Expert-based Model Guidance and Documentation (Version 1)

Project Information

- Species: seabeach amaranth (*Amaranthus pumilus*)
- Lead modeler: Adam Efird, NV5 (adam.efird@NV5.com) 919-836-4800
- Date started: 07/14/2018
- Date completed: August 2019

Species Information

NCDOT NRTR Habitat Description

USFWS Optimal Survey Window: July-October

Seabeach amaranth occurs on barrier island beaches where its primary habitat consists of overwash flats at accreting ends of islands, lower foredunes, and upper strands of noneroding beaches (landward of the wrack line). In rare situations, this annual is found on sand spits 160 feet or more from the base of the nearest foredune. It occasionally establishes small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, interdunal areas, and on sand and shell material deposited for beach replenishment or as dredge spoil. The plant's habitat is sparsely vegetated with annual herbs (forbs) and, less commonly, perennial herbs (mostly grasses) and scattered shrubs. It is, however, intolerant of vegetative competition and does not occur on well-vegetated sites. The species usually is found growing on a nearly pure silica sand substrate, occasionally with shell fragments mixed in. Seabeach amaranth appears to require extensive areas of barrier island beaches and inlets that function in a relatively natural and dynamic manner. These characteristics allow it to move around in the landscape, occupying suitable habitat as it becomes available.

Additional Information
NHP Tier 2 data from July 2018 indicate 34 EOs for seabeach amaranth in North Carolina. Eight of the 34 records are historic. Seabeach amaranth records from NHP listed counties are in Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, and Pender counties. NHP records used at the time of model were from July 2018.

County Information

- NHP eight listed counties: Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, Pender
- FWS eight current listed counties: Brunswick, Carteret, Currituck, Dare, Hyde, New Hanover, Onslow, Pender

Environmental Data Information

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

Layer 1

- Layer name: DCM Coastal Shorelines (Buffered 1 Mile)
- Layer description:
    - DCM Shoreline layer provided by NC Division of Coastal Management. Layer provides shoreline polylines from years 1849-2016.
- Layer selection justification:
    - 2016 and 2009 shorelines were selected for use in the models to have the most complete and most recent shoreline for North Carolina. The shoreline was buffered 1 mile in the model to capture all shoreline/beach areas for the entire NC coast.
- "Habitat" versus "Non-habitat" designations:
    - Shoreline within the eight listed counties is considered potential habitat.

Layer 2

- Layer name: nheo_tier2
- Layer description:
    - July 2018 Tier 2 data acquired from NC Natural Heritage Program
- Layer selection justification:
    - Data layer was incorporated into model with any seabeach amaranth records selected and included in final merged output file.
- "Habitat" versus "Non-habitat" designations:
    - Potential habitat are polygon areas delineated in the July 2018 NC NHP Tier 2 dataset.

Layer 3

- Layer name: NLCD Landcover Data 2016
- Layer description:
    - NLCD 2016 landcover data
- Layer selection justification:
    - NLCD 2016 data was used to erase units of the map that were classified as a variety of forested habitat types, medium-density development, high-density development, and areas designated as water.
- "Habitat" versus "Non-habitat" designations:
    - Utilized all forested classes, medium-density development, high-density development, and water classes for reducing or eliminating areas of potential non-habitat.

Known Issues with Model Data Layers

- The seabeach amaranth model includes potential habitat along the NC coast, focusing on beach/dune shoreline areas. The model takes a broad approach, using a 1-mile buffered shoreline to ensure areas of potential habitat are included in the model. Alternate approaches were considered, and when 2016 NLCD landcover data was made available, the layer was used to erase out areas of potential non-habitat based on the landcover class. There appeared to be numerous inconsistencies in the landcover data, which means the model will have a certain level of error when determining habitat.

<u>Model Information</u>

- 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
    - Created using ArcGIS 10.4.1
    - Model builder toolbox attached as deliverable
- ArcGIS Online (AGOL) Review
    - A model prediction field was shared with select reviewers on AGOL. 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 a draft version of this model (See Appendix 2)
- Independent Data Review
    - Describe data sources – Natural Heritage Program element occurrences, county boundaries, DCM oceanfront shorelines, NLCD 2016
    - Describe methods – Current aerial imagery was used to determine likelihood of potential habitat for the species.

