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Status and Trends of Michigan Stream Resources, 2002–2007

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Michigan Department of Natural Resources
Fisheries Report 09, 2015

Status and Trends of Michigan Stream Resources, 2002–2007

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Executive Summary

Science-based management of aquatic resources requires high-quality information that is readily available to managers and stakeholders. Collecting and distributing this information is an essential role of the Michigan Department of Natural Resources (DNR) and helps the DNR to fulfill its public trust mission. This report, Status and Trends of Michigan Stream Resources, 2002–2007, provides comprehensive information needed to understand and effectively manage Michigan streams.

This report represents the first statewide assessment of stream resources and is intended for use by scientists, managers, policy makers, and the public. It provides an up-to-date summary of information on streams and characterizes the broad scale patterns in stream habitat, fish community structure, and fish population characteristics. The findings presented here document the current status of selected stream resources and establish the baseline conditions against which future monitoring results can be compared.

Michigan's streams are an abundant, diverse, and valuable resource. A growing list of environmental issues place ever-increasing demands on stream habitats, fishes and other aquatic life. The findings of this report and the continued assessment efforts of the DNR will help in the conservation and enhancement of stream resources and in the optimum use of stream resources for the benefit of the people of Michigan.

Introduction

Michigan's inland lakes and streams are an abundant, diverse, and valuable resource. Over 10,000 lakes and more than 36,000 miles of streams are distributed across the Michigan landscape. The characteristics of these waters range from small, shallow lakes that support panfish to large, deep lakes that support diverse fish communities including yellow perch, walleye, and lake trout; and from the small, groundwater-driven headwater streams that support trout and other coldwater species to the large, runoff-driven rivers that support diverse communities of warmwater fishes. Michigan's inland lakes and streams are of great value providing diverse fishing and other recreational opportunities as well as a source for water, energy, and employment. The long-term quality of these fishery resources and the benefits that they provide (collectively known as ecosystem services) is threatened by a variety of factors including pollution, landscape development, water extractions, invasive species, over exploitation of fish stocks, and climate change. The demands placed on these resources by multiple user groups, together with a growing list of disturbances that threaten inland lakes and streams, necessitates the need for effective management to protect inland resources for current and future generations. Effective management of inland resources, however, depends upon information to assess their current condition and how they are changing over time.

The mission of the Michigan DNR Fisheries Division is "to protect and enhance fish environments, habitat, populations, and other forms of aquatic life, and to promote optimum use of these resources for benefit of the people of Michigan" (Anonymous 1997). Obtaining adequate information to meet this mission is a challenging task given the abundance and diversity of lakes and streams in the state. Recognizing this challenge, Fisheries Division implemented the Status and Trends Program (STP) in 2001. The objective of the STP is to collect and synthesize data needed by fisheries managers, policy makers, and the public to address inland aquatic resource management needs. The specific goals of the STP are to: 1) collect the information needed to maintain an inventory of inland lake and stream habitat and fish community characteristics statewide; 2) provide reference points or benchmarks for local, regional, and statewide management needs; and 3) to assess the status of, and detect changes to, aquatic communities across Michigan. To meet these goals, the STP surveys aquatic communities and habitats using standardized methods in lakes and streams that are representative of the broad range of waters found in the state.

This report describes the current status of Michigan stream resources by documenting the results of the first six years (2002–2007) of assessment surveys from the Stream Status and Trends Program (SSTP). We use the term "stream" to collectively describe flowing waters of all size, including brooks, creeks, streams, and rivers, through the remainder of this document. Results from the Lakes Status and Trends Program can be found in a companion report (Wehrly et al. 2015). In this report, status refers to both the geographic distribution and the ecological condition or "health" of the resource. Documenting current status is necessary to meet today's management needs and to establish baseline conditions against which future monitoring results can be compared. Comparisons such as these will enable researchers and managers to determine trends, or how inland fishery resources change through time in response to natural and human-induced sources of variability.

The first objective of this report is to provide statewide summaries of randomly surveyed habitat and fish community data collected during the first six years (2002–2007) of the Stream Status and Trends Program. These summaries, in the form of low, medium, and high classification ranges, are intended to serve as benchmarks to describe stream resources and guide their management from a statewide perspective (detailed summaries for each individual management unit are provided electronically to fisheries managers on an annual basis to help guide local management decisions). It is important to note that any difference between classifications (low, medium, and high ranges) presented in the text, figures, and tables throughout this report are intended to be descriptive and have not been tested for statistical significance. Thus, any reference to differences and variability among stream size, temperature, gradient, Great Lakes access, or region do not imply statistical importance.

The second objective of this report is to document the status of salmonid and smallmouth bass populations and their habitat at fixed sites, which will serve as baseline measurements to monitor trends (changes through time) in these valuable fisheries resources. To date, there has been no single source of compiled fisheries data for index stations throughout Michigan. Description of existing conditions at fixed sites (and past trends where historical data are available) provides the foundation for future comparisons of population characteristics and testing of hypothesized reasons for observed change.

This report begins by providing a brief background on the sampling design and survey methods used in the SSTP. Next, statewide patterns in physical stream habitat are presented in the section entitled “Status of Stream Habitat”. The report continues by describing statewide patterns of distribution, abundance, and length frequency of individual fish species in the section entitled “Status of Fishery Resources”. The report concludes by documenting baseline fishery and habitat conditions at fixed sites in the section entitled “Trends in Fishery Resources”. The results presented in this report characterize the broad-scale status of streams, and are presented in a nontechnical manner with a statewide perspective intended to inform a broad audience of scientists, resource managers, policy makers, and the public. Readers wishing to learn more about the status of individual streams should contact their local DNR operations service center.

Methods

Sampling Design

Stratified Random Sampling

The SSTP uses a two-pronged approach to assessing Michigan streams. First, a stratified random approach is used to characterize the fish community and habitat conditions in representative reaches of the different types of streams in Michigan. The primary sampling unit for the stratified random sampling design is the river valley segment (Seelbach et al. 1997, Baker 2006), a contiguous segment of a stream that is characterized by similar hydrology, water quality, channel morphology, riparian land cover, and fish communities along its length. The river valley segment, or simply valley segment, is stratified (i.e., categorized) according to DNR fisheries management unit, stream size (catchment area), and channel gradient or temperature class. Individual valley segments are sampled randomly, without replacement, from each category to ensure a representative, unbiased sample and comparison of different stream types throughout the state. Categories for size strata are based upon the area of the watershed at the midpoint of the valley segment, while temperature strata correspond to the categories described by Wehrly et al. 2003 (Figure 1, Table 1).

Sampling order of individual streams was determined by randomly assigning a number to each valley segment in Michigan (excluding small, warm water segments whose catchment areas were less than 10 mi^2). The resulting 2,107 valley segments were then sorted in ascending order by their randomly assigned number and distributed to field personnel in each fisheries management unit in the state, with instructions to start sampling with the stream at the top of the list and work sequentially towards the bottom. This random list is paired with a published map file from a geographic information system (GIS) to assist field personnel with finding suitable access locations (usually a road crossing) to each valley segment.

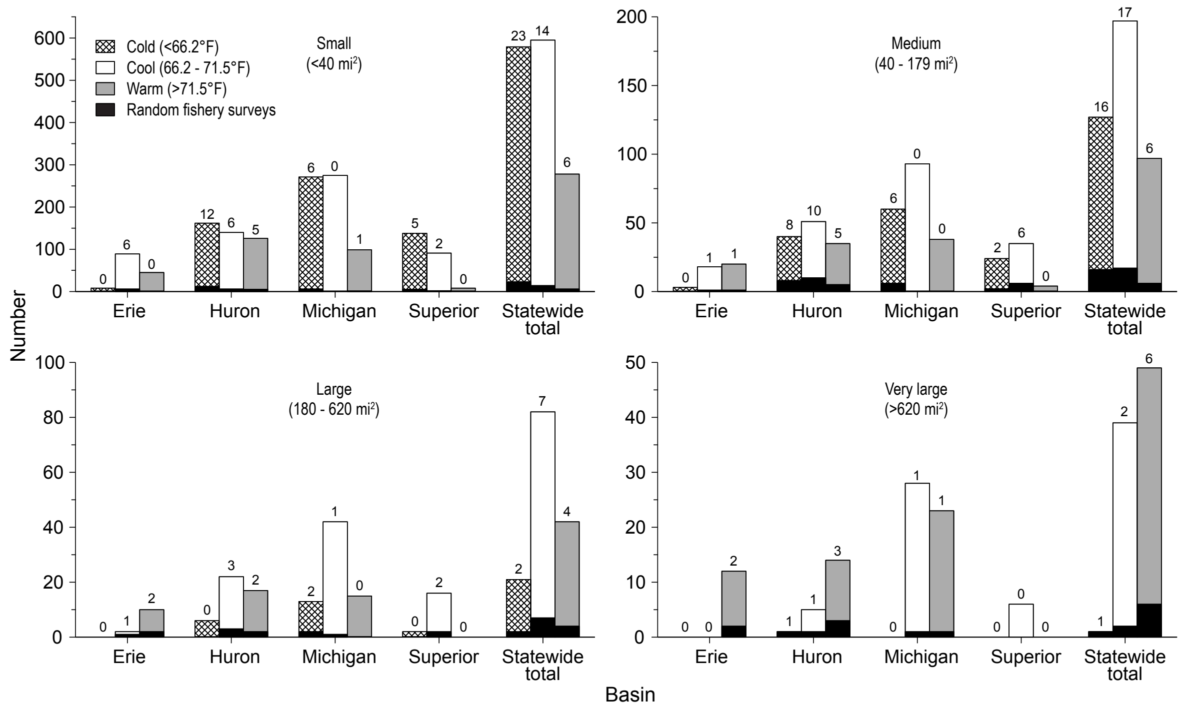

Figure 1.–Number of valley segments present in Michigan by size, temperature, and Great Lakes basin. The dark shading within, and numerals above, each column represent the number of random fishery surveys completed in each category. Note difference in scale of y-axes. Size classes are: small <40 mi², medium 40–179 mi², large 180–620 mi², very large >620 mi². Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

Table 1.–Number of randomly-chosen valley segments sampled (total number of segments in parentheses) in Michigan by size, temperature, and Great Lakes basin. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

Size and temperature classes	Erie	Huron	Michigan	Superior	Statewide total
Small (<40 mi^2)					
Cold	0 (8)	12 (162)	6 (271)	5 (138)	23 (579)
Cool	6 (89)	6 (140)	0 (275)	2 (91)	14 (595)
Warm	0 (45)	5 (126)	1 (99)	0 (8)	6 (278)
Total	6 (142)	23 (428)	7 (645)	7 (243)	43 (1,452)
Medium (40–179 mi^2)					
Cold	0 (3)	8 (40)	6 (60)	2 (24)	16 (127)
Cool	1 (18)	10 (51)	0 (93)	6 (35)	17 (197)
Warm	1 (20)	5 (35)	0 (38)	0 (4)	6 (97)
Total	2 (41)	23 (126)	6 (191)	8 (63)	39 (421)
Large (180–620 mi^2)					
Cold	0 (0)	0 (6)	2 (13)	0 (2)	2 (21)
Cool	1 (2)	3 (22)	1 (42)	2 (16)	7 (82)
Warm	2 (10)	2 (17)	0 (15)	0 (0)	4 (42)
Total	3 (12)	5 (45)	3 (70)	2 (18)	13 (145)
Very large (>620 mi^2)					
Cold	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
Cool	0 (0)	1 (5)	1 (28)	0 (6)	2 (39)
Warm	2 (12)	3 (14)	1 (23)	0 (0)	6 (49)
Total	2 (12)	5 (20)	2 (51)	0 (6)	9 (89)
Grand total	13 (207)	56 (619)	18 (957)	17 (324)	104 (2,107)

Index Stations (Fixed Sites)

Rather than a stratified random sampling approach, the SSTP uses a network of 59 fixed sites, stratified by size (stream width) and connectivity to the Great Lakes, to obtain the high-resolution picture of temporal trends needed in stream types supporting valuable fisheries (e.g., high-quality, wadeable, wild trout and smallmouth bass streams; Table 2). Fixed sites are sampled in multiple 3-years-on, 3-years-off rotations to provide broader geographic coverage throughout Michigan (Figure 2), and yet enable estimates of year-to-year survival of trout at individual sites. Survival estimates for trout are useful for assessing potential effects of management activities, such as changing fishing regulations.

The use of fixed sites allows the ability to determine trends in valuable fisheries through time while also providing a control for river- and site-level characteristics (e.g., river hydrology, local channel characteristics, and woody debris abundance) that can exert considerable influence on fish abundance. Fixed sampling sites are dispersed throughout the state with the sampling effort for each stratum being proportional to the geographic distribution of stream types (i.e., northern Michigan has proportionately more trout sites, while southern Michigan has more smallmouth bass sites). All fixed sites in the SSTP were chosen by fisheries managers and researchers using five criteria, listed in order of priority: 1) presence of a high-quality fishery that is amenable to sampling; 2) presence of a United State Geological Survey (USGS) stream flow gage; 3) the site helps to provide a spatially broad and even geographic coverage of fixed sites; 4) existence of long-term fish abundance data; and 5) simultaneous sampling of other parameters (water quality, macroinvertebrates, etc.) by other agencies or organizations.

Table 2.–Number of fixed sites in Michigan by rotation, strata, and Great Lakes basin. Strata abbreviations are: SLWT = small, landlocked, wild trout; SGLWT = small, Great Lakes access, wild trout, MLWT = medium, landlocked, wild trout; MGLWT = medium, Great Lakes access, wild trout, MSMB = medium smallmouth bass. Rotation years are approximate; some sites were started out of rotation due to delay in finding a suitable location.

Rotation and strata	Erie	Huron	Michigan	Superior	Statewide total
Rotation 1 (2002–2004)					
SLWT	0	4	6	2	12
SGLWT	0	2	4	4	9
MLWT	0	3	3	0	6
MGLWT	0	0	3	0	3
MSMB	1	1	2	0	4
Total	1	10	18	6	35
Rotation 2 (2005–2007)					
SLWT	0	1	4	0	6
SGLWT	0	1	5	2	7
MLWT	0	3	2	0	5
MGLWT	0	0	0	0	0
MSMB	2	2	2	0	5
Total	2	7	13	2	24
Grand total	3	17	31	8	59

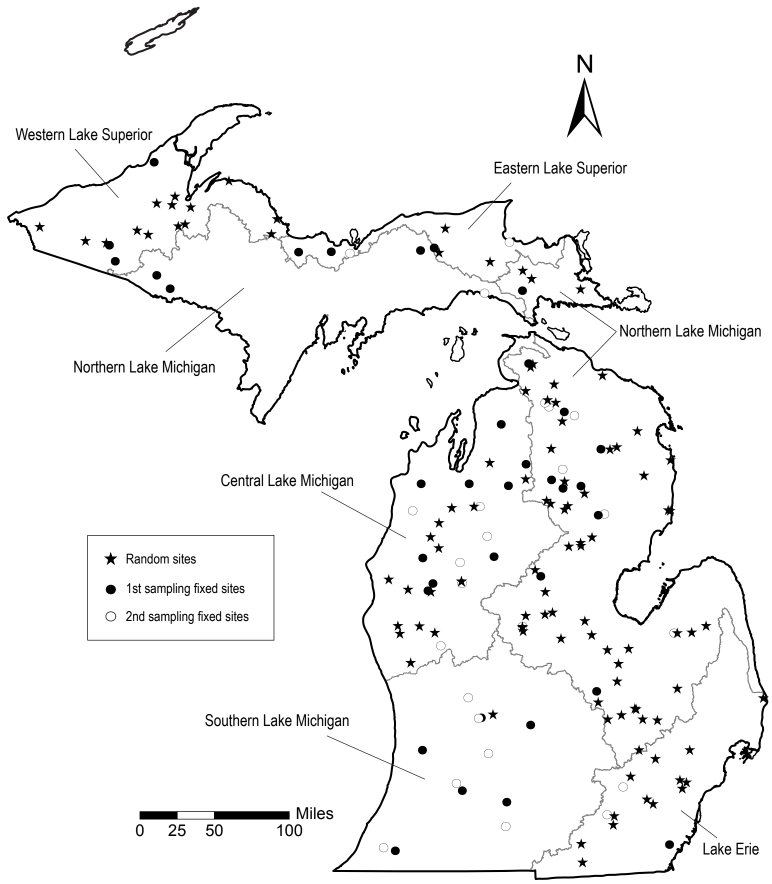

Figure 2.–Geographic distribution of random and fixed sampling locations within Michigan's fisheries management units and Great Lakes basins (individual Great Lakes basins are formed by aggregating fisheries management units; i.e., the Western and Eastern Lake Superior management units form the Lake Superior Basin). Stars = random sites, closed circles = fixed sites, first sampling rotation, open circles = fixed sites, second sampling rotation.

Field Surveys

All fish community data for the SSTP are collected by electrofishing. Surveys at random sites are scheduled between June 15 and September 15 (the low-flow period for most Michigan streams), with a preferred sampling timeframe between July 15 and August 30. In wadeable streams, a single upstream pass covering the entire sampling station is completed with a tow-barge electrofishing unit (or backpack electrofisher if the stream is impassable for a tow-barge), with the length of the sampling station varying between 500 feet and 1500 feet as determined by catchment area and stream width (Wills et al. 2008). The length of these stations roughly equates to 35 stream widths, which Lyons (1992) showed would provide an accurate estimate of fish species richness in Wisconsin streams. A single, one-mile long downstream pass is completed with a boomshocker in nonwadeable streams, which also follows established methods used in Wisconsin (Lyons 2001). Total catch and length information are recorded for all fish species encountered during each random site survey to obtain relative abundance (referred to throughout this report as catch-per-effort, or CPE) data. Fish less than 1 inch long are ignored, and scale samples are collected from a minimum of 10 fish per inch group (when possible) for all salmonids, smallmouth bass, and other species of interest to the local fisheries manager.

At fixed sites, Chapman-Petersen mark-recapture population estimates are made for salmonids to maintain continuity and comparability of data over time at sites with existing long-term data sets. Similar to random sites, surveys are scheduled during the low-flow period of the year, but preferably between August 15 and September 15 when young-of-year salmonids are of sufficient size to recruit to the sampling gear, thereby allowing the most accurate calculation of population estimates. Population estimates for salmonids are completed in one to two days using two passes with a tow-barge electrofishing unit or backpack electrofisher. All salmonids captured on the first pass are measured, marked with a small caudal fin clip, and released; fish caught on the second pass are again measured, examined for marks, and returned to the stream. A single pass covering the entire sampling station is completed by fishing upstream with a tow-barge electrofishing unit to collect CPE data for smallmouth bass because it is not possible to generate valid population estimates for them in Michigan streams (Lockwood et al. 1995). Block nets are optional in all cases. Population estimates or total catch by inch group and species are obtained for salmonids and smallmouth bass in each year of the 3-year sampling cycle; total catch by inch for other fish species is collected from the first half of the station during year two. A minimum of 10 scale samples per inch group (when possible) are collected from all salmonids and smallmouth bass. Station lengths are 1000 feet or the length of the established, long-term sampling station if one exists.

Habitat sampling occurs as close as possible to the time of the fish survey for random sites, and in year 1 of each 3-year sampling cycle for fixed sites. Habitat data include width, depth, and substrate measurements collected at points across equally-spaced transects located throughout the sampling station, as well as riparian vegetation and bank condition measurements collected where transects touch the stream bank. The amount of large woody material and natural and artificial instream structure is counted throughout the entire station, and one streamflow measurement is recorded at the time of habitat sampling in wadeable streams. Hourly temperature measurements are collected from continuously-recording data loggers at minimum from June 1 to August 31 at random sites and year-round for all 3 years of the sampling cycle at fixed sites (Wills et al. 2008).

Data Summaries

The majority of the data in the summary tables and figures from randomly sampled valley segments are presented in ranges classified as low (<25th percentile), medium (25th–75th percentile), and high (>75th percentile). For any given variable, 25% of measurements fall below the 25th percentile and are considered low relative to the medium range, which contains 25–75% of the measured values. Likewise, 75% of measurements fall below the high range; therefore, any value above the 75th percentile is considered high relative to the medium range. Some data from randomly sampled valley segments are presented as the median, or middle, value of the dataset. The median represents a measure of central tendency, or the "average" value in the dataset. We use the median, rather than the mean (true average) as an absolute measurement of central tendency because it is less influenced by extremely low or high observations.

Results

Waters Surveyed

A total of 104 randomly-chosen valley segments (approximately 5% of valley segments that will eventually be sampled by the SSTP) were surveyed during 2002–2007 (figures 1 and 2). The number of surveys completed by DNR fisheries management units (aggregated by Great Lakes basin) ranged from 13 to 56, or 2% to 9% of all valley segments selected for sampling within each basin. Few random surveys appear in the northern and southern Lake Michigan basin due to other competing fisheries management priorities that took precedence at the time. Because stratified random sampling selects valley segments in approximate proportion to their occurrence throughout the state, the majority of waters sampled were small or medium-sized streams. Large to very large rivers occur less frequently in Michigan, and were therefore sampled less frequently (Figure 1, Table 1). During the first (2002–2004) and second (2005–2007) sampling rotations, DNR fisheries management units surveyed 57 of 59 fixed sites throughout the state. The location of one of the two sites not surveyed was changed in mid-rotation due to difficulties surveying the station and will be surveyed 2008–2010, while the other site was delayed until 2011–2013.

Status of Stream Habitat

Habitat is defined as the places where individual fish, fish populations, or fish species assemblages find the physical and chemical features needed to reproduce, grow, and survive. Accordingly, habitat quality affects the number, types, and size of species within a stream fish community (Bain and Stevenson 1999). Since a stream is a landscape-scale system because of its physical extent, the strongest influences on habitat will always be regional climate and geologic setting, which in turn set the stage for local habitat conditions (Wiley and Seelbach 1997).

Regional climate influences the amount and timing of precipitation, which in concert with topography, geology, and land cover within a stream's watershed determine its flow regime (e.g., groundwater- vs. runoff-driven flow, stable vs. flashy flow pattern) and channel morphology (size, shape, and meander). Flow regime and channel morphology determine temperature, bed features (i.e., the amount of pool, riffle, and run habitat), sediment transport, and cover; all of which are important to the fish community. Since Michigan's climate is greatly influenced by its proximity to the Great Lakes, and its geology is influenced by the glaciers that covered the area during the ice age, many of the habitat conditions observed in streams throughout Michigan are beyond the control of the resource managers responsible for them. Nevertheless, it is crucial to quantify the range of habitat conditions across the state. By describing the habitat of different stream types within a given region, the conditions at the local scale that are outside of the expectation but within Fisheries Division's ability to manipulate can be identified.

The SSTP measures habitat variables both outside of the wetted stream channel (riparian zone and bank condition) and within the wetted stream channel (substrate and large woody material) that are known to influence the fish community and are indicative of the condition of the watershed as a whole. For this component of the report, we provide summaries of these variables by stream size and valley slope, or channel gradient. Gradient is one of the most important variables affecting physical habitat in streams because differences in gradient lead to differences in the stream's power to shape its channel, current velocity, sediment and woody material transport, and accordingly the fish community. Due to limited sample sizes (habitat data were not collected during 27 random surveys due to logistical constraints), we grouped segments into three channel gradient classes: very low; low; and moderate to very high gradient (Seelbach et al. 1997, Baker 2006). We also calculated statewide ranges, aggregated across all streams, for habitat conditions because low sample sizes within strata precluded us from calculating an expectation by size and gradient for some habitat variables. We have not included fisheries management unit as a stratum due to the limited number of valley segments sampled and habitat surveys completed (Table 3) during this first reporting period. Instead, we present map-based figures of the status of stream habitat at each individual random site relative to typical values to illustrate the geographic distribution of habitat conditions throughout the state.

Table 3.–Number of valley segments sampled (total number of segments in parentheses) in Michigan by size and gradient. Size classes are: small <40 mi^2, medium 40–179 mi^2, large 180–620 mi^2, very large >620 mi^2. Gradient classes are: very low <4 ft/mi, low 4–10 ft/mi, moderate to very high >10 ft/mi.

	Gradient class									
Size class	Very low		Low		Moderate to very high		No data		Statewide total	
Small	10	(431)	14	(684)	5	(184)	10	(238)	39	(1,452)
Medium	11	(161)	9	(169)	5	(48)	5	(43)	30	(421)
Large	2	(53)	4	(61)	0	(17)	2	(14)	8	(145)
Very large	0	(33)	0	(32)	0	(11)	0	(13)	0	(89)
Grand total	23	(599)	27	(914)	10	(254)	17	(297)	77	(2,431)

Bed Features

The SSTP classifies bed features, or areas of a stream channel that differ in depth and velocity characteristics from adjoining areas, as riffles, runs, or pools. As hydraulic diversity (defined as the number of different types of bed features within a reach, which create a variety of water depth and velocity conditions) increases, so does habitat diversity, and accordingly, the diversity of the fish community. Riffles are a rough, fast water bed feature associated with high valley slope and characterized by small hydraulic jumps over coarse bed material, which causes numerous ripples and waves in the streams surface. Runs are also a fast water bed feature, but occur with lower valley slope, are deeper than riffles, have a smooth water surface, and uniform flow. Pools are a slow water bed feature that is normally smooth, deeper, and wider than the channel units immediately above and below it. Pools often occur in sequence with riffles in streams with high valley slope, and in streams with lower valley slope at the outside of meander bends or where bed material is scoured due to the lack of boulders, wood, or some other hydrologic control.

Runs are the most common type of bed feature found in Michigan streams, followed by riffles and pools (Table 4). This is not surprising, given the large number of very low to low-gradient streams in Michigan (Table 3). However, as gradient increases so does habitat diversity. Throughout the state, very low gradient streams can be expected to contain nearly all run habitat with an occasional riffle in areas of transitional slope, while distinct riffles and pools become more common as gradient increases, with the highest frequency in small to medium, moderate to very high gradient streams (Table 4). Regionally, the highest diversity of bed features occurs in the western Upper Peninsula, with other streams containing pool-riffle sequences scattered throughout the rest of the state where streams flow across former end moraines and other topographically steep landscapes (figures 3 and 4). Many streams in the western Upper Peninsula flow across bedrock (erosion resistant) landscapes and have diverse bed features due to the relatively high abundance of moderate to high-gradient valley slope and the resulting pool-riffle sequences. Streams in the southern Lower Peninsula generally have less habitat diversity due to the low relief of the landscape in this region, with some exception due to local transition in geology or topography.

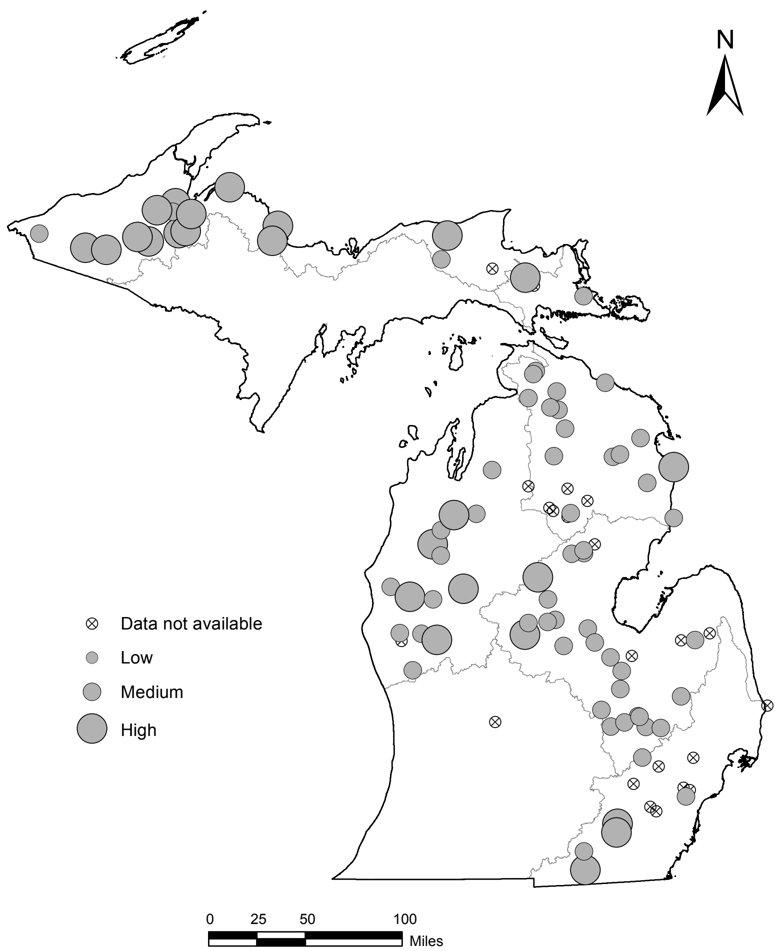

Figure 3.–Percent occurrence of pool habitats at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

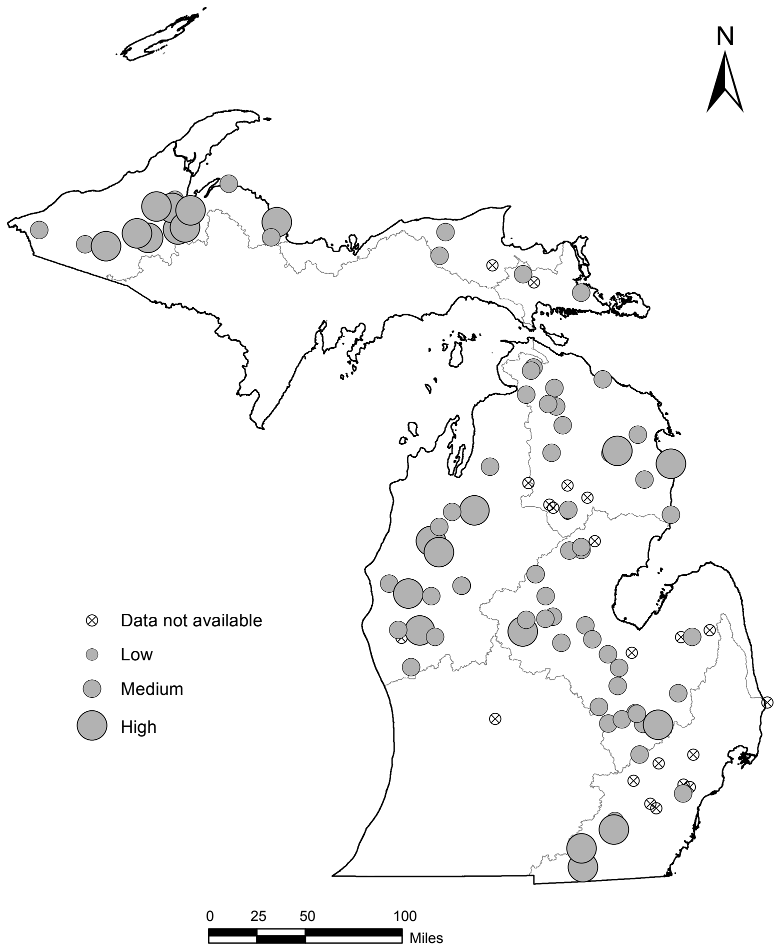

Figure 4.–Percent occurrence of riffle bed feature types at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 4.–Observed ranges of bed feature types, by stream size and gradient, calculated from Stream Status and Trends Program surveys completed between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, ND = not determined. Gradient classes are: very low <4 ft/mi, low 4–10 ft/mi, moderate to very high >10 ft/mi.

		Gradient class											
Bed feature		Very low			Low			Moderate to very high			All streams		
(% occurrence)	Size	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Pool	S	–	0–2	>2	–	0–7	>7	<6	6–71	>71	–	0–10	>10
	M	–	0	>0	–	0–20	>20	–	0–18	>18	–	0–13	>13
	L	–	0	>0	<2	2–28	>28	ND	ND	ND	–	0–8	>8
	All	–	0	>0	–	0–13	>13	–	0–41	>41	–	0–9	>9
Riffle	S	–	0–19	>19	–	0–19	>19	<4	4–39	>39	–	0–21	>21
	M	–	0–9	>9	–	0–32	>32	–	0–50	>50	–	0–14	>14
	L	ND	ND	ND	<2	2–23	>23	ND	ND	ND	<2	2–23	>23
	All	–	0–14	>14	–	0–19	>19	–	0–42	>42	–	0–19	>19
Run	S	<78	78–100	–	<81	81–100	–	<9	9–73	>73	<67	67–100	–
	M	<91	91–100	–	<52	52–100	–	<34	34–100	–	<80	80–100	–
	L	ND	ND	ND	<59	59–93	>93	ND	ND	ND	<60	60–98	>98
	All	<86	86–100	–	<68	68–100	–	<21	21–94	>94	<70	70–100	–

Riparian Zone and Bank Condition

The riparian zone is the interface between land and stream, an area of transition between aquatic and terrestrial ecosystems in which the terrestrial ecosystem influences the aquatic ecosystem, and vice-versa. Riparian zones are ecologically and socially significant in their effects on stream habitat, aesthetics, and overall biodiversity of the river and adjacent terrestrial habitats. A thick corridor of riparian vegetation (grasses, plants, and trees) serves several important roles; for example, reducing the erosive energy of floodwaters, ultimately helping to stabilize stream banks and reduce erosion and sedimentation. Dense or well-established riparian vegetation also provides shade, cover for fish, and filters excess sediments and nutrients (pollutants), thereby improving the overall health of the stream. Mature trees within the riparian zone are crucial to stream health because they serve as a source of large woody material (i.e., branches, logs, log jams, etc.) to the stream. When this large woody debris interacts with the river's current, habitat conditions in the stream channel become more diverse, making it suitable for an even greater variety of aquatic organisms.

Forested riparian types (small and large deciduous or coniferous trees and tag alder) are the most common throughout Michigan, followed by grassland/forb riparian types and agriculture (Table 5). This is not unexpected, given the forested nature of the state's land cover (NOAA 2001). Forested riparian types occur less frequently than anticipated in a number of streams scattered throughout the state, with no clear regional pattern (Figure 5). Occurrence of other riparian types in these areas may be due to local differences in land use. Grassland/forb riparian zones occurred in relatively low frequency throughout Michigan, and surprisingly few agriculture riparian types (cattle pastures or row crops) were encountered during surveys completed from 2002–2007 even though one quarter of Michigan's land cover is agricultural in nature. Agricultural riparian types that were observed were in low frequency in small, very low gradient streams. Agricultural types may be underrepresented in the SSTP dataset due to missing data from the southwest corner of the state (Figure 2) where it is a common land use, or may not be detected at all in streams if wooded riparian corridors extend more than 30' inland from the streambank.

Stable stream banks often show gradual, steady wear of the bank near or below the water (i.e., undercuts) and are associated with densely-vegetated riparian zones. The high frequency of forested riparian types contributes to frequent observation of stable banks throughout most of Michigan. Across all gradient classes, stream banks with less than 25% bare soil (good bank stability) are most common, followed by those with 25–50% bare soil (fair bank stability). Poor to very poor bank stability (>50% bare soil) is less common (Table 6). Regionally, the Southern Lower Peninsula has notably fewer banks classified as good stability (Figure 6) and less undercutting.

Undercut banks, which provide important cover for macroinvertebrates and fish, are formed by meandering that gradually erodes the outer banks of streams, leaving overhanging riparian vegetation and soil that is firmly anchored to the bank by plant roots. Undercuts and measureable stream shore depths, another correlate of habitat diversity, occur most frequently in the northern Lower Peninsula (Figure 7).

Table 5.–Observed ranges of riparian types, by stream size and gradient, calculated from Stream Status and Trends Program surveys completed between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, ND = not determined. Gradient classes are: very low <4 ft/mi, low 4–10 ft/mi, moderate to very high >10 ft/mi.

		Gradient class											
Riparian type		Very low			Low			Moderate to very high			All streams		
(% occurrence)	Size	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Forest	S	<16	16–100	–	<69	69–100	–	<93	93–100	–	<73	73–100	–
	M	<71	71–100	–	<80	80–100	–	<35	35–94	>94	<71	71–100	–
	L	ND	ND	ND	<80	80–99	>99	ND	ND	ND	<79	79–96	>96
	All	<35	35–100	–	<77	77–100	–	<83	83–100	–	<74	74–100	–
Grassland or forb	S	–	0–21	>21	–	0–31	>31	–	0–7	>7	–	0–19	>19
	M	–	0–25	>25	–	0–20	>20	<6	6–22	>22	–	0–23	>23
	L	ND	ND	ND	<1	1–20	>20	ND	ND	ND	<1	1–20	>20
	All	–	0–25	>25	–	0–20	>20	–	0–13	>13	–	0–20	>20
Agriculture	S	–	0–15	>15	–	–	>0	–	–	>0	–	–	>0
	M	–	–	>0	–	–	>0	–	–	>0	–	–	>0
	L	–	–	>0	–	–	>0	ND	ND	ND	–	–	>0
	All	–	–	>0	–	–	>0	–	–	>0	–	–	>0

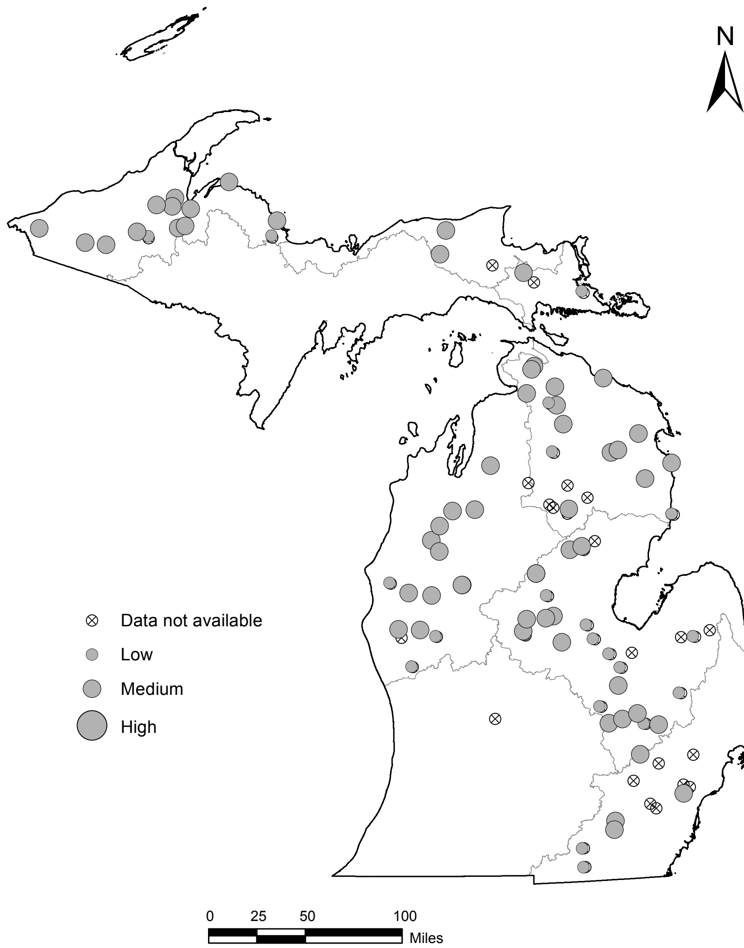

Figure 5.–Percent occurrence of forested riparian types at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 6.–Observed ranges of bank condition ratings and metrics, by stream size and gradient, calculated from Stream Status and Trends Program surveys completed between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, ND = not determined. Gradient classes are: very low <4 ft/mi, low 4–10 ft/mi, moderate to very high >10 ft/mi.

