Expert-based Model Guidance and Documentation (Version 1)

Project Information

- Species: Harperella (*Ptilimnium nodosum or Harperella nodosa*)
- Lead modelers: Jessica Tisdale (Jessica.tisdale@hdrinc.com), Alicia Jackson (ajackson@jhcarterinc.com), and Ryan Dugger (ryan.dugger@hdrinc.com)
- Date started: April 2018
- Date completed: September 2021

Species Information

NCDOT NRTR Habitat Description

USFWS Optimal Survey Window: July to mid-September

Harperella, found in North Carolina's eastern Piedmont and western Coastal Plain, comprises occurrences that occupy both riverine and ponded habitats. In the riverine habitat, this annual herb occurs in the Rocky Bar and Shore natural community, and grows on rocky, sandy, or gravelly shoals and margins of clear, swift flowing reaches of seasonally flooded streams. It can also be in such fluvial habitats as crevices of exposed bedrock and, rarely, along sheltered muddy stream banks. The species, which can tolerate a lot of shade, is typically found in riverine microsites, such as the downstream side of large rocks or amidst thick clones of water willow (*Justicia americana*), that are sheltered from the erosive effects of swift water. In harperella's ponded habitat, the species is found in the Coastal Plain along the edges of intermittent pineland ponds, damp meadows, and soggy ground around springs. These areas tend to be seasonally flooded and contain soils of a peat muck overlying sand or sandy silt. An occurrence in Georgia's Coastal Plain also occurs on a granite outcrop that is unrelated to its ponded habitat. In riverine and pond environments, the plant is restricted to a very narrow, intermediate range of mean water depths and moderate, periodic flooding. It is entirely absent from both the shallowest and driest as well as deep waters.

Additional Species Information

Given the 3 distinctly different habitat types described above, as well as some morphological differences, this species is sometimes split into 3 species. The type or form found in NC, which inhabits rocky or gravelly rivers and streams, has been referred to as *Ptilimnium vivipara* or *Harperella vivipara* (U.S. Fish and Wildlife Service (USFWS) 2011, Weakley 2018).

There are currently 6 element occurrences (EOs) in NC:

- Granville County: 4 locations, all current, found in the Tar River on gravel and sandy bars in the main channel and in sand accumulated around larger rocks.
- Chatham and Lee Counties: 2 locations in the Deep River, which forms the county boundary. The western location is current; the eastern was last observed in 1971.

Habitat for the current population is a large island of gravel and coarse sand accumulated around boulders (NC Natural Heritage Program (NCNHP) 2018).

County Information

- NHP listed counties: Chatham, Granville, and Lee
- FWS listed counties: Chatham, Granville, and Lee
- Additions proposed by reviewers: N/A

Environmental Data Information

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

Layer 1

- Layer name: County Boundary
- Layer description:
  - Select Chatham, Granville, and Lee Counties
- Layer selection justification:
  - The 3 counties listed contain the only known occurrences of harperella in the state according to NHP and USFWS data
- "Habitat" versus "Nonhabitat" designations:
  - Potential habitat is predicted within the 3 USFWS "current" listed counties.

Layer 2

- Layer name: NHDflowlines.shp
- Layer description:
  - NHDPlusV2- National Hydrography Dataset -Version 2, developed by the U.S EPA Office of Water, and U.S. Geological Survey.
  - Join EROM_MA0001.dbf table to NHDflowlines.shp
  - Select "Q0001C > 5 and V0001C > 0". Q0001C and V0001C are measures of natural flow. Q0001C is measured in cubic feet per second (cfs) and V0001C is a measure of velocity in feet per second. This is considered potential high habitat areas for harperella.

- Layer selection justification:
  Since harperella is dependent on swift-moving streams and rivers, a hydrology dataset mapping these waterways and containing attribute data on the general size, permanency and substrate of streams was sought. NHDPlusV2 and specifically the Enhanced Unit Runoff Method (EROM) Flow estimates (\EROMExtension\EROM_MA0001.dbf) were used to select stream natural flows. Q0001C values were used and represent flow with reference gage regression applied to Q0001B (cfs). All streams with values greater than 5 cfs were selected as "habitat". This threshold cut off was established by examining recent field verification data collected

across all three counties (n = 35). This layer has replaced the draft version model that was based on National Wetland Inventory mapping and is a better fit due to the finer detail of data associated with NDHPlus2. Most lakes and ponds have been removed due to negative or very low flow values which reflects the potential non-habitat/low habitat values of these areas.

EO polygon areas both historic and current are within the vicinity of the stream polylines of the final high potential habitat model.

- "Habitat" versus "Nonhabitat" designations:
    - From the NHDflowlines layer within the three counties, we selected all streams with flow:
        - > 5 cfs
        - Areas with negative velocity were removed. These represented lakes and ponds.