Figure 1. Range Map and High Potential Habitat Version 1

Previous Model Versions (Draft)

- The previous version of this model was developed in July 2018. NLCD 2016 was added and the buffer distance was altered to create the Version 1 model.

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)*
- *Field reviewer comments (shapefiles) and word document*

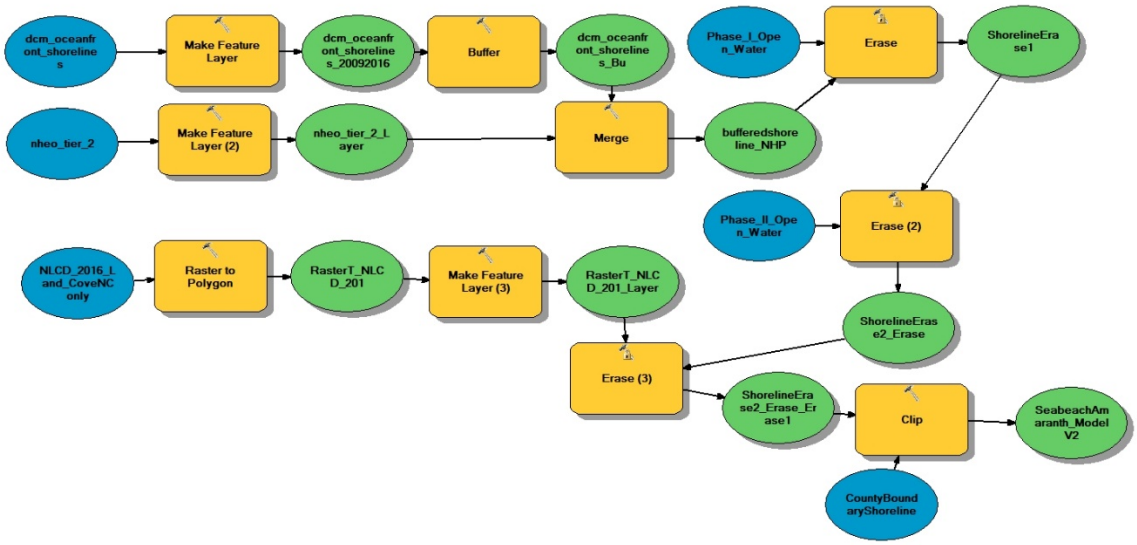
References

U.S. Fish and Wildlife Service (USFWS). ECOS Species Profile for Seabeach Amaranth. https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=8549 (Accessed: October 14, 2018).

USFWS. 1996. Recovery Plan for Seabeach Amaranth (*Amaranthus pumilus*) Rafinesque. Atlanta, Georgia.

USFWS. Seabeach Amaranth in North Carolina (*Amaranthus pumilus*). https://www.fws.gov/raleigh/species/es_seabeach_amaranth.html. (Accessed: October 14, 2018).

Appendix 1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Buffer
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Erase
ShorelineErase1
nheo_tier_2
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nheo_tier_2_Layer
Merge
bufferedshoreline_NHP
Phase_II_Open_Water
Erase (2)
NLCD_2016_Land_CoveNC only
Raster to Polygon
RasterT_NLCD_201
Make Feature Layer (3)
RasterT_NLCD_201_Layer
ShorelineErase2_Erase
Erase (3)
ShorelineErase2_Erase_Erase1
Clip
SeabeachAmaranth_ModelV2
CountyBoundaryShoreline

