Status of the State Endangered Channel Darter (*Percina copelandi*) in Huron National Forest: Surveys and Ground-work for eDNA Development.

Prepared by:
Peter J. Badra
Michigan Natural Features Inventory, P.O. Box 13036, Lansing, MI 48901

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Cover Photos: Inset photos- Channel darter (*Percian copelandi*) from the South Branch Pine River. Background photo- eDNA sample collection, South Branch Pine River near Cruzen Rd. Photos by Peter Badra on October 25, 2022.

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Introduction

The channel darter (*Percina copelandi*) is a state Endangered fish belonging to the Percidae family. It is part of a group of species in the sub-family Etheostomatinae, commonly known as darters, which are endemic to North America. The channel darter is of special interest because of its declining status and history of occurrence within and near Forest Service lands in Michigan. The species is designated as a Regional Forester Sensitive Species on the Huron-Manistee National Forests in the Eastern Region of the Forest. Though it does not have federal listed status in the United States, its Lake Erie and Lake Ontario populations in Canada have been designated as Endangered, and its St. Lawrence populations have been designated Special Concern. Based on occurrence data compiled from Michigan Natural Features Inventory and other Natural Heritage Programs, the NatureServe Global Conservation Rank for channel darter is Apparently Secure (G4). However, its State Conservation Rank for Michigan is Critically Imperiled (S1). The G4 Global Rank is defined as "at fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors." The S1 State Rank is defined as "at very high risk of extirpation in the jurisdiction (state of Michigan) due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors." Sixteen species of darter occur in Michigan. Two of these are state listed as Endangered (channel darter and river darter [*Percina shumardi*]), one is state listed as Threatened (Eastern sand darter [*Ammocrypta pellucida*]), and one is a Species of Special Concern (orangethroat darter [*Etheostoma spectabile*]). The river darter, along with the more common Johnny darter (*Etheostoma nigrum*) and blackside darter (*Percina maculata*), is somewhat similar to channel darter morphologically. Johnny darter and blackside darter are both common in Michigan and can occupy similar habitats to channel darter.

Channel darters occur in large to small rivers, in areas with moderate current and sand and gravel substrates, as well as lake shore habitats in clean coarse sand and fine gravel (Trautman 1981). Their preferred habitat has also been described as pools and margins of riffles of small to medium rivers over sand or gravel bottoms, and from lake shores (Page and Burr 2011). Channel darters, like other darter species, lack a swim bladder making them adept at living on the bottoms of rivers, streams, and lakes. They are bottom feeders whose diet includes insects such as mayfly and midge larvae, small crustaceans, algae, and organic debris (Turner 1921). Channel darters have been observed overwintering in deep backwater pool areas filled with organic debris (Branson 1967). A study of channel darters in the Cheboygan River, Cheboygan County, Michigan found that spawning occurred between July 9th and 23rd, when water temperatures were 20.6 to 22.2° C (69 to 72° F). Spawning took place in areas with good current. Males defend small territories around a gravel nest where the female deposits 4-10 eggs for the male to fertilize. Eggs are adhesive and do not require parental care. Females may deposit a total of 415 eggs over a single season (Winn 1953, 1958a, and 1958b). Threats to the channel darter include siltation caused by dredging, streamside construction, roads, agriculture, grazing, and impoundments, which can destroy spawning habitat. The species requires clear water, so increased turbidity can have an impact. Siltation can also reduce larval prey (Trautman 1981). Dams and impoundments interfere with migration to spawning grounds and can reduce flow enough to impact reproduction.

The global range of channel darter extends from southeastern Canada to south central U.S., including the upper St. Lawrence, lower Great Lakes, Ohio, and Mississippi River basins. Populations tend to be sparse and isolated over this large range (NatureServe 2024, COSEWIC 2002, COSEWIC 2016). In Michigan, the historical range of channel darter includes the Cheboygan/Black, Au Sable, Pine, Rifle, Cass, St. Clair, Detroit, and Huron Rivers, as well as near shore areas of Lake St. Clair, Lake Huron, and Lake Erie (MNFI 2024). Survey effort targeting channel darter in Michigan has been sparse over the past century. The earliest documented occurrences in the state date back to 1924 from the Au Sable River. Table 1. summarizes channel darter occurrence in Michigan

by watershed and year of survey (MNFI 2024). The number of areas where channel darter was once found, and then subsequently not found in later years, reflects a substantial decline of the species in Michigan over the past 100 years. It also emphasizes the importance of channel darter populations in the Pine, Au Sable, and St. Clair Rivers to the conservation of the species, as well as the need for more up to date and comprehensive surveys. There were a limited number of sites surveyed in each watershed making survey efforts far from comprehensive. Very few historical sites have been resurveyed in recent decades.

Over the past 30 years channel darters have only been observed in three river systems in Michigan, two of which, the Au Sable River and the Pine River (Alcona County), are located on the Huron National Forest. The third is the St. Clair River where they were found in 1995. In 2000, channel darters were found in the Pine River mainstem, West Branch of the Pine River, and an unnamed creek in the Pine River watershed. Additionally, the species was found in the South Branch of Pine River in 2001 (Thompson unpublished data 2001) (Appendix A.). Schnurer and Stuber (2007) (Appendix B) surveyed three locations where channel darter had been recorded in 2000 by Thompson (2001). The most recent occurrences of channel darter in Michigan, before 2022, were documented in 2017 in Lake St. Clair (Hessenauer et al. 2017) and 2007 in the Pine River Watershed (Schnurer and Stuber 2007). One site in the West Branch of the Pine River was found to still support channel darter in 2007 (35 found), while none were found at a site in the Pine River and in an unnamed creek off the West Branch of the Pine River. Surveys had not been conducted in the Huron National Forest since 2007. Current information about the range and abundance of the channel darter is needed to identify and prioritize watershed restoration work that will benefit this critically imperiled species on the Huron National Forest.

