Surveys for the Copperbelly Water Snake (*Nerodia erythrogaster neglecta)* in Michigan: Year One Progress Report - 2001

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STUDY PERFORMANCE REPORT

STATE: Michigan

COOPERATORS: Michigan Natural Features Inventory, Michigan Department of Natural Resources, U.S. Fish and Wildlife Service

PROJECT TITLE: Michigan's Endangered and Threatened Species Program

PROJECT NUMBER: E-1-31 JOB: 820

STUDY TITLE: Surveys for the copperbelly water snake (*Nerodia erythrogaster neglecta*) in Michigan

PERIOD COVERED: September 30, 2000 through March 31, 2002

OBJECTIVES:

1. Determine current distribution and status of copperbelly water snake in Michigan.
2. Characterize habitat at multiple spatial scales to clarify ecological requirements.
3. Maintain and enhance Michigan's information base to aid in the conservation and recovery of this species.

SUMMARY/FINDINGS:

The project objectives identified in the grant proposal were addressed, and significant progress was made toward accomplishment of these objectives during the first year of this two-year project. For more detailed information on activities and accomplishments, please see attached report.

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Introduction

The copperbelly water snake (*Nerodia erythrogaster neglecta*) has declined throughout much of its historical range. This species is believed to once have been distributed throughout southeastern Illinois, southwestern Indiana and western Kentucky, with a relict northern population in southern Michigan, northwestern Ohio and northeastern Indiana (U.S. Fish and Wildlife Service (USFWS) 1997). Today, the copperbelly water snake exists primarily in isolated, local population clusters in only about half the counties from which it was once known across its range (Sellers 1991, USFWS 1997). The species' decline has been particularly dramatic in the northern part of its range where the snakes now occur only in a few, small, scattered and isolated population clusters in south-central Michigan, northeastern Indiana and northwestern Ohio (Sellers 1991, USFWS 1997).

Habitat loss and fragmentation are the principal causes of the decline of the copperbelly water snake and the main threats to this species' persistence (Sellers 1991, Evers 1994, USFWS 1997). Copperbelly water snakes inhabit bottomland forests, shrub swamps and other scrub-shrub, shallow water wetlands as well as adjacent uplands. Much of these wetland habitats have been modified or destroyed due to agricultural use, dredging, stream channelization, road construction, coal mining (primarily in the southern part of its range), and commercial and residential development (Dahl and Johnson 1991, Evers 1994, USFWS 1997). Additional factors that have contributed to this species' decline include human persecution, collection of snakes for scientific and commercial purposes and road mortality (Evers 1994, Harding 1997).

In 1997, the U. S. Fish and Wildlife Service designated two distinct population segments of the copperbelly water snake, the northern population segment comprised of snakes in Michigan, Ohio and Indiana north of the 40th Parallel, and the southern population segment referring to snakes in Illinois, Kentucky and Indiana south of the 40th Parallel (USFWS 1997). The northern population segment of the copperbelly water snake was listed as federally threatened in 1997. Two Copperbelly Water Snake Conservation Agreements, implemented in 1997, protect the southern population. The species also is listed as state endangered in Michigan, Ohio and Indiana, and given special protected status in Illinois and Kentucky.

Despite its protected status, the long-term persistence of the northern population of the copperbelly water snake remains precarious. Regional species experts have identified seven priority activities for promoting conservation of the northern population of the copperbelly water snake. These include the following: 1) conducting baseline research on the species' ecology to identify basic ecological requirements such as habitat needs, seasonal movements and use of corridors; 2) continuing annual surveys for population, habitat quality and threat assessment; 3) developing methodology for quantifying status of individual populations; 4) developing landscape-level habitat characterizations based on known sites to interpret why these sites retain copperbellies and predict other areas that might contain them; 5) restoring habitat including wetland restoration and buffer and travel corridor development; 6) protecting habitat including voluntary registration, conservation agreements, easements or acquisition from willing landowners; and 7) educating the public (USFWS 1999).

In Michigan, the copperbelly water snake has been documented at 14 sites in 7 different counties in southern Michigan (Michigan Natural Features Inventory (MNFI) 2002). The copperbelly water snake was first discovered in Michigan in 1903 (Clark 1903), but was not confirmed again until 1933 (Clay 1934). A statewide herpetofaunal survey in the late 1970's failed to find any copperbellies, and the species was considered extirpated in the state (Tinkle et al. 1979). However, the species was reconfirmed in the state in 1978. Intensive statewide surveys from 1982 to 1988 and a rangewide survey from 1987 to 1990 documented copperbelly water snakes at 13 sites representing 7 habitat complexes (Sellers 1991). The rangewide survey compiled reports of additional copperbelly water snake sites, but was unable to confirm these sites. Only one new site has been added since the rangewide survey. Of the 14 known sites in Michigan, only three sites or habitat complexes have been identified as housing reproducing, viable populations, as defined by Sellers (1991) (i.e., population with an average of 50+ individuals and 12+ breeding pairs).

Limited surveys for this species have been conducted since the rangewide survey over a decade ago. In 1997, MNFI surveyed 5 known sites and 12 sites with suitable habitat, and documented the species at only one known site. Additionally, recent monitoring of the three reproducing populations in 1996 and 1997 documented only a few individuals (n=1, 5, 12) (Sellers 1996, Sellers pers. comm.). Prior to the current

study, copperbelly water snakes had not been observed at 9 of the 13 known sites within the last decade, and six of the sites had not been resurveyed since the late-1980's or early 1990's (MNFI 2002). Clearly, continued surveys of known sites and new sites with suitable habitat are needed to determine this species' current distribution, population status and viability in Michigan. Identification of viable, reproducing populations is particularly important for assessing the species' status and prioritizing sites for conservation and recovery efforts. More information on the species' habitat use and ecological requirements in Michigan also is essential.

In addition to obtaining information on current status and distribution, conservation efforts must focus on influencing local land use and land management decisions. Most of the known occurrences in the state are comprised of observations on small tracts of private land, and are isolated and scattered across several counties in southern Michigan. Therefore, conservation of this species will need to occur at the local level, and will require education of and cooperation with private landowners and land managers. Establishing strong, long-term relationships with landowners and providing them with the necessary stewardship information and resources will be critical to conservation efforts for the copperbelly water snake. These goals will likely require collaboration with local conservation organizations and other partners.

Project Objectives and Procedures

To address conservation needs in Michigan, this two-year project was designed with the following objectives:

1) determine the current distribution and status of the copperbelly water snake in Michigan;
2) characterize habitat at multiple spatial scales to clarify ecological requirements; and
3) maintain and enhance Michigan's information base to aid in the conservation and recovery of this species.

The specific procedures identified to address the project objectives include the following:

1) Characterize habitat at known sites at the landscape scale. Use habitat characteristics and aerial photographs to identify high quality potential habitat and prioritize areas to survey in the state.
2) Contact landowners to obtain permission to survey property. Develop and distribute educational materials to landowners and other project participants. Post educational materials on the Michigan Natural Features Inventory's (MNFI's) web site. Recruit field assistants and volunteers.
3) Conduct surveys in April and May at known sites and high priority de novo sites in the vicinity of known sites. Identify reproducing populations by surveying occupied sites in the fall to document the presence of juvenile and subadult snakes. Develop index of relative abundance at occupied sites. Consult with Dr. Bruce Kingsbury to develop study design and survey methodology. MNFI staff and volunteers will train with Dr. Kingsbury, if available, or other species expert on survey methodology and species identification prior to conducting surveys.
4) Characterize habitat use during spring and fall at occupied sites at community and microhabitat levels. Assess habitat quality and threats at all occupied sites to identify management and protection concerns.
5) Enter data into the Natural Heritage Biodiversity and Conservation Database, analyze data and prepare annual performance report. Share study results and provide technical assistance to state and federal government agencies, management and recovery teams and conservation organizations. Identify high priority areas for management and recovery efforts.
6) Inform landowners of survey results. Work with landowners and/or local conservation or education organizations to develop local, site-based expertise to survey and monitor occupied sites.

This report summarizes the efforts and results obtained during the first year of this two-year project. These results should be considered preliminary, and will be refined by work conducted in the second year of the project. Procedures 1 and 4 are discussed in the ***Habitat Characterization and Threat Assessment*** sections of the report. Procedures 2 and 6 are discussed under ***Landowner Contact and Education***. Procedure 3 is addressed in the ***Copperbelly Surveys*** sections. Procedure 5 is addressed in the ***Database Maintenance and Data Exchange*** sections.

Methods

Landowner Contact and Education

The MNFI Biological and Conservation Database (BCD), field forms from previous surveys, National Wetland Inventory maps and aerial photographs were consulted to identify areas in which copperbelly water snakes have been seen previously and areas with potential habitat in the vicinity of known sites. These areas were cross-referenced with Rockford Land Atlas and Plat maps to determine the appropriate parcels and landowners. This process identified a total of 66 different parcels as potential survey sites. Of these, most (n=59) are owned by private individuals and consist of residential property, agricultural land and private campgrounds. The remaining seven parcels are owned and managed by public or private organizations including the State of Michigan, the Boy Scouts of America, Michigan Nature Association, Michigan Audobon Society and the Kiwanis Club of Battle Creek.

Contact information for landowners in terms of addresses and/or phone numbers were obtained from county equalization offices or through various search engines on the Internet. Of the 66 landowners identified, 51 were contacted during April and May 2001 to request permission to survey their property. Most landowners (n=37) were contacted by phone. Thirteen landowners were contacted on-site by knocking on doors and talking with them face-to-face to request permission to survey. One landowner was contacted by mail.

A landowner contact letter describing the project and requesting permission to survey and a landowner authorization form were developed (Appendix A). A similar letter was developed and provided to landowners contacted on-site. Responses of landowners contacted by phone and on-site visits were recorded on landowner authorization forms. These forms were placed in project site folders and taken into the field for reference and to provide documentation of permission to survey. Landowner contact information, contact method, landowner response, survey date, presence of suitable habitat, and survey results were entered and tabulated in an Excel table used for mailings. At the project conclusion, follow-up letters were sent to all landowners that provided access to their property, thanking them for their cooperation and informing them of survey results. Four different landowner letters were developed based on survey results (i.e., no survey conducted, surveyed but no habitat, surveyed and habitat present but no copperbellies, and surveyed and copperbellies present) (see Appendix A for sample letter).

Discussions with landowners, either when requesting permission to survey or when surveying, were used as an opportunity to educate them about the copperbelly water snake. Additionally, a one-page informational sheet with photos and a brief description of the copperbelly water snake and its habitat was developed and provided to landowners during on-site landowner contact visits and surveys (Appendix B). This informational sheet was later revised (Appendix B). Several additional landowner educational materials were developed after surveys were conducted based on interactions with landowners. In addition, a four-color brochure for landowners and the general public was developed. MNFI contracted with Interpretive Ideas, a small graphic design company in Okemos, Michigan, to design and produce the brochure. The brochure is intended to for use across the northern population segment. The Endangered Species Coordinators in Michigan, Ohio and Indiana were contacted to solicit input regarding whether a brochure applicable across the northern population range would be useful, and were given an opportunity to review and provide comments on the brochure. The brochure also was sent to Dr. Bruce Kingsbury, , regional species expert and Director of the Center for Amphibian and Reptile Conservation at Indiana-Purdue University, Fort Wayne, for review. The brochure provides information and photos on the species status and distribution, key characteristics for identifying the species, look-alike species, habitat, ecology, threats facing the species, recommendations for helping to conserve the species and agencies to contact to report sightings and obtain additional information in Michigan, Ohio and Indiana.

Copperbelly Surveys

Surveys this first year focused on reconfirming copperbelly water snakes at known sites and examining areas with suitable habitat in their vicinity in an effort to identify new locations or populations. In Michigan, the copperbelly water snake is known from 14 sites in 7 counties in southern Michigan (Hillsdale, Cass, St. Joseph, Branch, Calhoun, Eaton and Oakland) (Figure 1) (MNFI 2002). Site selection was based on

information obtained from MNFI's BCD, field forms from previous surveys, National Wetland Inventory (NWI) maps, aerial photographs, landowner permission and consultation with species experts. Based on consultation with experts such as Dr. Bruce Kingsbury and his former graduate student, Ed Laurent, National Wetland Inventory categories that were designated as potential habitat for copperbellies focused on palustrine scrub-shrub wetlands (PSS), particularly those seasonally flooded, but also included palustrine forested wetlands (PFO), palustrine emergent wetlands (PEM) and palustrine open water (POW). Analysis of known sites and potential habitat identified a total of 66 parcels as priority survey sites, of which 45 were accessible based on landowner permission.

Survey design and methodology was developed in consultation with Dr. Bruce Kingsbury. Dr. Kingsbury developed and provided a survey protocol for copperbelly water snakes from northern populations, which was reviewed and comments were provided by MNFI (Appendix C). The survey protocol was employed during spring surveys, although the field form provided in the protocol was modified slightly for MNFI use (Appendix D). MNFI surveyors also spent a day training with Dr. Kingsbury and his graduate students working on copperbelly water snakes in Ohio. The training included a review of the survey protocol, a field demonstration on how to survey for copperbellies and visits to suitable habitat in which copperbellies had been observed. MNFI surveyors also encountered or contacted Dr. Kingsbury and/or his graduate students during the field season and throughout the year to share information and provide project updates.