		Gradient class											
		Very low			Low			Moderate to very high			All streams		
Bank condition or metric	Size	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Bank condition rating (% occurrence)													
Good (<25% bare soil)	S	<29	29–100	–	<7	7–97	>97	<37	37–100	–	<36	36–100	–
	M	–	0–67	>67	<54	54–89	>89	<15	15–82	>82	–	0–89	>89
	L	ND	ND	ND	<9	9–89	>89	ND	ND	ND	<45	45–81	>81
	All	–	0–100	–	<33	33–92	>92	<31	31–100	–	<31	31–98	>98
Fair (25-50% bare soil)	S	–	0–31	>31	–	0–41	>41	–	0–37	>37	–	0–32	>32
	M	–	0–35	>35	<8	8–29	>29	<8	8–29	>29	<3	3–35	>35
	L	ND	ND	ND	<11	11–63	>63	ND	ND	ND	<9	9–31	>31
	All	–	0–33	>33	<7	7–33	>33	–	0–36	>36	–	0–33	>33
Poor (50-75% bare soil)	S	–	0–11	>11	–	0–28	>28	–	0–15	>15	–	0–8	>8
	M	–	0–69	>69	–	0–14	>14	<4	4–43	>43	–	0–24	>24
	L	ND	ND	ND	–	0–24	>24	ND	ND	ND	–	0–11	>11
	All	–	0–50	>50	–	0–17	>17	–	0–23	>23	–	0–17	>17
Very poor (>75% bare soil)	S	–	0	>0	–	0	>0	–	0–12	>12	–	0	>0
	M	–	0–15	>15	–	0–7	>7	–	0–17	>17	–	0–7	>7
	L	ND	ND	ND	–	0–13	>13	ND	ND	ND	–	0–13	>13
	All	–	0–4	>4	–	0	>0	–	0–12	>12	–	0–2	>2

Table 6.–Continued.

Bank condition or metric	Size	Gradient class: Very low – Low	Very low – Medium	Very low – High	Low – Low	Low – Medium	Low – High	Moderate to very high – Low	Moderate to very high – Medium	Moderate to very high – High	All streams – Low	All streams – Medium	All streams – High
Metrics													
Number of undercut banks	S	–	0–5	>5	–	0–8	>8	<4	4–11	>11	<2	2–8	>8
	M	–	0–5	>5	<1	1–6	>6	–	0–4	>4	–	0–6	>6
	L	ND	ND	ND	–	0–11	>11	ND	ND	ND	<0	0–8	>8
	All	–	0–5	>5	–	0–8	>8	<1	1–8	>8	<1	1–7	>7
Average undercut depth (ft)	S	<0.5	1–1.7	>1.7	<0.3	0.3–0.9	>0.9	<0.3	0.3–1.2	>1.2	<0.5	0.5–0.9	>0.9
	M	<0.5	1–1.2	>1.2	<0.3	0.3–0.9	>0.9	<0.1	0.3–0.6	>0.6	<0.4	0.4–0.9	>0.9
	L	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.4	0.4–1	>1
	All	<0.5	1–1.1	>1.1	<0.3	0.3–0.9	>0.9	<0.2	0.2–0.9	>0.9	<0.5	0.5–0.9	>0.9
Number of stream-shore depth readings	S	–	0–21	>21	–	0–20	>20	<6	6–23	>23	<2	2–20	>20
	M	–	0–6	>6	<1	1–21	>21	<1	1–15	>15	–	0–18	>18
	L	ND	ND	ND	–	0–6	>6	ND	ND	ND	<0	0–20	>20
	All	–	0–20	>20	–	0–19	>19	<2	2–21	>21	<1	1–20	>20
Average stream-shore depth (ft)	S	<0.3	0.3–0.6	>0.6	<0.2	0.2–0.5	>0.5	<0.2	0.2–0.6	>0.6	<0.2	0.2–0.6	>0.6
	M	<0.6	1–1.1	>1.1	<0.2	0.2–0.5	>0.5	<0.1	0.1–0.4	>0.4	<0.3	0.3–0.8	>0.8
	L	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.2	0.2–0.9	>0.9
	All	<0.3	0.3–0.8	>0.8	<0.2	0.2–0.5	>0.5	<0.2	0.2–0.5	>0.5	<0.2	0.2–0.6	>0.6

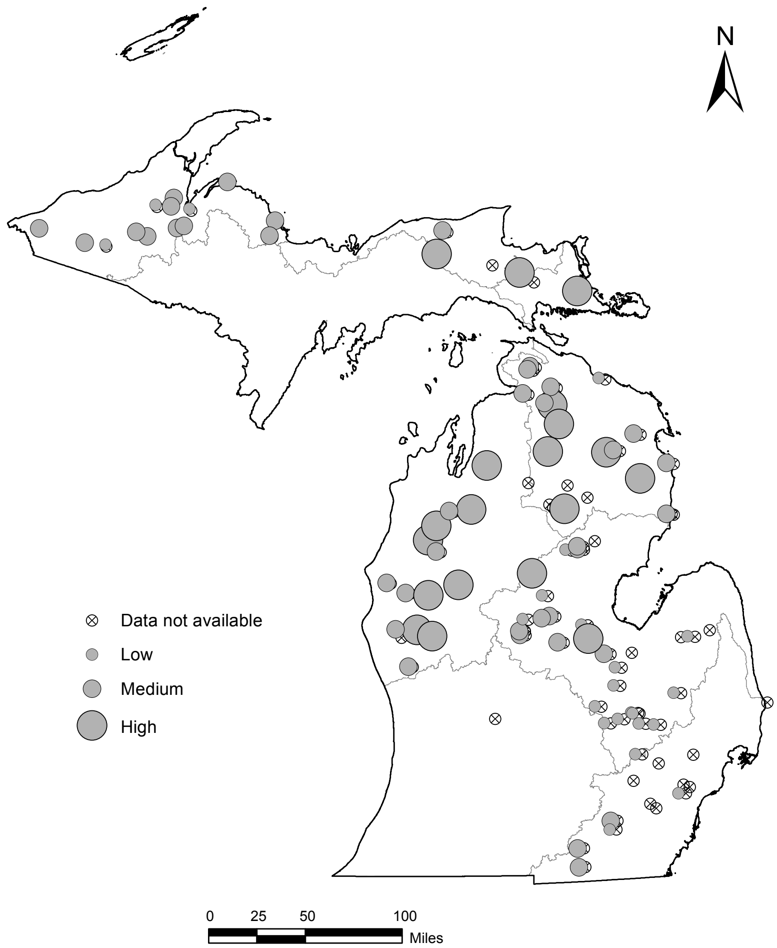

Figure 6.–Percent occurrence of banks rated as having "good" bank stability (<25% bare soil) at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

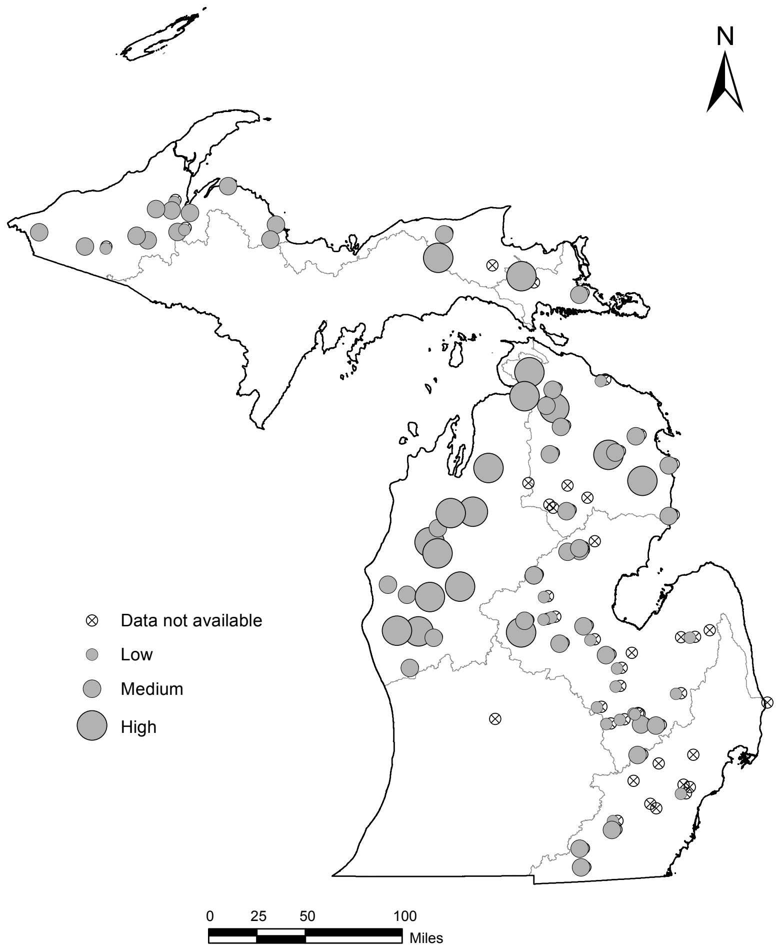

Figure 7.–Number of undercut stream banks at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Large Woody Material and Cover

When large sticks, branches, and entire trees fall into streams, they become important habitat for both aquatic and terrestrial organisms. Large woody material creates additional habitat and food for aquatic invertebrates, provides escape cover for prey fish, ambush cover for predator fish, adds nutrients, traps smaller debris, and supplies feeding, resting, and egg-laying sites for a variety of other wildlife including amphibians, reptiles, birds, and mammals. Large woody material also makes streamflow more turbulent, slowing high water velocities and reducing the river's erosive power. Fallen trees also initiate scour, creating plunge pools that increase hydraulic diversity within the stream channel. Natural recruitment of large woody material can only occur in areas with mature riparian forests, which often take many decades to grow. Substantial amounts of large woody material were removed from Michigan streams during the 19th-century logging era to facilitate transport of logs downstream to sawmills and market, and since then, many streams have received few inputs of large woody material during this long period of reforestation of riparian corridors. Many of Michigan's streams experience exceptionally stable flows, which have drawn residential development to their riparian corridors, with attendant grooming of stream banks. To compensate for these deficiencies, much time and money has been spent on the addition of whole trees and manmade structures to streams to restore cover for aquatic organisms.

The "medium" (25th–75th percentile) density of total cover (the combination of manmade habitat enhancement structure, large woody material [fallen trees], and other natural structure such as log jams and brush deposits) in streams throughout Michigan is rather wide, ranging between 2,500 to 23,000 square feet of cover per acre of water surface, and varies with stream size and gradient (Table 7). Total cover is most abundant in low and very low gradient streams and less abundant in moderate to high gradient streams where stream power becomes sufficient enough to move large woody material and natural structure downstream to lower gradient reaches. The medium density of large woody material is also wide, ranging between 600 to 7,100 square feet per acre, with medium ranges again changing between size and gradient classes. Manmade cover such as individual logs, log jams, lunker structures, rafts, stumps, wing deflectors, and rip-rap makes up a small (though sometimes locally important) proportion of the total amount of cover, while naturally-occurring structure is much more common. Streams in the northern Lower Peninsula have the highest density of total cover, ranging from 6,500 to 46,500 square feet per acre, as well the highest densities of large woody material and manmade and naturally-occurring structure. Densities of total cover classed lower than "medium" were observed in streams scattered throughout the Upper Peninsula and particularly the southern Lower Peninsula (Figure 8). The paucity of cover in some Upper Peninsula streams is most likely due to seasonally high stream power, resulting from high-gradient channels and high spring flow conditions, while in the southern Lower Peninsula, cover in the form of large woody material is often removed from streams to facilitate water transport and reduce flooding.

Table 7.–Observed ranges of instream cover density (ft^2/ac), by stream size and gradient, calculated from Stream Status and Trends Program surveys completed between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, ND = not determined, LWM = large woody material. Gradient classes are: very low <4 ft/mi, low 4–10 ft/mi, moderate to very high >10 ft/mi.

		Gradient class											
Instream		Very low			Low			Moderate to very high			All streams		
cover type	Size	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Manmade	S	–	0	>0	–	0–1,262	>1,262	–	0–420	>420	–	0	>0
structure	M	–	0–6,974	>6,974	–	0–332	>332	–	0–126	>126	–	0–2,261	>2,261
	L	–	0	>0	–	0–398	>398	ND	ND	ND	–	0	>0
	All	–	0	>0	–	0–530	>530	–	0–63	>63	–	0–391	>391
LWM	S	–	0–3,858	>3,858	<266	266–17,182	>17,182	<170	170–3,860	>3,860	<339	339–7,200	>7,200
	M	<1001	1,001–7,566	>7,566	<362	362–6,628	>6,628	<348	348–10,755	>10,755	<920	920–7,625	>7,625
	L	ND	ND	ND	<1,031	1,031–5,885	>5,885	ND	ND	ND	<893	893–4,165	>4,165
	All	<100	100–3,284	>3,284	<544	544–10,080	>10,080	<260	260–4,776	>4,776	<626	626–7,134	>7,134
Natural	S	–	0–7,088	>7,088	–	0–40,819	>40,819	<1,272	1,272–8,453	>8,453	–	0–9,707	>9,707
structure	M	–	0–16,621	>16,621	–	0–9,628	>9,628	–	0–16,347	>16,347	–	0–19,670	>19,670
	L	ND	ND	ND	–	0–56,346	>56,346	ND	ND	ND	–	0–26,660	>26,660
	All	–	0–8,135	>8,135	–	0–14,211	>14,211	–	0–7,827	>7,827	–	0–13,464	>13,464
Total	S	<2,077	2,077–11,891	>11,891	<488	488–51,613	>51,613	<1,441	1,441–12,733	>12,733	<2,883	2,883–19,516	>19,516
woody cover	M	<4,720	4,720–31,650	>31,650	<850	850–16,766	>16,766	<348	348–27,228	>27,228	<2,000	2,000–32,245	>32,245
	L	ND	ND	ND	<1,031	1,031–60,811	>60,811	ND	ND	ND	<1,031	1,031–32,197	>32,197
	All	<2,769	2,769–17,886	>17,886	<650	650–24,263	>24,263	<512	512–12,723	>12,723	<2,543	2,543–23,242	>23,242

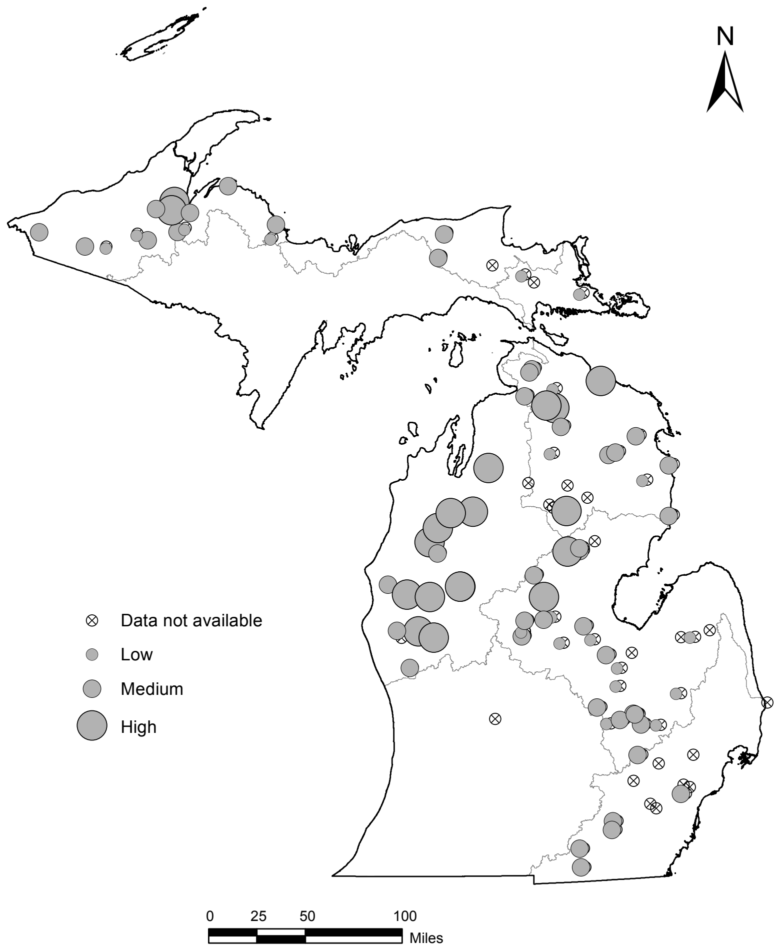

Figure 8.–Density of total instream cover (ft^2/ac) at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Substrate

Substrate is the mineral or organic material that forms the bottom of a water body. In streams, substrate includes detritus (fine organic matter), clay, silt, sand, gravel, cobble, boulders, bedrock, woody material, and plants. Stable substrates, such as gravel or coarser hard substrates, provide habitat for algae and plants to attach, and ultimately food for fish and aquatic invertebrates including insects, crayfish, snails, and mussels. Certain substrates also provide critical spawning habitat for fish. For example, 75 of 114 Michigan fishes spawn on the substrate, and 71 of those 75 species spawn on gravel or coarser substrates (T. Zorn, DNR, unpublished data). Coarse substrate spawners include all trout and salmon, walleye, lake sturgeon, smallmouth bass and other sunfishes, suckers and redhorses, sculpins, and many species of minnows, darters, and catfishes. Trout and salmon spawn over coarse substrates, where their eggs become lodged between pebbles or rocks and oxygenated by the water passing through. Other substrates can be extremely detrimental to spawning fish. Excess sand can cover the coarse substrates preferred by trout and salmon, suffocating eggs that are already deposited or forcing adults to seek alternate spawning areas with more suitable habitat (Alexander and Hansen 1986).

Michigan streams are expected to have a mix of fine (silt, clay, and sand) and coarse (gravel, cobble, and boulder) substrates due to the patchy distribution of different surficial geology types across the state. This is reflected in the medium ranges of each substrate type observed from SSTP data. Fine substrates are slightly more common than coarse substrates statewide; medium ranges also vary widely by stream size and gradient (Table 8). Regionally, the occurrence of fine and coarse substrates was variable (Figure 9). The percent of woody debris and plants observed on sampling transects was low across all stream sizes and gradients.

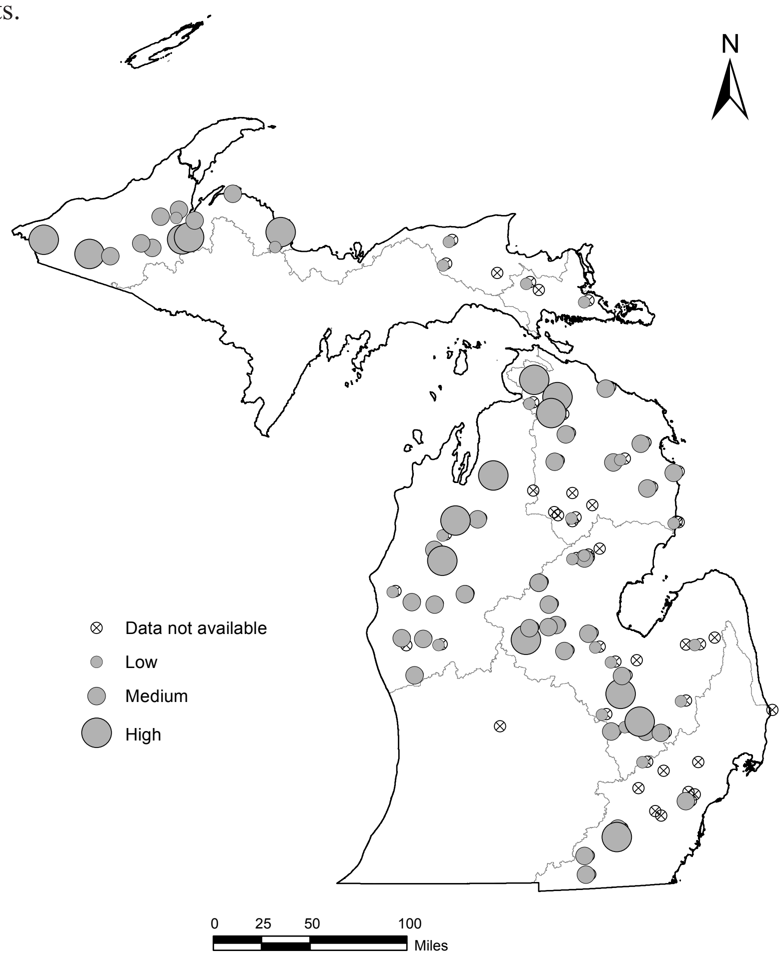

Figure 9.–Percent occurrence of coarse substrate types at random sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 8.–Observed ranges of substrate types, by stream size and gradient, calculated from Stream Status and Trends Program surveys completed between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, ND = not determined. Gradient classes are: very low <4 ft/mi, low 4–10 ft/mi, moderate to very high >10 ft/mi.

		Gradient class											
		Very low			Low			Moderate to very high			All streams		
Substrate type (% occurrence)	Size	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Fine (silt, clay, sand)	S	<32	32–86	>86	<54	54–94	>94	ND	ND	ND	<31	31–93	>93
	M	<23	23–100	–	<12	12–62	>62	<16	16–93	>93	<12	12–84	>84
	L	<9	9–9	>9	<17	17–76	>76	ND	ND	ND	<13	13–89	>89
	All	<29	29–86	>86	<16	16–90	>90	<16	16–96	>96	<18	18–92	>92
Coarse (gravel, cobble, boulder)	S	<14	14–68	>68	<6	6–46	>46	ND	ND	ND	<6	6–69	>69
	M	–	0–77	>77	<38	38–88	>88	<4	4–72	>72	<16	16–86	>86
	L	<91	91–91	>91	<24	24–83	>83	ND	ND	ND	<11	11–87	>87
	All	<14	14–71	>71	<10	10–83	>83	<2	2–81	>81	<8	8–77	>77
Wood	S	–	0–10	>10	<3	3–17	>17	<3	3–28	>28	<3	3–13	>13
	M	<1	1–7	>7	<0	0–11	>11	<0	0–14	>14	<1	1–11	>11
	L	ND	ND	ND	<4	4–8	>8	ND	ND	ND	<2	2–7	>7
	All	<1	1–7	>7	<3	3–11	>11	<2	2–12	>12	<3	3–11	>11
Plants	S	–	0–14	>14	<0	0–6	>6	–	0–10	>10	–	0–3	>3
	M	–	0–2	>2	<0	0–6	>6	<0	0–9	>9	–	0–3	>3
	L	ND	ND	ND	–	0–10	>10	ND	ND	ND	<0	0–11	>11
	All	–	0–3	>3	<0	0–5	>5	–	0–5	>5	–	0–3	>3

Status of Fishery Resources

Michigan's diverse landscape shapes its stream habitats, which in turn shape the fish communities that are present within them. These communities range from simple, small cold water systems with only one or two species to large-river, warmwater communities with over 40 species at a site. Fisheries Division's mission statement clearly indicates its responsibility for stewardship of these resources extends to all types of streams, regardless of game fish potential. Successfully accomplishing this rests on the Division's ability to describe the status of the wide variety of streams throughout the state, and if necessary, respond through management action. Therefore, spatially extensive data describing the status of Michigan's stream fishery resources are crucial to fulfilling Fisheries Division's mission.

The SSTP develops expectations, or benchmarks, to describe stream fishery resources from random survey electrofishing data in terms of the number of different types of species caught (richness), how often they are captured (proportion of occurrence), and their relative abundance, or simply the number of individuals captured per mile of stream sampled. These benchmarks improve a fisheries manager's ability to interpret the significance of the findings from an individual survey, determine what factors may be responsible for those findings, decide whether management action is needed, and identify the types of management actions most likely to have the desired effects.

Fish community surveys were completed at 104 random sites (Figure 2, Table 9) and 57 fixed sites (Figure 2). We begin this section by describing species richness, species of greatest conservation need, and non-native species at both random and fixed sites surveyed throughout Michigan from 2002–2007. Then, we summarize findings for individual species.

Table 9.–Number of randomly-chosen valley segments sampled (total number of segments in parentheses) in Michigan by size and temperature or Great Lakes access. Size classes are: small <40 mi^2, medium 40–179 mi^2, large 180–620 mi^2, very large >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Temperature class						Great Lakes access				Statewide	
Size class	Cold		Cool		Warm		No		Yes		total	
Small	23	(579)	14	(595)	6	(278)	36	(1,021)	7	(431)	43	(1,452)
Medium	16	(127)	17	(197)	6	(97)	28	(289)	11	(132)	39	(421)
Large	2	(21)	7	(82)	4	(42)	10	(109)	3	(36)	13	(145)
Very large	1	(1)	2	(39)	6	(49)	4	(48)	5	(41)	9	(89)
Grand total	42	(728)	40	(913)	22	(466)	78	(1,467)	26	(640)	104	(2,107)

Species Richness

The number of different species present within the community at a particular sampling site or location is referred to as species richness. Richness often varies predictably with certain habitat gradients or environmental factors; for example, the richness of many animal communities (including fish) often increases along a latitudinal gradient from north to south or a temperature gradient from cold to warm. Species richness can also serve as an indicator of stability. Richness is often higher at intermediate levels of disturbance because frequent perturbations (less stable) eliminate the most sensitive species while infrequent perturbations (very stable) allow time for the most competitive species to eliminate those that are less competitive.

Species richness at two thirds (66%) of 161 random and fixed sites sampled from 2002–2007 was within the medium range for other similar sites throughout Michigan. The remaining sites were evenly split between lower than medium or higher than medium species richness (Figure 10). The number of species encountered at random sites tended to increase with both stream size and temperature, with small, cold streams having the lowest number of species and very large, warm streams having the highest number of species (Table 10). Accordingly, it is not surprising that nearly all of the streams with species richness that was higher than medium occurred in the southern half of the Lower Peninsula (Figure 10), where larger, warmer streams (with presumably higher species richness) are more common (Figure 1).

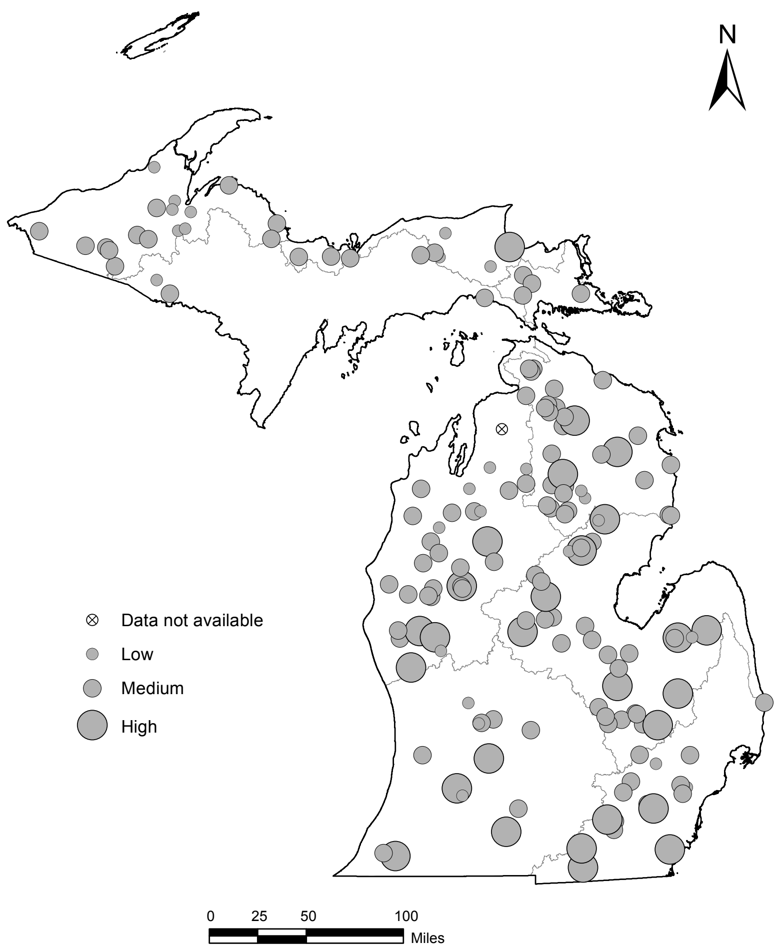

Figure 10.–Species richness at random and fixed sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 10.–Observed ranges of species richness (number of species sampled), by stream size and temperature, calculated from all Stream Status and Trends Program surveys completed between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2, ND = not determined. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Temperature class											
	Cold			Cool			Warm			All streams		
Size	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
S	<4	4–10	>10	<8	8–16	>16	<6	6–15	>15	<6	6–14	>14
M	<7	7–14	>14	<9	9–17	>17	<9	9–16	>16	<8	8–15	>15
L	<6	>6	ND	<12	12–20	>20	<15	>15	ND	<11	11–21	>21
VL	<10	10	>10	<16	>16	ND	<14	14–25	>25	<14	14–23	>23
All	<6	6–13	>13	<9	9–17	>17	<10	10–20	>20	<7	7–16	>16

Species of Greatest Conservation Need

Species of greatest conservation need (SGCN) are defined in Michigan's Wildlife Action Plan as aquatic and terrestrial wildlife species with small or declining populations or other characteristics that make them vulnerable. They include species currently listed as threatened or endangered by either the state or federal government and other species identified through analysis of available data and recommendations from experts on particular taxa of Michigan. There are currently 44 fish SGCN within the state (Eagle et al. 2005).

Eighteen different SGCN species were captured during 56 SSTP surveys of random or fixed sites between 2002 and 2007. Stonecat *Noturus flavus* were the most widely distributed species, occurring in 22 surveys, followed by golden redhorse *Moxostoma erythrurum* (18 surveys) and river chub *Nocomis micropogon* (12 surveys). All other SGCN were captured in fewer than 5 surveys. Golden redhorse were the most frequently encountered species by both number and biomass. The river chub and striped shiner *Luxilus chrysocephalus* were the second and third most frequently occurring species by number, while black redhorse *Moxostoma dusquesnei* and spotted sucker *Minytrema melanops* were the second and third most frequently occurring species by weight (Table 11). The median catch rates of all SGCN at random sites statewide was zero, highlighting their rare occurrence.

The number of different SGCN captured on each survey increased along a gradient from the northwest portion of the Upper Peninsula to the southeast portion of the Lower Peninsula (Figure 11). Many of the streams in southeast Michigan are warm water systems that typically support diverse fish communities and contain species that are at the northern edge of their distribution range. Thus, it is not unexpected to encounter a greater number of species (including SGCN) in this area of the state. However, the region is also subject to intense urbanization and agriculture, which in turn leads to many of the threats associated with declines in SGCN, including riparian modification, altered hydrology, nutrients, and sediment loads, fragmentation, dredging, and channelization, and thermal changes (readers are referred to Eagle et al. 2005 for species-specific threats). Recognition of these threats and incorporation of best management practices to reduce or mitigate for them will help to ensure that SGCN populations persist into the future.

Table 11.–Species of Greatest Conservation Need captured during all Stream Status and Trends Program surveys, 2002–2007. Abbreviations are: E = state endangered species, T = state threatened species, R = random site, F = fixed site, ND = not determined.

			Number of surveys			Total catch	
Common name	Scientific name	Status	R	F	Total	No.	Lbs.
Bigmouth shiner	*Notropis dorsalis*	–	1	0	1	2	0.01
Black redhorse	*Moxostoma duquesnei*	–	2	3	5	37	28.71
Brassy minnow	*Hybognathus hankinsoni*	–	5	1	6	19	0.11
Creek chubsucker	*Erimyzon oblongus*	E	0	1	1	104	2.00
Fantail darter	*Etheostoma flabellare*	–	5	1	6	50	0.22
Finescale dace	*Phoxinus neogaeus*	–	3	0	3	132	0.51
Golden redhorse	*Moxostoma erythrurum*	–	12	6	18	282	187.70
Grass pickerel	*Esox americanus*	–	5	6	11	49	1.84
Lake sturgeon	*Acipenser fulvescens*	T	1	0	1	1	0.03
Pirate perch	*Aphredoderus sayanus*	–	2	1	3	8	0.15
Pugnose minnow	*Opsopoeodus emiliae*	E	1	0	1	5	0.03
River chub	*Nocomis micropogon*	–	4	8	12	237	6.87
River darter	*Percina shumardi*	E	1	0	1	10	0.10
Silver shiner	*Notropis photogenis*	E	0	1	1	10	ND
Spotted sucker	*Minytrema melanops*	–	2	0	2	20	15.88
Stonecat	*Noturus flavus*	–	15	7	22	156	10.38
Striped shiner	*Luxilus chrysocephalus*	–	1	2	3	211	6.00
Tadpole madtom	*Noturus gyrinus*	–	0	1	1	6	ND

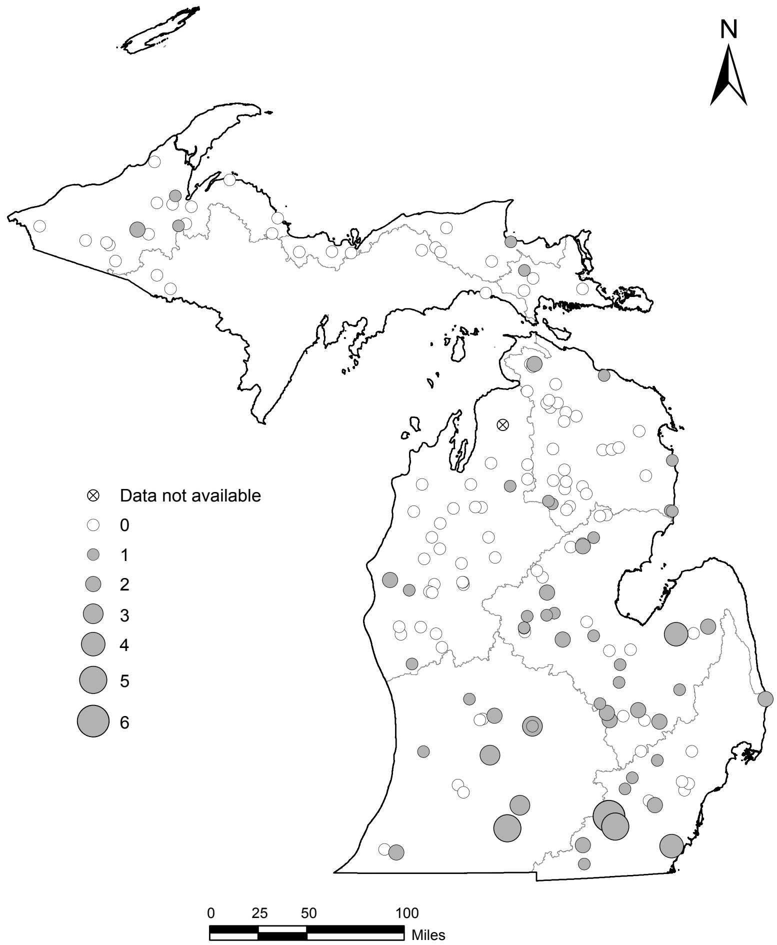

Figure 11.–Location and number of Species of Greatest Conservation Need (SGCN) captured during Stream Status and Trends Program surveys, 2002–2007.

Non-native Species

Non-native species are organisms that are living outside of their naturally-occurring range that have been introduced, either intentionally or unintentionally, by human activity. There are currently 26 introduced fish species in Michigan (Fisheries Division 2002); 11 different non-native species were captured during random and fixed SSTP surveys between 2002 and 2007. Six non-native species captured during these surveys (brown trout *Salmo trutta*, Chinook salmon *Oncorhynchus tshawytscha*, Coho salmon *Oncorhynchus kisutch*, pink salmon *Oncorhynchus gorbuscha*, rainbow trout *Oncorhynchus mykiss*, and redear sunfish *Lepomis microlophus*) are considered desirable and managed for by the DNR. Some (such as Chinook salmon) continue to be stocked in water bodies where natural reproduction is insufficient to maintain populations, while others (such as the brown trout) persist in many waters without further intervention. Other species not managed by the DNR are considered invasive and have the potential to harm native species, disrupt stream ecosystems, and spread to other water bodies.

Five invasive species were captured during 22 SSTP surveys located mostly in the southeastern quarter of the Lower Peninsula (Figure 12). No more than two invasive species were captured during any individual survey. Common carp were the most frequently occurring invasive species; a total of 152 carp with an estimated total weight of nearly 750 lbs were captured during 19 surveys (Table 12). All other invasive species were found in no more than one survey, with relative abundances ranging from 11 fish per mile (white perch) to 515 fish per mile (unidentified gobies).

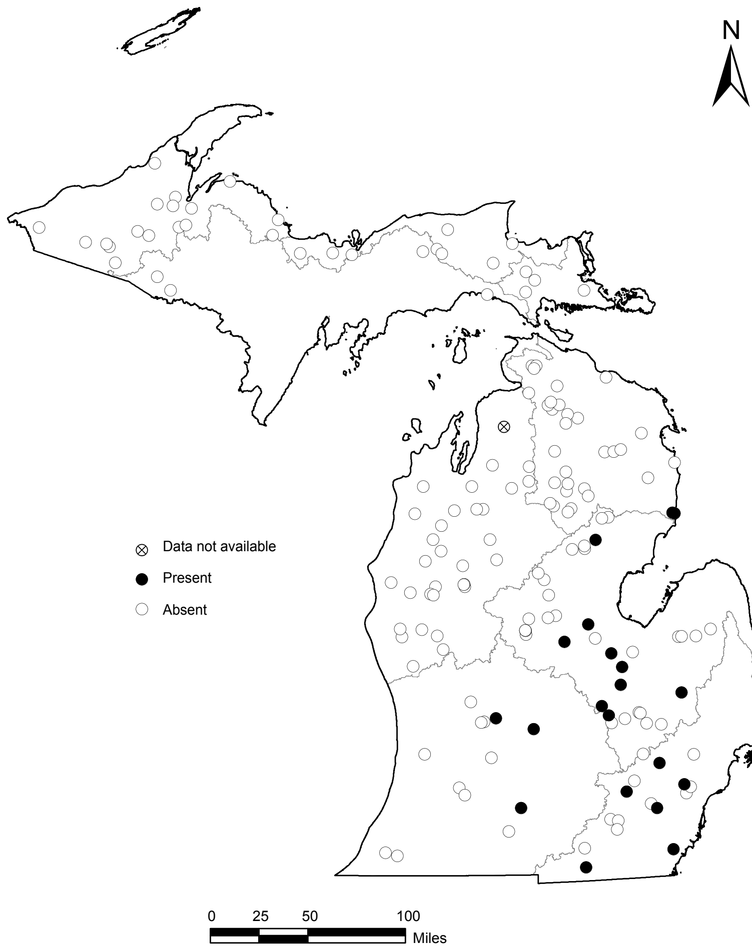

Figure 12.–Location of surveys where invasive species were reported during Stream Status and Trends Program surveys, 2002–2007.

Table 12.–Invasive species captured during all Stream Status and Trends Program surveys, 2002–2007. Median catch rates are only for those surveys where an individual species was captured.

