

**Copperbelly Water Snake
Northern Population Segment**

(Nerodia erythrogaster neglecta)

**5-Year Review:
Summary and Evaluation**
September 5, 2018



**U.S. Fish and Wildlife Service
Michigan Ecological Services Field Office
East Lansing, Michigan**

5-YEAR REVIEW

Species Reviewed: Copperbelly Water Snake (*Nerodia erythrogaster neglecta*)

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Cover photo courtesy of Omar Attum.

5-YEAR REVIEW
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Nerodia erythrogaster neglecta

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology used to complete the review

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12) as required by section 4(c)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*). The Service provided notice of this status review in the *Federal Register* (76 FR 44564) and requested new scientific or commercial data and information that may have a bearing on the classification of the copperbelly water snake (*Nerodia erythrogaster neglecta*) as a threatened species.

Jessica Pruden with the Service's East Lansing, Michigan Ecological Services Field Office conducted this review in coordination with staff at the cooperating field offices and the Midwest Regional Office. We reviewed past and recent literature and reports, public comments, new genetic analyses and an associated technical review, the final listing rule (62 FR 4183), the Northern Population Segment of the Copperbelly Water Snake Recovery Plan (USFWS 2008), and the most recent 5-year review for the species (USFWS 2010).

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review: 76 FR 44564 (July 26, 2011)

1.3.2 Listing history

FR notice: 62 FR 4183

Date listed: January 29, 1997

Entity listed: *Nerodia erythrogaster neglecta*, Michigan, Ohio, and Indiana north of 40° N. latitude (see Figure 1)

