

Expert-based Model Guidance and Documentation

Project Information

- Species: Mountain Sweet Pitcher Plant (*Sarracenia rubra* ssp. *jonesii*)
- Team Contact: Eric Black (e.black@sncgrp.com) 919-612-2591; Katie Talavera (ktalavera@ESINC.CC), 919-602-4430.
- Date started: April 2018
- Date completed: March 2020

Species Information

NCDOT NRTR Habitat description

USFWS Optimal Survey Window: April to October

The NCDOT habitat summary describes the Mountain sweet pitcher plant (MSPP) as endemic to the Blue Ridge Mountains of North and South Carolina and is found along stream banks and in shrub-dominated, seepage-fed mountain bogs (Southern Appalachian Bog - Southern Subtype). Both stream bank and bog habitats are usually situated along intermittently exposed to infrequently flooded level depressions associated with valley floodplains. These habitats, typically on soils of the Toxaway or Hatboro series, contain deep, poorly drained, saturated soils of loam, sand, and silt with a high organic matter content and medium to high acidity. A few occurrences of the pitcher plant also grow in cataract bogs, either in thin strips along the edges of waterfalls or on soil islands over granite rock faces, where sphagnum and other bog plants species line the sides. This early successional species relies on natural disturbance (e.g., drought, water fluctuation, periodic fire, ice damage) to maintain its habitat by preventing the establishment of later successional woody seedlings.

Additional Information

MSPP is also associated with the Swamp Forest-Bog Complex community. Known habitat for MSPP consist of Southern Appalachian Bogs in **North Carolina** and cataract bogs in **South Carolina**. Cataract bogs are restricted to the Blue Ridge escarpment region of South Carolina and a small area of North Carolina.

Twenty-four element occurrences (EO's) (10 current and 14 historic) are listed in North Carolina per Natural Heritage (July 2018). Of the current EO's, 3 of 10 included introduced/transplanted plants to existing sites. Natural communities associated with these EO's include lake/pond edges, forested/shrub bogs and wet depressions.

County Information

- NHP listed counties: Buncombe, Henderson, Macon, and Transylvania

- FWS listed counties: Buncombe, Henderson, Macon and Transylvania

Environmental Data Information

All spatial data are in NAD83 North Carolina StatePlane FIPS 3200 (US feet)

Layer 1

- Layer name: County_Boundary
- Layer description:
 - Select Buncombe, Henderson, Macon and Transylvania Counties from County Boundary shapefile
- Layer selection justification:
 - Species only listed in Buncombe, Henderson, Macon and Transylvania Counties
- “Habitat” versus “Nonhabitat” designations:
 - Habitat for the MSPP is listed as Buncombe, Henderson, and Transylvania Counties.

Layer 2

- Layer name: NRCS_Soils_NC (Buncombe, Henderson, Macon and Transylvania Counties)
- Layer description:
 - SSURGO Map Unit Polygon feature class of soil type and drainage classification.
 - Selected soils by drainage.
 - Select soils with somewhat poorly drained, poorly drained and very poorly drained soils.
- Layer selection justification:
 - Mountain sweet pitcher plant habitat is described as occurring on poorly drained soils that occur on level depressions associated with floodplains usually Toxaway silt loam and Hatboro loam. The selected soil drainage classes above include all soils with a “poorly drained” classification which includes Toxaway and Hatboro series soils.
- “Habitat” versus “Nonhabitat” designations:
 - Habitat soils for the MSPP are designated with the drainage criteria above.

Layer 3

- Layer name: County Elevation (Q2DEM) (Buncombe, Henderson, Macon and Transylvania).
- Layer description:
 - County Elevation Grid rounded to nearest foot, 20 ft grid cell.
 - Analyze Q2DEM Grid file for slope using ARCGIS slope tool.
 - Extract slopes ranging from <6%.
- Layer selection justification:
 - Specific slope data was not available for MSPP; however, habitat is described as most commonly on bogs with flat to gently sloping valley bottoms. A <6% slope

layer was generated from Q2DEM county elevation data. The slope layer was overlaid with known MSPP occurrences to evaluate if the proposed slope range captured potential MSPP habitat. The overlay of known occurrences of SMPP and <6% slopes showed good correlation.

- “Habitat” versus “Nonhabitat” designations:
 - Habitat for the MSPP was designated as having <6% slopes.

Layer 4

- Layer name: NRCS_Soils_NC (Buncombe, Henderson, Macon and Transylvania Counties)
- Layer description:
 - SSURGO Map Unit Polygon feature class of soil type including Catchment mean of pH of surface soils as reported in SSURGO soils database.
- Layer selection justification:
 - MSPP populations are associated with soils with moderately to extremely acidic pH. This pH range is approximately 3.0 to 6.0 using the USDA NRCS Soil Quality Indicators for pH.
 - Extract pH classes 3.0 to 6.0, up to 6.2 for Buncombe County.
- “Habitat” versus “Nonhabitat” designations:
 - Habitat for the MSPP is designated as soil pH ranging 3.0-6.0, up to 6.2 for Buncombe County.

Layer 5

- Layer name: USFWS National Wetland Inventory (NWI): (Buncombe, Henderson, Macon and Transylvania).
- Layer description:
 - Polygons representing extent and approximate location and type of wetlands and deepwater habitats in the United States and its territories.
- Layer selection justification:
 - MSPP is associated with shrub-dominated, seepage-fed mountain bogs.
 - Add NWI layer: Select Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, and Lake. Buffer Pond and Lake wetland types to capture only perimeters.
 - Merge to final model output.
- “Habitat” versus “Nonhabitat” designations:
 - Potential habitat for the MSPP occurs within shrub-dominated, seepage-fed mountain bog wetlands.

