as low potential habitat.

#### **Layer 1**

- Layer name: County Boundary Shoreline
- Layer description:
  - Selection: Anson, Richmond, Scotland, Robeson, Bladen, Sampson, Cumberland, Harnett, Hoke, Moore, Montgomery, Lee, Chatham, Orange, Wake, Johnston, Wayne, Lenoir, Greene, Pitt, Wilson, Nash, Edgecombe, Halifax, Northampton, Hertford, Gates, Camden, Currituck, Bertie, Washington, Tyrrell, Dare, Hyde, Beaufort, Craven, Pamlico, Carteret, Jones, Onslow, Duplin, Pender, New Hanover, Columbus, and Brunswick Counties.
  - Layer selection justification:
    - Species listed for potential habitat according to ECOS USFWS range map data and placed into larger ecoregions; Central, Sandhills, Coastal South and Coastal North. These ecoregions were created by location and size for manageability of data and to address physiographic changes in landscape of RCW known occurrences.
  - “Habitat” versus “Nonhabitat” designations
    - Potential habitat for 45 counties (11 historic)

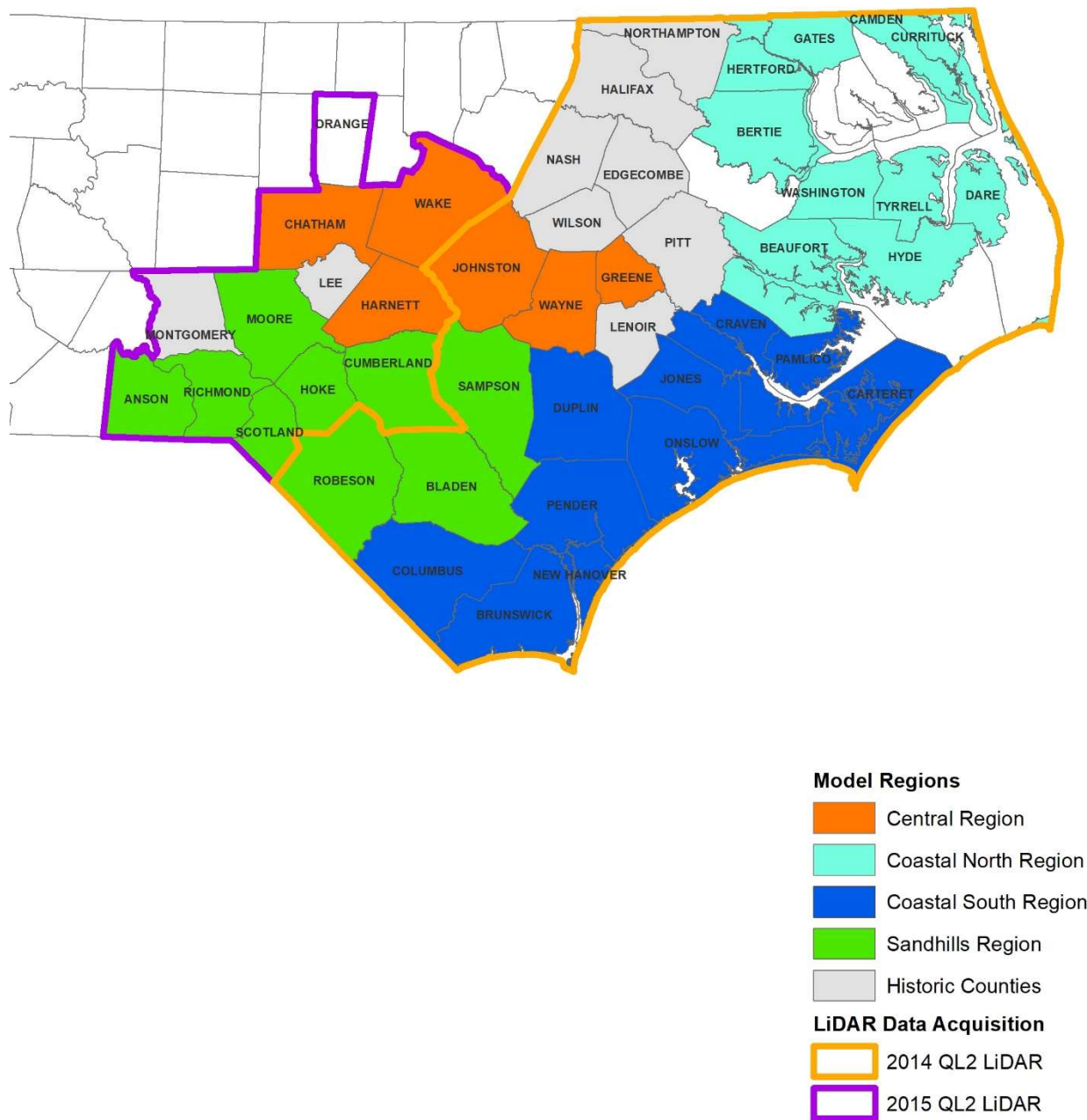


Figure 1.

**Layer 2**

- Layer name: (%Name%)\_Co\_DHM
  - Rasters created from QL2 LiDAR point cloud data in LAS Format, per county.
- Layer description:
  - Latest LAS Format point cloud elevation data acquired from the NC Floodplain Mapping Program. LAS point cloud LiDAR data is classified into 13 categories defined by strata or feature type such as roads or buildings. North Carolina was

divided into 5 phases for statewide collection of LiDAR, starting in the east and moving westward. The phases consist of approximately 20 counties and were collected with the latest technologies at time of collection.

- Data used in the RCW model consist of QL2 LAS Format data, at 2 points per meter collected in 2014 and 2015.
- Layer selection justification:
  - The data was processed by class levels that represent various vegetative strata and ground data. Buildings, structural or impervious levels were not considered in this model. A Digital Elevation Model (DEM) was created from ground data, a Digital Surface Model (DSM) developed from vegetative point cloud data and from these, a Digital Height Model (DHM) was created representing heights of canopies.
- “Habitat (Medium/High)” versus “Nonhabitat (Low or NA)” designations:
  - The modeled elevations were correlated with the soil site index values to derive approximate age of trees. RCW habitat consists of trees  $\geq 30$  years of age or older for foraging and  $\geq 60$  years of age for nesting. Medium and high were identified in the modeling process while low is remaining USFWS county coverage.

### Layer 3

- Layer name: (%CountyName%)\_SiteIndex\_longleaf/loblolly
- Layer description:
  - USDA soil site index values on a county scale. The index is the mean height that dominant and codominant trees of a given species attain in a specified number of years. The quantitative data per tree species represents the mid and upper values. These vary per species and per county soils.
- Layer selection justification:
  - The soils site index correlated with the tree heights provide an approximation of tree age taking into consideration potential habitat conditions that may be ideal for growth or naturally stunted based on soils.
- “Habitat” versus “Nonhabitat” designations:
  - Indices for longleaf and loblolly pines were included to capture potential suitable needled-leaved evergreens across the range of potential landscape and hydrologic settings.

### Data Layer 4

- Layer name: NLCD\_2016\_Land\_Cover\_L48\_20190424\_NC
- Layer description:
  - 2016 USGS National Land Cover Database (NLCD) Is a multi-temporal land cover modeling product derived from assembled Landsat imagery, geospatial ancillary datasets including a detailed change analysis strategy derived from the U.S. Geological Survey.

- Layer selection justification:
  - NLCD was used as an upper level filter to select potential habitat for RCW. Selects (Evergreen Forest, Developed Open Space, Shrub/Scrub, Herbaceous, Wood Wetlands) suitable for pine and to minimize deciduous forests as potential habitat for all regions
- “Habitat” versus “Nonhabitat” designations:
  - Landcover selected for potential habitats include Evergreen Forest, Woody Wetlands, Shrub/Scrub, Grasslands/Herbaceous, and Developed Open Space suitable for pine and to minimize deciduous forests as potential habitat for all regions.

#### **Data Layer 5**

- Layer name: CONUS\_wet\_poly (National Wetlands Inventory (NWI))
  - Layer description: This data set represents the extent, approximate location, type of wetlands and deep-water habitats in the conterminous United States. These data delineate the spatial extent of wetlands and surface waters as defined by Cowardin et al. (1979).
- Layer selection justification:
  - This layer was used to lessen the potential of Headwater Forests and Riverine Swamp Forests that consist of hardwood dominated old growth trees for the Sandhills, Coastal South and Central Regions. In many areas, co-located foraging or nesting areas are less prevalent and many of these old growth trees are due to hydrologic stream buffers. This layer was less helpful in the coastal north region as RCW have been found to occur in more hydrologically prevalent landscapes.
- “Habitat” versus “Nonhabitat” designations:
  - The model should over predict in these areas of the Coastal North more so than the other regions due to these limitations.

#### *Known Issues with Model Data Layers*

- NLCD layer: This data is not as detailed as the Gap Analysis Project (GAP) data but was found to be more accurate overall. In the modeling process it was identified that some areas in the sandhills region mapped as developed open space are open understory areas with large growth trees.
- Overall Habitat: There is potential for areas that were mapped as habitat to conflict with recently clear-cut areas.

#### Model Information

- Model domain
  - This model identifies year-round potential suitable habitat for the species.
  - The model was produced from a weighted overlay where the outputs represent a range of potential habitat from high, medium, and low including USFWS species

range. Habitat defined as “Low Potential Habitat” are areas deemed low quality or non-habitat.

