Interim Core Map Documentation for the Copperbelly Water Snake

Date Posted to EPA's Geoplatform: July 2025
Interim Core Map Developer: Compliance Services International (CSI).

Species Summary

The copperbelly water snake (*Nerodia erythrogaster neglecta*; Entity ID 180) is a threatened reptile. The U.S. Fish and Wildlife Service (FWS) has not designated critical habitat for the copperbelly water snake. This species uses shallow wetlands such as shrub-scrub, emergent, and the margins of palustrine open water wetlands (FWS 2008). The listed population inhabits the tristate area of Michigan, Ohio, and Indiana. The copperbelly water snake is otherwise known as the plain-bellied watersnake, and its only listed population is from the northern portion of the species range. Additional information is provided in **Appendix 1**.

EPA Review Notes

The developers created this core map using the U.S. Environmental Protection Agency's (EPA) process available at: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas. EPA reviewed the draft interim map and documentation and evaluated if: (1) the map and documentation are consistent with the agency's process; (2) areas included or excluded from the interim core map are consistent with the biology, habitat, and/or recovery needs of the species; (3) data sources are documented and appropriate; and (4) the GIS data and mapping process are consistent with the stated intention of the developer. EPA agrees that this map is a reasonable depiction of core areas for this species and was consistent with the agency's mapping process. This documentation was not prepared by EPA, but EPA may have edited this documentation for clarity or other purposes.
The core map developed for this species is considered interim and can be used to develop pesticide use limitation areas (PULAs). This core map incorporates information developed by FWS and made available to the public; however, the core map has not been formally reviewed by FWS. This interim core map may be revised in the future to incorporate expert feedback from FWS.

This core map does not replace or revise any range or designated critical habitat developed by FWS.

Description of Core Map

The core map for the copperbelly water snake is based on biological information, which was used to refine an extent defined as the species range. Specifically, a description of species habitat was matched to a subset of habitat types available from a national wetlands dataset, the National Wetlands Inventory (NWI) (NWI 2023). Appropriate wetland areas were clipped to the species range, then had contiguous cultivated areas > 25 acres (EPA 2025) removed to develop the core map. Note that the range used to develop the copperbelly water snake core map corresponds only to its lone listed population, found in the northern part of the overall species range (Michigan, Ohio, and Indiana).

Available known location information from the Global Biodiversity Information Facility (GBIF) and iNaturalist databases, and other types of datasets from NatureServe and FWS were not used due to core map development scope, inaccuracies, or simply in favor of more complete and recent datasets.

The core map developed in this document spans 226,891 acres. A summary of acreage by National Landcover Database (NLCD) land use type is provided in

Table 1.

Based on EPA's "best professional judgment classification" system, CSI has graded this core map as "moderate" (4) because assumptions were made when connecting species life history and/or biological needs (habitat preferences and water body descriptions) to a GIS dataset, in this case the NWI dataset (NWI 2023). More information about this classification system and its definitions can be found in the core map process document (EPA 2024).

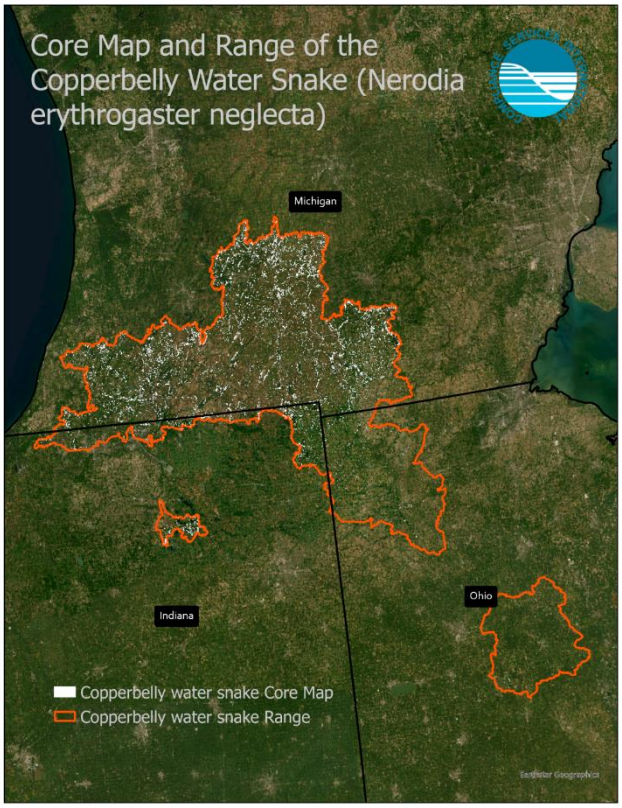

Figure 1. Interim core map for the copperbelly water snake.

Table 1. Acres by National Land Cover Database (NLCD) class within the core map of the copperbelly water snake. Total core map area (based on NLCD pixel count): 226,883 acres[1].

NLCD_Land_Cover_Class	Acres
Woody Wetlands	126,266
Deciduous Forest	42,052
Cultivated Crops	16,328
Developed, Open Space	10,545
Hay/Pasture	9,831
Emergent Herbaceous Wetlands	5,987
Developed, Low Intensity	5,412
Open Water	4,880
Mixed Forest	1,927
Developed, Medium Intensity	1,546
Evergreen Forest	857
Herbaceous	661
Developed, High Intensity	333
Barren Land	141
Shrub/Scrub	117

[1] This acreage is slightly different from the core map acreage (226,891) due to the pixelation of NLCD land cover. The core map is not developed from raster data.

