Expert-based Model Guidance and Documentation (Version 1)

Project Information

- Species: Piping plover (*Charadrius melodus*)
- 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

Primary constituent elements of wintering piping plover habitat include sand and/or mud flats with no or very sparse emergent vegetation. In some cases, these flats may be covered or partially covered by a mat of blue-green algae. Adjacent unvegetated or sparsely vegetated sand, mud, or algal flats above high tide are also essential, especially for roosting piping plovers. Such sites may have debris, detritus (decaying organic matter), or micro-topographic relief (less than 20 inches above substrate surface) offering refuge from high winds and cold weather. Essential components of the beach/dune ecosystem include surf-cast algae for feeding of prey, sparsely vegetated back beach (beach area above mean high tide seaward of the dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure or road) for roosting and refuge during storms, spits (a small point of land, especially sand, running into water) for feeding and roosting, salterns (bare sand flats in the center of mangrove ecosystems that are found above mean high waters and are only irregularly flushed with sea water) and wash over areas for feeding and roosting. Wash over areas are broad, unvegetated zones with little or no topographic relief that are formed and maintained by the action of hurricanes, storm surge, or other extreme wave action. Several of these components (sparse vegetation, little or no topographic relief) are mimicked in artificial habitat types used less commonly by piping plovers, but that are considered critical habitat (e.g., dredge spoil sites).

Additional Species Information

The piping plover breeds along the entire eastern coast of the United States. North Carolina is uniquely positioned in the species' range, being the only State where the piping plover's breeding and wintering ranges overlap, and the birds are present year-round. They nest most commonly where there is little or no vegetation, but some may nest in stands of beach grass. The nest is a shallow depression in the sand that is usually lined with shell fragments and light-colored pebbles.

NHP Tier 2 data from June 2022 indicate 36 NHP EOs for piping plover. Twelve of the 34 records are historic. NHP records used at the time of model were from June 2022.

County Information

- NHP listed counties: Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, Pender
- 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 piping plover 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 piping plover 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. 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.
- Layer selection justification:
  - Data layer was incorporated into the model with 2009 and 2016 shorelines (to ensure complete coverage of coast) buffered 1.5 miles. This buffer was established to ensure capturing all areas of dune/shoreline habitat along the coast.
- "Habitat" versus "Nonhabitat" designations:
  - Area within buffer is potential habitat.

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 piping plover records selected and included in final merged output file.

Layer 4

- Layer name: USFWS ECOS Critical Habiat – WinteringExceptGreatLakes_TXtoNC, Wintering_NC_Units_revised, FCH_Charadrius_melodus_20170506.
- Layer description:
  - USFWS ECOS Active Critical Habitat layers for piping plover. This layer was processed in a preliminary model step included in the GDB as a model entitled "Prelim_CriticalHabitat" in order to create a merged and dissolved feature that would be used in the model.
- Layer selection justification:
  - Layer was used in the model to ensure all critical habitat for piping plover is mapped and included in the final merged output file.

Layer 5

- 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 designations used for this model – deciduous forests, developed – high intensity, emergent herbaceous wetlands, evergreen forest, mixed forest, and woody wetlands. The purpose of excluding these was to designate these habitat types as low potential habitat since they are the most likely habitat types that would not support piping plover.
  - 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 designations was inconsistent.

<u>Model Information</u>

- Model domain
  - This model identifies 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.
- 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 in order 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, critical habitat data, DCM shorelines (2009 and 2016).
  - Describe methods – Current aerial imagery was used to determine likelihood of habitat.