Known Issues with Model Data Layers

- NHD polylines do not match up perfectly with the current river and stream banks in some areas, partially due to the natural shift of channels over time. However, this is the best data source to represent length of stream since this dataset uses single channel line and not both banks on larger streams.
- The ATLAS hydrology layer(s) will not be utilized at this time. The NHD polyline layer will run better when calculating length in the screening tool.
- Based on where the currently known populations are found in NC, this model likely overpredicts potential habitat by identifying streams. The known occurrences in NC are all in major rivers, but the species has been found in streams in other states (USFWS 1990) so the model includes these habitats as well.

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 identified USFWS species range as listed on ECOS IPAC Consultation page. The species model range is split between "High" and "Low" potential habitat. "High potential habitat" represents a GIS based layer of areas deemed suitable habitat, and "Low potential habitat" representing stream lines identified as areas deemed low quality or non-habitat.
    - Shapefile representing potential habitat within the three USFWS listed counties.

- ArcGIS Model Builder
    - Created using ArcGIS 10.7.1.11595
    - Graphical depiction of model included in Appendix 1.
    - Summary of model steps:
        - Select the 3 counties where the species is listed: Chatham, Granville, and Lee, export as Harperella Counties.
        - Clip NHDflowlines.shp to Harperella Counties.
        - Add "Habitat" field (houses 0 & 1 Values for High Potential Habitat and Low potential habitat)
        - Join NHD dbf "EROM_MA0001" to the Harperella_Clipped_Streams FC. Select "Q0001C" >5 AND V0001C > 0". Calculate output of Select and give it a "1" for Habitat. Exported as "Harperella_Habitat"
        - Select ""Q0001C" <5 AND V0001C >-9998" and give a value of "0" for NonHabitat. Calculate output of Select and give it a "0" for NonHabitat or low potential habitat. Exported as "Harperella_NonHabitat". Records with a value of -9998 remove all standing water e.g lakes, reservoirs and ponds.
        - Merge Harperella_Habitat and Harperella_NonHabitat. Exported as Harperella_Final.
- AGOL Review
    - A model prediction file was shared with select desktop reviewers on ArGIS Online (AGOL) in November 2018. 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 (See Appendix 2).
    - A field review was completed in November 2020 on the draft model (See Appendix 2).
- Independent Data Review
    - Describe data sources – NHP element occurrences
    - Describe methods – NHP element occurrences were compared to Model output to determine if predicted habitat intersected known habitat.
    - NHP element occurrences intersected predicted habitat.
    - The model was independently reviewed using NCNHP EO data and field survey results from recent natural resource investigations for NCDOT projects.