		Number of surveys			Total catch		Median catch rate	
Common name	Scientific name	Random	Fixed	Total	No.	Lbs	No./mile	Lbs/mile
Bigmouth buffalo	*Ictiobus cyprinellus*	1	–	1	4	16.7	18	73
Common carp	*Cyprinus carpio*	14	5	19	152	749.7	21	91
Unidentified gobies	*Gobiidae* species	1	–	1	117	0	515	0
Orangespotted sunfish	*Lepomis humilis*	–	1	1	2	0	14	0
White perch	*Morone americana*	1	–	1	3	0.02	11	0

Individual Fish Species Occurrence and Relative Abundance

We illustrate the distribution of the 103 individual fish species or taxonomic groups encountered during all random and fixed SSTP surveys completed from 2002–2007 (Table 13) with map-based summaries (taxonomic groups are presented for fishes that could not be identified to species in the field). For species or groups captured in at least 5% of all random surveys we summarized their proportion of occurrence and relative abundance by stream size, temperature, and Great Lakes access. When a species or group was encountered in at least 10% of all random stream surveys, we determined length-frequency from the catch and used the map-based summaries to illustrate both distribution and CPE, relative to the statewide medium range (i.e., the 25th to 75th percentile) calculated from random surveys (Table 14). Summaries for species and groups are arranged in phylogenetic order. Readers seeking information on the life history, identification, and fishing regulations of Michigan fishes should consult Bailey et al. (2004), Hubbs et al. (2004), Scott and Crossman (1973), or the DNR web site (www.michigan.gov/dnr).

Table 13.–Proportion of occurrence for 103 individual fish species or taxonomic groups captured during random Stream Status and Trends Program surveys, 2002–2007. Taxonomic groups are indicated by a five-letter abbreviated code ending with "FA". The number of fixed sites where an individual fish species or taxonomic group was encountered is shown in the right-hand column for reporting purposes. N refers to the total number of sites sampled.

Common name	Abbreviated code	Proportion of occurrence	Number of sites random (N=104)	Number of sites fixed (N=57)
White sucker	CWS	0.71	74	38
Creek chub	CRC	0.63	66	29
Johnny darter	JOD	0.50	52	20
Blacknose dace	BND	0.49	51	30
Common shiner	CSH	0.46	48	11
Bluegill	BLG	0.38	40	18
Rock bass	RKB	0.36	37	15
Bluntnose minnow	BNM	0.35	36	12
Brook trout	BKT	0.34	35	39
Central mudminnow	MUD	0.34	35	24
Green sunfish	GSF	0.33	34	18
Brown trout	BNT	0.32	33	36
Northern hog sucker	NHS	0.30	31	11
Pumpkinseed	PSF	0.30	31	12
Largemouth bass	LMB	0.28	29	14
Mottled sculpin	MOS	0.26	27	22
Blackside darter	BSD	0.25	26	10
Unidentified sculpin	SCU FA	0.23	24	21
Yellow perch	YEP	0.22	23	9
Smallmouth bass	SMB	0.21	22	11
Rainbow trout	RBT	0.20	21	27
Hornyhead chub	HHC	0.18	19	11
Longnose dace	LND	0.18	19	13
Rainbow darter	RBD	0.17	18	11
Central stoneroller	CSR	0.16	17	7
Northern pike	NOP	0.15	16	5

Table 13.–Continued.

Common name	Abbreviated code	Proportion of occurrence	Number of sites	
			random (N=104)	fixed (N=57)
Stonecat	STC	0.14	15	7
Common carp	CAR	0.13	14	5
Brook stickleback	BSB	0.13	13	12
Logperch	LOG	0.13	13	6
Golden redhorse	GOR	0.12	12	6
Northern redbelly dace	NRD	0.12	12	13
Spotfin shiner	SFS	0.12	12	7
Emerald shiner	EMS	0.11	11	0
Yellow bullhead	YLB	0.11	11	7
Greenside darter	GSD	0.10	10	6
Black crappie	BCR	0.09	9	3
Mimic shiner	MIS	0.09	9	3
Black bullhead	BLB	0.08	8	0
Golden shiner	GOS	0.08	8	3
Burbot	BUR	0.07	7	3
Sand shiner	SAS	0.07	7	2
Spottail shiner	STS	0.07	7	1
Coho salmon	COS	0.06	6	11
Fathead minnow	FHM	0.06	6	2
Gizzard shad	GZS	0.06	6	0
Shorthead redhorse	SHR	0.06	6	0
Walleye	WAE	0.06	6	0
Brassy minnow	BRM	0.05	5	1
Channel catfish	CCF	0.05	5	2
Fantail darter	FTD	0.05	5	1
Grass pickerel	GRP	0.05	5	6
Greater redhorse	GRR	0.05	5	2
Longear sunfish	LSF	0.05	5	1
Northern brook lamprey	NBL	0.05	5	3
Unidentified redhorse	RHS	0.05	5	1
Rosyface shiner	ROS	0.05	5	8
Blacknose shiner	BNS	0.04	4	1
Bowfin	BOW	0.04	4	0
Brown bullhead	BRB	0.04	4	2
Chinook salmon	CHS	0.04	4	8
Freshwater drum	DRU	0.04	4	0
Pearl dace	PRD	0.04	4	2
River chub	RIC	0.04	4	8
Silver redhorse	SIR	0.04	4	2
Slimy sculpin	SLS	0.04	4	7
Unidentified stickleback	STI FA	0.04	4	2
American brook lamprey	ABL	0.03	3	3
Finescale dace	FSD	0.03	3	0
Hybrid sunfish	HSF	0.03	3	4

Table 13.–Continued.

Common name	Abbreviated code	Proportion of occurrence	Number of sites	
			random (N=104)	fixed (N=57)
Quillback	QIL	0.03	3	0
Trout–perch	TRP	0.03	3	0
Unidentified lamprey	LAM FA	0.02	2	5
Black redhorse	BLR	0.02	2	3
Iowa darter	IOD	0.02	2	0
Longnose gar	LNG	0.02	2	0
Pirate perch	PIP	0.02	2	1
Redfin shiner	RFS	0.02	2	1
Spotted sucker	SPS	0.02	2	0
Unidentified bullhead	BUL FA	0.01	1	0
Blackchin shiner	BCS	0.01	1	0
Bigmouth buffalo	BIB	0.01	1	0
Banded killifish	BKF	0.01	1	1
Bigmouth shiner	BMS	0.01	1	0
Flathead catfish	FCF	0.01	1	1
Unidentified goby	GOB FA	0.01	1	0
Longnose sucker	LNS	0.01	1	0
Pink salmon	PKS	0.01	1	0
Pugnose minnow	PNM	0.01	1	0
River darter	RID	0.01	1	0
Round whitefish	RWF	0.01	1	0
Striped shiner	SRS	0.01	1	2
Lake sturgeon	STN	0.01	1	0
Tiger trout	TIT	0.01	1	1
Warmouth	WAR	0.01	1	0
White bass	WHB	0.01	1	0
White perch	WHP	0.01	1	0
Chestnut lamprey	CNL	–	0	1
Creek chubsucker	CCS	–	0	1
Orangespotted sunfish	OSF	–	0	1
Redear sunfish	RSF	–	0	1
Silver shiner	SIS	–	0	1
Tadpole madtom	TMT	–	0	1

Table 14.–Observed ranges of catch-per-effort (CPE, number of fish per mile) for species occurring in more than 5% of 104 Stream Status and Trends Program random surveys completed in Michigan between 2002 and 2007. Ranges are classified as low = <25th percentile, medium = 25th–75th percentile, and high = >75th percentile; low and high numbers in the medium column are the 25th and 75th percentile values for the stratum. Max values represent the maximum CPE recorded among all surveys. Species are sorted based on the number of surveys where they occurred (N).

Common name	Species code	N	Low	Medium	High	Median	Max
White sucker	CWS	74	<20	20–206	>206	77	2,196
Creek chub	CRC	66	<53	53–818	>818	263	2,530
Johnny darter	JOD	52	<21	21–174	>174	41	1,368
Blacknose dace	BND	51	<35	35–444	>444	244	3,464
Common shiner	CSH	48	<39	39–341	>341	119	12,450
Bluegill	BLG	40	<12	12–57	>57	444	22
Rock bass	RKB	37	<12	13–132	>132	48	442
Bluntnose minnow	BNM	36	<17	17–219	>219	46	929
Brook trout	BKT	35	<29	29–560	>560	152	2,439
Central mudminnow	MUD	35	<13	13–137	>137	42	6,336
Green sunfish	GSF	34	<13	13–53	>53	33	454
Brown trout	BNT	33	<39	39–548	>548	125	2,756
Northern hog sucker	NHS	31	<16	16–158	>158	70	2,640
Pumpkinseed	PSF	31	<7	7–26	>26	13	112
Largemouth bass	LMB	29	<7	7–41	>41	11	227
Mottled sculpin	MOS	27	<32	32–458	>458	211	1,683
Blackside darter	BSD	26	<13	13–60	>602	21	201
Unidentified sculpin	SCU FA	24	<48	48–499	>499	171	1,859
Yellow perch	YEP	23	<4	4–26	>26	13	757
Smallmouth bass	SMB	22	<13	13–69	>69	32	1,505
Rainbow trout	RBT	21	<13	13–128	>128	63	1,672
Hornyhead chub	HHC	19	<26	26–350	>350	48	2,408
Longnose dace	LND	19	<9	9–387	>387	86	1,278
Rainbow darter	RBD	18	<16	16–139	>139	45	716
Central stoneroller	CSR	17	<20	20–180	>180	95	575
Northern pike	NOP	16	<5	5–16	>16	8	53
Stonecat	STC	15	<14	14–48	>48	30	92
Common carp	CAR	14	<9	9–33	>33	21	70
Brook stickleback	BSB	13	<11	11–58	>58	26	253
Logperch	LOG	13	<16	16–62	>62	22	2,671
Golden redhorse	GOR	12	<6	6–61	>61	16	309
Northern redbelly dace	NRD	12	<17	17–69	>69	21	141
Spotfin shiner	SFS	12	<11	11–245	>245	67	3,502
Emerald shiner	EMS	11	<14	14–211	>211	67	803
Yellow bullhead	YLB	11	<4	4–35	>35	8	111
Greenside darter	GSD	10	<18	18–248	>248	40	6,565
Black crappie	BCR	9	<4	4–9	>9	8	32
Mimic shiner	MIS	9	<7	7–136	>136	42	306
Black bullhead	BLB	8	<4	4–19	>19	12	26

Table 14.–Continued.

Common name	Species code	N	Low	Medium	High	Median	Max
Golden shiner	GOS	8	<6	6–11	>11	9	22
Burbot	BUR	7	<5	5–32	>32	16	53
Sand shiner	SAS	7	<9	9–264	>264	143	818
Spottail shiner	STS	7	<9	9–299	>299	13	939
Coho salmon	COS	6	<7	7–32	>32	10	97
Fathead minnow	FHM	6	<7	7–26	>26	17	106
Gizzard shad	GZS	6	<26	26–234	>234	113	242
Shorthead redhorse	SHR	6	<13	13–22	>22	16	60
Walleye	WAE	6	<3	3–5	>5	4	6
Brassy minnow	BRM	5	<5	5–42	>42	16	95
Channel catfish	CCF	5	<13	13–21	>21	14	62
Fantail darter	FTD	5	<26	26–48	>48	32	253
Grass pickerel	GRP	5	<11	11–26	>26	11	42
Greater redhorse	GRR	5	<6	6–10	>10	7	15
Longear sunfish	LSF	5	<15	15–40	>40	16	48
Northern brook lamprey	NBL	5	<6	6–21	>21	11	21
Unidentified redhorse	RHS	5	<18	18–88	>88	68	91
Rosyface shiner	ROS	5	<7	7–32	>32	25	58

Petromyzontidae

- Chestnut lamprey *Ichthyomyzon castaneus* (CNL)

  Chestnut lampreys (a native parasitic lamprey species) were not encountered in any random stream surveys, but were reported at 1 fixed site in the southern Lake Michigan basin (Figure 13, Table 13).

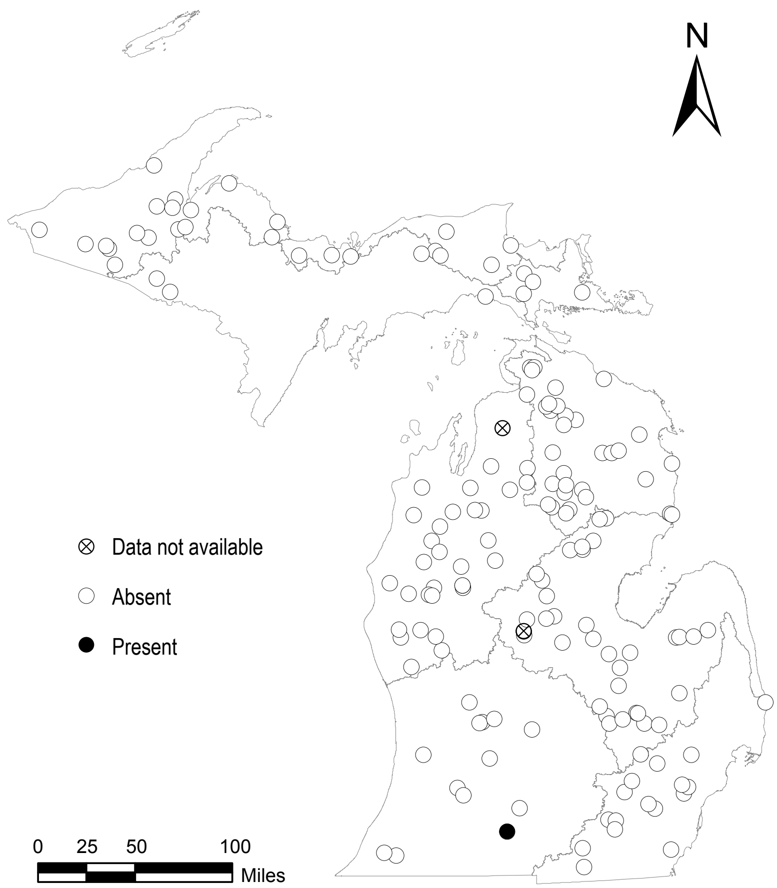

Figure 13.–Map of distribution of chestnut lampreys.

- Northern brook lamprey *Ichthyomyzon fossor* (NBL)

  Northern brook lampreys (a nonparasitic lamprey species) were distributed across the Lower Peninsula in the Lake Huron, Michigan, and Erie basins (Figure 14). They occurred in 5% of all random streams surveyed (Table 13), and were reported at 3 fixed sites.

  Northern brook lampreys were found in cold and cool small streams without Great Lakes access and in cool large streams with Great Lakes access (Table 15). Average CPE across all random surveys did not exceed 3 fish per mile. When encountered, electrofishing CPE of northern brook lampreys typically ranged between 6 and 21 fish per mile, with a maximum CPE of 21 fish per mile.

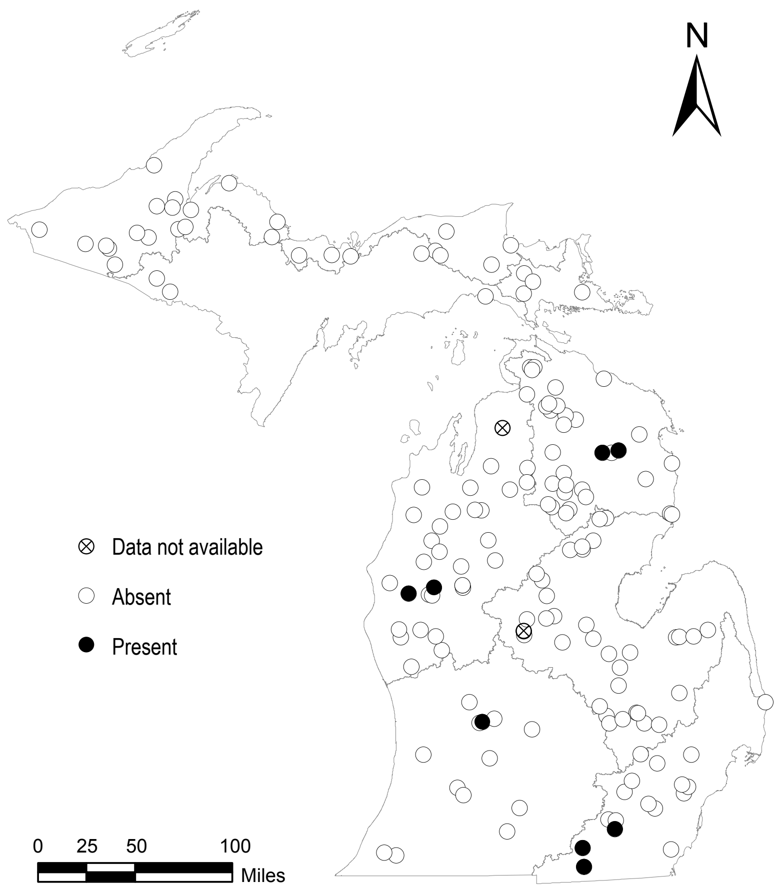

Figure 14.–Map of distribution of northern brook lampreys.

Table 15.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of northern brook lampreys. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.23	0	0.10	0.11	0	0.10	0.9	2.9	0	1.4
M	0	0	0	0	0	0	0	0	0	0	0
L	0	0.14	0	0.08	0	0.33	0.08	0	0.6	0	0.3
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.02	0.10	0	0.05	0.05	0.04	0.05	0.5	1.1	0	0.6

- American brook lamprey *Lampetra appendix* (ABL)

American brook lampreys (a nonparasitic lamprey species) were not widely distributed in Michigan (Figure 15), occurring in only 3% of random streams surveyed (Table 13).

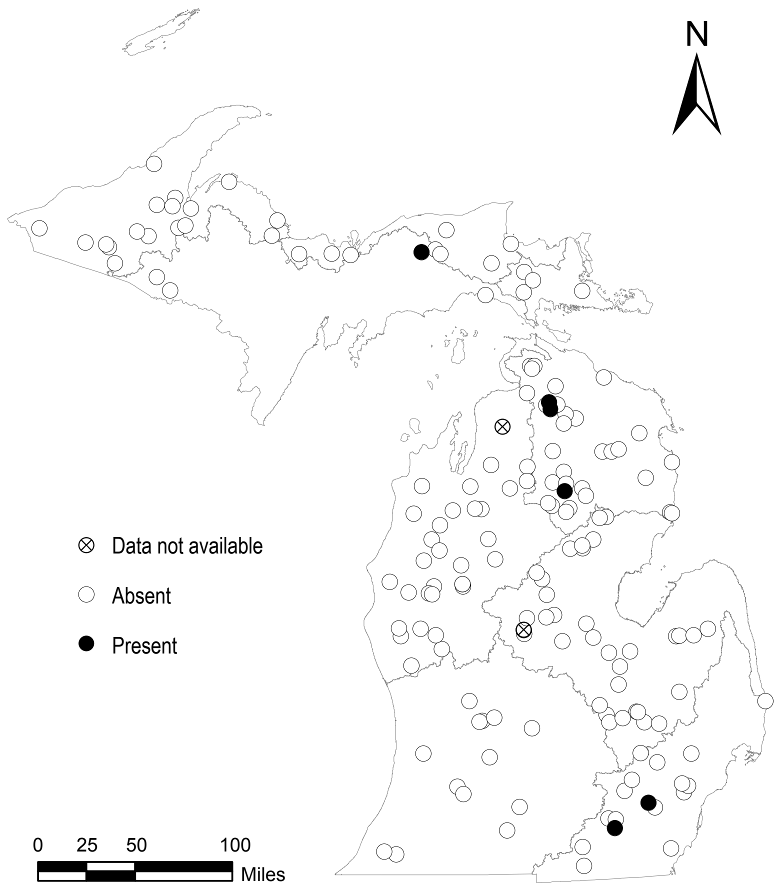

Figure 15.–Map of distribution of American brook lampreys.

- Unidentified lamprey (LAM FA)

  Unidentified lampreys were reported in 2 random stream surveys and at 5 fixed sites (Figure 16, Table 13). We did not calculate proportion of occurrence or typical catch rates for these unidentified specimens.

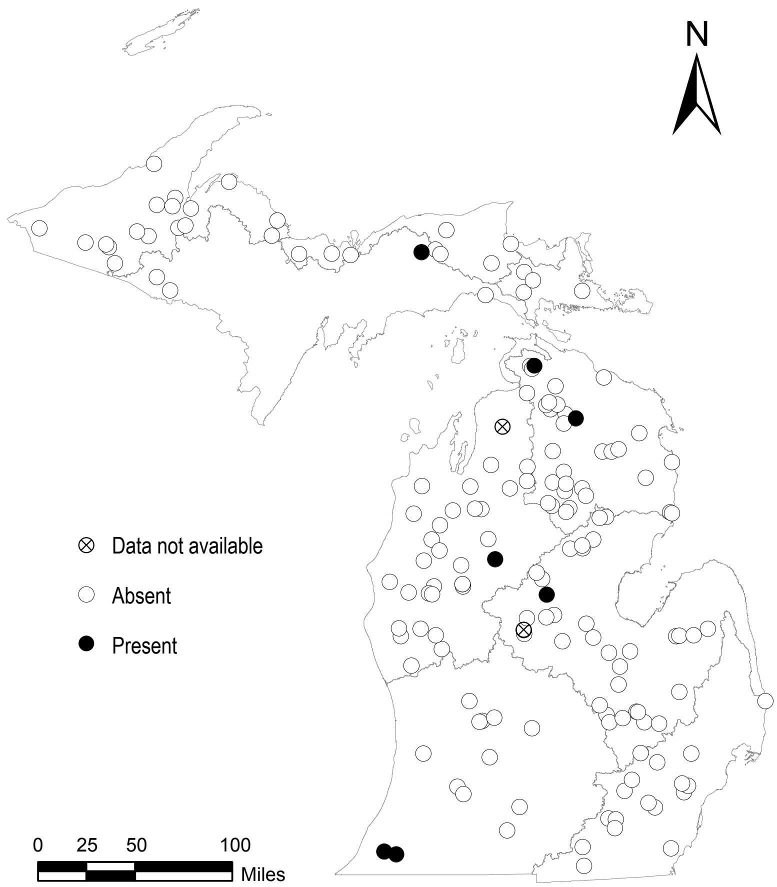

Figure 16.–Map of distribution of unidentified lampreys.

Acipenseridae

- Lake sturgeon *Acipenser fulvescens* (STN)

  Lake sturgeon are a state-listed threatened species and species of greatest conservation need (Table 11). They were reported in only 1 random stream surveyed in the Lake Superior basin of the western Upper Peninsula (Figure 17, Table 13).

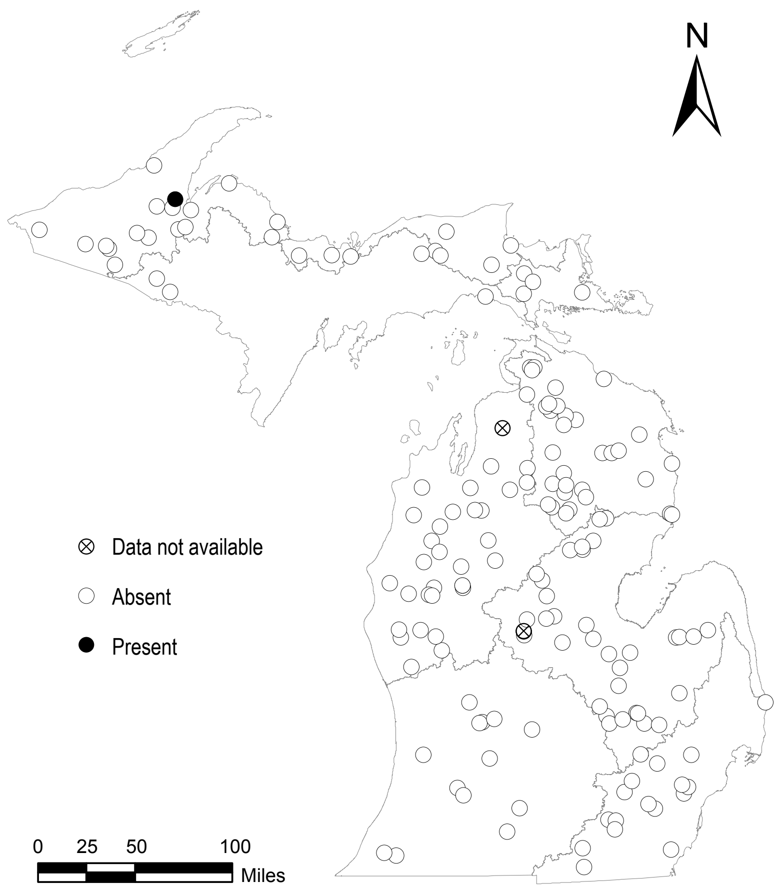

Figure 17.–Map of distribution of lake sturgeon.

Lepisosteidae

- Longnose gar *Lepisosteus osseus* (LNG)

  Longnose gars were not widely distributed in Michigan (Figure 18), occurring in only 2% of random streams surveyed (Table 13).

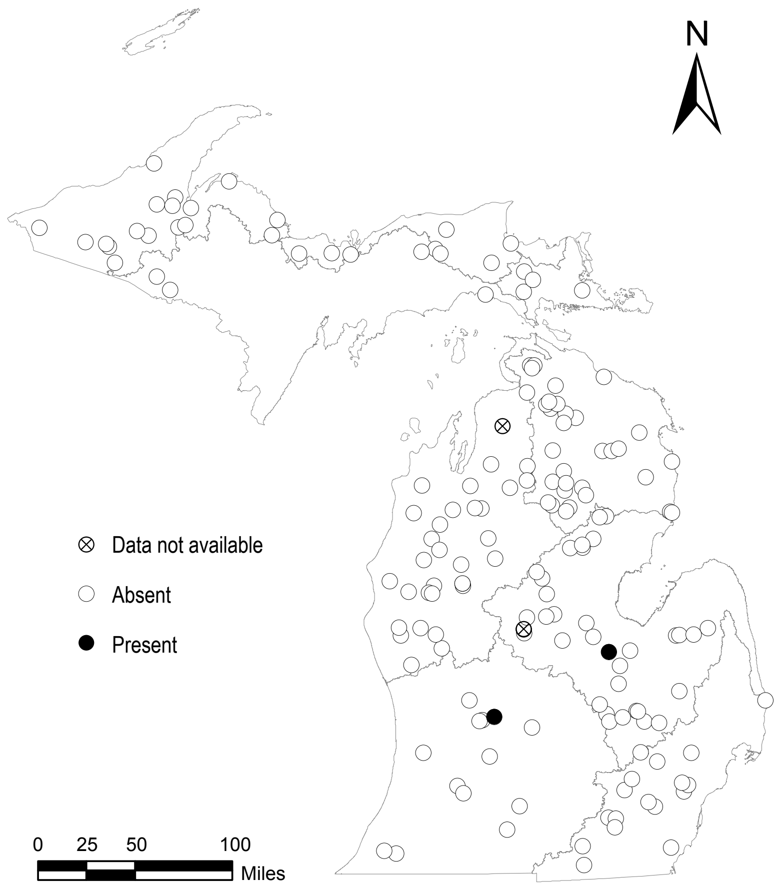

Figure 18.–Map of distribution of longnose gars.

Amiidae

- Bowfin *Amia calva* (BOW)

Bowfins occurred in 4% of random stream surveys (Table 13), all within the Lake Huron and Erie basins in the Lower Peninsula (Figure 19).

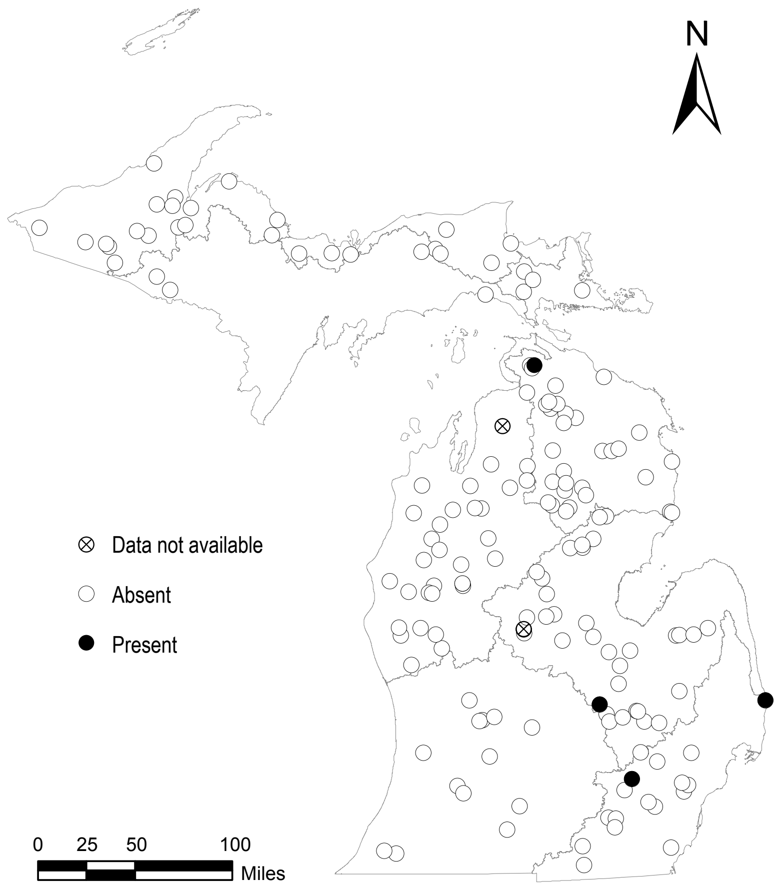

Figure 19.–Map of distribution of bowfins.

Clupeidae

- Gizzard shad *Dorosoma cepedianum* (GZS)

  Gizzard shad were distributed in a small number of streams concentrated in the Saginaw Bay and Thumb area of the Lake Huron basin in the Lower Peninsula (Figure 20). They occurred in 6% of all random streams surveyed (Table 13).

  Gizzard shad occurred in all size classes of streams and were most frequently encountered in warm waters (Table 16). They were reported in small, medium, and large streams without Great Lakes access and in very large streams with Great Lakes access. The highest proportion of occurrence and average CPE across all random surveys was in medium and very large warm streams, respectively. When encountered, electrofishing CPE of gizzard shad typically ranged between 26 and 234 fish per mile, with a maximum CPE of 242 fish per mile.

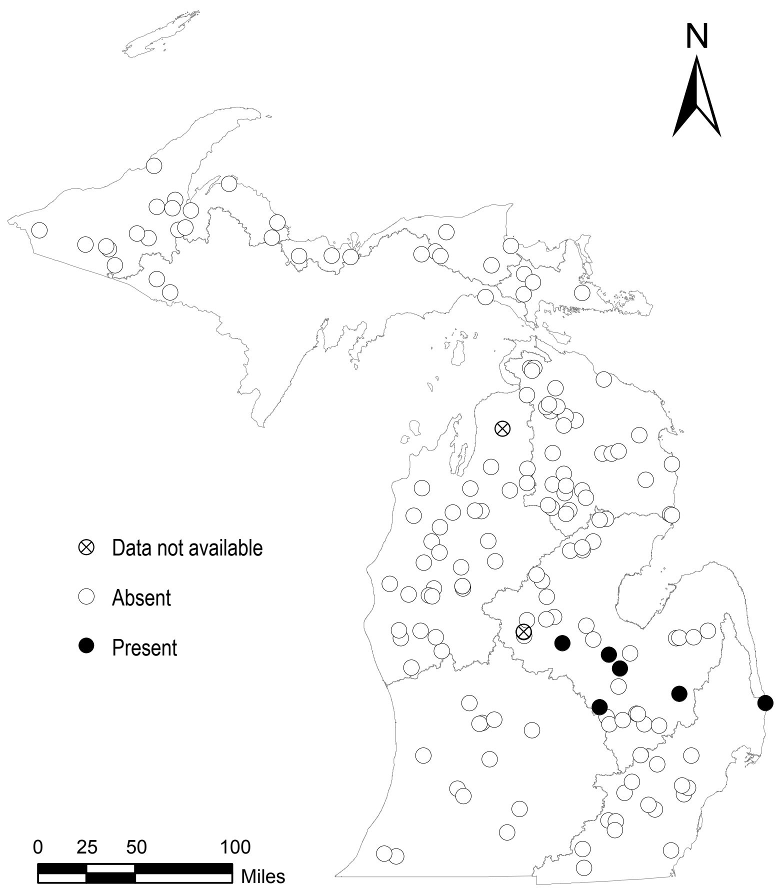

Figure 20.–Map of distribution of gizzard shad.

Table 16.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of gizzard shad. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0	0.02	0.03	0	0.02	0	3.5	0	1.1
M	0	0	0.17	0.03	0.04	0	0.03	0	0	40.3	6.2
L	0	0	0.25	0.08	0.10	0	0.08	0	0	6.5	2.0
VL	0	0	0.50	0.33	0	0.60	0.33	0	0	69.3	46.2
All	0	0.03	0.23	0.06	0.04	0.12	0.06	0	1.2	31.1	7.1

Cyprinidae

- Central Stoneroller *Campostoma anomalum* (CSR)

Central stonerollers were widely distributed in the southeastern quarter of the Lower Peninsula within the Lake Huron, Michigan, and Erie basins (Figure 21). They did not occur in any other region of Michigan. Central stonerollers occurred in 16% of random stream surveys and at 7 of 57 fixed sites sampled throughout the state (Table 13).

Central stonerollers were reported in all size and temperature classes of streams and in greater proportion among waters without Great Lakes access (Table 17). Their proportion of occurrence was variable by stream size and increased with temperature. The highest average CPE of central stonerollers across all random surveys was in warm medium streams. When encountered, electrofishing CPE of central stonerollers typically ranged between 20 and 180 fish per mile, with a maximum CPE of 575 fish per mile.

The size distribution of 337 central stonerollers measured during random stream surveys ranged from 1 to 6 in (Figure 22). The bell-shaped curve was centered on 3 in fish, which comprised over one third (38%) of the total catch.

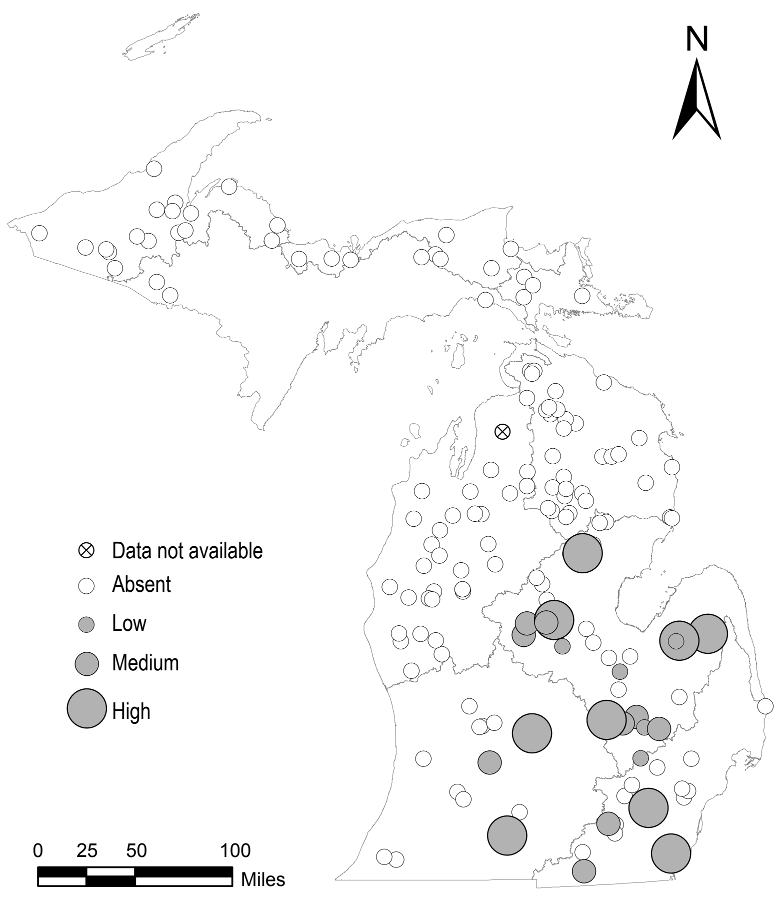

Figure 21.–Map of distribution of central stonerollers. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 17.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of central stonerollers. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.23	0.50	0.17	0.19	0	0.17	7.2	24.8	48.8	18.6
M	0.06	0.18	0.33	0.15	0.21	0	0.15	27.1	21.0	108.0	36.9
L	0	0.29	0.25	0.23	0.30	0	0.23	0	14.3	1.3	8.1
VL	0	0	0.17	0.11	0	0.20	0.11	0	0	1.2	0.8
All	0.05	0.21	0.32	0.17	0.21	0.04	0.17	14.2	20.0	43.3	22.6

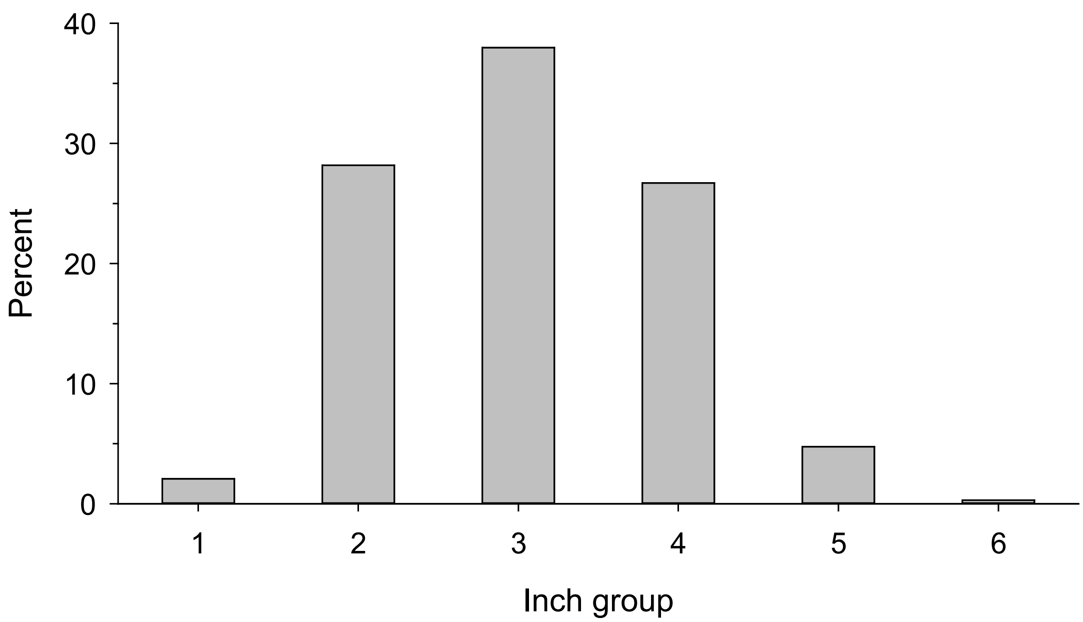

Figure 22.–Size distribution of central stonerollers.

- Spotfin Shiner *Cyprinella spiloptera* (SFS)

Spotfin shiners were widely distributed throughout the southeastern quarter of the Lower Peninsula in the Lake Huron, Michigan, and Erie basins (Figure 23). They occurred in 12% of random stream surveys and at 7 of 57 fixed sites sampled throughout the state (Table 13).

Spotfin shiners were reported in all size classes of streams, and in cool and warm temperature groups (Table 18). Their proportion of occurrence was greatest in large and very large streams and was similar regardless of access to the Great Lakes. The highest average CPE of spotfin shiners across all random surveys was in very large warm streams. When encountered, electrofishing CPE of spotfin shiners typically ranged between 11 and 245 fish per mile, with a maximum CPE of 3,502 fish per mile.

The size distribution of 1,031 spotfin shiners measured during random stream surveys ranged from 1 to 5 in (Figure 24). Fish in the 2–3 in size group comprised nearly all (95%) of the total catch.