Appendix 2: Reviewer Documentation

Project Information

- Species: seabeach amaranth (*Amaranthus pumilus*)
- Lead modeler: Adam Efird, NV5 (adam.efird@NV5.com) 919-836-4800
- Reviewer names: 1. Dale Suiter (USFWS)
  2. Kevin Markham (ESI)
  3. Matt Smith (ESI)
    - Dale Suiter (USFWS) has worked as a biologist with the U.S. Fish and Wildlife Service in Raleigh, NC since 2000. He has the recovery lead for several petitioned and at-risk species. He monitors and conducts surveys for rare plants throughout eastern NC and in neighboring states.
    - Kevin Markham (ESI) is a principal in the Natural and Cultural Resource practice group for Environmental Services, Inc., a Terracon Company. He has more than 30 years of experience conducting and providing technical oversight for rare and protected species surveys and assessments in North Carolina. AGOL review was completed in May 2019 on version 1 of this model (See Appendix 2).
    - Matt Smith (CZR) is a biologist with CZR, Inc., with more than 20 years of professional experience. He has conducting field surveys and habitat assessments for federally plant species including American chaffseed, Cooley's meadowrue, dwarf-flowered heartleaf, golden sedge, harparella, Michaux's sumac, pondberry, rough-leaved loosestrife, Schweinitz's sunflower, seabeach amaranth, sensitive joint-vetch, smooth coneflower, Virginia spiraea. This experience has resulted in the documentation of new occurrences for dwarf-flowered heartleaf, Michaux' sumac, rough-leaved loosestrife, Schweintiz's sunflower, and sensitive joint-vetch. He has also completed field surveys documenting occurrences of federally protected animal species including piping plover, red-cockaded woodpecker, red knot rufa, wood stork, Appalachian elktoe, dwarf wedgemussel, yellow lance, and James spiny mussel.