Classification: Threatened

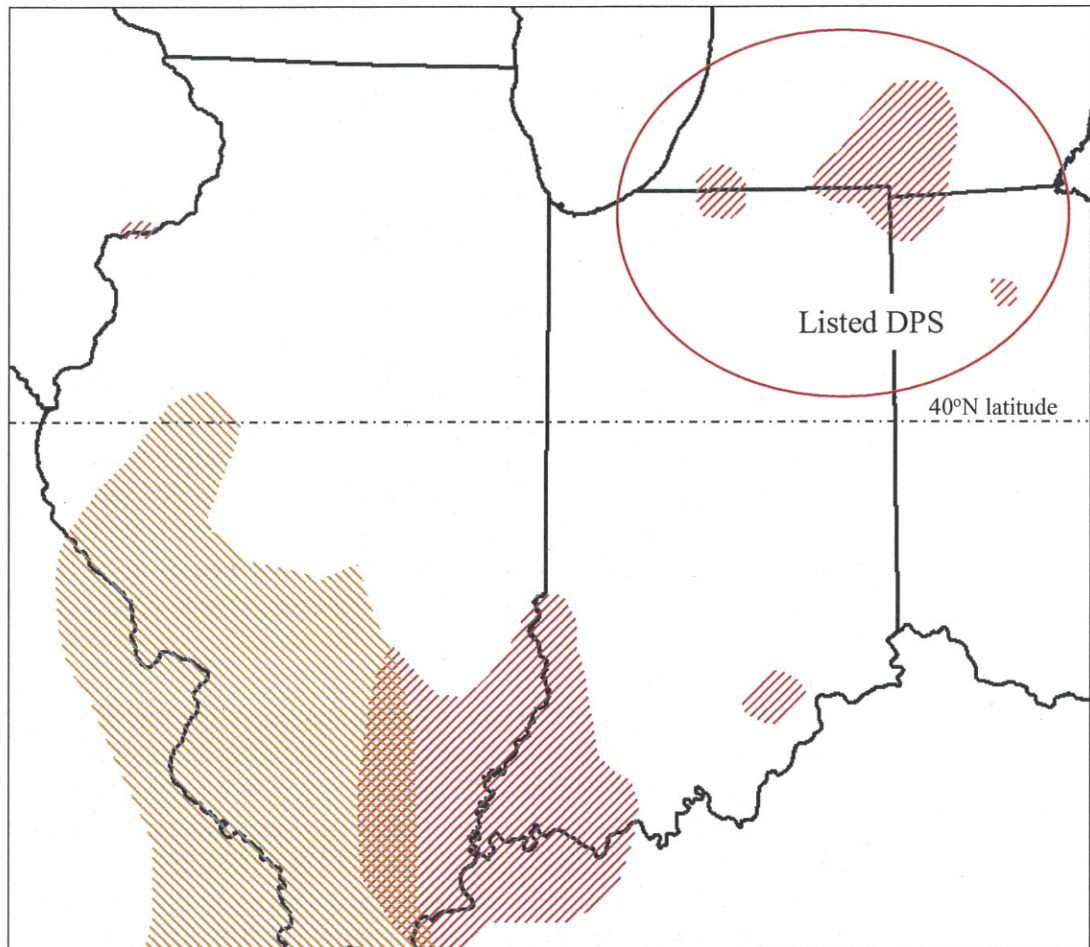


Figure 1. Historical distribution of the copperbelly water snake in the Midwest (six polygons with red hatching). To the northeast, north of the 40th North Parallel, are the isolated remaining copperbelly populations of the listed DPS (circled area). All known remaining populations of the DPS are within 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 yellowbelly water snake, the closest relative of the copperbelly, whose distribution continues south, and for which there is no Federal protection.

1.3.3 Associated rulemakings: N/A

1.3.4 Review History

May 2010: Copperbelly Water Snake Northern Population Segment (*Nerodia erythrogaster neglecta*) 5-Year Review

This 5-year review summarized all new information regarding the species status, distribution, and threats, leading to a recommendation to uplist the species to endangered status.

1.3.5 Species' Recovery Priority Number at start of 5-year review

3C, indicating that it is: (1) taxonomically, a subspecies; (2) facing a high degree of threat; (3) rated high in terms of recovery potential; and (4) in conflict with construction or other development project(s) or other forms of economic activity.

1.3.6 Recovery Plan

Name of plan: Northern Population Segment of the Copperbelly Water Snake (*Nerodia erythrogaster neglecta*) Recovery Plan

Date issued: December 23, 2008

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? Yes

2.1.2 Is the species under review listed as a DPS? Yes

2.1.3 Was the DPS listed prior to 1996? No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy? Yes

See section 2.3.1.3 for new genetics information. That new information provides further support for the discreteness and significance of the Northern DPS, based on the significant genetic differentiation between the northern DPS and other populations within the species' range as supported by microsatellite analyses.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes

2.2.3 List the recovery criteria as they appear in the recovery plan and discuss how each criterion has or has not been met, citing information.

The copperbelly water snake will be considered for delisting when the following criteria are met:

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 1000 adults; or three populations must have a total population size of 3000 adults, with none less than 500, and
- b) These populations must persist at these levels for at least ten years.

Discussion

In 2011, Monfils and Lee used occupancy modeling to reanalyze the 2005-2006 survey data (Monfils and Lee 2011, Lee *et al.* 2011, Lee and Kingsbury 2014). Occupancy modeling may be a useful approach for long-term monitoring efforts because it allows the estimation of population parameters that could be tracked over time, without the need for more intensive studies, and adjusts estimates for detection probabilities less than one. This analysis produced abundance estimates ranging from 19.7 (SE=5.7) to 39.4 (SE=10.1) for the three Ohio/Michigan populations. This information was also used to develop a sampling design for future surveys.

Copperbelly surveys were conducted in 2011, 2012, and 2013 using the monitoring protocol developed in 2011 and single season occupancy models (Lee and Kingsbury 2014). These models were developed by MacKenzie *et al.* (2002), Royle and Nichols (2003), and Royle (2004) to estimate occupancy, probability of detection, animal density, and total abundance. Monitoring was conducted in the northern half of the Upper St. Joseph River Watershed in Hillsdale County, Michigan; Steuben County, Ohio; and Williams County, Indiana. Surveys were conducted in a total of 207 wetlands in 30 different wetland complexes. Surveys in 2011 to 2013 documented a total of 73 copperbelly water snake detections in 7 of the 30 wetland complexes surveyed and 20 of the 207 wetlands surveyed.