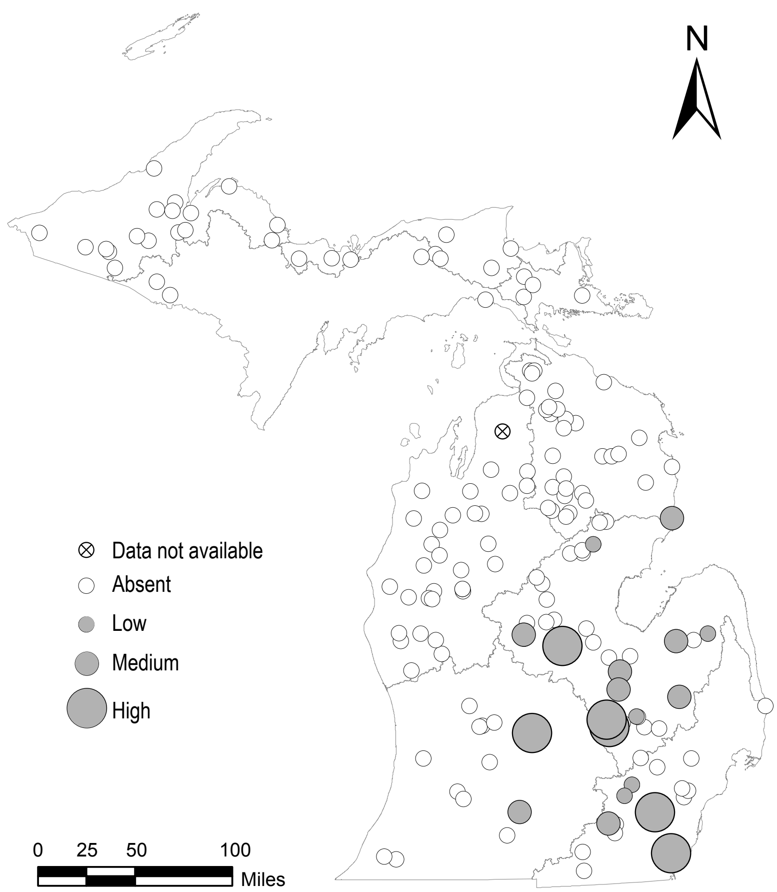

Figure 23.–Map of distribution of spotfin shiners. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 18.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of spotfin shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0.33	0.07	0.08	0	0.07	0	13.7	3.7	4.8
M	0	0.06	0.17	0.05	0.04	0.09	0.05	0	0.3	7.7	1.3
L	0	0.29	0.75	0.38	0.40	0.33	0.38	0	15.1	243.0	82.9
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	599.0	399.3
All	0	0.10	0.36	0.12	0.12	0.12	0.12	0	7.4	210.6	47.8

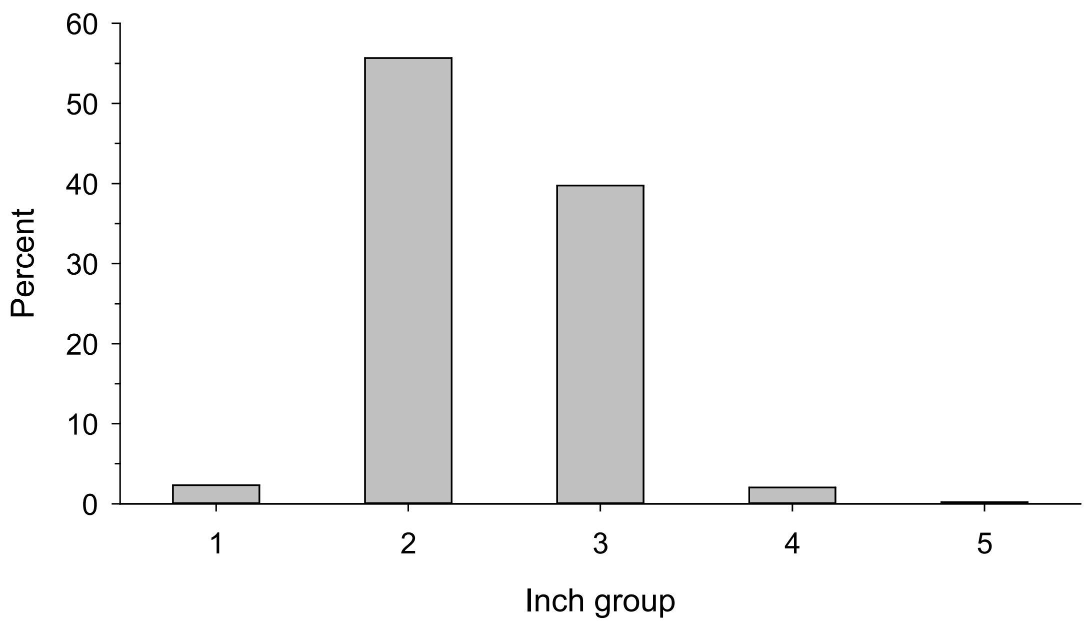

Figure 24.–Size distribution of spotfin shiners.

- Common carp *Cyprinus carpio* (CAR)

  Common carp, an invasive species (Table 12), were mostly distributed throughout the southeast quarter of the Lower Peninsula in the Lake Huron, Michigan, and Erie basins (Figure 25). They occurred in 13% of random stream surveys and at 5 of 57 fixed sites sampled throughout the state (Table 13).

  Common carp proportion of occurrence was greatest in very large streams, and increased with water temperature (Table 19). There was relatively little difference in proportion of occurrence between streams with or without Great Lakes access. The highest average CPE of common carp across all random surveys occurred in very large warm streams; when encountered, electrofishing CPE typically ranged between 9 and 33 fish per mile, with a maximum CPE of 70 fish per mile.

  The size distribution of 138 common carp measured during random stream surveys ranged from 4 to 30 in (Figure 26). The distribution was skewed towards larger individuals; fish in the 18–22 in size group comprised nearly one half (45%) of the total catch. Smaller fish in the 6–12 in size group were relatively rare.

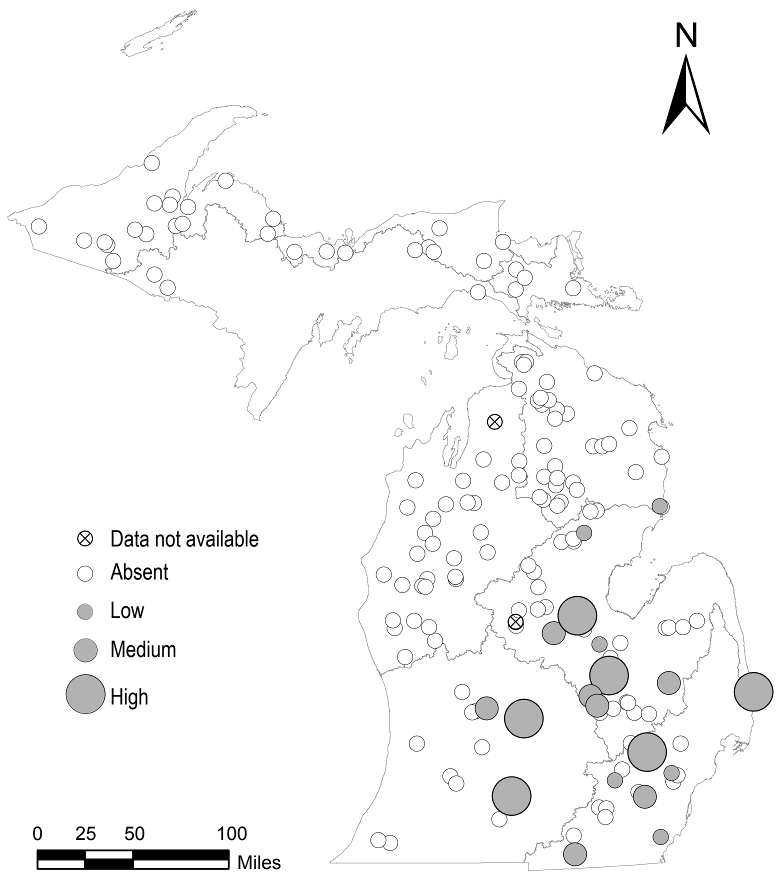

Figure 25.–Map of distribution of common carp. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 19.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of common carp. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.23	0	0.07	0.08	0	0.07	0	4.1	0	1.3
M	0	0.12	0.33	0.10	0.11	0.09	0.10	0	2.5	10.7	2.7
L	0	0	0.25	0.08	0.10	0	0.08	0	0	5.3	1.6
VL	0	0.50	0.83	0.67	0.75	0.60	0.67	0	3.5	29.7	20.6
All	0	0.15	0.36	0.14	0.13	0.16	0.14	0	2.6	12.0	3.5

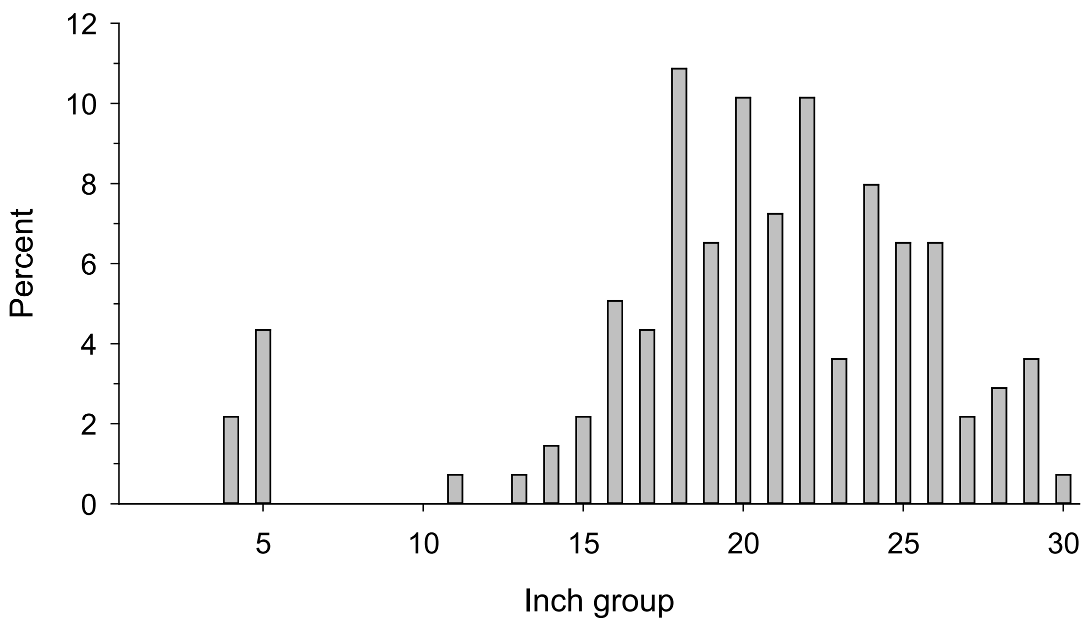

Figure 26.–Size distribution of common carp.

• Brassy minnow *Hybognathus hankinsoni* (BRM)

Brassy minnows are a state-listed species of greatest conservation need (Table 11). They occurred at a small number of sites in the Upper Peninsula (Lake Superior basin) and northern half of the Lower Peninsula (Lake Huron basin, Figure 27). Brassy minnows were reported in 5% of all random streams surveyed and at one fixed site (Table 13).

Brassy minnows were found in all temperature classes of streams and in small through large size classes (Table 20). They occurred more frequently as temperature increased; in small- and large- sized streams they were only found in waters without Great Lakes access. Although the highest proportion of occurrence across all random surveys was in large warm streams, the highest average CPE was in small warm streams. When encountered, electrofishing CPE of brassy minnows typically ranged between 5 and 42 fish per mile, with a maximum CPE of 95 fish per mile.

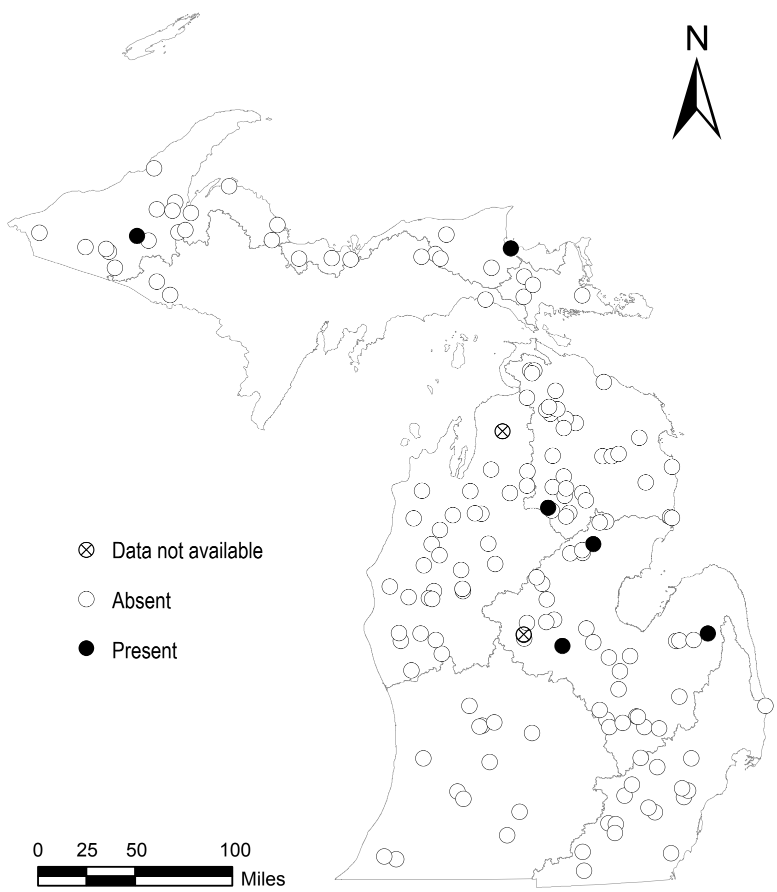

Figure 27.–Map of distribution of brassy minnows.

Table 20.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of brassy minnows. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0.17	0.02	0.03	0	0.02	0	0	15.8	2.3
M	0.06	0.12	0	0.08	0.04	0.18	0.08	2.6	1.2	0	1.6
L	0	0	0.25	0.08	0.10	0	0.08	0	0	1.3	0.4
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.02	0.05	0.09	0.05	0.04	0.08	0.05	1.0	0.5	4.5	1.6

- Bigmouth shiner *Hybopsis dorsalis* (BMS)

  Bigmouth shiners are a state-listed species of greatest conservation need (Table 11). They were reported in only 1 random stream survey within the Lake Superior basin in the western Upper Peninsula (Figure 28, Table 13).

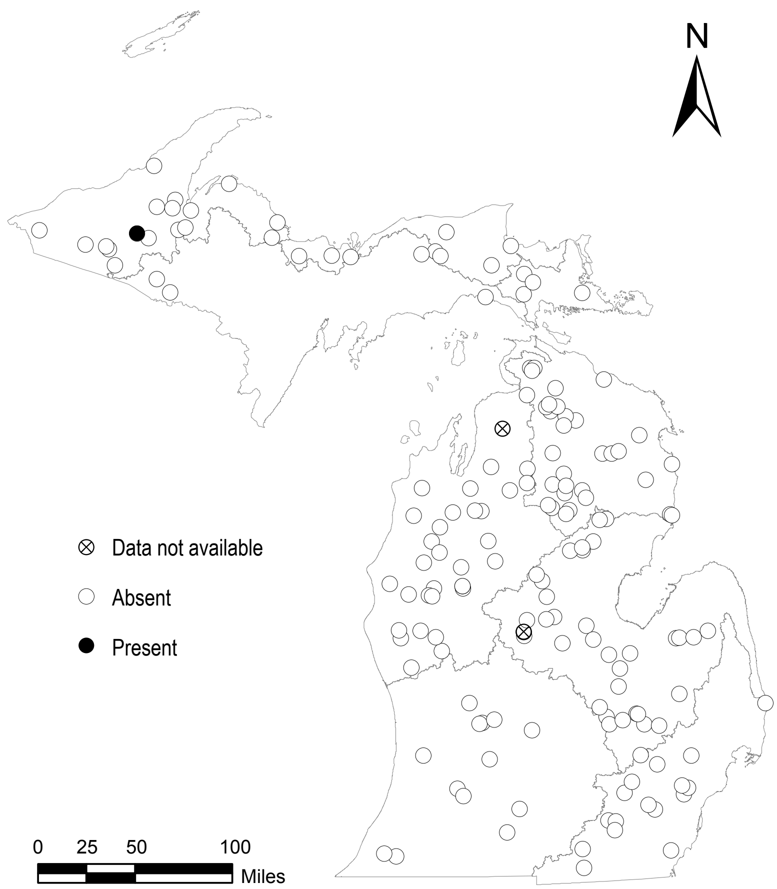

Figure 28.–Map of distribution of bigmouth shiners.

• Striped shiner *Luxilus chrysocephalus* (SRS)

Striped shiners are a state-listed species of greatest conservation need (Table 11). They occurred in only 1 random stream surveyed and at 2 fixed sites, all within the Lake Erie basin (Figure 29, Table 13).

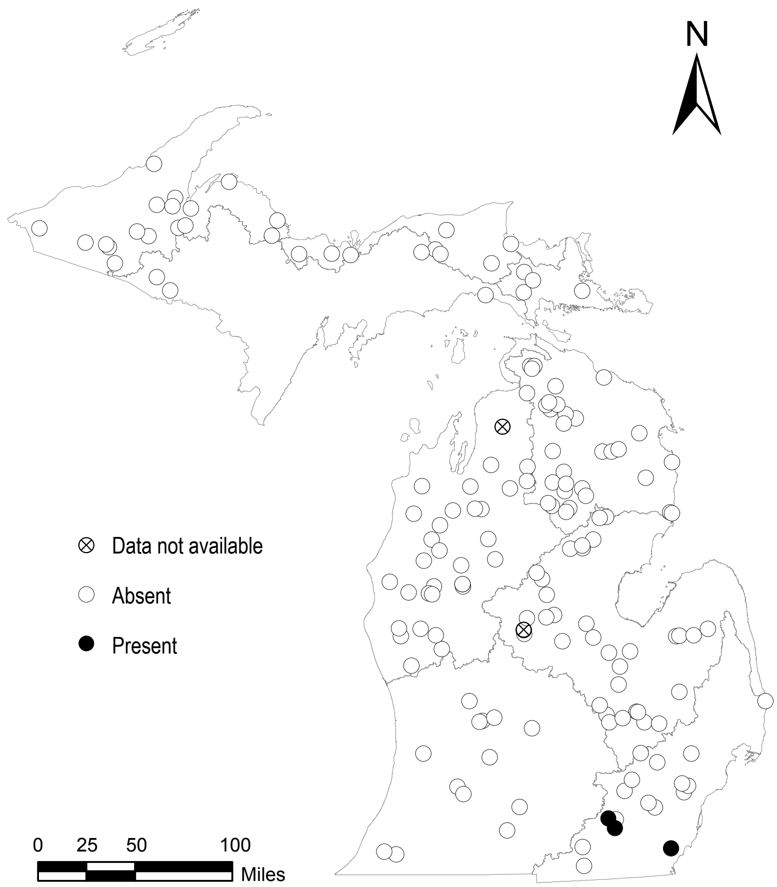

Figure 29.–Map of distribution of striped shiners.

• Common shiner *Luxilus cornutus* (CSH)

Common shiners were the fifth most frequently encountered species in Michigan streams, occurring in 46% of random surveys (Table 13). They were also reported at 11 of 57 fixed sites sampled throughout the state.

Common shiners were widely distributed across the Lower Peninsula and western Upper Peninsula (Figure 30), occurring in each Great Lakes basin and all size and temperature classes of streams. Across all surveys, they occurred in nearly equal proportion among waters with or without Great Lakes access (Table 21). Their proportion of occurrence varied by size and temperature class, and the highest average CPE was in small cool waters. When encountered, electrofishing CPE of common shiners typically ranged between 39 and 341 fish per mile, with a maximum CPE of 12,450 fish per mile.

The size distribution of 3,001 common shiners measured during random stream surveys ranged from 1 to 7 in (Figure 31). Small, 2–3 in fish comprised more than three-quarters (76%) of the total catch. Common shiners greater than 5 in total length were relatively rare, comprising less than 5% of the total catch.

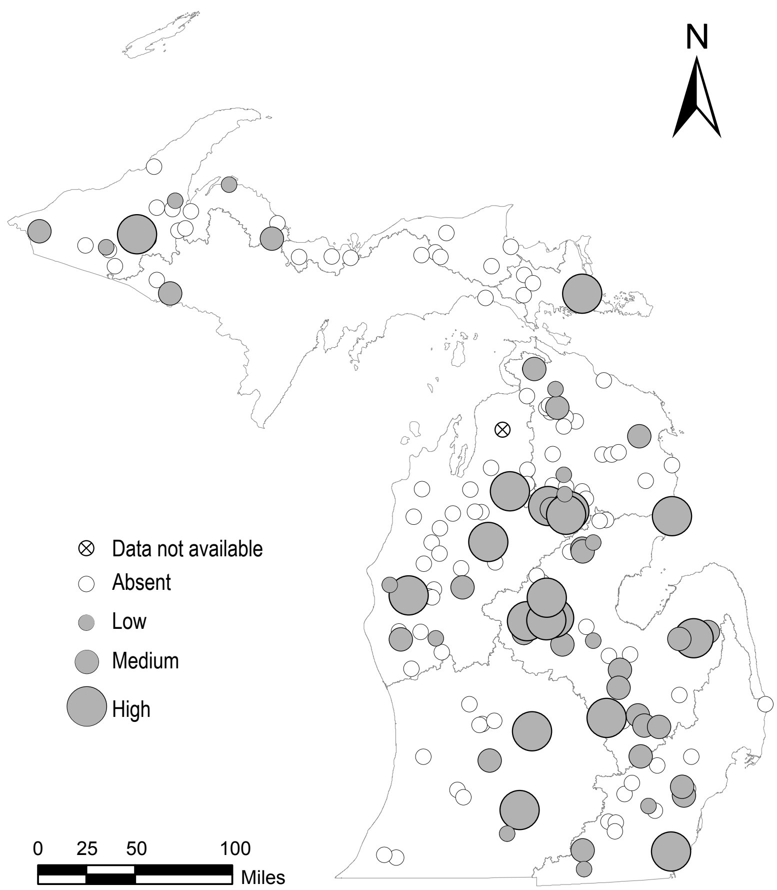

Figure 30.–Map of distribution of common shiners. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 21.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of common shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.17	0.54	0.67	0.36	0.42	0	0.36	33.4	1,002.8	63.8	337.8
M	0.44	0.71	0.83	0.62	0.61	0.64	0.62	264.9	190.9	759.8	308.8
L	0	0.71	0.25	0.46	0.30	1.00	0.46	0	151.4	55.5	98.6
VL	0	1.00	0.17	0.33	0.25	0.40	0.33	0	30.0	16.5	17.7
All	0.26	0.67	0.50	0.47	0.46	0.48	0.47	119.2	446.2	239.2	268.7

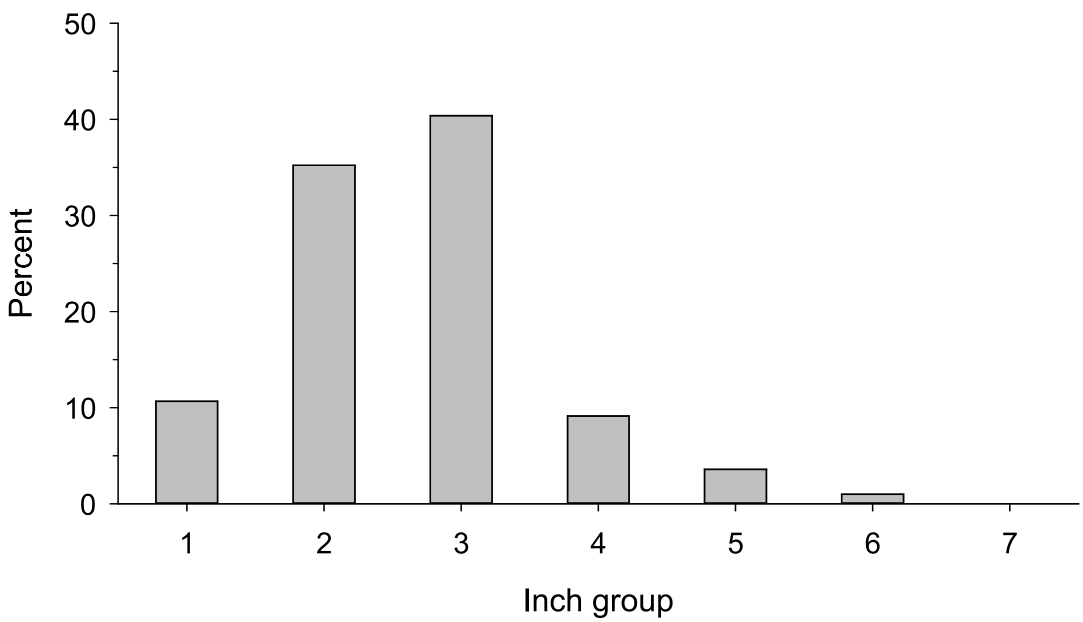

Figure 31.–Size distribution of common shiners.

- Redfin shiner *Lythrurus umbratilis* (RFS)

Redfin shiners occurred in only 2% of random streams surveyed and at 1 fixed site (Table 13), all of which were located within the Lake Huron and Erie basins in the Lower Peninsula (Figure 32).

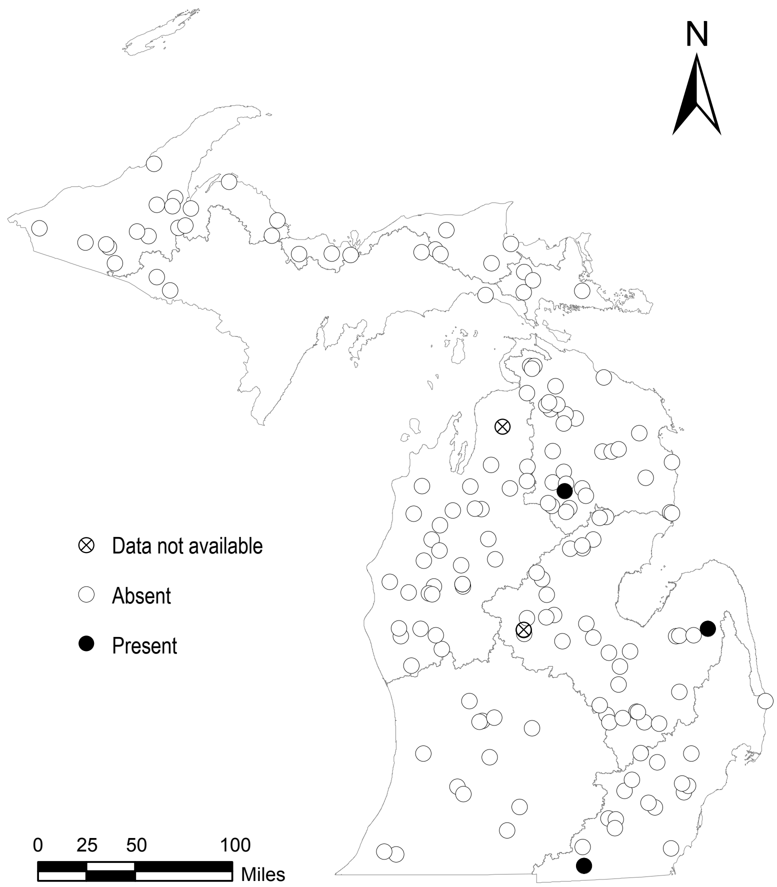

Figure 32.–Map of distribution of redfin shiners.

- Pearl dace *Margariscus nachtriebi* (PRD)

  Pearl dace occurred in 4% of random streams surveyed and at 2 fixed sites (Table 13), all located in the Upper Peninsula (Lake Superior basin) or northern half of the Lower Peninsula (Lake Huron basin, Figure 33).

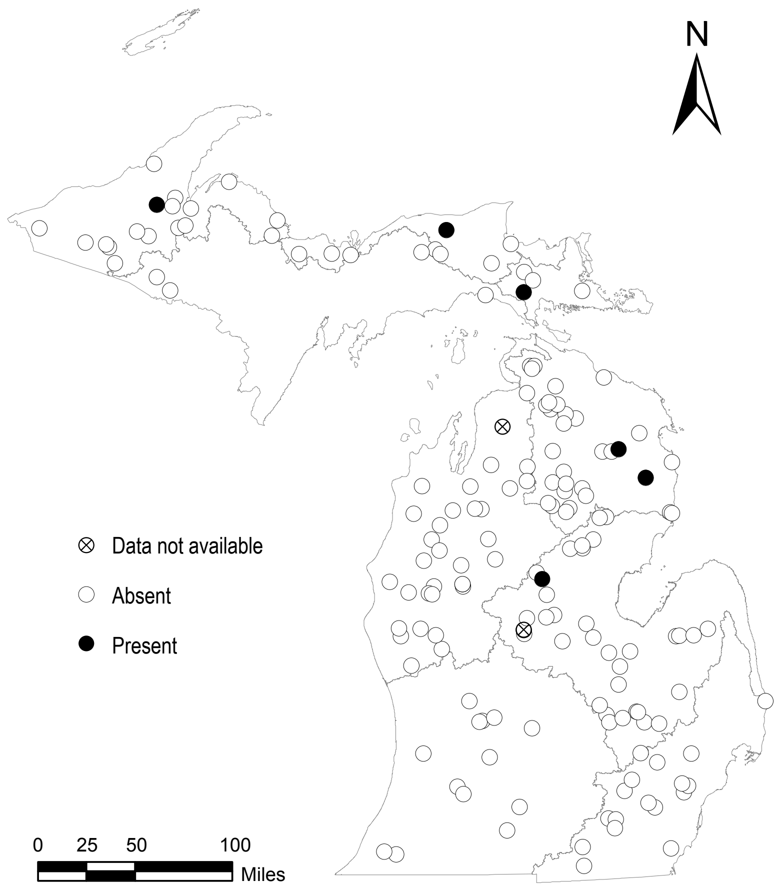

Figure 33.–Map of distribution of pearl dace.

• Hornyhead chub *Nocomis biguttatus* (HHC)

Hornyhead chub were widely distributed throughout the Lower Peninsula, but were only reported in the far western Upper Peninsula (Figure 34). They occurred in 18% of random stream surveys and at 11 of 57 fixed sites sampled throughout the state (Table 13).

Hornyhead chub were reported in all Great Lakes basins, all size and temperature classes of streams, and, except for small streams, in greater proportion among waters without Great Lakes access (Table 22). Their proportion of occurrence varied with stream size and temperature; the highest average CPE of hornyhead chub across all random surveys was in medium cold and large cool streams, respectively. When encountered, electrofishing CPE of hornyhead chub typically ranged between 26 and 350 fish per mile, with a maximum CPE of 2,408 fish per mile.

The size distribution of 666 hornyhead chub measured during random stream surveys ranged from 1 to 7 in (Figure 35). Over 90% of all individuals were 4 in or less in length; more than half (56%) were in the 2–3 in size group. Hornyhead chub greater than 5 in were relatively rare.

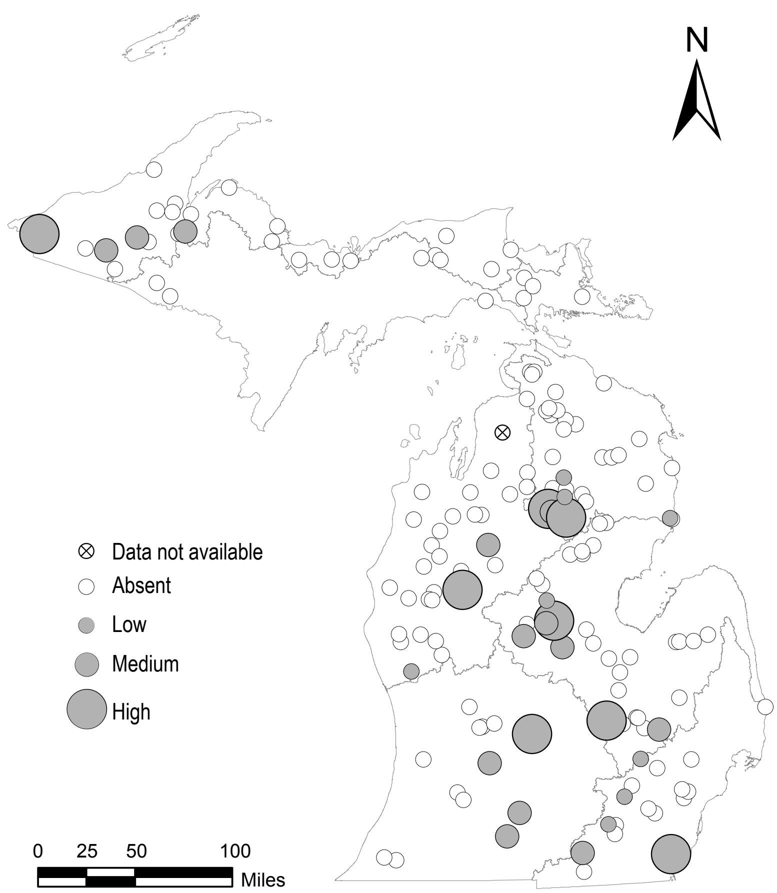

Figure 34.–Map of distribution of hornyhead chub. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 22.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of hornyhead chub. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.13	0.08	0	0.10	0.08	0.17	0.10	22.3	3.1	0	13.2
M	0.13	0.35	0.33	0.26	0.32	0.09	0.26	165.6	48.5	83.0	101.8
L	0	0.29	0.50	0.31	0.40	0	0.31	0	143.1	40.8	89.6
VL	0	0.50	0	0.11	0.25	0	0.11	0	12.5	0	2.8
All	0.12	0.26	0.18	0.18	0.22	0.08	0.18	75.3	48.5	30.0	55.5

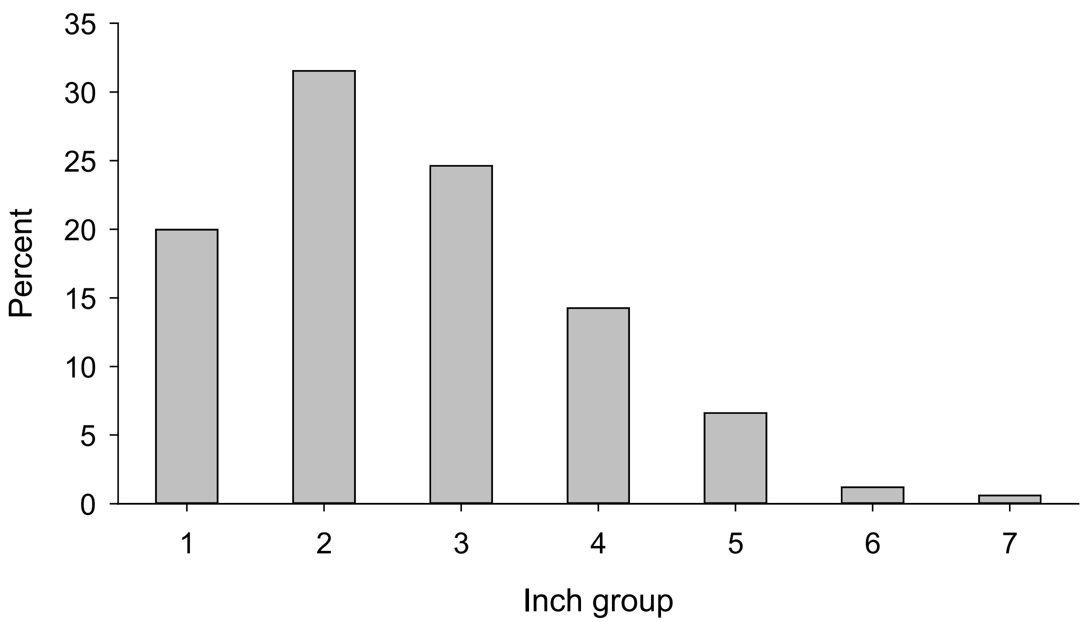

Figure 35.–Size distribution of hornyhead chub.

- Golden shiner *Notemigonus crysoleucas* (GOS)

  Golden shiners were widely distributed across Michigan (Figure 36), occurring in all Great Lakes basins but in only 8% of all random streams surveyed (Table 13). They were also encountered at 3 fixed sites.

  Golden shiners were found in all size classes and temperature classes of streams (Table 23). They occurred more frequently with increasing water temperature, and were least likely to be encountered in small streams. No golden shiners were captured in streams with Great Lakes access. The highest average CPE across all random surveys occurred in medium warm streams; when encountered, electrofishing CPE of golden shiners typically ranged between 6 and 11 fish per mile, with a maximum CPE of 22 fish per mile.

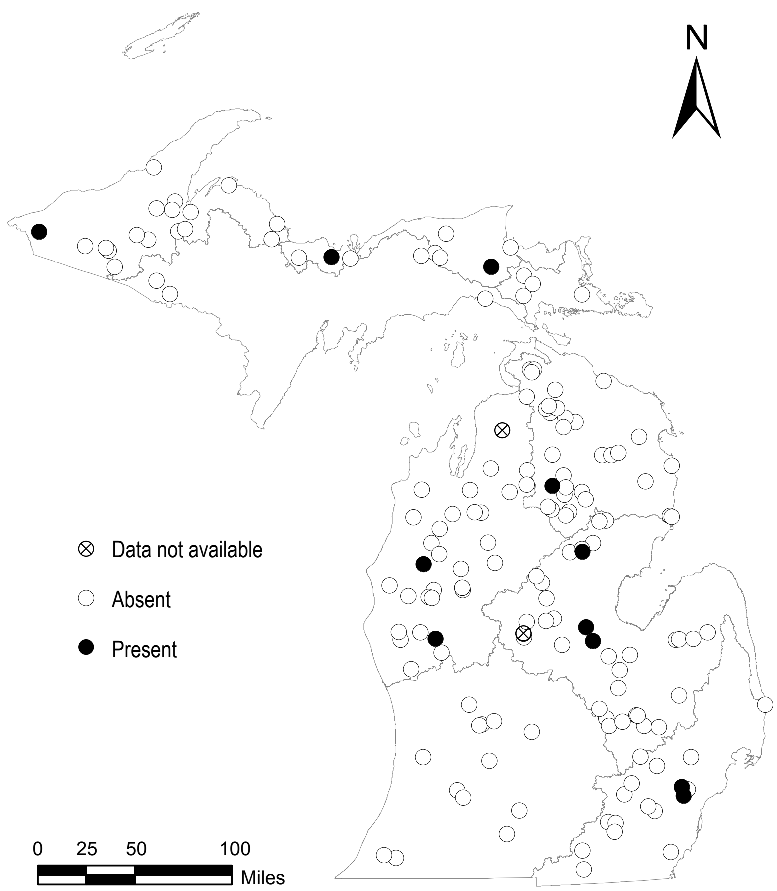

Figure 36.–Map of distribution of golden shiners.

Table 23.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of golden shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0.17	0.05	0.06	0	0.05	0	0.5	1.8	0.4
M	0.13	0.06	0.17	0.10	0.14	0	0.10	1.3	0.5	3.7	1.3
L	0	0.14	0	0.08	0.10	0	0.08	0	0.6	0	0.3
VL	0	0	0.17	0.11	0.25	0	0.11	0	0	0.2	0.1
All	0.05	0.08	0.14	0.08	0.10	0	0.08	0.5	0.5	1.5	0.7

- Emerald shiner *Notropis atherinoides* (EMS)

  Emerald shiners were not widely distributed in Michigan, occurring only in the Lake Huron and Erie basins in the southeastern Lower Peninsula (Figure 37). They were reported in 11% of random stream surveys and at 11 of 57 fixed sites sampled throughout the state (Table 13).

