

Expert-based Model Guidance and Documentation (Version 1)

Project Information

- Species: roseate tern (*Sterna dougallii dougallii*)
- 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: June to August

In North Carolina, the roseate tern is most likely to be seen on a barrier island as it passes through the area to and from northern breeding grounds. March through May and August through October are the most likely times to see these birds. Although sight records of this species exist for June, July, and August, these are likely non-breeding males. Only one nesting record for this species has been documented for the state within the past twenty years. However, if this species expands its range, it is likely to choose coastal areas of the state for nesting. The roseate tern nests on isolated, less disturbed coastal islands in areas characterized by sandy, rocky, or clayey substrates with either sparse or thick vegetation. Eggs are usually laid such that grasses or overhanging objects provide shelter. They may also nest in marshes, but it is an uncommon occurrence.

Additional Species Information

NHP records used at time of model were from January 2018 and checked in June 2022. There are 2 NHP EOs for roseate tern, with both records being historic.

County Information

- NHP listed counties: Carteret, Dare
- FWS current listed counties: Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, Pender
- 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 Water and roseate tern counties 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 roseate tern 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. This layer was processed in a preliminary model included in the GDB entitled “Prelim_DCMShoreline_RoseateTern” to be used in the model as a merged and dissolved feature.
- Layer selection justification:
 - Data layer was incorporated into the model with 2009 and 2016 shorelines (to ensure complete coverage of coast) buffered 4 miles in order to ensure minimum coverage of 4 miles inland across the entire NC coast.
- “Habitat” versus “Nonhabitat” designations:
 - Area within buffer is most likely potential habitat, but other layers were used to refine the model beyond this 4-mile buffer.

Layer 3

- Layer name: nheo_tier2
- Layer description:
 - Tier 2 data acquired from NC Natural Heritage Program
- Layer selection justification:
 - Data layer was incorporated into model with any roseate tern records selected and included in final merged output file.

Layer 4

- 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, NHP element occurrence data, buffered DCM shorelines (2009 and 2016), and selected counties and merged. Eliminated areas of nonhabitat based on 2019 NLCD land cover data.
- 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 to solicit feedback. Reviewers could place additional comments for consideration by modeler.
 - AGOL review was completed in May 2019 on draft version of this model (See Appendix 2).
- Independent Data Review
 - Describe data sources –natural heritage element occurrence data, open water data, NLCD land cover and DCM shorelines (2009 and 2016).
 - Describe methods – Current aerial imagery was used to determine likelihood of habitat.