Based on data from all wetland complexes/wetlands surveyed, the abundance-induced heterogeneity model generated total abundance estimates of 17.0 (SE=6.0) in 2012 and 10.3 (SE=4.5) in 2013 compared to 29.8 (SE=11.8) in 2011. The repeated-count model generated total abundance estimates of 33.3 (SE=12.0) in 2012 and 29.0 (SE=14.9) in 2013 compared to 65.3 (SE=25.5) in 2011.

Lee and Kingsbury (2014) caution that due to potential issues with some of the assumptions of the model, abundance estimates produced by these models should be considered “coarse measures or indicators of abundance at this time” and used to detect and monitor population trends.

Population levels remain well below the recovery goal of 3,000 adults. Further, none of the extant populations meet the minimum population criterion of 500 adults. Criterion 1 has not been met.

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.

Discussion

In 2013, the Ohio Department of Natural Resources (ODNR) utilized a Recovery Land Acquisition grant to acquire three parcels including a 53-acre parcel and a 15.8-acre parcel both adjacent to Lake La Su An Wildlife Area. The third parcel is 50.3 acres and is adjacent to the 53-acre parcel (Scott Butterworth and Justin Harrington, Ohio Department of Natural Resources, pers. comm. 2016).

Since 2010, the Service’s Partners for Fish and Wildlife Program, entered into Landowner Protection Agreements with three landowners in the priority areas in Hillsdale County, Michigan, and one landowner in the priority areas of Steuben County, Indiana, and four landowners in the Fish Creek Watershed in Ohio pursuant to authority contained in the Partners for Fish and Wildlife Act (P.L. 109-294), the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the

Endangered Species Act of 1973 and the Fish and Wildlife Act of 1956 (16 U.S.C. 742a-j), as amended. These sites were within one mile of known copperbelly populations. The Agreements recognize the voluntary contribution of a landowner to improve and maintain habitat for copperbelly water snakes and potentially attract the snakes to their property, and does not hold the landowner accountable for any lawful act that may result in take. The goal of the Agreement is to achieve a net conservation benefit for copperbelly water snakes by expanding or buffering existing occupied habitat and increasing habitat connectivity within their range. Specifically, these improvements are expected to improve breeding and foraging habitat over the life of the project.

Since 2009, the Wetland Reserve Program (WRP), a USDA Farm Bill program, has been a valuable tool to provide long-term protection for the copperbelly through protection of potential habitat, restoration of wetlands, and establishment of forest land. This tool will continue through the Wetland Reserve Easement Program (WRE) established in the 2014 Farm Bill. In 2009, the WRP eligibility criteria were revised to increase the WRP enrollment ratio of upland to wetland from 1:1 to 10:1 in the copperbelly water snake Priority Area, Hillsdale County, Michigan. This 10:1 ratio is also used in the Fish Creek watershed in Steuben and DeKalb Counties in Indiana, and has been in place since 2005. Priority ranking was given to WRP applications in the copperbelly focus area provided a determination was made by the Service and NRCS that the lands proposed by eligible applicants would provide benefit to copperbellies. As a result, there have been eight WRP applications for more than 600 acres of land that have been accepted in Michigan, and twelve easements totaling more than 825 acres that have been enrolled in Indiana. The acres enrolled are actively being restored by NRCS and the Service including restoration of shallow wetlands, and tree and shrub planting on wetlands and uplands.

In addition to the WRE Program, NRCS in Michigan enrolled six landowners through the Healthy Forest Reserve Program (HFRP) to manage and protect an additional 214 acres of land. NRCS in Indiana has enrolled nine landowners into the HFRP totaling 1,200 acres of land. The lands will be managed to maintain sustainable forestry on private land while enhancing or measurably aiding in the recovery of threatened or endangered species, improvement of biological diversity or an increase in carbon storage.

In 2015, the Service recommended expansion of the copperbelly priority area in Michigan to include two additional areas encompassing about 15 square miles. These two areas were identified using data from modeling, documented snake observations, historical records, and high habitat suitability, as high priority habitat areas. The expansion request has been approved regionally and is waiting on a final approval at the national level.