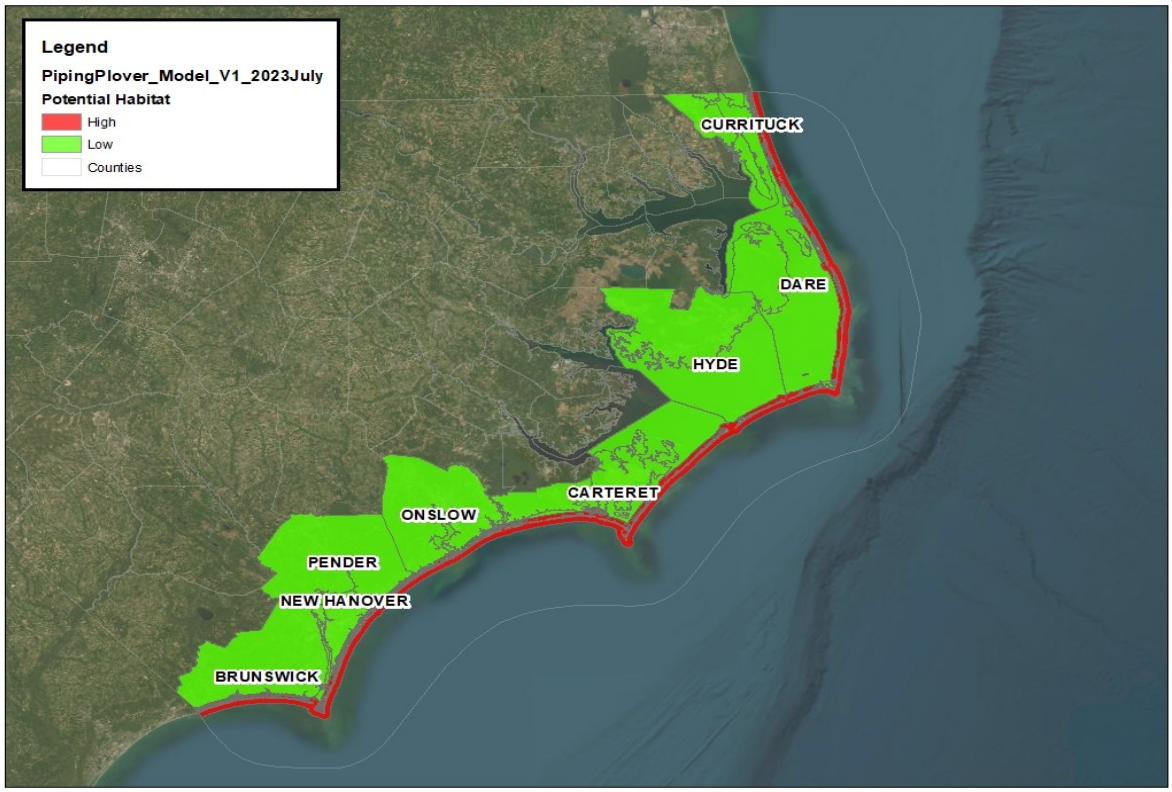


Figure 1. High and Low Potential Habitat (V1)

Previous Model Versions (Draft)

The previous version of this model was developed in July 2018. NLCD landcover data was used to refine the model by excluding areas of non-habitat. The V1 model was finalized in July 2023. The model remained the same from 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 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)*