Layer 6

- Layer name: NHD_Flowlines (Buncombe, Henderson, Macon and Transylvania).
- Layer description:
 - National Hydrography Dataset High Resolution flowlines.
- Layer selection justification:

- Queried for Ftype 460 which captures streams.
- MSPP is associated with cataract bogs. Cataract bogs are known to occur in the Blue Ridge Escarpment region of North Carolina.
- Buffer by 5 feet to represent streams extents and select stream segments.
- Clip NHD_Stream_Lines shapefile with Buncombe, Henderson, Macon and Transylvania counties Blue Ridge Escarpment shapefile
- Merge to final model output.
- “Habitat” versus “Nonhabitat” designations:
 - Potential habitat for the MSPP occur along stream/waterfall edges, soil islands, or granite rock faces.

Layer 7

- Layer name: Blue_Ridge_Escarp (Buncombe, Henderson, Macon and Transylvania).
- Layer description:
 - Blue Ridge Escarpment geologic province located in Buncombe, Henderson, Macon and Transylvania Counties.
- Layer selection justification:
 - MSPP is associated with cataract bogs. Cataract bogs are known to occur in the Blue Ridge Escarpment region of North Carolina.
 - Blue Ridge escarpment shape file for Buncombe, Henderson, Macon and Transylvania counties was generated by tracing (digitizing) the Tennessee Valley Divide/Blue Ridge Mountain Range Boundary to the southern or eastern county boundary for each respective county.
- “Habitat” versus “Nonhabitat” designations:
 - Potential habitat for the MSPP occur along stream/waterfall edges, soil islands, or granite rock faces in the North Carolina Blue Ridge Escarpment geologic province.

Known Issues with Model Data Layers

- Geology: The North Carolina geologic map represents a generalized geology map of North Carolina. The data was reviewed for the presence of granite in Buncombe, Henderson, Macon and Transylvania Counties. The presence of granite was not shown in these counties, however granitic gneiss a metamorphic form of granite is shown.

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
 - If Model Builder was used, provide the version of ArcGIS – 10.6
 - Model file included in Appendix 1.
 - Summary of model steps
 - Selected North Carolina counties where plant is known to occur
 - Selected soils with defined drainage characteristics
 - Selected soils with defined pH values
 - Derived slopes from Q2DEM data, extracted ideal slopes for species
 - Add NWI layer: Select Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, and Lake. Buffered Pond and Lake wetland types were to capture only perimeters.
 - NHD Flowlines were clipped and buffered to Blue Ridge Escarpment landform to reflect streams that may contain cataract bog habitat
 - All resulting output data was merged to define potential MSPP habitat
- AGOL review
 - A model prediction file was shared with select reviewers on ArcGIS Online (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 March 2019 on the DRAFT version of this 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.
 - Provide summary result – NHP element occurrences intersected predicted habitat.