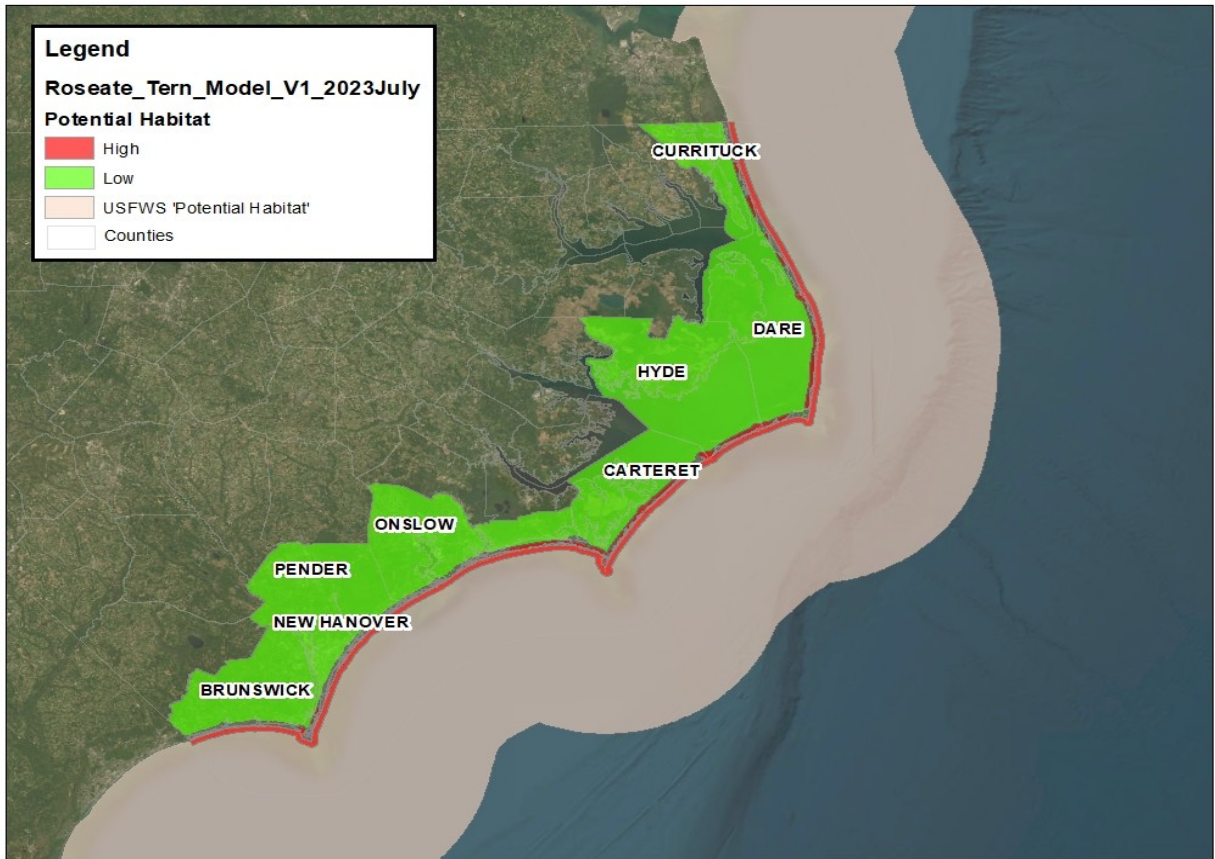


Figure 1. USFWS Range Map and Potential Habitat (V1)

Previous Model Versions (Draft)

The previous version of this model was developed in July 2018. NLCD 2019 landcover data was used to refine the model. In addition, the area of model coverage was expanded in 2022 and 2023 to include the range counties with areas of high and low potential habitat. USFWS last updated the range maps in January 2022 for the Atlantic Coast south to NC region. Figures 1 and 4 shows the current Version 1 model with the current USFWS range. The model was unchanged from the 2022 version except for areas of overlapping polygons being corrected and dissolved in the model.

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)*

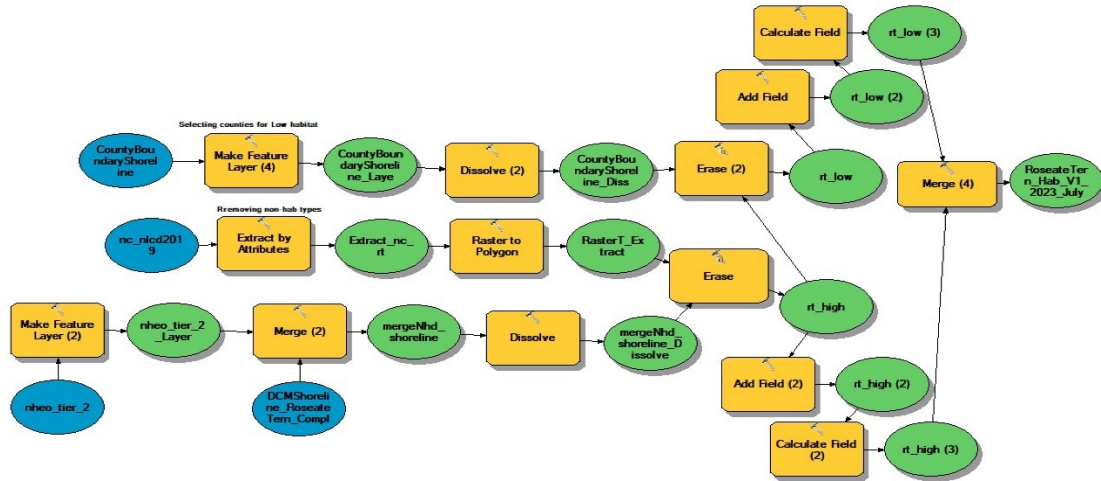
References

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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.