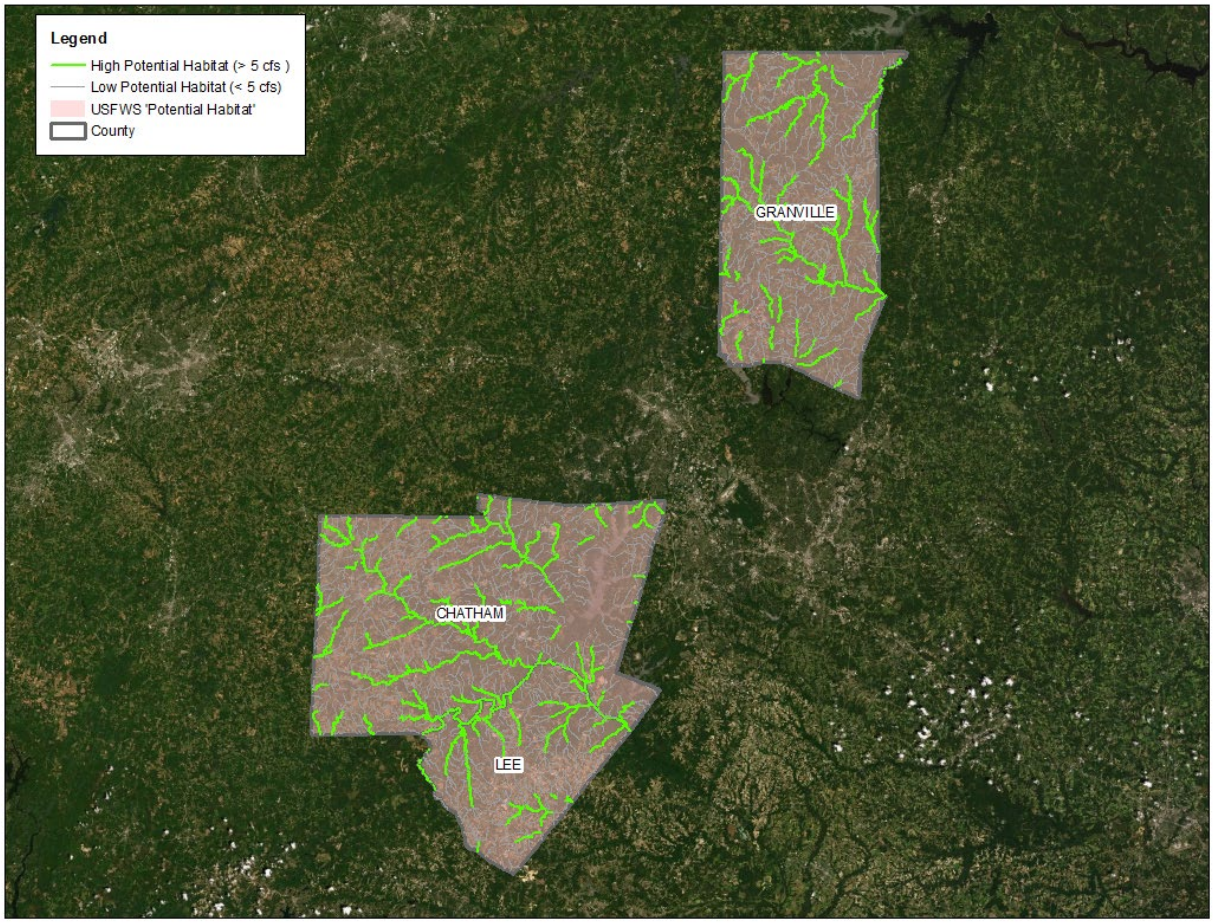


Figure 1. USFWS Range Map and Low and High Potential Habitat Version 1

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) (shapefile)*
- *Desktop AGOL reviewer comments (shapefile)*
- *Field Review comments and word document (shapefile)*

References

North Carolina Natural Heritage Program. 2018. Element Occurrence Database. Division of Land and Water Stewardship. Department of Natural and Cultural Resources, Raleigh, North Carolina. GIS data dated July 2018.

U.S. Environmental Protection Agency (USEPA). 2019. NHD*Plus* Version 2: User Guide (Data Model Version 2.1). 183 pp. https://s3.amazonaws.com/edap-nhdplus/NHDPlusV21/Documentation/NHDPlusV2_User_Guide.pdf

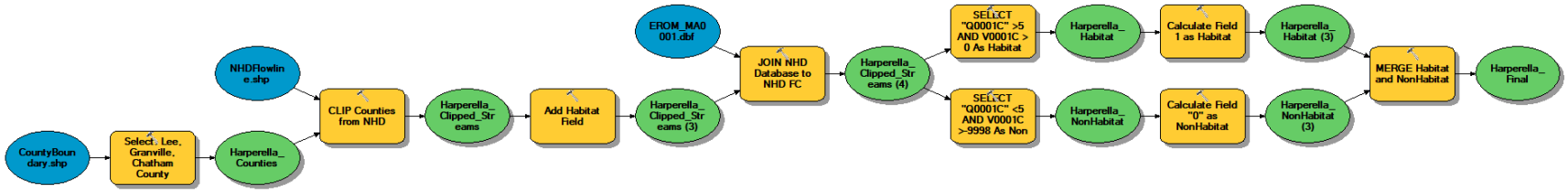
U.S. Fish and Wildlife Service (USFWS). 1990. Harperella (*Ptilimnium nodosum*) Recovery Plan. Newton Corner, Massachusetts. 60 pp. Accessed 29 June 2021 at https://ecos.fws.gov/docs/recovery_plan/910305b.pdf

USFWS. 2020. Harperella (*Ptilimnium nodosum*) Species Profile. USFWS Raleigh Ecological Services Field Office. Last Updated 10 November 2020. Accessed 29 June 2021 at https://www.fws.gov/raleigh/species/es_harperella.html

USFWS. 2017. National Wetlands Inventory metadata.

Weakley, A. S. 2020. Flora of the Southern and Mid-Atlantic States. Edition of 20 October 2020. 1,848 pp. Accessed 29 June 2021 at http://herbarium.bio.unc.edu/FSUS_2020/FSUS.pdf

Appendix 1: Harperella Version 1 Expert Model



Appendix 2: Reviewer Documentation

Project Information

- Species: Harperella (*Ptilimnium nodosum* or *Harperella nodosa*)
- Lead modeler: Jessica Tisdale (Jessica.tisdale@hdrinc.com), Alicia Jackson (ajackson@jhcarterinc.com) and Ryan Dugger (ryan.dugger@hdrinc.com)
- Desktop Reviewers: 1. Jame Amoroso (NCNHP)
  2. Suzanne Mason (NCNHP)
- Field Reviewers: 3. Erick Black (Canebrake Environmental)
  4. Logan Williams (Scenic Consulting Group)
- Habitat Reviewer: 5. Dale Suiter (USFWS)