- Model output
  - Figure 1: Model Regions
  - Figures 2a-2d: Potential Habitat Version 1.
  - Figures 3a-3d: Draft Model prediction for AGOL review. (Appendix 2)
  - Figure 4: Reviewer Points (Draft) (Appendix 2)
  - Figure 5: Desktop AGOL Confusion Matrix.
  - Table 1. Accuracy Statistics Summary Table for Desktop Review.
  - Figures 6a-6: Changes to Models from AGOL review: Sandhills detail. (Appendix 2)
  - Figures 7a-7c: Changes to Models from AGOL review: Coastal South detail. (Appendix 2)
  - Figure 8: Field Assessment Confusion Matrix.
  - Table 2. Accuracy Statistics Summary Table for Field Validation.
- ArcGIS Model Builder
  - Model Builder version of ArcGIS – 10.6.1
  - Model file included in Appendix 1.
  - Summary of model steps:
    - Selected North Carolina counties where RCW is listed by USWFS.
    - Processed LAS point cloud data to create DHMs from Digital Terrain Models.
    - Extracted site index values for the USFWS known RCW counties, for loblolly and long leaf pine. This data was then correlated with the derived heights.
    - Extracted desired community types and those that overlaid known occurrences from NLCD.
    - Extracted NWI classifications known to occur in RCW habitats.
    - Created a weighted overlay placing potential habitat into two bins of high and medium potential.
    - Converted all Raster outputs to shapefile format.
- Independent Data Review:
  - Describe data sources – NHP element occurrences and preliminary desktop review. NHP EO’s were compared to model output to determine if predicted habitat intersected known habitat.
  - Preliminary field review for NRTR R-2561 (See Appendix 2).
  - Preliminary Atlas team AGOL review (See Appendix 2).
- AGOL review:
  - The model prediction outputs, per region were shared with select reviewers on ArcGIS Online (AGOL). AGOL data points were placed within the USFWS potential habitat range maps as well as the draft model potential habitat identified areas to solicit feedback. Reviewers could place additional comments for consideration by modeler.
  - AGOL review was completed in September 2019 on the DRAFT version of this model (See Appendix 2).
- Field Validation Effort:

- Two teams of two completed the field validation effort in January 2020. Roughly 10 points per county were identified for verification based off available access and coverage across the 35 counties, resulting in 359 data field validation data points.
- Results can be found in Appendix 2.

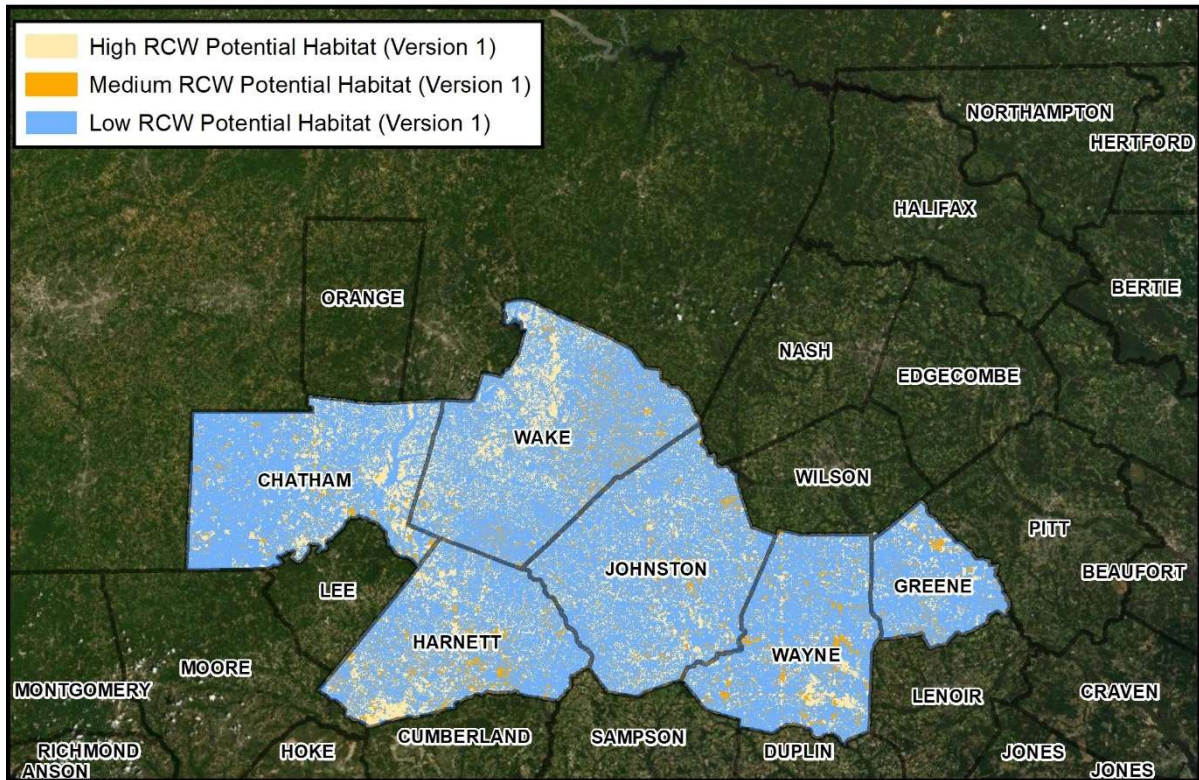


Figure 2a. Central Region Potential Habitat (Version 1).

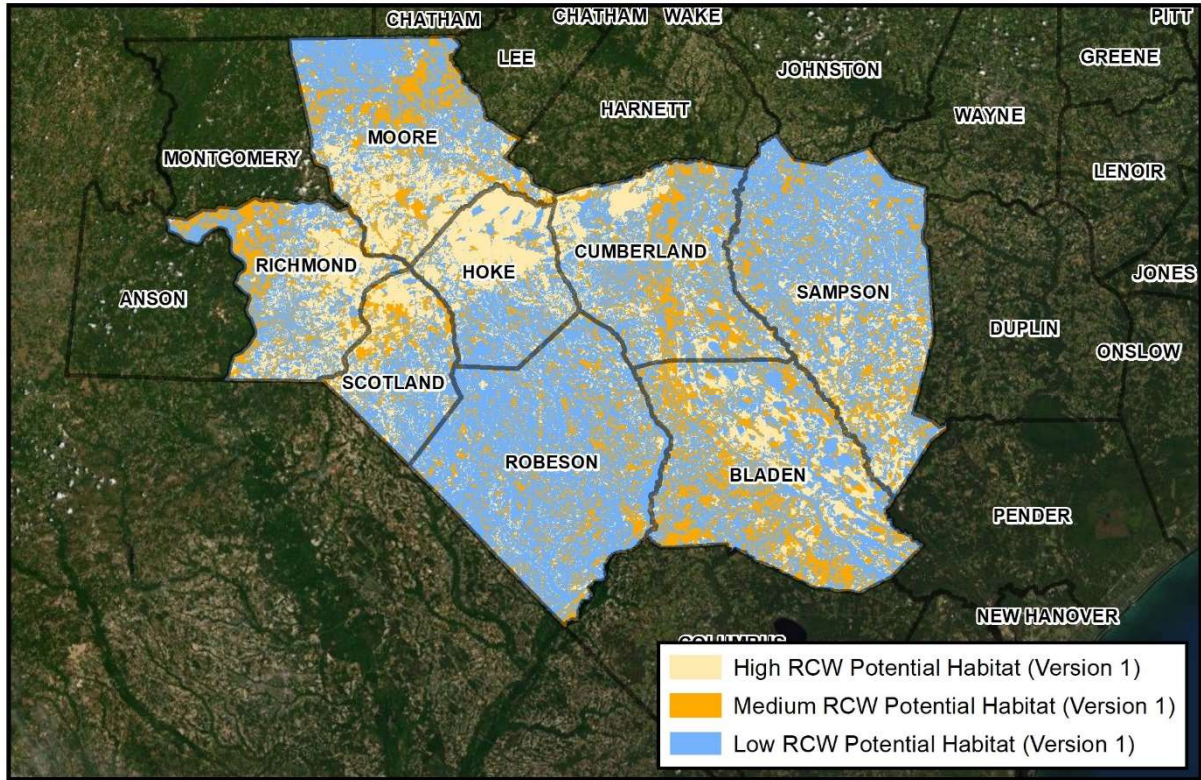


Figure 2b. Sandhills Region Potential Habitat (Version 1).

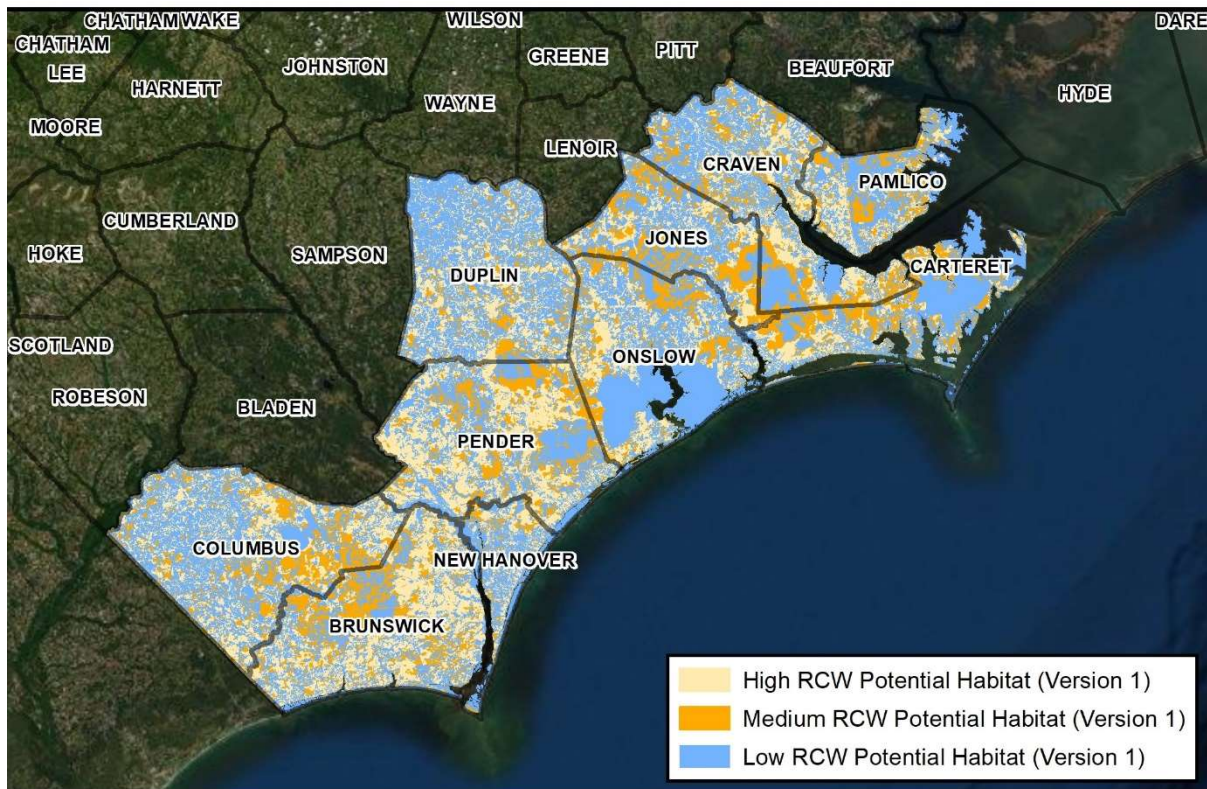


Figure 2c. Coastal South Region Potential Habitat (Version 1).