Copperbelly surveys in the spring were conducted from May 1 to June 18, 2001. Known sites or habitat complexes were surveyed one to five times during the spring field season, with individual parcels visited generally only once or twice. Three field assistants were recruited to conduct spring surveys. Surveys were usually conducted in teams of two or three people. In addition, several volunteers assisted with spring surveys. At each survey site, time, weather conditions, habitat surveyed and snakes observed were recorded. Survey locations and routes were indicated on topographic maps, and Global Positioning System (GPS) units were used at some locations. Photographs of some of the sites also were taken. All snakes encountered during surveys were recorded including time of observation, microhabitat, age class and behavior. Other herps observed during surveys also were noted.

Observed copperbelly water snakes were captured, measured (i.e., total length and snout-vent length), and sexed, when possible. Individuals were scale-clipped by removing a small portion of a ventral scale near the belly to mark individuals so that recaptured individuals could be identified. These scale clippings provide tissue samples that can be used for genetic analysis in the future. The scale clippings were preserved in an alcohol solution and deposited into the University of Michigan Museum of Zoology herpetology collection. General condition of the snake also was noted. Photographs were taken of each copperbelly water snake observed. Snakes were released at initial capture site when processing was completed.

In addition to spring surveys, a volunteer monitored the copperbelly water snake population at one of the known sites in Hillsdale County. This site is located on a small dairy farm, and consists of two, small permanent ponds surrounded by wet meadow, sedge meadow, shrub swamp, a small buttonbush depression, dry-mesic southern forest and mesic southern forest. The ponds were artificially created by dredging a wetland that had previously supported tamarack. Surveys were conducted every 1-3 days from June 9 to August 13, 2001. Additional surveys were conducted on August 18, August 25 and September 9. To standardize surveys and generate comparable results, surveys were conducted by walking along the same transect and looking for snakes in the same areas of suitable habitat during approximately the same time of day throughout the summer. All snakes encountered, their size or age class, behavior, location along the transect and microhabitat were recorded.

Fall surveys for the copperbelly water snake were conducted at extant sites confirmed in the spring (i.e., sites at which copperbellies were seen in the spring). Due to unfavorable weather conditions in September for snake surveys (i.e., early, cool rain and windy conditions), fall surveys were limited. Surveys were conducted from September 29 to October 5. Snakes also were noted during vegetation or community sampling in the fall from October 10 to October 12. Wetland areas in which copperbellies were seen in the spring as well as surrounding upland forests were surveyed with visual meander surveys.

Figure 1. Copperbelly Water Snake Element Occurrences in Michigan according to the Michigan Natural Features Inventory Biological and Conservation Database (2002).

Habitat Characterization and Threat Assessment

Landscape Level

MNFI used geographic information systems (GIS) to characterize and model copperbelly water snake habitat at the landscape scale. Habitat characterization at the landscape scale hopefully will enhance our understanding of the copperbelly water snake's distribution and ecological requirements in Michigan. The models also will be used to help identify and prioritize areas for ongoing copperbelly survey efforts.

The GIS models are based on landscape patterns around the 14 known copperbelly sites in Michigan. The landscape patterns were analyzed at two different scales. A one kilometer buffer (314 hectares, 1.2 square miles) around each site was used to determine localized landscape patterns. A five kilometer buffer (7854 hectares, 30.3 square miles) was used to provide a larger landscape context (see Appendix E for illustration of buffers). Since the buffers for sites near the state's border overlapped the Michigan boundary and contiguous land cover data sets beyond Michigan were not available, the buffers were clipped with the Michigan Boundary. Consequently, not all buffers had the same area.

Several different data sets have been examined, either independently or concurrently. Data sets include the 1:24,000 National Wetland Inventory (NWI) (U.S. Fish and Wildlife Service), Circa 1800 vegetation (MNFI), Integrated Forest Monitoring Assessment and Prescription (IFMAP) current land cover (Michigan DNR), 1:250,000 watersheds (USGS), 1:250,000 STATSGO soil survey (USDA), 1:500,000 Michigan quaternary geology (Michigan DNR & MNFI), and 1:63,360 Michigan bedrock geology (Michigan DEQ). The copperbelly occurrences have been examined in relation to the STATSGO soil survey, watersheds, and quaternary and bedrock geology. Two change analyses also have been incorporated into the model. One is a change in land cover between the Circa 1800 vegetation and the IFMAP land cover. The second is a change analysis between wetland classes in the Circa 1800 landcover and current NWI wetlands.

Community Level

Habitat for the copperbelly water snake at the community level was characterized through field site evaluations conducted in October 2001. Community-level habitat evaluation was conducted only at extant copperbelly sites that were identified during spring surveys. The following habitat information was recorded: 1) estimates of the relative abundance of plant species in the ground layer, understory and overstory; 2) soil type, soil pH, and litter depth; 3) water conductivity and depth; 4) short description of the general habitat; 5) estimates of the extent of the overall vegetative community; 6) description of the landscape context and surrounding land use(s); and 7) rankings of the quality and viability of the vegetative community. A habitat evaluation form was developed and used to record data in the field (Appendix D).

A detailed field assessment of potential threats also was conducted as part of the habitat characterization. The field assessment of threats included: 1) recording exotic plant species and estimating their relative abundance; 2) characterizing any hydrologic alterations; 3) recording evidence of habitat destruction or disturbance; 4) documenting habitat manipulation such as mowing and grazing; and 5) noting evidence of soil erosion. A data form for recording habitat threats in the field was developed (Appendix D).

Microhabitat Level

Information on microhabitat use was recorded in the field during copperbelly surveys. The microhabitat classifications provided in the copperbelly survey protocol (see Appendix C) were used to describe where snakes were observed. More detailed microhabitat information (e.g., specific plant species) also was noted whenever possible. The microhabitat data from copperbelly surveys were summarized and analyzed qualitatively. Microhabitat use also was examined in relation to behavior of snakes observed.

Database Maintenance and Data Exchange

Data from copperbelly survey forms were transcribed onto MNFI site survey summary and special animal forms. The data were entered into MNFI's BCD to update the element occurrence records for known copperbelly sites in Michigan. The locations and spatial extent of the areas in which copperbellies were observed were delineated on 1:24,000 USGS topographic maps. Field forms and maps from previous copperbelly surveys and reports were pulled from MNFI's files, and specific locations and extent of these copperbelly sightings also were delineated on topographic maps. These maps will be used to digitize the known copperbelly occurrences in Biotics so that occurrences in the database will have spatial

representation. Updating and digitizing known copperbelly occurrences in Michigan provide for a more accurate, current information base on this species that will aid in the state and federal permitting process and conservation and management efforts. Results of this study and current information on copperbelly occurrences in Michigan were provided, and will be continue to be provided, to state and federal management agencies, researchers, conservation partners and other project collaborators through this report, information requests, data exchanges and/or access to MNFI's database.

Results and Discussion

Landowner Contact and Education

Of the 51 landowners contacted, a total of 45 landowners (88%) granted MNFI permission to survey their property. Some landowners requested notification prior to surveys on their property. Several landowners requested that surveys be conducted only when they were present on the property. The percentage of positive landowner responses in this study was very high. This could be attributed to primarily contacting landowners by phone or in person during on-site visits. These methods of landowner contact seemed to be very effective in that they allowed direct interaction with the landowner, providing opportunities for questions and concerns to be expressed and addressed. For example, landowners often expressed concern regarding legal implications for their property if a copperbelly water snake was found or had questions regarding the nature of the surveys. Discussions with landowners about these issues often alleviated or minimized their concerns and resulted in providing access to their property.

Many landowners, particularly in Hillsdale County, were familiar with the copperbelly water snake, due to contact with Mark Sellers and surveys conducted on their property in the past. In some cases, familiarity with past surveys resulted in negative responses to requests for permission to survey. Most of the landowners we contacted either had a neutral or negative response to the presence or idea of copperbelly water snakes, or snakes in general, on their property. Landowners who had a neutral response accepted the copperbelly as part of the ecosystems or natural communities in which their property was contained. This type of response may be the best we can strive for at the moment. Although few landowners were pleased or excited about having copperbellies on their property, many of them were still willing to share information about where snakes had been seen in the past, recent sightings such as roadkills or lack of recent sightings. This type of information and interaction is still available, and may provide a foundation for building relationships with landowners to encourage stewardship and conservation for the copperbelly water snake. Additionally, misperceptions about implications of the presence of threatened and endangered species, such as the copperbelly, on private property were common. Further landowner education on private property rights and responsibilities in relation to threatened and endangered species is warranted.

Landowners assisted with field surveys at two sites. Landowner contact and development of a positive relationship with one particular landowner in Hillsdale County resulted in the training and recruitment of a survey volunteer and eventual field assistant. The landowner was already familiar with the copperbelly water snake and aware of its presence on their property for over a decade. One of the landowner's daughters was particularly interested in wildlife, and showed us where she had seen copperbellies on their property in the past and volunteered to assist with field surveys. She also helped us gain access and assisted with surveys and identifying suitable habitat on several adjacent properties. In addition, she conducted surveys and monitored the copperbelly population and associated snake species on their property throughout the summer using the survey protocol developed for this study. She also assisted with fall surveys and vegetation sampling. Although she has since moved residence, her family still owns the property, and she has offered to continue surveying and monitoring the population on their property. Having a local contact within the community will hopefully help promote conservation of this species in the area.

Additional landowner educational materials were produced. Based on interactions with landowners, a copperbelly FAQ (i.e., frequently asked questions) sheet was developed (see Appendix B). A copperbelly sighting form adapted from MNFI's eastern massasauga sighting form also was generated (see Appendix B). Both forms will be distributed to landowners contacted in 2001 and 2002, along with other educational materials. Both forms also will be placed on MNFI's web site. The production of the copperbelly brochure was completed (see Appendix B).

The brochure will be printed and ready for distribution by early April. Three thousand copies of the brochure will be printed and available. Additional copies of the brochure may be printed in the future if funding is available. Copies of the brochure will be provided to all landowners contacted in 2001 and 2002 and to U.S. Fish and Wildlife Service offices and Department of Natural Resources' (DNR) Wildlife Divisions in Michigan, Ohio and Indiana. Copies of the brochure also will be provided to county extension offices, local conservation organizations, project partners or collaborators and other interested parties. The brochure also will be available through MNFI's web site and also potentially through the Indiana and Ohio DNR Division of Wildlife web sites, based on communications with the Endangered Species Coordinators in those two states.

Landowner contact and education will continue in 2002. Educational materials developed in 2001 and copies of the copperbelly brochure will be distributed to landowners. A species abstract on the copperbelly water snake, similar to those produced by MNFI in the past, will be developed in 2002. This abstract will provide information on the species' range, statewide distribution, identification, best survey period, habitat, ecology and conservation and management recommendations. These abstracts are more technical in nature, and are generally intended for land managers. The abstract, when completed, will be distributed to land managers within the copperbelly water snake range, and will be available on MNFI's web site.

Copperbelly Surveys

Copperbelly surveys in the spring were conducted on 40 of the 45 properties for which permission to survey was granted. These properties are associated with 13 of the 14 known sites or element occurrences (EO's) in Michigan. One known site in Eaton County was not surveyed due to time constraints and limited landowner permission. It also is questionable as to whether this site still contains suitable habitat. The primary landowner associated with one Hillsdale County occurrence (EO .010) did not provide access to their property, but agreed to cooperate by providing data. Also, further examination of another known occurrence in Hillsdale County (EO .014) and consultation with Mark Sellers, a species expert who conducted previous surveys in Michigan, revealed that this occurrence is actually part of another known site (EO .011), and does not represent a separate copperbelly occurrence. These two element occurrences will be merged, resulting in 13 separate, known occurrences in the database.

Of the properties surveyed, suitable habitat appeared to be available at 31 sites. However, copperbelly water snakes were observed on only three private parcels associated with two known occurrences in Hillsdale County (EO .005 and .008). A summary of survey results is provided in Appendix F. A total of nine individuals were observed on these three properties during spring surveys. Copperbellies had been last documented at these two known sites in 1996 and 1983. Copperbellies were newly documented on the two properties associated with EO .008, although one landowner was aware of the species' presence on their property for over a decade. Additionally, different age classes (i.e., adults, subadults and juveniles) were observed at the two newly documented properties, including a young-of-the-year from last fall. This provides evidence of a reproducing population at this known site, which was previously not documented. Indices of relative abundance (e.g., number of snakes observed per transect or survey distance) were not calculated due to the small number of snakes observed at these sites during spring surveys.

Recent observations of copperbelly water snakes also were reported at three known sites in Hillsdale, Eaton and Oakland counties, and two potential new sites in Branch and Muskegon counties. Permission to survey was not granted at the site in Hillsdale County, but this report should be considered reliable based on the source of the information. The copperbelly report in Eaton County came from a professor at Olivet College who apparently saw a copperbelly water snake on property owned by the College in 1997 or 1998. This site was surveyed three times during the spring field season. Northern water snakes (*Nerodia sipedon*) were observed at this site, but no copperbellies were observed. Suitable habitat is present, and additional surveys are warranted to confirm this report. The copperbelly report from Oakland County came from a landowner who apparently found the snake in a pond in his yard, captured it and brought it to a nature center where a staff member identified it as a copperbelly water snake. However, after further discussions with the landowner and review of field guides and photographs of look-alike species, the landowner concluded that the snake was most likely a northern red-bellied snake (*Storeria occipitomaculata occipitomaculata*) instead of a copperbelly based on the snake's size. Upon further discussion, initial reports of copperbellies by other landowners in the vicinity of

the Oakland County site also appear to be most likely red-bellied snakes. A herpetologist at Michigan State University reported seeing copperbelly water snakes at a new site in Branch County within the last several years. This site was surveyed from the road on two occasions. No copperbellies were observed, but surveys were conducted late in the season and under less than ideal weather conditions. Additional surveys of this site are warranted. The copperbelly report from Muskegon County also was based on a recent sighting by herpetologists from Illinois. The snake was seen in a buttonbush depression. If confirmed, this record would represent a significant range extension for this species, and would greatly expand the geographic area for future surveys. Surveys will be conducted in this area in 2002.