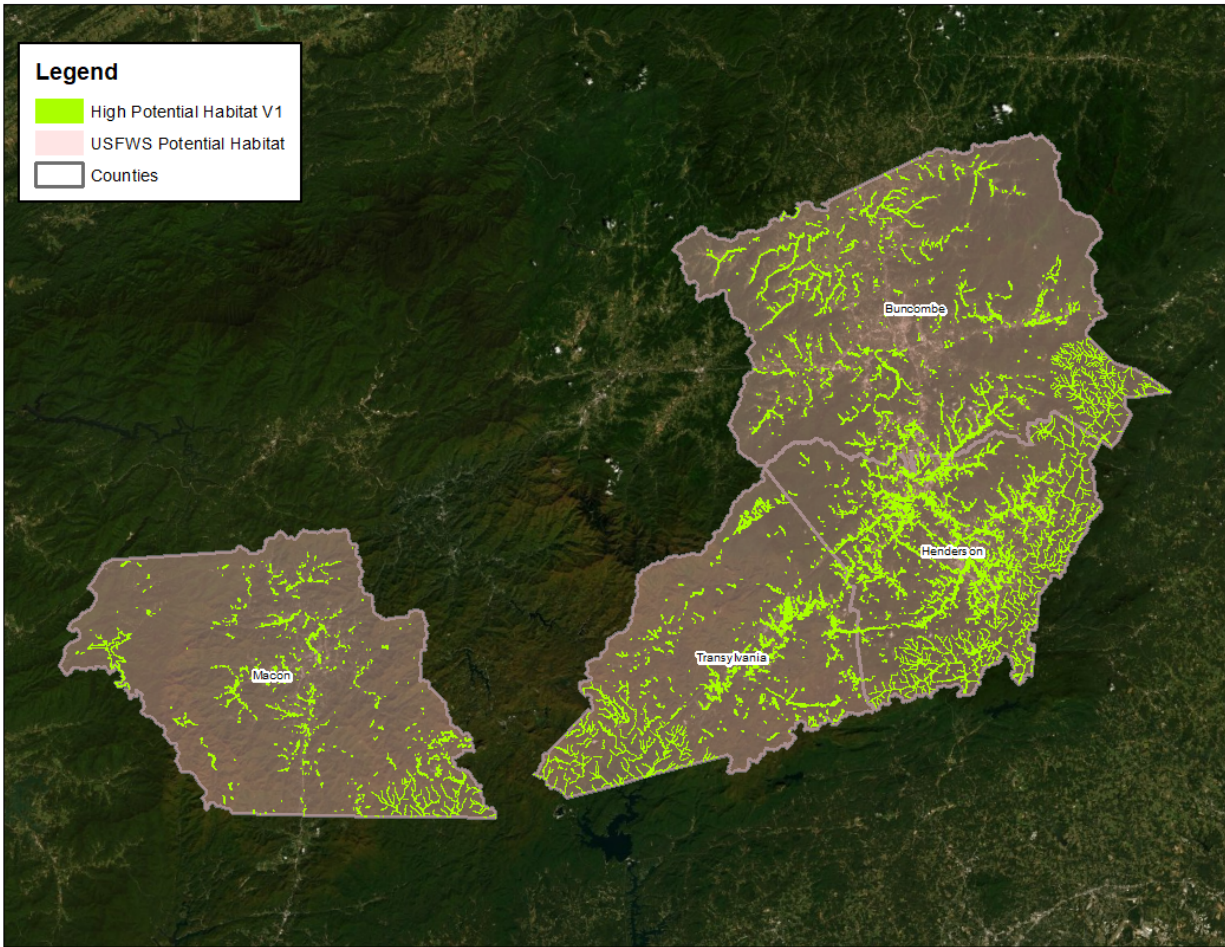


Figure 1. Range Map and High Potential Habitat (Version 1).

Previous Model Version (DRAFTS 1 & 2)

Two model DRAFTs were developed between the time period of 2018 and 2020. No original layers were modified following desktop review in 2019, however one new layer (USFWS NWI) was added. Additionally, one original layer (GAP_LANDFIRE National Terrestrial Ecosystems 2011) was removed following model field review in December 2019.

Layer 4

- Layer name: GAP_LANDFIRE National Terrestrial Ecosystems 2011. (Buncombe, Henderson, Macon and Transylvania).
- Layer description:
 - GAP Landfire National Terrestrial Ecosystems (2011) is a highly thematically covered land cover map of the United States.
 - Raster data has a 30 x 30 m cell resolution.
- Layer selection justification:
 - North Carolina MSPP populations are associated with the Southern Appalachian Bog (Southern subtype) (Schafale and Weakley, 1990). This community corresponds with the GAP Landfire Data's Southern and Central Appalachian Bog and Fen. No GAP Landfire Southern and Central Appalachian Bog data was listed for Buncombe, Henderson, or Transylvania counties. NCNHP Tier II data did include known southern bog data for 70 locations in the Blue Ridge physiographic region. This data was overlaid with GAP landcover data to extrapolate landcover types that may contain Southern Appalachian Bogs.
 - Extract NVI Classes Appalachian Hemlock-Hardwood Forest, Evergreen Plantation or Managed Pine, Pasture/Hay, South-Central Interior Small Stream and Riparian, Southern and Central Appalachian Bog and Fen, and Southern and Central Appalachian Oak Forest.
 - Convert Raster to Polygon
- "Habitat" versus "Nonhabitat" designations:
 - Habitat for the MSPP included the GAP Landfire communities listed above.

Layer 6

- Layer name: USFWS National Wetland Inventory (NWI): (Buncombe, Henderson, Macon and Transylvania).
- Layer description:
 - Polygons representing extent and approximate location and type of wetlands and deepwater habitats in the United States and its territories.
- Layer selection justification:
 - MSPP is associated with shrub-dominated, seepage-fed mountain bogs.

- Add NWI layer: Select Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, and Lake. Buffer Pond and Lake wetland types to capture only perimeters.
 - Merge to final model output.
- “Habitat” versus “Nonhabitat” designations:
 - Potential habitat for the MSPP occurs within shrub-dominated, seepage-fed mountain bog wetlands.

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 reviewer comments (shapefile) and word document*

References

McMillan, Patrick. 2011. "Mountain Bogs on the Verge of Vanishing". Expeditions with Patrick McMillan.

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https://projects.ncsu.edu/cals/plantbiology/ncsc/rare/images/Sarracenia_jonesii_NHP.pdf.
(Accessed April 4, 2018).