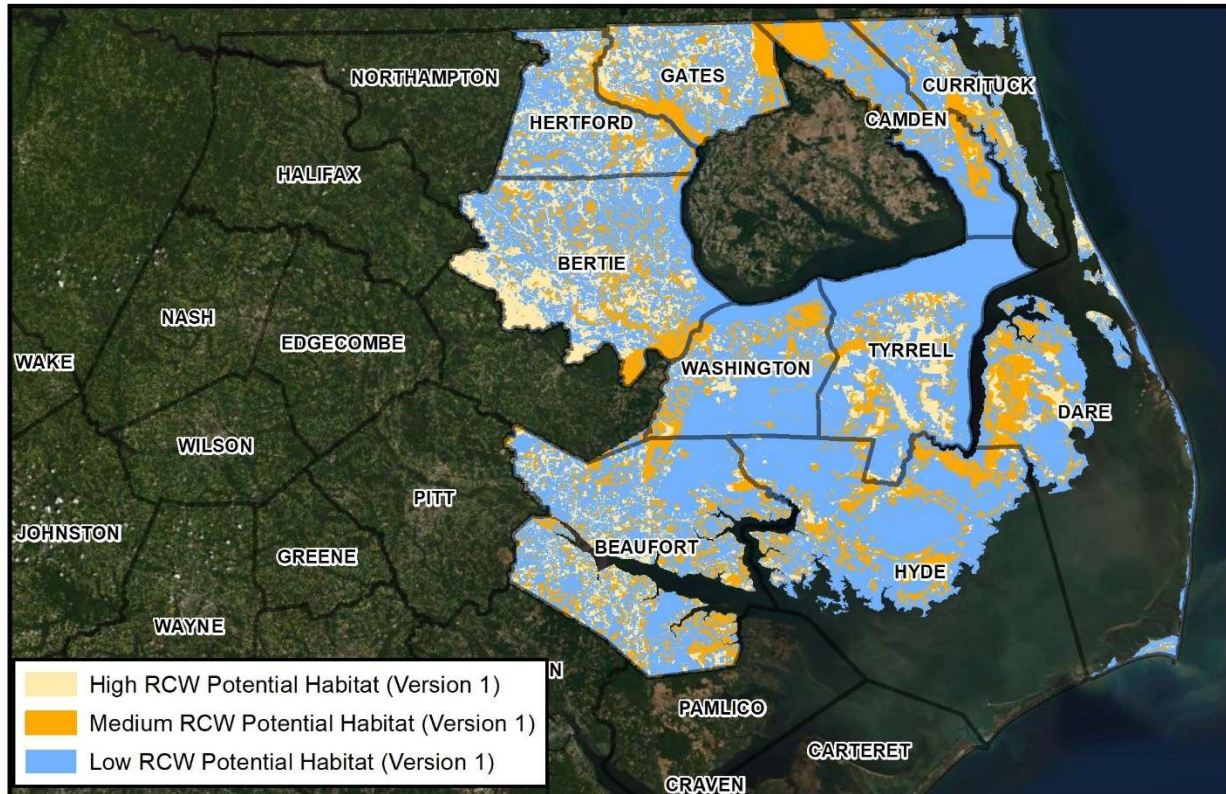


Figure 2d. Coastal North Region Potential Habitat (Version 1).

#### List of Delivered Model Products

- *This summary document.*
- *Version 1 Model builder file (toolbox) and model screenshot (Appendix 1).*
- *Reviewer documentation (Appendix 2) – summary of comments and general model recommendations.*
- *Version 1 Model prediction file(s)- shapefiles per county split up by historic or current.*
- *Field Reviewer comments (shapefile).*

#### References

Carmean, Willard H.; Hahn, Jerold T.; Jacobs, Rodney D. 1989. Site index curves for forest tree species in the eastern United States. General Technical Report NC-128. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station. 142 p.

<https://doi.org/10.2737/NC-GTR-128>.

Gross, S. B. "Evaluation of Multi-Return LIDAR for Forestry Applications." (2001).

[https://www.fs.fed.us/eng/techdev/IM/rsac\\_reports/lidar\\_report.pdf](https://www.fs.fed.us/eng/techdev/IM/rsac_reports/lidar_report.pdf)

North Carolina Department of Transportation. EAU. 2018. Red-cockaded Woodpecker Survey Protocol.

<https://connect.ncdot.gov/resources/environmental/pdea%20procedures%20manual%20documents/red-cockaded%20woodpecker%20survey%20protocol.pdf>

North Carolina Natural Heritage Program (NCNHP). 2021. Geographic Information System (GIS) data. Department of Natural and Cultural Resources (NCDNCR), Raleigh, NC.

<https://ncnhde.natureserve.org/content/map> (Accessed June 2021).

United States Fish and Wildlife Service. 2018. Safe Harbor Program Properties. Shapefile. Acquired from Sue Cameron of USFWS.

United States Fish and Wildlife Service. 2020. Red-cockaded Woodpecker Recovery.

<https://fws.gov/rcwrecovery/rcw.html>

Appendix 1: Red-cockaded Woodpecker Model Screenshots (Full overall version)

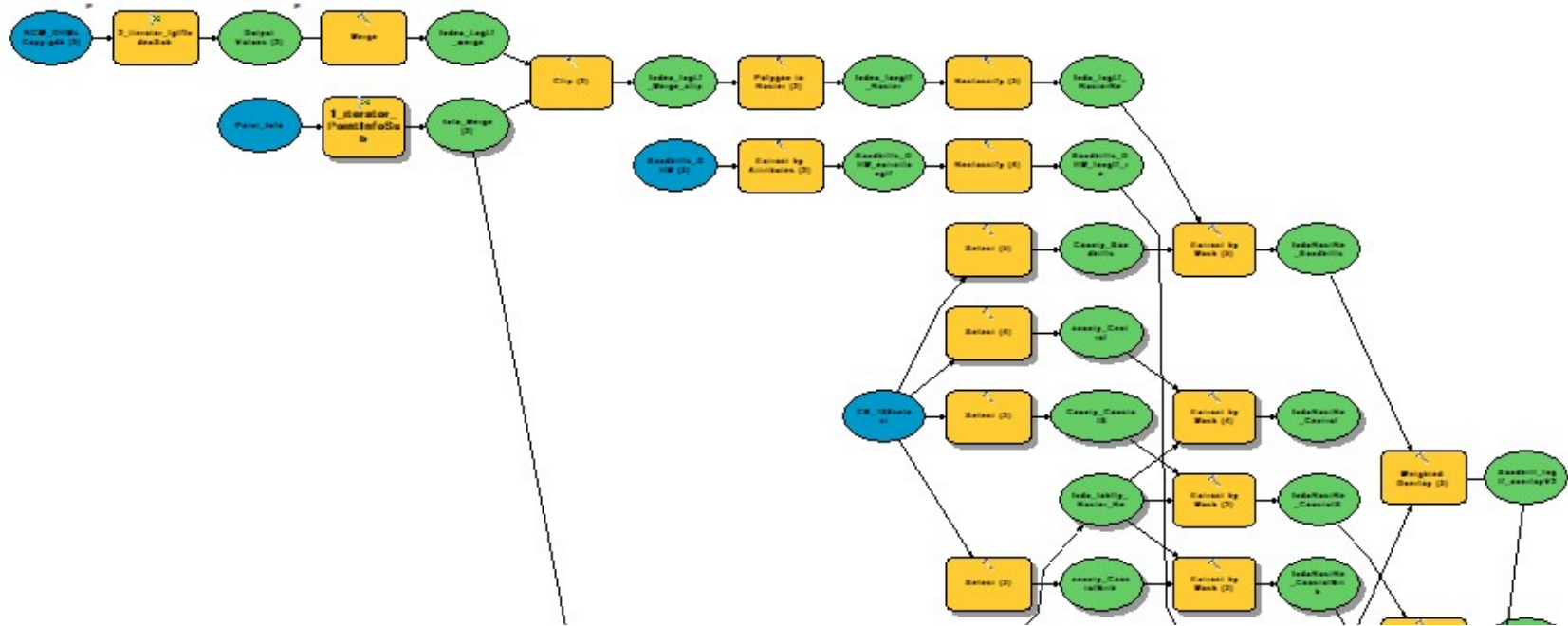


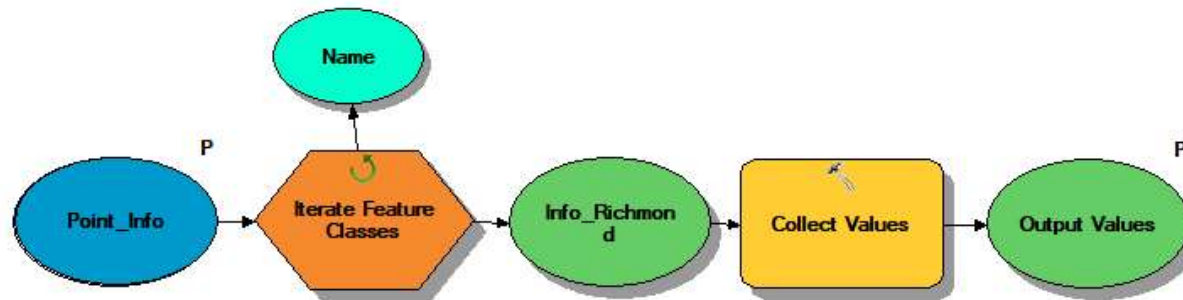
Figure 1-1.