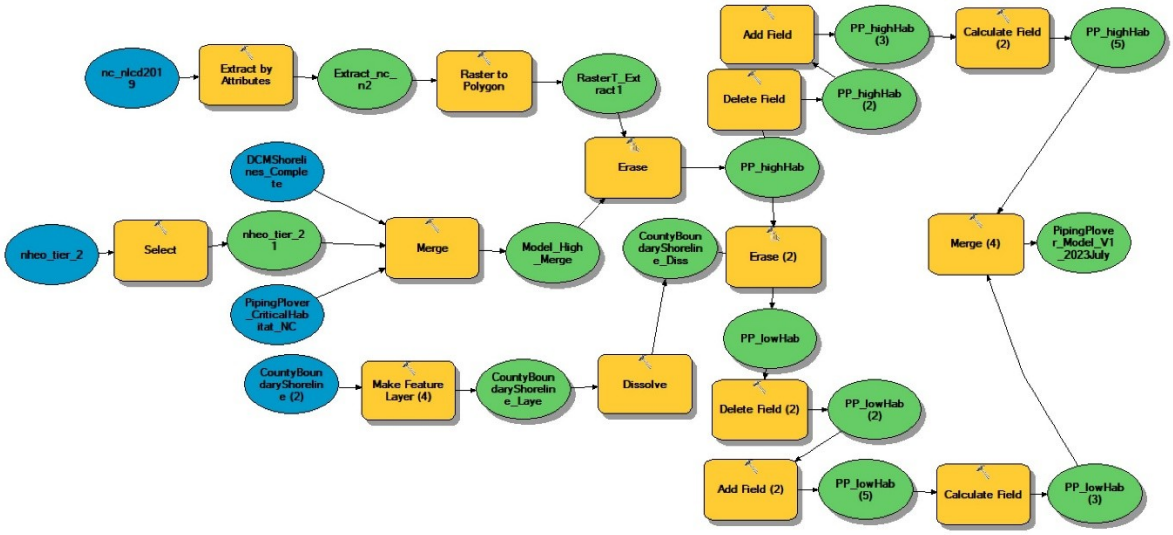
References

USFWS 2018. ECOS Environmental Conservation Online System (Accessed: November 22, 2022).

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: Piping Plover Version 1 Expert Model



Appendix 2: Reviewer Documentation

Project Information

- Species: Piping plover (*Charadrius melodus*)
- Lead modeler: Adam Efird (adam.efird@threeoaksengineering.com), 919-407-8461
- Reviewer names: 1. John Hammond (USFWS)
  2. Kathryn Matthews (USFWS)
  - 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.

Range Map to Potential Habitat Draft Model

- USFWS Range 2,893,157 acres (includes USFWS open water range)
- ATLAS Draft Range 441,562 acres

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

Summary of Model Draft Version

- Environmental data layers remained the same between versions, except for NLCD 2019 data to designate areas of non-habitat as low potential habitat.
- Selected all coastal open water areas, NHP element occurrence data, buffered DCM shorelines (2009 and 2016), critical habitat, and selected counties and merged all layers. 2019 NLCD landcover data was then used to designate areas of non-habitat such as forests and medium to highly developed area as low potential habitat.