  Emerald shiners were reported in medium, large, and very large size streams and in cool and warm temperature classes (Table 24). In medium and large streams, they occurred only in waters without Great Lakes access. Their proportion of occurrence increased with stream size and temperature; accordingly, the highest average CPE of emerald shiners across all random surveys was in very large warm streams. When encountered, electrofishing CPE of emerald shiners typically ranged between 14 and 211 fish per mile, with a maximum CPE of 803 fish per mile.

  The size distribution of 453 emerald shiners measured during random stream surveys ranged from 1 to 3 in (Figure 38). Fish in the 2 in size group comprised over a half (55%) of the total catch.

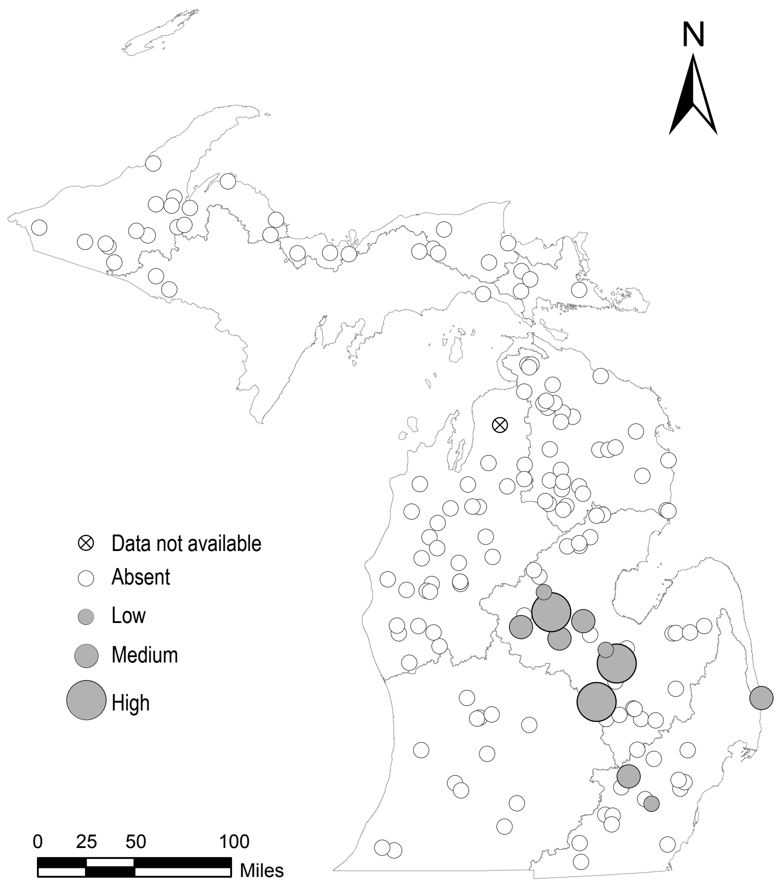

Figure 37.–Map of distribution of emerald shiners. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 24.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of emerald shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0	0	0	0	0	0	0	0	0
M	0	0.06	0.33	0.08	0.11	0	0.08	0	0.5	78.2	12.3
L	0	0.14	0.50	0.23	0.30	0	0.23	0	9.6	56.8	22.6
VL	0	0	0.83	0.56	0.50	0.60	0.56	0	0	160.0	106.7
All	0	0.05	0.41	0.11	0.10	0.12	0.11	0	1.9	75.3	16.8

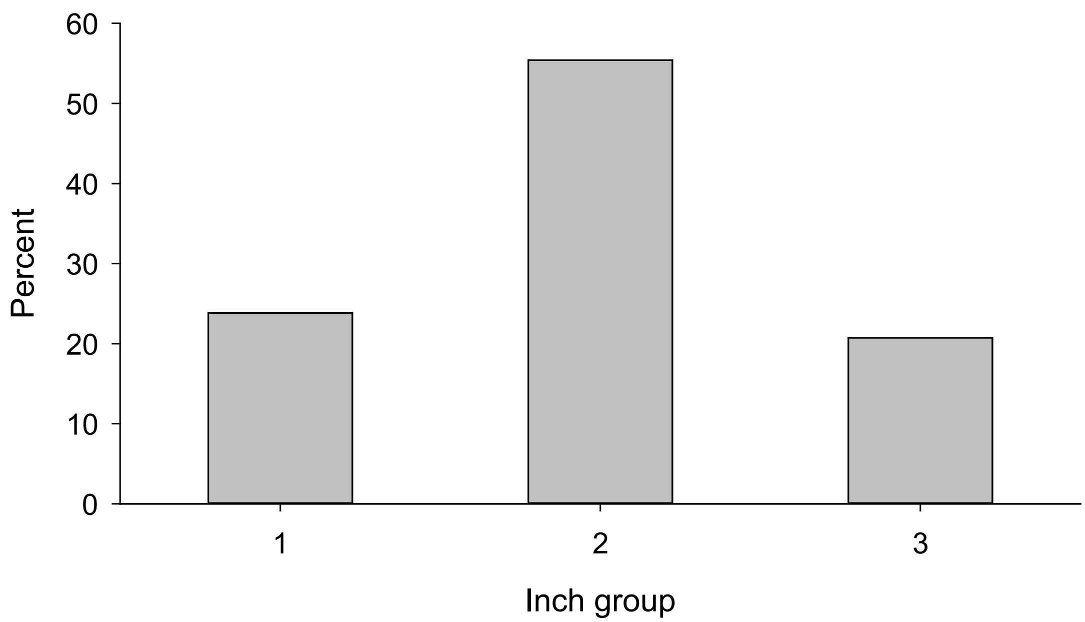

Figure 38.–Size distribution of emerald shiners.

- Blackchin shiner *Notropis heterodon* (BCS)

  Blackchin shiners occurred in only 1 random stream survey in the Lake Huron basin (Figure 39, Table 13).

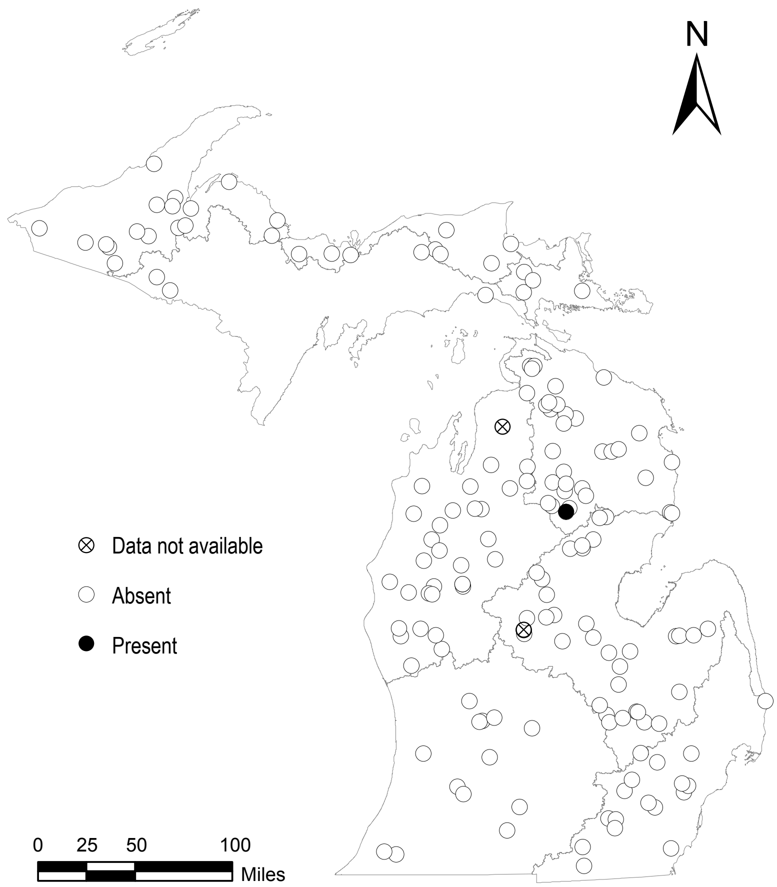

Figure 39.–Map of distribution of blackchin shiners.

- Blacknose shiner *Notropis heterolepis* (BNS)

  Blacknose shiners were reported in the Lake Superior and Huron basins (Figure 40), occurring in only 4% of random streams sampled and at 1 fixed site (Table 13).

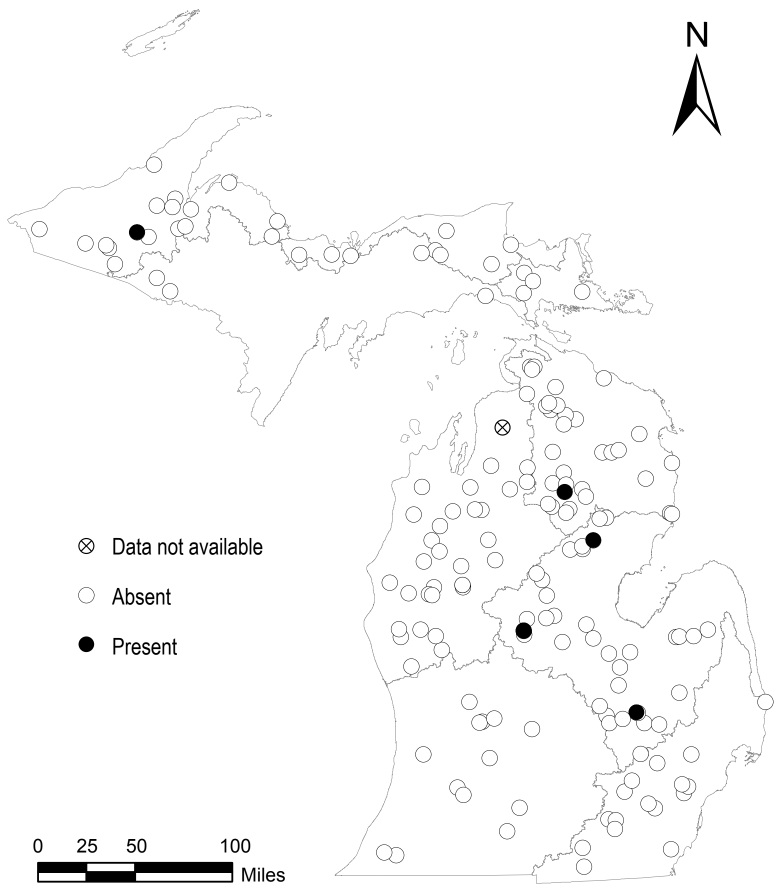

Figure 40.–Map of distribution of blacknose shiners.

- Spottail shiner *Notropis hudsonius* (STS)

Spottail shiners were scattered throughout the Lower Peninsula in the Lake Michigan, Huron, and Erie basins (Figure 41), but occurred in only 7% of all random streams surveyed (Table 13). They were also encountered at 1 fixed site.

Spottail shiners most often occurred in warm water streams, although some were captured in cold water streams (Table 25). In small and medium streams, they were only encountered in waters without Great Lakes access. Although the highest proportion of spottail shiner occurrence across all random surveys was in very large warm streams, the highest average CPE was in medium warm streams. When encountered, electrofishing CPE of spottail shiners typically ranged between 9 and 299 fish per mile, with a maximum CPE of 939 fish per mile.

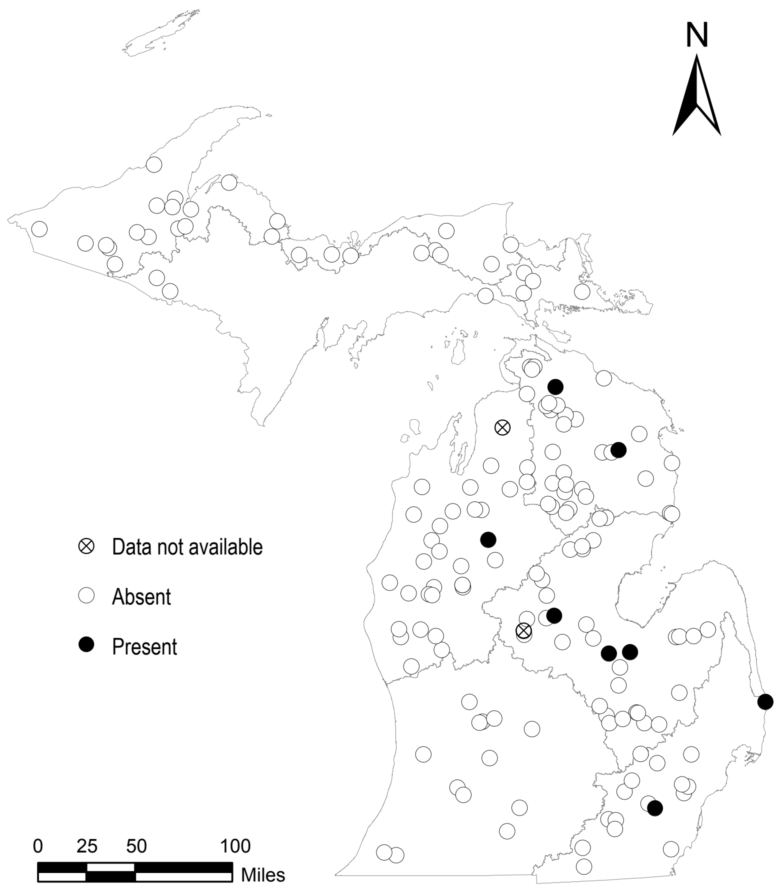

Figure 41.–Map of distribution of spottail shiners.

Table 25.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of spottail shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0	0.17	0.05	0.06	0	0.05	0.5	0	49.8	7.4
M	0.06	0	0.17	0.05	0.07	0	0.05	0.8	0	156.5	24.4
L	0	0	0	0	0	0	0	0	0	0	0
VL	0	0	0.50	0.33	0.25	0.40	0.33	0	0	8.0	5.3
All	0.05	0	0.23	0.07	0.06	0.08	0.07	0.6	0	58.5	12.7

- River chub *Nocomis micropogon* (RIC)

  River chub are a state-listed species of greatest conservation need (Table 11). They were widely distributed across the Lake Michigan, Huron, and Erie basins in the Lower Peninsula (Figure 42), but occurred in only 4% of random streams surveyed and at 8 fixed sites (Table 13).

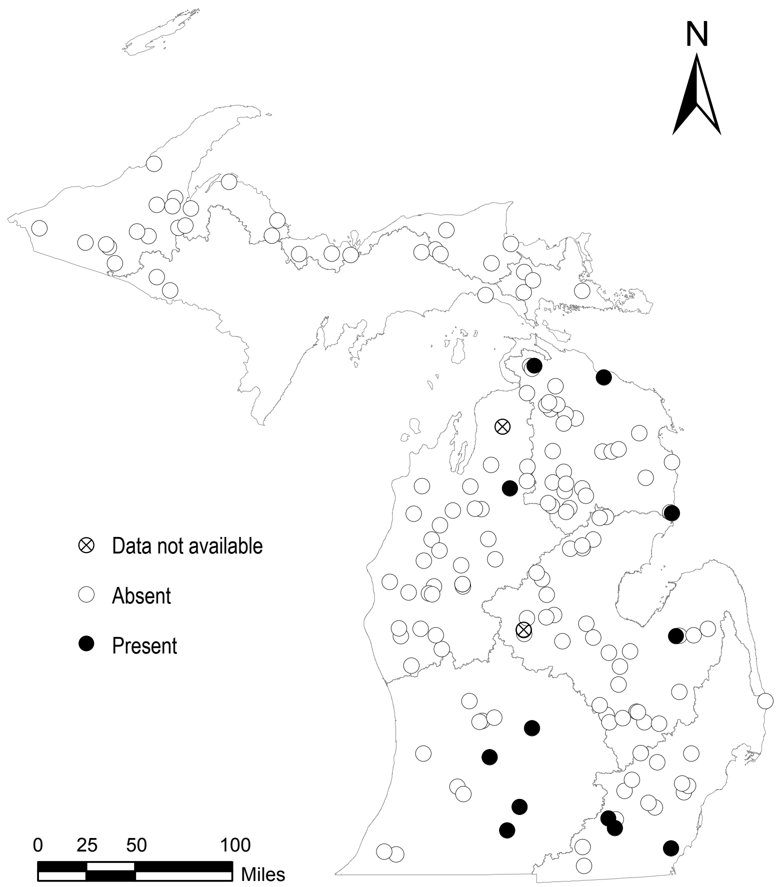

Figure 42.–Map of distribution of river chub.

- Silver shiner *Notropis photogenis* (SIS)

  Silver shiners are a state-listed endangered species and species of greatest conservation need (Table 11). They were not captured in any random stream surveyed, but occurred at 1 fixed site in the Lake Erie basin (Figure 43, Table 13).

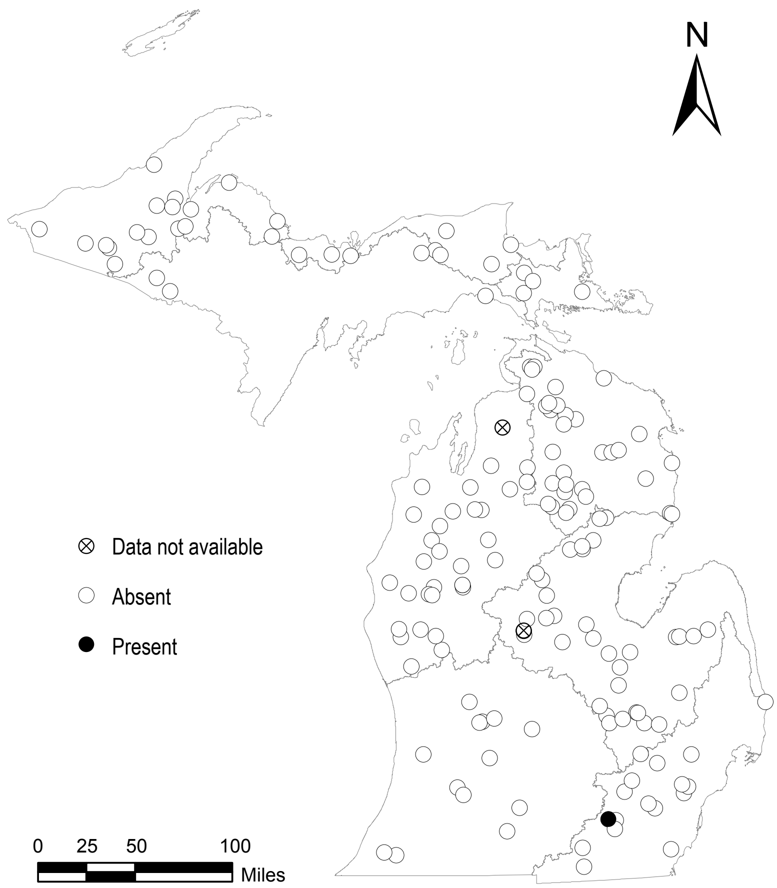

Figure 43.–Map of distribution of silver shiners.

- Rosyface shiner *Notropis rubellus* (ROS)

Rosyface shiners were widely distributed throughout the southern half of the Lower Peninsula in the Lake Michigan, Huron, and Erie basins (Figure 44), but occurred in only 5% of all random streams surveyed (Table 13). They were also encountered at 8 fixed sites.

Rosyface shiners were found in all size classes of streams, but only in those classified as cool or warm water (Table 26). No rosyface shiners were captured in streams with Great Lakes access. Across all random surveys, the highest proportion of occurrence and average CPE was in large cool streams. When encountered, electrofishing CPE of rosyface shiners typically ranged between 7 and 32 fish per mile, with a maximum CPE of 58 fish per mile.

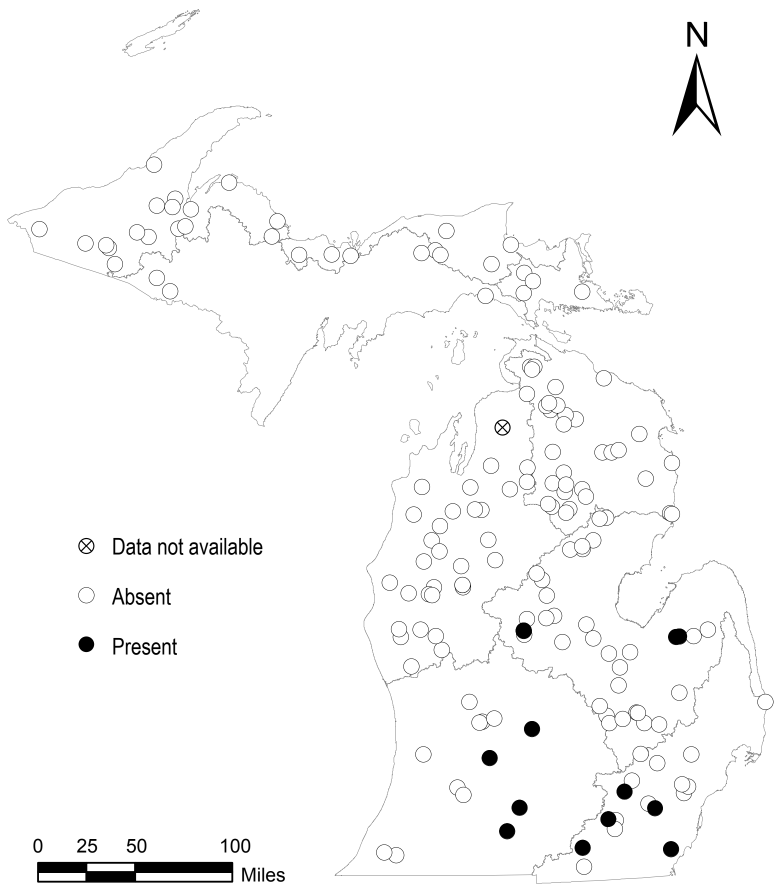

Figure 44.–Map of distribution of rosyface shiners.

Table 26.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of rosyface shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0	0.02	0.03	0	0.02	0	0.5	0	0.2
M	0	0.06	0	0.03	0.04	0	0.03	0	3.4	0	1.5
L	0	0.29	0	0.15	0.20	0	0.15	0	8.1	0	4.4
VL	0	0	0.17	0.11	0.25	0	0.11	0	0	0.7	0.4
All	0	0.10	0.05	0.05	0.06	0	0.05	0	3.1	0.2	1.2

- Sand shiner *Notropis stramineus* (SAS)

    Sand shiners were encountered only in the Lake Huron and Erie basins in the eastern half of the Lower Peninsula (Figure 45). They were reported in 7% of all random streams surveyed and at 2 fixed sites (Table 13).

    Sand shiners occurred in all size classes and temperature classes of streams. They were mostly found in large or very large warm water streams, and in waters that did not have Great Lakes access (Table 27). Across all random surveys, the highest proportion of occurrence and average CPE was in large warm streams. When encountered, electrofishing CPE of sand shiners typically ranged between 9 and 264 fish per mile, with a maximum CPE of 818 fish per mile.

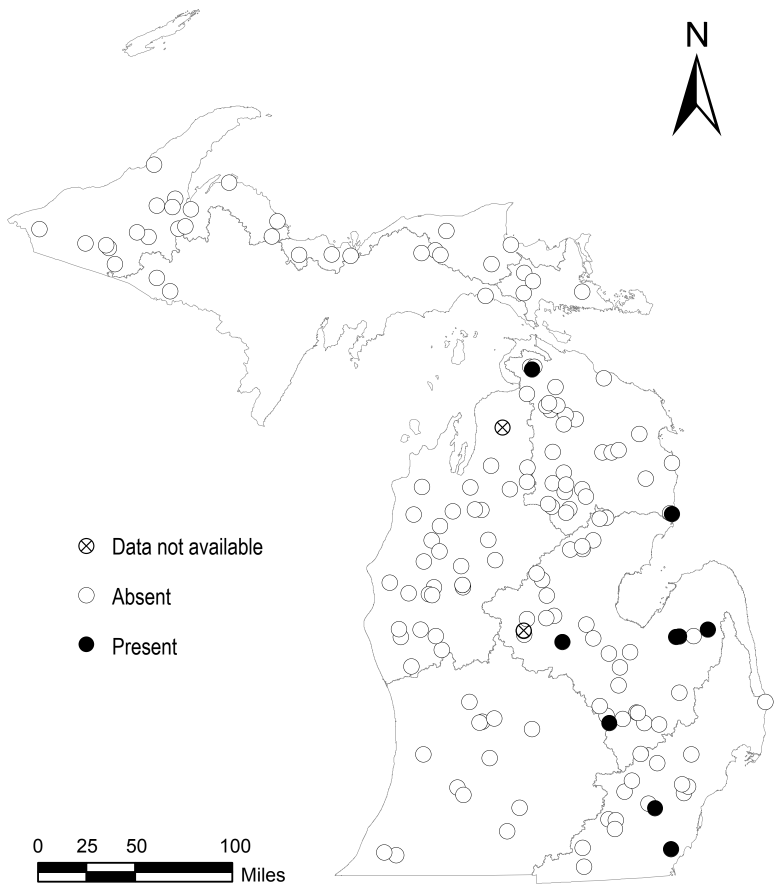

Figure 45.–Map of distribution of sand shiners.

Table 27.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of sand shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0.17	0.02	0.03	0	0.02	0	0	44.0	6.3
M	0.06	0.06	0	0.05	0.07	0	0.05	0.3	8.4	0	3.8
L	0	0.14	0.50	0.23	0.20	0.33	0.23	0	1.9	259.3	80.8
VL	0	0	0.17	0.11	0.25	0	0.11	0	0	1.5	1.0
All	0.02	0.05	0.18	0.07	0.08	0.04	0.07	0.1	4.0	59.5	14.3

- Mimic shiner *Notropis volucellus* (MIS)

Mimic shiners were widely distributed throughout the eastern half of the Lower Peninsula (Figure 46), with reports in the Lake Michigan, Huron, and Erie basins. They occurred in 9% of all random streams surveyed and were encountered at 3 fixed sites (Table 13).

Mimic shiners were found in all size classes and temperature classes of streams, occurring most frequently in cool to warm water large and very large streams (Table 28). Their proportion of occurrence in streams with and without Great Lakes access varied with stream size. The highest average CPE of mimic shiners across all random surveys was in warm large streams, followed by cool large streams. When encountered, electrofishing CPE of mimic shiners typically ranged between 7 and 136 fish per mile, with a maximum CPE of 306 fish per mile.

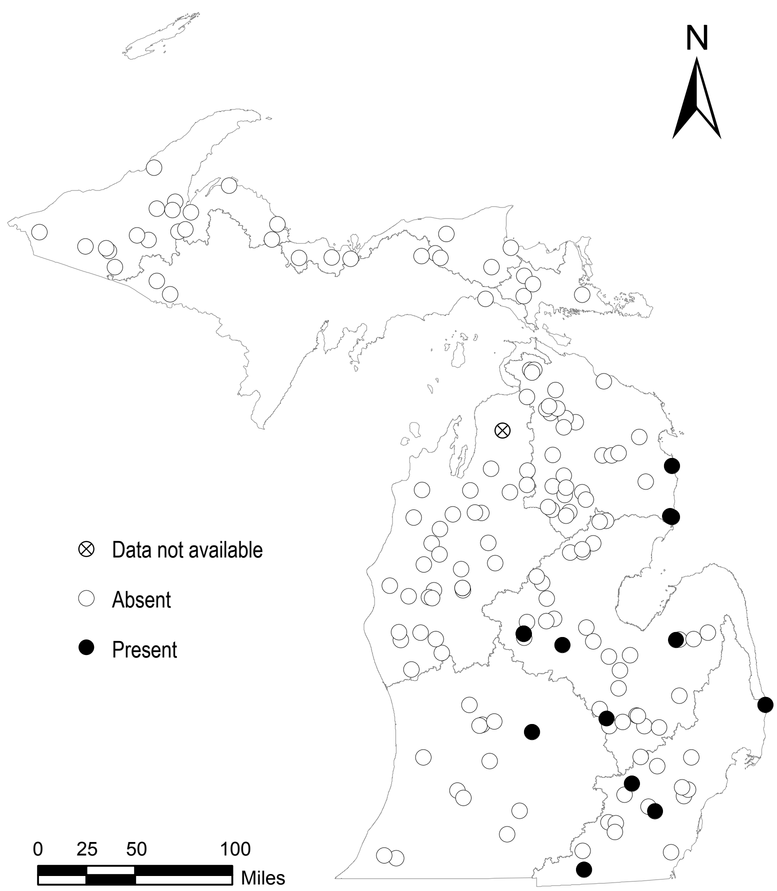

Figure 46.–Map of distribution of mimic shiners.

Table 28.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of mimic shiners. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0	0.02	0.03	0	0.02	0	0.5	0	0.2
M	0.06	0	0	0.03	0	0.09	0.03	0.6	0	0	0.2
L	0	0.29	0.50	0.31	0.30	0.33	0.31	0	43.1	87.0	50.0
VL	0	0.50	0.33	0.33	0.50	0.20	0.33	0	0.5	23.3	15.7
All	0.02	0.10	0.18	0.09	0.08	0.12	0.09	0.2	7.9	22.2	7.8

• Pugnose minnow *Opsopoeodus emiliae* (PNM)

Pugnose minnows are a state-listed endangered species and species of greatest conservation need (Table 11). They were reported in only 1 random stream surveyed (Figure 47, Table 13), which is well outside of the known range of pugnose minnows in Michigan (no voucher specimen is available to confirm the identification). Thus, it is possible that the report is a misidentification of the bluntnose minnow *Pimephales notatus*, a species that is similar in appearance.

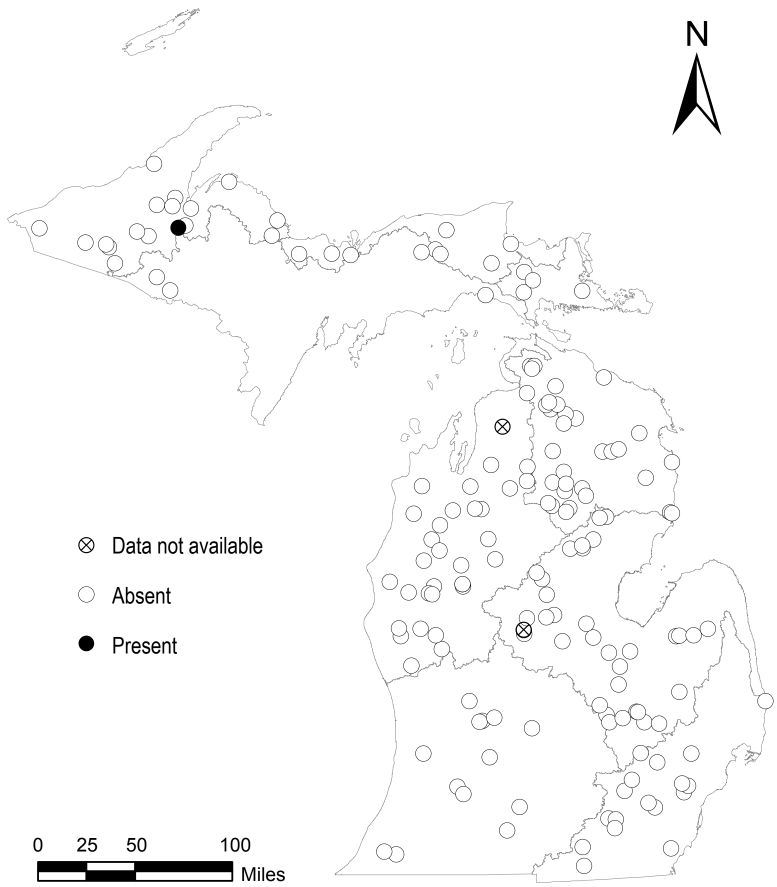

Figure 47.–Map of distribution of pugnose minnows.

- Northern redbelly dace *Phoxinus eos* (NRD)

  Northern redbelly dace were widely distributed throughout the northern Lower Peninsula (Lake Michigan and Huron basins) and far eastern Upper Peninsula (Lake Superior and Huron basins, Figure 48). They occurred in 12% of random stream surveys and at 13 of 57 fixed sites sampled throughout the state (Table 13).

  Northern redbelly dace were reported in all temperature classes of streams, but only in small and medium size groups (Table 29). Their proportion of occurrence decreased with increasing temperature and was similar regardless of access to the Great Lakes. The highest average CPE of northern redbelly dace across all random surveys was in medium cold and cool streams. When encountered, electrofishing CPE of northern redbelly dace typically ranged between 17 and 69 fish per mile, with a maximum CPE of 141 fish per mile.

  The size distribution of 76 northern redbelly dace measured during random stream surveys ranged from 1 to 3 in (Figure 49). Fish in the 2 in size group comprised over three quarters (78%) of the total catch.

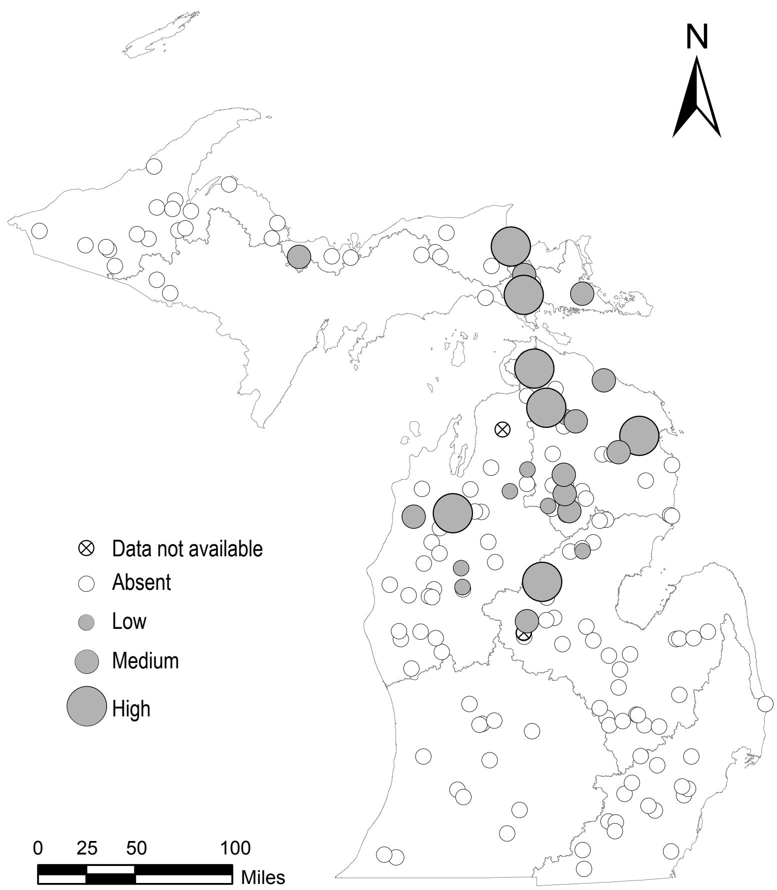

Figure 48.–Map of distribution of northern redbelly dace. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 29.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of northern redbelly dace. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.17	0.08	0	0.12	0.11	0.17	0.12	4.2	8.2	0	4.8
M	0.19	0.18	0.17	0.18	0.18	0.18	0.18	9.8	9.3	3.5	8.6
L	0	0	0	0	0	0	0	0	0	0	0
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.17	0.10	0.05	0.12	0.12	0.12	0.12	6.0	6.8	1.0	5.2

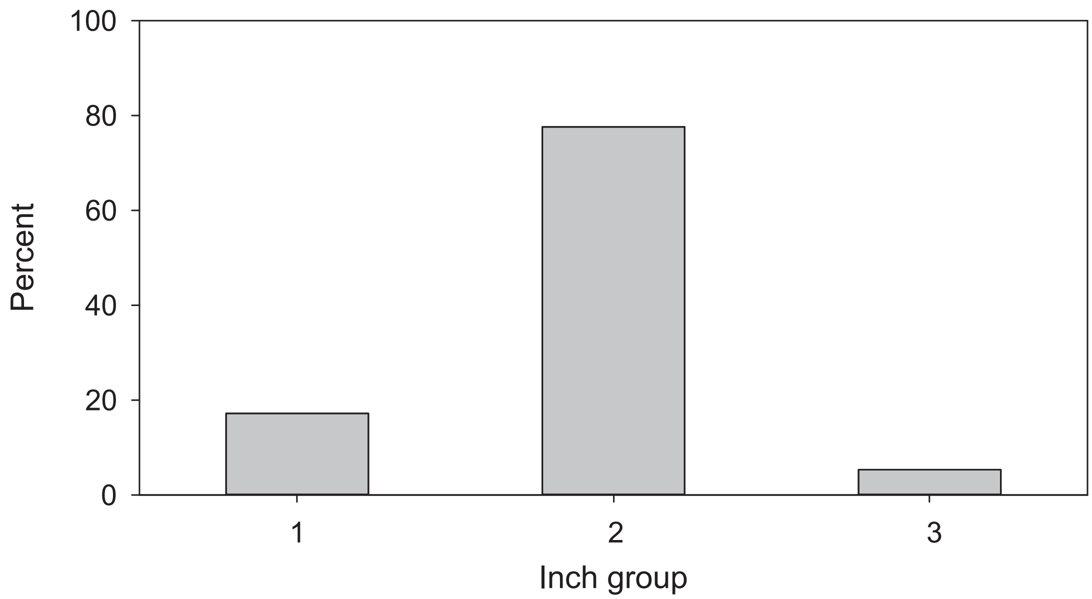

Figure 49.–Size distribution of northern redbelly dace.

• Finescale dace *Phoxinus neogaeus* (FSD)

Finescale dace are a state listed species of greatest conservation need (Table 11). They were not widely distributed in Michigan (Figure 50), occurring in only 3% of random streams surveyed (all in the northern Lake Huron basin).

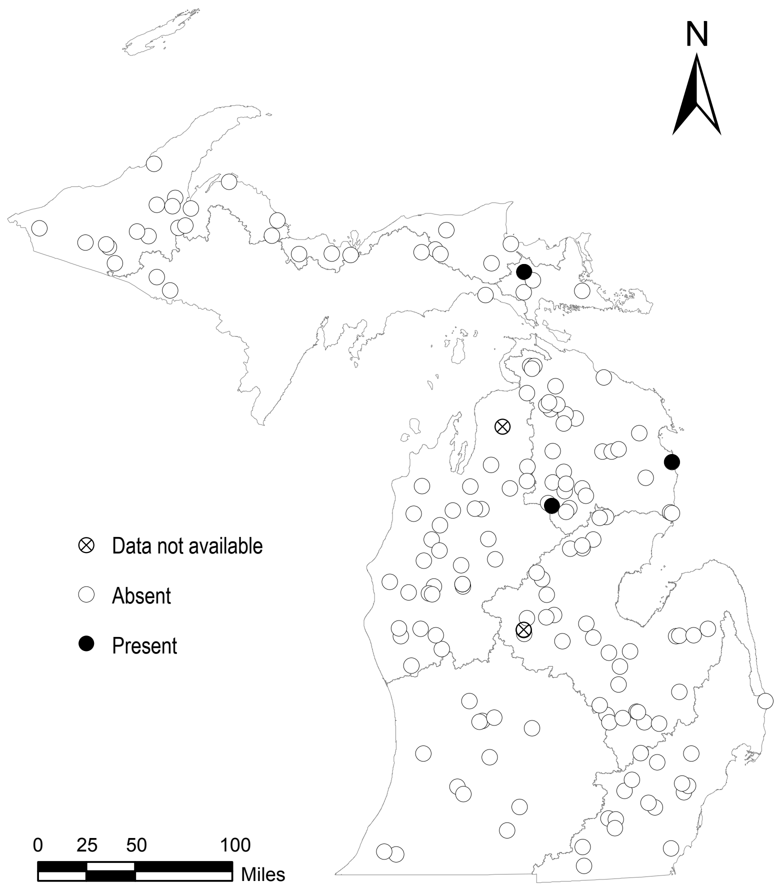

Figure 50.–Map of distribution of finescale dace.

