Expert-based Model Guidance and Documentation (Version 1)

Project Information

- Species: rufa red knot (*Calidris canutus rufa*)
- Lead modeler: Adam Efird, Three Oaks Engineering (adam.efird@threeoaksengineering.com), 919-407-8461
- Date started: April 2018
- Date completed: July 2023

Species Information

NCDOT NRTR Habitat Description

USFWS Optimal Survey Window: Year Round

The rufa red knot is one of the six recognized subspecies of red knots and is the only subspecies that routinely travels along the Atlantic coast of the United States during spring and fall migrations. It is known to winter in North Carolina and to stop over during migration. Habitats used by red knots in migration and wintering areas are similar in character: coastal marine and estuarine habitats with large areas of exposed intertidal sediments. In North America, red knots are commonly found along sandy, gravel, or cobble beaches, tidal mudflats, salt marshes, shallow coastal impoundments and lagoons, and peat banks. Ephemeral features such as sand spits, islets, shoals, and sandbars, often associated with inlets can be important habitat for roosting.

Additional Species Information

There are 14 occurrences of rufa red knot in the NHP Data Explorer as of June 2022.

County Information

- NHP listed counties: New Hanover and Onslow wintering habitat only.
- FWS current listed counties: Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven, Currituck, Dare, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell, Washington
- Additions proposed by reviewers: NA

Environmental Data Information

All spatial data are in NAD 1983 State Plane North Carolina FIPS 3200 (US feet).

Layer 1

- Layer name: CountyBoundaryShoreline
- Layer description:
  - Select counties with potential for red knot presence from County Boundary shapefile.
- Layer selection justification:
  - Layer is used for county boundaries and shoreline area.
- "Habitat" versus "Nonhabitat" designations:
  - Layer is used to delineate counties with red knot presence and is not used for habitat determinations. The layer was also used to create an area of low potential habitat within the county boundary but outside of the high potential habitat area.

Layer 2

- Layer name: dcm_oceanfront_shorelines
- Layer description:
  - Division of Coastal Management shoreline data from 2009 and 2016.
- Layer selection justification:
  - Data layer was incorporated into the model with 2009 and 2016 shorelines (to ensure complete coverage of coast) buffered 20 miles in order to incorporate all inland areas that may contain potential habitat. The layer was processed in a preliminary model step included in the GDB as the model entitled "Prelim_DCMShorelines" in order to process the merge and dissolve of the 2009 and 2016 shorelines to a cohesive file for use in the model.
- "Habitat" versus "Nonhabitat" designations:
  - Area within 20-mile buffer is potential habitat. Areas of buffer were removed using NLCD data to reduce areas of nonhabitat.

Layer 3

- Layer name: NLCD Landcover Data 2019
- Layer description:
  - NLCD 2019 landcover data.
- Layer selection justification:
  - The NLCD 2019 data was used to reduce areas of nonhabitat such as forested areas and medium to highly developed areas.
- "Habitat" versus "Nonhabitat" designations:
  - Nonhabitat or low potential habitat designations used for this model – deciduous forests, developed – high intensity, emergent herbaceous wetlands, evergreen forest, mixed forest, and woody wetlands
  - Habitat designations used for this model - open water, developed – low intensity, developed – medium intensity, barren land, shrub/scrub, herbaceous, hay/pasture, cultivated crops. Note that these habitats were not excluded and used in the model, but accuracy for these types varied widely.

Model Information

- Model domain
  - This model identifies all year-round potential suitable habitat for the species.
- Model output
  - Figure 1 – Model prediction.
  - Model output is binary, and includes the USFWS species range, excluding historic counties. The species model range is split between “High” and “Low” potential habitat. “High potential habitat” represents GIS based layer areas deemed suitable habitat, and “Low potential habitat” representing areas identified as areas deemed low quality or non-habitat.
  - Shapefile covering listed counties.
- ArcGIS Model Builder
  - version ArcMap 10.4.1.
  - Model builder toolbox attached as deliverable.
- Selected all coastal open water areas, buffered DCM shorelines (2009 and 2016), and selected counties and merged all layers. Any landcover classes that are not typical habitat were then removed from the modeled area to produce the final model. ArcGIS Online (AGOL) Review
  - A model prediction file was shared with select reviewers on ArcGIS Online. Points were placed within the USFWS potential habitat as well as the model potential habitat.
  - AGOL review was completed in May 2019 on the draft version of this model (See Appendix 2).
- Independent Data Review
  - Describe data sources –NLCD landcover and DCM shorelines (2009 and 2016).
  - Describe methods – Current aerial imagery was used to determine likelihood of habitat.