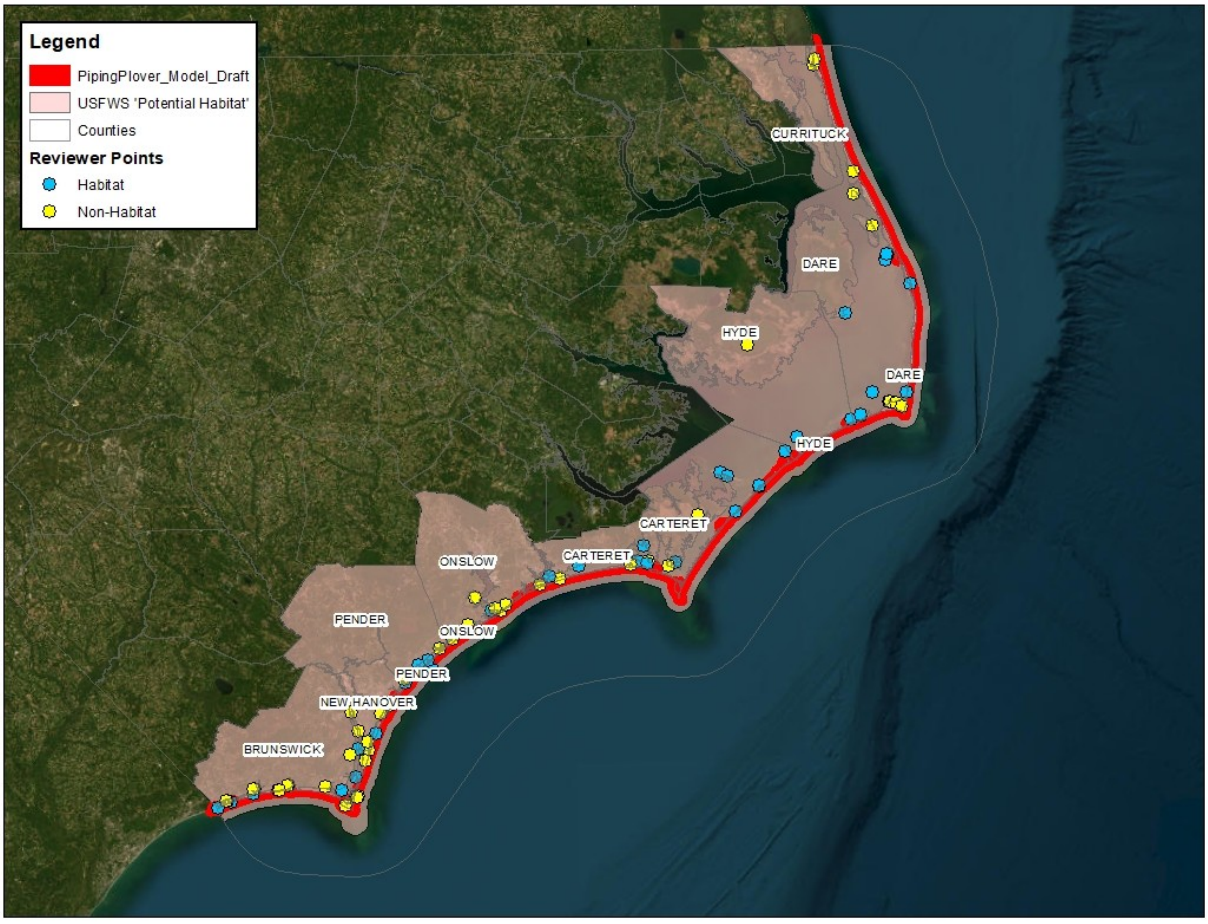


Figure 3. Desktop AGOL Reviewer Points

- Desktop Response Rate
  - AGOL Reviewer Response Rate: 100%
    - 34 reviewer points placed by modeler
  - # Additional comments (placed by reviewers): 79

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. Most comments were about non-

beach shorelines and upland areas showing up as habitat and needed the value to be reversed to non-habitat.

- 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, non-sandy shorelines or beaches, marshes, canals, ditches, developed land, and inland waterbodies not connected to the estuary.

<u>Proposed Version 1 Model</u>

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

- NLCD landcover data from 2019 were used to designate areas of non-habitat such as forested habitats and medium to high density development 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.