Appendix 1: Roseate Tern Version 1 Expert Model



Appendix 2: Reviewer Documentation

Project Information

- Species: Roseate tern (*Sterna dougallii dougallii*)
- 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 568,558 acres (open water excluded)
- ATLAS Draft Range 852,464 acres (incorporates areas of open water and land)

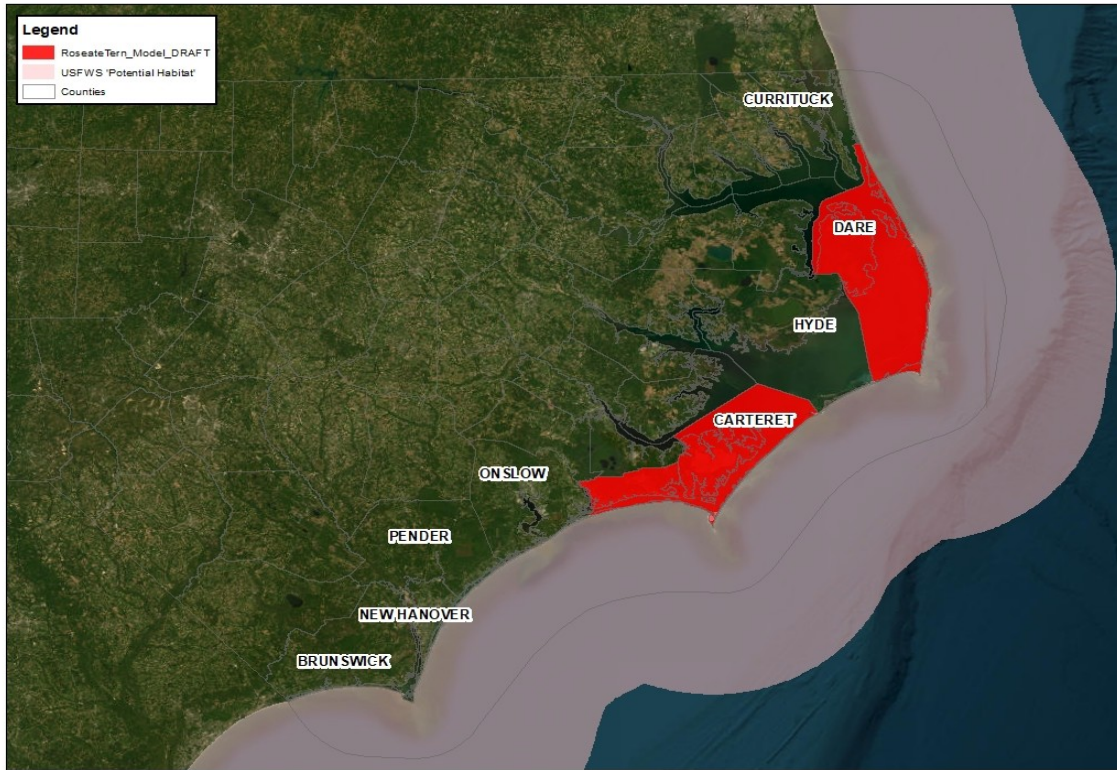


Figure 2. USFWS 2022 Range Map and High Potential Habitat (DRAFT)

Summary of Model Draft

- Selected all NHP element occurrence data, buffered DCM shorelines (2009 and 2016), and selected counties and merged. Designated areas of nonhabitat as low potential habitat using 2019 NLCD land cover data.