One barrier to obtaining the needed occurrence data on channel darter is the time and cost associated with field surveys. Some of the habitats within its range, e.g. within the Au Sable River, are too deep to wade, making them more difficult and costly to survey. Since channel darters do not have swim bladders, they tend to stay near the river bottom when shocked, increasing the likelihood of avoiding detection and capture in deep habitats. The use of environmental DNA (eDNA) as an indicator for fish species presence holds great promise for more quickly and cheaply detecting extant channel darter populations and identifying river reaches for further targeted surveys (Thomsen and Willerslev 2015). This is especially true for habitats that are too deep to wade making capture of channel darter with electrofishing difficult. Recent technological improvements in genetics and the study of eDNA have revolutionized fish survey techniques for rare and cryptic species, such as the channel darter. The use of eDNA techniques will allow the presence of channel darters in a study reach to be determined from a water sample. Applying this technique to sampling for channel darters will greatly simplify future surveys and will contribute to more effective restoration and management outcomes into the future. The purpose of this project is to update the status of the species in the Huron National Forest with field surveys and begin the groundwork to make future eDNA surveys for channel darter possible.

Methods

Surveys targeting channel darter within the Huron National Forest were performed at five sites using a backpack electrofisher (Table 2. and Figure 1.). Due to similar morphology among channel darter, Johnny darter, blackside darter, and river darter, special effort was made to correctly identify these fish to species. See Appendix C. for species identification key and tips developed to help separate these similar darter species. To support eDNA marker development and validation for channel darter, tissue samples (fin clips) were collected from channel darters, as well as non-target species, rainbow darter (*Etheostoma caeruleum*), Johnny darter, logperch, and blackside darter. Fish captured with backpack electrofisher were placed in a bucket of river water with an aerator. The bucket was carried to the riverbank and fish were placed one by one in an enamel

Table 1. Channel darter (*Percina copelandi*) occurrence in Michigan by watershed (listed from north to south) and year of survey. Data were compiled from the Natural Heritage Database (MNFI 2024), Schnurer and Stuber (2007), and Thompson (2001). Surveys from this study are denoted in italics.

Watershed	Locator	Year Found	Year Not Found
Cheboygan River		1951	1982, 1986, 1994
Black River		1926	1982, 1986, 1994
Lake Huron near shore area		1923, 1925, 1930	1986, 1994
Devils River		1925	1986
Pine River Watershed			
East Branch Pine River	E. Trask Lake Rd.	1994	
Unnamed creek (off W.Br. Pine R.)	Fowler Rd.	2000	2007
West Branch Pine River	Cruzen Rd.	1951, 1986, 2000, 2007	
West Branch Pine River	Fowler Road		*2023*
Pine River	EF30	2000	2007
Unnamed creek (off Pine River)	Cruzen Rd.	2000	
South Branch Pine River	FS Road 4745	2001	
South Branch Pine River	Cruzen Rd.	*2022*	
Pine River	Andrews Rd. end	*2023*	
Pine River	West of SF41	1951, 1957	1994
Van Etten Creek	S. Barlow Rd.	1951, 1986	1994
Pine River	Kings Corner Rd.	1951, 1957, 1986, 1994, 2000	
Au Sable River	Foote Dam	1924, 1986	1994, *2023*
Au Sable River	Cooke Dam	1924, 1986, 1994	*2023*
Rifle River		1940, 1941	1986, 1994
Cass River		1941	
St. Clair River		1990, 1993, 1995	
Lake St. Clair		1996, 2017	
Detroit River		1935	
Huron River		1941	1986, 1994
Lake Erie near shore area		1952	

pan with river water. A clip of fin tissue was cut from a ventral fin with scissors. An approximately 3mm square section of fin was clipped from each fish. Tissue samples were labeled and packaged. All fish were returned to the river at the site they were captured.

Habitat assessments following the Michigan Department of Environment, Great Lakes, and Energy (EGLE) P-51 methods for riffle/run streams (EGLE 2014) were made at site 2 (South Branch of the Pine River at Cruzen Rd.) and site 3 (in the Pine River at Andrews Rd.) where channel darter were found. In these assessments, ten habitat parameters are scored, three related to substrate and instream cover, five related to channel morphology, and three related to riparian and bank structure. The numerical score of each habitat parameter falls into one of four condition categories, Poor, Marginal, Good, or Excellent. The sum of the ten habitat scores gives a total point score categorized as Excellent >154, Good 154-105, Marginal 104-56, or Poor <56. A description of each condition category for each of the ten habitat parameters is given in Appendix D. Additionally, the substrate at sites 2 and 3 was characterized by visually estimating percent composition of each of the following six particle size classes (diameter): boulder (>256 mm); cobble (256-64 mm); pebble (64-

16 mm); gravel (16-2 mm); sand (2-0.0625 mm); and silt/clay (<0.0625 mm) (Hynes 1970). The percentage of the search area with pool, riffle, and run habitat was estimated visually. Fieldwork was completed by USFS and MNFI staff.

eDNA samples were collected at site 2 on October 25, 2022, and at site 3 on May 31, 2023. Samples were collected following protocols from the USFS Rocky Mountain Research Station (Carim et al. 2016). Five litters of river water were filtered for genetic material at each river site using a battery powered Geotech brand peristaltic pump (Figure 2 pump photo). The resulting filter samples were packaged and shipped for analysis. Tissue and eDNA samples were sent to the Forest Service's National Genomics Center at the Rocky Mountain Research Station, Missoula, MT, where the samples are being used to test and validate a qPCR assay for the Channel Darter in Michigan. The assay being developed will be maintained at the National Genomics Center in the public domain, freely available for the use and benefit of all state agencies, universities, and non-governmental organizations. Design work on candidate assays for channel darter has begun and the most promising ones will be tested to validate their use in the field.

Table 2. Locations surveyed for channel darter (*Percina copelandi*) by MNFI and USFS in 2022 and 2023.