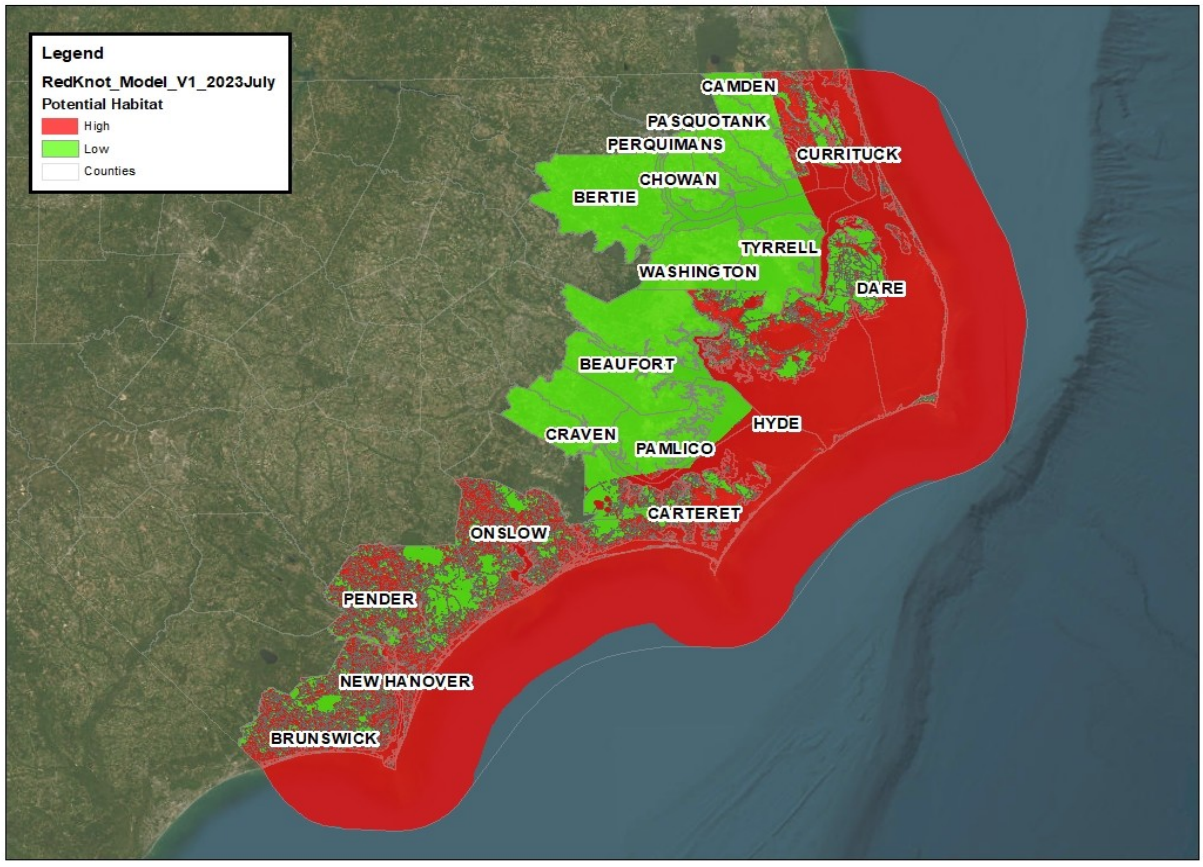


Figure 1. High and Low Potential Habitat (V1)

Previous Model Versions (Draft)

The previous version of this model was developed in July 2018. A second version after review was developed (DRAFT 2). In 2022, the Version 1 model was updated to reflect the current county ranges for red knot. Figure 1 and Figure 4 shows the current Version 1 model as updated in 2023. The model remained primarily the same as previous versions, but with areas of overlapping polygons removed and cleaned up for the July 2023 version.