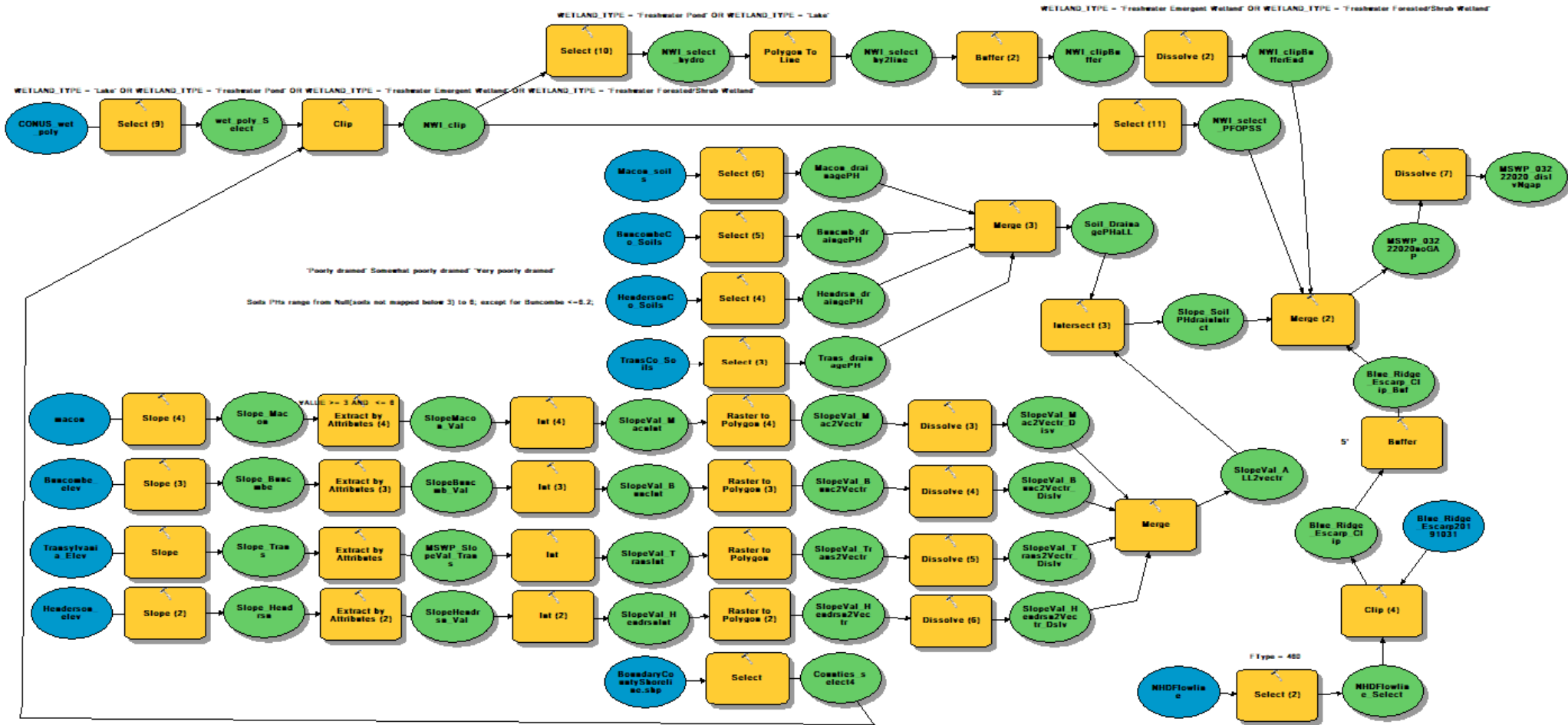
Schafale, M. P. and A. S. Weakly. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health and Natural Resources. Raleigh, NC 325 pp.

(USFWS) US Fish and Wildlife Service. 1990. Mountain Sweet Pitcher Plant (*Sarracenia rubra* ssp. *jonesii* [Wherry] Wherry).
https://projects.ncsu.edu/cals/plantbiology/ncsc/rare/Recovery_Sarracenia_jonesii.pdf.
(Accessed April 4, 2018).

USFWS. 2011. Mountain sweet pitcher plant (*Sarracenia rubra* ssp. *jonesii*) Fact Sheet.
https://www.fws.gov/asheville/pdfs/MtSweetPitcherPlant_factsheet.pdf. (Accessed April 4, 2018).

USFWS. 2013. Mountain sweet pitcher plant (*Sarracenia rubra* ssp. *jonesii*), 5-Year Review: Summary and Evaluation. <https://www.fws.gov/southeast/pdf/five-year-reviews/mountain-sweet-pitcher-plant.pdf>. (Accessed September 17, 2018).

Appendix 1: Mountain Sweet Pitcher Plant Expert Model



Appendix 2: Reviewer Documentation

Project Information

- Species: Mountain Sweet Pitcher Plant (*Sarracenia rubra* ssp. *jonesii*)
- Lead modeler: Eric Black (e.black@sncgrp.com) 919-612-2591; Katie Talavera (ktalavera@ESINC.CC), 919-602-4430.
- Reviewer names:
 1. Suzanne Mason (NCNHP)
 2. Jame Amoroso (NCNHP)
 3. Rebekah Reid (USFWS – West)
 - Suzanne Mason (NCNHP) – Suzanne 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.
 - Jame Amoroso (NCNHP) – Jame 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 Master 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.
 - Rebekah Reid (USFWS-West) – Rebekah is an endangered species listing and recovery biologist with the US Fish and Wildlife Service, Asheville. She specializes in plants and lichens

Range Map to Potential Habitat (DRAFT)