## Model Details:

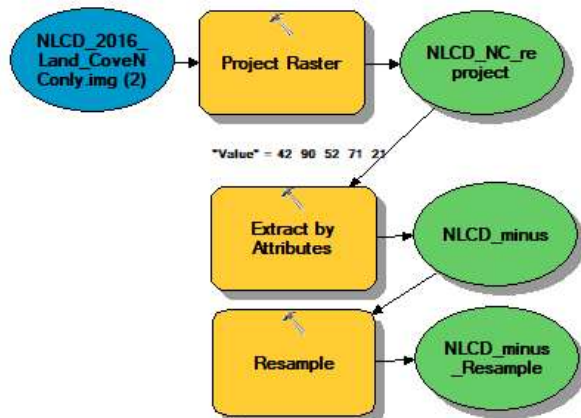
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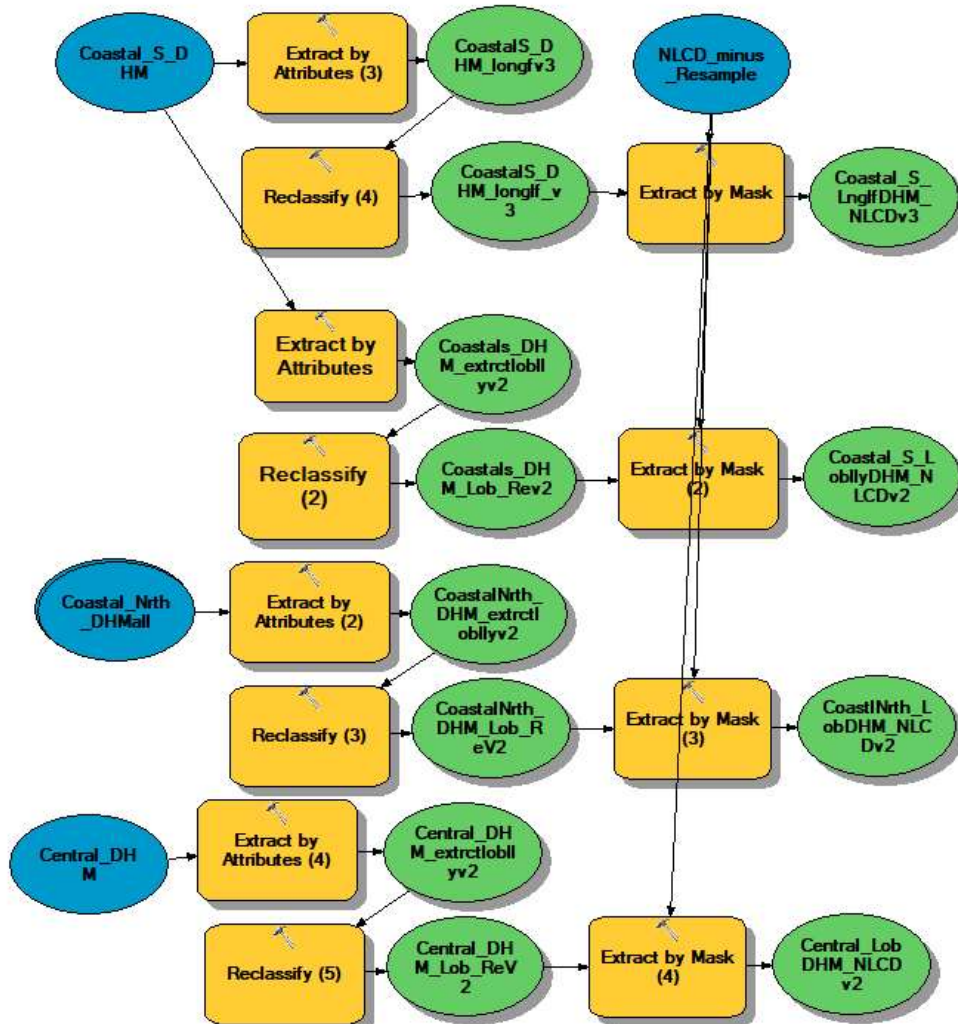
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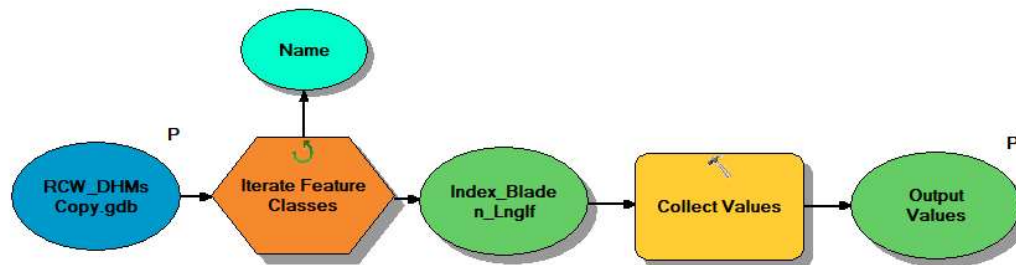
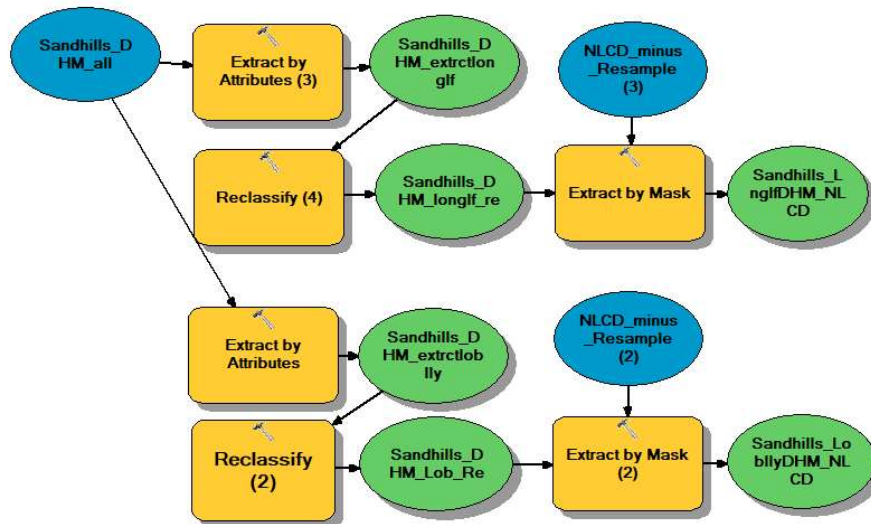


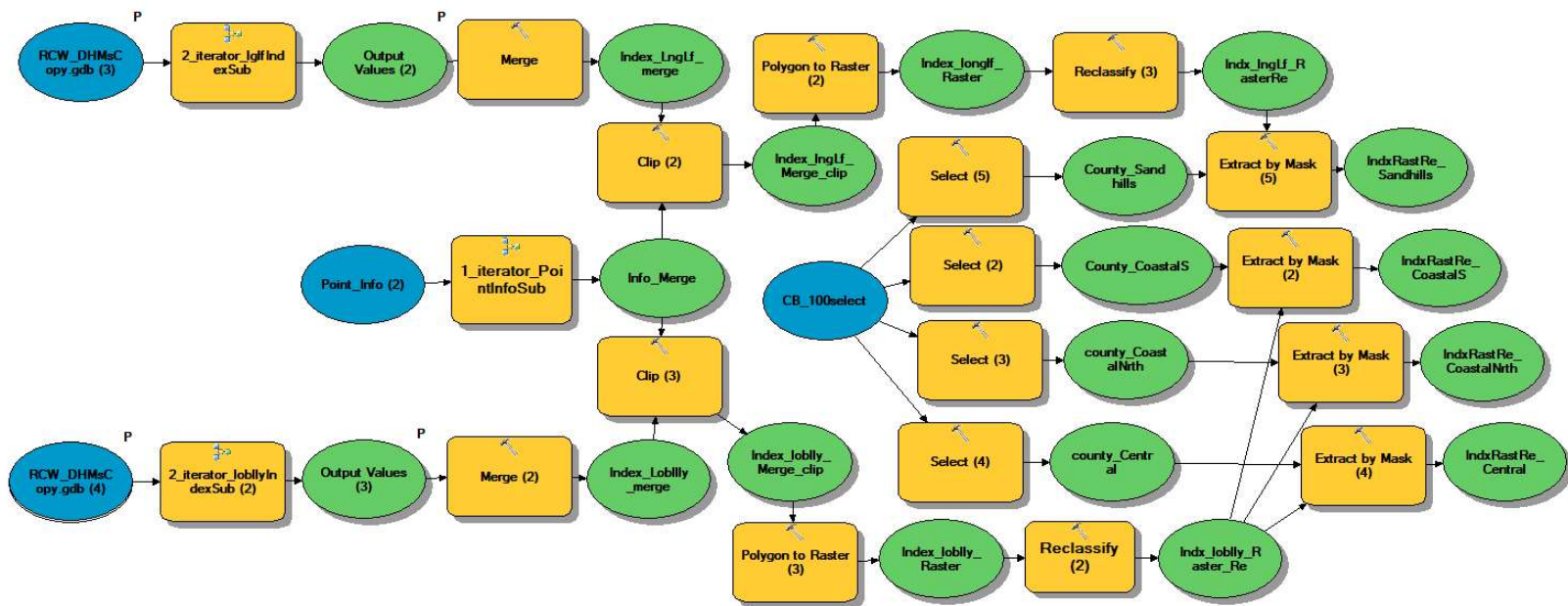
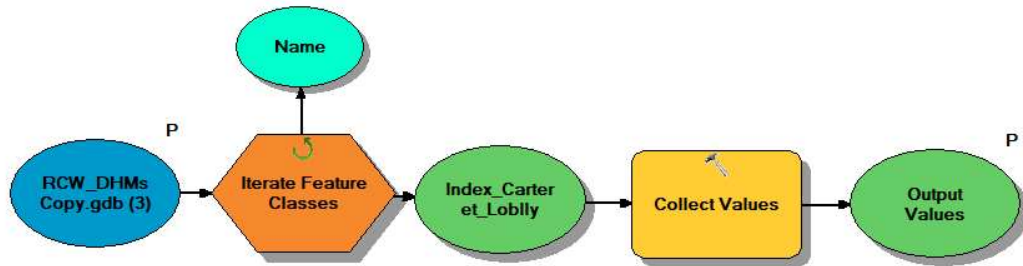
1\_NLCD

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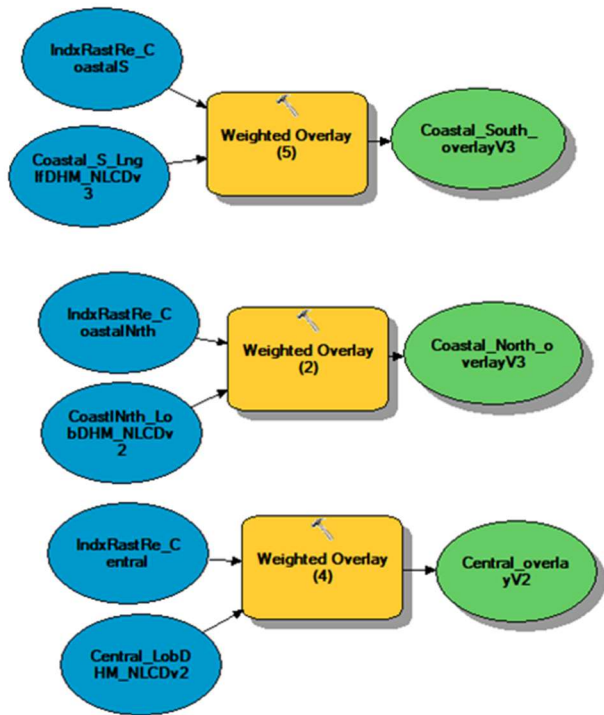


Figure 1-1.