Evaluation of Known Location Information

There were four evaluated datasets with known location information:

- Descriptions of locations provided by FWS;
- Occurrence locations in iNaturalist;
- Occurrence locations in Global Biodiversity Information Facility (GBIF); and
- Occurrence locations in NatureServe.

Compliance Services International (CSI) evaluated these four datasets before developing the core map. Overall, there were several thousand research-grade observations found in iNaturalist[2] for the plain-bellied water snake, that were not specific to the northern population segment listed. A small number do occur in the vicinity of the range, but these were not usable for the creation of a core map for this species. The GBIF database was significantly sparser, and most observations with coordinates were too old (> 50 years) to be seriously considered for core map development. Public NatureServe element occurrence data did not include the northern population of the species, so was not usable for core map development.

Textual descriptions of species location information from the FWS were not specific enough to use for core map development. While there is general discussion about captivity sites and presence/absence of species identification at those sites, CSI determined that these were not reliable enough to use—particularly for a mobile species like the copperbelly water snake—at this time.

Approach Used to Create Core Map

The core map was developed using the process EPA uses to develop core maps for draft Pesticide Use Limitation Areas for species listed by the FWS and their designated critical habitats[2] (referred to as "the process"). This core map was developed by CSI using the four steps described in the process document:

1. Compile available information for a species;
2. Identify core map type from among the following defined types: Designated Critical Habitat, Range, and Biological Information. From EPA, summaries of each core map type are provided below (EPA 2024).
3. Develop the core map for the species; and
4. Document the core map.

For step 1, CSI compiled available information for the copperbelly water snake from the FWS, as well as observation information available from various publicly available sources including iNaturalist, GBIF, and NatureServe. The information compiled for the copperbelly water snake is included in **Appendix 1**. Influential information that impacted the development of the core map includes a description of the species habitat from the FWS's Species Status Assessment:

> "Copperbellies prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush

[2] According to iNaturalist, an observation is designated as "research grade" if it 1) is verifiable with date, coordinates, photos/sounds, and not captive; 2) achieves community agreement defined as "more than 2/3 of identifiers needs to agree on the species level ID or lower;" and 3) "must pass a data quality assessment, which includes checks for accurate date and location, evidence of a wild organism, and clear evidence of the organism itself" (https://help.inaturalist.org/en/support/solutions/articles/151000169936-what-is-the-data-quality-assessment-and-how-do-observations-qualify-to-become-research-grade-).

(Cephalanthus occidentalis), emergent wetlands, or the margins of palustrine open water wetlands (Kingsbury 1996, Herbert 2003, Kingsbury et al. 2003, Laurent and Kingsbury 2003). Copperbellies use buttonbush swamps as basking or "loafing" areas. Foraging occurs in shallower margins of such systems, or in ephemeral, emergent wetlands. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Thus, they are less likely to be found in forested wetlands, unless they could find a gap in the canopy, or were otherwise on the edge of forest." (FWS 2008)

For step 2, CSI used the compiled information including the species range, known locations, and habitat location information to determine the core map type. CSI compared the known location data to the range and found that known locations from larger databases (iNaturalist and GBIF) included a significant amount of area extending to geographies nowhere near the range of the subpopulation, reducing confidence in their utility for the core map development process. By contrast, known location information from FWS about captivity sites were consistent with range, but not usable for core map development.

Review of the available data also suggested that the species is likely excluded from smaller areas within the extent, corresponding to cultivated lands. Because the species has specific habitat requirements that are not located everywhere within this extent, the copperbelly water snake was judged by CSI to be "off-field." When weighing that information together, CSI selected the biological information core map type, limited to an extent defined by its range. CSI used a combination of range, habitat information, and EPA's Cultivated areas > 25 acres layer (EPA 2025) to derive this core map.

For step 3, CSI used the best-available data sources to generate the core map. Data sources are discussed in the EPA's core map process document. For this interim core map, CSI followed EPA's decision framework to arrive at a core map type of biological information. Designated critical habitat was quickly eliminated as a core map type because the copperbelly water snake does not have designated critical habitat. The range core map type was not used because the species range includes large, contiguous areas that are further refined.

The NWI dataset was queried for classes relevant to the copperbelly water snake (i.e., within its range) to form the basis of core map areas within the core map extent (range) (FWS 2013). Finally, cultivated lands > 25 acres were removed from this area; this did not remove a substantial fraction of area because the habitat-based areas definitionally exclude cultivated land. **Appendix 2** provides more details on the GIS analysis and data used to generate the core map.

Discussion of Approaches and Data that were Considered but not Included in Core Map

Population Modeling

As part of the scoping and data aggregation processes, a search for copperbelly water snake-specific habitat models led core map developers to a model produced jointly by the Michigan Natural Features Inventory (Lansing, MI) and the Center for Reptile and Amphibian Conservation and Management (Fort Wayne, IN) for FWS (FWS 2007).