Criterion 2a has not been met despite significant effort to restore, enhance, and preserve copperbelly habitat. Currently not enough habitat exists to support the populations described in Criterion 1.

There is an insufficient amount of habitat that has been permanently conserved in order for copperbelly to sustain their life history requirements. This includes the preservation of habitat that contains a suitable number of hibernacula at a suitable distance from summer habitat. Criterion 2b has not been met because multiple (two or more) hibernacula for each population are not permanently conserved. Two hibernacula may be available within a minimum of one kilometer of all suitable summer habitat, though there is not enough suitable habitat permanently conserved.

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.

Discussion

Successful recovery requires the creation of corridors to link suitable wetland/forest complexes to facilitate a healthy metapopulation structure. The presence of barriers, such as row crops and roads, hinders these efforts. In 2010, a copperbelly was found dead on a road at a new wetland site (Lee and Kingsbury 2014). In 2012, a young copperbelly was found dead in a small wetland in a wetland complex in Michigan (Lee and Kingsbury 2014). The cause of death is not known, but the snake was intact. It is unclear whether the cause of death was due to impeded migration or some other cause. Regardless, habitat fragmentation disrupts copperbelly movements and migration and also increases their vulnerability to predation. These threats continue to impede recovery. Research to investigate the impact of barriers and mitigation measures is needed.

Criterion 3 and subpart 3b have not been met despite significant efforts to restore or enhance wetlands and forests within the range of the northern DPS of the copperbelly. The creation of migration corridors is a key part of habitat management that still must be addressed. A mosaic of linked wetland and upland habitat must be created to eliminate or reduce the threat posed by roads and row crops. Copperbelly water snakes are also still believed to be collected by amateur

collectors and commercial dealers, although the frequency and extent to which this occurs is not known. Additional habitat restoration and creation of migration corridors is necessary as well as measures to address illegal collection.

The Recovery Plan has habitat management guidelines for private landowners. These guidelines have not been independently distributed to landowners. Criterion 3a has been partially met. Habitat management guidelines are available in the recovery plan; however, building awareness among landowners who may not be aware of these practices is a critical piece of this objective that needs to be completed.

In 2014, the Partners Program, in coordination with the Threatened and Endangered Species Program in the East Lansing Field Office, sent outreach postcards to landowners in Michigan, Ohio, and Indiana. The postcards contained information on copperbelly water snakes and encouraged individuals to contact the Service if they had any information on copperbellies. During 2013 and 2014, students from the area provided information on copperbellies at the Hillsdale County Fair. At least one article has been published in local media about copperbelly water snakes, likely raising awareness and perhaps interest in the species. Overall this effort has raised public awareness about this species in Hillsdale County, Michigan. Criterion 3c has been partially met through some outreach efforts in Hillsdale County specifically, though additional public education and outreach throughout the range of the northern DPS would be beneficial.

The copperbelly water snake will be considered for reclassification from threatened to endangered status when either of the following criteria is met:

Criterion 1. There are no known populations of more than 500 adults.

Criterion 2. The cumulative population size is estimated at less than 1000 adults.

As discussed in section 2.2.3, occupancy modeling developed in 2011 was applied to 2011-2013 survey results and suggested a potential decreasing population trend (Lee and Kingsbury 2014) given that coarse abundance estimates were well below 100 individuals. Based upon the best available information from the most recent surveys and population estimates, both Criteria 1 and 2 have been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history: No new information.

2.3.1.2 Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

As discussed in [section 2.2.3](#), occupancy modeling developed in 2011 was applied to 2011-2013 survey results and suggested a potential decreasing population trend (Lee and Kingsbury 2014).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