    - Jame Amoroso is a conservation information specialist for the North Carolina Natural Heritage Program. She has been with NCNHP since 1994, starting as Program Botanist. Past and current work has included publishing the NCNHP Rare Plant List and maintaining conservation data for federally-protected species. Jame received her Masters of Science degree in Botany from the University of Florida with the thesis A Floristic Study of Cedar Key Scrub State Reserve, Levy County, Florida.
    - Suzanne Mason is a data manager for the North Carolina Natural Heritage Program. She has been with the NCNHP since 2005 and specializes in maintaining conservation data for federally-protected species. Suzanne previously studied the genetic diversity of Schweinitz's sunflower (*Helianthus schweinitzii*) for her Master of Science thesis.
    - Eric Black is a senior environmental project manager with CaneBrake Environmental with experience in federally protected plant and animal surveys in both the private and public environmental sectors. He served as western plant coordinator for the ATLAS project.
    - Logan Williams is a senior environmental project manager with Scenic Consulting Group with 30+ years' experience in federally protected plant and animal surveys in both the private and public environmental sectors.
    - Dale Suiter has worked as a biologist with the U.S. Fish and Wildlife Service in Raleigh, North Carolina since 2000. He is 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.

Range Map to Potential Habitat Draft Version

- USFWS Range 962,064 acres
- ATLAS Draft Range 2,952 acres
- ATLAS Version 1 Range 648 miles of stream