Site #	Waterbody	Locator	Latitude	Longitude	Date
1	West Branch Pine River	Fowler Road	44.626879	-83.532891	05/31/2023
2	South Branch Pine River	Cruzen Road	44.573766	-83.463866	10/13 & 25/2022
3	Pine River	Andrews Road	44.561506	-83.443353	05/31/2023
4	Au Sable River	Pine Acres Boat Landing	44.450814	-83.671183	05/30/2023
5	Au Sable River	Au Sable R. Scenic Lookout	44.425176	-83.430263	05/30/2023

Results

Channel darters were found at two of five sites surveyed, site 2 in the South Branch of the Pine River at Cruzen Rd., and site 3 in the Pine River near Andrews Rd. (Figure 3). The channel darters found at site 2 and site 3 each represent a new occurrence record and expand the known range of the species in the Pine River watershed. Fish species captured and released at each site are given in Table 3. A female channel darter gravid with eggs was captured at site 3. Surveys at the two sites in the Au Sable River were limited to areas of habitat that were shallow enough to wade. One amphibian, the common mudpuppy (*Necturus maculosus*), was captured at site 4. All captured animals were returned to the river where they were found.

A total of 53 fin clip tissue samples were collected at site 2 in the South Branch Pine River at Cruzen Rd. in October of 2022 (Figure 4). These included samples from 25 channel darters, 6 logperch, 1 rainbow darter, 12 Johnny darters, and 9 blackside darters. A total of 20 fin clip tissue samples were collected at site 3 in the Pine River near Andrews Rd. in May of 2023. These included 1 channel darter, 14 rainbow darters, 4 Johnny darters, and 1 blackside darter. There was one mortality of a channel darter during surveys, the individual at site 3. The EGLE P-51 qualitative habitat assessments at site 2 and site 3 had overall scores of 149 and 136 respectively, which both fall into the upper portion of the Good category (105-154). The difference in scores between the two sites is mainly due to higher levels of sediment deposition and bank scour (flashiness), lower levels of bank stability, and lower frequency of riffles at site 2 versus site 3. Individual scores for each habitat parameter at each site are given in Appendix D.

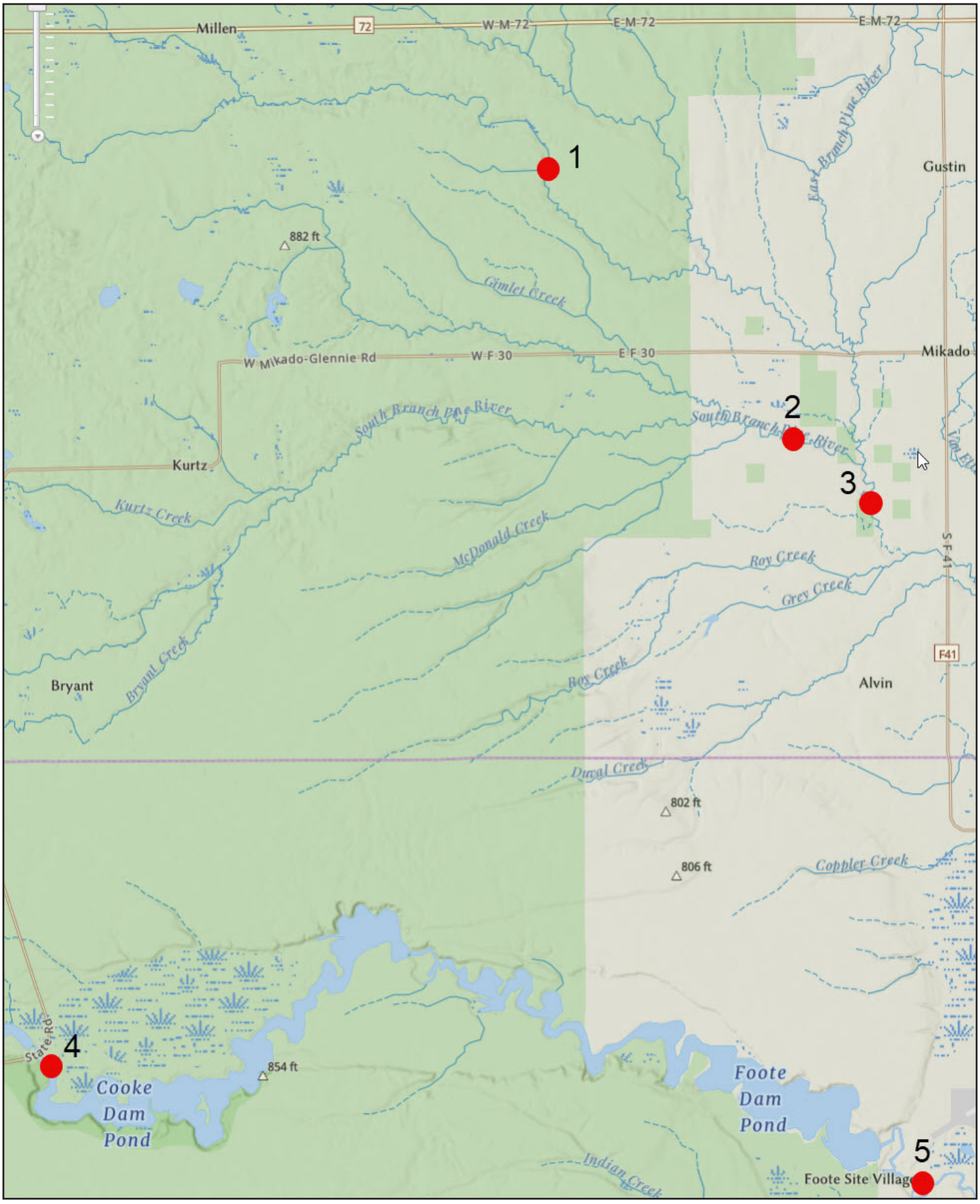

Figure 1. Map of sites surveyed for channel darter (*Percina copelandi*) in 2022/2023.

Figure 2. eDNA samples were collected at site 2 in the South Branch Pine River (pictured) and site 3 in the Pine River by filtering 5L of river water with a peristaltic pump. Photo by Peter Badra, October 25, 2022.

Figure 3. Channel darter (*Percina copelandi*) from site 2 in the South Branch of the Pine River, October 25, 2022. Photo by Peter Badra.

Table 3. The number of fish of each species captured or observed while backpack electrofishing, and the number of fin clip tissue samples collected for each species (in parentheses).