- USFWS Range 905,619 acres
- ATLAS Range 28,990 acres

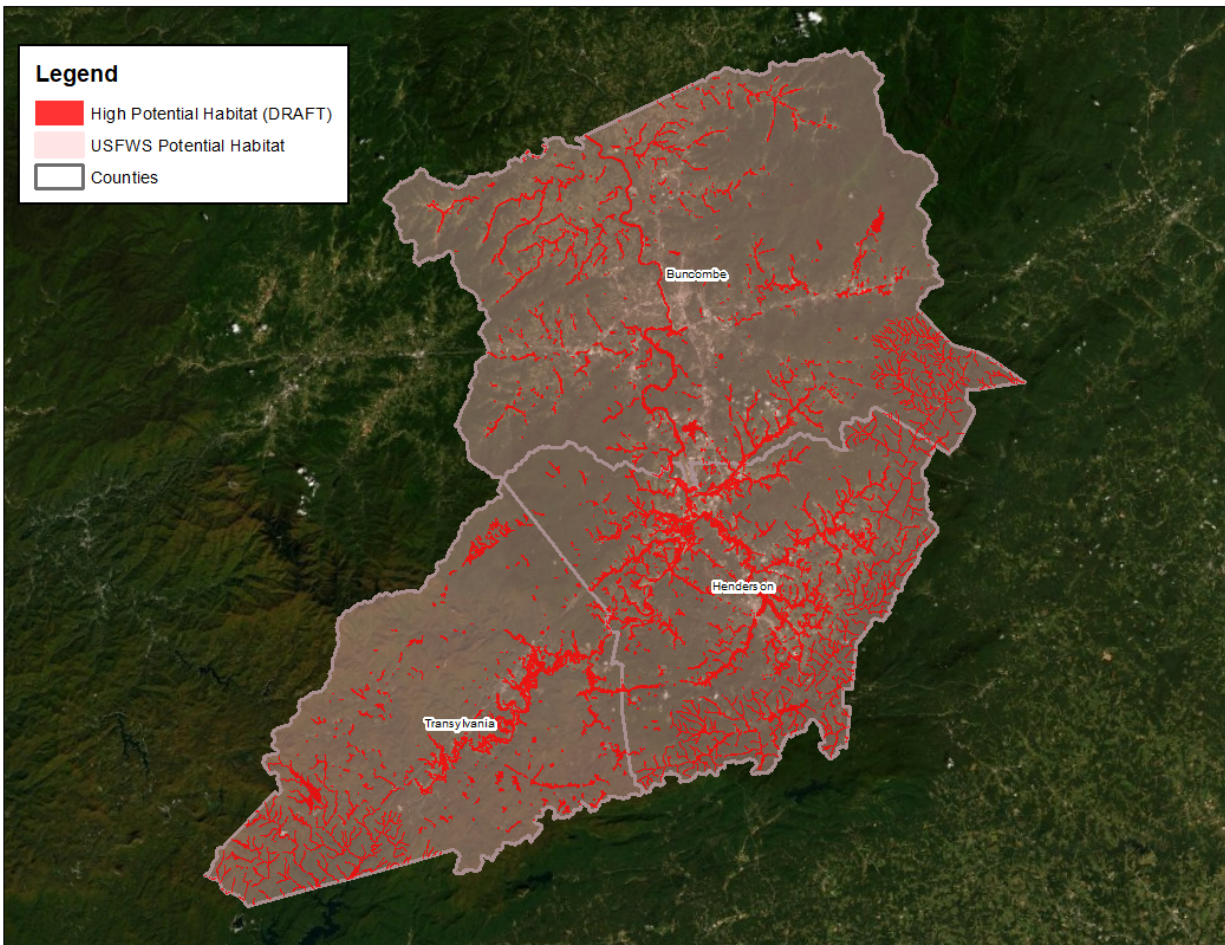


Figure 2. Range Map and High Potential Habitat (DRAFT).

Summary of Model (DRAFT)

Environmental data layers used included County Boundary, NRCS Soil (drainage characteristics), Q2DEM (slopes), GAP Landfire data, Soil pH, NHD Flowlines, and Blue Ridge Escarpment landform.

- Summary of model steps
 - Selected North Carolina counties where plant is known to occur
 - Selected NRCS soils with defined drainage characteristics
 - Derived slopes from Q2DEM data, extracted ideal slopes for species
 - Extracted known community types from GAP Landfire data
 - Selected soils with defined pH values
 - NHD Flowlines were clipped and buffered to Blue Ridge Escarpment landform to reflect streams that may contain cataract bog habitat
 - All resulting output data was merged to define potential MSPP habitat
- Response Rate
 - Reviewer Response Rate: 88%

- 21 reviewer points placed by modeler
- # Additional Comments (placed by reviewer): 16