In 2009, Marshall *et al.* collected samples within the range of *N. erythrogaster neglecta* to examine the genetic relationship among sites. Collections included three sites within the Northern DPS (Michigan/Ohio sites: La Su Ann, Clear Fork, and Pioneer); 2 sites in Indiana that are disjunct from the Northern DPS (Muscatatuck National Wildlife Refuge and Austin); and 2 sites in Kentucky (Hardy Slough and Highland Creek Management Unit). Seven microsatellite loci were used to quantify genetic population structure. Multi-dimensional scaling and AMOVA analyses are consistent with the observed patterns of genetic differentiation as is the STRUCTURE analysis, which indicates there is support for either a two or three population cluster model among the sites. The two population cluster structure includes: the Michigan/Ohio sites (La Su Ann, Clear Fork, and Pioneer), Kentucky sites (Hardy Slough and Hardy Creek), and one of the Indiana sites (Austin) as one cluster; and the other Indiana site (Muscatatuck National Wildlife Refuge) as the second cluster. The three population cluster structure includes: the Michigan/Ohio sites as one cluster; the Kentucky sites and Austin, Indiana site as a second cluster; and the MNWR, Indiana site as the third cluster. The Ohio/Michigan sites are significantly different from the Indiana and Kentucky sites, though the differences are much greater between the Indiana sites than the Kentucky sites.

Marshall *et al.* (2009) indicate that a number of factors may be responsible for the observed patterns of differentiation among the sites. One of the more influential factors may be habitat conditions, which could either encourage or limit gene flow between sites. Intergradation with *N. e. flavigaster* at the Kentucky sites was also identified as a potential factor influencing genetic differentiation at the Kentucky sites.

In 2010, the taxonomy of *Nerodia erythrogaster* came under scrutiny based on genetic analyses of the plain-bellied water snake conducted by Makowsky *et al.* (2010). Makowsky *et al.* (2010) analyzed genetic variation in mitochondrial DNA of the plain-bellied water snake throughout its range to test for: 1) existence of distinct evolutionary significant lineages; 2) assess validity of the currently recognized subspecies; 3) determine whether geographic genetic variation corresponds to that seen in other species or species groups with respect to potential biogeographic barriers; and 4) test for ecological niche differentiation

among lineages or recognized subspecies. Three mitochondrial markers were evaluated as well as one nuclear marker. However, the nuclear marker was dropped from the analysis due to low divergence among samples. Makowsky *et al.* (2010) evaluated 156 individuals from 100 sites. Their results indicate that *N. erythrogaster* comprises five major mitochondrial lineages, all of which partially or almost completely overlap geographically with at least one other lineage. These results are based on analysis of partial sequences from 3 mitochondrial genes that are linked. They found that the subspecies show little genetic divergence from one another and concluded that most populations assigned to *N. erythrogaster* represent a single, freely interbreeding, widespread species. Their analyses of ecological niche differentiation were not significant. The seventh edition of the Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico no longer recognizes any subspecies of plain-bellied water snake (Crother *et al.* 2012).

Some experts do not agree with Makowsky's conclusions. They assert that Makowsky's results do not support his conclusion that the subspecies designation is not valid, but rather that the data reinforce that the subspecies should not be elevated to full species status (J. LeClere, MN DNR, pers. comm. 2013). We have reviewed both Marshall *et al.* (2009) and Makowsky *et al.* (2010) in great detail and interpreting the potential implications of their results in the context of the ESA required additional genetic expertise. As a result, we requested a technical review from the Service Conservation Genetics Community of Practice. In response, three geneticists from the Service as well as one geneticist from U.S. Geological Survey, evaluated the information presented in Makowsky *et al.* (2010) to determine if review of the current listing status of copperbelly water snake under the ESA is warranted based on revised taxonomic classification (Memorandum from Bartron *et al.* 2016). The review focused on two questions: 1) Is the northern Ohio/Michigan population genetically unique; and 2) Is the current species/subspecies designation for *N. erythrogaster neglecta* valid based on the results of Makowsky *et al.* (2010)

With respect to the first question regarding genetic uniqueness, the technical review concluded that Makowsky *et al.* (2010) does not necessarily provide sufficient information on the uniqueness of the Ohio/Michigan site, other than that only the Central lineage was detected at that location. The review notes that this could be due in part to how the analysis was presented. Other sites where only the Central lineage was present were identified. The reviewers suggest that additional evaluation of the data in Makowsky *et al.* (2010) could provide insight into the estimate of differentiation between the sites with the Central lineage. The review identifies Marshall *et al.* (2009) as providing the best evidence of uniqueness in the Ohio/Michigan site, but recommends the consideration of additional sites for comparison. Sites in Ohio and Indiana would be particularly helpful based on geographic proximity and potential for recent gene flow.