		Site #				
Common Name	Scientific Name	1	2	3	4	5
Blacknose dace	*Rhinichthys atratulus*	15				
Blacknose shiner	*Notropis heterolepis*					5
Blackside darter	*Percina maculata*		9 (9)	1 (1)		
Brook trout	*Salvelinus fontinalis*	9				
Channel darter (State End.)	*Percina copelandi*		25 (25)	5 (1)		
Common mudpuppy (Amphibia)	*Necturus maculosus*				1	
Eastern mudminnow	*Umbra pygmaea*			1		
Johnny darter	*Etheostoma nigrum*		12 (12)	4 (4)		
Lamprey sp.	Petromyzontidae	1				
Logperch	*Percina caprodes*		6 (6)			
Mottled sculpin	*Cottus bairdii*	4	1			
Northern hog sucker	*Hypentelium nigricans*					1
Rainbow darter	*Etheostoma caeruleum*		1 (1)	14 (14)		8
Rainbow trout	*Oncorhynchus mykiss*	1				3
Rock bass	*Ambloplites rupestris*					7
Round goby	*Neogobius melanostomus*				1	
Smallmouth bass	*Micropterus dolomieu*				>2*	1
Yellow perch	*Perca flavescens*				>2*	

* Observed, not captured.

Discussion

The results of these field surveys show the continued presence of channel darter in the Pine River watershed on Forest Service lands despite an apparent decline in the species' overall range in Michigan over the past several decades. These are the first records of channel darter on Huron National Forest lands documented in the past 15+ years. The presence of a female channel darter with eggs at site 3 in the Pine River suggests at least some successful reproduction is occurring in the watershed. Water temperature at the time the gravid female was observed was 24° C (75.2° F) on May 31, 2023, which is slightly warmer and earlier in the year than previously documented (Winn 1953, 1958a, and 1958b), 20.6 to 22.2° C (69 to 72° F) between July 9 and 23. It was a particularly warm day on May 31, 2023 (High of 32.2° C, Low of 11.1° C [90° and 52° F]) and the temperature was taken in the afternoon on that day, which may explain the difference. Brook trout and channel darter were not found at the same sites, which is consistent with brook trout being a cold water species and channel darter a cool water species. Water temperature at site 1 in the West Branch of the Pine River was 16° C (60.8° F) on the same day that water temperature was measured at 24° C (75.2° F) at site 3 in the Pine River. The habitat at the location was an approximately 0.5 m (1.6 ft) deep riffle with fine gravel substrate, also consistent with what was reported by Winn (1953, 1958a, and 1958b). Blackside darters and channel darters were captured in close proximity of each other and appeared to occur in the same riffle habitat at both sites they were found (sites 2 and 3).

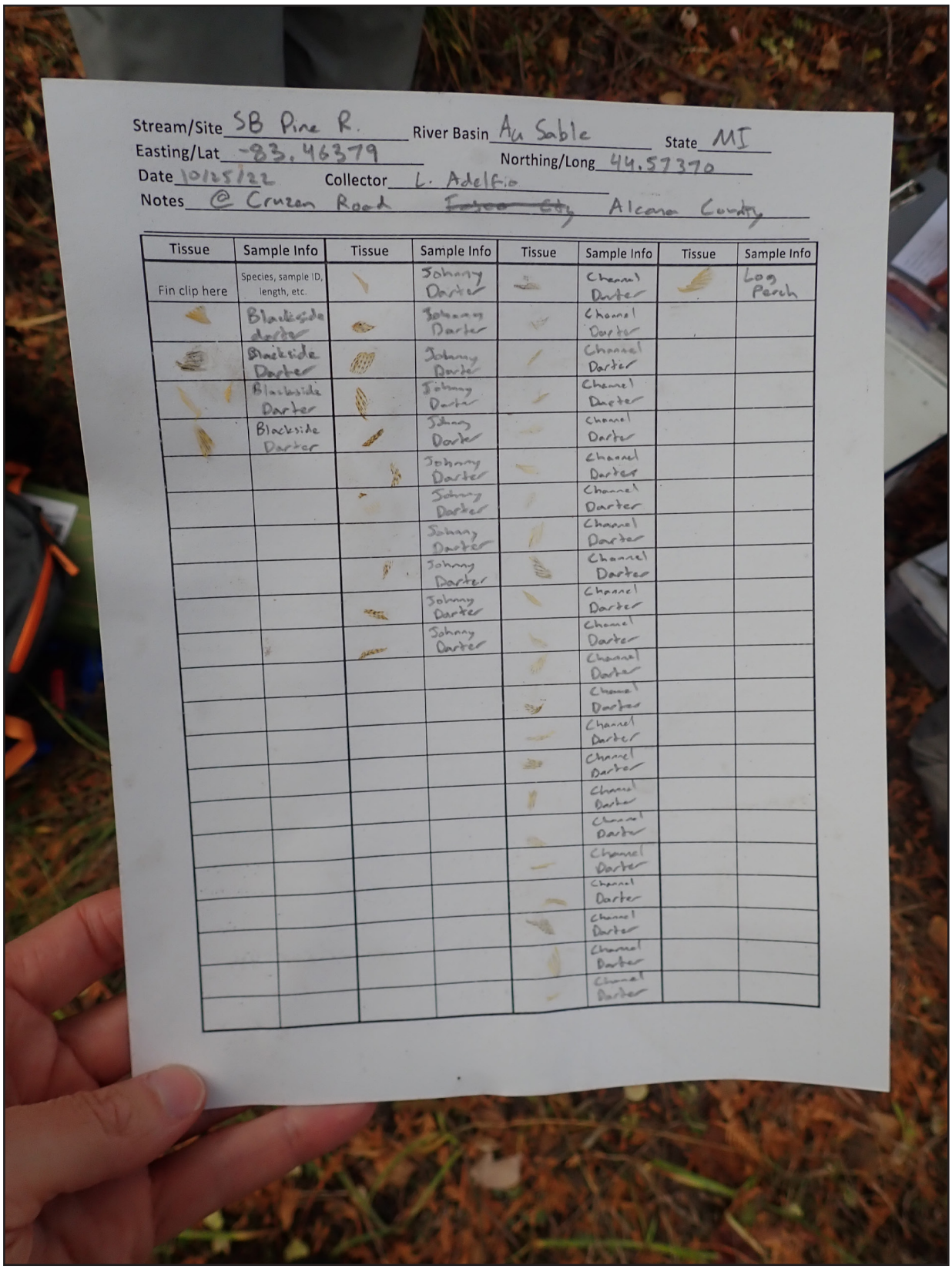

Figure 4. Fin clip tissue samples collected from site 2 in the South Branch Pine River, October 25, 2022. Photo by Peter Badra.