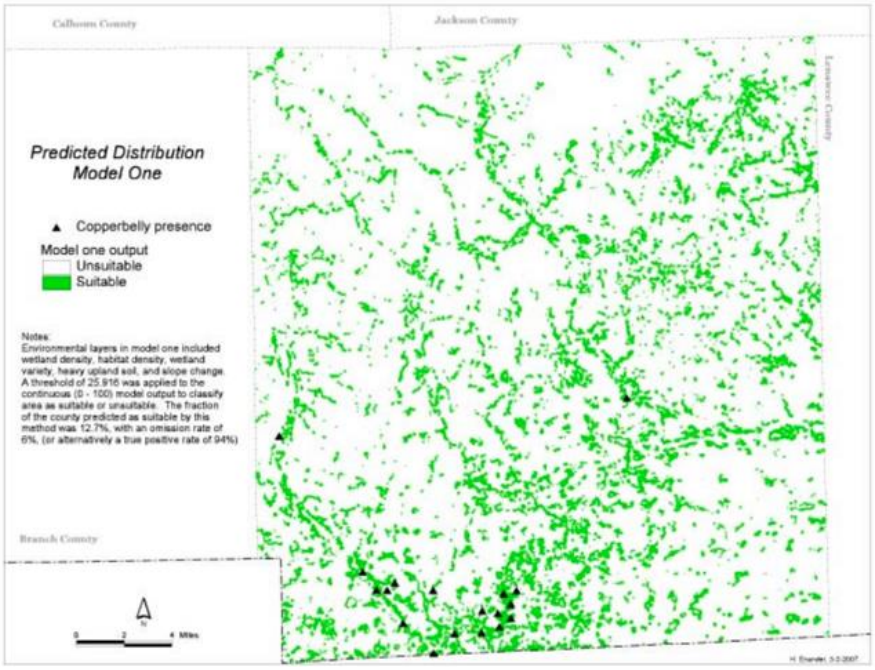

Figure 2. Map of predicted distribution of suitable areas (shown in green) for copperbelly water snakes in Hillsdale County, Michigan based on results of Maxent model one, "heavy soils," with a threshold determined by the ROC (receiver operator characteristics) curve. This model predicted 12.7% of the study area as suitable, with an omission rate of 6%. Copied from Figure 11 of the source document (FWS 2007).

The model uses GIS methods to rank habitat suitability areas based on five data layers: upland heavy soil (clay, silt, and muck), wetland density, habitat density, wetland variety, and slope change.

The model was removed from consideration because the spatial data could not be obtained, and the imagery from the report were not usable for core map development. Furthermore, the scope of this analysis was limited to Hillsdale County in Michigan, which is only a subset of the species range. Because of this, a formal analysis on the quality of the model was not performed before ruling it out as a source for core map development.

Appendix 1. Information compiled for the copperbelly water snake

1. **Recent FWS documents**
   - Recovery Plan (2008) https://ecos.fws.gov/docs/recovery_plan/081223.pdf
   - 5-Year Review (2023) https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/10539.pdf

2. **Background information**

- Status: Federally listed as threatened in 1997.
- Resiliency, redundancy, and representation (the 3Rs).
  - The 3 Rs were not specifically described in the species recovery plan or most recent 5-year review for this species and there is no species status assessment.

- Habitat, Life History, and Ecology
  - Habitat: "Copperbellies prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (*Cephalanthus occidentalis*), emergent wetlands, or the margins of palustrine open water wetlands (Kingsbury 1996, Herbert 2003, Kingsbury et al. 2003, Laurent and Kingsbury 2003). Copperbellies use buttonbush swamps as basking or "loafing" areas. Foraging occurs in shallower margins of such systems, or in ephemeral, emergent wetlands. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Thus, they are less likely to be found in forested wetlands, unless they could find a gap in the canopy, or were otherwise on the edge of forest." (Recovery Plan, 2008).
  - "Courtship and breeding principally occur in spring, although this activity may continue into summer (Conant 1934, Kingsbury 1996, Kingsbury et al. 2003). Males seek females and may aggregate around them. Mating "balls" may be observed where the female remains relatively immobile but alert while multiple males endeavor to mate with her, a mating behavior typical for natricine snakes. It is unknown whether copperbellies breed annually or less frequently, and we also lack significant information on clutch size. Gibbons and Dorcas (2004) summarized litter size for *N. erythrogaster* as a whole and reported that they ranged from 2 to 55, but averaged 17.7 across 53 records. Not enough data are currently available to state whether or not litter size is correlated with adult body size." (Recovery Plan, 2008).
  - Diet: "Plain-bellied water snakes eat primarily amphibian adults and larvae, particularly frogs of the genus Rana, such as the green frog (*Rana clamitans*) (Mushinsky and Hebrard 1977, Diener 1957, Kofron 1978). However, they are opportunistic and will eat a variety of small fish and amphibians. A regurgitated gut contents survey found only amphibians and a single crayfish claw in copperbellies, whereas northern water snakes sampled in the same way from the same area had about half amphibians and half small fish (Kingsbury et al. 2003).