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) (shapefile).*
- *Desktop AGOL reviewer comments (shapefile).*

References

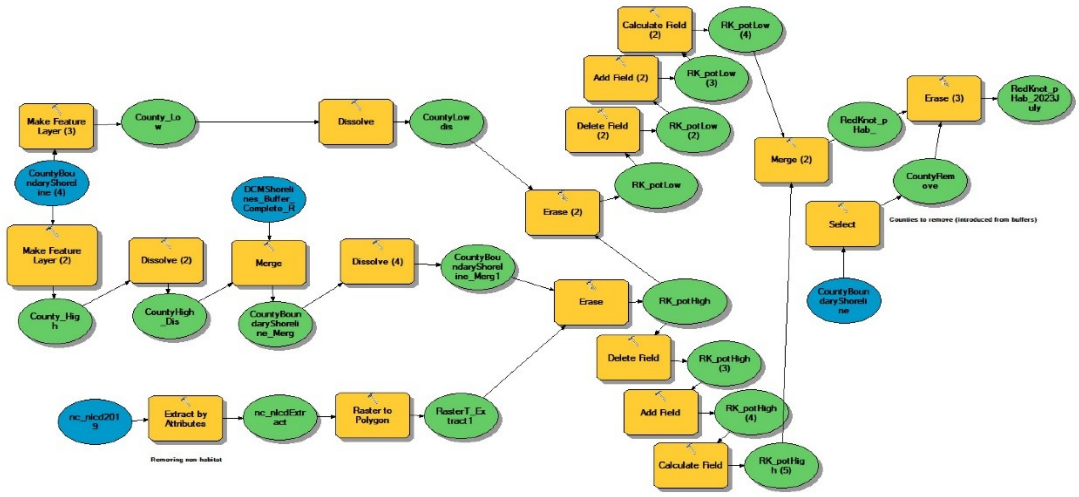
NatureServe. 2018. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.

North Carolina Natural Heritage Program. 2022. Biotics Database. Division of Land and Water Stewardship. Department of Natural and Cultural Resources, Raleigh, North Carolina.

United States Fish and Wildlife Service (USFWS). 2018. ECOS Environmental Conservation Online System (Accessed: May 2, 2018).

USFWS. Rufa Red Knot Ecology and Abundance, Supplement to: Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*) http://www.fws.gov/northeast/redknot/pdf/20130923_REKN_PL_Supplement02_Ecology%20Abundance_Final.pdf. (Accessed: June 02, 2018.)

Appendix 1: Rufa Red Knot Version 1 Expert Model



Appendix 2: Reviewer Documentation

Project Information

- Species: rufa red knot (*Calidris canutus rufa*)
- Lead modeler: Adam Efird (adam.efird@threeoaksengineering.com), 919-407-8461
- Reviewer names:
  1. John Hammond (USFWS)
  2. Kathryn Matthews (USFWS)
  3. Sara Schweitzer (NCWRC)
  - 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.
  - Kathy Matthews is a biologist with the U.S. Fish and Wildlife Service, and previously worked for EPA as a wetland biologist. She reviews proposed projects for impacts to federally listed species. She has degrees in marine biology and marine ecology from Florida Institute of Technology.
  - Dr. Sara Schweitzer is the Assistant Chief for the Division of Wildlife Management and oversees the Wildlife Diversity Program for the N.C. Wildlife Resources Commission (WRC). She led the Waterbirds Investigations and Management Project for WRC from 2010-2018. She came to WRC from the University of Georgia where she a wildlife faculty member in the Warnell School of Forestry and Natural Resources from 1995-2010. Currently, she is an Adjunct Professor and Graduate Faculty member with UNCW, serving on several graduate student committees.