With respect to the second question regarding the validity of the subspecies designation, the review recommends additional genetic analyses prior to taxonomic reclassification. Specifically, analysis of additional genetic data, preferably nuclear sequence data from a similar set of samples, if not the same as used in Makowsky *et al.* (2010), in order to assess range-wide partitioning of genetic variation. The review suggests that taxonomic reclassification could also incorporate range-wide microsatellite data if more populations were analyzed. The review concluded that reclassification of taxonomic delineations solely based on mitochondrial data may not appropriately reflect the fundamental genetic structure. Thus, the current taxonomic status of the copperbelly water snake, and its listing under the ESA as a Distinct Population Segment, remain valid at this time.

2.3.1.4 Taxonomic classification or changes in nomenclature:

The recovery plan (USFWS 2008) summarizes the taxonomic history of the copperbelly water snake. At the time of listing, the copperbelly water snake was regarded as a subspecies of the plainbelly water snake (*Nerodia erythrogaster*). Subsequent to the Makowsky *et al.* (2010) findings, referenced above, the seventh edition of the Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico no longer recognizes any subspecies of plainbellied water snake (Crother *et al.* 2012). We concluded that the subspecies designation and delineation as a DPS remain valid until additional genetic analysis provides clarification.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.): No new information.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): No new information.

2.3.2 Threat Analysis and Current Species Status

Surveys during the ten years prior to listing in 1997 indicated eight local populations in the range of what is now the northern DPS; but by the time of listing, only five local populations persisted: two populations within the area of the West Branch of St. Joseph River in Ohio and Michigan, a population in the area of the Clear Fork of the East Branch of St. Joseph River in Michigan, and two populations within the Fish Creek watershed of Indiana and Ohio (USFWS 1997). The final listing rule identified habitat loss and fragmentation as the primary causes of the decline of the copperbelly water snake. The final listing rule also indicated small, isolated populations of copperbelly water snakes are vulnerable to stochastic events, such as weather extremes or fluctuations. Other

threats addressed in the final listing rule include collection by amateur collectors and commercial dealers and a general persecution of snakes by humans (62 FR 4183). In fact in July of 2017, a copperbelly watersnake was intentionally killed by an individual in Hillsdale County, Michigan.

Since listing the copperbelly water snake in 1997, we have achieved a better understanding of its habitat requirements and foraging movements. This improved knowledge, however, highlights the negative effects of habitat loss and fragmentation on the copperbelly. While many efforts to restore habitat for the copperbelly have been accomplished and continue to be pursued, landscape-level wetland and upland restoration to improve overall copperbelly populations has not been achieved. Furthermore, habitat connectivity to link small, isolated populations to improve resiliency to stochastic events has not been accomplished.

Although habitat loss and fragmentation remain the primary threat, climate change may constitute a significant new threat for the copperbelly water snake. According to the Intergovernmental Panel on Climate Change (IPCC) (2007), "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Pryor *et al.* (2014) summarizes projected changes and associated effects at national and regional scales for the United States. Hayhoe *et al.* (2010) also assessed regional impacts of climate change, specifically within the Great Lakes region. In the Midwest, increases in the frequency and intensity of extreme precipitation are projected across the region (Pryor *et al.* 2014). At the same time the average number of days without precipitation is projected to increase in the future resulting in drought conditions (Pryor *et al.* 2014). Hayhoe *et al.* (2010) projections show a shift in the timing of precipitation, with winter and spring showing the greatest amount and little change to a decrease in the summer. Heat waves are also predicted to be more frequent and intense (Pryor *et al.* 2014).