    Copperbellies forage both aquatically and terrestrially. In aquatic settings, copperbellies forage in water only several (< 10-20) centimeters deep (Bruce Kingsbury, Indiana Purdue University Fort Wayne, personal observation 2000). Small fish and larval amphibians (tadpoles) are captured by being trapped against folds of the body or debris in the water. Seasonal wetlands, important sources for recruitment into the amphibian prey base, are also favored foraging areas. Their gradual drying provides excellent foraging opportunities as tadpoles become stranded and accessible to the snakes. Copperbellies do not forage in open

deeper water and do not take larger live fish; however, water snakes will scavenge on larger dead fish (Kingsbury, personal observation 1996). Roe et al. (2005) reported on terrestrial feeding events in which adult American toads (*Bufo americanus*) were consumed away from water" (Recovery Plan, 2008).

- Taxonomy

  The copperbelly water snake is a subspecies of the plain-bellied water snake (*Nerodia erythrogaster*) (Recovery Plan, 2008).

- Recovery Criteria
  - 5-Year Review (2023) –Recovery Criteria
    - Criterion 1. Multiple population viability is assured:

    a) Five geographically distinct populations have population sizes of more than 500 adults, with at least one population exceeding 1,000 adults; or three populations must have a total population size of 3,000 adults, with none less than 500, and
    b) These populations must persist at these levels for at least ten years. Restore and enhance habitat

    - Criterion 2. Sufficient habitat is conserved and managed:

    a) Wetland/upland habitat complexes sufficient to support the populations described in Criterion 1 are permanently conserved.

    1) A population of 1,000 adults will require at least five square miles of landscape matrix with a high density and diversity of shallow wetlands embedded in largely forested uplands.

    2) A population of 500 adults will require at least three square miles of the same type of habitat.

    b) Multiple (two or more) hibernacula for each population are permanently conserved. A minimum of two hibernacula will be available within one kilometer of all suitable summer habitat included above.

    - Criterion 3. Significant threats due to lack of suitable management, adverse land features and uses, collection, and persecution have been reduced or eliminated:

    a) Habitat management and protection guidelines have been developed, distributed, and maintained.

    b) Adverse land features and uses, such as row crops, roads and accompanying traffic have been removed, minimized or managed within occupied Criterion 1 landscape complexes to the extent possible.

    c) A comprehensive education and outreach program, including persecution and collection deterrence, has been developed and implemented.

3. Description of Species Range (From the 2023 5-Year Review)

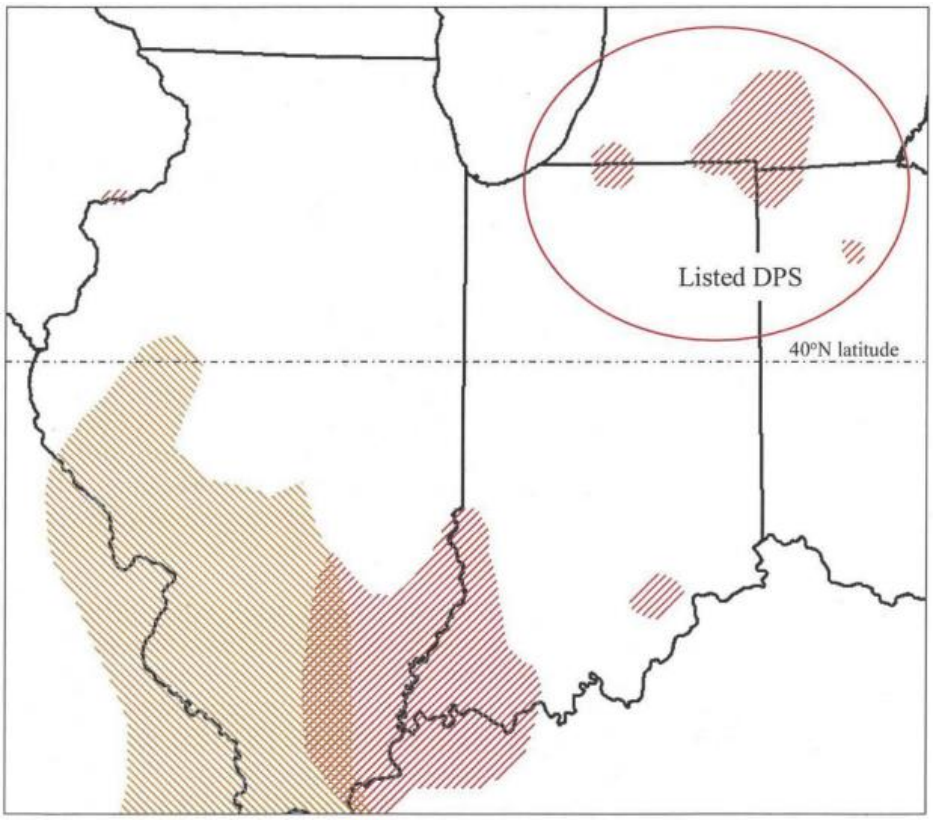

Figure 3. Historical distribution of the copperbelly water snake in the Midwest (six polygons with red hatching). To the northeast, north of the 40th North Parallel, are the isolated remaining copperbelly populations of the listed distinct population segment (DPS) (circled area). All known remaining populations of the DPS are within 15 miles of the intersection of Indiana, Michigan, and Ohio. Neither the southern populations nor the southeastern disjunct population near Seymour, Indiana, are federally listed, nor is the northwestern population along the Mississippi River in northwestern Illinois and eastern Iowa. Also shown (yellow hatching) is the Midwestern extension of the distribution of the plain-bellied watersnake, a relative or the copperbelly, whose distribution continues south, and for which there is no federal protection. Copied from Figure 1 of the 5-Year Review (FWS 2023).