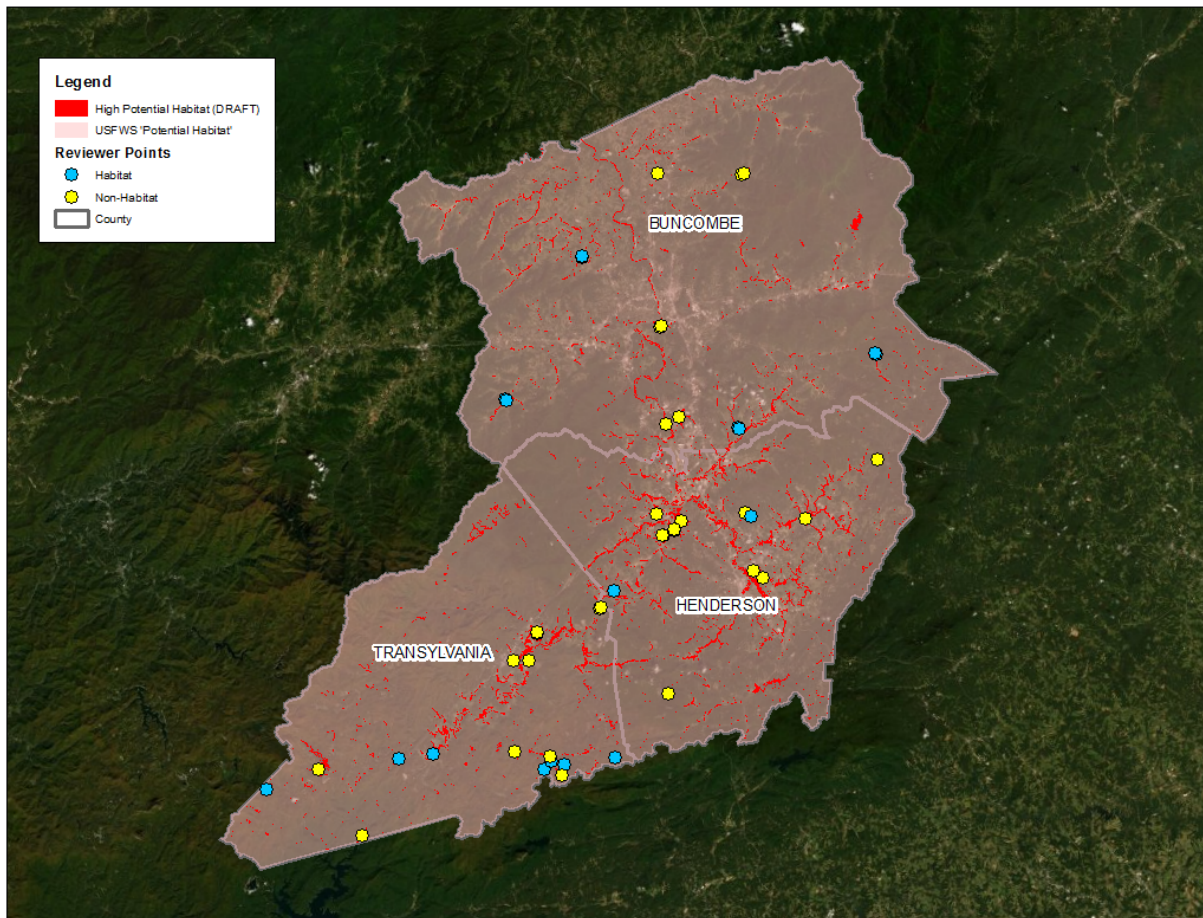


Figure 3. Reviewer Points High Potential Habitat (DRAFT)

Reviewer Responses

- Twenty-one model flags were placed throughout the USFWS listed range to elicit reviewer response regarding model accuracy (i.e. Judgment Class: False negative, False positive, True Negative, and True Positive) for predicted SWP habitat. Reviewers provided a total of 53 responses consisting of 37 responses (88% response rate) for flagged location accuracy, and 16 responses for accuracy of unflagged locations.
- General agreement regarding judgment class for flagged locations was observed among reviewers. Reviewers for the most part agreed with the model's prediction of potential habitat (True Positive) and non-habitat (True Negative). Model over prediction (False Positive) was associated with model capture of open water areas and incorrect GAP landcover classification. Underprediction (False Negative) was generally attributed to absence of required NRCS soil drainage classification, or failure to predict habitat for introduced MSPP occurrences. Introduced MSPP occurrence sites were not used for model verification. A shapefile including all comments is included as part of this appendix.

Proposed Version 1 Model

In order to address comments by reviewers and changes to the USFWS MSPP range, the following changes were made to the model:

- Added USFWS NWI layer: Selected Freshwater Emergent, Freshwater Forested/Shrub, Freshwater Pond, and Lake wetland types. Buffered Pond and Lake wetland types to capture feature margins and exclude open water areas. Addition of the NWI layer captured potential habitat areas not included in the DRAFT model, and/or more accurately define habitat associated with pond and lake margins.
- Added Macon County to reflect changes in USFWS MSPP range map.
- Removed GAP_LANDFIRE National Terrestrial Ecosystems 2011 layer for more uniform habitat coverage.
- Version 1 of the MSPP potential habitat model consists of an increase in 2,567 acres for a total range of 31,557 acres. While potential MSPP habitat increased as a result of the addition of Macon County, overall acreage decreased as result of removing open water areas as potential habitat.