Range Map to Potential Habitat Version 1

- USFWS Range 5,608,210 acres
- ATLAS Draft Range 658,383 acres

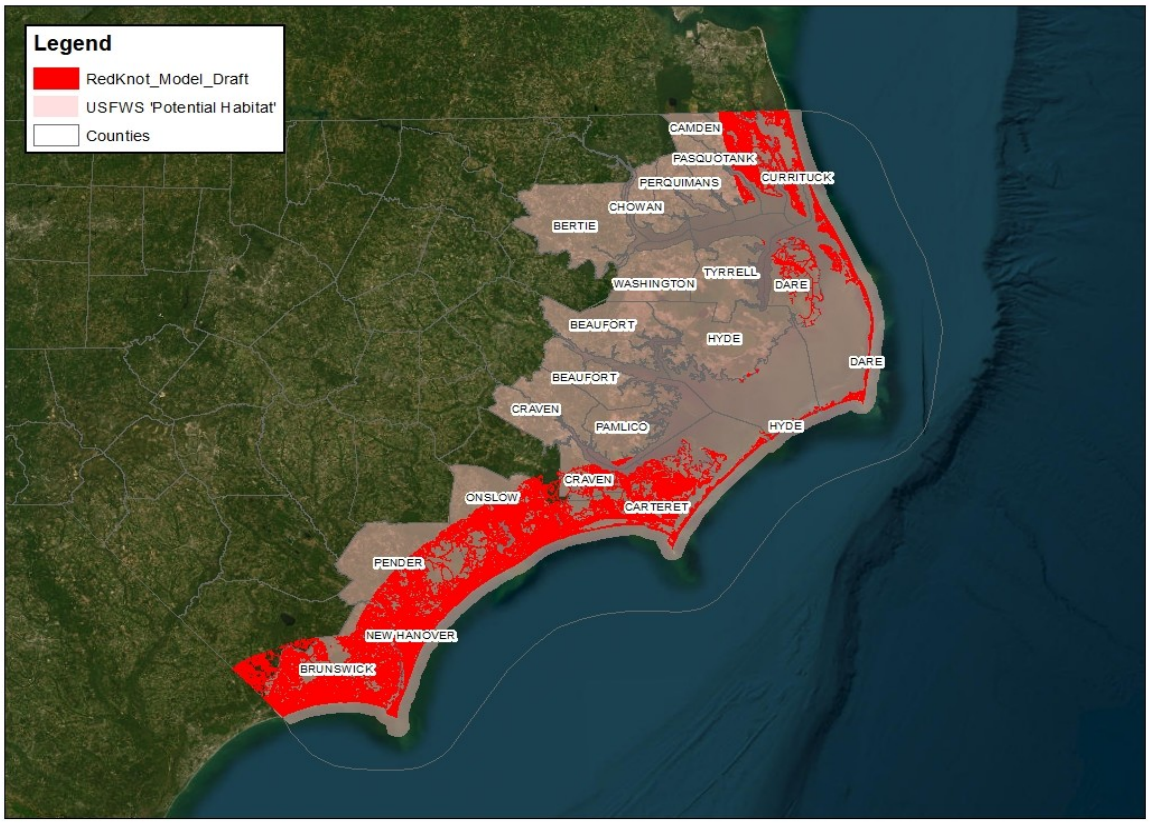


Figure 2. Range Map and High Potential Habitat (DRAFT)

Summary of Draft Model

- Primary change to the model is the data source for open water has been substituted, as well as a significant reduction in total acreage for the model's potential habitat, using 2019 NLCD landcover data to extract non-habitat land use categories, such as medium and high-density development and forested landcover classes. In addition, further model coverage for USFWS current counties were added using a 2-mile buffered tidal influence layer.
- Selected all coastal open water areas, NHP data, buffered DCM shorelines (2009 and 2016), and selected counties and merged all layers. Any landcover classes that are not typical habitat were then removed from the modeled area to produce the final model. The tidal influence layer from the ATLAS sweeping team was added and buffered 2 miles to add additional model coverage for current USFWS-listed counties.