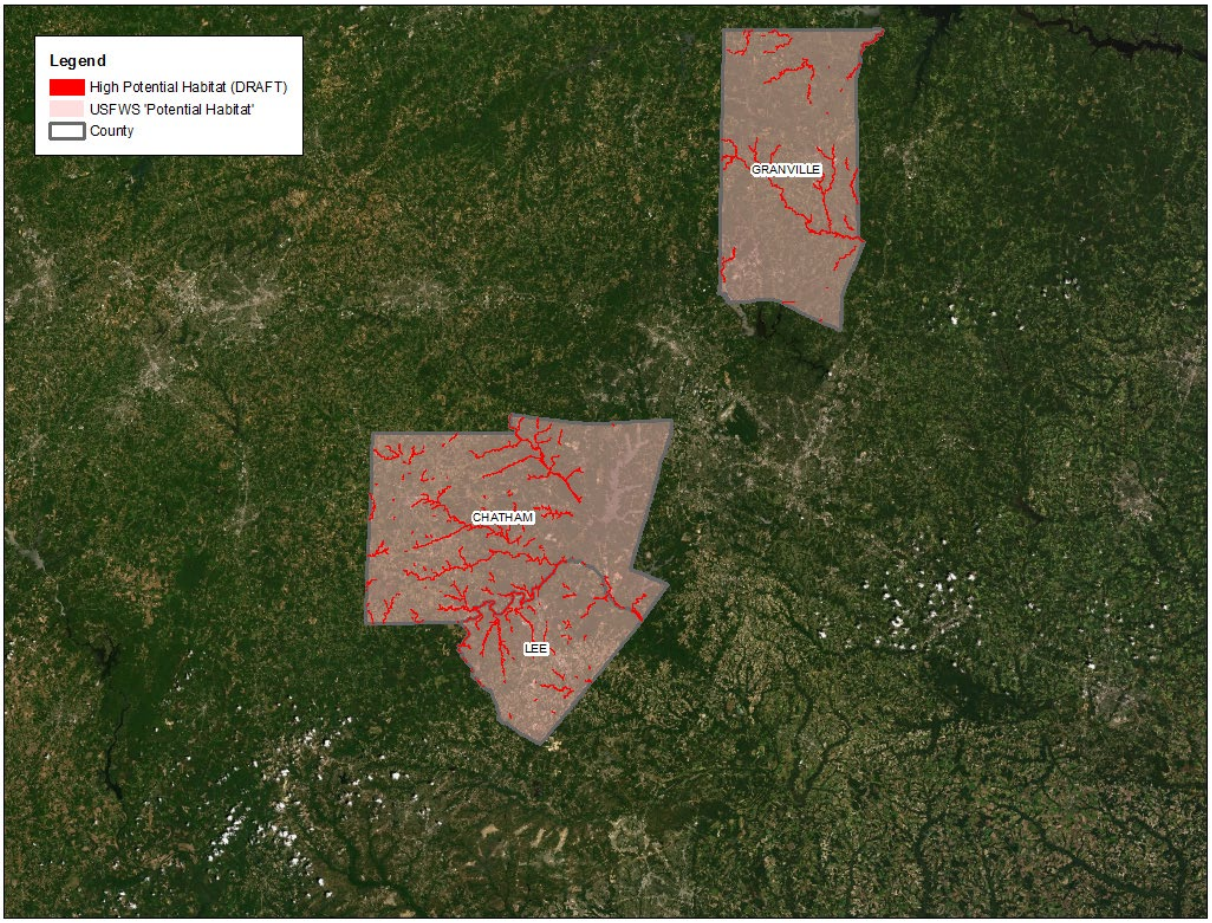


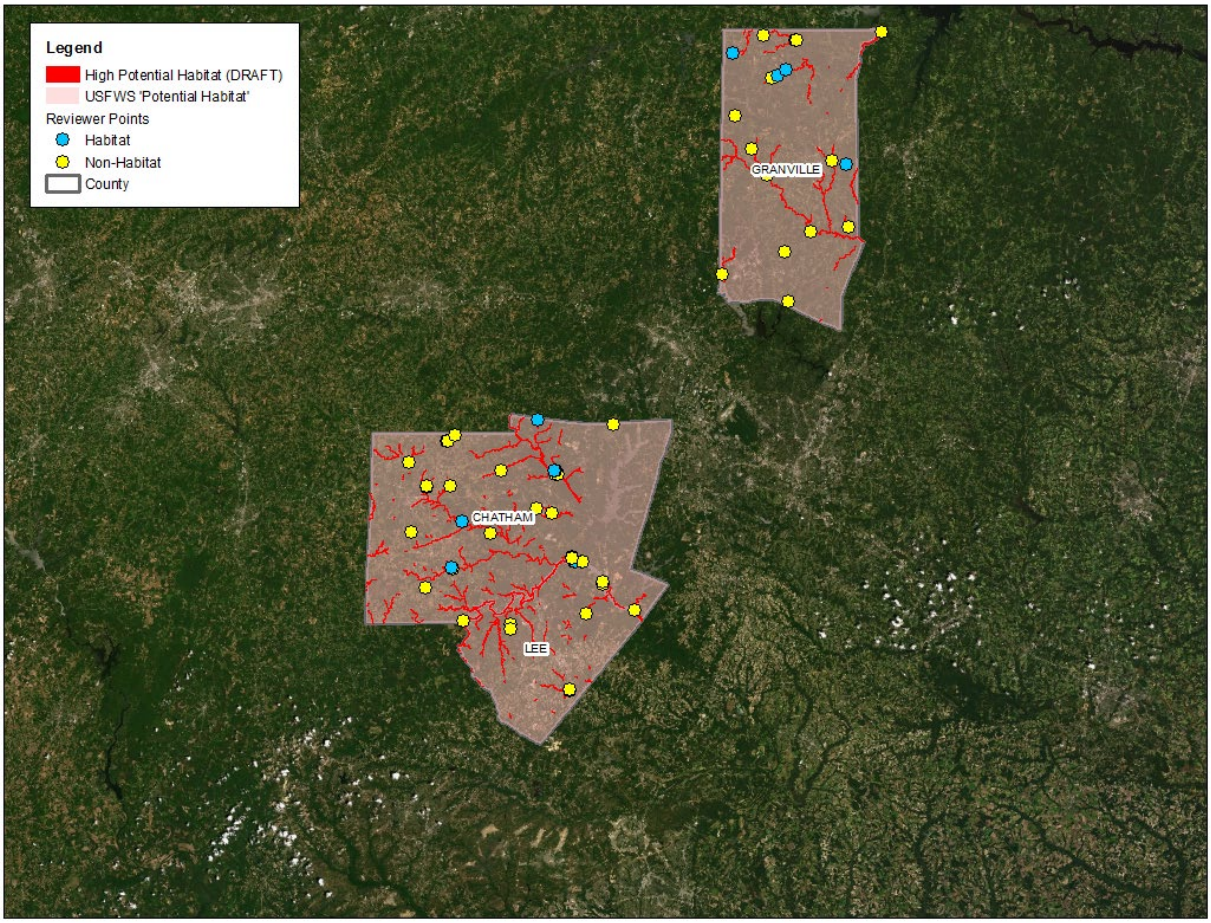
Figure 2. Range Map and High Potential Habitat (DRAFT)

- The previous version of this model was developed in October 2018 by using the National Wetlands Inventory Hydrography Dataset developed by the U.S. Fish and Wildlife Service (USFWS, 2017).
- Selection of the following riverine Cowardin classification included: R2RSC, R2UB1H, R2UB2H, R2UB3H, R2UBF, R2UBFh, R2UBFx, R2UBG, R2UBGx, R2UBH, R2UBHh, R2UBHx, R2USA, R2USC, R2USCx, R3RB1F, R3RB1H, R3RB2H, R3RBF, R3RBFx, R3RBH, R3RSA, R3RSC, R3UB1F, R3UB1H, R3UB2H, R3UB3H, R3UBF, R3UBH, R3UBHh, R3UBHx, R3US1C, R3US3C, R3USA, R3USAr, R3USC. Additional ObjectIDs, 585085(L1UBHh) and 585091(L1UBHh) around both Bynum (Haw River) and Moncure dams (Deep River), were included due to proximity of harperella occurrences.