- Bluntnose minnow *Pimephales notatus* (BNM)

Bluntnose minnows were the eighth most frequently encountered species in Michigan streams, occurring in 35% of random surveys (Table 13). They were also reported at 12 of 57 fixed sites sampled throughout the state.

Bluntnose minnows were widely distributed across the southern Lower Peninsula, but were reported less often in the northern Lower Peninsula and Upper Peninsula (Figure 51). They occurred in all Great Lakes basins, all size and temperature classes of streams, and (on average) in equal proportion among waters with or without Great Lakes access (Table 30). Although the proportion of occurrence of bluntnose minnows generally increased with increasing size and temperature, the highest average CPE was in small warm waters. When encountered, electrofishing CPE of bluntnose minnows typically ranged between 17 and 219 fish per mile, with a maximum CPE of 929 fish per mile.

The size distribution of 826 bluntnose minnows measured during random stream surveys ranged from 1 to 4 in (Figure 52). Fish belonging to the 2 in size group comprised over 60% of the total catch.

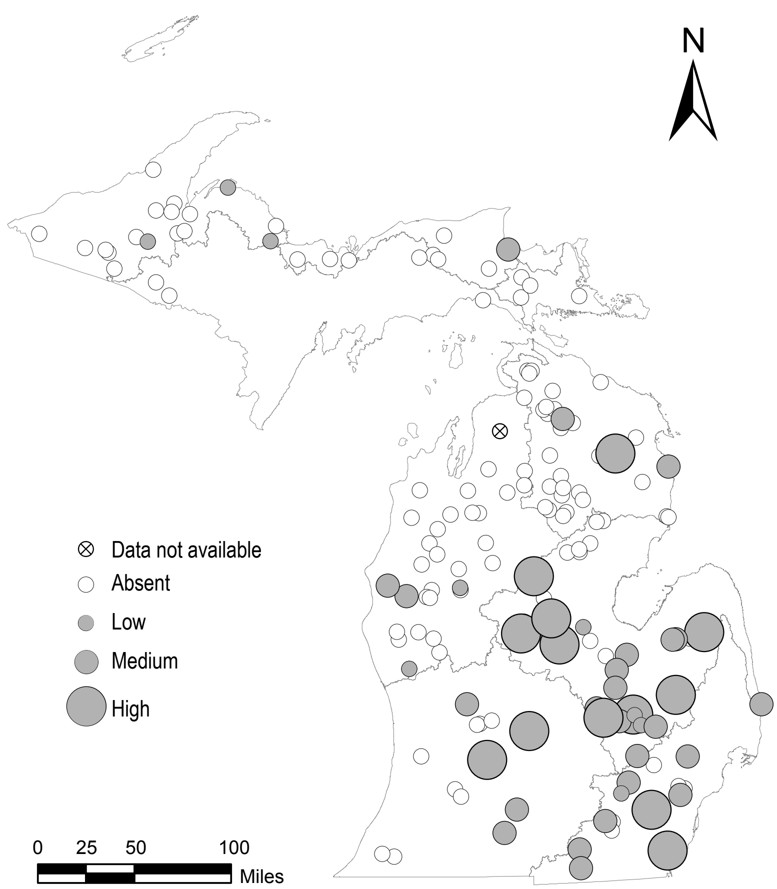

Figure 51.–Map of distribution of bluntnose minnows. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 30.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of bluntnose minnows. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.22	0.38	0.67	0.33	0.36	0.17	0.33	52.4	31.4	245.7	73.5
M	0.13	0.29	0.67	0.28	0.25	0.36	0.28	2.4	12.5	121.3	25.1
L	0	0.43	0.75	0.46	0.50	0.33	0.46	0	101.3	131.8	95.1
VL	0	0.50	0.67	0.56	0.50	0.60	0.56	0	13.0	86.5	60.6
All	0.17	0.36	0.68	0.35	0.35	0.36	0.35	29.6	34.8	147.6	56.8

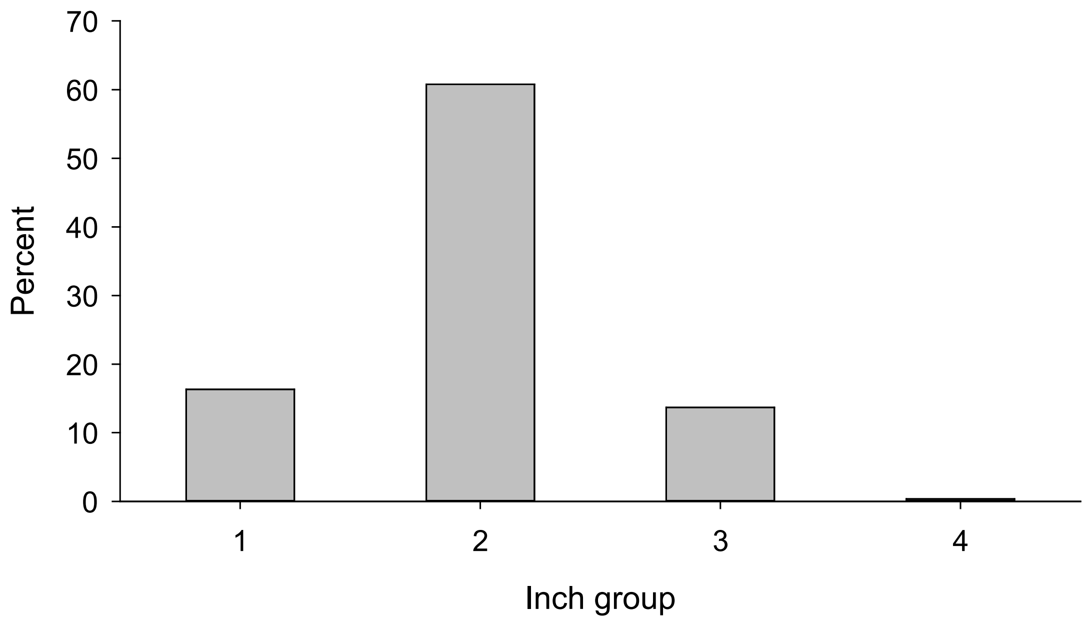

Figure 52.–Size distribution of bluntnose minnows.

- Fathead minnow *Pimephales promelas* (FHM)

Fathead minnows were scattered throughout the Upper and Lower Peninsula (Figure 53), but were not reported in the Lake Michigan basin. They occurred in 6% of all random streams surveyed, and were encountered at 2 fixed sites (Table 13).

Fathead minnows occurred only in cool and warm water streams, and were usually more common in streams without Great Lakes access (Table 31). Although the highest proportion of occurrence across all random surveys was in medium warm streams, the highest average CPE was in medium cool streams. When encountered, electrofishing CPE of fathead minnows typically ranged between 7 and 26 fish per mile, with a maximum CPE of 106 fish per mile.

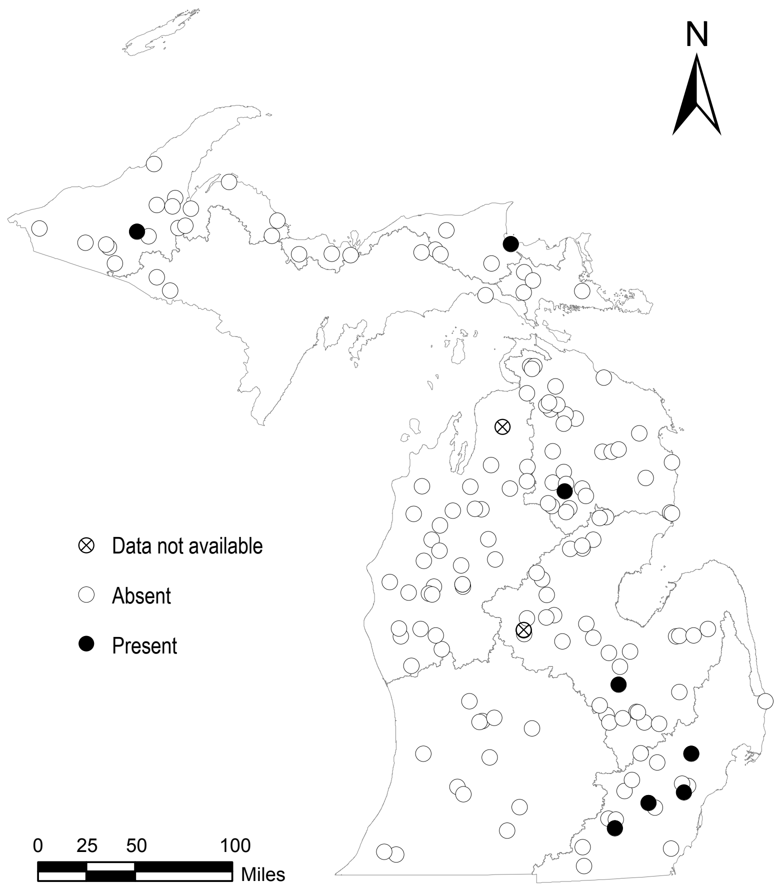

Figure 53.–Map of distribution of fathead minnows.

Table 31.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of fathead minnows. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.15	0	0.05	0.06	0	0.05	0	3.6	0	1.1
M	0	0.06	0.33	0.08	0.07	0.09	0.08	0	6.2	3.3	3.2
L	0	0.14	0	0.08	0.10	0	0.08	0	1.0	0	0.5
VL	0	0	0	0	0	0	0	0	0	0	0
All	0	0.10	0.09	0.06	0.06	0.04	0.06	0	4.1	0.9	1.7

- Blacknose dace *Rhinichthys obtusus* (BND)

  Blacknose dace were the fourth most frequently encountered species in Michigan streams, occurring in 49% of random surveys (Table 13). They were also reported at 30 of 57 fixed sites sampled throughout the state.

  Blacknose dace were widely distributed across the Upper and Lower peninsulas (Figure 54), occurring in all Great Lakes basins and all size and temperature classes of streams. Across all surveys, blacknose dace were reported in nearly equal proportion among waters with or without Great Lakes access (Table 32). Although their proportion of occurrence tended to decrease with increasing stream size and water temperature, the highest average CPE was in large cool waters. When encountered, electrofishing CPE of blacknose dace typically ranged between 35 and 444 fish per mile, with a maximum CPE of 3,464 fish per mile.

  The size distribution of 2,770 blacknose dace measured during random stream surveys ranged from 1 to 4 in (Figure 55). Fish in the 2-in size group comprised half (50%) of the total catch.

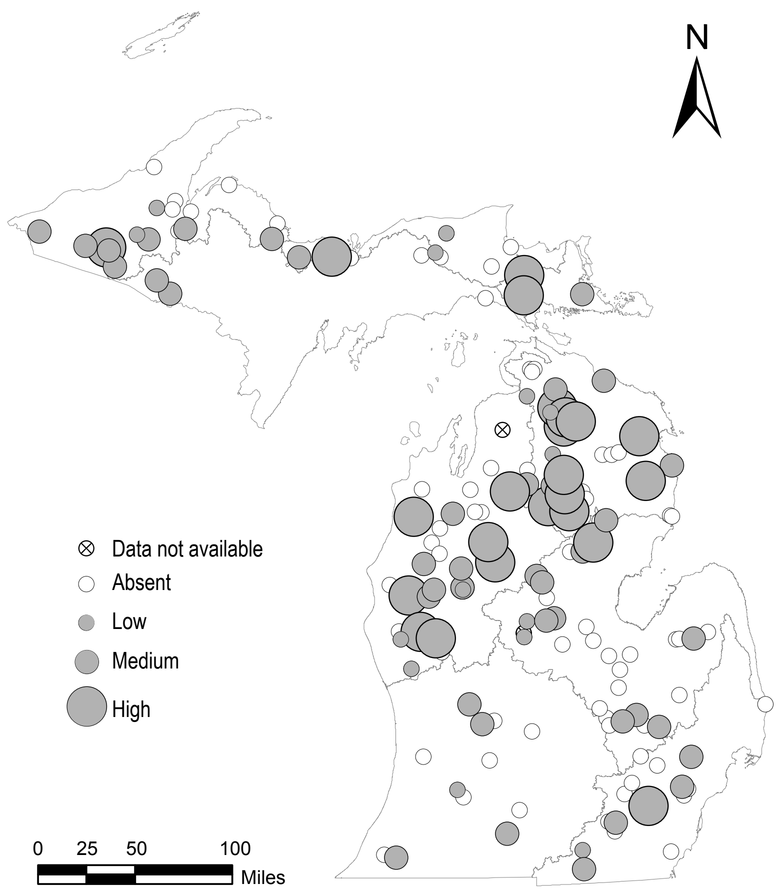

Figure 54.–Map of distribution of blacknose dace. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 32.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of blacknose dace. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi2, M = medium catchment 40–179 mi2, L = large catchment 180–620 mi2, VL = very large catchment >620 mi2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.65	0.69	0.17	0.60	0.61	0.50	0.60	309.9	351.5	31.7	283.0
M	0.69	0.41	0.50	0.54	0.43	0.82	0.54	238.7	67.2	168.7	153.2
L	0.50	0.43	0	0.31	0.30	0.33	0.31	200.5	370.3	0	230.2
VL	1.00	0	0	0.11	0.25	0	0.11	3.0	0	0	0.3
All	0.67	0.49	0.18	0.50	0.49	0.52	0.50	270.3	212.9	54.6	202.5

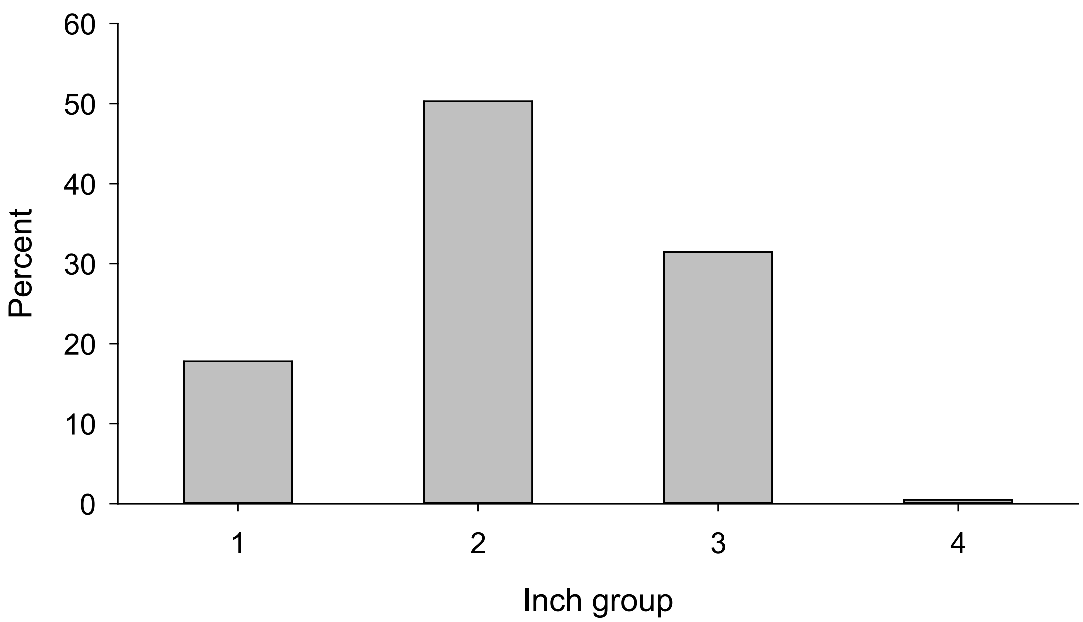

Figure 55.–Size distribution of blacknose dace.

- Longnose dace *Rhinichthys cataractae* (LND)

  Longnose dace were widely distributed throughout the Upper Peninsula and northern Lower Peninsula in the Lake Superior, Michigan, and Huron basins (Figure 56). They occurred in 18% of random stream surveys and at 13 of 57 fixed sites sampled throughout the state (Table 13).

  Longnose dace were reported in all size classes of streams, but in greater frequency in medium and large waters (Table 33). They occurred in nearly equal proportion in streams classified as cold or cool, and in greater frequency among those with Great Lakes access. The highest average CPE of longnose dace across all random surveys was in large cool streams. When encountered, electrofishing CPE of longnose dace typically ranged between 9 and 387 fish per mile, with a maximum CPE of 1,278 fish per mile.

  The size distribution of 671 longnose dace measured during random stream surveys ranged from 1 to 4 in (Figure 57). Fish in the 2 in size group comprised over one third (36%) of the total catch, followed by those in the 3 in (29%) and 1 in (25%) size classes. Larger (4 in) longnose dace occurred less frequently, comprising11% of the total catch.

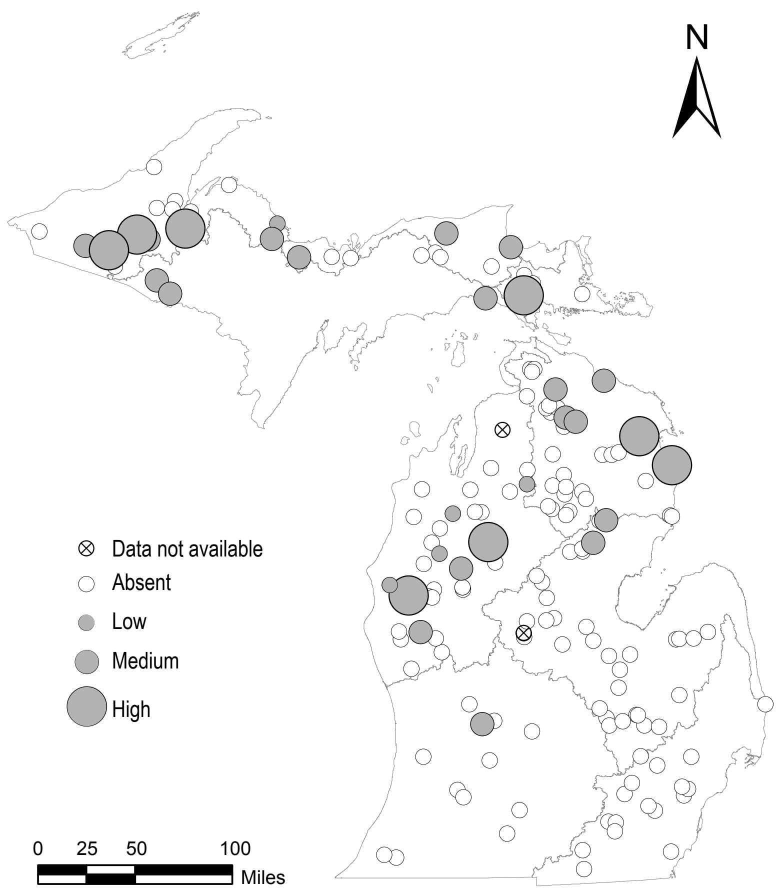

Figure 56.–Map of distribution of longnose dace. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 33.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of longnose dace. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.13	0.08	0	0.10	0.08	0.17	0.10	15.5	39.8	0	20.8
M	0.31	0.35	0	0.28	0.18	0.55	0.28	88.8	92.4	0	76.7
L	1.00	0.14	0	0.23	0.20	0.33	0.23	4.5	182.6	0	99.0
VL	0	0.50	0	0.11	0	0.20	0.11	0	0.5	0	0.1
All	0.24	0.23	0	0.18	0.13	0.36	0.18	42.5	86.3	0	50.0

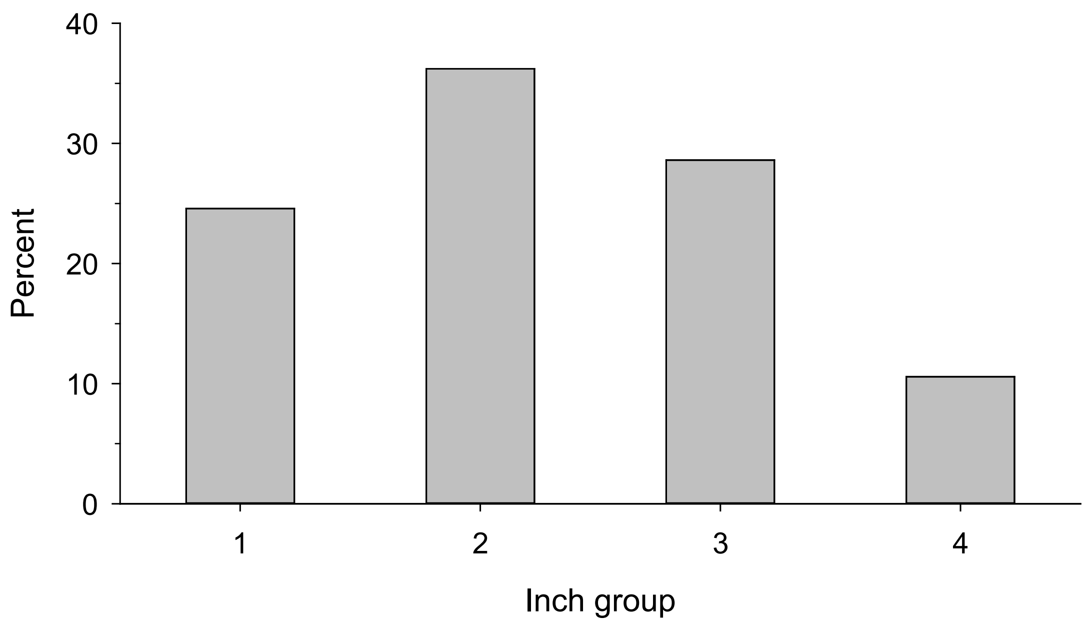

Figure 57.–Size distribution of longnose dace.

• Creek chub *Semotilus atromaculatus* (CRC)

Creek chub were the second-most frequently encountered species in Michigan streams, occurring in 63% of random surveys (Table 13). They were also reported at 29 of 57 fixed sites sampled throughout the state.

Creek chub were widely distributed across the Upper and Lower peninsulas (Figure 58), occurring in all Great Lakes basins, all size and temperature classes of streams and in slightly greater proportion among waters without Great Lakes access (Table 34). In general, the highest proportion of occurrence across all random surveys was in small- to medium-size streams regardless of temperature class; although the highest average CPE was in small, warm waters. When encountered, electrofishing CPE of creek chub typically ranged between 53 and 818 fish per mile, with a maximum CPE of 2,530 fish per mile.

The size distribution of 3,952 creek chub measured during random stream surveys ranged from 1 to 9 in (Figure 59). Small, 1–3 in fish occurred most frequently and in nearly equal proportion to comprise 68% of the total catch; catches of larger fish decreased rapidly with increasing size. Creek chub greater than 5 in total length were rare, comprising less than 7% of the total catch.

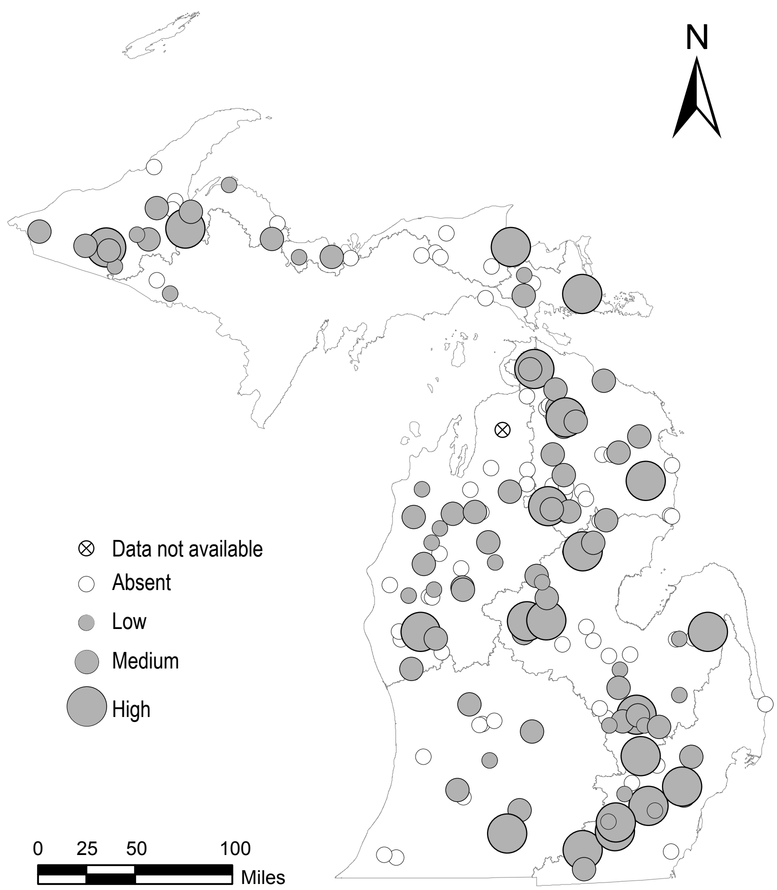

Figure 58.–Map of distribution of creek chub. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75[th] percentile, medium = 25[th]–50[th] percentile, low = <25[th] percentile.

Table 34.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of creek chub. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.78	0.77	0.67	0.76	0.78	0.67	0.76	221.2	543.2	757.0	397.4
M	0.56	0.76	0.67	0.67	0.68	0.64	0.67	418.6	344.7	618.8	417.2
L	0	0.71	0.25	0.46	0.50	0.33	0.46	0	156.0	5.8	85.8
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	13.3	8.9
All	0.64	0.72	0.50	0.64	0.68	0.52	0.64	280.6	359.3	379.9	331.6

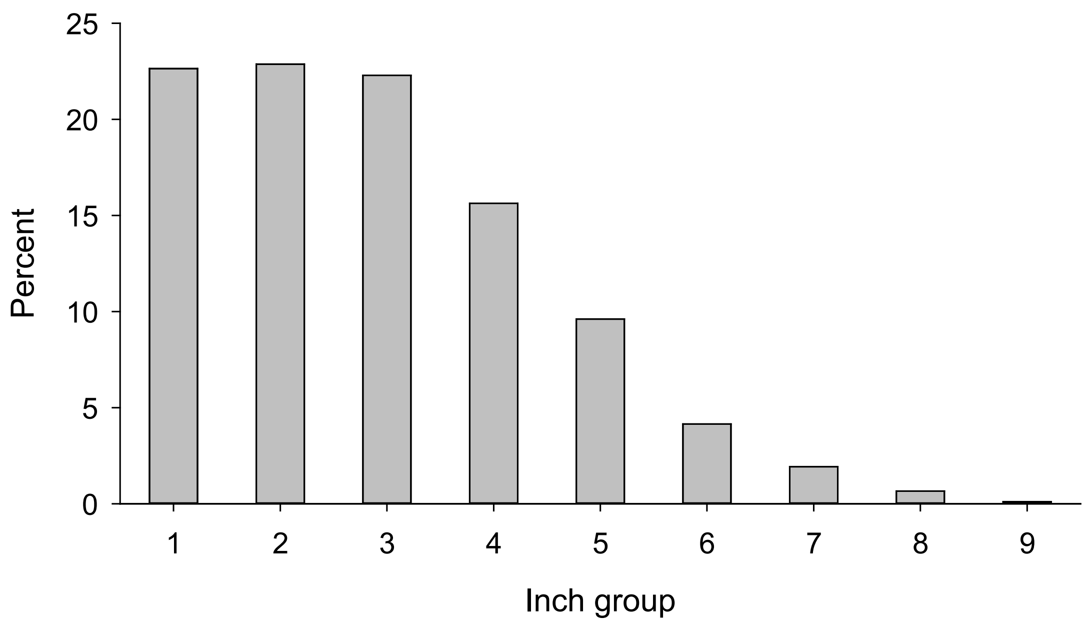

Figure 59.–Size distribution of creek chub.

Catostomidae

- Quillback *Carpiodes cyprinus* (QIL)

 Quillback were not widely distributed in Michigan (Figure 60), occurring in only 3% of random streams surveyed (Table 13).

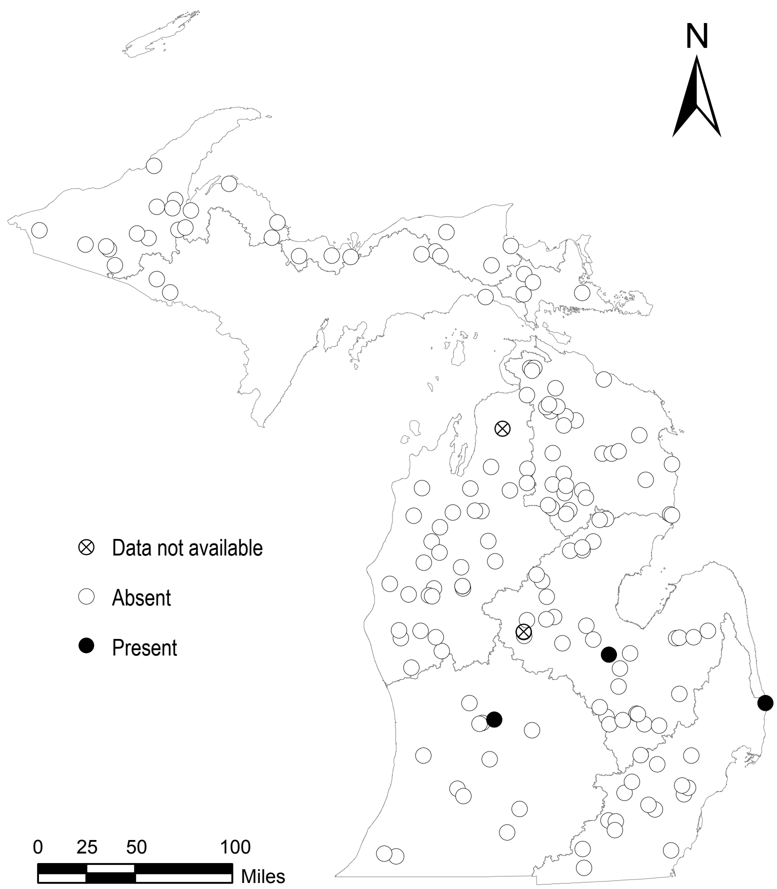

Figure 60.–Map of distribution of quillback.

- Longnose sucker *Catostomus catostomus* (LNS)

  Longnose suckers occurred in only 1 random stream survey in the southern Lake Michigan basin (Figure 61, Table 13).

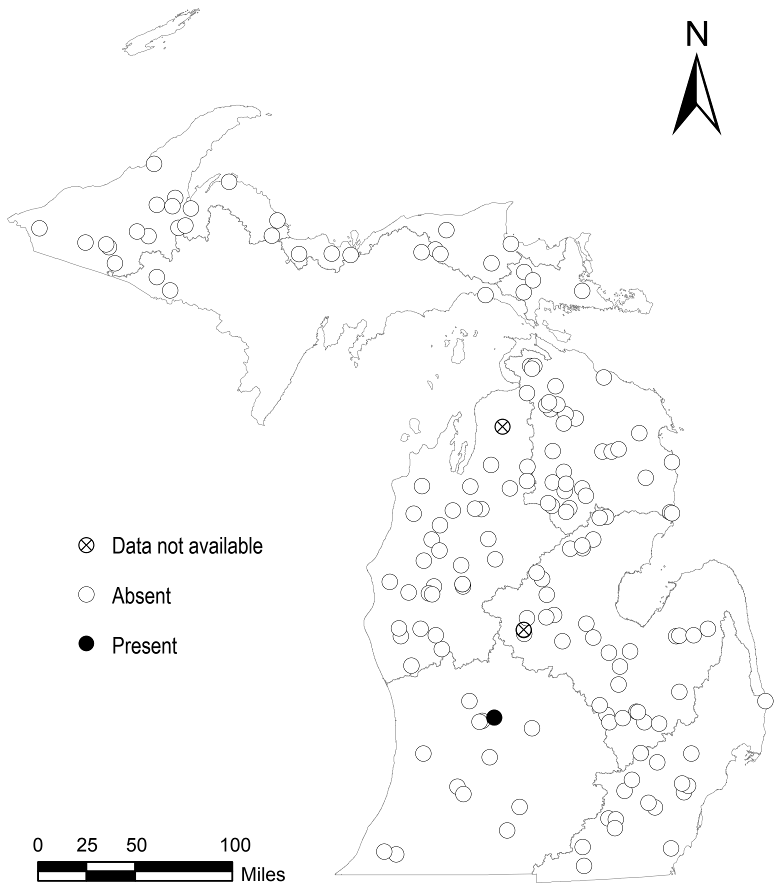

Figure 61.–Map of distribution of longnose suckers.

- White sucker *Catostomus commersonii* (CWS)

  Common white suckers were the most frequently encountered species in Michigan streams, occurring in 71% of random surveys (Table 13). They were also reported at 38 of 57 fixed sites sampled throughout the state.

  Common white suckers were widely distributed across the Upper and Lower peninsulas (Figure 62), occurring in all Great Lakes basins, all size and temperature classes of streams, and (on average) in nearly equal proportion among waters with or without Great Lakes access (Table 35). Although the highest proportion of occurrence across all random surveys was in cool water, medium- to large-size streams the highest average CPE was in small cool waters. When encountered, electrofishing CPE of common white suckers typically ranged between 20 and 206 fish per mile, with a maximum CPE of 2,196 fish per mile.

  The size distribution of 2,412 common white suckers measured during random stream surveys ranged from 1 to 18 in (Figure 63). Small, 2–4 in fish comprised more than half (55%) of the total catch, with a second mode centered on 8 in. Common white suckers greater than 10 in total length were relatively rare, comprising less than 9% of the total catch.

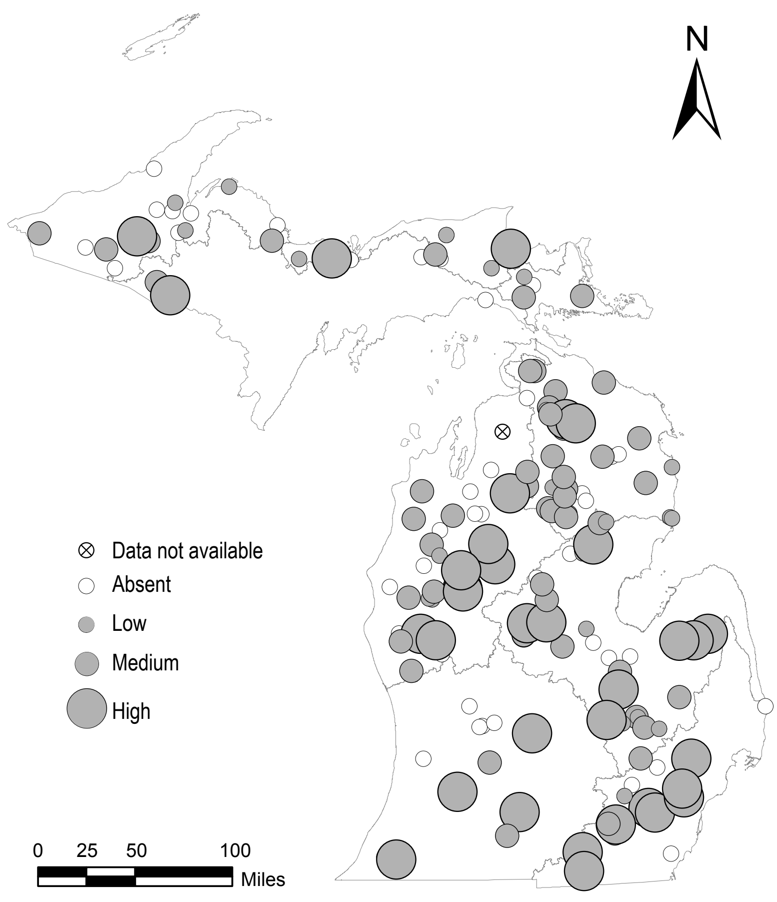

Figure 62.–Map of distribution of common white suckers. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 35.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of common white suckers. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.48	0.85	0.50	0.60	0.64	0.33	0.60	122.4	357.5	156.8	200.1
M	0.81	0.94	0.67	0.85	0.79	1.00	0.85	57.1	124.4	258.5	117.4
L	1.00	1.00	0.50	0.85	0.80	1.00	0.85	22.0	289.0	26.5	167.2
VL	1.00	0.50	0.50	0.56	1.00	0.20	0.56	113.0	6.0	88.5	72.9
All	0.64	0.90	0.55	0.72	0.73	0.68	0.72	92.5	225.6	142.2	153.5

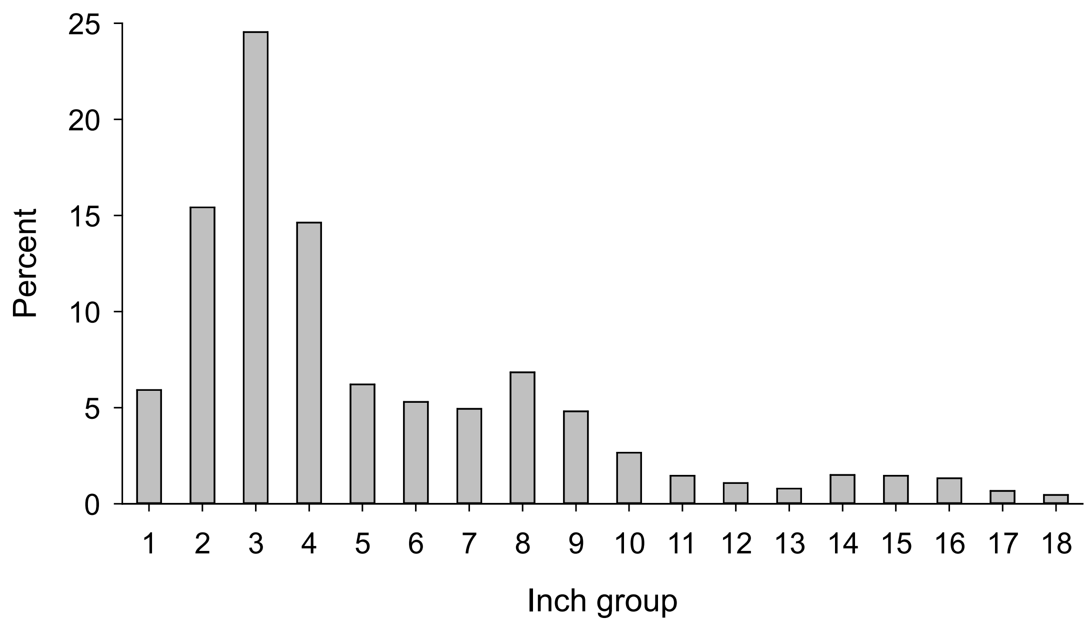

Figure 63.–Size distribution of common white suckers.

• Creek chubsucker *Erimyzon oblongus* (CCS)

Creek chubsuckers are a state-listed endangered species and species of greatest conservation need (Table 11). They were not captured in any random stream surveyed, but occurred at 1 fixed site in the southern Lake Michigan basin (Figure 64, Table 13).