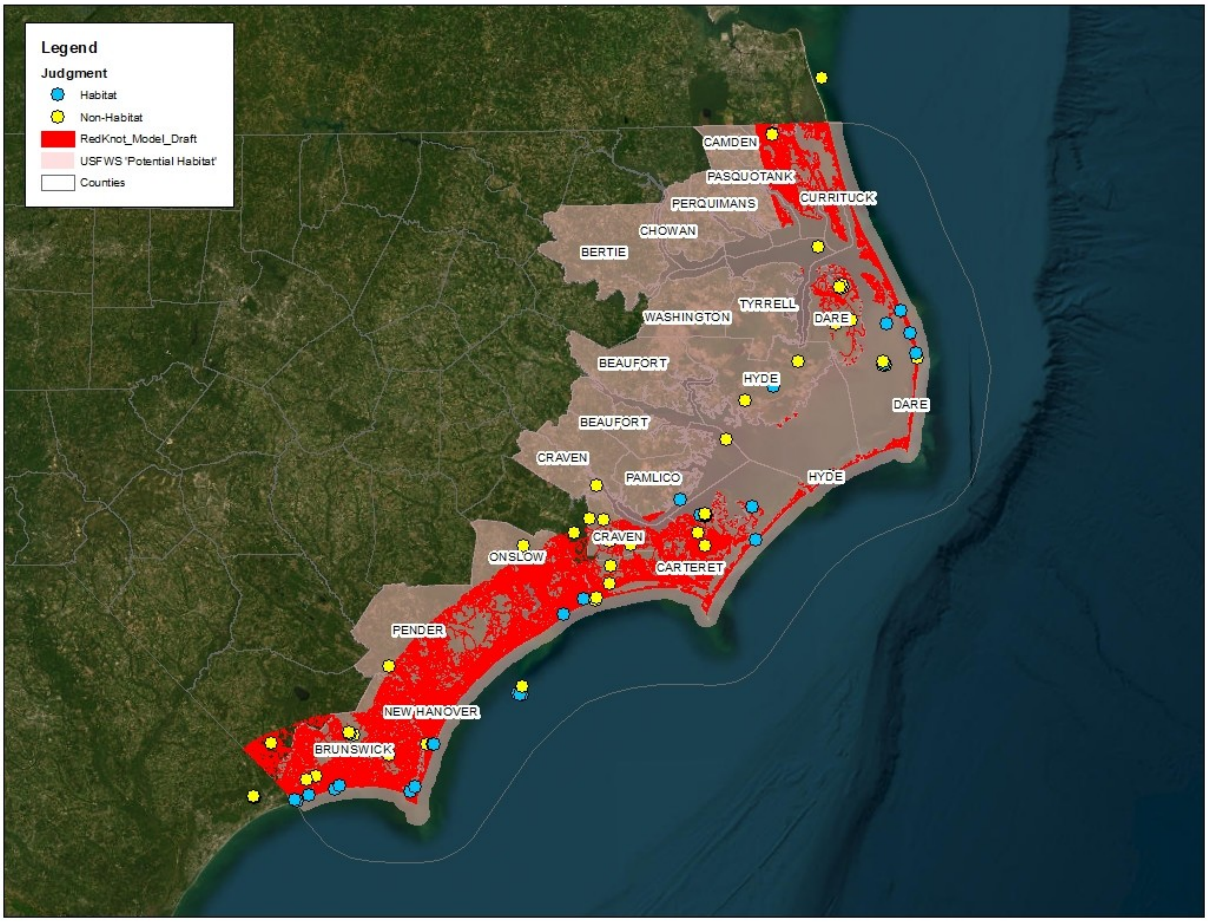


Figure 3. Desktop Reviewer Points

- Desktop Response Rate
  - AGOL Reviewer Response Rate: 100%
    - 24 reviewer points placed by modeler
  - # Additional comments (placed by reviewers): 55

<u>Reviewer Responses</u>

- Reviewers provided a complete and balanced review. Flags of non-habitat areas were primarily focused on areas where the landcover data or the open water data did not match what was viewable on the aerial photography.
- Reviewers for the most part agreed with the potential habitat. Modelers commented that areas of non-habitat occasionally were included in the model and should be removed. Examples of non-habitat observed by reviewers: maritime forest, forested uplands, marshes, canals, ditches, developed land, open waters and inland waterbodies not connected to the estuary.