This layer was sufficient in the representation of harperella high potential habitat; however streams were segmented and there were many small streams in Chatham and Lee Counties that were found not to be potential habitat during model field validation. NHDPlusV2-

National Hydrography Dataset -Version 2 was determined to be a better approach due to the many stream attributes included in this dataset.

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



Desktop Reviewer Responses

- Desktop reviewers provided a complete and balanced review. Flags were dispersed across the three counties and many were found to be non-habitat areas, and agreement by reviewers that many smaller streams are not optimal habitat.
- Reviewers partially agreed with the potential habitat model. Modelers commented that many streams were unlikely habitat therefore suggesting the small streams the models are predicting are too small.

Proposed Version 1 Model

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

- NHDPlus2 dataset, specifically flow, was used instead of the NWI riverine features to capture larger streams and remove smaller streams
- Size of stream is an important predictor of habitat, streams wider than 30 feet (Comm. with Dale Suiter, USFWS)
- Open canopy with little to no plant competition (Comm. With Dale Suiter, USFWS)
- Substrate presence of gravel bars and shoals are important indicators of harperella habitat

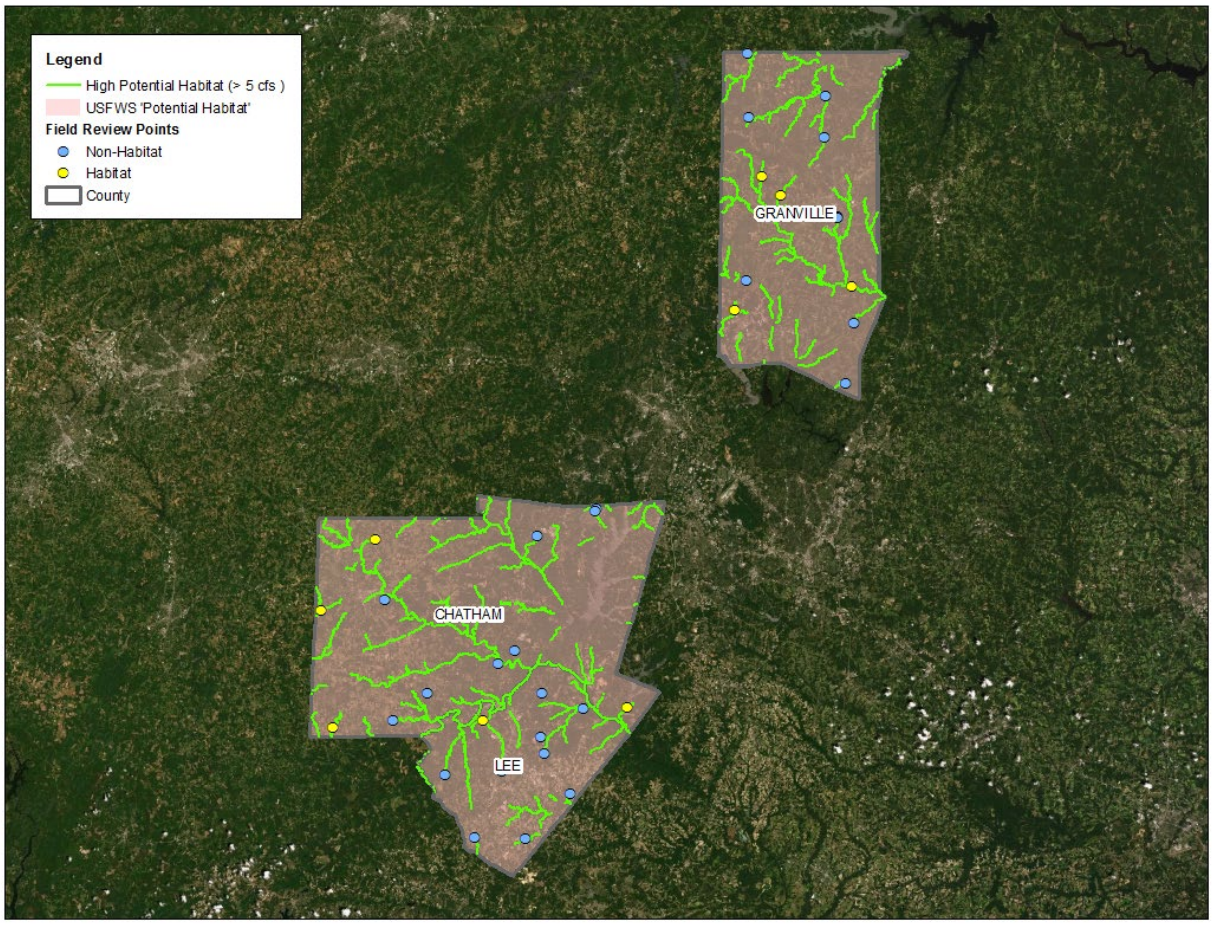


Figure 4. Field Reviewer Comments High Potential Habitat Version 1 Model

Model Accuracy

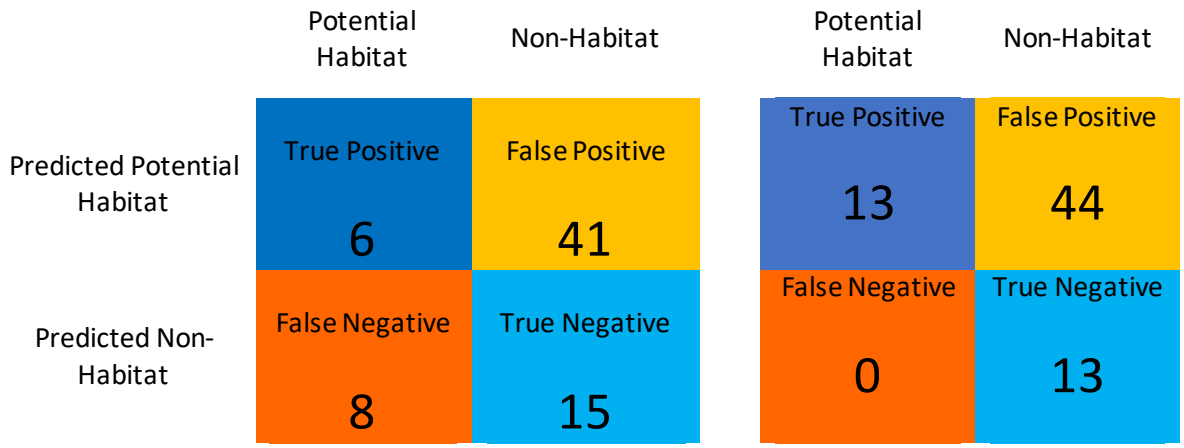


Figure 4. Accuracy summary of the desktop reviewer responses to Draft (left) and Version 1 model output