Range Map to High Potential Habitat Draft Model

- USFWS Range 2,893,157 acres
- ATLAS Range 332,233 acres

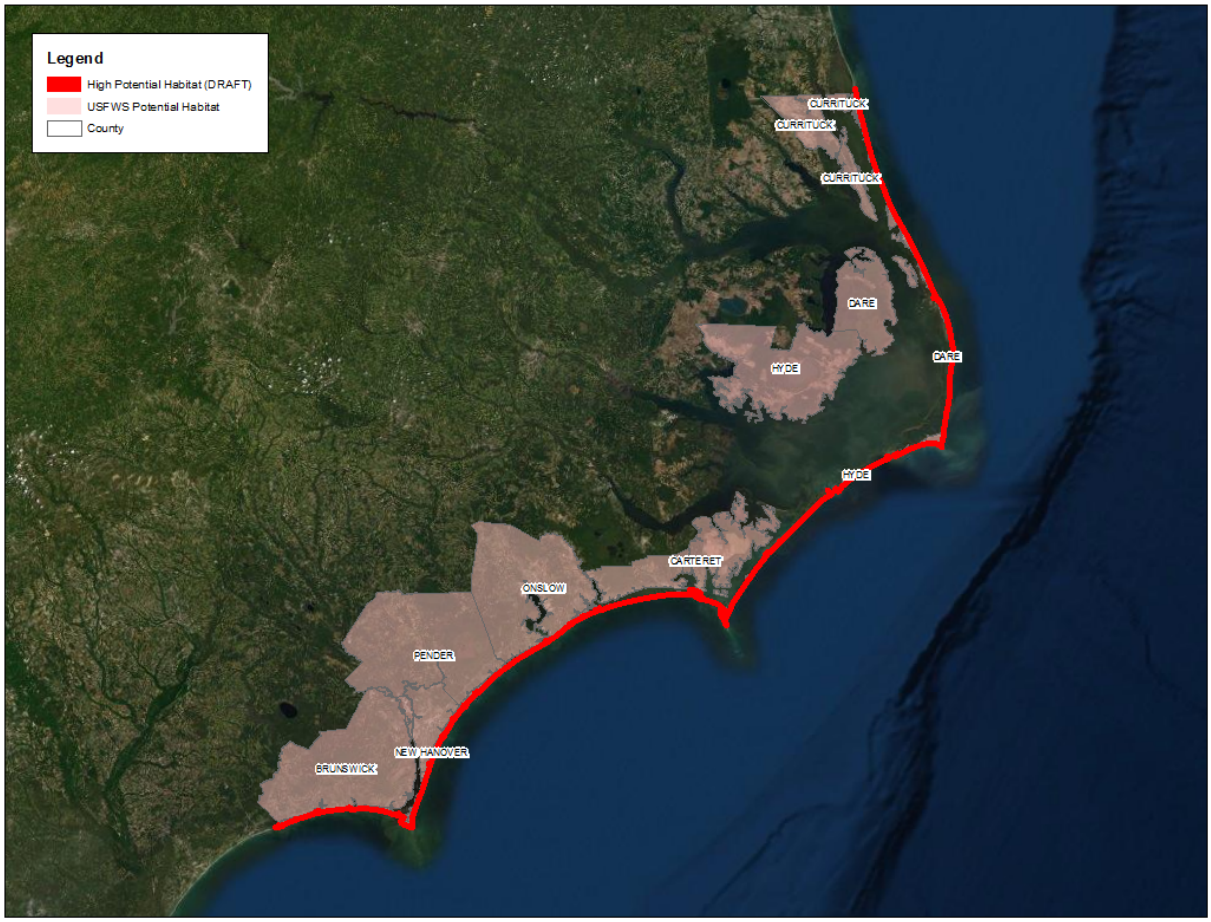


Figure 1. Range Map and High Potential Habitat Draft Model

Summary of Model Draft

- Environmental data layers used included NLCD 2016, county boundaries, DCM oceanfront shorelines, and natural heritage data.
  Extracted 2016 and 2009 DCM oceanfront shorelines and buffered 0.75 miles. Extracted seabeach amaranth records from the natural heritage data. Merged files along with NLCD 2016 data with appropriate non-habitat classes such as forested or developed classes out and clipped to county boundaries.

- Response Rate
  - Reviewer Response Rate: 100%
    - 7 reviewer points placed by modeler
  - # Additional Comments (placed by reviewer): none

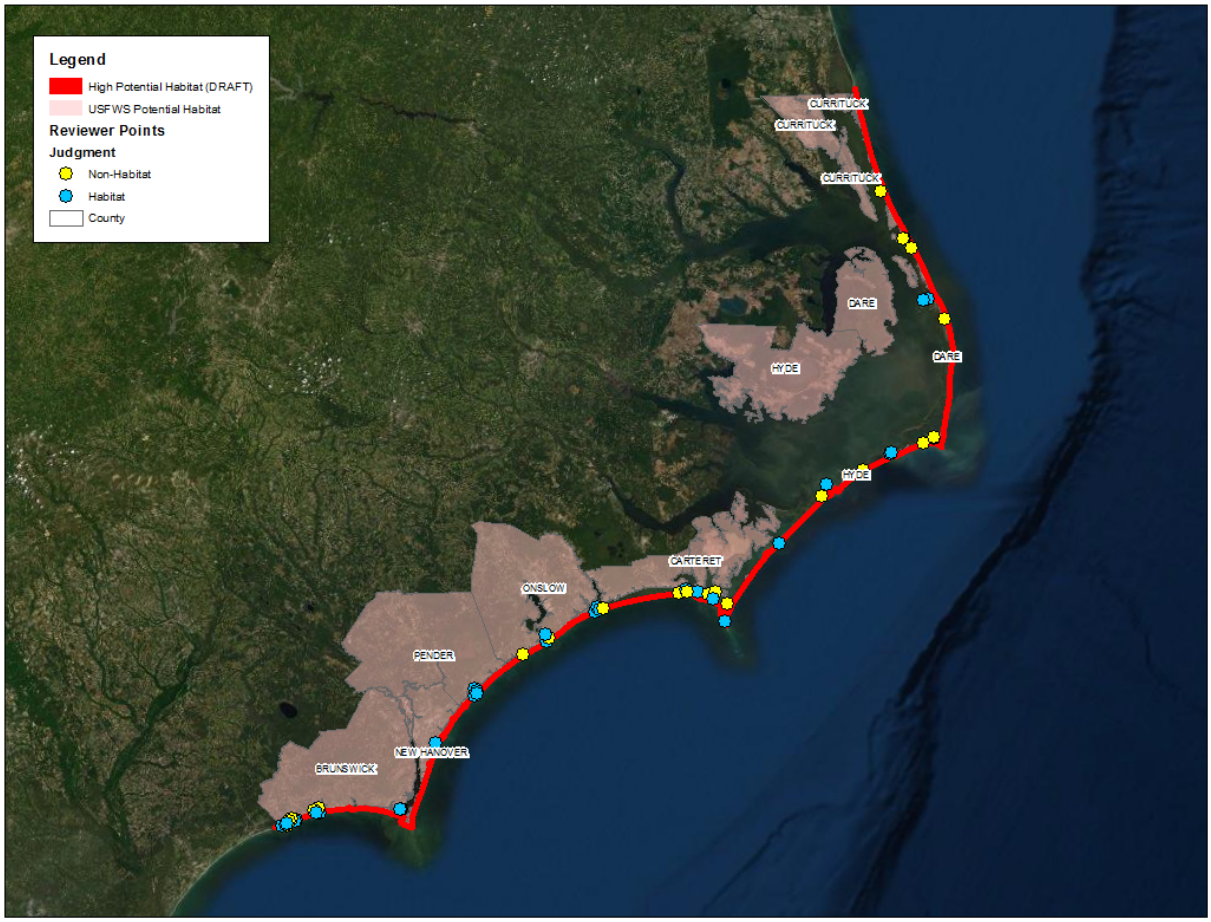


Figure 2. Reviewer Points High Potential Habitat (DRAFT)