Copperbelly water snakes feed primarily on amphibians and are adapted to foraging in ephemeral wetlands that dry out in the summer months when copperbellies shift to uplands (Kingsbury *et al.* 2003). A decline in precipitation and the predicted increase in the frequency and intensity of heat waves will directly affect wetlands causing ephemeral wetlands to dry out. The potential changes to ephemeral wetlands and amphibian populations, as discussed in Kling *et al.* (2003), may have consequences for the copperbelly, which relies on foraging for amphibians in ephemeral wetlands. In the spring and summer of 2012, some wetlands that were surveyed as part of the monitoring program, were either drying up completely or earlier than normal due to drought conditions. This may have contributed to fewer copperbelly observations in 2013 due to the reduced availability of prey such as frogs and tadpoles. Depending on extreme weather events in the future (*e.g.*, drought and flood conditions), copperbelly populations and habitat may be significantly affected (Sellers pers. comm. in Lee and Kingsbury 2014). We lack sufficient certainty, however, to know specifically how climate change will affect this species.

Snake fungal disease (SFD) is another emerging potential threat to copperbelly water snake populations. Recently, a growing number of snakes have been found in the U.S. with severe and often fatal fungal infections. The number of species of snakes with documented or suspected cases of the disease, and the geographic distribution of the disease, continues to increase annually. A causative agent, *Ophidiomyces ophidiicola* (formerly *Chrysosporium ophidiicola*) was first described from an Eastern Rat Snake (*Pantherophis obsoletus*) in Georgia (Rajeev *et al.* 2009). Other species of snake have been diagnosed with SFD in Michigan. Multiple agencies are monitoring for SFD in reptile species in the tri-state area. In the wake of the devastating impacts on amphibians due to Chytrid beginning in 1996 (caused by the fungus *Batrachochytrium dendrobatidis*) (Longcore *et al.* 1999), and White Nose Syndrome (caused by the fungus *Pseudogymnoascus destructans*) on bats beginning in 2005 (Gargas *et al.* 2009), there may be genuine cause for concern that the emerging fungal disease in snakes could have a significant impact on copperbelly populations.

During the 2012 survey conducted by Michigan Natural Features Inventory (MNFI), an individual at a wetland complex in Michigan was observed shedding abnormally or incompletely. Skin samples were collected and sent for SFD testing. Although the test results were negative, it is possible that this test was a false negative due to the nature and limited amount of sample collected.

The best available information indicates that the copperbelly water snake northern DPS population is likely below 100 individuals. In surveys conducted between 2005 and 2006, fewer copperbelly water snakes were observed at several wetlands than had been found during previous surveys in the 1980s and 1990s and by MNFI from 2001-2003. In 2011, occupancy modeling was used to reanalyze the 2005-2006 survey data and produced abundance estimates ranging from 19.7 (SE=5.7) to 39.4 (SE=10.1) for the three Ohio/Michigan populations. Copperbelly surveys were conducted in 2012 and 2013 using the occupancy model and monitoring protocol developed in 2011. Based on data from all wetland complexes/wetlands surveyed, the abundance-induced heterogeneity model generated total abundance estimates of 17.0 (SE=6.0) in 2012 and 10.3 (SE=4.5) in 2013. The repeated-count model generated total abundance estimates of 33.3 (SE=12.0) in 2012 and 29.0 (SE=14.9) in 2013. Lee and Kingsbury (2014) caution that due to some assumptions of the model, abundance estimates produced are fairly coarse, but can be used to detect and monitor population trends. Lee and Kingsbury (2014) concluded that 2011-2013 survey results and modeling suggest a potential decreasing trend.

At its current level, the copperbelly water snake population meets both criteria set forth in the recovery plan for reclassification from threatened to endangered status.

As the recovery criteria have not been met, the known threats have not significantly diminished, climate change represents a new and uncertain threat, and the copperbelly population has declined since listing to its current level, which meets the criteria for reclassification, we recommend reclassifying the copperbelly water snake northern population segment from threatened to endangered. The copperbelly water snake northern population segment is in danger of extinction throughout all or a significant portion of its range.

3.0 RESULTS

3.1 Recommended Classification

- Downlist to Threatened
- Uplist to Endangered
- Delist (*Indicate reasons for delisting per 50 CFR 424.11*):
 - Extinction
 - Recovery
 - Original data for classification in error
- No change is needed

3.2 New Recovery Priority Number

No change is needed.

Brief Rationale: The recovery priority number for the copperbelly water snake is 3c, indicating that it is: (1) taxonomically, a subspecies; (2) facing a high degree of threat; (3) rated high in terms of recovery potential; and (4) in conflict with construction or other development project(s) or other forms of economic activity.