The tissue samples and eDNA water samples provided by this project help provide a foundation for the development and use of future eDNA sampling for channel darter within Forest Service lands, as well as across the species' range including non-wadable habitats. The time and cost associated with traditional fish surveys can be a barrier to obtaining the needed occurrence data for management on Forest Service lands and species conservation range wide. eDNA sampling has the potential to make monitoring of the range and status of channel darter on Forest Service lands quicker and with lower cost. eDNA sampling at each confluence in the Pine River watershed may reveal the presence of new populations and/or confirm the continued presence of populations in the upstream river reach. eDNA sampling of the watershed could be done relatively quickly with a crew of one to two staff. It also makes possible the sampling of deep habitats where wading with a backpack electrofisher is not possible. Surveying for channel darter in deep, non-wadable habitats is especially difficult because they tend to not float to the water's surface when shocked due to their lack of a swim bladder and because deep water requires the use of a more expensive boat electroshocker. eDNA surveys are a potential option for gathering occurrence data in deeper Au Sable River habitats. A combination of eDNA sampling to identify river reaches where channel darters are present, along with traditional field surveying to pin-point locations of channel darter and obtain site specific biological/ecological data may be an effective strategy for efficiently gathering the occurrence data needed for management and conservation of the species.

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Appendix A. Number of Channel Darters (*Percina copelandi*) captured in Pine River watershed during 2000 and 2001 electrofishing surveys (Brad E. Thompson, Michigan State University).

Stream	Latitude	Longitude	Locator	Date	# Captured
Unnamed Creek	44.57830	83.46361	Cruzen Rd	08/08/2000	4
West Branch Pine River	44.58922	83.44915	F-30	07/13/2000	1
West Branch Pine River	44.58922	83.44915	F-30	08/10/2000	1
Pine River	44.51297	83.40807	Kings Corner	07/13/2000	49
Pine River	44.51297	83.40807	Kings Corner	08/10/2000	2
South Branch Pine River	44.57611	83.53378	FS Road 4745	05/18/2001	5

Appendix B. Schnurer, K.M[1]. and B. Stuber[2]. 2007. The occurrence of channel darters (*Percina copelandi*), in known locations in the Pine River system, on the Huron National Forest, Michigan. Poster presentation. [1]Dept. of Biology, Lake Superior State University; [2]U.S. Forest Service, Huron-Manistee National Forests.

The occurrence of channel darters (*Percina copelandi),* in known locations in the Pine River system, on the Huron National Forest, Michigan

Kandi M. Schnurer [1] (kschnurer@lssu.edu)

and Bob Stuber [2] (rstuber@fs.fed.us)

[1] Department of Biology, Lake Superior State University

[2] U.S. Forest Service, Huron-Manistee National Forests

Abstract

The channel darter, *Percina copelandi,* is a state-endangered species in Michigan that typically inhabits the warm waters of rivers and large creeks. Historically, the range in Michigan included shorelines and connecting tributaries of Lake Huron and western Lake Erie, but has been drastically reduced over the past century due to human activity. A remnant population exists in the Pine River system on the Huron National Forest. One of the conservation measures for this endangered species is periodic monitoring of known populations. Three locations in the Pine River system where this species was documented to occur in 2000 were sampled in 2007. Channel darters are still present in the Pine River system; however, only at one of the three sites where found in 2000. 2007 numbers at this site were 2/3 of the reported 2000 level (35 versus 51, respectively). And, while none were captured at the other two sites, the number of channel darters reported in 2000 from these sites was low (< 5). Thus, while their absence in 2007 is of concern, it is not considered catastrophic. Another point of interest related to endangered species was of the presence of logperch (*Percina caprodes*), the host fish for the State-endangered snuffbox mussel (*Epioblasma triquerta*). Follow-up monitoring is recommended to determine: (1) if the lower numbers of channel darters encountered in 2007 are a trend or simply natural variation in population levels; and, (2) if the snuffbox mussel occurs within this system.

Introduction

Distribution: The channel darter occurs primarily in the Ohio River basin, extending into the lower Great Lakes basin and upper St. Lawrence drainages. It also occurs through out the plain states. While the range is large, this species often occurs in isolated populations (Rudolph et al. 2002). The range in Michigan includes shorelines along Lake Huron and Lake Erie on the eastern coast of Michigan. Historic concentrations were in the Au Sable River, Pine River, Rifle River, Saginaw Bay region and Thunder Bay. Since 1994, the channel darter has only been observed in the Au Sable, Pine, and St. Clair Rivers in Michigan (Carman and Goforth 2000).

Life History and Habitat Requirements: The channel darter inhabits the warm waters of large creeks, rivers, and lakeshores. They are diurnal, benthic feeders, consuming macroinvertebrates along with algae and bottom debris that are found between and behind rocks. They remain in water more than three feet deep during the day, moving into the shallows at night. This species matures in one year, spawning in late spring to early summer (69-72F water temperature) in fairly rapid currents with rocky substrate, migrating to fast-flowing riffles.

Threats: Much of the decline in channel darter numbers can be linked to diminishing suitable habitat. In Michigan, habitat in the Cass and Huron Rivers has become polluted and apparently no longer supports channel darter populations. In more pristine waters such as the Pine and Au Sable rivers, suitable habitat and viable channel darter populations exist. Other threats include siltation and turbidity caused by impoundments. Dams and impoundments themselves replace lotic habitat (both high gradient spawning habitat and medium gradient rearing habitat), and fragment habitat which blocks migrational corridors (Carman and Goforth 2000; Rudolph et al. 2002;).