4. Critical Habitat

The copperbelly water snake does not have designated critical habitat.

5. Known Locations

FWS

- "Of the seven clusters of wetlands surveyed in Ohio and Michigan during 2022, copperbellies were only found within one wetland cluster (FWS 2023). Six (86%) of the seven copperbelly sightings were from the same wetland (FWS 2023). It appears that many of the wetlands that were occupied by this species in previous years are no longer inhabited. Thus, the population appears to be concentrated into a smaller area. In addition, a single snake was found at La Su An Wildlife Area in 2023 indicating that very few individuals are present at this site. The capture of a gravid female in 2022 (FWS 2023) appears to indicate that reproduction is continuing to occur in the wild." (From the 2023 5-Year Review)

iNaturalist: https://www.inaturalist.org/observations?subview=map&taxon_id=29328

- iNaturalist does not distinguish the copperbelly water snake (subspecies) from the entire species known as the plain-bellied watersnake; therefore, the observations may or may not correspond to the listed species. Additionally, only a small subset of these observations overlap with the range of the listed species/population. This uncertainty reduced the confidence of this dataset for the copperbelly water snake; therefore, iNaturalist was not used for core map development.

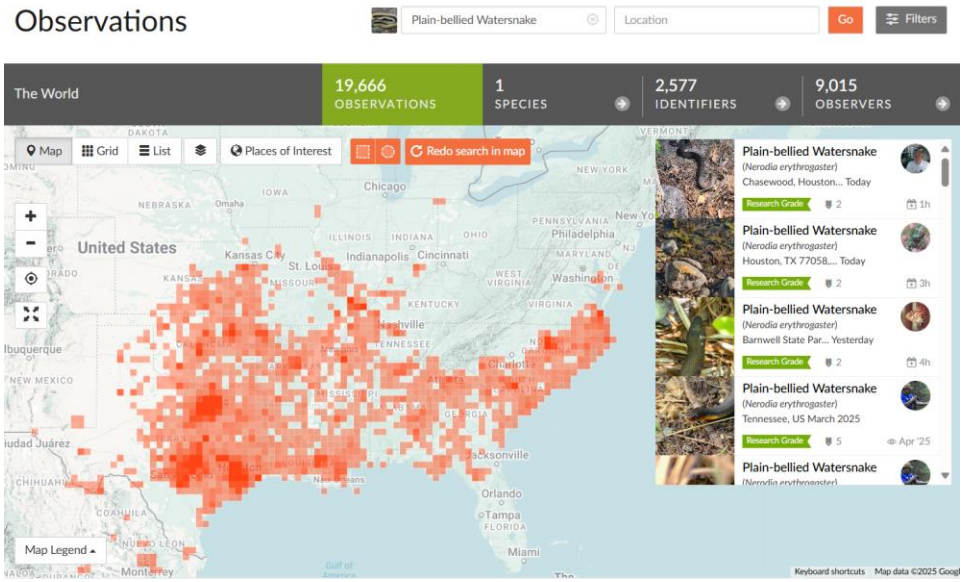

Figure 4. iNaturalist occurrences for the plain-bellied watersnake.

GBIF: https://www.gbif.org/species/5223373

- GBIF includes 77 occurrences dated from 2005 to July 2024.
- There are 18 occurrences with coordinates, the vast majority of which are > 50 years old and the most recent of which is dated 2008.

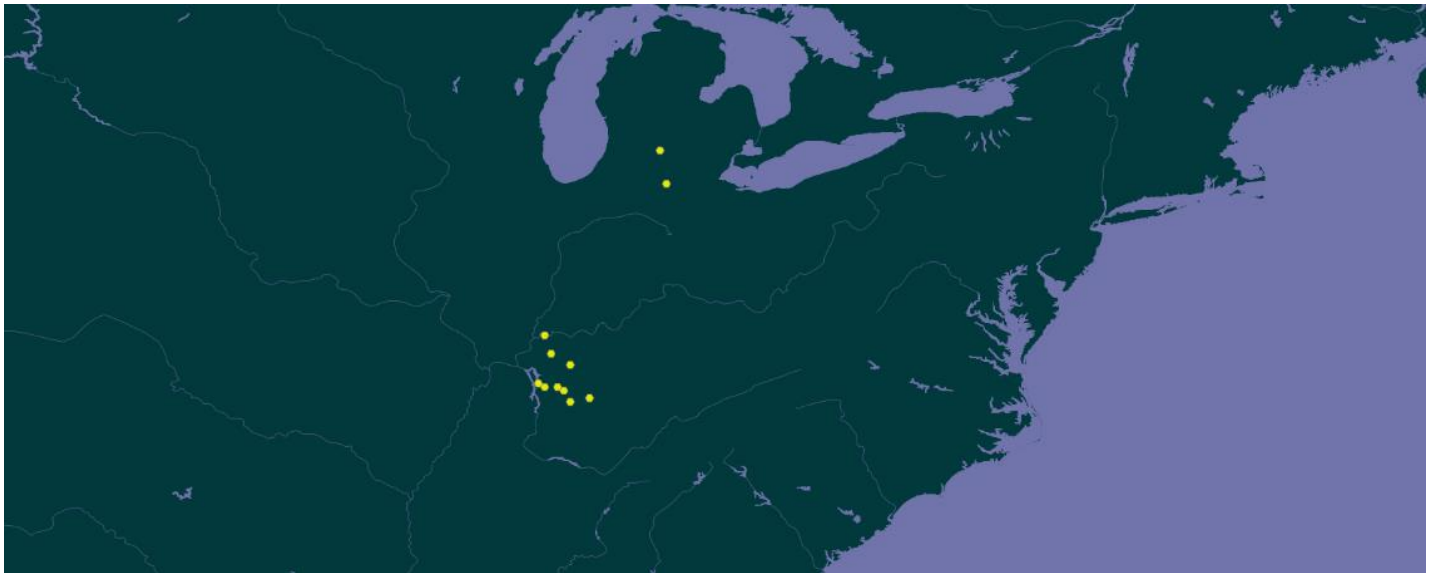
Figure 5. GBIF occurrences for the copperbelly water snake.