Table 1. Desktop accuracy statistics based on counts in the above summary table of Version 1 model

Statistic	Draft
Percent Correctly Classified	34
Sensitivity	1
Specificity	0.23

Model Field Assessment and Accuracy Statistics

Habitat model field assessments performed in 35 locations across the current USFWS listed counties in November 2020 assisted to clarify model strengths and weaknesses. A stratified sample of points were generated by the field assessor on "accessible lands" (generally public lands and right-of-ways) and biologists aimed to survey at least 10 points per county within the current USFWS range. At a given point, biologists characterized the site as "Potential Habitat" or "Non-Habitat", mapped a point along the stream length, 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 7. Accuracy summary based on field assessment of Version 1 model. (units in the confusion matrix are points along streams placed by field biologists)

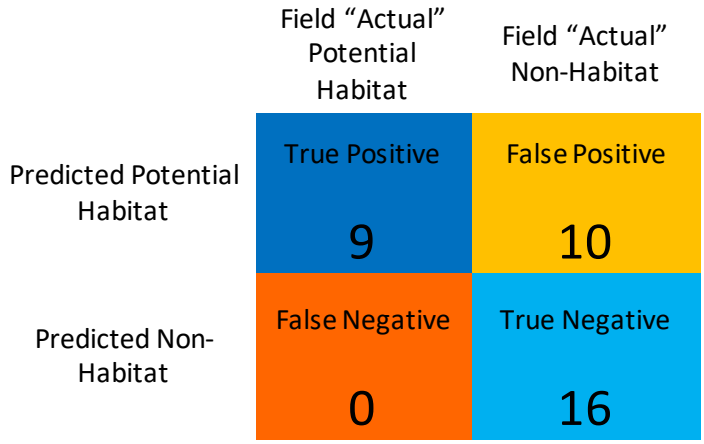


Table 2. Field accuracy statistics based on counts in the above summary table of Version 1 model

Statistic	Final Model
Percent Correctly Classified	71
Sensitivity	1
Specificity	0.62

Based on the biologists' field observations, accuracy of the binary classification model was found to be 71 percent correctly classified. Field accuracy statistics are a more robust measure than desktop accuracy statistics since conditions were viewed for each site by a trained biologist. This model is generally predicting many large streams with flows greater than 5 cfs that might not be suitable habitat however, the final model makes more sense to use flow data rather than NWI classifications. The final model has no false negatives based on both desktop and field review comments.