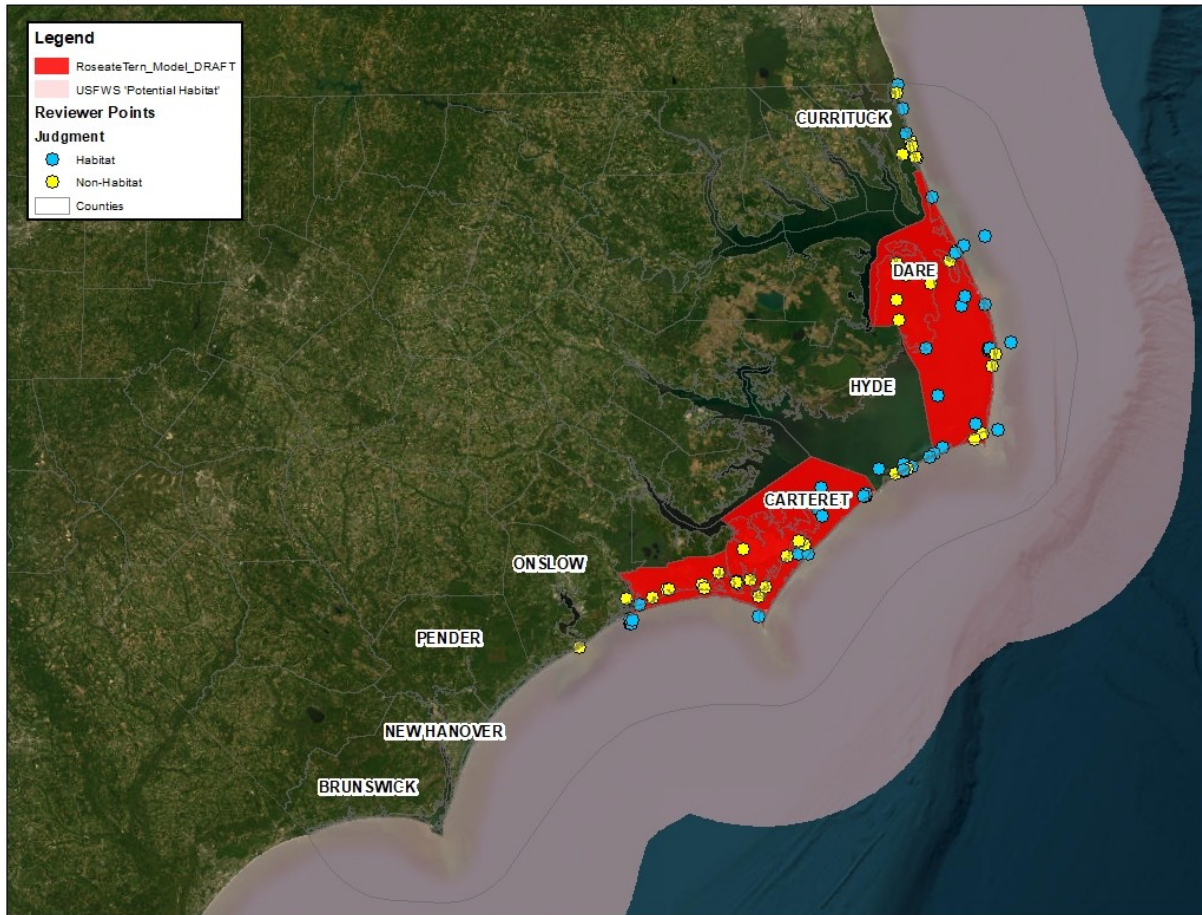


Figure 3. Desktop Reviewer Points

Reviewer Responses

- 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, 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:

- NLCD land cover data was used to designate areas of non-habitat such as forests and medium to high density development areas as low potential habitat in the model.
- 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.
- A final version of the model was produced in 2022 with the model including the expanded current USFWS range, with areas of high and low potential habitat included in the model. The model was updated in 2023 from the 2022 version to correct areas of overlapping polygons.