- NatureServe Explorer: https://explorer.natureserve.org/
    - Like the iNaturalist database, NatureServe does not have an entry for the copperbelly water snake, but rather the plain-bellied water snake. There are no public observations within the range of the listed portion of the copperbelly water snake; therefore, this dataset was not used in core map development.

Appendix 2. GIS Data Review and Method to Develop Core Map

The core map for this species is based on biological information, which includes the habitat used by this species found within a spatial extent based on range. The core map identifies all areas within the range matching its habitat description of "shrub-scrub wetlands dominated by buttonbush (*Cephalanthus occidentalis*), emergent wetlands, or the margins of palustrine open water wetlands," using professional judgment to match classes in the NWI dataset (FWS 2023). The NWI dataset is regarded as a high quality national-level dataset that is appropriate to identify aquatic habitat for reptile species such as the copperbelly water snake.

1. **References and Software**
   - EPA Cultivated Lands > 25 acres: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas.
   - National Wetlands Inventory: https://www.fws.gov/program/national-wetlands-inventory
   - Software used: ArcGIS Pro version 3.2.
   - EPA Modified Cultivated Layer: https://cdn.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668
   - FWS Species Range: https://ecos.fws.gov/ecp/species/7253

2. **Datasets Used in Core Map Development**

   2.1. Range

The range for this species was last updated by the FWS on December 13, 2021. A shapefile including species range for all listed species was downloaded from the FWS ECOS website on January 24, 2025. The shapefile was converted to a feature class stored in a file geodatabase and reprojected to WKID #4269 ("North America Albers Equal Area Conic").

1. Using an ArcGIS Web Map the species was queried based on the ECOS listed "Entity ID" of 180 and exported as a feature class to a temporary file geodatabase as a standalone Entity ID-specific layer.
2. The area of the range was calculated automatically by loading it into the software (ArcGIS Pro version 3.2) and reading its area from the attribute table ("Shape_Area"), then converting its units (square meters) into acres with a conversion factor of 0.000247105.

This shapefile was added to an ArcGIS Pro map and compared against the available known locations described in the FWS 5-year review. The known observations of extant populations in FWS documentation were judged to be sufficient for use in core map development, without addition (or subtraction) resulting from other datasets.

2.2. National Wetlands Inventory

The NWI dataset was preliminarily vetted to determine its appropriateness in representing aquatic areas matching descriptions of the copperbelly water snake habitat. The species primarily inhabits and forages in wetland areas, which are included in the NWI dataset.

The NWI is publicly available as state-level downloads. The state-level NWI datasets were downloaded for

each state intersecting the species range (Indiana, Michigan, and Ohio), merged into a single layer, and clipped to species range. The resulting attribute table was examined for different wetland types relevant to the copperbelly water snake. Additionally, a 100-meter (m) buffer was added to the selected water bodies, based on species-specific habitat information provided in the Recovery Plan (FWS 2008):

> "Wetlands must be buffered from Intact land-water interfaces protect adjoining aquatic resources by filtering chemical pollutants, moderating temperatures, and reducing siltation from activities in the surrounding landscape. This is standard wetland buffering and should follow best management practices for wetlands. These areas will also have the heaviest snake use, and so activities in these zones could lead to direct mortality. A starting point for such a buffer might be 50 meters. However, the following logic also applies.
> Copperbellies require extensive upland matrix as part of the "core habitat." The term buffer is misleading for this additional habitat, as it does not relate directly to protection of wetland water quality. However, its use is so embedded in conservation language that the term may be unavoidable. Although copperbellies will benefit from greater areas, core widths of 100 meters, or 250 meters between wetlands in a complex (roughly two merged buffer zones), will likely be the most beneficial. An implication is that adjacent wetlands should be linked by upland habitat that lacks barriers such as roads, row crops, or other development."