## Appendix 2: Reviewer Documentation

### Project Information

- Species: Red-cockaded Woodpecker (*Picoides borealis*)
- Lead modeler: Katie Talavera ([katie.talavera@Terracon.com](mailto:katie.talavera@Terracon.com)), 919-602-4430.
  - Katie Talavera is a GIS Analyst at Environmental Services a Terracon Company with more than 18 years of professional experience. She has conducted field surveys, habitat assessments and potential habitat analysis for various threatened and endangered species.
- Reviewer names:
  1. Jan Goodson (Dr. J. H. Carter III and Associates, Inc.)
  2. John Hammond (USFWS)
  3. Susan Westberry (AECOM)
  4. Eric Black (SCG)
  5. Rachelle Beauregard (AECOM)
  6. Kevin Lapp (AECOM)
  7. Rebekah Reid (USFWS – West)
  8. Alicia Jackson (Dr. J. H. Carter III and Associates, Inc)
  - Jan Goodson is a senior biologist with Dr. J. H. Carter III and Associates, Inc. She has worked in the longleaf pine ecosystem(s) of the southeast for 25 years and is an expert on the federally endangered red-cockaded woodpecker (*Picoides borealis*).
  - John Hammond has worked as a biologist with the U.S. Fish and Wildlife Service in Raleigh, NC since 1999. His specialty is birds and does research with the red-cockaded woodpeckers in eastern NC.
  - Rachelle Beauregard worked for J.H. Carter III & Associates, Inc. for 4 years as a biologist specializing in the federally endangered red-cockaded woodpecker (RCW) where she conducted surveys and demographic monitoring and prepared foraging habitat assessments and Biological Assessments. She has another 15 years working for the NCDOT-Natural Environment Section where she conducted RCW surveys, managed, and obtained Section 7 concurrence for complex RCW Biological Assessments on several NCDOT projects, and was the project manager for NCDOT's RCW mitigation sites.
  - Kevin Lapp is a biologist and GIS analyst at AECOM with more than 22 years of experience in the field of natural resources. His work includes surveys for threatened and endangered plants and animals for public and private sector projects. Previous experience includes a fellowship with the U.S. Army Environmental Center assisting with management of red-cockaded woodpeckers in the NC Sandhills. He has a Master of Science in Biology from Appalachian State University where he performed research on activity patterns of a terrestrial salamander community including a state listed species.
  - Rebekah Reid is an endangered species listing and recovery biologist with the US Fish and Wildlife Service, Asheville. She specializes in plants and lichens.

- Alicia Jackson is a botanist and Certified Wildlife Biologist® with Dr. J.H. Carter III and Associates, Inc. She has over 20 years of experience surveying for rare plants in the coastal plain and sandhills and with red-cockaded woodpecker monitoring, surveys, and management.

#### Reviewer Responses from Initial Field & Desktop Reviews

- Eric Black (SCG) and Susan Westberry (AECOM) conducted a review of the potential foraging habitat of Bladen and Columbus Counties for the R-2561 study area for the initial model processes (December 2018). NRTR R-2561 consists of a 30-mile-long corridor project along existing road with a width of 1,000' wide. After review, comments include, 'Good match between areas identified in field and RCW model. Over predicts but seems to hit potential areas. It was also noted that the model was overpredicting in older growth hardwood areas.
- Alicia Jackson (JH Carter) and Katie Talavera (ESI) finished field review for R-2561 looking mainly at medium and low-quality habitats. (February 2019). It was determined the Medium quality habitat threshold should be lowered. In the model output draft 2 these low areas are identified as medium.
- Jan Goodson (JH Carter) and Melissa Ruiz (Stantec) reviewed three different versions of the sandhills region draft model output and agreed on the final draft output. The agreed upon draft output over predicts but does not miss known occurrences as the sandhills region output 3 and better defines the high potential and medium potential areas as with sandhills region output 1 (June 2019).

Range Map to Potential Habitat Draft 1

- USFWS Range 18,106,747 acres (with historic counties)
- ATLAS Range 263,963 acres (includes low, medium, high probabilities)

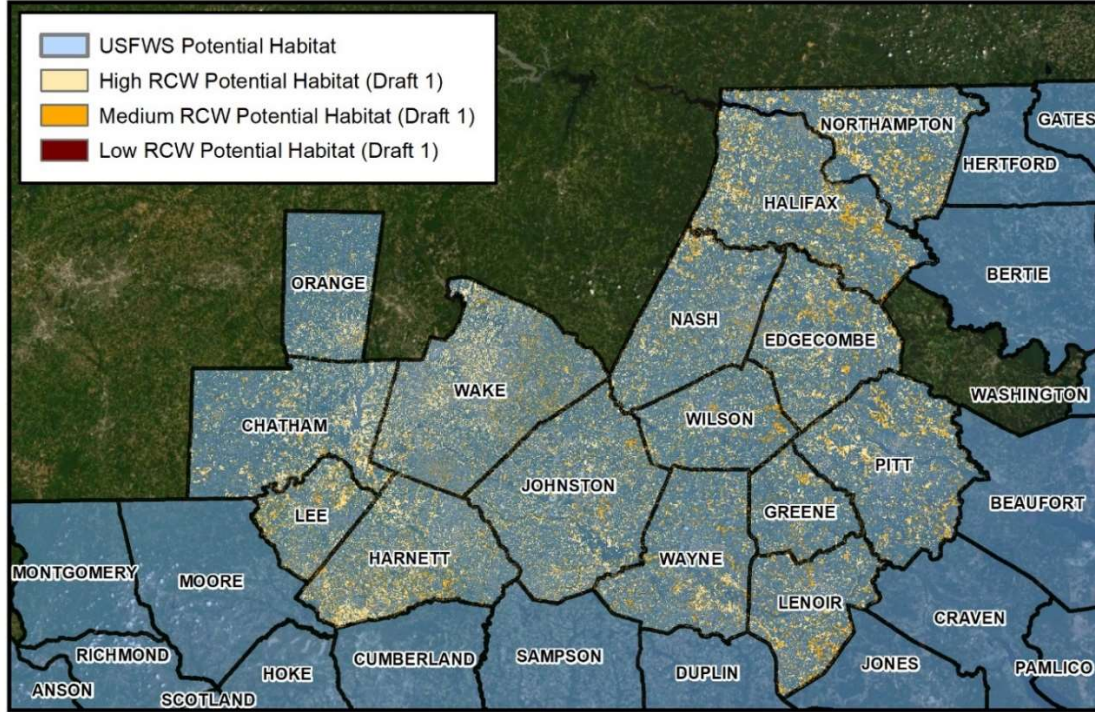


Figure 3a. Central Region Potential Habitat (Draft 1).

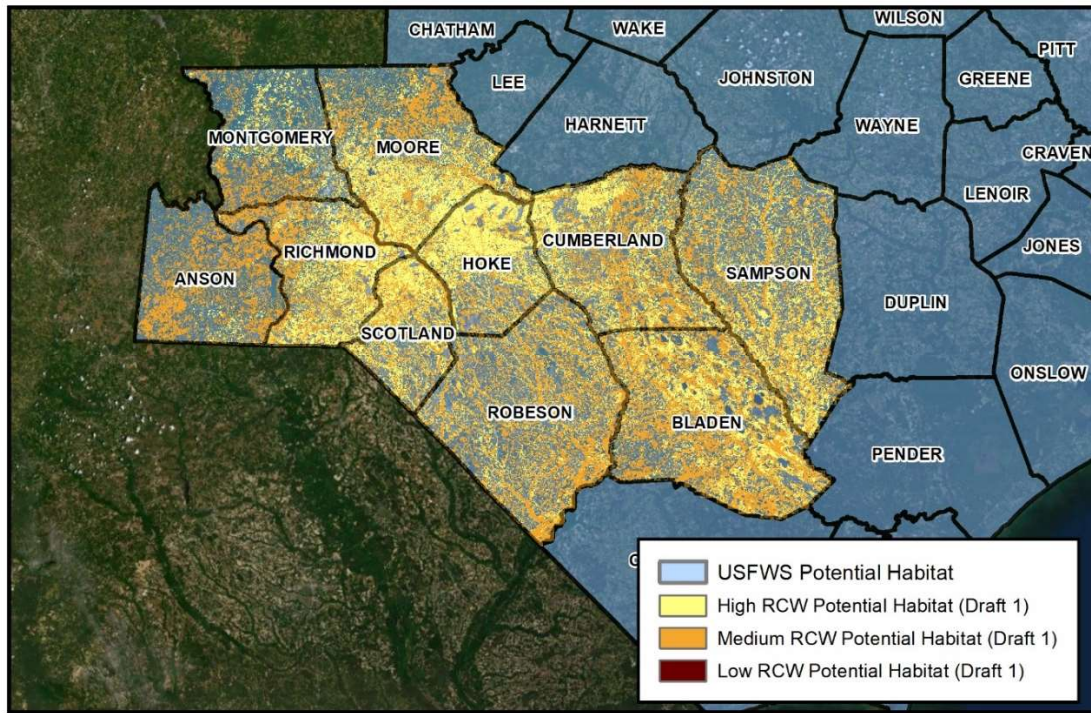


Figure 3b. Sandhills Region Potential Habitat (Draft 1).