The channel darter, *Percina copelandi,* is a state-endangered species in Michigan. A survey by Schultz (1986) documented its occurrence in the Pine River system, and follow-up surveys in 2000-2001 verified its continued presence (Thompson et al. 2001).

Conservation measures in the Huron-Manistee Land and Resource Management Plan call for periodic monitoring of known populations of the channel darter (USDA Forest Service 2006). Thus, sampling at previous documented locations within the Pine River system was undertaken in 2007. ***Our objective was to see if channel darters were still present at these locations.***

Methods

Sampling was done in July 2007 in the Pine River using a backpack electrofishing unit in one unnamed tributary and an electrofishing tow barge at the two mainstem sites. Sampling was a cooperative effort with the Michigan Department of Natural Resources Hunt Creek Fisheries Research Station. Sampling stations were 100 meters in length and were the same stations reported by Thompson et al. (2001) . Block nets were used at both ends of the sample sites. A pulsed DC current was used and a three-pass depletion method (Schneider 2000) was done at all three sites. All captured fish were identified, measured to the nearest millimeter (fork length and total length), and returned to water.

Pine River System

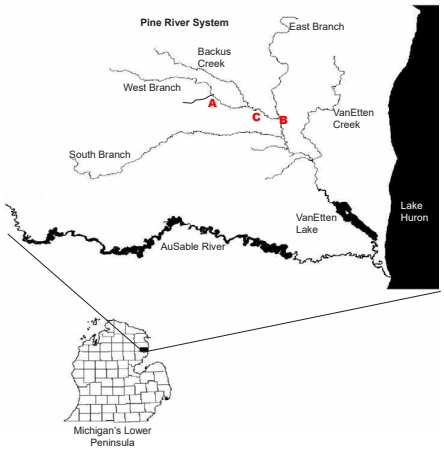

Figure 1: Site map for all three sampling sites

Results and Discussion

Channel darters were only captured at the lowermost station (Site C) on the Pine River. Number captured were only 2/3 of those captured during the previous 2000-2001 sampling (35 vs. 51 individuals; Figure 2). None were captured at the other two sites; however, the number of channel darters reported in 2000 from these sites was low (< 5). Thus, while their absence in 2007 is of concern, it is not considered catastrophic.

A Seber-LeCren (1967) two-pass estimator was used to estimate the population of channel darters at Site C as more individuals were captured in the third pass than the second pass (10 vs. 9), thus precluding use of the three-pass estimator (Figure 3). The population estimate for channel darters is 37 ± 15 (SE), all of which were captured at Site C (370 per km). Mean length of captured channel darters was 56.1 mm with a range of 86 to 339 mm.

Site A was a small unnamed tributary with a predominantly sand substrate. Site B was just below the confluence of the various branches of the Pine River and is a higher gradient reach with more coarse substrate (gravel, cobble). Site C is a lower gradient, larger warmer reach with a substrate again predominated by sand. This is where the majority of channel darters were captured during both recent samples (93 and 100 %, respectively, for 2000-2001 and 2007). Given their preference for larger creeks and rivers (Rudolph et al. 2002), it may be that Site C provides the best habitat for this species. Site B, being higher gradient, may provide suitable spawning habitat, but it appears that Site C provides better post-spawning rearing habitat based on the numbers captured. More in-depth seasonal analysis is needed to verify this possibility.

Overall, 18 species were captured at the three stations. This was consistent with previous surveys (MDEQ 2000). Channel darters comprised 10 % of the species composition. The species composition is indicative of a cool water – cold water thermal habitat classification as described by Wehrly et al. (1999) for Michigan streams. Also of interest was the capture of logperch (*Percina caprodes*), the host fish for the State-endangered snuffbox mussel (*Epioblasma triquerta*).

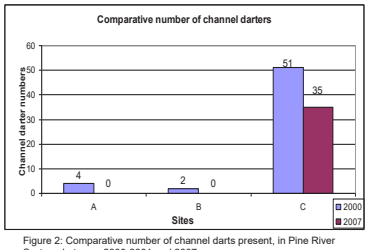

Figure 2: Comparative number of channel darts present, in Pine River System, between 2000-2001 and 2007.

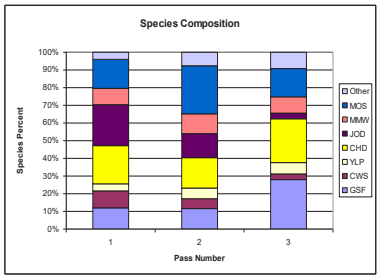

Figure 3: Species composition for site C, for all three passes.

Conclusions and Recommendations

- The State-endangered channel darter, *Percina copelandi*, is still occurring in the Pine River system.
- Numbers are lower than encountered in 2000; however it is unknown if this is a trend or natural population variation.
- There is potential for the State-endangered snuffbox mussel to occur as its only known host fish, the logperch, is present.
- Follow-up monitoring is recommended to determine: Trends in channel darter numbers and if the snuffbox mussel is present in this stream system.

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•Todd Wills, MDNR, and Ashley Moerke, LSSU, for their review and edits of this presentation.

Appendix C. Channel darter (*Percina copelandi*) identification tips for the Au Sable River and adjacent watersheds, Michigan. All fish photographed were captured during 2022 and 2023 surveys and were released back where they were found.

Channel darter (*Percina copelandi)* identification tips for the Au Sable River and adjacent watersheds, Michigan