In addition to copperbelly water snakes, several other snake species were commonly encountered during spring surveys. These include the northern water snake, northern ribbon snake (*Thamnophis sauritus septentrionalis*) and eastern garter snake (*Thamnophis sirtalis sirtalis*). Brown snakes (*Storeria dekayi*) and eastern milk snakes (*Lampropeltis triangulum triangulum*) (in the uplands) were occasionally encountered. Painted turtles (*Chrysemys picta*) also were occasionally observed at survey sites. As for rare herps, the state special concern eastern box turtle (*Terrapene carolina carolina*) was documented at the known copperbelly site along the border of Cass and St. Joseph counties. This represents an update of a previously documented box turtle occurrence at this site. A state special concern eastern massasauga (*Sistrurus catenatus catenatus*) was reported at a survey site with suitable copperbelly in Branch County, but this report needs to be confirmed. An occurrence of the state special concern Blanding's turtle (*Emydoidea blandingii*) also was found.

The copperbelly monitoring efforts at one property in Hillsdale County generated some interesting resullts. Surveys were conducted on 36 days throughout the summer and early fall. Surveys were generally conducted in the morning before 1 pm. Copperbelly water snakes were observed on 31 of the 36 survey days, almost every day surveys were conducted. These results suggest that if copperbellies occur at a fairly good density at a site, they should be detected with a relatively small number of visits (e.g., 3-4) over several weeks. These surveys resulted in a total of 67 observations of copperbelly water snakes at this site. Many of these snake observations likely represent the same individuals, based on visual recognition and evidence of scale clipping. However, since not all individuals were captured and marked, it is uncertain, and impossible to determine, the exact number of individuals represented by these observations. Individuals of all different age classes were observed at this site, including the largest adult observed in the study. A dense population of northern water snakes also inhabits this site. Copperbelly water snakes were observed primarily in two general areas, in the sedge meadow and wet meadow around the small pond and along the southern shore of the large pond and in emergent vegetation and wet meadow along the northwest side of the large pond. Copperbellies were seen primarily in the ponds or along the shore of the ponds early in the summer and appeared to make a steady progression away from the ponds later in the summer. By mid-August, the snakes were no longer seen at the site. This pattern of habitat use appears similar to that observed in radio-tracked snakes in Ohio. The monitoring data requires further analysis, such as developing an index of relative abundance for this site.

Fall surveys at three properties associated with two reconfirmed extant sites in Hillsdale County failed to document any copperbelly water snakes. Weather conditions during surveys were appropriate and conducive for seeing snakes. This was evidenced by multiple observations of northern ribbon snakes, eastern garter snakes, brown snakes and a blue racer (*Coluber constrictor*). MNFI will try to visit some copperbelly hibernation sites and habitat identified through Dr. Kingsbury's radio-telemetry work in Ohio to help target fall surveys in 2002.

Copperbelly water snake surveys in 2002 will focus on revisiting known sites, particularly those that were not reconfirmed in 2001, and surveying new sites with potential habitat in the vicinity of known sites. Landscape-level habitat models will help identify high-priority sites for *de novo* surveys. Surveys also will attempt to verify numerous copperbelly reports and site leads that MNFI has obtained in the past.

Habitat Characterization and Threat Assessment

Landscape Level

Tabulations of IFMAP cover classes, NWI classes, and the wetland change analyses have been completed but not thoroughly analyzed (Appendix G). The Circa 1800 vegetation is in the process of being tabulated. The change analysis between wetland classes in the Circa 1800 landcover and current NWI wetlands has been completed and tabulated. The change analyses between

the Circa 1800 vegetation and the IFMAP landcover has been completed bit not tabulated. There are over 900 classes of change in this analysis, requiring that some of the classes be aggregated together and the important change classes selected out.

Preliminary examinations of the tabular results from the landscape-level habitat analysis of NWI wetland classes using the one-kilometer buffer indicate that most of the area within this buffer around known occurrences is comprised of uplands followed by open water and forested wetlands (see Appendix G). Emergent and scrub-shrub wetlands comprise only small percentages of the area within the one-kilometer buffers. This may not be surprising since wetlands in southern Michigan are numerous but are generally small and comprise a small percentage of the land cover in a given area. Similar results were obtained for the IFMAP current land cover analysis with the one-kilometer buffer. The IFMAP landcover classes that appeared to comprise the highest percentages of the buffer area for most of the occurrences include row/forage crops, herbaceous open land, upland deciduous forest and non-forested wetland (see Appendix G). The wetland change one-kilometer buffer change analysis seemed to indicate a slight trend or tendency for areas around occurrences to have experienced less wetland loss from circa 1800 (Appendix G). Results for the five-kilometer buffer analyses were similar, although areas within these buffers were dominated even more by uplands (Appendix G). All these relationships warrant further analysis.

Examinations of copperbelly occurrences in relation to quaternary and bedrock geology, soils and watersheds also are considered preliminary, and will need to be reexamined in conjunction with land cover and land use information. No strong relationships between known copperbelly occurrences and quaternary geology have been detected. Nine of fourteen occurrences are over various glacial features, four occur over alluvial deposits, and one occurs on an ice contact area in very close proximity to alluvial deposits. A stronger, potential trend has been detected in relation to bedrock geology. Eleven of the fourteen known occurrences are over the Coldwater shale bedrock formation. Two occurrences are over Bayport limestone, and one is over the Michigan formation in close proximity of Bayport limestone.

Of the fourteen copperbelly occurrences, one occurs in the Huron River watershed, three occur in the Kalamazoo River watershed and ten occur in the St. Joseph watershed. The Kalamazoo and St. Joseph watersheds border each other. The Huron watershed is disjunct from both the St. Joseph and the Kalamazoo.

Using the STATSGO soil survey, three of the occurrences are on hydric soils and eleven are on non-hydric soils. Only two occurrences fall on soils containing at least 10% clay and three fall on soils containing at least 5% clay. Soil examinations at two known copperbelly sites indicate a high level of clay in the soil. This discrepancy between the STATSGO soil survey information and on-site soil testing may indicate that the soils under the wetlands of known copperbelly occurrences are too small of a unit to map.

Landscape-level habitat characterization and modeling will continue in 2002. Present models and their implications will be analyzed further. Copperbelly occurrences also will be examined in relation to ecoregion and possibly climate or growing season. A model will be developed to identify priority *de novo* survey sites for 2002. Data from radio-telemetry study in Ohio conducted by Dr. Kingsbury's graduate students also will be consulted and incorporated to help in model development and refinement.

Community Level

Community-level habitat information was gathered at three different properties that comprised two extant sites in southern Hillsdale County (EO .005 and .008). Habitat and threats were characterized at 14 separate locations within the two extant sites. A variety of habitat types or vegetative communities are used by the copperbelly water snake. Two types of upland habitats were characterized, dry-mesic southern forest (oak-hickory forest) and mesic southern forest (beech-maple forest and maple-white ash forest). Wetland habitats characterized included shrub swamp (button bush depression), emergent marsh, wet meadow, sedge meadow, and pond. The soils of all upland and wetland habitats were underlain by clay with gleyed clays occurring in all wetland types.

Habitat types at the two properties associated with EO .008 include dry-mesic southern forest, mesic southern forest (sugar maple-white ash forest), wet meadow, sedge meadow, shrub swamp, and pond. Because of their close proximity to active agriculture or seasonal use by livestock, all of the habitat types were characterized as having low natural community quality, low viability, and poor landscape context. The pond, which supports the copperbelly water snake during mid-summer, was artificially created by dredging a wetland that had previously supported tamarack. Exotic plants were common or dominant in all habitat

types except for one very small, partially forested sedge meadow located between an agricultural field and button bush depression.

Habitat types at EO .005 include dry-mesic southern forest, mesic southern forest (beech-maple forest), sedge meadow, and emergent marsh. The landscape context and natural community quality and viability varied among habitat patches. Several of the upland forests appeared to be in moderate condition with many large trees, a diverse understory and canopy layer, and few exotic species. However, evidence of selective logging was apparent and each of the forested patches are relatively small and occur directly adjacent to mowed fields. Two emergent marsh habitats were characterized, both occurring as very thin bands (1 to 2 meters wide) along the edge of manmade ponds. Purple loosestrife, an aggressive exotic species, is abundant in both emergent marshes. Because they are extremely small in size and occur directly adjacent to mowed lawn, these areas were characterized as having poor landscape context and low natural community quality and viability.

The two extant copperbelly water snake sites were similar in several respects. Each site contained habitat patches (ponds) that retained water throughout the year. Clay subsoils also occurred at both sites and probably accounts for water retention in wetlands and ponds at both sites. The quality of the natural communities, especially the wetlands, was very low. Exotic plants were common in most of the habitats, especially the wetlands. Habitat disturbance and manipulation such as seasonal grazing, mowing, and active use by boy scouts also commonly occur at both sites.

Microhabitat Level

Of the nine copperbelly water snakes encountered during MNFI spring surveys, all were observed basking or resting in the shade along the shore or within one meter of the shore of a permanent pond or small, ephemeral buttonbush depression. Three snakes were observed on logs, three were observed on or in cattails, willow or grass/sedge, and two were in the water. One snake was seen briefly, and microhabitat was not recorded.

Most of the copperbelly water snakes observed during monitoring of one property in Hillsdale County consisted of snakes basking or resting along the shore of a permanent pond in cattails, buttonbush, grass/sedge or willows. Some individuals were observed swimming in the water. All individuals found on land were within 10 meters of the shore.

These observations are consistent with previous studies and our current understanding of copperbelly behavior and microhabitat use. Copperbelly surveys and monitoring in 2002 will continue to record microhabitat associated with copperbelly observations. Microhabitat analysis will continue to be refined.

Database Maintenance and Data Exchange

Data from copperbelly surveys at 12 of the 14 previously documented sites were compiled and entered into MNFI's BCD to update the element occurrence records for these sites. Data from the Michigan Nature Association will be incorporated when obtained. The locations and spatial extent of areas in which copperbellies were observed during 2001 and previous surveys were delineated on topographic maps. These maps will be used to digitize known copperbelly occurrences in Biotics in 2002. These occurrences will be updated again after 2002 surveys.

Study results and copies of this report will be provided to U.S. Fish and Wildlife Service, Michigan Department of Natural Resources (MDNR) and Dr. Bruce Kingsbury as principal collaborators. Element occurrence data and a shapefile with locations for all copperbelly occurrences in Michigan were provided to Dr. Bruce Kingsbury in 2001 upon his request. Copies of MNFI survey forms for five of the known sites were provided to the Michigan Chapter of The Nature Conservancy (TNC) to assist with their conservation planning efforts. A copy of this report also will be sent TNC's Michigan Chapter, and opportunities to get them more involved in conservation of copperbelly sites will be further investigated. The MDNR and TNC also can obtain current information on copperbelly occurrences in Michigan through direct access to BCD, access through MNFI's web database and/or annual data exchanges. Copies of this report also will be sent to land managers at two copperbelly sites that occur on state land, and other landowners, collaborators and partners, upon request. Technical consultations with state and federal agencies, researchers, conservation organizations, landowners and other collaborators or partners have been provided as needed.

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Acknowledgements

This project would not have been possible without the generous assistance and diligence of many Michigan Natural Features Inventory (MNFI) staff and other partners. Mary Rabe, MNFI Zoology Program Leader, and Judy Soule, MNFI Program Director, provided invaluable assistance with development of the original project proposal. Staff within the U.S. Fish and Wildlife Service (USFWS), and the Michigan Department of Natural Resources (MDNR) assisted with the financial and legal administration of this project, including Lucinda Corcoran, USFWS Fish and Wildlife Biologist; Mike DeCapita, USFWS Fish and Wildlife Biologist; Eric Sink, MDNR Federal Aid Coordinator; Robert Humphries, MDNR Wildlife Division Federal Aid Coordinator; Ray Rustem, MDNR Wildlife Division Natural Heritage Supervisor; and Patrick Lederle, MDNR Endangered Species Coordinator. Special thanks to Pat Lederle for his efforts administering this project and for his words of advice, understanding and patience. Lyn Scrimger, MNFI Project Management Specialist, Sue Ridge, MNFI Director of Administration, and staff at Michigan State University's (MSU) Contracts and Grants Office also provided tremendous assistance with project administration.

We would like to thank Dr. Bruce Kingsbury, Director of the Center for Amphibian and Reptile Conservation at Indiana-Purdue University, Fort Wayne, for his generous assistance with study design, development of the survey protocol, field training and technical consultation throughout the project. This project has benefited greatly by ongoing collaboration with Dr. Kingsbury. Special thanks also go to John Roe and Nathan, two of Dr. Kingsbury's graduate students who are working with copperbelly water snakes across the border in Ohio, for taking time to share information from their study with us. Mark Sellers, local species expert who has contributed greatly to documenting copperbelly water snake status and distribution in Michigan, also graciously provided ongoing consultation on study design and survey methodology and information on known copperbelly occurrences in the state. Ed Laurent, doctoral student at MSU and former graduate of Dr. Kingsbury who studied copperbellies in Kentucky, also provided technical consultation with the survey site selection process and design of survey methodology.