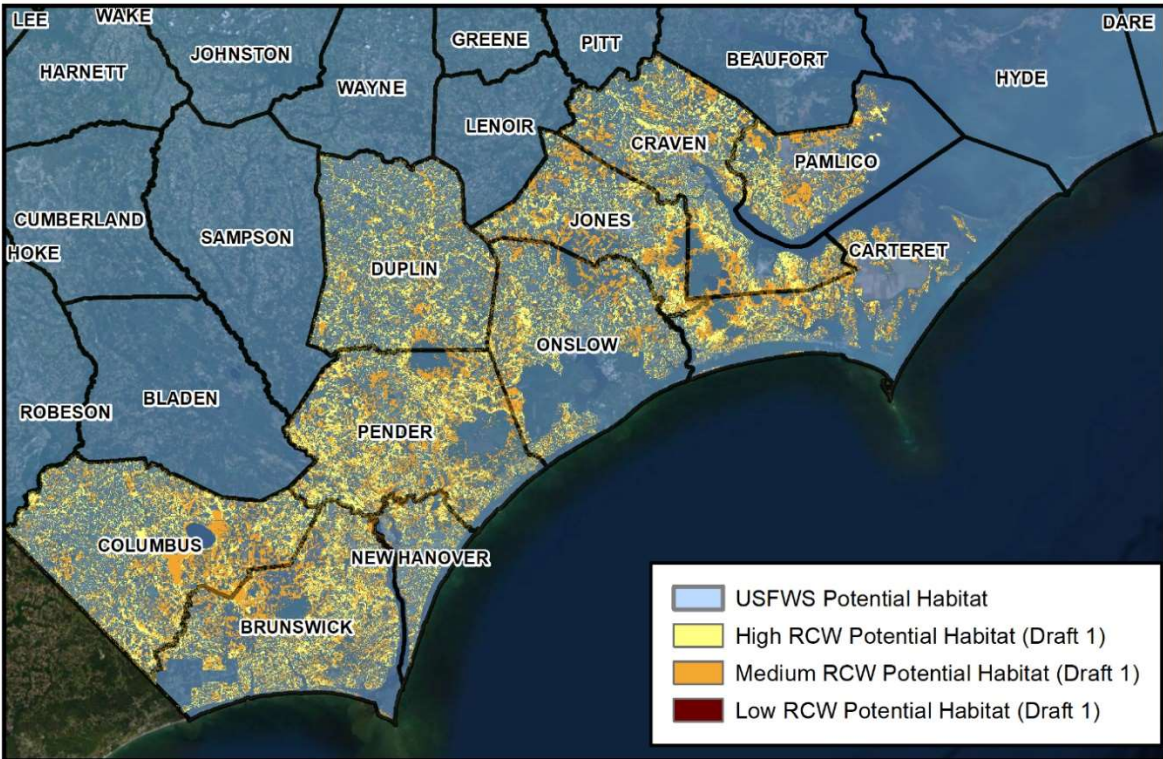


Figure 3c. Coastal South Region Potential Habitat (Draft 1).

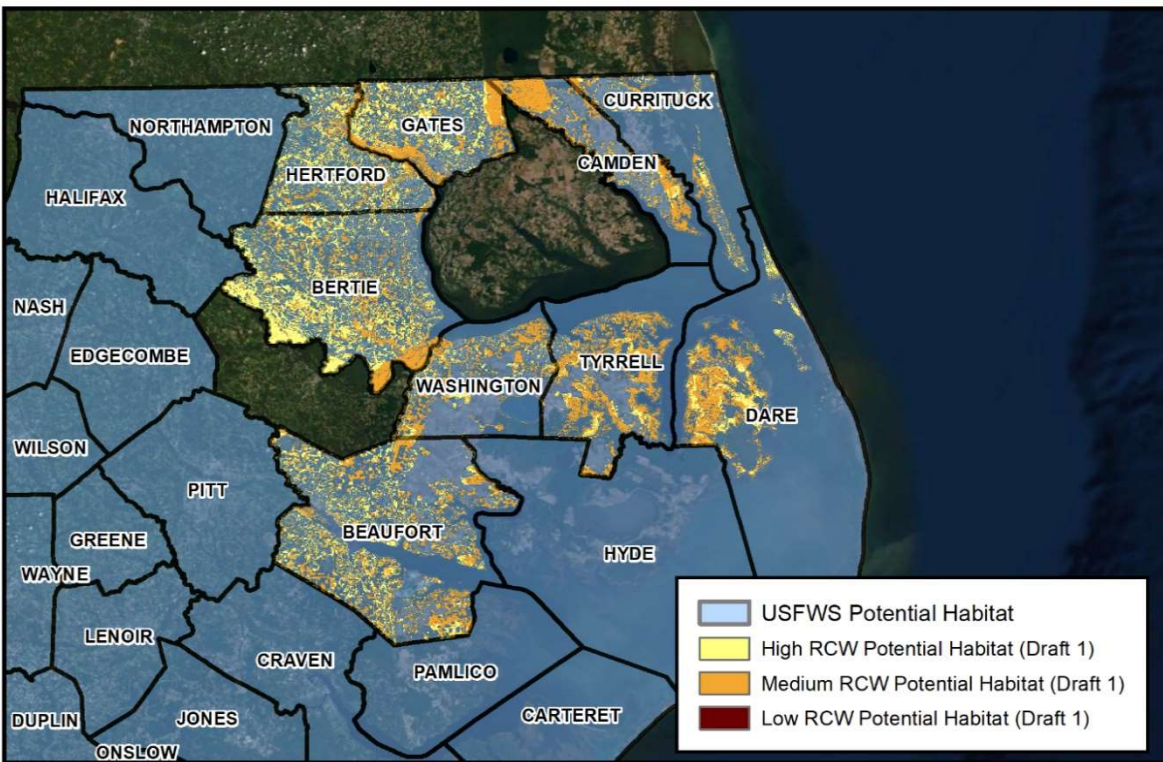


Figure 3d. Coastal North Region Potential Habitat (Draft 1).

## Summary of Draft Model

Environmental data layers used included County Boundary, LiDAR data, Soil Index values, and NLCD.

- Summary of model steps:
  - Selected North Carolina counties where RCW is known to occur.
  - Extracted vegetation strata from LiDAR data to create a Digital Height Model and reclassified.
  - Reclassified soil index values for longleaf and loblolly pines for weighted overlay.
  - Extracted known community types and those that intersect with known RCW occurrences from NLCD data.
  
- Response Rate:
  - Reviewer Response Rate: 78%
    - 53 reviewer points placed by AGOL team
    - 11,020 additional points added by reviewer

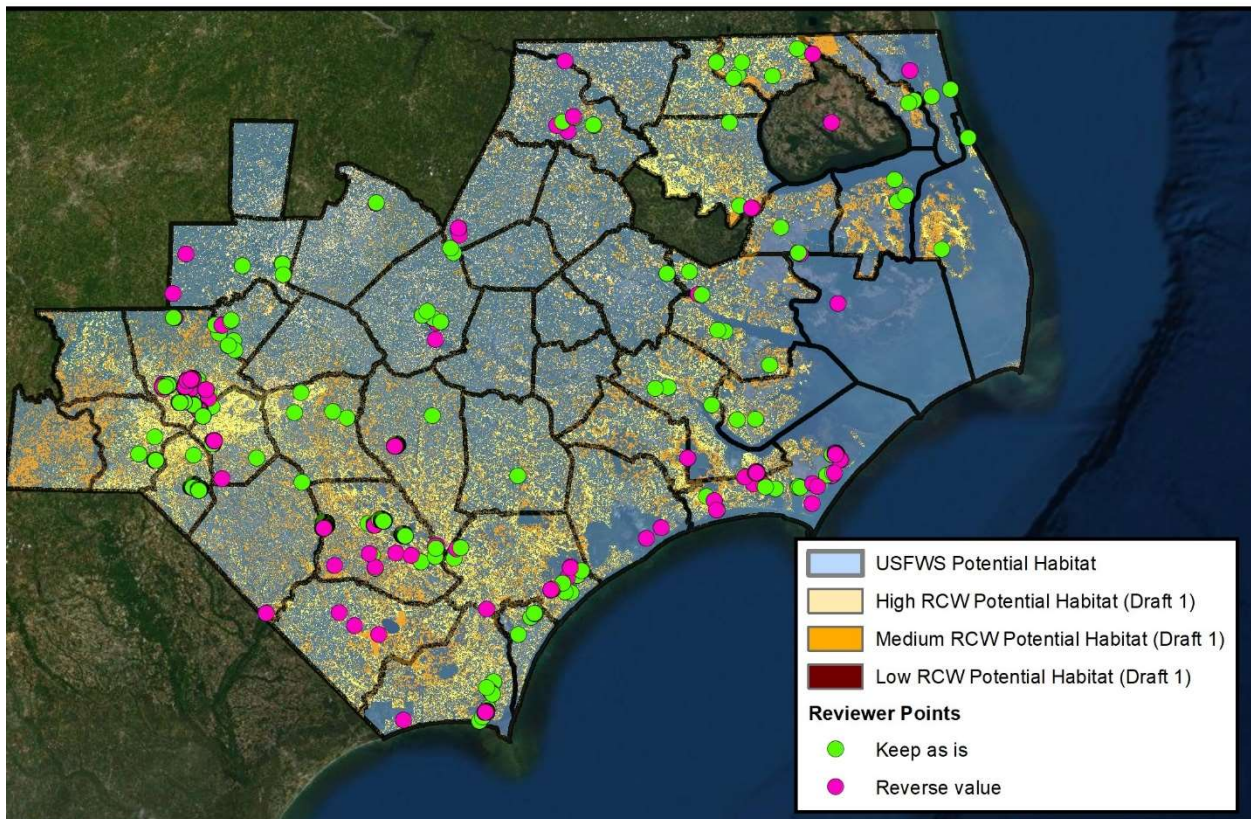


Figure 4: Reviewer Points (Draft 1)

Figure 5. Accuracy summary of the AGOL desktop review responses to model.

	Desktop Review Potential Habitat	Desktop Review Non-Habitat
Predicted Potential Habitat	True Positive 8376	False Positive 1221
Predicted Non-Habitat	False Negative 1256	True Negative 167

Based on the biologists’ desktop observations, accuracy of the classification model was as follows:

- Percent correctly classified was 78%
- Sensitivity was 0.873
- Specificity was 0.117

Table 1. Accuracy statistics based on counts in the above desktop evaluation summary table.

Statistic	Draft	Percentage
Overall accuracy	0.77522686	78%
Potential Habitat accuracy	0.87277	87%

Reviewer Responses from Preliminary Atlas Team AGOL Review

- Fifty-three model flags were placed throughout the USFWS listed range to elicit reviewer response regarding model accuracy i.e., Judgement Class: false negative, false positive, true negative and true positive for predicted RCW potential habitat. Reviewers provided a total of 11,020, with a response rate of 78%.
- Reviewers for the most part agreed with the model’s prediction of potential habitat (True Positive) and non-habitat (True Negative). Model over prediction (False Positive) was associated with model capture of hardwood areas that would meet height requirement but had incorrect NLCD landcover classification. Underprediction (False Negative) was generally adjusted with lower thresholds to capture potential areas especially in the coastal south regions. Roughly one half of the false negatives occur along open or

maintained corridors, in single pixels surrounded by potential habitat with the remaining areas recommended for further field validation.