Most of the land in the range of the northern DPS is privately owned. The primary form of economic activity in conflict with the copperbelly is agriculture. Row crops in particular do not provide suitable habitat and fragment remaining habitat. Residential development also removes and fragments habitat, but is not widespread in the copperbelly range. Although several projects (*e.g.*, conservation easements, restoration grants) have resulted in either the protection or restoration of suitable habitat for the copperbelly water snake, the threat of habitat loss and fragmentation remains high. Many of these successful restoration and conservation projects are relatively recent (since 2006) events. Although it will require a substantial investment to work with private landowners to restore suitable habitat for the copperbelly, these efforts are ongoing and have been steadily increasing, creating a high potential for recovery.

3.3 Listing and Reclassification Priority Number

Reclassification (from Threatened to Endangered) Priority Number: 3

Brief Rationale: The reclassification priority number of 3 indicates: (1) the magnitude of threat is high; (2) the immediacy of threats is imminent; and (3) taxonomically, the copperbelly is a subspecies.

The reclassification priority number of 3 is justified because the copperbelly has already been identified as facing a high degree of threat (Criterion 1). The primary threat facing copperbellies, habitat loss and fragmentation, is an actual, known threat that has been well documented, most recently in the recovery plan (Criterion 2).

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS WITHIN THE NEXT 5 YEARS

- Identify and conserve habitat complexes sufficient for recovery
 - Evaluate the applicability of Strategic Habitat Conservation as a tool for prioritizing copperbelly water snake habitat for conservation (i.e., *Landscape Design for Conservation of the Northern Population Segment of the Copperbelly Water Snake*, Bradley Potter and Barbara Hosler, USFWS Draft Report)
 - Restore suitable wetlands and associated uplands for the copperbelly
 - Prioritize properties for conservation easements and acquisition; purchase, protect, and/or manage these properties based on priority and availability
 - Prioritize properties for conservation easements and acquisition based on creation of corridors for migration between suitable wetland and upland areas.
- Identify, assess, and reduce threats at known sites and focal management areas
 - Clarify the influence of roads on migration of individual snakes and the connectivity of subpopulations
 - Research and implement techniques to create road crossings for snakes to reduce road mortality and remove barriers to movement
 - Assess the impact of predation on snakes particularly in areas influenced by significant agriculture

- Improve baseline understanding of copperbelly water snake ecology
 - Clarify characteristics of high quality hibernacula
 - Clarify gestation site requirements

- Subspecies Structure
 - Collect additional genetic samples within the range of copperbelly water snake to conduct microsatellite analyses to elucidate the level of significant genetic differentiation among populations and whether these represent zones of deep divergence
 - Conduct additional genetic analyses using multiple data sources (*e.g.*, comparing mitochondrial and nuclear genomic sequence data) to assess level of gene flow, genetic differentiation among subspecies, and range-wide genetic structure.
 - Analyze morphological variation and ecological niche differentiation between subspecies.

- Monitor known copperbelly water snake populations and their habitat
 - Investigate the relevance of eDNA as a survey tool.
 - Monitor West Branch (OH, MI)
 - Monitor Clear Fork (MI)
 - Monitor Fish Creek (IN, OH)
 - Investigate the abundance and stability of the southern population and any potential landscape level differences in habitat use and conservation

- Develop and implement public education and outreach efforts
 - Reevaluate the effectiveness of previous and ongoing education and outreach efforts in enhancing copperbelly water snake conservation
 - Develop copperbelly education and outreach program that will enhance and support conservation

- Investigate recovery approaches to enhance recruitment and population size
 - Investigate and implement techniques for enhancing remaining populations by increasing recruitment and reducing mortality. These methods may include captive breeding, headstarting, translocation as a method of population augmentation, and potential reintroductions into historical/suitable habitats

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Copperbelly Water Snake Northern Population Segment

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Appropriate Listing/Reclassification Priority Number: 3

Review Conducted By: Jessica Pruden

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve *J. Pruden* Date *9/5/2018*