The comprehensive and intensive field surveys conducted this first year for the copperbelly water snake were accomplished only with the skill and dedication of several key individuals. Glenn Fox, former MNFI Zoology Assistant, Matt Smar, former MNFI Zoology Assistant, and Kristin (Krissi) Wildman, MNFI Zoology Student Intern, comprised the copperbelly survey crew. They assisted with landowner contact and development of educational materials, and conducted the spring field surveys diligently and enthusiastically through the swamps in the heat and rain. We are deeply indebted to Audrey DeRose-Wilson, former MNFI volunteer and Zoology Assistant, for her interest and hours of assistance with spring and fall surveys and monitoring of copperbellies at one site throughout the summer. We also are grateful to Mark Sellers, Jim Harding, MSU Extension, and Alan Holman, MSU, who took time out of their busy schedules to share their expertise with us in the field and provide information on site leads.

Krissi Wildman has continued to provide invaluable assistance on the project with landowner contact efforts, development of educational materials, data entry and database maintenance through the fall and winter. We thank Krissi for all her hard work and contributions to this project. Edwin Abbey, MNFI Student Intern, generously offered to assist with landscape-level habitat characterization and data digitization efforts. Helen Enander, MNFI GIS and Information Technology Professional, assisted with creation of habitat data layers that were used in landscape-level habitat characterizations. Rebecca Boehm and Michael Fashoway, MNFI Information Technology Professionals, entered and digitized data from copperbelly surveys into the database and provided assistance and training with formatting of this report. We also would like to thank Sue Ridge and Laraine Reynolds, MNFI Administrative Assistant, who provided administrative support in countless ways that aid in conducting and completing our work.

Finally, we would like to express our sincere gratitude to all the landowners who provided access to their property during spring and fall surveys. We would like to especially acknowledge the DeRose-Wilson family for generously allowing us to conduct numerous surveys on their property and for tremendous assistance with field surveys and landowner contact. Without willing and interested landowners, this study would not have been possible.

Funding for this project is a contribution of Federal Aid in Endangered Species, Michigan Project E-1-31.

Appendix A

Landowner Contact Letters

MICHIGAN STATE
UNIVERSITY
EXTENSION

May 3, 2001

«First_name» «Last_name»
«address»
«city», «state» «zip»

Dear «First_name» «Last_name»:

The Michigan Natural Features Inventory (MNFI) is a partnership between Michigan State University Extension and the Wildlife Division of the Michigan Department of Natural Resources. We are in our twenty-first year of conducting surveys for Michigan's unusual natural features. These features include rare plants and animals, unique geological features, and representative examples of Michigan's native forests, grasslands, and wetlands.

This year, we are starting a project to better understand the current status and distribution of the copperbelly water snake in Michigan. This species is typically associated with swamp floodplain forests, shrub swamps and other scrub-shrub wetlands next to lakes, ponds and slow-moving rivers as well as the surrounding uplands. This species has declined throughout much of its range, and is currently known from only fourteen sites in southern Michigan, based on previous surveys and historical records. As a result of its rare and declining status, the copperbelly water snake is state and federally-listed.

We are conducting field surveys for this species at previously known sites as well as new sites with potential habitat. Based on examination of aerial photographs, topographic maps and plat maps, it appears that portions of your property support wetlands that may be suitable for copperbelly water snakes. Would you be willing to allow us to visit your property to see if suitable habitat is available, and if so, to survey for the copperbelly water snake?

We plan to conduct surveys between May and mid-October. One or two people would visit your property up to five times, and walk around and take notes on the vegetation, animals and natural characteristics of the wetlands and surrounding uplands. We will be conducting visual surveys, mostly with binoculars, for the copperbelly water snake and associated amphibians and reptiles. We may capture some of the snakes to verify identification and take some measurements, but will release all snakes unharmed immediately after handling. With your permission, we also may collect plant specimens to verify their identities, although this is usually not necessary. If you wish, we would be happy to notify you of the day we plan to visit. We also will provide you with a list of species found on your property and a summary of study results.

We would greatly appreciate your participation in this study. Please use the second page of this letter to indicate your willingness to assist in our efforts and return it in the enclosed, self-addressed stamped envelope. We will be following up with a phone call in the next week or so to answer any questions you might have about this project. If you would like to contact us, you can reach Yu Man Lee, project coordinator, at (517) 373-3751.

Sincerely,

Yu Man Lee

MICHIGAN STATE
UNIVERSITY
EXTENSION

MNFI Copperbelly Water Snake Project 2001
Access to Private Property Permission Form

**Please make corrections below if necessary:

Name: «First_name» «Last_name»

Address: «address»

City, State zip: «city», «state» «zip»

Phone: _____

County: «location»

**Please check the following with an X:

____Yes, you may visit my property to conduct a survey.

____Yes, you may collect plant specimens for identification purposes.

____ No, you may not have access to my property.

Michigan State University (MSU) agrees to indemnify the Landowner for losses from any personal injury or property damage claims made by others alleging negligence by MSU in its activities on the Landowner's property.

This authorization shall expire on October 15, 2001.

Signature _____ Date _____

**Please indicate below if you have any concerns or wish to make additional comments.

Comments:_____

_____

_____

_____

_____

_____

_____

Please use the enclosed, self-addressed, stamped envelope to return this form at your earliest convenience. Thank you for your cooperation!

Michigan Natural Features Inventory
P.O. Box 30444
Lansing, MI
48909-7944
(517) 373-1552
FAX: (517) 373-6705

MICHIGAN STATE
UNIVERSITY
EXTENSION

«Firstname» «Lastname»
«Address»
«City» «State» «Zipcode»

Dear «Firstname» «Lastname»,

Last summer, someone from our office contacted you requesting access to wetlands on your property to conduct surveys for the federally threatened and state endangered copperbelly water snake, its habitat and associated amphibians and reptiles. We would like to take this opportunity to thank you for allowing us access to your property during the months of May and June. We especially appreciated your willingness to allow our survey on very short notice.

Last May and June, we conducted surveys for the copperbelly water snake in southern Michigan as a part of a two-year study to gain a better understanding of this species' current status and distribution as well as habitat use in the state. This species was previously known from only thirteen sites in seven different counties in Michigan, and only several were considered to contain reproducing populations. Surveys last year focused on trying to reconfirm the species at or near previously known sites. The copperbelly water snake generally requires open, slow-moving or stagnant water with emergent vegetation or woody debris along the water's edge. This species is typically associated with floodplain forests, shrub swamps and scrub-shrub wetlands (often with buttonbush) next to lakes, ponds, and slow-moving rivers. These snakes also use adjacent upland forests during late summer, fall and winter.

Overall, we surveyed a total of 31 different properties. We were able to confirm copperbelly water snakes at only two of the known sites. Of the sites we surveyed, copperbellies were mainly found along the emergent edge of small, open ponds and lakes and a relict buttonbush swamp. Other rare and/or declining species observed at the survey sites include the Blanding's turtle, eastern box turtle and northern leopard frog. Although we did not observe any copperbelly water snakes when we surveyed your property, we did find suitable copperbelly habitat. As you may know, wetlands are a valuable resource and are home to a rich assortment of plants and animals. Copperbelly habitat and wetlands in general are also vulnerable to human disturbance and land use activities, and have been significantly impacted and reduced in the state. Surveys for the copperbelly water snake will continue in 2002, in which previously known sites and new, potential sites will be examined. We may want to visit your property in the future, in which case we would contact you again to request permission.

We sincerely appreciate your cooperation with our efforts to understand more about this rare snake species. On behalf of all our staff who worked on this survey, especially, Matt Smar, Glenn Fox, and Kristin Wildman, thank you for helping us with our study. Please contact us if you have any questions about our work or if you have any information regarding copperbelly water snakes in your area.

Sincerely,

Yu Man Lee
Zoologist

Michigan Natural Features Inventory
P.O. Box 30444
Lansing, MI
48909-7944
(517) 373-1552
FAX: (517) 373-6705

MICHIGAN STATE
UNIVERSITY
EXTENSION

«Firstname» «Lastname»
«Address»
«City» «State» «Zipcode»

Dear «Firstname» «Lastname»,

Last summer, someone from our office contacted you requesting access to wetlands on your property to conduct surveys for the federally threatened and state endangered copperbelly water snake, its habitat and associated amphibians and reptiles. We would like to take this opportunity to thank you for allowing us access to your property during the months of May and June. We especially appreciated your willingness to allow our survey on very short notice.

Last May and June, we conducted surveys for the copperbelly water snake in southern Michigan as a part of a two-year study to gain a better understanding of this species' current status and distribution as well as habitat use in the state. This species was previously known from only thirteen sites in seven different counties in Michigan, and only several were considered to contain reproducing populations. Surveys last year focused on trying to reconfirm the species at or near previously known sites. The copperbelly water snake generally requires open, slow-moving or stagnant water with emergent vegetation or woody debris along the water's edge. This species is typically associated with floodplain forests, shrub swamps and scrub-shrub wetlands (often with buttonbush) next to lakes, ponds, and slow-moving rivers. These snakes also use adjacent upland forests during late summer, fall and winter

Overall, we surveyed a total of 31 different properties. Unfortunately, we were unable to confirm copperbelly water snakes at only two known sites. Copperbellies were mainly found along the emergent edge of small, open ponds and lakes and a relict buttonbush swamp. Other rare and/or declining species observed at the survey sites include the Blanding's turtle, eastern box turtle and northern leopard frog. We surveyed your land but did not find the copperbelly water snake or suitable habitat. However, as you may know, wetlands are a valuable resource and are home to a rich assortment of plants and animals. Wetlands also are vulnerable to human disturbance and land use activities, and have been significantly impacted and reduced in acreages in the state. We encourage you to help maintain this special habitat. Surveys for the copperbelly water snake will continue in 2002, in which previously known sites and new, potential sites will be examined

We sincerely appreciate your cooperation with our efforts to understand more about this rare snake species. On behalf of all our staff who worked on this survey, especially, Matt Smar, Glenn Fox, and Kristin Wildman, thank you for helping us with our study. Please contact us if you have any questions about our work or if you have any information regarding copperbelly water snakes in your area.

Sincerely,

Yu Man Lee
Zoologist

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Appendix B

Landowner Educational Materials

COPPERBELLY WATER SNAKE CONSERVATION

The copperbelly water snake (*Nerodia erythrogaster neglecta*) is a medium-to-large sized non-venomous snake with a dark (sometimes black) body and an orange, yellow, or red underside. Copperbelly water snakes are listed as endangered by the Michigan Department of Natural Resources (DNR) and threatened by the U.S. Fish and Wildlife Service (USFWS), and are protected by state and federal law.

Copperbelly water snakes are found in wet areas; streams, lakes, vernal ponds, and permanent wetlands are preferred habitats. From mid-April through early June they can oftentimes be seen in the morning and late afternoon basking in low-lying branches (typically 1-3 feet above the ground), on logs, or on debris near water. In late summer copperbellies can be found away from water where females give birth to their young.

Copperbelly water snakes superficially resemble several other snake species. Northern water snakes (*Nerodia sipedon*) are easily confused with copperbellies. An adult copperbelly will usually have a trace of orange coloration on the lip and throat region and will also lack the banding pattern typical of northern water snakes. The copperbelly water snake should also not be confused with the copperhead (*Agkistrodon contortrix*); copperheads do not occur in Michigan. Any sightings of a copperbelly water snake should be reported to the DNR.

An example of good copperbelly habitat. Notice the scrub-shrub vegetation that fills the stream bank and offers excellent cover for snakes.

An adult copperbelly water snake. Note the dark, mottled back and orange mouth and throat scales. (Photo coutesy of R.W. VanDevender)

Copperbelly Water Snake Conservation

The copperbelly water snake (*Nerodia erythrogaster neglecta*) is a medium-to-large sized non-venomous, stout-bodied snake, with adults averaging a total body length of 30 to 40 inches, attaining a maximum of 56 inches. Adult copperbelly water snakes are typically solid black or dark brown with a bright orange-red underside, or belly, and orange-red labial scales ("lips") characterizes. The young of the year are dark brown to black with saddle-like blotches alternating along the back and fusing into bands near the head. Coloration of the "saddles" is generally reddish brown with a thin, white outline, but may vary. The belly, chin, and labial scales have a pale orange coloration for young less than 20 inches long. Young average a length of 9 inches at birth. The underside of copperbellies can range from a light yellow-orange to an almost pink color. Also, the backsides of some adults may show slight traces of juvenile banding until the snake reaches sexual maturity.

A copperbelly water snake

A northern water snake with copperbelly coloration

Variation among a similar species, the northern water snake, will often lead to the false identification of northern water snakes as copperbellies. Many northern water snakes have extremely dark backs that may make it very difficult to see their characteristic banding. Northern water snakes can also have orange belly coloration, in some instances. However, northern water snakes will have a pattern of half-moon shapes down the length of its belly and a dark mottled pattern near the edges of the underside; copperbelly water snakes tend to have generally plain undersides.

A typical northern water snake

Copperbelly water snakes have also been confused with the northern red-bellied snake. This species has brown to dark gray back coloration with three light spots at the back of the head and a red underside brown to dark gray back coloration with three light spots at the back of the head and a red underside. Red-bellies are a much smaller species than the copperbelly water snake, with adults averaging eight to sixteen inches long. The Kirtland's snake, another endangered snake in Michigan, has a reddish belly and cream-colored labial scales. This snake could also be confused with a copperbelly, but Kirtland's snakes have a blotched pattern on the back and two rows of dots lining the edges of its underside. The copperbelly water snake should never be mistaken for a copperhead, which does not occur in Michigan.