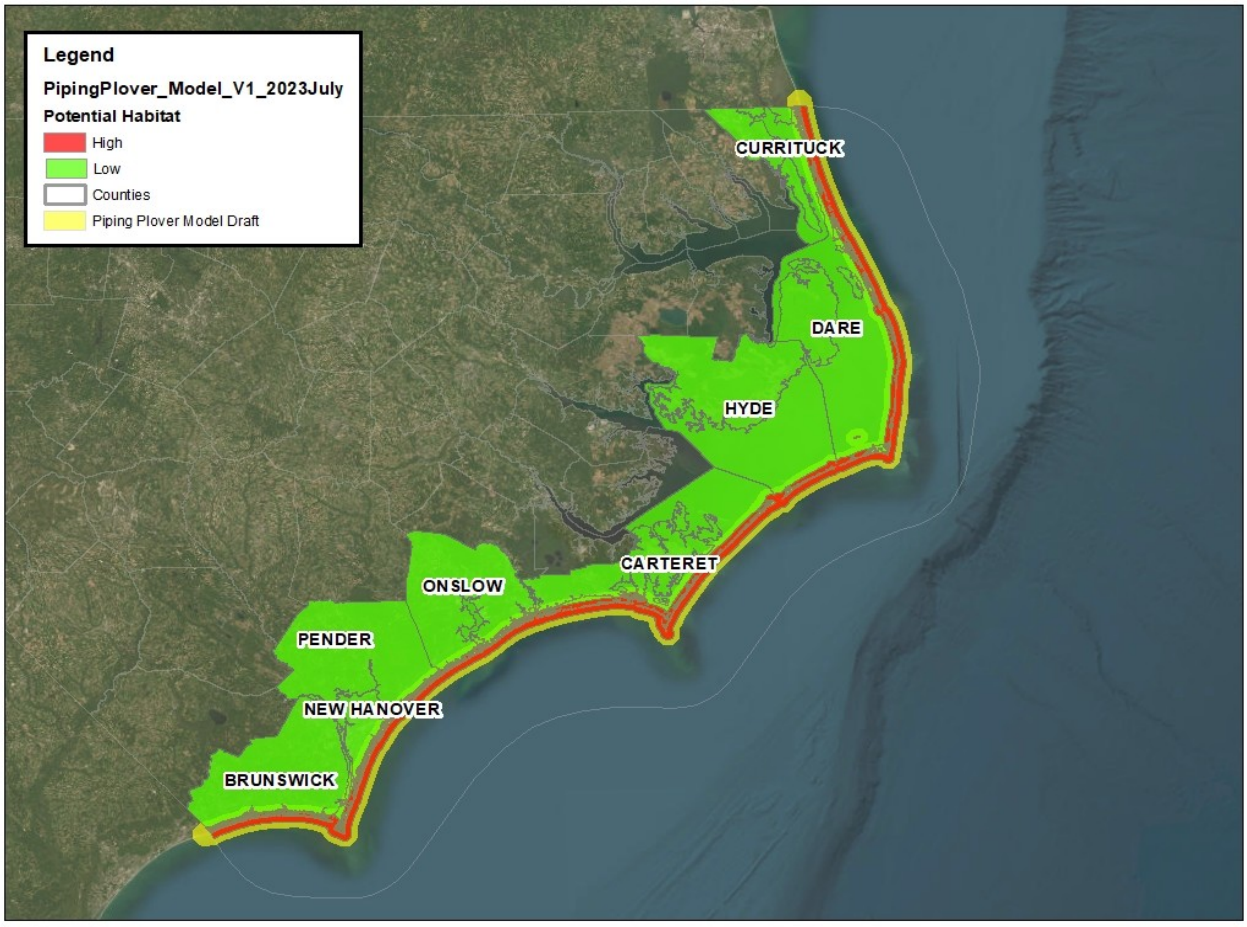


Figure 4. Potential Habitat Version 1 vs DRAFT model

Model Assessment and Accuracy Statistics

Figure 5 illustrates the accuracy statistics for the model assessment sites. The piping plover 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 time period.

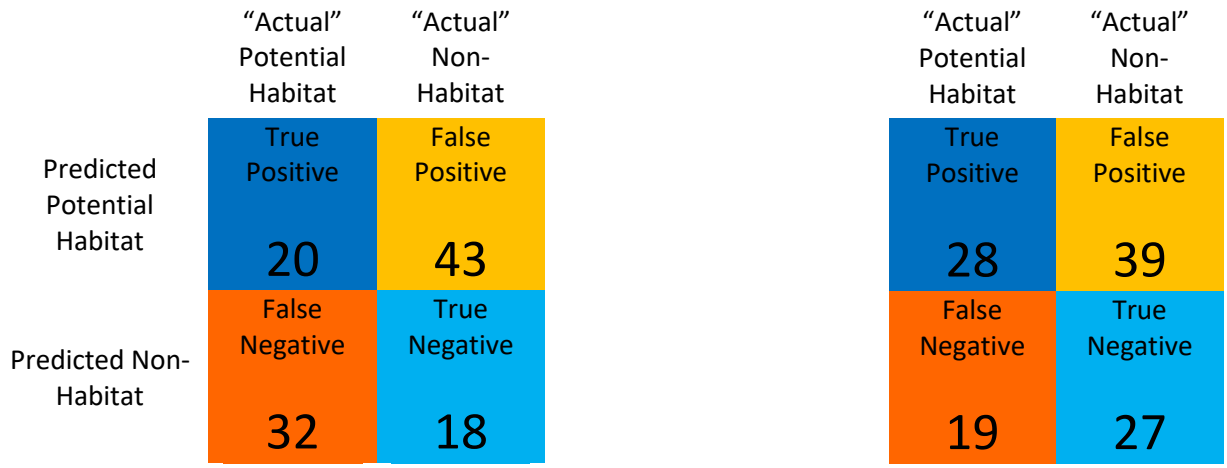


Figure 5. Accuracy summary of the desktop reviewer responses based on model assessment of Draft (left) Version and Version 1 (right) model output.

Based on the biologists' observations, accuracy of the draft binary classification model was as follows:

- Percent correctly classified was 34% (Draft), 49% (Version 1)
- Sensitivity was 0.38461538 (Draft), 0.59574468 (Version 1)
- Specificity was 0.29508197 (Draft), 0.40909091 (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 not connected to the estuary. It was unable to distinguish between eroding shorelines from accreting

shorelines. Due to the dynamic nature of coastal beaches this model will capture a snapshot in time of the current shoreline.

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.