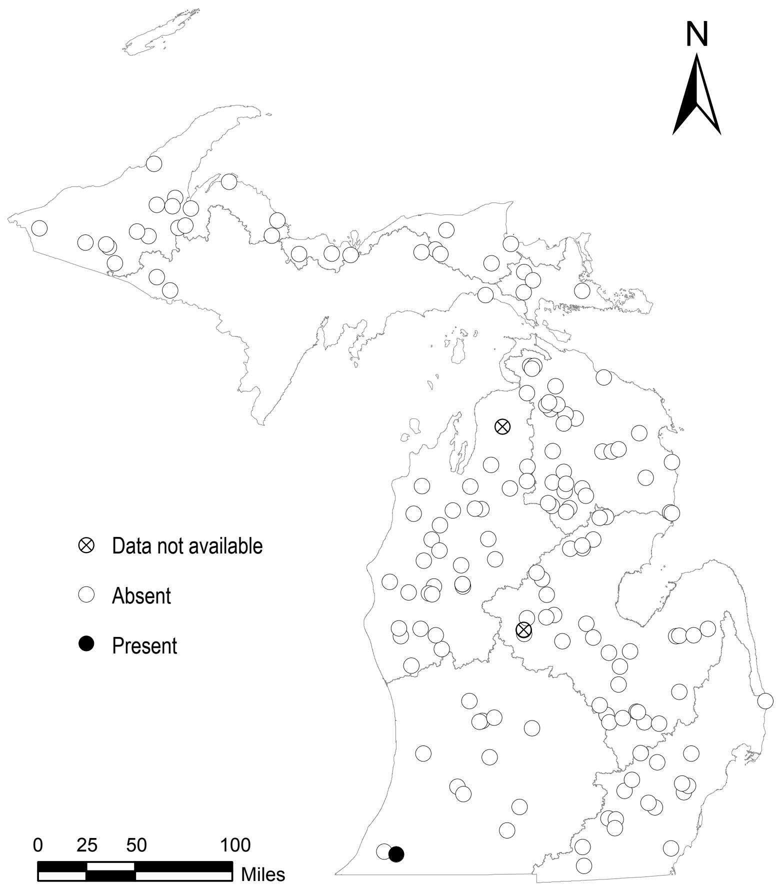

Figure 64.–Map of distribution of creek chubsuckers.

• Northern hog sucker *Hypentelium nigricans* (NHS)

Northern hog suckers were scattered throughout all Great Lakes basins within the Lower Peninsula, but were not reported in the Upper Peninsula (Figure 65). They occurred in 30% of random stream surveys and at 11 of 57 fixed sites sampled throughout the state (Table 13).

Northern hog suckers were reported in all size and temperature classes of streams and in greater proportion among waters without Great Lakes access (Table 36). Their proportion of occurrence increased with stream size and temperature; accordingly, the highest average CPE of northern hog suckers across all random surveys was in very large warm streams. When encountered, electrofishing CPE of northern hog suckers typically ranged between 16 and 158 fish per mile, with a maximum CPE of 2,640 fish per mile.

The size distribution of 1,016 northern hog suckers measured during random stream surveys ranged from 1 to 17 in (Figure 66). Small, 2–3 in fish comprised over one half (52%) of the total catch. Northern hog suckers greater than 4 in were captured less frequently, with each individual inch group comprising less than 5% of the total catch. Individuals greater than 14 in were relatively rare.

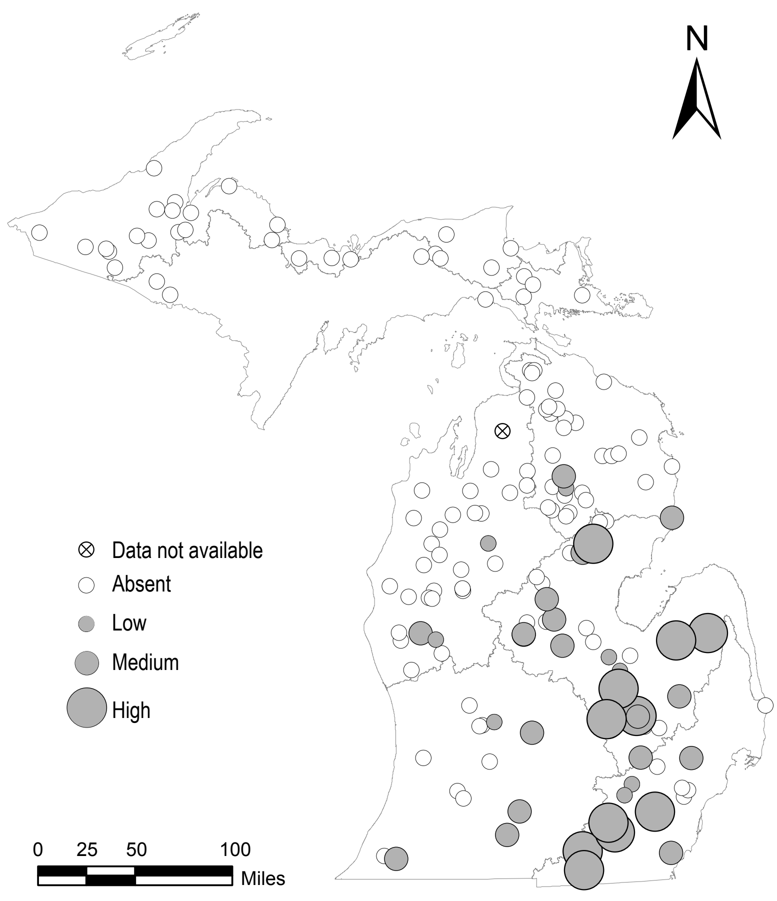

Figure 65.–Map of distribution of northern hog suckers. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75[th] percentile, medium = 25[th]–50[th] percentile, low = <25[th] percentile.

Table 36.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of northern hog suckers. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.46	0.33	0.21	0.25	0	0.21	0.9	63.2	116.2	36.7
M	0.13	0.29	0.33	0.23	0.25	0.18	0.23	5.9	31.1	40.0	22.1
L	0	0.57	0.75	0.54	0.60	0.33	0.54	0	29.1	53.3	32.1
VL	1.00	0.50	0.67	0.67	0.75	0.60	0.67	1.0	4.0	442.2	295.8
All	0.10	0.41	0.50	0.30	0.32	0.24	0.30	2.8	40.1	172.9	53.2

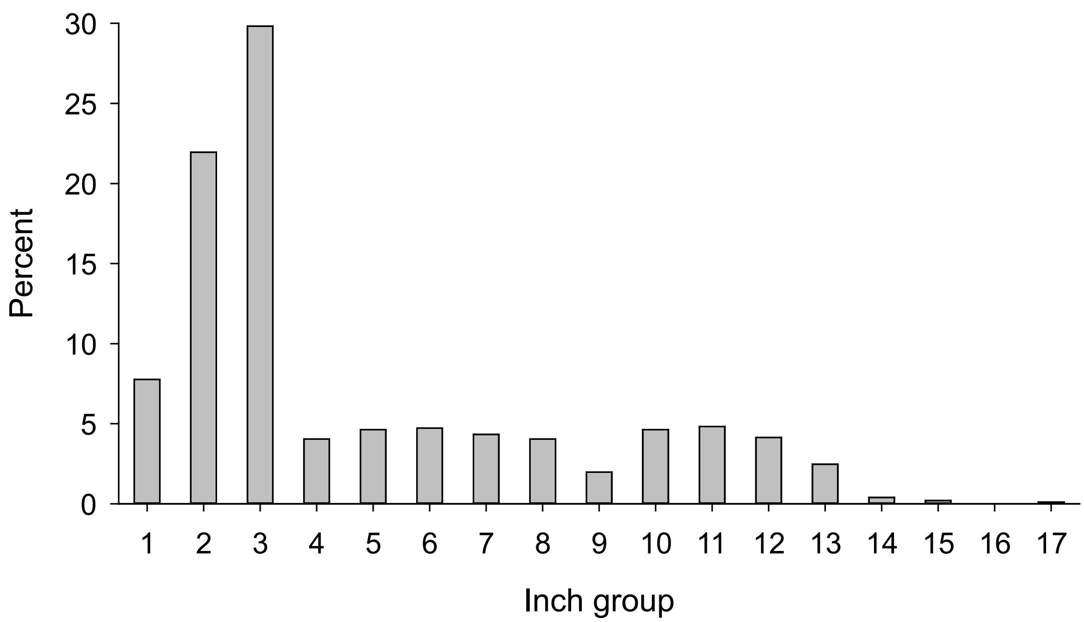

Figure 66.–Size distribution of northern hog suckers.

- Bigmouth buffalo *Ictiobus cyprinellus* (BIB)

  Bigmouth buffalo, an invasive species (Table 12), occurred in only 1 random stream survey in the southern Lake Huron basin (Figure 67, Table 13).

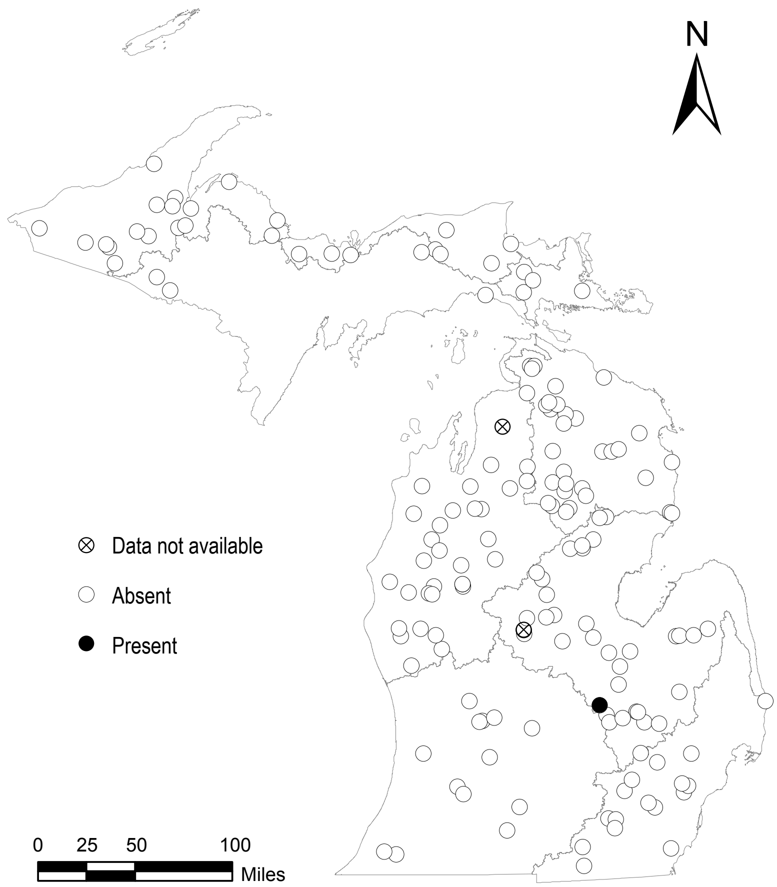

Figure 67.–Map of distribution of bigmouth buffalo.

- Spotted sucker *Minytrema melanops* (SPS)

  Spotted suckers are a state-listed species of greatest conservation need (Table 11). They were not widely distributed in Michigan (Figure 68), occurring in only 2% of random streams surveyed (Table 13).

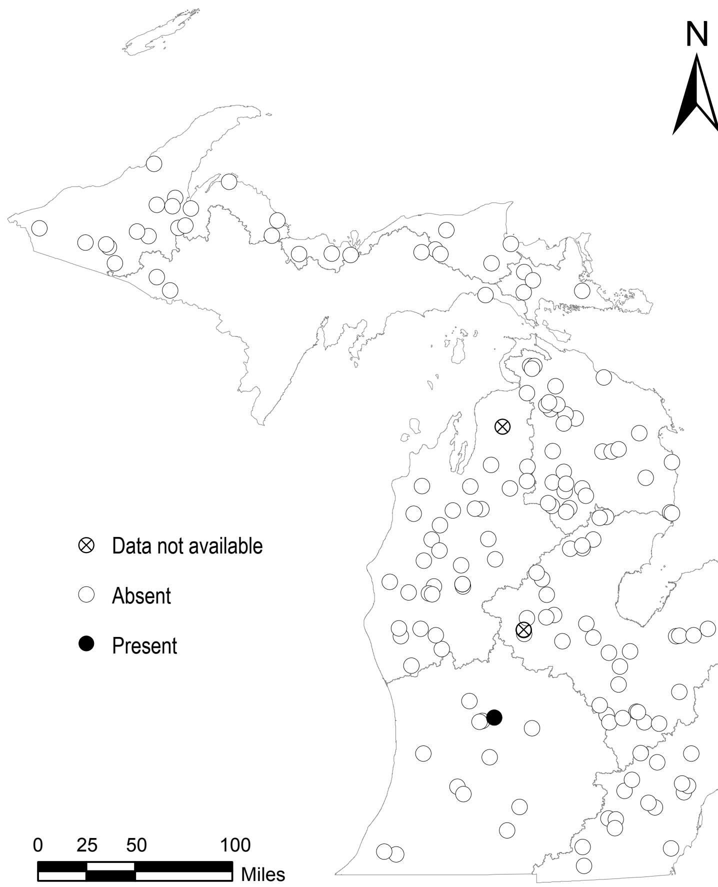

Figure 68.–Map of distribution of spotted suckers.

- Silver redhorse *Moxostoma anisurum* (SIR)

Silver redhorses were widely distributed across the southern half of the Lower Peninsula (Figure 69), but occurred in only 4% of random streams surveyed and at 2 fixed sites (Table 13).

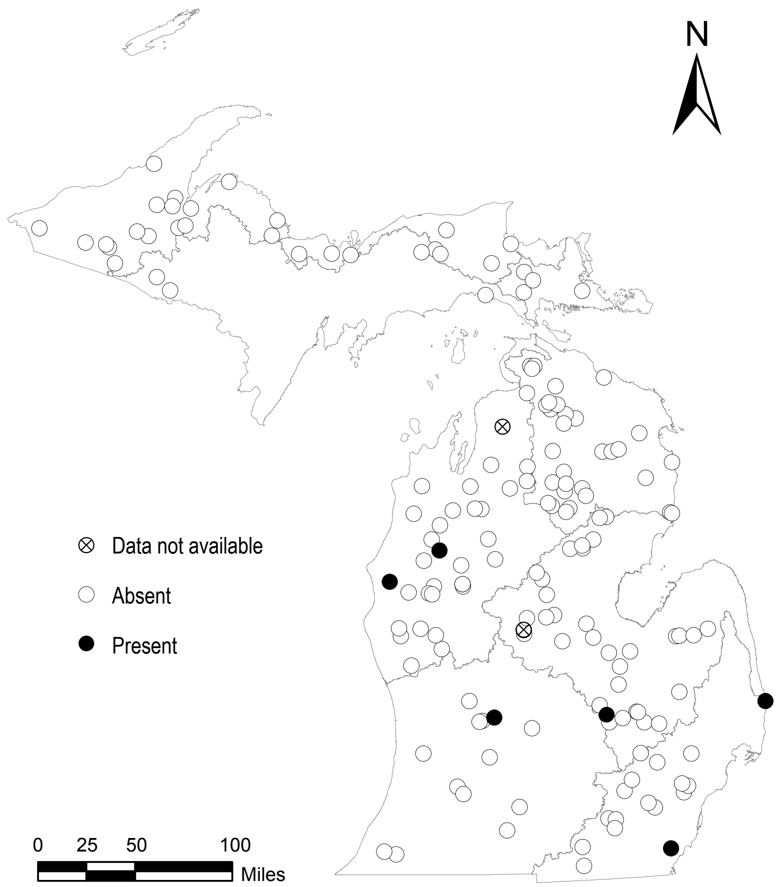

Figure 69.–Map of distribution of silver redhorses.

- Black redhorse *Moxostoma duquesnii* (BLR)

 Black redhorses are a state-listed species of greatest conservation need (Table 11). They occurred in 2% of random streams surveyed and at 3 fixed sites (Table 13), all of which were located in the southeastern quarter of the Lower Peninsula (Lake Michigan, Huron, and Erie basins, Figure 70).

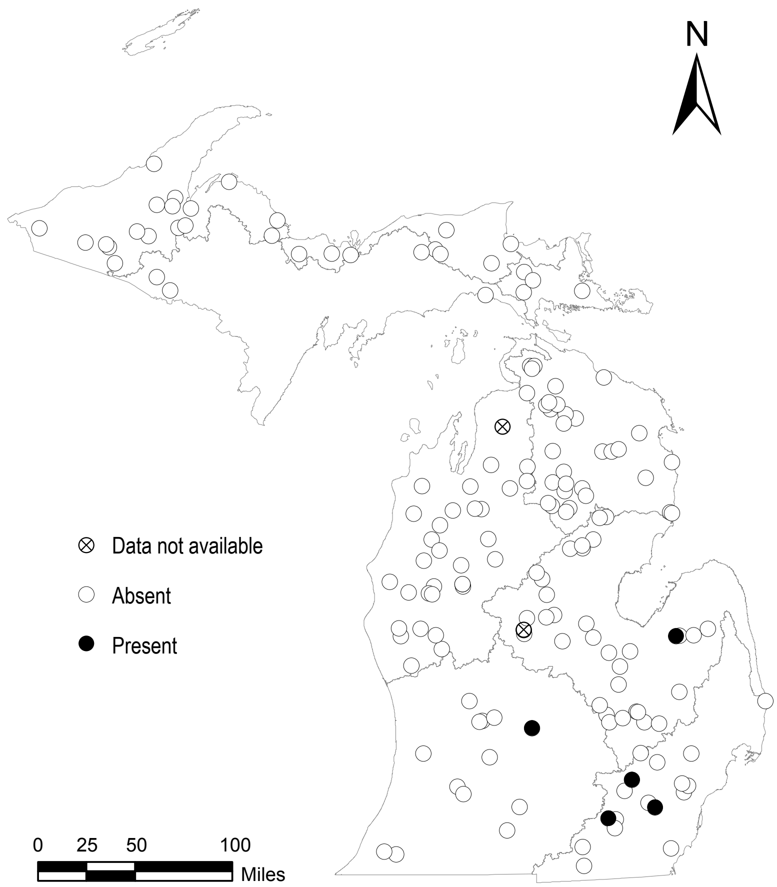

Figure 70.–Map of distribution of black redhorses.

- Golden redhorse *Moxostoma erythrurum* (GOR)

Golden redhorses are a state-listed species of greatest conservation need (Table 11). They were scattered throughout all Great Lakes basins within the southern half of the Lower Peninsula (Figure 71), occurring in 12% of random stream surveys and at 6 of 57 fixed sites sampled throughout the state (Table 13).

Golden redhorses were reported in all size classes of streams and cool and warm temperature classes (Table 37). Their proportion of occurrence increased with stream size and temperature and was greater in streams with Great Lakes access. The highest average CPE of golden redhorses across all random surveys was in large warm streams. When encountered, electrofishing CPE of golden redhorses typically ranged between 6 and 61 fish per mile, with a maximum CPE of 309 fish per mile.

The size distribution of 131 golden redhorses measured during random stream surveys ranged from 3 to 21 in (Figure 72). Individuals in the 13–15 in size group were most common and comprised nearly half (47%) of the total catch. Fish in the 3–12 in size group occurred less frequently, while individuals greater than 18 in were relatively rare.

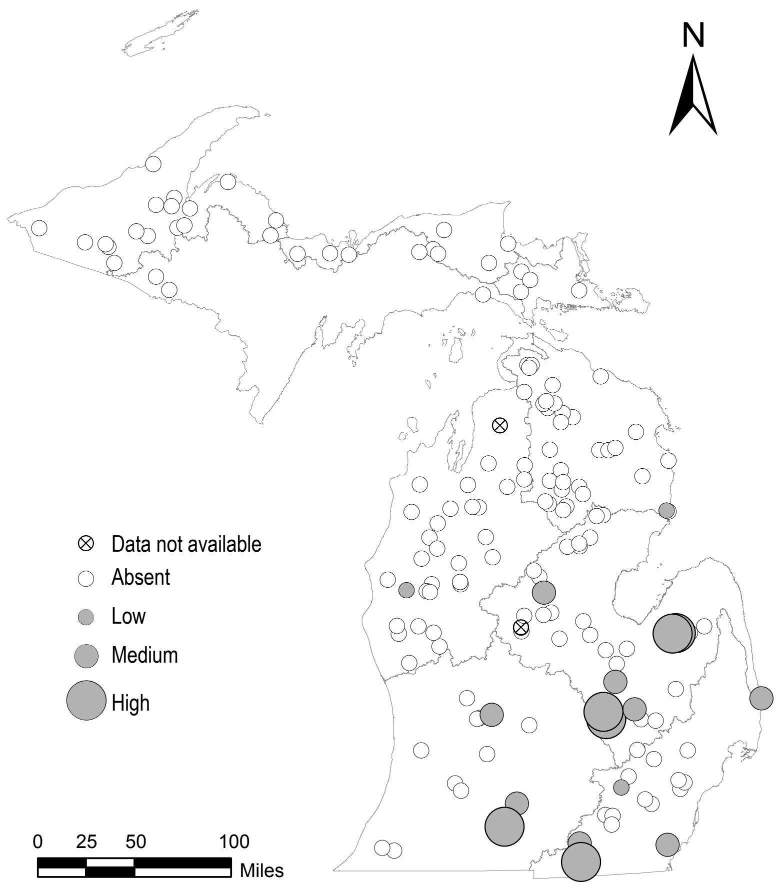

Figure 71.–Map of distribution of golden redhorses. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 37.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of golden redhorses. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.15	0	0.05	0.06	0	0.05	0	6.6	0	2.0
M	0	0.18	0.33	0.13	0.14	0.09	0.13	0	4.6	10.5	3.6
L	0	0.14	0.25	0.15	0.10	0.33	0.15	0	0.6	77.3	24.1
VL	0	0.50	0.33	0.33	0.25	0.40	0.33	0	1.0	11.0	7.6
All	0	0.18	0.23	0.12	0.10	0.16	0.12	0	4.4	19.9	5.9

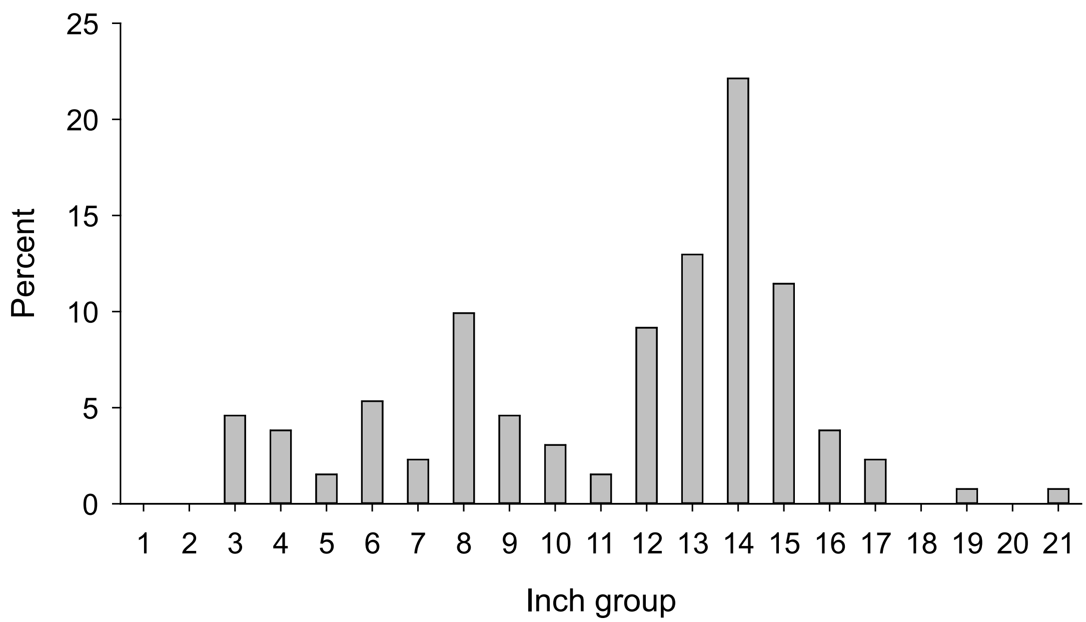

Figure 72.–Size distribution of golden redhorses.

- Shorthead redhorse *Moxostoma macrolepidotum* (SHR)

  Shorthead redhorses were widely distributed throughout the Lower Peninsula (Figure 73), but occurred in only 6% of all random streams surveyed (Table 13).

  Shorthead redhorses were found in all size classes of streams, and tended to occur more frequently as stream size and temperature increased (Table 38). They were more likely to occur in streams without Great Lakes access in all size classes but very large. Although the highest proportion of occurrence across all random surveys was in large cold streams, the highest average CPE was in large cool streams. When encountered, electrofishing CPE of shorthead redhorses typically ranged between 13 and 22 fish per mile, with a maximum CPE of 60 fish per mile.

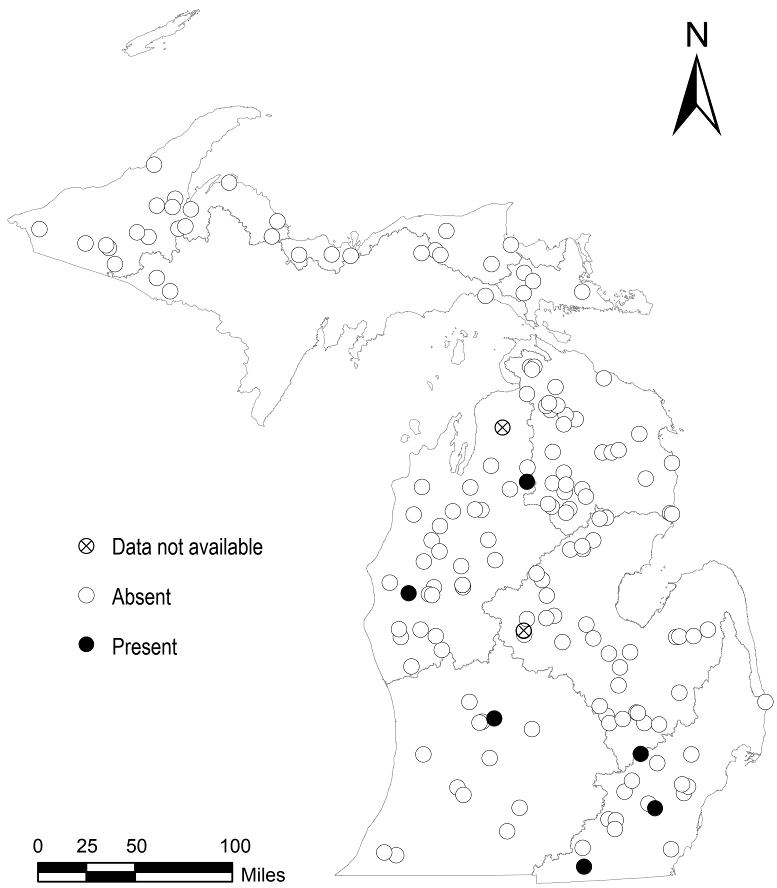

Figure 73.–Map of distribution of shorthead redhorses.

Table 38.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of shorthead redhorses. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0	0.02	0.03	0	0.02	0	1.0	0	0.3
M	0	0.06	0	0.03	0.04	0	0.03	0	0.8	0	0.3
L	0.50	0.14	0	0.15	0.10	0.33	0.15	2.5	8.6	0	5.0
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	6.7	4.4
All	0.02	0.08	0.09	0.06	0.05	0.08	0.06	0.1	2.2	1.8	1.3

• Greater redhorse *Moxostoma valenciennesi* (GRR)

Greater redhorses were widely distributed throughout the central third of the Lower Peninsula (Figure 74), but occurred in only 5% of all random streams surveyed (Table 13). They were also encountered at 2 fixed sites.

Greater redhorses were only found in very large cool and warm water streams, and were more likely to occur in streams with Great Lakes access (Table 39). Average CPE across all very large cool and warm water streams was 5–6 fish per mile. When encountered, electrofishing CPE of greater redhorses typically ranged between 6 and 10 fish per mile, with a maximum CPE of 15 fish per mile.

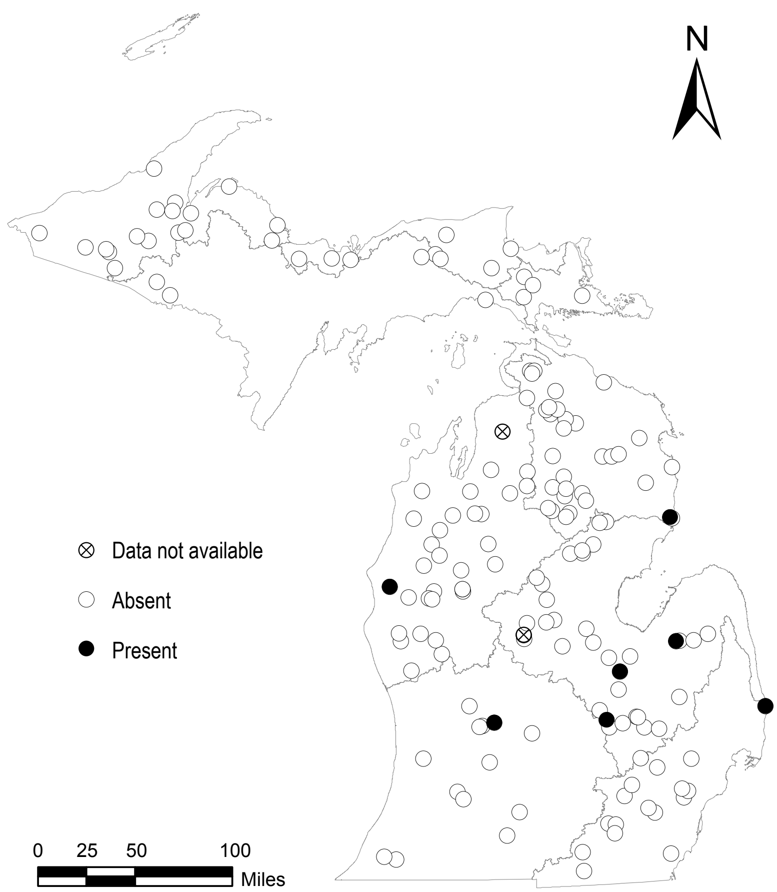

Figure 74.–Map of distribution of greater redhorses.

Table 39.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of greater redhorses. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0
VL	0	1.00	0.50	0.56	0.25	0.80	0.56	0	5.5	5.3	4.8
All	0	0.05	0.14	0.05	0.01	0.16	0.05	0	0.3	1.5	0.4

- Unidentified redhorse (RHS)

  Unidentified redhorses were reported in each Great Lakes basin except Lake Michigan (Figure 75), but occurred in only 5% of all random streams surveyed (Table 13). They were also reported at 1 fixed site. All unidentified redhorses were captured in large cool water or very large warm water streams (Table 40).

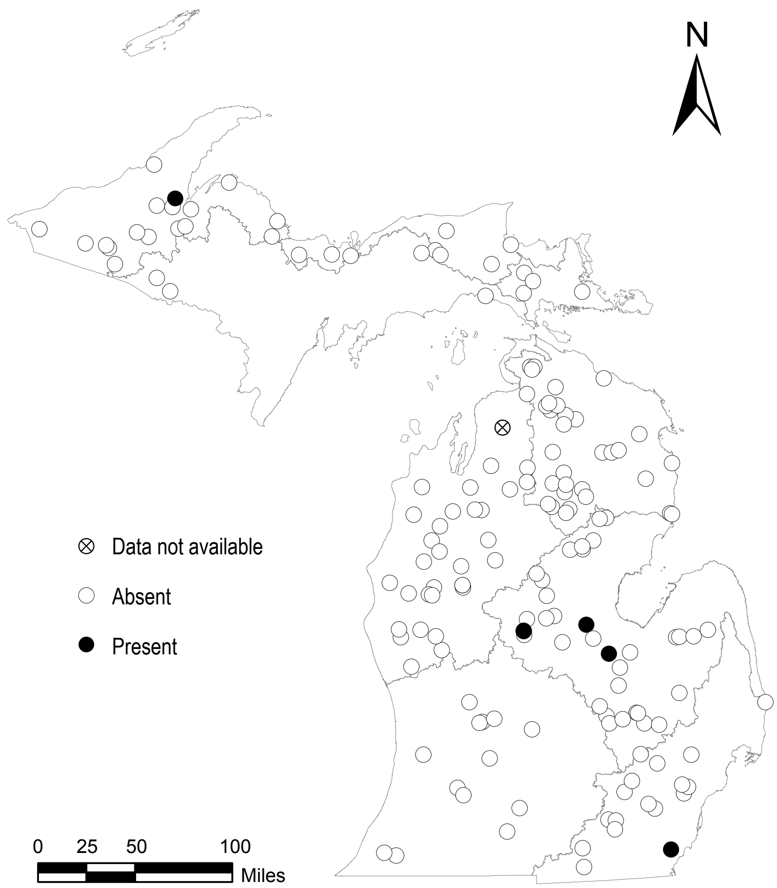

Figure 75.–Map of distribution of unidentified redhorses.

Table 40.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of unidentified redhorses. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi², M = medium catchment 40–179 mi², L = large catchment 180–620 mi², VL = very large catchment >620 mi². Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0	0	0	0
L	0	0.43	0	0.23	0.20	0.33	0.23	0	16.3	0	8.8
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	26.0	17.3
All	0	0.08	0.09	0.05	0.04	0.08	0.05	0	2.9	7.1	2.6

Ictaluridae

- Black bullhead *Ameiurus melas* (BLB)

    Black bullheads were mostly distributed throughout the northern half of the Lower Peninsula in the Lake Michigan and Huron basins (Figure 76), but occurred in only 8% of all random streams surveyed statewide (Table 13).

    Black bullheads were found in all size classes and temperature classes of streams and were usually more common in waters without Great Lakes access (Table 41). The highest average CPE of black bullheads across all random surveys was in warm very large streams. When encountered, electrofishing CPE of black bullheads typically ranged between 4 and 19 fish per mile, with a maximum CPE of 26 fish per mile.

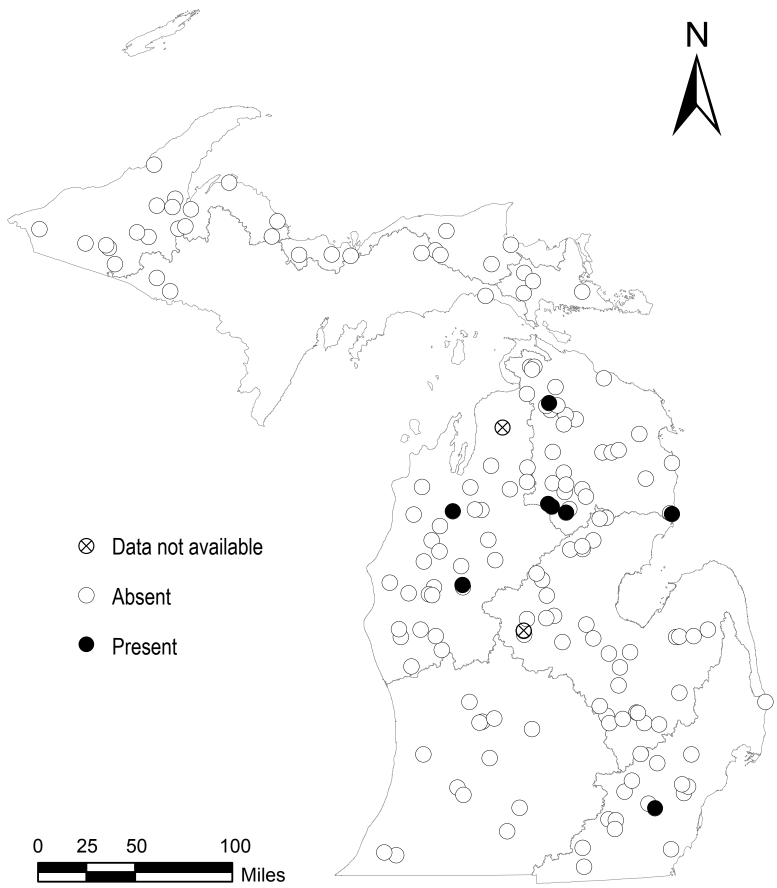

Figure 76.–Map of distribution of black bullheads.

Table 41.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of black bullheads. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0	0	0.02	0.03	0	0.02	0.6	0	0	0.3
M	0.19	0.12	0	0.13	0.18	0	0.13	1.8	1.5	0	1.4
L	0	0.14	0	0.08	0	0.33	0.08	0	0.6	0	0.3
VL	0	0	0.17	0.11	0.25	0	0.11	0	0	4.3	2.9
All	0.10	0.08	0.05	0.08	0.09	0.04	0.08	1.0	0.8	1.2	0.9

- Yellow bullhead *Ameiurus catus* (YLB)

  Yellow bullheads were scattered mostly throughout the southern Lower Peninsula in the Lake Michigan, Huron, and Erie basins, with some reports in the northern Lower Peninsula (Figure 77). They occurred in 11% of random stream surveys and at 7 of 57 fixed sites sampled throughout the state (Table 13).

  Yellow bullheads were reported in all size and temperature classes of streams, occurring in greater proportion among large and very large warm streams and (on average) waters with Great Lakes access (Table 42). The highest average CPE of yellow bullheads across all random surveys was also in large warm streams. When encountered, electrofishing CPE of yellow bullheads typically ranged between 4 and 35 fish per mile, with a maximum CPE of 111 fish per mile.

  The size distribution of 40 yellow bullheads measured during random stream surveys ranged from 2 to 10 in (Figure 78). Fish in the 3 in size group comprised nearly one third (30%) of the total catch; a second mode in the size distribution comprising over one half (53%) of the total catch was centered on 6 in.