### Proposed Draft 2 Model

To address comments by desktop reviewers, the following changes were made to the model:

- Thresholds were reduced for the southern coastal region to address comments regarding potential habitats in pocosin areas.
- NWI layers were used to exclude hardwood drainages across all regions, with less values filtered for the coastal north region to not eliminate hydrologic wetland margins that have been previously identified as potential habitat. The NWI layers were addressed per region to minimize the result of new false negatives.

### Previous Model Version (DRAFT)

The DRAFT version of the model was developed in 2018. One new layer, USFWS NWI, was added following model review and the threshold was lowered in the coastal south region to include more potential pocosin habitat areas as suggested by the AGOL review.

### ***Layer 5 (layer added to model after AGOL review)***

#### **Data Layer 5**

- Layer name: CONUS\_wet\_poly (National Wetlands Inventory (NWI))
- Layer description:
  - This data set represents the extent, approximate location, and type of wetlands and deep-water habitats in the conterminous United States. These data delineate the spatial extent of wetlands and surface waters as defined by Cowardin et al. (1979).
- Layer selection justification:
  - This layer was used to lessen the potential of Headwater Forests and Riverine Swamp Forests that consist of hardwood dominated old growth trees for the Sandhills, Coastal South and Central Regions. In many areas, co-located foraging or nesting areas are less prevalent and many of these old growth trees are due to hydrologic stream buffers. This layer was less helpful in the coastal north region as RCW have been found to occur in more hydrologically prevalent landscapes.
- “Habitat” versus “Nonhabitat” designations:
  - The model should over predict in these areas of the Coastal North more so than the other regions due to these limitations.



Changes from AGOL Review

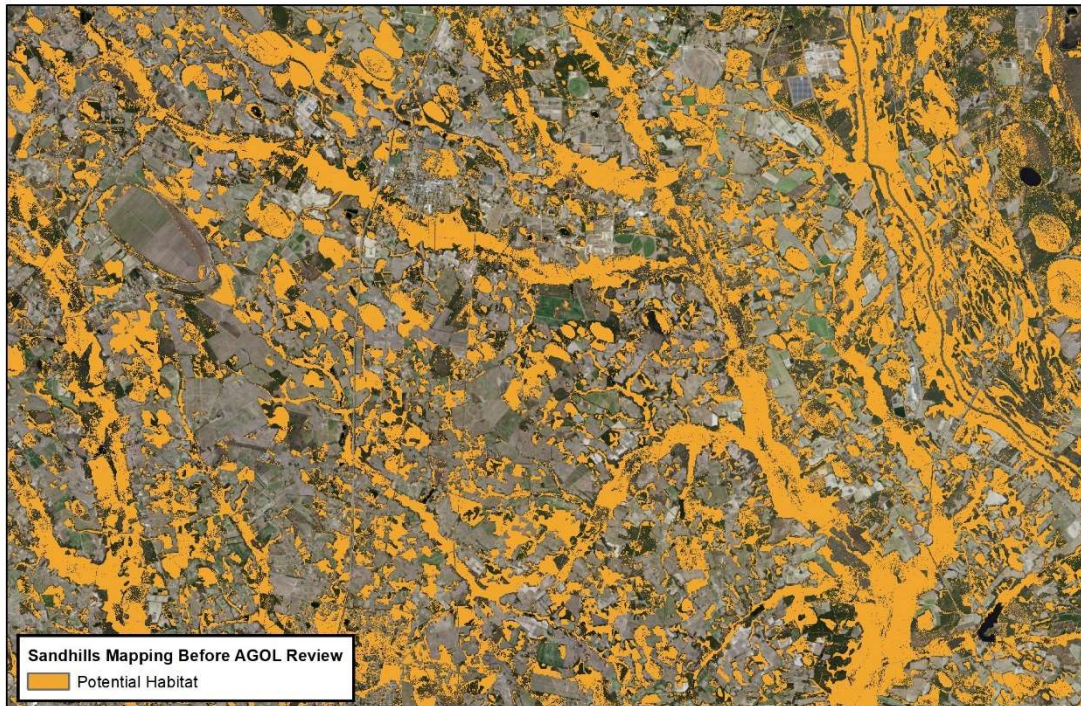


Figure 6a. Sandhills Region Potential Habitat (Draft 1).

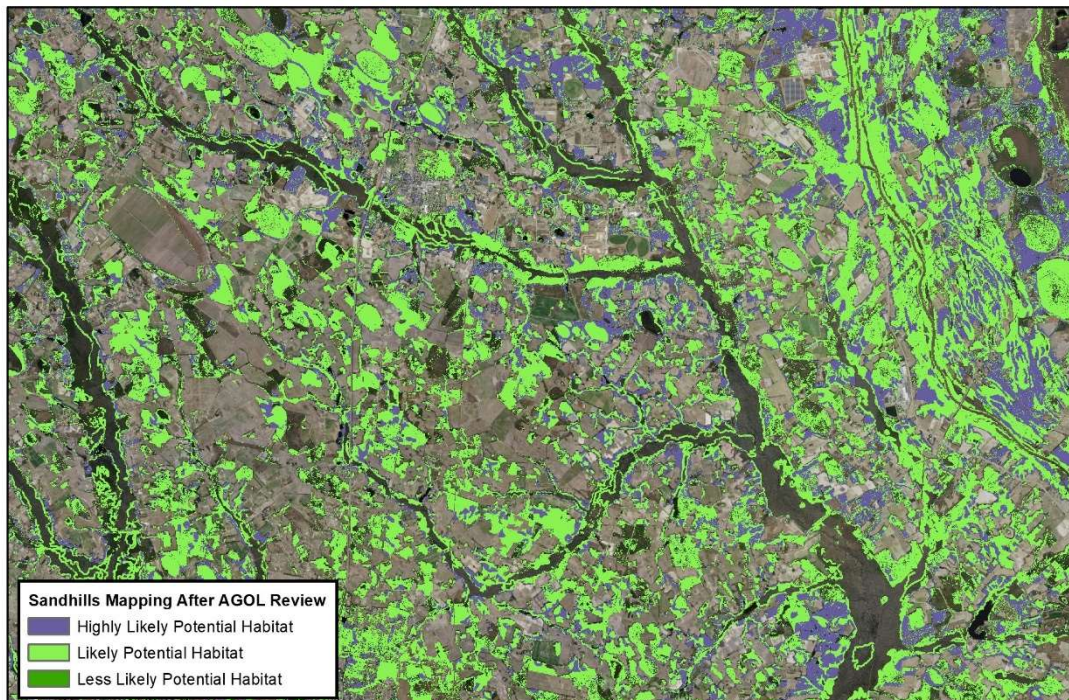


Figure 6b. Sandhills Region Potential Habitat (Draft 2).

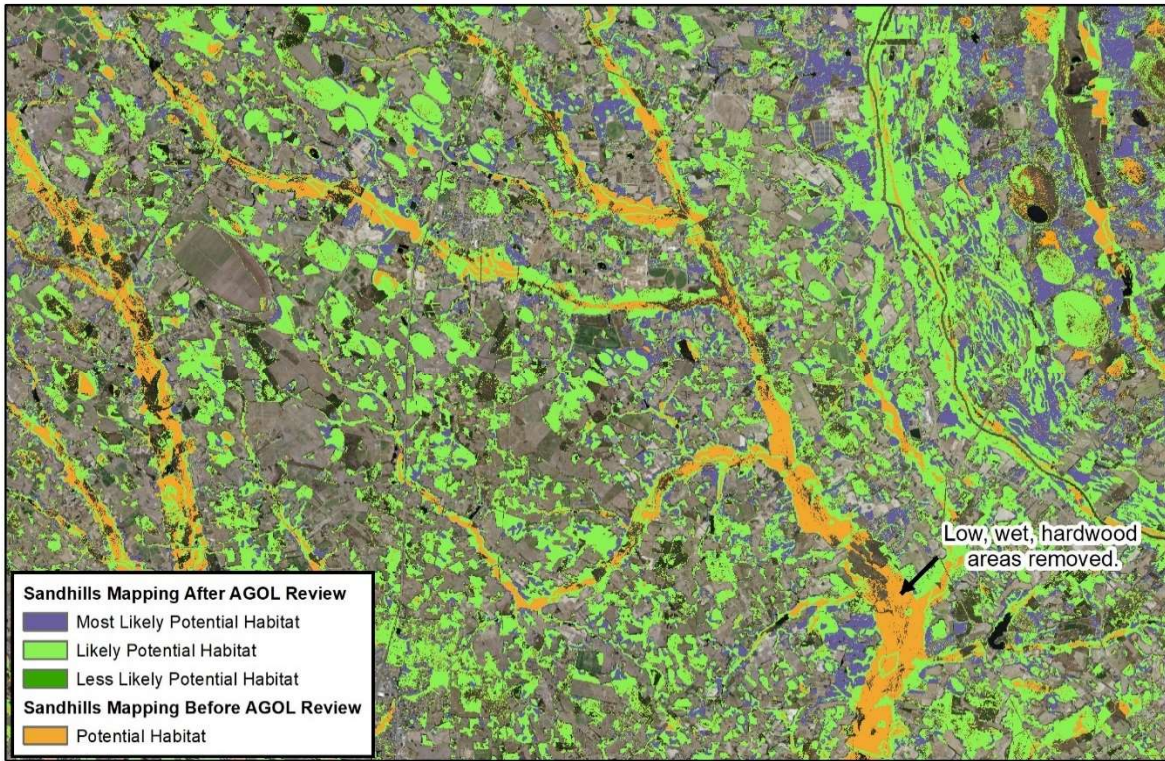


Figure 6c. Overlay of mapping after addressing AGOL comments.