Michigan Natural Features Inventory
P.O. Box 30444 – Lansing, MI 48909-7944
Phone: 517-373-1552

MICHIGAN STATE UNIVERSITY EXTENSION

Goods hallow wetland habitat for copperbellies

Copperbellies generally prefer wooded floodplains and scrub-shrub wetlands that are adjacent to lakes, ponds, and slow-moving rivers. Areas with sparse vegetation and clear, deep waters are avoided. Due to the relatively high mobility of this species, copperbelly water snakes will utilize various habitats throughout the seasons. During spring, these snakes are usually found in shallow ponds surrounded by lowland woods and shrubs. Woody vegetation and debris piles near the water provide the snakes with good basking sites. When seasonal ponds begin to recede in the summer, copperbellies will utilize wooded corridors to migrate to more permanent bodies of water. Winter hibernation sites may be located in felled tree-root networks, crayfish burrows, dense brush piles, fieldstone piles, muskrat and beaver lodges, and upland scrub-shrub woodland slopes in proximity to summer habitat. The copperbelly water snake requires large areas to accommodate its extensive range and movement patterns.

Good river habitat for copperbellies

Copperbelly water snakes usually enter hibernacula by early November where they stay inactive until they emerge in April. Mating usually occurs between April and June. During the day during spring and early-summer months, copperbellies are often found basking in low-lying branches, logs, or debris, foraging and traveling. As the days get hotter, snakes are more likely to be found during early morning and evening hours. Mid to late-summer activities usually center within forest and forest edges. Females give birth to their young during late summer to fall. These snakes will become inactive in the case of severe drought if more favorable conditions cannot be found elsewhere.

An adult copperbelly foraging

Copperbelly water snakes are listed as endangered by the Michigan Department of Natural Resources (DNR) and threatened by the U.S. Fish and Wildlife Service (USFWS), and are protected by state and federal law. Any sightings of a copperbelly water snake should be reported to the DNR.

MICHIGAN STATE
UNIVERSITY
EXTENSION

Copperbelly Water Snake
(*Nerodia erythrogaster neglecta*): Frequently Asked Questions

Is it poisonous?

No. Copperbelly water snakes are non-venomous snakes as are northern water snakes (*Nerodia sipedon sipedon*), a similar species in Michigan. The only venomous snake in Michigan is the eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*), another species of concern.

Does it bite?

This snake may strike if one attempts to capture it. The snake s first defense is to escape, usually heading toward or into a body of water.

Is it aggressive towards people and pets?

Copperbelly water snakes are an elusive species that will typically try to escape an encounter with a person or an outdoor pet. A copperbelly s first reaction to a threat tends to be retreating to the water. Although, if it is captured, the snake will typically attempt to strike and will often emit a milky anal secretion with an unpleasant odor as well. It is highly unlikely that a copperbelly water snake would ever pursue an encounter with people or pets.

How close will it come to my house and garden/yard?

Houses and manicured yards typically don t provide the kind of habitat preferred by copperbelly water snakes for foraging, mating, and hibernation. These snakes generally avoid areas lacking in vegetation and cover, such as a mowed lawn, and areas with much human activity. Copperbellies may be seen traveling across your yard to migrate to other suitable habitat.

What does it eat?

Prey for this species includes aquatic vertebrates, such as tadpoles, frogs, and salamanders and invertebrates, such as insect larvae and crayfish. Copperbelly water snakes tend to forage within the waters of emergent wetlands and swamps during the day.

What preys upon them?

Natural predators of copperbelly water snakes include skunks, raccoons, and raptors. These animals tend to prey on copperbellies when they are vulnerable, migrating across land.

How long do they live?

Information on the copperbelly water snake is lacking, but related snakes have been known to live from eight to fifteen years in captivity.

When are the young born?

Mating usually occurs in May and young are born in September or October. Copperbellies are live bearing and give birth to one to two dozen young. Young are born near or in winter hibernation sites and may immediately enter hibernation, staying inactive until the following spring.

Why is it threatened?

The primary threat to the existence of the copperbelly water snake population is loss of habitat, mainly due to human activities. Wide-spread wetland draining, residential development, agricultural

fields and farmland, roadways and traffic, and other such human activities which fragment the landscape in which copperbellies range are collectively responsible for their declining populations. The collection of snakes for pet trade as well as the indiscriminate killing of snakes in general has also impacted the species. Weather extremes such as drought, flooding, unusually mild and severe winters may have also influenced the copperbelly population at times.

Is it illegal to capture or kill them?

It is illegal to harm, pursue, wound, kill, trap, capture, or collect copperbelly water snakes. There are permits available to make allowances when used for scientific, educational, or zoological purposes, for propagation in captivity or other activities to ensure survival of the species.

What is MNFI and what happens with the survey information?

Michigan Natural Features Inventory (MNFI) is a partnership between Michigan State University Extension and the Wildlife Division of the Michigan Department of Natural Resources. MNFI conducts surveys for Michigan s unusual natural features, including rare plants and animals, unique geological features, and representative examples of Michigan s natural communities. Survey information is entered into a database that keeps track of the State s rare, declining, and endangered natural features and is used to determine the current status and distribution of rare species. Such information is essential to the decisions and processes involved in listing threatened and endangered species. This information also aids in the development of plans for conservation, protection, management, and public education of rare species, natural communities, and unique natural features.

What happens if one is found on my property?

If it is confirmed that a listed species is supported on your property, you will not be required to alter your property in any way. Such confirmations rarely impact landowners. MNFI will consult with landowners about ways they can improve the habitat on their land. If a landowner plans on initiating any projects on their property that require permits, the landowner will need to consult the US Fish and Wildlife Service and some State and Federal agencies to ensure that activities are minimizing negative impacts upon the species.

What can I do to help the copperbelly population?

Some ways property owners may help the copperbelly water snake population:

1. Protect and preserve the copperbelly water snake s existing wetland habitat
2. Preserve seasonal shrub swamps and pools
3. Leave or build debris piles near or within wetland habitat
4. Retain a wide vegetative zone along waterways
5. Restrict grazing along riparian shorelines from April to June
6. Minimize mowing in suitable habitat, around the edges of wetlands and water bodies
7. Selective cutting of wooded areas between November and March every 20 to 30 years to improve habitat conditions

What should I do if I see one?

If you observe a copperbelly water snake, contact the Michigan Department of Natural Resources and Michigan Natural Features Inventory. It is best to confirm the sighting with a photograph of the snake and/or confirmation from another experienced observer. Note the date, time, and location of the snake and the habitat in which it was found.

Michigan Natural Features Inventory, P.O. Box 30444, Lansing, MI 48909-7944, (517) 373-1552

COPPERBELLY WATER SNAKE SIGHTING DATA SHEET

The Michigan Natural Features Inventory is collecting data on recent sightings of the copperbelly water snake in an ongoing effort to determine the current distribution and trends of populations in Michigan. Please take time to fill out this data sheet and return it as soon as possible. Remember to include photo documentation whenever possible. If you have more than one location to report, please complete a separate sheet for each site.

Name_____ **Phone** _____

Address _____

Date of Sighting_____ **Number Observed** _____

Location: County _____ **Township, Range, Section, ¼-¼-¼ Sec.** _____
(Please be as specific as possible, and please include a map marking the site, if possible.)

Was this sighting made by you _____ or by another person _____ ? (Check one)

Was the snake dead _____ or alive _____ ? (Check one)
(If snake dead, if possible, please save for voucher specimen and deposit into appropriate institution.)

Rank your level of confidence in this identification (Check one):
Extremely Confident _____ Confident _____ Some Reservations ____

Features used in identifying the sighted snake as a copperbelly (Check all that apply):
Dorsal Coloration _____ Belly Coloration_____ Mouth/Chin Coloration_____ Pattern_____
Other _____

Documentation? (Check all that apply): Photo _____ Specimen _____ Expert Verification ____

Have copperbellies been sighted at this site other times since 1989? If so, when and how many individuals? (Attach another sheet if necessary.) _____

Description of Habitat (including both the specific site and the surrounding area):_____
_____

Estimated Area of Copperbelly Habitat at this Site: _____

Surrounding Land Uses: _____

Threats to Site: _____

Landowner: _____

Please return to: Michigan Natural Features Inventory
4th Floor Mason Bldg., P.O. Box 30444, Lansing, MI 48909-7944.
Telephone: 517/373-1552 FAX: 517/373-9566

Copperbelly water snake brochure

How Can You Help the Copperbelly?

- Learn how to identify the snake
- If you find one, please remember that because of their endangered status in Michigan, Ohio, and Indiana, it is illegal to harm, pursue, wound, kill, trap, capture, or collect individuals
- Help us educate others about the snake
- Protect existing wetlands, adjacent uplands, and connecting corridors
- Preserve seasonal shrub swamps
- Leave or build debris piles near or within wetlands
- Maintain natural vegetation along waterways
- Minimize mowing and grazing around shoreline and riparian areas, especially from April to June
- Selectively cut woodlands between November and March to provide sunny habitat.
- Maintain water quality of wetland habitats
- Minimize dredging, especially between April and October

For more information, or to report a Copperbelly Water Snake sighting, please contact:

Michigan Natural Features Inventory
P.O. Box 30444
Lansing, MI 48909-7944
Phone: 517/373-1552
www.dnr.state.mi.us/wildlife/heritage/mnfi

Indiana Department of Natural Resources
Division of Fish and Wildlife
402 W. Washington St.
Indianapolis, IN 46204-2782
Phone: 317/232-4080
www.in.gov/dnr/

Ohio Department of Natural Resources
Division of Wildlife
1840 Belcher Drive, Building G
Columbus, OH 43224-1329
Phone: 614/265-6300
www.dnr.state.oh.us/wildlife/

Thank you for helping the Copperbelly Water Snake.

Funding was provided by the U.S. Fish and Wildlife Service, and the Michigan Department of Natural Resources Nongame Wildlife Fund.

This brochure was produced by the Michigan Natural Features Inventory, Michigan State University Extension. Review by the Indiana Department of Natural Resources and the Ohio Department of Natural Resources.

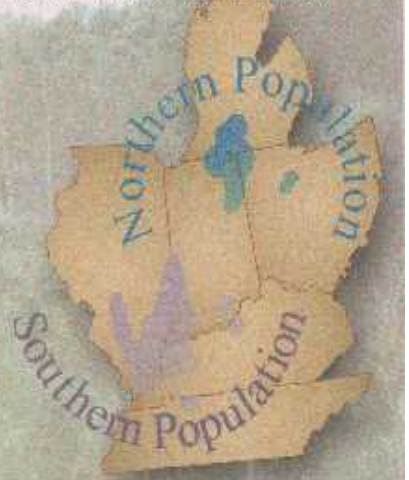
Design by Interpretive Ideas, Okemos, Michigan

Copperbelly Water Snake

Conservation and Recovery

MICHIGAN STATE UNIVERSITY EXTENSION

The Copperbelly Water Snake is a large non-venomous snake, found primarily in southwestern Indiana and adjacent Illinois and Kentucky. A few isolated populations exist in southern Michigan, northeastern Indiana, and northwestern Ohio. This makes up the Northern Population. The Copperbelly Water Snake may have settled this far north thousands of years ago when the climate was warmer and wetter.



The Northern Population of the Copperbelly Water Snake has declined due to habitat loss. As a result, the Copperbelly Water Snake is listed as an Endangered Species in Michigan, Ohio, and Indiana. The Northern Population is Federally Threatened.

It is crucial that we understand the Copperbelly Water Snake and identify its remaining populations. By doing so, we can help save the remaining snakes.

What do they look like?

The adult Copperbelly is 26" to 56" in length and uniformly black, gray, or dark brown on its back. The snake's unpatterned belly can range from pale orange or red, to coppery red.





A young Copperbelly is dark brown to black with saddle-like markings along its back. The markings are reddish brown with a thin, white outline. Young are about 8" - 12" at birth, and acquire their adult appearance by the time they reach 30".

The Copperbelly has been confused with:



Northern Water Snake *Queen Snake* *Kirtland's Snake*

Unlike the Copperbelly Water Snake, all three have markings on their belly.

Northern Red-bellied Snake

Unlike the Copperbelly Water Snake, the Northern Red-bellied Snake rarely exceeds 12"

Habitat Cycle

Generally, the Copperbelly is found in wooded floodplains and scrub/shrub wetlands adjacent to lakes, ponds and slow moving rivers. The Copperbelly, however, also uses different habitats during different seasons.

Spring: April - June
Migrates from hibernating sites to edges of shallow ponds and willow-buttonbush swamps. Frequently basks during the day on woody debris, shoreline vegetation, and muskrat lodges. Mating occurs during the spring.

Summer: July - August
Migrates through dry grassy or wooded corridors to permanent waters and forests. Most active in morning and evening.

Winter: November - April
Hibernates in upland and floodplain forests near wetlands in crayfish burrows, debris piles, felled tree root networks, or rock piles.

Fall: September - October
Migrates to upland areas for hibernation. Females give live birth in September and October to 8-37 young.

Under pressure

Due to its need for a variety of habitats and pathways connecting them, the Copperbelly Water Snake is very vulnerable. Habitat loss from wetland draining and residential development decreases the snake's chances for survival. Traveling between areas puts the snake at further risk from increased road traffic, predators, and human persecution.