The biologists' summarized their field observations as follows:

- The model generally predicts known habitat (e.g. roadside seeps/ditches, low velocity stream associated seeps), excludes unlikely habitat (e.g. upland forests, upland pastures, parking lots, regularly maintained properties, urban areas, ridgelines, hilltops).
- False positives were located in areas where the floodplain hydrology has been altered or high velocity streams.
- The model generally had more areas of false positives in agriculturally impacted floodplains as well as greater than first order streams.

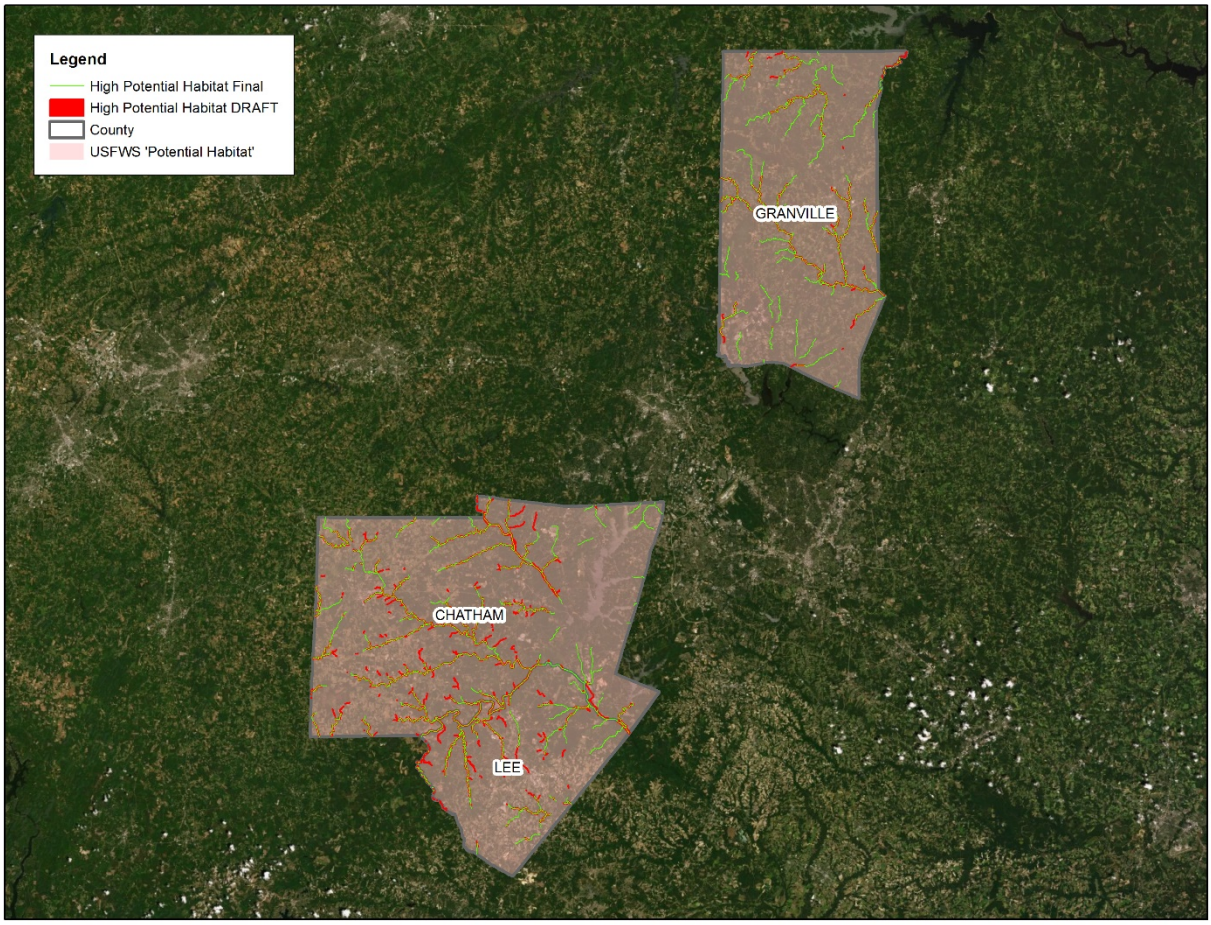


Figure 5. Range Map and High Potential Habitat Version 1 vs. DRAFT Model