Photo by Peter Badra, Michigan Natural Features Inventory

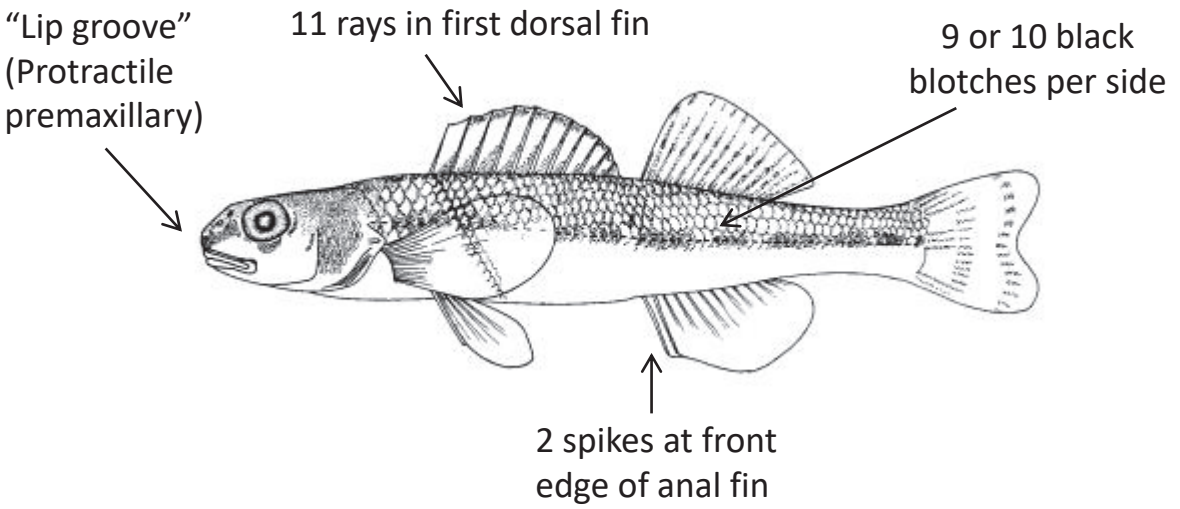
A working document prepared by the U.S. Forest Service in May 2023.

For more information, contact the Huron-Manistee NF East Zone Fish Biologist: Luca.Adelfio@usda.gov

1

Appendix C. Continued.

Channel darter defining characteristics



Photos by Peter Badra, Michigan Natural Features Inventory

Drawing from:
https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_channel_darter_e.pdf

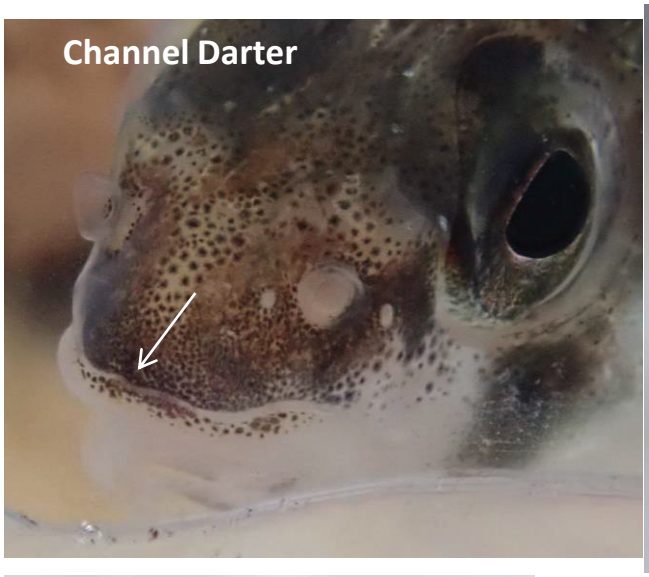
2

Comparison to Blackside Darter (1/2)

Both blackside darter (*P. maculata*) and channel darter have 2 spines on the front edge of the anal fin, but blackside darter has 13-14 rays in the first dorsal fin (channel darter has 11 rays). Blackside darter has 6-9 black blotches on the side (channel darter has 9-10).

3

Comparison to Blackside Darter (2/2)



Blackside darter (above right) has a premaxillary frenum (bridge of flesh connecting the upper lip and snout). Channel darter (left) has a protractile premaxillary with a deep groove between upper lip and snout that is visible all the way across the snout (upper left).

Top photos by Peter Badra, Michigan Natural Features Inventory, bottom photo by US Forest Service

4

Comparison to Johnny Darter

Johnny Darter (*Etheostoma nigrum*) has only 1 spine on the front edge of the anal fin and has “x” and “w” markings around the lateral line.

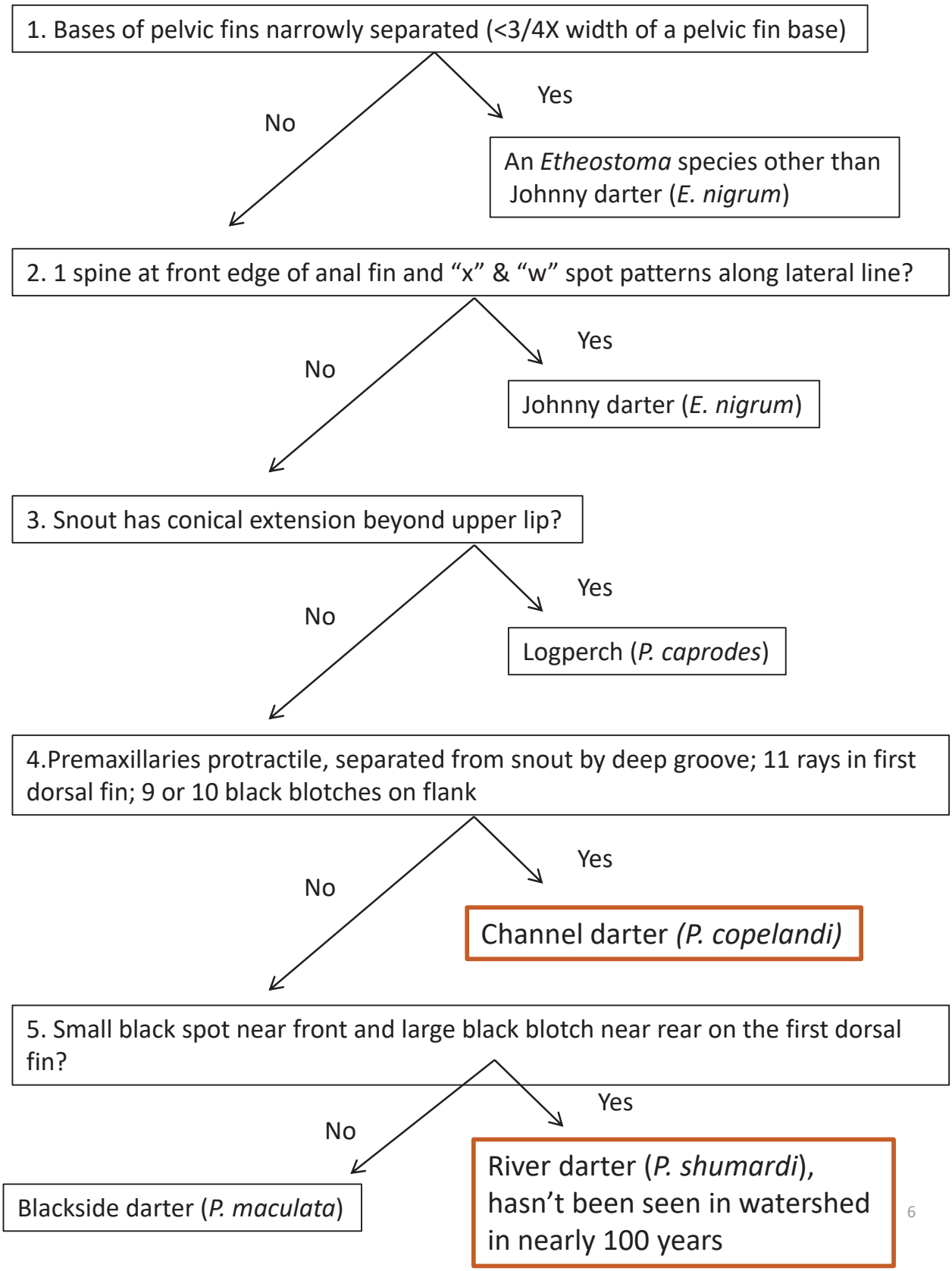
Channel Darter has 2 spines on the front edge of the anal fin and 9-10 blotches along side.