Food Chain

The Copperbelly Water Snake is an important player in a well-balanced ecosystem.

Prey

Frogs, tadpoles, salamanders, crayfish

Copperbelly Water Snake

Predators

Large fish, snapping turtles, hawks, opossums, raccoons, foxes, otters, coyotes

Appendix C

Survey Protocol for Copperbelly Water Snakes

A SURVEY PROTOCOL FOR COPPERBELLY WATER SNAKES (*NERODIA ERYTHROGASTER NEGLECTA*) FROM NORTHERN POPULATIONS

Bruce Kingsbury, Indiana-Purdue University

In order to increase the value and compatibility of surveys for the copperbelly water snake by different individuals, we suggest the following protocol and datasheet. If surveyors are consistent in their approach, we may be able to use the information they collect in more sophisticated ways than simply stating whether or not copperbellies were found. Adhering to such guidelines will also strengthen the implication of surveys where no copperbellies are observed.

Surveys are conducted for different reasons, and the stringency of the survey effort will be dependent upon those reasons. Copperbelly detectability is extremely variable, depending on the set of conditions at a particular time. Thus, while any discovery of copperbellies at a site implies that they are resident there, negative findings from surveys not adhering to the restrictions detailed in this document are inconclusive. Furthermore, residency does not imply viability. If copperbellies are relatively abundant in an area and are searched for as suggested below, then they should be found within several hours. On the other hand, if a small (<100 ha), isolated, wetland complex is examined by an experienced copperbelly surveyor as directed here for 10 or more hours spread out over three or more different days, and no copperbellies are observed, then it is reasonably certain that they do not occur in the area. Such an approach should be taken in those cases where excellent habitat remains at a site and the intent is to establish with a high level of certainty whether or not the snakes are present. In large-scale status surveys where numerous areas are being examined, such extensive efforts at each wetland may be prohibitive. If a low level of omission error is acceptable, then I would recommend that sites be visited at least twice, and hopefully three times, for a cumulative survey time of five or more hours under good conditions. Negative findings of such an effort indicate at least that copperbellies are not common in an area. The goals of a survey and available funds will ultimately need to drive the intensity of the effort.

To minimize the impact of environmental and seasonal conditions, surveys should only be conducted on partly sunny days of at least 20 C (68 F), or sunny days between about 18 and 30 C (65-86 F). Surveys should also only be conducted while the sunlight would be able to strike the ground in the survey area (roughly 9-5). These constraints will maximize the chances of seeing snakes out basking and traveling. Also, as the weather turns hot, surveys should be conducted in early morning and late afternoon to avoid hot temperatures that drive the snakes into cooler microhabitats. The best time to see copperbellies is mid-April through the end of May, when water temperatures are not too great and vegetation has not leafed out. Surveys conducted later in the season with negative results are inconclusive.

Copperbellies are very mobile and can be found in all sorts of habitat in and around wetlands, but they should be sought in specific habitats to maximize the chance of seeing them. Empirical evidence shows that copperbellies prefer 1) the edge habitat between open canopy areas, such as shrub-scrub wetlands, and forest, to bask and rest, and 2) extremely shallow waters (<10 cm (4”)), to forage. They do not spend much time in open, deep water (>30 cm), or moving water. However, they are often seen basking on platforms over deeper water, and will not hesitate to swim across open areas. They are not routinely seen in forest, but sometimes can be found at isolated pools of water. Surveyors are most likely to find stationary snakes basking on horizontal surfaces just above the water, such as on nearly sunken logs or branches, or a little higher on living branches of bushes such as buttonbush (Cephalanthus occidentalis). Foraging snakes may be seen cruising shorelines. Ripples on the water’s surface may also indicate the presence of a foraging or traveling snake, and should be investigated.

If the goal of the survey is simply to try to find copperbellies at a site, then a group of surveyors may be the most effective means of finding them. On the other hand, if the intent is also to quantify observations so that findings can be compared between sites, especially where the differences between them are relatively subtle, then methodology will have to be more strictly defined.

A quantifiable approach is to measure observations per survey effort, such as snakes per km, or per hour. Surveys are conducted by traveling the survey path (transect) and counting the snakes seen over a known time and estimated distance. Surveyors should move slowly and cautiously with frequent stops (pauses) of one or more minutes to scan both sides of the transect for snakes. The duration of pauses is left to the discretion of the surveyor, but should be long enough to allow careful examination of the field of view before moving on. An initial suggestion for distance to move between pauses when surveying wetlands is 20 paces. On the other hand, searching in forest, which is not anticipated to be very productive and mostly transitional between wetlands, may just be a slow walk. Transect length will be approximated as accurately as possible using an aerial photograph or topographical map. The time will be recorded at the beginning and end of the transect, as well as each time the *Macrohabitat* type, as defined by the attached Habitat Classification, changes. Habitat shifts should be marked on the map as well.

Surveyors should always bring binoculars and use them. They are *vital* for examining complex habitats such as brush, and for properly identifying snakes to species. You *will* miss snakes if you do not use binoculars to scan ahead. A watch is needed for timing transects. Surveyors will also need to consider footwear. Hip or chest waders may keep you dry, but are tiring to wear for any length of time, and can get hot. Pull-on farm boots work okay unless there is any flooding. Once the water has warmed, I just go ahead and get wet, wearing “Army” boots to protect my feet. Use pencil to keep your notes- pen will smear and run if it gets wet, erasing your data. Ziplock bags are good for keeping things dry. Cell phones are also a plus.

Data Sheet Explanation

At the top of the data sheet, Date, *Site*, Surveyors, and Weather Summary are filled out prior to beginning the survey. *TimeBeg* is entered when the survey actually begins. *TimeEnd* is entered when the survey is suspended. Times should be recorded in military time (1200 is 12 noon, 1400 is 2PM).

Weather Summary comments include air temperature, cloud cover, wind, etc. Air temperature (*Tair*) is taken with the thermometer held at about waist height with the bulb shaded (by your hand is fine). Substantive changes in the weather during surveys should be indicated on data rows between observations. TransectL is an estimate of the total transect length. Length should be recorded in meters. Additionally, a line is provided to summarize your observations for numbers of selected snake species.

Snake Observations and Habitat Shifts

The codes for data entries are described in the survey code descriptions provided below. The last column is for brief or coded additional comments. In the field, comments can also be inserted on the data row(s) beneath the relevant observation. If habitat changes during the length of the transect, times and lengths of subtransects should be recorded by habitat. Time is when you start a new habitat classification, Elapsed Time is the number of minutes spent surveying the previous habitat. This should be entered on the first record line for the habitat. Species of snake is coded. Your comments should include mention of other species observed. This column is also used to measure the subtransect length (*TransectL*) if you switch macrohabitats. As with the elapsed time, the subtransect length should be placed on the initial row for that macrohabitat. Where necessary, you can figure that out elapsed time and subtransect length later. AgeClass is the apparent age class of the snake. Keep in mind that male copperbellies are often substantially smaller than the females. Behavior is the activity of the snake at time of observation. If you have disturbed it and don’t know, don’t speculate.

Shore is the distance (in meters) the snake is from shore (distance to shore will be negative for terrestrial observations). *Depth* is the apparent depth (in meters) of the water at the snake’s location. Macrohabitat and Microhabitat are coded as indicated in the attached habitat classification (based on a simplification of Cowardin et al.’s wetland classification system). The code should be strictly adhered to, and deviation from the code should be well documented with comments.

Comment Code is space for symbol to link to comments made below. For example, "A" would relate to comments next to "A" in the comments area. Use the Comments section to make initial notes on any details about the survey site. Additional comments can be made there as you go or on data rows between observations. Surveyor comments will be used to help establish habitat extent and quality throughout the range of the snake, so surveyors are encouraged to make detailed notes of their surroundings (including apparent condition of water and abundance of prey).

A final note: pursuit of individual snakes may not only be illegal for some surveyors, it will also disrupt the continuity of the survey. Snakes should be approached only to the extent that species identification is certain. Which brings up another point: many individual northern water snakes may look quite a bit like copperbellies, especially along the border between Ohio and Michigan. Be careful in making your assignments to species. The most certain diagnostic on adults is the lack of any crescents on the belly. Very young northerns and copperbellies look very similar dorsally, but the presence/absence of crescents still holds.

SURVEY CODE DESCRIPTIONS

Macrohabitat

This classification was designed to be suitable for studying habitat use by the copperbelly in the northern populations. It is therefore not intended to be an exhaustive classification scheme. Wetland components are intended to be relatively compatible with the National Wetlands Inventory (NWI) classification developed by Cowardin et al. (1979). "Macrohabitat" as used here is a large-scale measure. Distinct areas less than about 10 meters in diameter should just be incorporated into the surrounding habitat type. A patch of a few buttonbush in the middle of a forest is still forest. Microhabitat will be used to indicate finer levels of selection.
IMPORTANT: For the purposes of these surveys, when working along the margin between habitat types, we default the habitat classification to the more open side of the macrohabitat. For example, if you are surveying along a PFO/PSS boundary, you mark that as PSS. If your route takes you into just PFO, then PFO is what you write down.
PFO Palustrine Forested Wetland: has standing water and tree canopy cover exceeding 30%.
PSS Palustrine Scrub-shrub: shrub cover exceeds 30%, but tree cover does not.

PFS Palustrine Forest/shrub: areas where trees are interspersed with the shrubs, such that *both* trees and shrubs are "co-dominant" in representation.

PEM Palustrine Emergent: vegetation present (cats, etc.) but not enough shrubs to be considered PSS.
POW Palustrine Open Water: shallow wetland systems with little or no vegetation present. Note: moist soil units should be commented as such, but would be classified as PEM or POW.
LIM Lacustrine Open Water: deep water (>2m) of lakes.
LIT Littoral (shoreline) zone of lakes.
UFO Upland Forest: greater than 30% canopy cover by trees, elevated above any potential flooding by sloping topography
USS Upland Scrub-Shrub: extensive areas of berry bushes, willows, crab apples and hawthorns.
OLD Oldfield: fallow fields well covered with herbaceous or grassy cover. CRP lands would often be included here
FRM Crops: farm fields, croplands
GRZ Grazed: grazed or mowed areas
RES Residential: all space used for living by people

Microhabitat Classification

Microhabitat classification is somewhat similar to habitat, but on a smaller scale. Its use as a category allows the specific position (substrate) of the animal to vary to some degree from its general surroundings.

Shrub -up in a bush
Tree -up in a tree
Herbaceous -in a patch of herbs
Water -in the water

Grass -in a patch of grass
Rock -on a rock or rocks
Log -on a log
Bare -on bare soil
Island -on a small hummock
Detritus -on leafy debris

Behavioral Classification

Basking -at rest in sunny location
Resting -resting in non-basking position
Courting -male pursuing female, female, being pursued by male
Mating -actually copulating (much less likely than courting)
Foraging -moving slowly and methodically through shallow water or on shore
Traveling -moving continuously in linear path, with little investigative behavior along the way
Unknown -behavior ambiguous or snake disturbed before behavior observed: something that happens all the time

Miscellaneous

Species: **CWS**- copperbelly (N.e. neglecta), **NOR**- northern water sake (N. sipedon), **EGS**- eastern garter snake (*T. sirtalis*), **UNK**-unknown. Other species can just be written out. Age class: **Y** = yearling, only about 20 cm long with distinct, **S** = subadult, losing juvenile markings, but not more than about 2/3 meter in total length. **A** = adult.

Appendix D

MNFI Copperbelly Survey and Habitat Evaluation Data Forms

COPPERBELLY SURVEY SHEET

Date:		County:		Site:		Landowner:					
TimeBeg:		Surveyor(s):									
TimeEnd:				Beg Tair:		Sun:		Wind:			
Duration:		Weather Summary:		End Tair:		Sun:		Wind:			
TransectL:											
SUMMARY: # of		CWS:		NOR:		EGS:		NRS:			

Time	New Macrohab	Macrohab/ NWI Code	GPS Waypt.	Elapsed Time (min)	TransectL/ Species	AgeClass	Behav	Distance to Shore (m)	Depth (m)	Microhab	Comment Code
	Macros: PFO, PSS, PEM, POW, LIM, LIT, UFO, USS, OLD, FRM, GRZ, RES				B, R, C, M, F, T	meters	meters	**Micros:** S, H, T, W, G, B, R, I, L, D		Include plant species	

COMMENTS (Draw site map showing macrohabitats and transects on back):

COPPERBELLY WATER SNAKE HABITAT EVALUATION

Date:_____ Site:_____

Community:_____

Habitat Description
D=Dominant or Co-dominant; A=Abundant; C=Common; O=Occassional; U=uncommon;
L=Locally, as in LD, Locally Dominant; LA, Locally Abundant; or LC, Locally Common

Code: Ground Cover (% cover)

Code: Understory (% cover)

Overstory (% cover)

Soil Type:_____ pH:_____ Litter Depth:_____
Water Conductivity:_____
Water Depth:_____

Describe Habitat:_____

Estimate extent of community and overall habitat:_____

Describe and Rank Landscape Context (Low, Medium, High), comment on surrounding landuse: _____

Natural Community Quality and Viability (comments and rank: Low, Medium, High): _____

COPPERBELLY WATER SNAKE THREATS

Date:_____ Site:_____

Community:_____

Exotic Plants:
D, Dominant or Co-dominant; A, Abundant; C, Common; O, Occassional; U, uncommon;
L, Locally; as in LD, Locally Dominant; LA, Locally Abundant; or LC, Locally Common