While 50 m is stated as a protective starting point for buffering wetland habitat, FWS indicates a minimum buffer of 100 m is protective of upland habitat surrounding wetlands that copperbelly water snakes rely on. The 250 m distance appears to be protective of larger wetland complexes whereas the 100 m distance appears to be protective of the true upland habitat area. While snakes move between wetlands, their travel time is limited (FWS 2008):

> "When copperbellies first emerge from their hibernacula, they stay nearby, and may re-enter the ground if the weather turns cold. Within a few days, however, they begin to move into adjacent wetlands. As the weather warms, copperbellies become more active, searching for food and also for mates. Courtship and mating occur largely in the spring. Individuals engage in what becomes the standard pattern of behavior, spending a few days to weeks in one wetland, then move upland or to another wetland (Kingsbury 1996, Kingsbury et al. 2003, Roe et al. 2003, Roe et al. 2004)."

> "Because of the limited amount of time snakes spend in transit between activity centers, observations of behavior under such circumstances are rare, thus limiting our ability to confirm routes used by copperbellies to travel from one site to another. Snakes appear to travel relatively directly from activity center to activity center across apparently suitable habitats, or use habitat edges as corridors, as suggested by Kingsbury (1996). They do not cross expansive agricultural areas readily, nor do they appear to detour extensively to follow streams or other aquatic thoroughfares."

Therefore, while individuals may be traveling greater distances, and moving between habitats, a buffer of 100 m was selected to protect the "core habitat" where snakes would ultimately be traveling to.

From this description, it was determined using professional judgment that only palustrine systems with the following systems are relevant to the species: "EM – Emergent," "SS – Scrub-Shrub," and "US – Unconsolidated Shore." This SQL query was used to select for these waters: ATTRIBUTE LIKE '%PUS%' OR ATTRIBUTE LIKE '%PEM' OR ATTRIBUTE LIKE '%PSS%'. This reduced water body count within the range from 119,173 to 15,070.

2.3. EPA Cultivated Lands Layer

EPA has developed and published its own modified cultivated layer (fields > 25 acres) for use in core map development as a potential refinement of extent (EPA 2024). For the copperbelly water snake, extent was refined by this layer using the Pairwise Erase tool to remove significant areas of agriculture because the species habitat is not consistent with cultivated land and is therefore considered by CSI to be "off-field." Specifically, as mentioned in section 2.2, FWS indicated snakes "do not cross expansive agricultural areas readily" and explicitly identified agricultural land as "unsuitable habitat" (FWS 2008).

3. Creating the Core Map

3.1. Identifying Habitat Areas

The core map for the copperbelly water snake is based on its habitat locations. These were identified according to the procedure below:

1. Download the state-level dataset of the NWI dataset for each of these states: Indiana, Michigan, and Ohio.
2. Use the Merge tool to merge the state-level layers from the previous step into a single layer, "NWI_merge".
3. Use the Pairwise Clip tool to clip the previous layer "NWI_merge" by the species range ("CWS_range") and save as a new layer, "NWI_pcCWS".
4. (Optional) Delete the state-level NWI layers and the "NWI_merge" layer from the geodatabase. This was done to reduce file size and facilitate geoprocessing and file transfer and is not necessary to develop the core map.
5. Use the Select by Attributes tool to select the wetland types relevant to the copperbelly water snake (palustrine waters with classes of emergent, scrub-shrub, or unconsolidated shore) from the previous layer ("NWI_pcCWS") using the following SQL query: ATTRIBUTE LIKE '%PUS%' OR ATTRIBUTE LIKE '%PEM' OR ATTRIBUTE LIKE '%PSS%'. Export selected features as a standalone layer, "NWI_pcCWS_sel".
6. Use the Pairwise Dissolve tool to dissolve selections from the previous layer ("NWI_pcCWS_sel") into a single feature, named "NWI_pcCWS_sel_pd".
7. Use the Pairwise Buffer tool to buffer the previous layer by 100 m. Select the option to dissolve output features into a single shape. Save output layer as "NWI_pcCWS_sel_pd_pb100m".
8. Use the Pairwise Clip tool to clip the previous layer ("NWI_pcCWS_sel_pd_pb100m") by the species range ("BT_range") and save as a new layer "NWI_pcCWS_sel_pd_pb100m_pcRange".

3.2. Cultivated Lands-based Refinement

The species is not considered to be "on-field." That is, it is unlikely the species would be found in agricultural fields and its natural habitat does not account for this land use type. To account for off-field species like the copperbelly water snake, EPA developed and published its own cultivated layer for use in core map development as a potential refinement of extent (EPA 2024). CSI applied this refinement as follows:

1. Use the Pairwise Erase tool to erase contiguous cultivated areas > 25 acres from the species habitat established in the previous step ("NWI_pcCWS_sel_pd_pb100m_pcRange") and save as a new layer, "NWI_pcCWS_sel_pd_pb100m_pcRange_peCultivated25ac".

2. (Optional) Export the previous layer ("NWI_pcCWS_sel_pd_pb100m_pcRange_peCultivated25ac") as a new layer with a file name recognizable as the core map ("CWS_CoreMap") (Figure 1). This step removed potential agricultural land from the core map area. The resulting core map layer spans 226,891 acres.

4. Datasets Considered but Not Used in Core Map Development

4.1. Population Modeling

As part of the scoping and data aggregation processes, a search for copperbelly water snake-specific habitat models led core map developers to a model for the copperbelly water snake produced jointly by the Michigan Natural Features Inventory (Lansing, MI) and the Center for Reptile and Amphibian Conservation and Management (Fort Wayne, IN) for FWS (FWS 2007).