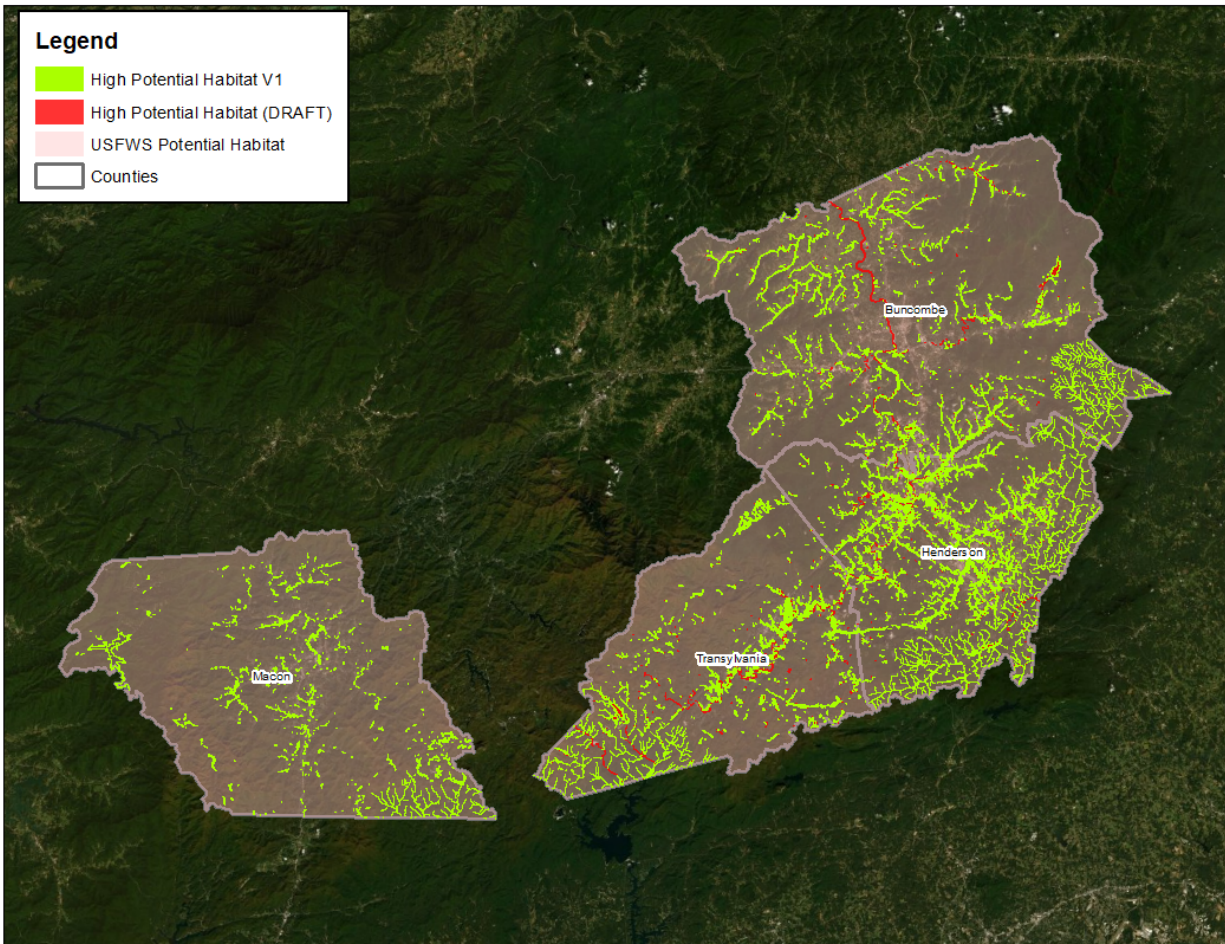


Figure 4. Range Map and High Potential Habitat Version 1 and DRAFT

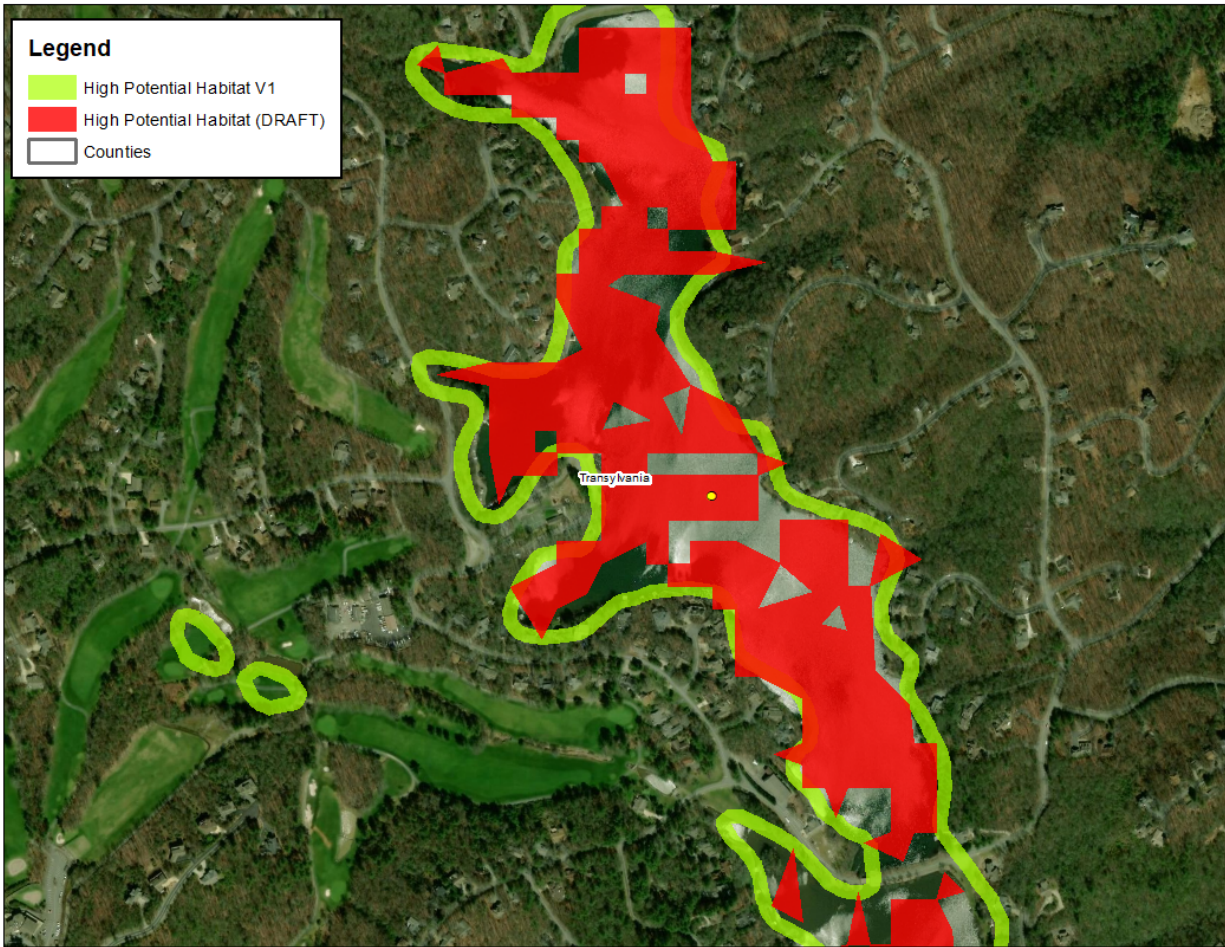


Figure 5. High MSPP habitat (Lake and Pond Edges) following model revision (Version 1)