	Abundance	**Location**
Phalaris arundinacea		
Phragmites australis		
Typha angustifolia		
Lythrum salicaria		
Rhamnus frangula		
Rhamnus cathartica		
Lonicera morrowii		
Other:		

Hydrologic Alteration:

Type **Comments**

- Drainage ditch draining wetland:_____
- Drain tiled: _____
- Surface water flow into wetland from farm field or development (roads, culverts etc.):_____
- Surface run-off into wetland from non-native upland system (erosion):_____
- Excessive draw-down of aquifer:_____
- Water control structures present (dams, pumps etc.): _____

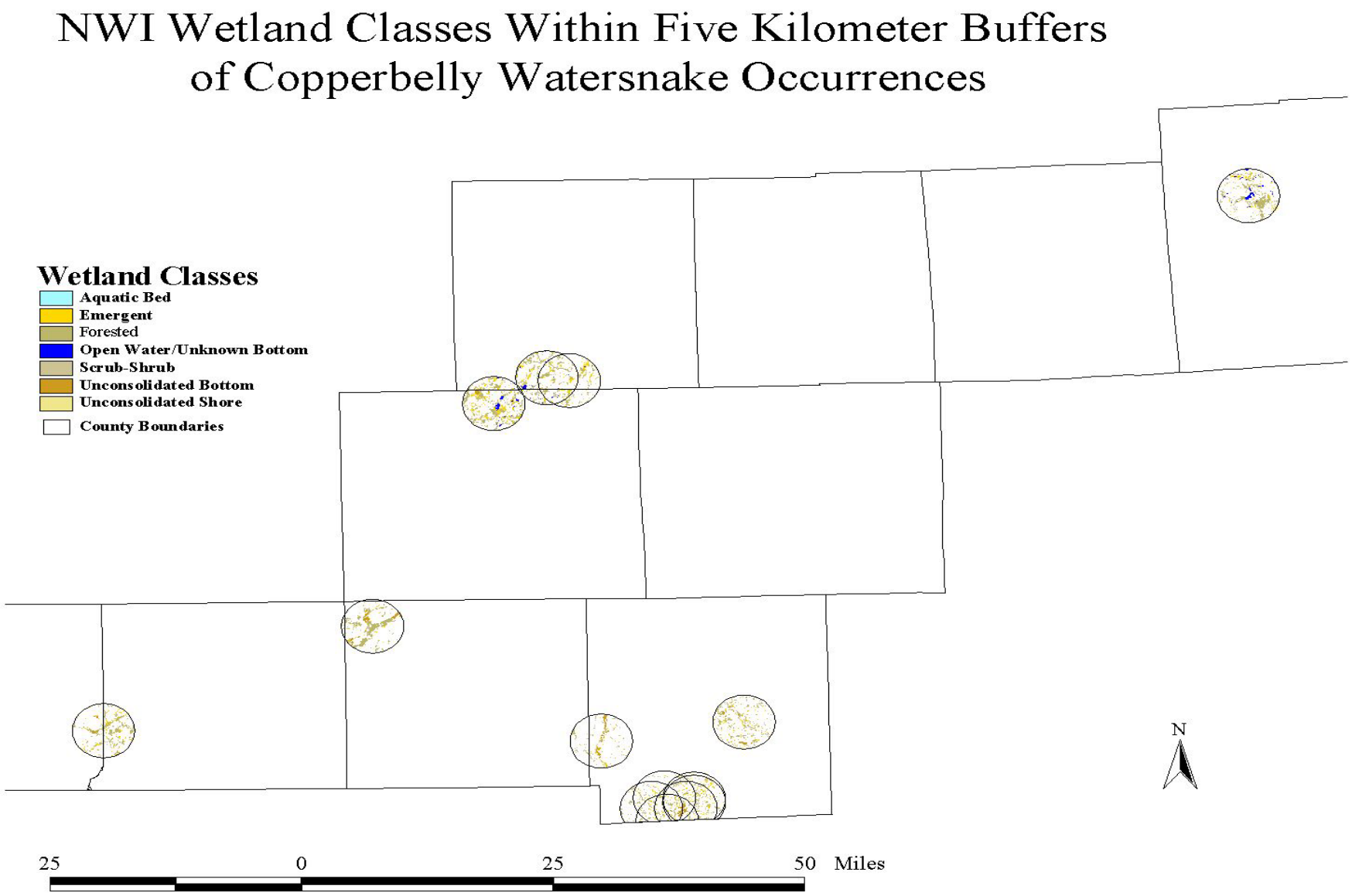
Habitat Destruction/Disturbance

Habitat Manipulation:
Mowing:_____
Water level manipulation:_____
Grazing:_____

Soil Erosion: _____

Appendix E

Example of landscape-level habitat analysis using NWI wetland classes and 5-km buffers



Appendix F

Summary of Copperbelly Water Snake Occurrences in Michigan and Results of 2001 Copperbelly Surveys

County	EO Number	First Observed	Last Observed*	Survey Dates	No. of Parcels Surveyed	Survey Results**
Hillsdale	.001	1959	1983	5/31, 6/11, 6/12, 6/13	2	1 EGS
	.005	1978	1996	5/1, 5/29, 6/7, 10/1	1	**2 CWS**, 4 NOR, 1 EGS, 2 NRS
	.007	NA	1982	5/17, 5/30, 6/8	3	None observed
	.008	1952	1983	5/14, 5/17, 5/21, 5/22, 5/23, 5/28, 5/31, 6/7, 6/8, 6/9-8/13, 8/18, 8/25, 9/9, 9/29, 10/2, 10/3, 10/8	10	Surveys: **7 CWS** on 2 properties, 39 NOR, 7 NRS Monitoring: **67 CWS** obs., 165 NOR obs., 30 NRS, 14 EGS Made up of diff. areas.
	.009	1982	1982	5/2, 5/3, 6/4, 6/11	1	6 EGS, 7 NOR, 2 NRS
	.010	1983	1997	6/7	1	None observed; recent (post-1997) reports of CWS
	.011	1989	1989	5/8, 5/14, 5/15, 5/19, 5/21, 5/29, 6/7, 6/8	4	11 NOR, 1 NRS, 1 BRS
	.014	1989	1989	Surveyed with EO .011		Merged with EO .011
Cass / St. Joseph	.002	1963	1989	5/10	1	None observed except 1 E. box turtle
Branch	.012	1987	1987	6/10, 6/14	2	None observed
Calhoun	.013	1992	1992	5/20, 6/18	1	None observed except painted turtles
Eaton	.003	1933	1959	Did not survey		
	.004	1959	1959	5/9, 5/13, 6/18	1	3 NOR
Oakland	.006	1963	1963	6/8, 6/9	5	2 EGS

* Date of last observation of copperbelly water snake prior to 2001 surveys.
** Survey Results: CWS = copperbelly water snake, NOR = northern water snake, NRS = northern ribbon snake, EGS = eastern garter snake, BRS = brown snake
NA = Not available.

Appendix G

Summary tables with preliminary results of landscape-level habitat analyses

Changes in Wetlands Within One Kilometer of Copperbelly Water Snake Element Occurrences								
	No Change in Wetland		Wetland Loss		NWI wetland but not		Not Wetland	
EO Number	Area (Ha)	% Total Area	Area (Ha)	% Total Area	Area (Ha)	% Total Area	Area (Ha)	% Total Area
001	45.5	14.5%	37.8	12.1%	3.6	1.2%	225.8	72.2%
002	60.4	19.3%	10.4	3.3%	37.7	12.1%	203.9	65.3%
003	41.2	13.2%	15.6	5.0%	39.1	12.5%	216.4	69.3%
004	42	13.4%	54.5	17.4%	8.4	2.7%	207.9	66.5%
005	2.2	1.4%	2.6	1.7%	9.4	6.2%	138.1	90.7%
006	107.5	34.3%	26.8	8.6%	12.6	4.0%	166	53.0%
007	35.3	11.3%	53	16.9%	7.2	2.3%	217.4	69.5%
008	10.7	3.4%	14.4	4.6%	16.1	5.2%	271.5	86.8%
009	20.3	6.5%	8.4	2.7%	57.9	18.5%	225.8	72.3%
010	24.4	7.8%	36.3	11.6%	14.5	4.6%	237.9	76.0%
011	62.5	20.0%	10.5	3.4%	23	7.3%	217	69.3%
012	190.3	60.9%	30.4	9.7%	8.4	2.7%	83.5	26.7%
013	86	27.6%	25.7	8.3%	23.2	7.5%	176.7	56.7%
014	29.9	9.6%	41.2	13.2%	15.6	5.0%	226.2	72.3%

Changes in Wetlands Within Five Kilometers of Copperbelly Water Snake Element Occurrences								
	No Change in Wetland		Wetland Loss		NWI wetland but not		Not Wetland	
EO Number	Area (Ha)	% Total Area	Area (Ha)	% Total Area	Area (Ha)	% Total Area	Area (Ha)	% Total Area
001	430.1	5.5%	388.4	5.0%	206.6	2.6%	6790	86.9%
002	825	10.6%	481.2	6.2%	335.9	4.3%	6169	79.0%
003	774.8	9.9%	581.3	7.4%	627.8	8.0%	5829	74.6%
004	457.8	5.9%	460.5	5.9%	574.5	7.4%	6320	80.9%
005	310.6	8.0%	279.8	7.2%	186.1	4.8%	3115	80.0%
006	1064	13.6%	499.9	6.4%	469.3	6.0%	5781	74.0%
007	379.9	5.0%	546.2	7.2%	358.5	4.7%	6283	83.0%
008	349.7	5.6%	518.4	8.3%	246.9	4.0%	5120	82.1%
009	773.4	9.9%	715	9.2%	373.7	4.8%	5951	76.2%
010	512.8	7.4%	593.7	8.6%	328.5	4.7%	5496	79.3%
011	454.1	7.5%	537.9	8.9%	285.4	4.7%	4782	78.9%
012	1080	13.8%	409.9	5.2%	392	5.0%	5931	75.9%
013	1806	23.1%	615	7.9%	509.3	6.5%	4880	62.5%
014	515.3	7.0%	621.1	8.4%	354.5	4.8%	5862	79.7%

NWI Wetland Types Within One Kilometer of Copperbelly Water Snake Element Occurrences

EO Number	Emergent		Forested		Scrub-Shrub		Unconsolidated Bottom		Open Water / Unknown Bottom		Aquatic Bed		Uplands	
	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total
001	7.6	2.4%	4.3	1.4%	21.1	6.7%	15.9	5.1%	0.0	0.0%	0.0	0.0%	264.0	84.4%
002	17.2	5.5%	67.6	21.6%	10.1	3.2%	3.0	1.0%	0.0	0.0%	0.0	0.0%	214.4	68.7%
003	8.4	2.7%	61.6	19.7%	10.1	3.2%	0.0	0.0%	0.0	0.0%	0.3	0.1%	232.6	74.3%
004	27.4	8.8%	18.7	6.0%	4.1	1.3%	0.0	0.0%	0.1	0.0%	0.0	0.0%	262.1	83.9%
005	0.6	0.4%	3.2	2.1%	0.2	0.1%	7.8	5.1%	0.0	0.0%	0.0	0.0%	140.5	92.2%
006	6.9	2.2%	7.3	2.3%	19.9	6.4%	0.0	0.0%	85.8	27.4%	0.0	0.0%	192.6	61.6%
007	6.4	2.0%	35.6	11.4%	0.5	0.1%	0.2	0.1%	0.0	0.0%	0.0	0.0%	270.1	86.4%
008	5.8	1.8%	17.8	5.7%	0.7	0.2%	2.2	0.7%	0.0	0.0%	0.0	0.0%	285.9	91.5%
009	27.6	8.8%	24.9	8.0%	24.0	7.7%	1.4	0.5%	0.0	0.0%	0.4	0.1%	234.1	74.9%
010	3.2	1.0%	22.3	7.1%	10.1	3.2%	3.4	1.1%	0.0	0.0%	0.0	0.0%	273.7	87.5%
011	7.7	2.4%	8.6	2.7%	0.5	0.1%	68.7	22.0%	0.0	0.0%	0.0	0.0%	227.3	72.7%
012	11.7	3.7%	159.6	51.0%	27.2	8.7%	0.3	0.1%	0.0	0.0%	0.0	0.0%	114.0	36.5%
013	16.4	5.2%	19.9	6.4%	18.5	5.9%	2.9	0.9%	52.5	16.8%	0.0	0.0%	202.6	64.8%
014	9.9	3.2%	21.3	6.8%	8.6	2.8%	5.3	1.7%	0.0	0.0%	0.0	0.0%	267.7	85.6%

NWI Wetland Types Within Five Kilometers of Copperbelly Water Snake Element Occurrences

EO Number	Emergent		Forested		Scrub-Shrub		Unconsolidated Bottom		Open Water/ Unknown Bottom		Aquatic Bed		Uplands	
	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total
001	108.4	1.4%	234.4	3.0%	100.2	1.3%	192.9	2.5%	0.0	0.0%	0.3	0.0%	7179.3	91.9%
002	274.0	3.5%	664.7	8.5%	105.0	1.3%	108.6	1.4%	0.0	0.0%	5.1	0.1%	6654.2	85.2%
003	351.5	4.5%	644.8	8.3%	324.7	4.2%	0.0	0.0%	76.2	1.0%	4.9	0.1%	6410.4	82.1%
004	355.4	4.5%	471.0	6.0%	193.0	2.5%	0.0	0.0%	11.1	0.1%	2.4	0.0%	6780.3	86.8%
005	79.9	2.1%	238.0	6.1%	33.3	0.9%	145.4	3.7%	0.0	0.0%	0.5	0.0%	3397.9	87.2%
006	274.7	3.5%	661.7	8.5%	396.4	5.1%	0.0	0.0%	197.6	2.5%	2.9	0.0%	6280.7	80.4%
007	173.1	2.3%	384.5	5.1%	27.8	0.4%	152.9	2.0%	0.0	0.0%	0.5	0.0%	6830.6	90.2%
008	113.7	1.8%	343.1	5.5%	36.6	0.6%	103.2	1.7%	0.0	0.0%	0.9	0.0%	5641.1	90.4%
009	231.5	3.0%	443.9	5.7%	312.0	4.0%	159.0	2.0%	0.0	0.0%	1.6	0.0%	6667.8	85.3%
010	213.1	3.1%	371.3	5.4%	96.8	1.4%	159.7	2.3%	0.0	0.0%	0.5	0.0%	6091.7	87.9%
011	168.4	2.8%	351.5	5.8%	65.3	1.1%	154.1	2.5%	0.0	0.0%	0.5	0.0%	5322.6	87.8%
012	131.9	1.7%	939.3	12.0%	129.2	1.7%	271.4	3.5%	0.0	0.0%	1.1	0.0%	6342.0	81.2%
013	669.3	8.6%	991.4	12.7%	400.1	5.1%	95.1	1.2%	153.8	2.0%	5.5	0.1%	5496.8	70.4%
014	226.8	3.1%	388.3	5.3%	97.8	1.3%	156.2	2.1%	0.0	0.0%	0.5	0.0%	6482.1	88.2%

Note: One occurrence, 013, contained 1.3 Hectares of unconsolidated shore. This area is less than 0.01% of the total area.