Proposed Version 1 Model

In order to address comments by reviewers, the following changes were made to the model:

- A significant portion of the area deemed potential habitat in the previous model was designated as low potential habitat based on the 2019 NLCD landcover data classifications, such as forested class types and medium to high intensity developed areas.
- While reviewers commented on the overprediction of non-suitable habitats, potential habitat could not be further refined using landcover due to limitations and inconsistencies in data content and scale.

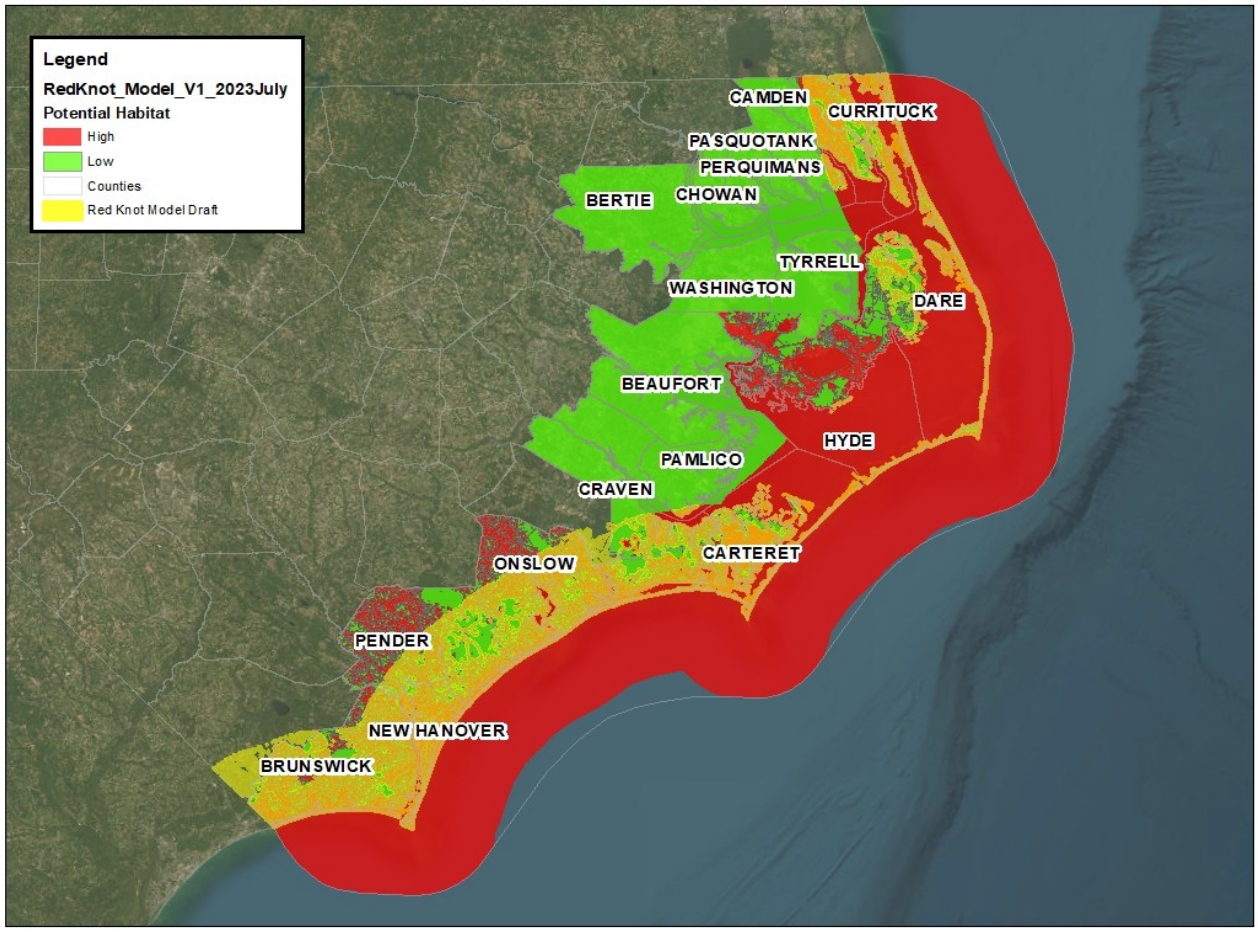


Figure 4. Potential Habitat Version 1 vs DRAFT version of model.

Model Assessment and Accuracy Statistics

Figure 5 illustrates the accuracy statistics for the model assessment sites. The rufa red knot potential habitat model clearly illustrates the general geographic areas along barrier islands beaches, sounds, and sandy natural areas that GIS-based layers can best predict for at a particular period of time.

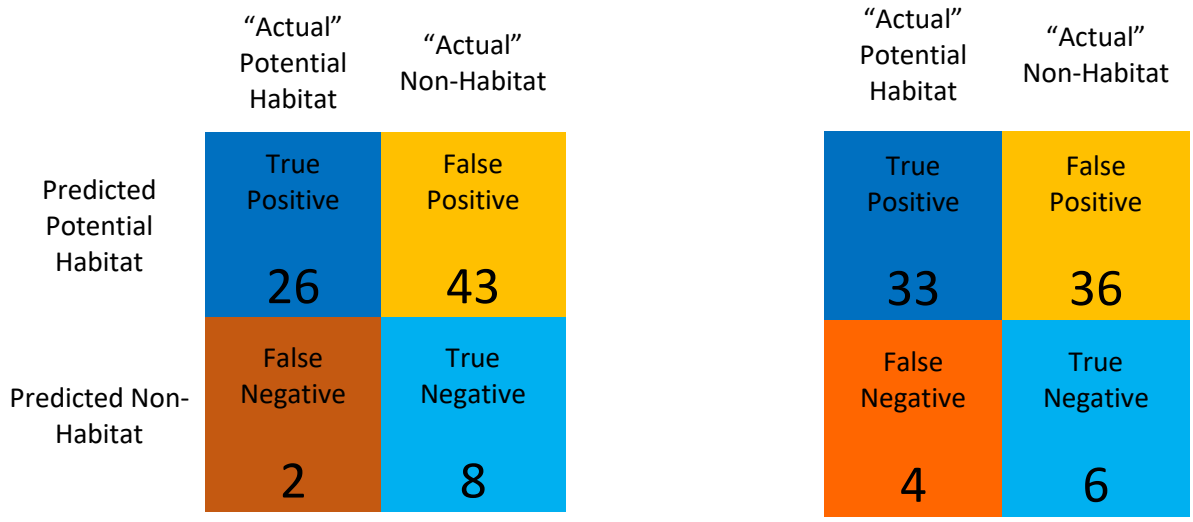


Figure 5. Accuracy summary of the desktop reviewer responses based on model assessment of Draft (left) Version and Version 1 (right) model output.

Desktop accuracy statistics of the Draft and Version 1 binary classification model as follows:

- Percent correctly classified was 43% (Draft), 49% (Version 1)
- Sensitivity was 0.928571429 (Draft), 0.891891892 (Version 1)
- Specificity was 0.156862745 (Draft), .14285714 (Version 1)

Desktop comments are summarized as follows:

- The model generally overpredicts for potential habitat and predicted false positives for developed neighborhoods, maritime forests, forested uplands, non-sandy shorelines or beaches, marshes, canals, ditches, and inland waterbodies. Due to the dynamic nature of coastal beaches this model will capture a snapshot in time of the current shoreline and coastal ecosystem.

The model remained largely the same between draft and V1 versions except for the county range of the model V1 version being corrected as well as improvements in determining non-habitat landcover types. This allowed for the percent correctly classified of the V1 model increasing from the draft version.