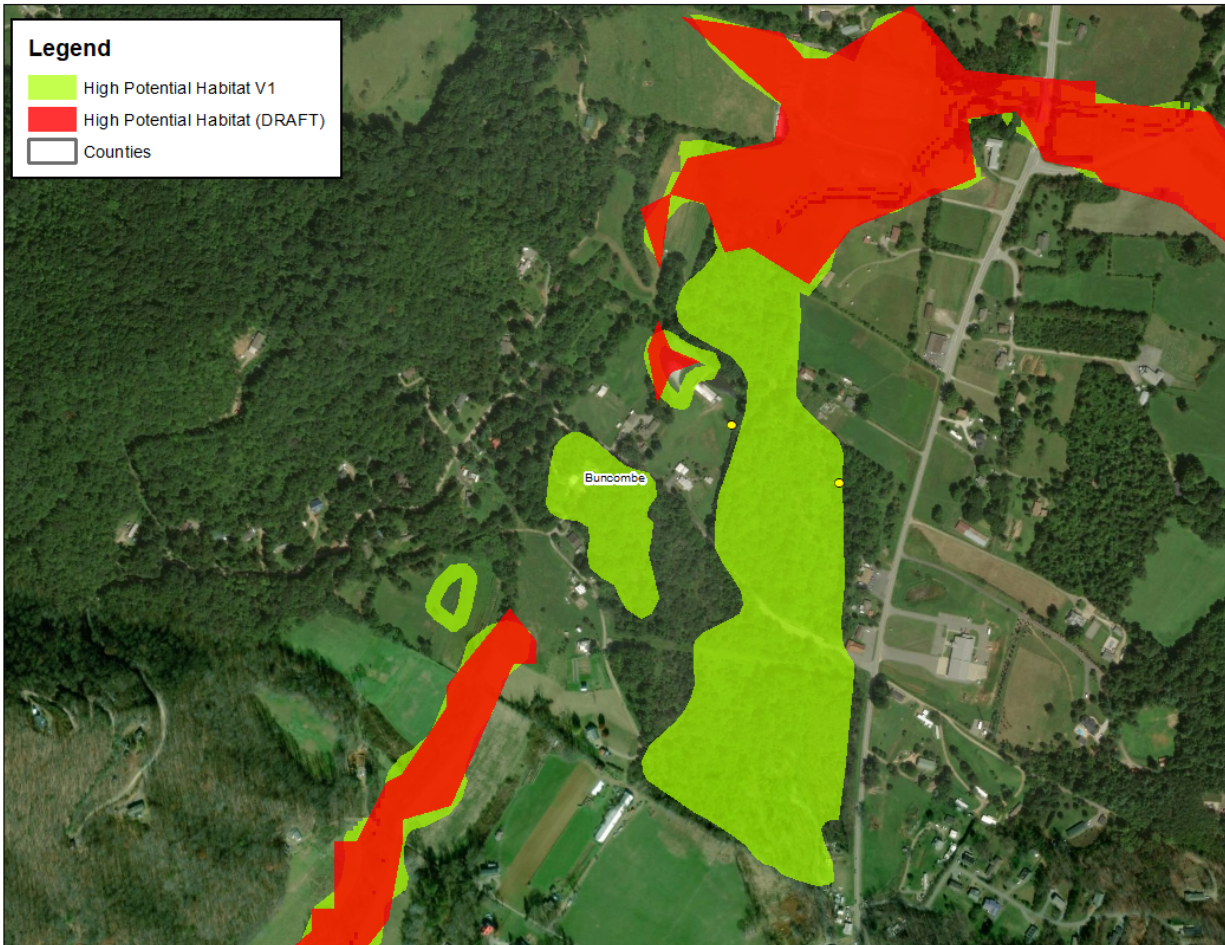


Figure 6. High MSPP habitat (Additional Habitat) following revisions (Version 1)

Model Field Assessment and Accuracy Statistics

Habitat model field assessments performed in 39 locations across the “current” USFWS listed counties in December 2019 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

- Eric Black is a Senior Environmental Project Manager with Scenic Consulting Group 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.

Figure 7. Accuracy summary based on field assessment of Version 1 model. (units in the confusion matrix are polygons drawn by biologists)

	Field "Actual" Potential Habitat	Field "Actual" Non-Habitat
Predicted Potential Habitat	True Positive 12	False Positive 12
Predicted Non- Habitat	False Negative 0	True Negative 15

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

- Percent correctly classified was 69%
- Sensitivity was 1
- Specificity was 0.555556

The biologists' summarized their observations as follows:

- The MSPP model generally predicts known habitat (e.g. stream associated wetlands, spring seepages, swamp forest, floodplain associated wetlands) and excludes unlikely habitat (e.g. upland forests, pastures, parking lots, regularly maintained properties, urban areas, ridgelines, hilltops, hillsides etc.)
- False positives were generally in areas where floodplain hydrology had been altered and/or agriculturally impacted floodplains (e.g. drain or fill, incised stream, or steep gradient high velocity streams)
- No false negatives were observed.