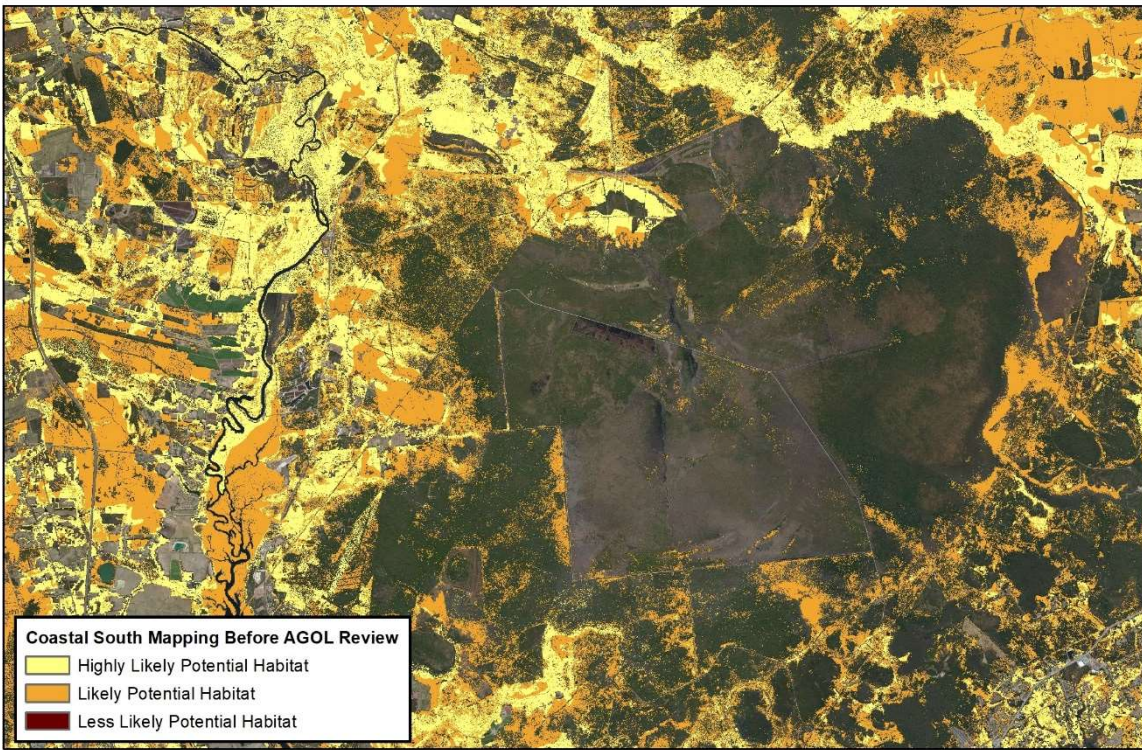


Figure 7a. Coastal South Region Potential Habitat (Draft 1).

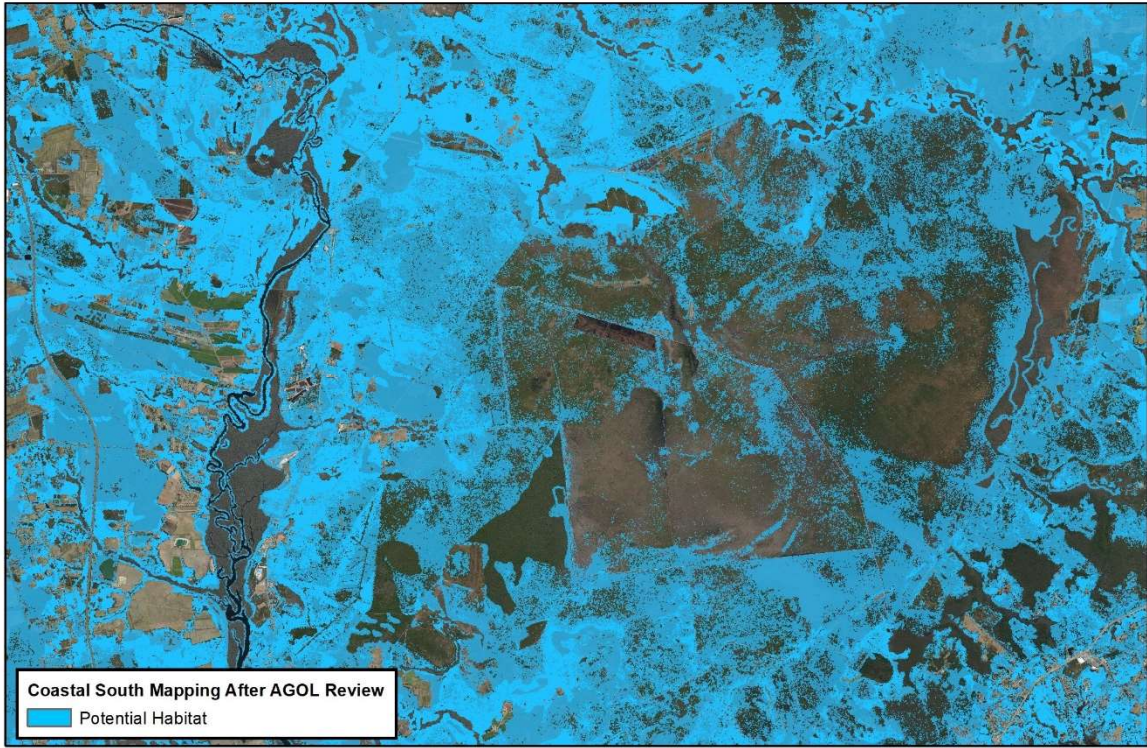


Figure 7b. Coastal South Region Potential Habitat (Draft 2). More Pocasin coverage.

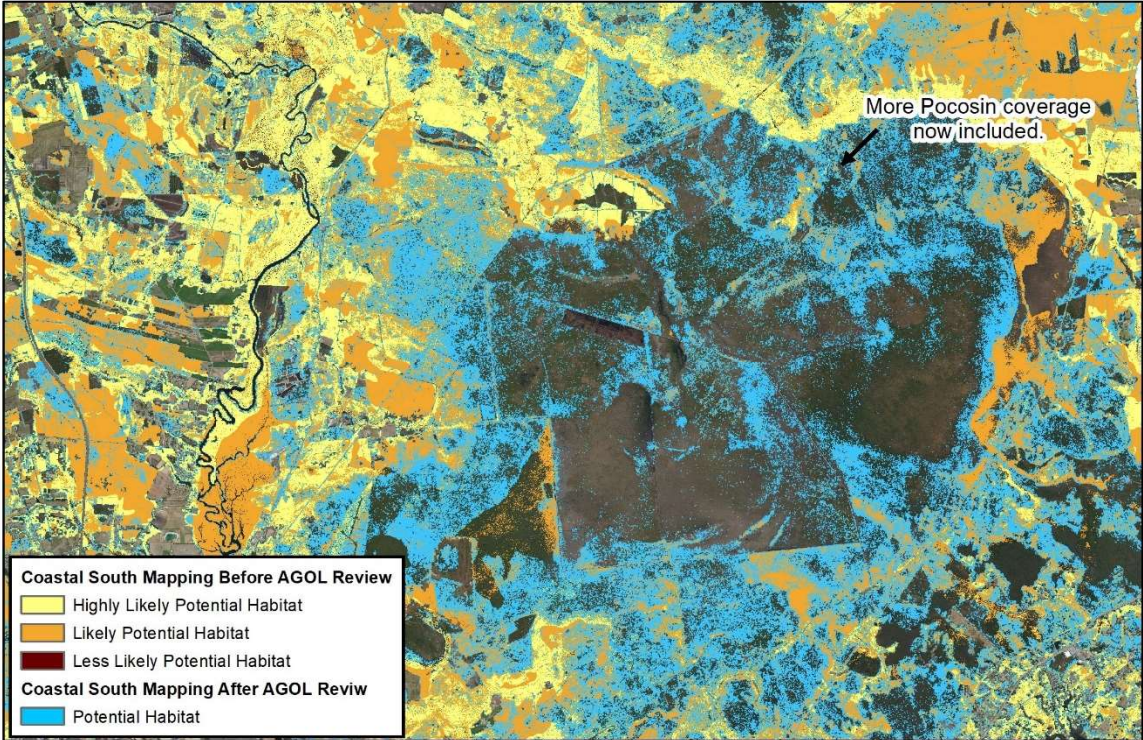


Figure 7c. Overlay of mapping after addressing AGOL comments.

Model Field Assessment and Accuracy Statistics

Habitat model field assessments performed in 359 locations across the “current” USFWS listed counties in December 2019, assisted to clarify model strengths and weaknesses. Across 33 of 34 current counties including Currituck, Camden, Gates, Hertford, Dare, Tyrell, Wake, Washington, Chatham, Johnston, Beaufort, Hyde, Greene, Wayne, Camden, Pamlico, Sampson, Cumberland, Jones, Carteret, Hoke, Duplin, Richmond, Scotland, Onslow, Robeson, Bladen, Pender, Columbus, New Hanover, Brunswick, Harnett, and Moore Counties, no data was collected for Bertie County. A stratified sample of points were generated on “accessible lands” (generally public lands and right-of-ways) and biologists aimed to survey at least 10 points per county within the range. At a given point, biologists characterized the site as “Potential Habitat” or “Non-Habitat”, mapped the area as a polygon, and provided site descriptions and photos to justify their conclusion. If a single site included both Potential Habitat and Non-Habitat (e.g., differing habitat on either side of a road), two polygon entries were logged.

Figure 8. Accuracy summary of the review responses after field validation.

	Field “Actual” Potential Habitat	Field “Actual” Non-Habitat
Predicted Potential Habitat	True Positive <b>113</b>	False Positive <b>67</b>
Predicted Non- Habitat	False Negative <b>28</b>	True Negative <b>151</b>

Based on the biologists’ field observations, accuracy of the classification model was as follows:

- Percent correctly classified was 74%
- Sensitivity was 0.63
- Specificity was 0.156

Table 2. Accuracy statistics based on counts in the above field validation summary table.

Statistic	Version 1	Percentage
Overall accuracy	0.735376	74%
Potential Habitat accuracy	0.627777	63%

The biologists/ summarized their observations as follows:

- Overall assessment from field reviewers describe 'there were not many areas that were underpredicted.' It was also described to overpredict, picking up hardwood areas with old growth trees.
- Occasional comments included in field review discuss the potential for habitat down the road, 'Pines are young now. But this will "become" habitat with age.' Reviewer is correct, but their assumptions/risk differ from assumptions/risk relevant to NCDOT. The model tries not to include habitat that is too young because it does not meet the current criteria for potential nesting or foraging habitat. It could be cut before it reaches the proper age. The model was built with the expectation that trees close to age are captured and an update to the model in 15/30 years would then collect what may be habitat at that time.

Additional revisions to the model include converting final model outputs to shapefile, moving low potential habitat areas into medium and adding county coverage as the low classification for full county coverage. County status including use of historic counties have also changed since the start of the process. The model outputs include counties that are listed by USFWS as of September 2021.