Reviewer Responses

- Reviewers provided a complete and balanced review. Flags were concentrated on the low potential habitat areas.
- Reviewers for the most part agreed with the potential habitat. Modelers commented that in many areas, the landcover based on the aerial may not match landcover data but were unsure how to capture that in the model. There were areas where high potential habitat could exist but was not depicted in the model, as well as areas called high potential habitat in the model that would not be appropriate seabeach amaranth habitat and should have a low potential. A shapefile including all comments is attached to this documentation.

Proposed Version 1 Model

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

- The latest 2016 NLCD dataset was integrated into the model to gain a more specific potential habitat dataset. Areas of potential non-habitat such as forests and highly developed areas were erased based on the 2016 NLCD data.
- Reviewers commented on areas where landcover data likely didn't match aerial photography. The new landcover data led to some improvements in landcover data quality.

Figure 3. Range Map and High Potential Habitat DRAFT and Version 1

Model Field Assessment and Accuracy Statistics

Habitat model field assessments performed in 94 locations (with 36 polygon areas of habitat/non-habitat) across the "current" USFWS listed counties in December 2019/January 2020 assisted to clarify model strengths and weaknesses. 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

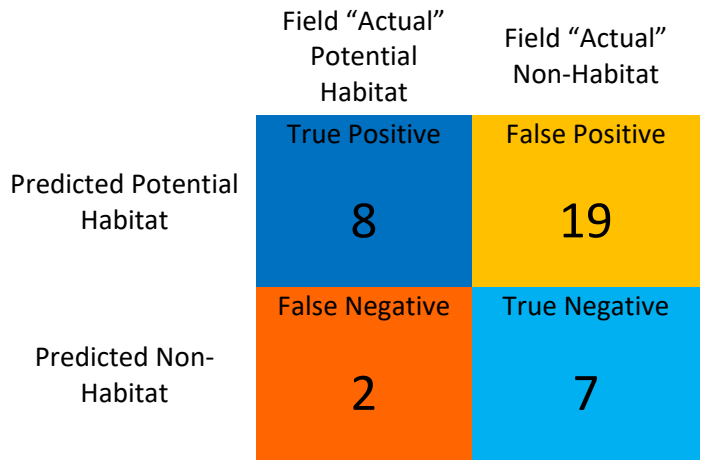
and Non-Habitat (e.g., differing habitat on either side of a road), two polygon entries were logged.

Contributing Biologists

- Mary Frazer is a biologist with Three Oaks Engineering. She has been working with endangered species of North Carolina since 2000, with a focus on endangered plants and bats. She worked in NCDOT's Biological Surveys Group from 2001-2015.
- Jim Mason is a biologist with Three Oaks Engineering. He has been working with federally protected species since 2000, moving to North Carolina in 2001. His focus has been on threatened and endangered plant and bird species. He worked for the NCDOT Environmental Coordination and Permitting Group between 2006 and 2018 and has been with Three Oaks since then.

Figure 4 illustrates the accuracy statistics for the field assessment sites. The seabeach amaranth potential habitat model illustrates the general geographic areas along barrier islands beaches, overwash flats, and sandy natural areas above the wrackline that GIS-based layers are able to best predict for at a particular time period. The specificity of the model is low (0.27) and the sensitivity is high (0.8), therefore this model better predicts low potential habitat and is less accurate in predicting the dynamic habitat locations of seabeach amaranth.

Figure 4. Accuracy summary based on field assessment of Version 1 model. (units in the confusion matrix are polygons drawn by biologists)



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

- Percent correctly classified was 42%
- Sensitivity was 0.8
- Specificity was 0.269231

The biologists' summarized their observations as follows:

- The model generally overpredicts for potential habitat and predicted false positives for developed neighborhoods, maritime forests, bridges, causeways, commercial areas, artificial dunes, and areas below the high-water mark. 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.