IFMAP Landcover Classes in One Kilometer Buffers

EO Number	001		002		003		004		005		006	
	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total
Low Intensity Urban	4.32	1.38%	6.48	2.07%	0.90	0.29%	0.90	0.29%	0.72	0.47%	8.64	2.76%
High Intensity Urban \ Roads	12.60	4.03%	6.21	1.99%	6.66	2.14%	6.39	2.07%	3.24	2.13%	14.04	4.49%
Row \ Forage Crops	137.25	43.90%	73.71	23.58%	189.90	61.07%	226.53	73.51%	7.83	5.14%	3.60	1.15%
Herbaceous Openland	19.89	6.36%	38.43	12.29%	6.57	2.11%	13.14	4.26%	21.60	14.18%	49.95	15.97%
Upland Shrub	2.34	0.75%	2.43	0.78%	2.52	0.81%	4.50	1.46%	5.40	3.54%	3.42	1.09%
Upland Deciduous	33.84	10.82%	75.42	24.12%	17.91	5.76%	24.30	7.89%	81.81	53.69%	87.93	28.11%
Upland Conifer	20.16	6.45%	4.50	1.44%	0.99	0.32%	0.45	0.15%	2.43	1.59%	9.54	3.05%
Upland Mixed	6.12	1.96%	2.88	0.92%	0.81	0.26%	0.81	0.26%	4.50	2.95%	5.13	1.64%
Open Water	7.56	2.42%	0.27	0.09%	0.00	0.00%	0.00	0.00%	0.36	0.24%	84.15	26.90%
Lowland Deciduous \ Conifers	18.99	6.07%	51.57	16.49%	51.48	16.56%	12.60	4.09%	3.42	2.24%	16.29	5.21%
Non-forest Wetland	47.34	15.14%	50.67	16.21%	32.94	10.59%	18.54	6.02%	20.16	13.23%	28.62	9.15%
Sand \ Bare Soil	0.27	0.09%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.09	0.03%
Mud Flats	1.98	0.63%	0.09	0.03%	0.00	0.00%	0.00	0.00%	0.90	0.59%	1.44	0.46%
Other Bare \ Sparsely Vegetated	0.00	0.00%	0.00	0.00%	0.27	0.09%	0.00	0.00%	0.00	0.00%	0.00	0.00%

EO Number	007		008		009		010		011		012	
	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total
Low Intensity Urban	1.53	0.49%	3.33	1.07%	2.07	0.66%	2.25	0.72%	7.11	2.27%	1.53	0.49%
High Intensity Urban \ Roads	8.73	2.79%	5.85	1.87%	3.96	1.27%	9.27	2.96%	21.69	6.94%	8.64	2.77%
Row \ Forage Crops	169.29	54.11%	165.33	52.89%	10.80	3.45%	87.93	28.09%	80.19	25.64%	59.67	19.13%
Herbaceous Openland	16.56	5.29%	29.79	9.53%	29.70	9.50%	34.29	10.95%	40.59	12.98%	14.13	4.53%
Upland Shrub	4.32	1.38%	3.33	1.07%	3.69	1.18%	12.96	4.14%	8.64	2.76%	0.90	0.29%
Upland Deciduous	47.52	15.19%	55.35	17.71%	141.03	45.09%	91.35	29.18%	46.08	14.73%	22.50	7.22%
Upland Conifer	0.63	0.20%	1.26	0.40%	14.40	4.60%	4.86	1.55%	0.36	0.12%	2.61	0.84%
Upland Mixed	0.90	0.29%	2.07	0.66%	14.67	4.69%	5.58	1.78%	1.80	0.58%	1.44	0.46%
Open Water	0.00	0.00%	0.00	0.00%	0.00	0.00%	1.08	0.35%	41.85	13.38%	0.00	0.00%
Lowland Deciduous \ Conifers	23.76	7.59%	15.12	4.84%	39.78	12.72%	14.85	4.74%	7.65	2.45%	131.58	42.19%
Non-forest Wetland	39.51	12.63%	31.05	9.93%	52.47	16.78%	47.79	15.27%	46.89	14.99%	68.85	22.08%
Sand \ Bare Soil	0.00	0.00%	0.09	0.03%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Mud Flats	0.00	0.00%	0.00	0.00%	0.18	0.06%	0.81	0.26%	9.81	3.14%	0.00	0.00%
Other Bare \ Sparsely Vegetated	0.09	0.03%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.09	0.03%	0.00	0.00%

IFMAP Landcover Classes in One Kilometer Buffers

EO Number	013		014	
	Area (Ha)	% Total	Area (Ha)	% Total
Low Intensity Urban	2.25	0.72%	3.24	1.04%
High Intensity Urban \ Roads	5.49	1.76%	11.70	3.74%
Row \ Forage Crops	88.56	28.37%	115.11	36.78%
Herbaceous Openland	14.67	4.70%	27.27	8.71%
Upland Shrub	5.58	1.79%	7.56	2.42%
Upland Deciduous	68.58	21.97%	71.37	22.81%
Upland Conifer	7.02	2.25%	5.76	1.84%
Upland Mixed	4.23	1.36%	6.48	2.07%
Open Water	17.55	5.62%	0.72	0.23%
Lowland Deciduous \ Conifers	24.84	7.96%	14.94	4.77%
Non-forest Wetland	70.74	22.66%	48.15	15.39%
Sand \ Bare Soil	0.09	0.03%	0.00	0.00%
Mud Flats	2.52	0.81%	0.63	0.20%
Other Bare \ Sparsely Vegetated	0.00	0.00%	0.00	0.00%

IFMAP Landcover Classes in Five Kilometer Buffers

EO Number	001		002		003		004		005		006	
	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total
Low Intensity Urban	75.0	0.96%	142.4	1.82%	61.3	0.78%	32.2	0.41%	32.8	0.84%	346.1	4.43%
High Intensity Urban \ Roads	271.7	3.48%	200.1	2.56%	398.4	5.10%	247.1	3.16%	137.5	3.53%	311.1	3.98%
Row \ Forage Crops	5138.8	65.75%	4401.6	56.42%	4401.6	56.34%	5462.3	69.91%	1661.0	42.66%	1419.2	18.17%
Orchards	0.0	0.00%	8.8	0.11%	21.4	0.27%	2.3	0.03%	0.0	0.00%	3.6	0.05%
Herbaceous Openland	409.2	5.24%	478.2	6.13%	385.8	4.94%	245.9	3.15%	395.6	10.16%	1151.2	14.74%
Upland Shrub	57.1	0.73%	65.7	0.84%	97.4	1.25%	77.8	1.00%	75.5	1.94%	108.2	1.38%
Parks	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	185.2	2.37%
Upland Deciduous	809.8	10.36%	1218.7	15.62%	953.0	12.20%	743.8	9.52%	795.7	20.44%	2375.6	30.41%
Upland Conifer	100.5	1.29%	87.2	1.12%	41.3	0.53%	23.3	0.30%	12.6	0.32%	138.7	1.78%
Upland Mixed	56.3	0.72%	62.7	0.80%	37.3	0.48%	25.6	0.33%	24.8	0.64%	103.1	1.32%
Open Water	95.9	1.23%	36.7	0.47%	52.7	0.68%	4.5	0.06%	80.7	2.07%	170.2	2.18%
Lowland Deciduous \ Conifers	217.4	2.78%	549.3	7.04%	617.9	7.91%	426.4	5.46%	177.8	4.57%	470.4	6.02%
Non-forest Wetland	559.4	7.16%	546.0	7.00%	734.9	9.41%	507.4	6.49%	475.6	12.21%	1015.3	13.00%
Sand \ Bare Soil	3.7	0.05%	2.2	0.03%	2.4	0.03%	2.2	0.03%	0.4	0.01%	1.2	0.01%
Mud Flats	19.7	0.25%	1.6	0.02%	5.0	0.06%	1.5	0.02%	23.0	0.59%	12.4	0.16%
Other Bare \ Sparsely Vegetated	0.6	0.01%	0.8	0.01%	2.7	0.03%	10.8	0.14%	0.5	0.01%	0.6	0.01%

EO Number	007		008		009		010		011		012	
	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total	Area (Ha)	% Total
Low Intensity Urban	82.9	1.09%	43.3	0.74%	76.2	0.98%	43.1	0.62%	43.5	0.72%	64.1	0.82%
High Intensity Urban \ Roads	255.1	3.36%	186.8	3.19%	337.9	4.32%	254.2	3.67%	214.5	3.54%	262.0	3.35%
Row \ Forage Crops	4294.2	56.52%	3470.6	59.27%	3604.9	46.14%	3521.8	50.81%	2951.2	48.69%	4826.3	61.76%
Orchards	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	3.1	0.04%
Herbaceous Openland	569.0	7.49%	470.0	8.03%	611.6	7.83%	555.1	8.01%	515.9	8.51%	266.2	3.41%
Upland Shrub	101.5	1.34%	76.8	1.31%	116.7	1.49%	124.5	1.80%	104.5	1.72%	55.8	0.71%
Parks	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Upland Deciduous	1132.7	14.91%	994.1	16.98%	1355.0	17.34%	1171.3	16.90%	1103.4	18.21%	636.9	8.15%
Upland Conifer	23.3	0.31%	17.6	0.30%	79.1	1.01%	23.7	0.34%	24.1	0.40%	25.2	0.32%
Upland Mixed	41.2	0.54%	31.4	0.54%	77.7	0.99%	37.2	0.54%	39.2	0.65%	20.0	0.26%
Open Water	81.4	1.07%	54.7	0.93%	74.9	0.96%	87.0	1.26%	83.8	1.38%	175.7	2.25%
Lowland Deciduous \ Conifers	260.5	3.43%	246.4	4.21%	486.4	6.22%	294.4	4.25%	264.2	4.36%	858.4	10.99%
Non-forest Wetland	731.9	9.63%	246.4	4.21%	976.7	12.50%	793.8	11.45%	690.8	11.40%	600.5	7.68%
Sand \ Bare Soil	0.6	0.01%	0.6	0.01%	0.5	0.01%	0.4	0.01%	0.5	0.01%	2.8	0.04%
Mud Flats	23.0	0.30%	15.8	0.27%	14.9	0.19%	24.5	0.35%	24.7	0.41%	16.9	0.22%
Other Bare \ Sparsely Vegetated	0.5	0.01%	0.5	0.01%	0.7	0.01%	0.5	0.01%	0.6	0.01%	0.6	0.01%

IFMAP Landcover Classes in Five Kilometer Buffers

EO Number	013		014	
	Area (Ha)	% Total	Area (Ha)	% Total
Low Intensity Urban	82.9	1.06%	45.0	0.61%
High Intensity Urban \ Roads	343.2	4.39%	260.4	3.54%
Row \ Forage Crops	2598.4	33.25%	3846.9	52.32%
Orchards	0.7	0.01%	0.0	0.00%
Herbaceous Openland	500.7	6.41%	574.4	7.81%
Upland Shrub	121.3	1.55%	129.4	1.76%
Parks	0.0	0.00%	0.0	0.00%
Upland Deciduous	1509.8	19.32%	1192.2	16.21%
Upland Conifer	125.4	1.60%	22.7	0.31%
Upland Mixed	63.9	0.82%	36.0	0.49%
Open Water	140.5	1.80%	84.8	1.15%
Lowland Deciduous \ Conifers	828.3	10.60%	301.0	4.09%
Non-forest Wetland	1427.0	18.26%	835.5	11.36%
Sand \ Bare Soil	2.2	0.03%	0.5	0.01%
Mud Flats	20.2	0.26%	23.9	0.33%
Other Bare \ Sparsely Vegetated	49.5	0.63%	0.5	0.01%