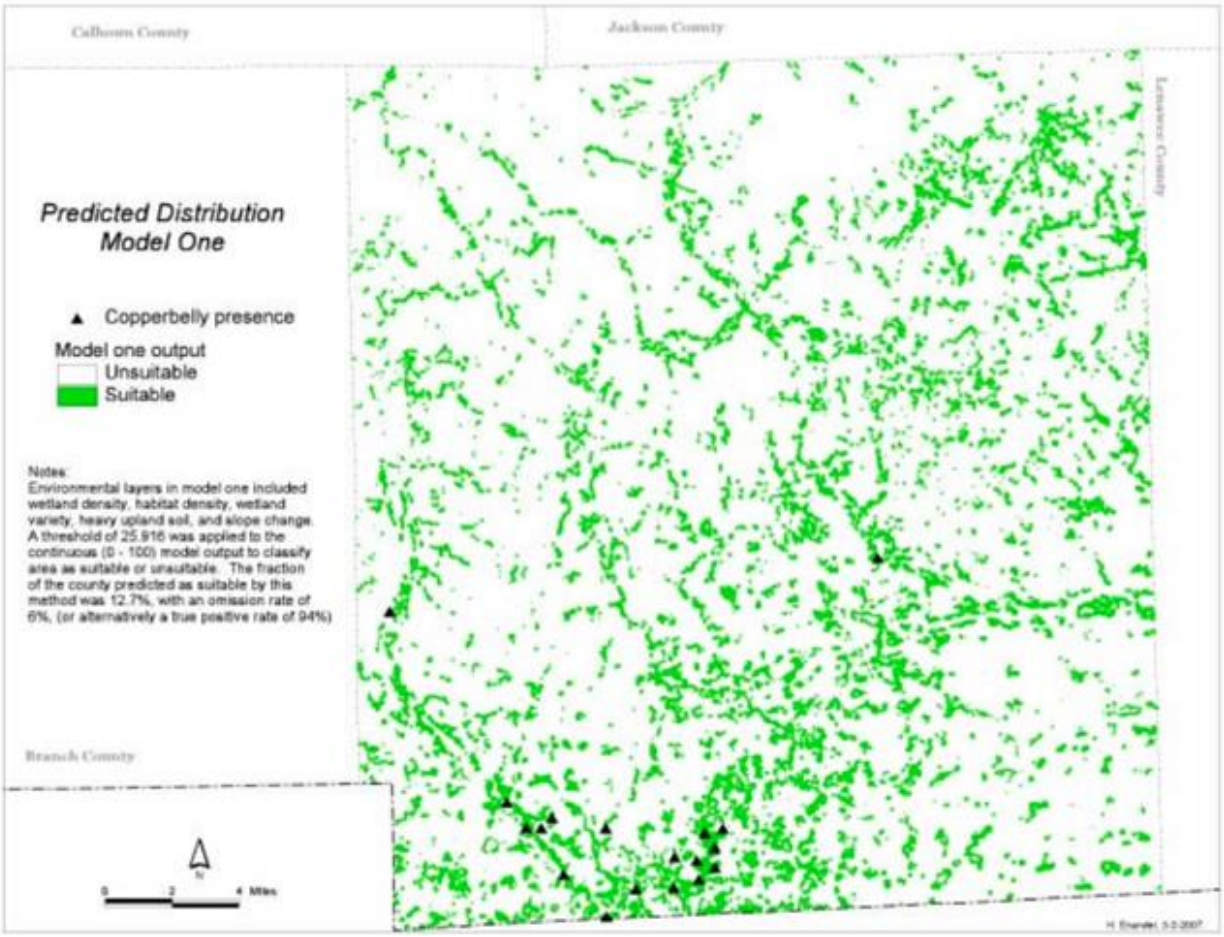

Figure 6. Map of predicted distribution of suitable areas (shown in green) for copperbelly water snakes in Hillsdale County, Michigan based on results of Maxent model one, "heavy soils," with a threshold determined by the ROC (receiver operator characteristics) curve. This model predicted 12.7% of the study area as suitable, with an omission rate of 6%. Copied from Figure 11 of the source document (FWS 2007).

The model uses GIS methods to rank habitat suitability areas based on five data layers: upland heavy soil (clay, silt, and muck), wetland density, habitat density, wetland variety, and slope change.

The model was removed from consideration because the spatial data could not be obtained, and the imagery from the report were not usable for core map development. Furthermore, the scope of this analysis was limited to Hillsdale County in Michigan, which is only a subset of the species range. Because of this, a formal analysis on the quality of the model was not performed before ruling it out as a source for core map development.

4.2. Other Known Location Datasets: iNaturalist, GBIF, NatureServe

Textual descriptions of species location information from FWS were not specific enough to use for core map development. While there is general discussion about captivity sites and presence/absence of species identification at those sites, CSI determined that these were not reliable enough to use—particularly for a mobile species like the copperbelly water snake—at this time.

iNaturalist observations were voluminous, but not specific to the northern population segment listed. A small number do occur in the vicinity of the range, but these were not usable for the creation of a core map for this species.

The GBIF database was significantly sparser than iNaturalist, and most observations with coordinates were too old (> 50 years) to be seriously considered for use here.

Public NatureServe element occurrence data did not include the northern population of the species, so was not usable for core map development.

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