Photos by Peter Badra, Michigan Natural Features Inventory

5

Appendix C. Continued.

Channel darter (and river darter) ID key for species found in Au Sable R. watershed



Appendix D. Habitat assessment score sheets for sites 2 and 3, where channel darter (*Percina copelandi*) were found in 2022 and 2023. Habitat assessments followed the Michigan Department of Environment, Great Lakes, and Energy (EGLE) P-51 methods for riffle/run streams (EGLE 2014).

South Branch Pine River, Cruzen Rd.
2 May 2024

Site 2

Appendix J (continued)

HABITAT ASSESSMENT FIELD DATA SHEET - RIFFLE/RUN STREAMS

Habitat Parameter	Condition Category			
	Excellent	**Good**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is <1.0 f/s, deep is >2 ft.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected, slight deposition in pools.	Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5a. Channel Flow Status - Maintained Flow Volume	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	10 9	8 7 6	5 4 3	2 1 0
5b. Channel Flow Status – Flashiness	Vegetation along the stream bank is complete nearly to the waters edge. Little or no evidence of frequent changes in discharge and/or frequent high water events that scour stream bank vegetation. Channel retention devices (if present) stable and extending laterally across the stream channel.	Some evidence of bank scour approximately 4-8 inches above the waters surface. Channel retention devices (if present) mostly stable and extending partially into the active stream channel.	Bank scour evidence 9-18 inches above the waters surface. Channel retention devices (if present) tend to lay more against the stream bank rather than extending into the active channel.	Bank scour (>20 inches) along the stream channel. Channel retention devices are generally absent from the active channel and/or may exist as woody debris jams along the stream bank above the active channel.
SCORE	10 9	8 7 6	5 4 3	2 1 0

Appendix D. Continued.

Site 2

Habitat Parameter	Condition Category: Excellent	Good	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization is continuous but not recent (>5 years). Embankments without mature trees and dominated by grasses and shrubs.	Stream reach has been recently channelized (<5 years). OR Banks shored with gabion, rock, cement or bare earth. Instream habitat greatly altered or removed entirely. Bank vegetation moderately dense to absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the stream bank surfaces covered by native vegetation, but 1 class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >150 feet and dominated by native vegetation including trees, shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. Human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 75-150 feet; human activities have impacted zone only minimally.	Width of riparian zone 10-75 feet; human activities have impacted zone a great deal.	Width of riparian zone <10 feet; little or no riparian vegetation due to human activities.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 149

Appendix D. Continued.

Pine River, Andrews Rd.
2 May 2024

Site 3

Appendix J (continued)

HABITAT ASSESSMENT FIELD DATA SHEET - RIFFLE/RUN STREAMS

Habitat Parameter	Condition Category			
	Excellent	**Good**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is <1.0 f/s, deep is >2 ft.).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand, or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5a. Channel Flow Status - Maintained Flow Volume	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	**10** 9	8 7 6	5 4 3	2 1 0
5b. Channel Flow Status – Flashiness	Vegetation along the stream bank is complete nearly to the waters edge. Little or no evidence of frequent changes in discharge and/or frequent high water events that scour stream bank vegetation. Channel retention devices (if present) stable and extending laterally across the stream channel.	Some evidence of bank scour approximately 4-8 inches above the waters surface. Channel retention devices (if present) mostly stable and extending partially into the active stream channel.	Bank scour evidence 9-18 inches above the waters surface. Channel retention devices (if present) tend to lay more against the stream bank rather than extending into the active channel.	Bank scour (>20 inches) along the stream channel. Channel retention devices are generally absent from the active channel and/or may exist as woody debris jams along the stream bank above the active channel.
SCORE	10 9	8 7 6	5 4 3	2 1 0

Appendix D. Continued.

Site 3

Habitat Parameter	Condition Category: Excellent	Good	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization is continuous but not recent (>5 years). Embankments without mature trees and dominated by grasses and shrubs.	Stream reach has been recently channelized (<5 years). OR Banks shored with gabion, rock, cement or bare earth. Instream habitat greatly altered or removed entirely. Bank vegetation moderately dense to absent.
SCORE	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 (6)	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the stream bank surfaces covered by native vegetation, but 1 class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 (7) 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >150 feet and dominated by native vegetation including trees, shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. Human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 75-150 feet; human activities have impacted zone only minimally.	Width of riparian zone 10-75 feet; human activities have impacted zone a great deal.	Width of riparian zone <10 feet; little or no riparian vegetation due to human activities.
SCORE (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0

Total Score 136