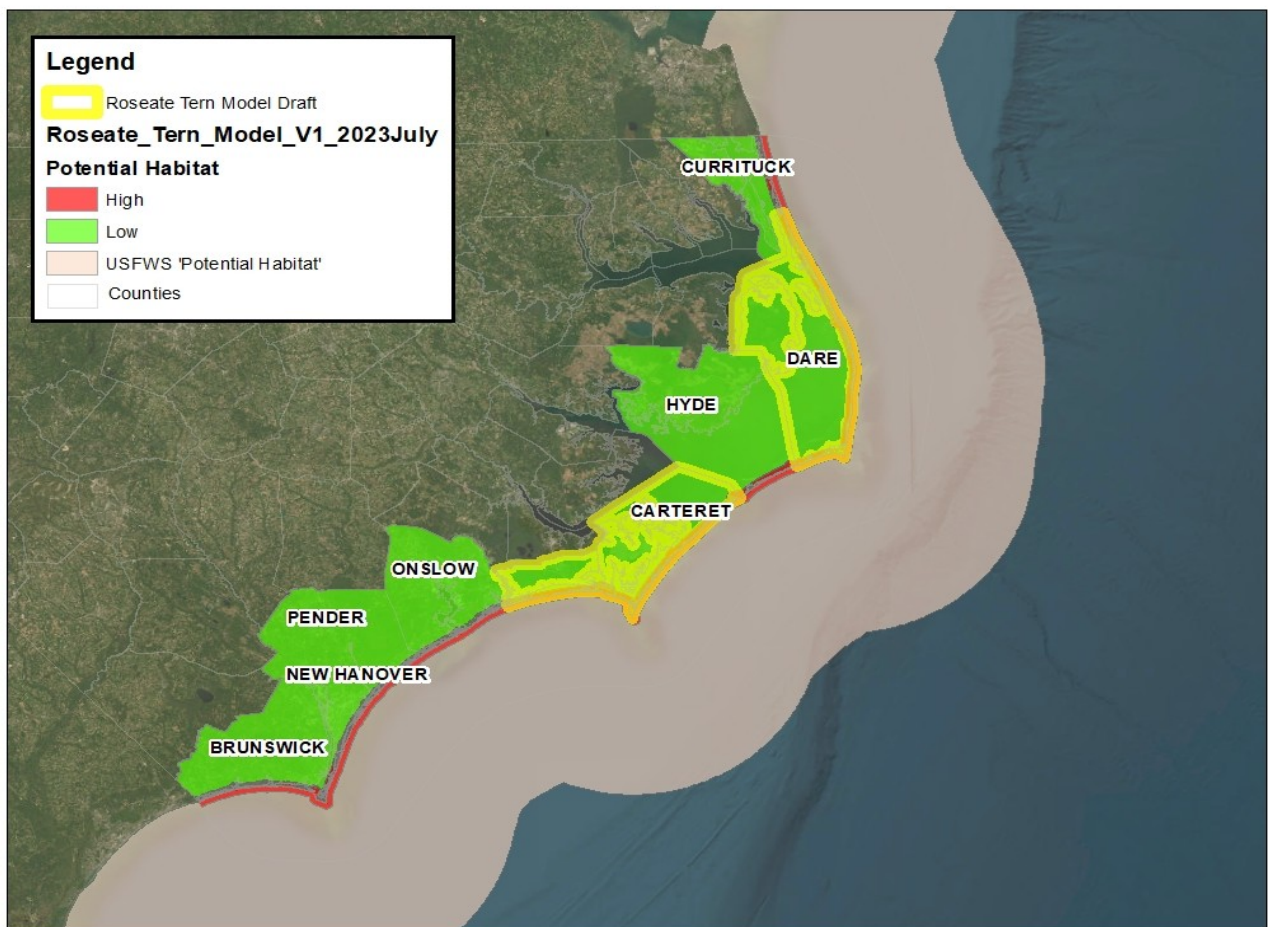


Figure 4. USFWS 2022 Range Map and Potential Habitat Version 1 vs DRAFT model

- Desktop Response Rate
 - AGOL Reviewer Response Rate: 100%
 - 30 reviewer points placed by modeler.
 - # Additional comments (placed by reviewers): 56

Model Assessment and Accuracy Statistics

Figure 5 illustrates the accuracy statistics for the model assessment sites. The roseate tern 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 with current datasets.

	“Actual” Potential Habitat	“Actual” Non-Habitat	“Actual” Potential Habitat	“Actual” Non-Habitat
Predicted Potential Habitat	True Positive 29	False Positive 24	True Positive 38	False Positive 14
Predicted Non- Habitat	False Negative 18	True Negative 15	False Negative 11	True Negative 23

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 are as follows:

- Percent correctly classified was 51% (Draft), 71% (Version 1)
- Sensitivity was 0.617021277 (Draft), 0.7755102 (Version 1)
- Specificity was 0.384615385 (Draft), 0.62162162 (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, and ditches.

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 specificity value, sensitivity, and percent correctly classified of the V1 model increasing from the draft version.