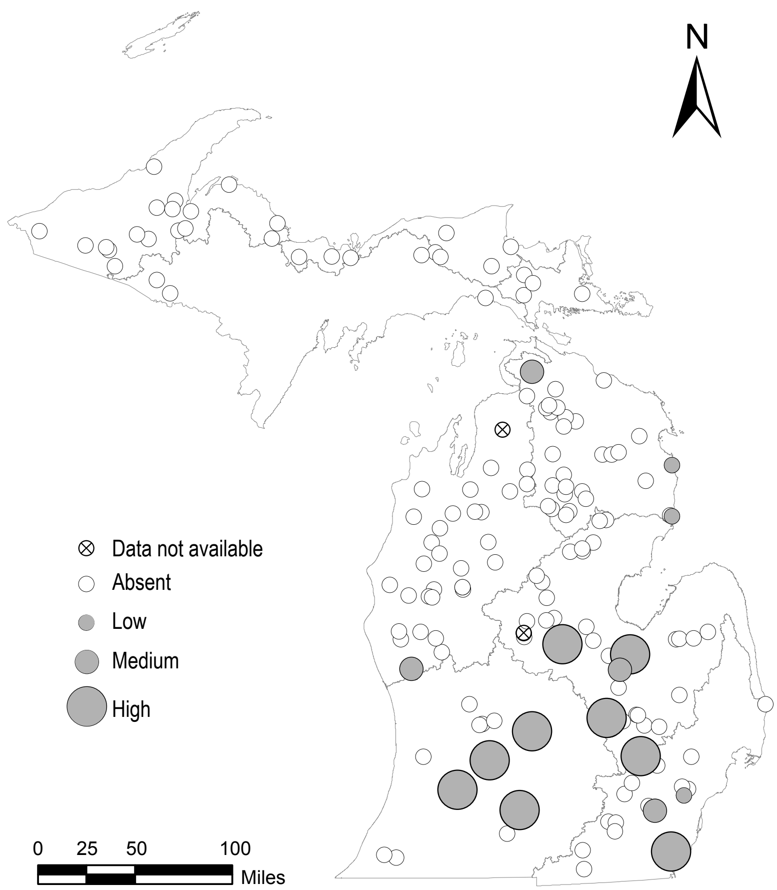

Figure 77.–Map of distribution of yellow bullheads. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 42.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of yellow bullheads. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0	0.17	0.05	0.03	0.17	0.05	0.5	0	5.8	1.1
M	0.13	0.06	0.17	0.10	0.11	0.09	0.10	0.6	2.7	0.7	1.5
L	0	0.14	0.50	0.23	0.20	0.33	0.23	0	0.6	29.8	9.5
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	4.2	2.8
All	0.07	0.05	0.27	0.11	0.09	0.16	0.11	0.5	1.3	8.3	2.5

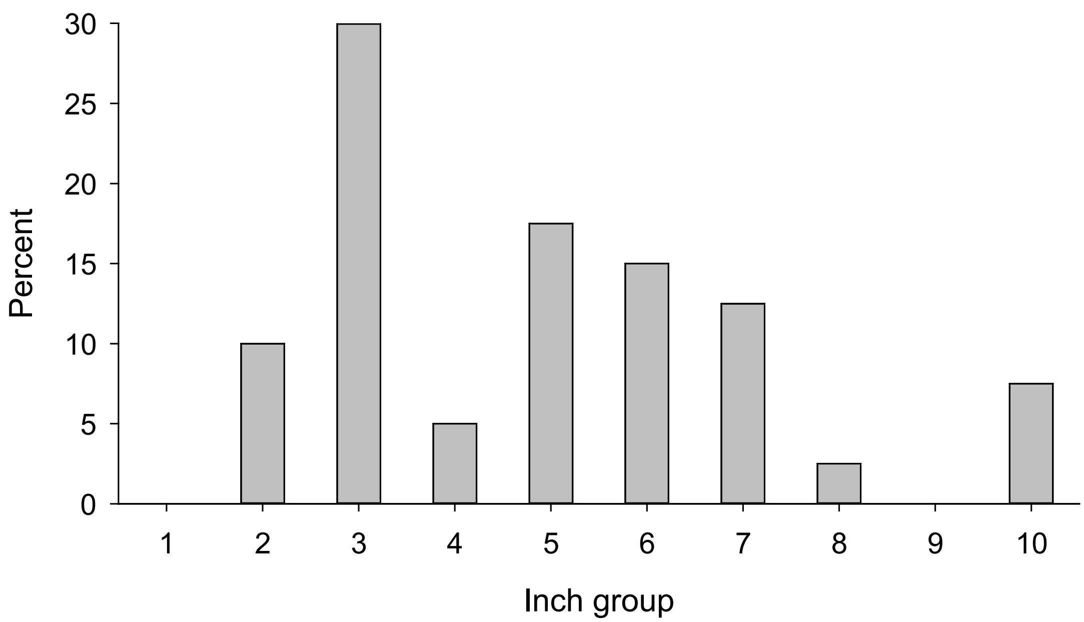

Figure 78.–Size distribution of yellow bullheads.

- Brown bullhead *Ameiurus nebulosus* (BRB)

  Brown bullheads were reported in each Great Lakes basin, but occurred in only 4% of random streams surveyed and at 2 fixed sites (Table 13) scattered across the western Upper Peninsula and southeastern quarter of the Lower Peninsula (Figure 79).

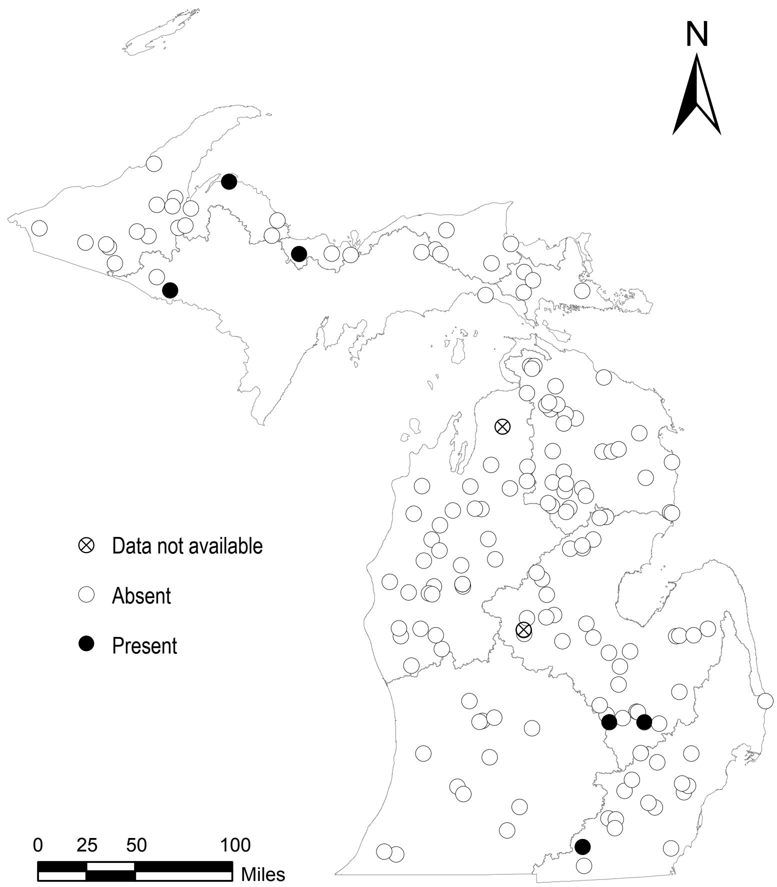

Figure 79.–Map of distribution of brown bullheads.

- Unidentified bullhead (BUL FA)

  Unidentified bullheads were reported in only 1 random stream surveyed (Figure 80, Table 13). We did not calculate proportion of occurrence or typical catch rates for these unidentified specimens.

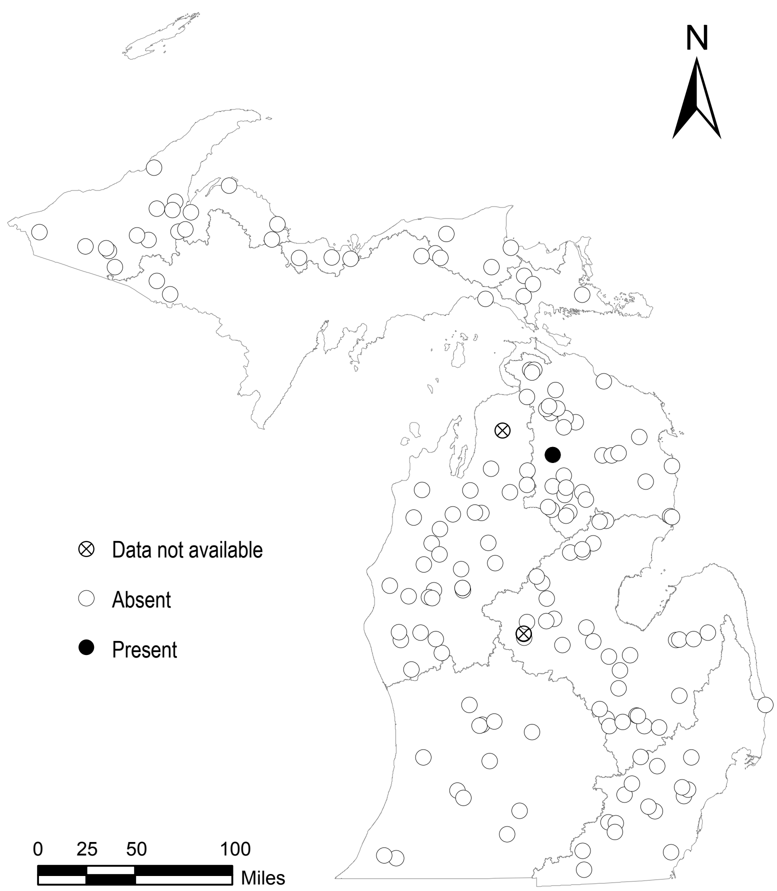

Figure 80.–Map of distribution of unidentified bullheads.

- Channel catfish *Ictalurus punctatus* (CCF)

Channel catfish were distributed in the southern half of the Lower Peninsula in the Lake Michigan, Huron, and Erie basins (Figure 81), occurring in 5% of all random streams surveyed (Table 13). They were also encountered at 2 fixed sites.

Channel catfish were only found in large or very large warm water streams, and occurred more frequently in waters with Great Lakes access (Table 43). When encountered, electrofishing CPE of channel catfish typically ranged between 13 and 21 fish per mile, with a maximum CPE of 62 fish per mile.

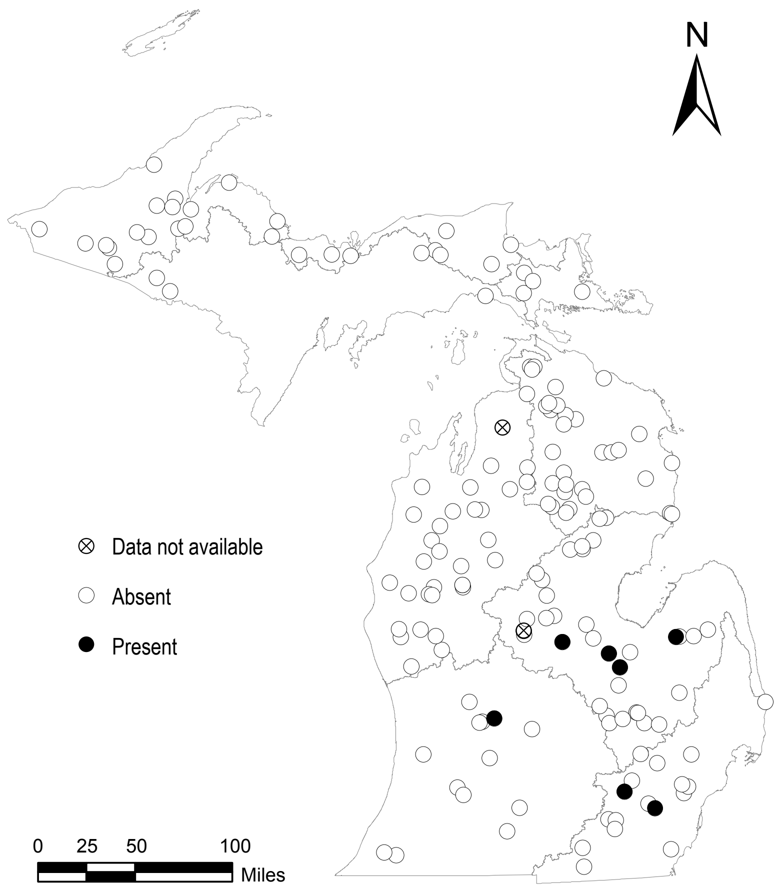

Figure 81.–Map of distribution of channel catfish.

Table 43.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of channel catfish. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0.25	0.08	0.10	0	0.08	0	0	5.3	1.6
VL	0	0	0.67	0.44	0.25	0.60	0.44	0	0	15.0	10.0
All	0	0	0.23	0.05	0.03	0.12	0.05	0	0	5.0	1.1

- Stonecat *Noturus flavus* (STC)

  Stonecats are a state-listed species of greatest conservation need (Table 11). They were scattered throughout the southeast quarter of the Lower Peninsula in the Lake Michigan, Huron, and Erie basins (Figure 82), occurring in 14% of random stream surveys and at 7 of 57 fixed sites sampled throughout the state (Table 13).

  Stonecats were reported in all size and temperature classes of streams and in greater proportion among waters without Great Lakes access (Table 44). Their proportion of occurrence generally increased with stream size and temperature; the highest average CPE of stonecats across all random surveys was in very large warm streams followed by medium warm streams and large warm streams. When encountered, electrofishing CPE of stonecats typically ranged between 14 and 48 fish per mile, with a maximum CPE of 92 fish per mile.

  The size distribution of 95 stonecats measured during random stream surveys ranged from 1 to 8 in (Figure 83). The bell-shaped curve of the distribution was skewed towards larger individuals; fish in the 5–7 in size comprised over a half (53%) of the total catch.

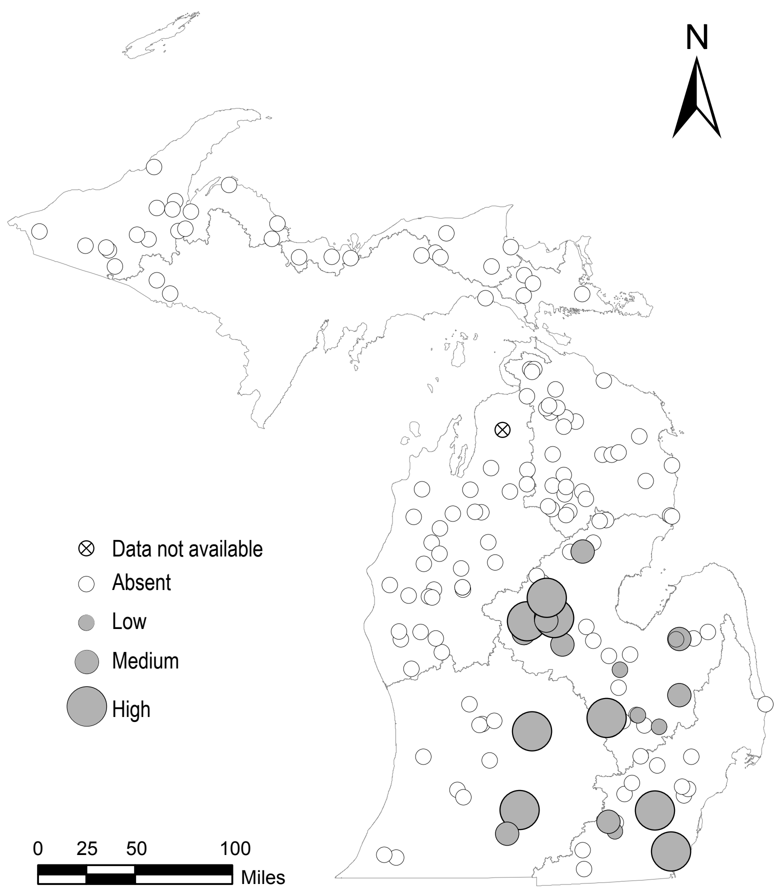

Figure 82.–Map of distribution of stonecat. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 44.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of stonecat. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.15	0	0.07	0.08	0	0.07	0.6	2.4	0	1.0
M	0.06	0.24	0.33	0.18	0.21	0.09	0.18	2.6	8.8	17.0	7.5
L	0	0.14	0.50	0.23	0.30	0	0.23	0	3.6	16.8	7.1
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	17.7	11.8
All	0.05	0.18	0.27	0.15	0.17	0.08	0.15	1.3	5.3	12.5	5.2

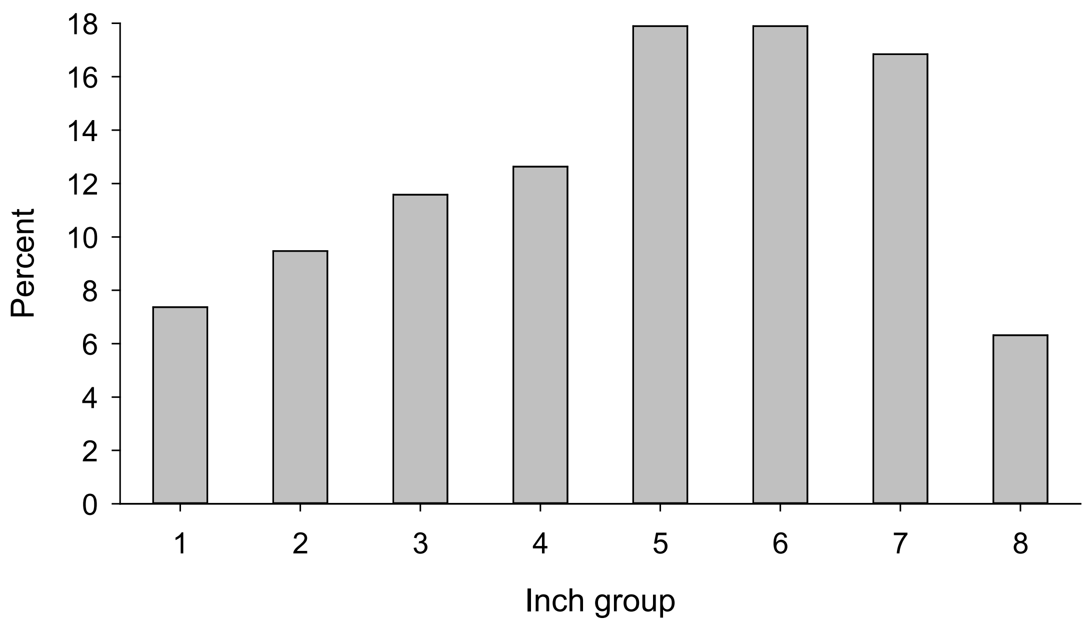

Figure 83.–Size distribution of stonecat.

- Tadpole madtom *Noturus gyrinus* (TMT)

  Tadpole madtoms are a state-listed species of greatest conservation need (Table 11). They were not captured in any random stream surveyed, but occurred at 1 fixed site in the southern Lake Michigan basin (Figure 84, Table 13).

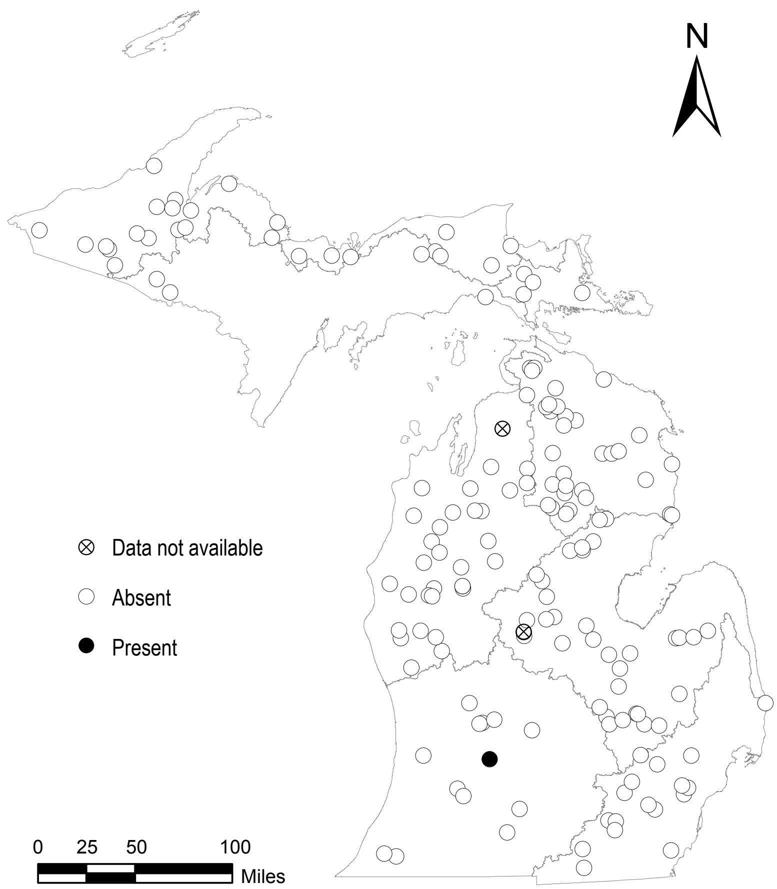

Figure 84.–Map of distribution of tadpole madtoms.

• Flathead catfish *Pylodictis olivaris* (FCF)

Flathead catfish occurred in only 1 random stream surveyed and at 1 fixed site, both in the southern Lake Michigan basin (Figure 85, Table 13).

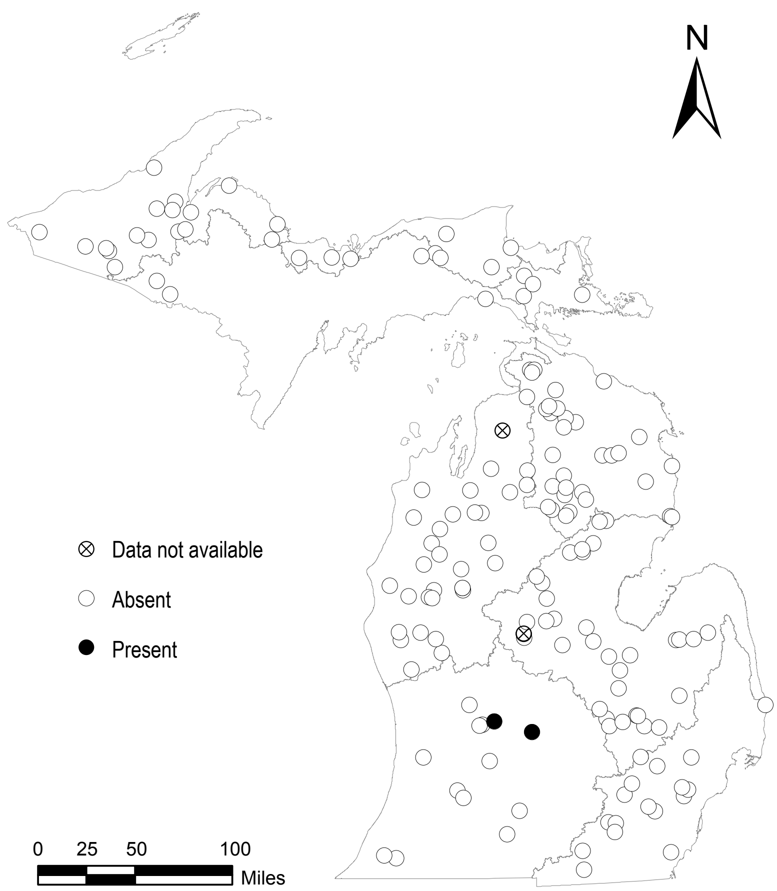

Figure 85.–Map of distribution of flathead catfish.

Esocidae

- Grass pickerel *Esox americanus vermiculatus* (GRP)

Grass pickerel are a state-listed species of greatest conservation need (Table 11). They were widely distributed mostly throughout the Lake Michigan and Erie basins in the southern half of the Lower Peninsula (Figure 86), but occurred in only 5% of all random streams surveyed (Table 13). Grass pickerel were also encountered at 6 fixed sites.

Grass pickerel were only found in cold and cool water streams, and did not occur in any large-sized waters (Table 35). On average, they were more likely to be found in streams with Great Lakes access compared to those without. The highest proportion of occurrence and average CPE across all random surveys was in very large cool streams. When encountered, electrofishing CPE of grass pickerel typically ranged between 11 and 26 fish per mile, with a maximum CPE of 42 fish per mile.

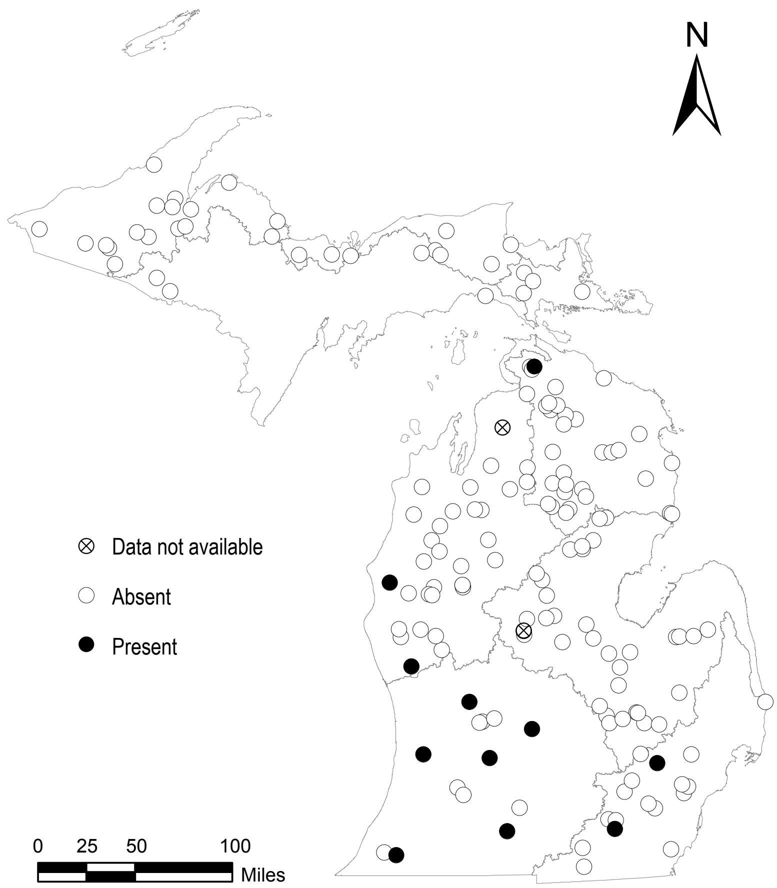

Figure 86.–Map of distribution of grass pickerel.

Table 35.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of grass pickerel. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.08	0	0.05	0.03	0.17	0.05	1.8	0.8	0	1.3
M	0	0.12	0	0.05	0.07	0	0.05	0	1.8	0	0.8
L	0	0	0	0	0	0	0	0	0	0	0
VL	0	0.50	0	0.11	0	0.20	0.11	0	5.5	0	1.2
All	0.02	0.10	0	0.05	0.04	0.08	0.05	1.0	1.4	0	0.9

- Northern pike *Esox lucius* (NOP)

Northern pike were widely distributed throughout the Upper and Lower peninsulas (Figure 87). They occurred in 15% of random stream surveys and at 5 of 57 fixed sites sampled throughout the state (Table 13).

Northern pike were reported in all Great Lakes basins, all size and temperature classes of streams and in variable proportion among waters with Great Lakes access (Table 36). Their proportion of occurrence was variable among different stream size and temperature classes; the highest average CPE of northern pike across all random surveys was in very large cool streams. When encountered, electrofishing CPE of northern pike typically ranged between 5 and 16 fish per mile, with a maximum CPE of 53 fish per mile.

The size distribution of 46 northern pike measured during random stream surveys ranged from 5 to 30 in and was highly variable (Figure 88). Fish in the 8–9 in size group occurred most frequently, comprising over one quarter (26%) of the total catch. Other size groups generally comprised 2–4% of the total catch, although some (12–13 in and 18 in) occurred more frequently.

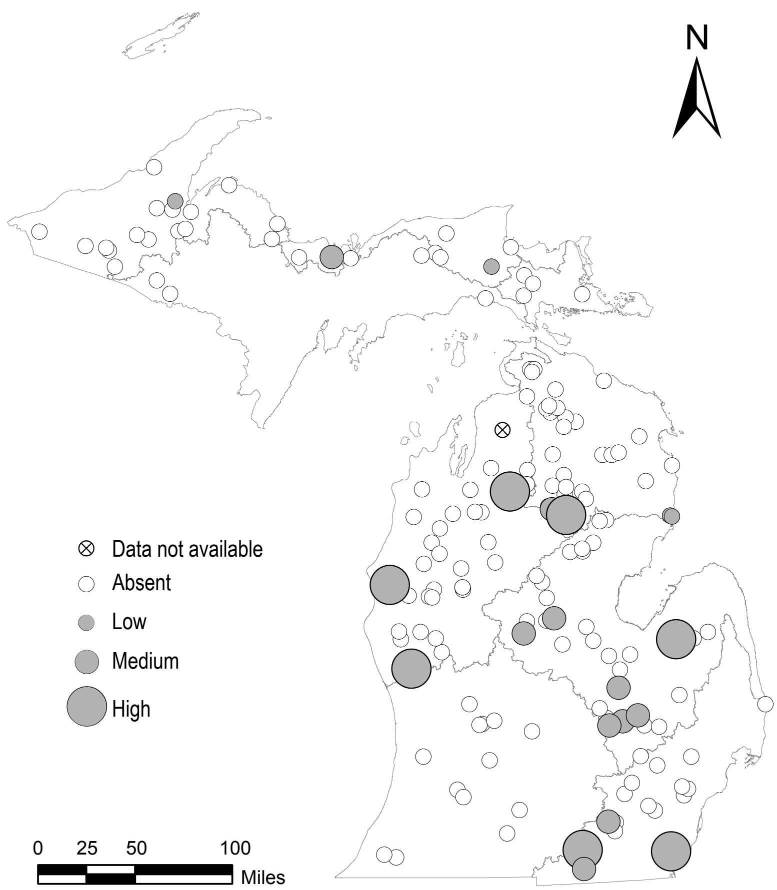

Figure 87.–Map of distribution of northern pike. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 36.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of northern pike. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.23	0	0.10	0.08	0.17	0.10	1.4	5.9	0	2.6
M	0	0.24	0.33	0.15	0.18	0.09	0.15	0	2.0	3.2	1.4
L	0	0.43	0.25	0.31	0.20	0.67	0.31	0	1.7	2.0	1.5
VL	0	1.00	0	0.22	0.25	0.20	0.22	0	9.5	0	2.1
All	0.02	0.31	0.14	0.16	0.14	0.20	0.16	0.8	3.6	1.2	2.0

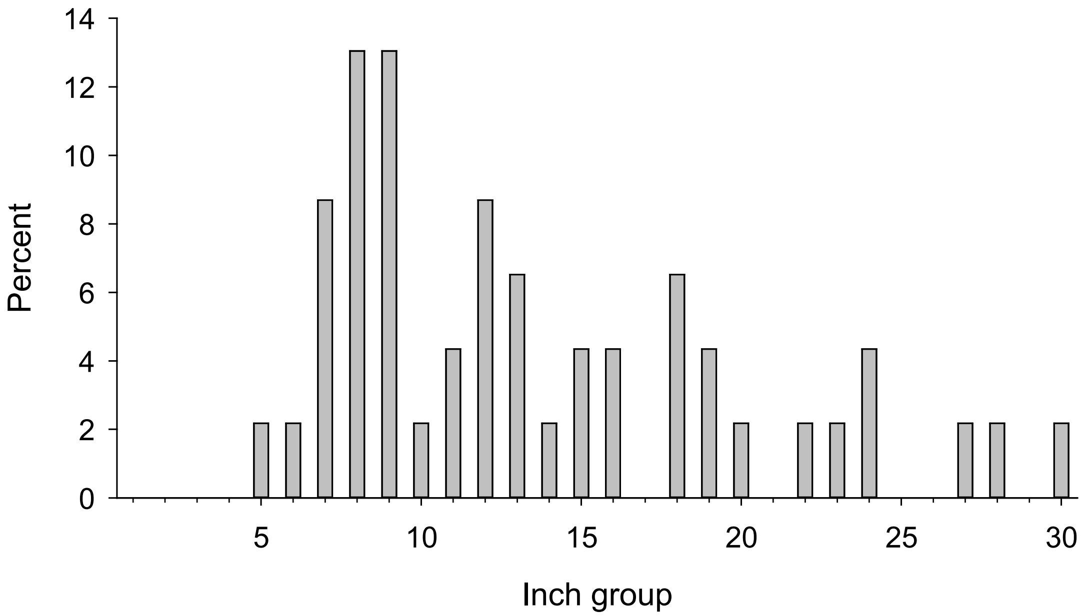

Figure 88.–Size distribution of northern pike.

Umbridae

- Central mudminnow *Umbra limi* (MUD)

  Central mudminnows were the tenth most frequently encountered species in Michigan streams, occurring in 34% of random surveys (Table 13). They were also reported at 24 of 57 fixed sites sampled throughout the state.

  Central mudminnows were widely distributed across the Upper and Lower peninsulas (Figure 89), occurring in all Great Lakes basins and most size and all temperature classes of streams (Table 37). Their proportion of occurrence decreased with increasing stream size and temperature, and was somewhat greater in waters without Great Lakes access. The highest average CPE of central mudminnows across all random stream surveys was in small cool and cold water streams. When encountered, electrofishing CPE of central mudminnows typically ranged between 13 and 137 fish per mile, with a maximum CPE of 6,336 fish per mile.

  The size distribution of 1,079 central mudminnows measured during random stream surveys ranged from 1 to 5 in (Figure 90). Fish in the 2–3 in size range comprised nearly all (92%) of the total catch.

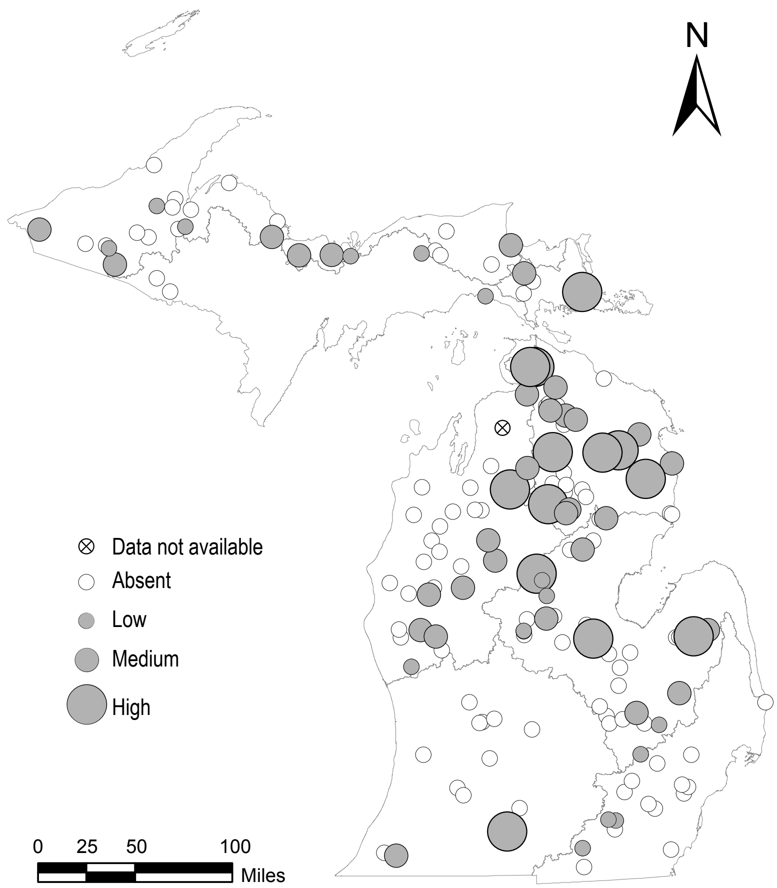

Figure 89.–Map of distribution of central mudminnows. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 37.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of central mudminnows. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.48	0.38	0.50	0.45	0.44	0.50	0.45	210.2	502.0	36.8	275.7
M	0.38	0.35	0.33	0.36	0.43	0.18	0.36	23.3	58.4	79.0	47.2
L	0	0.29	0	0.15	0.20	0	0.15	0	2.6	0	1.4
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.40	0.33	0.23	0.34	0.38	0.20	0.34	124.0	193.3	31.6	130.5

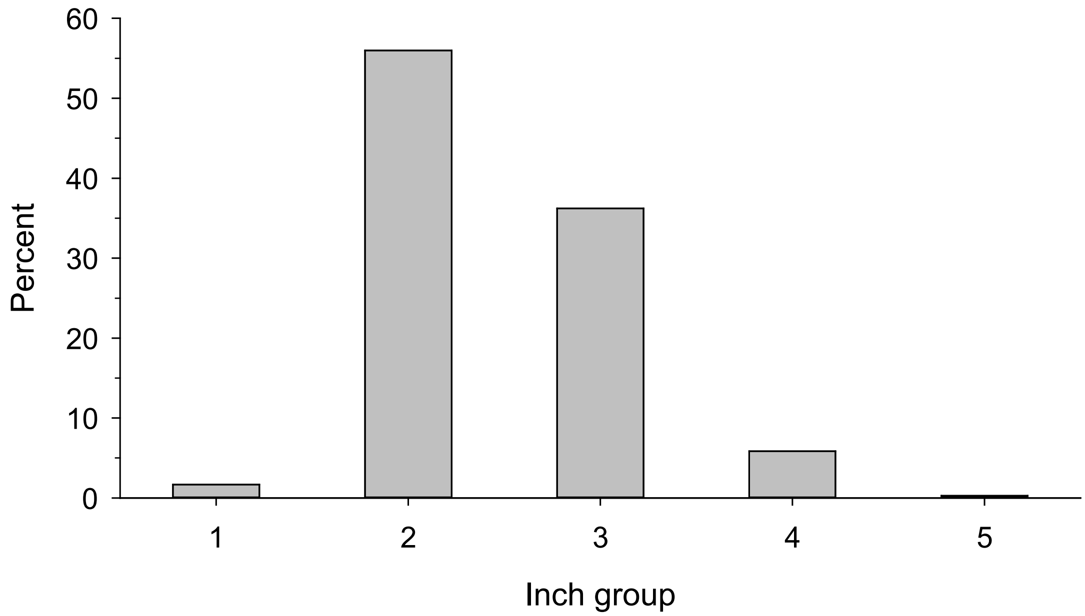

Figure 90.–Size distribution of central mudminnows.

Salmonidae

- Pink salmon *Oncorhynchus gorbuscha* (PKS)

    Pink salmon, a non-native salmon species, occurred in only 1 random stream survey in the Lake Superior basin of the western Upper Peninsula (Figure 91, Table 13).

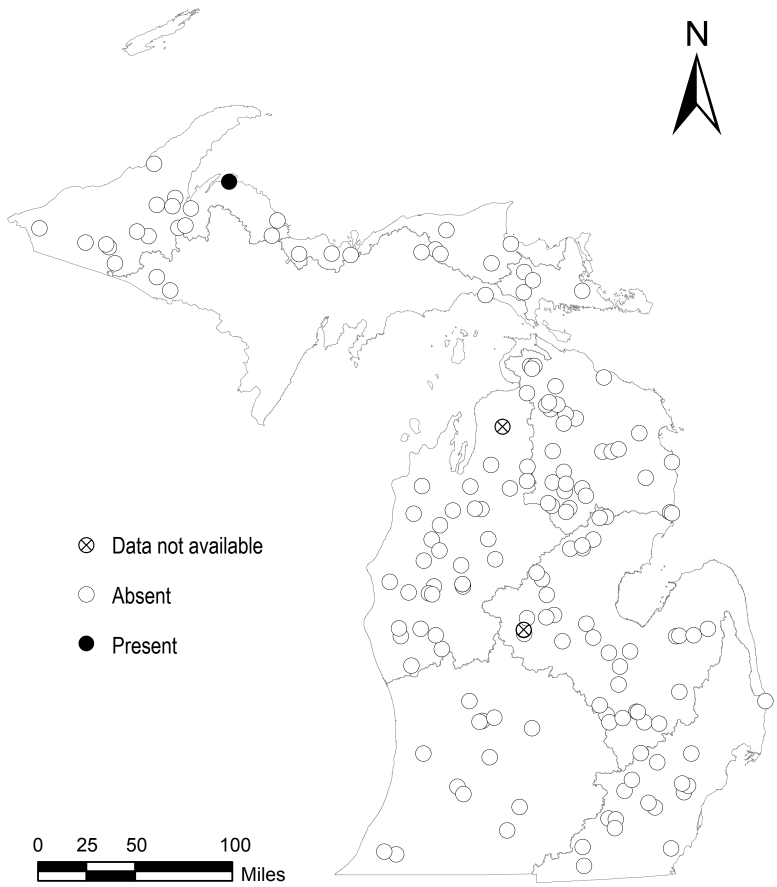

Figure 91.–Map of distribution of pink salmon.

- Coho salmon *Oncorhynchus kisutch* (COS)

Coho salmon, a non-native salmon species, were widely distributed in the Lake Superior and Lake Michigan basins (Figure 92), but occurred in only 6% of all random streams surveyed (Table 13). They were encountered at 11 fixed sites.

Coho salmon occurred most frequently in cold water streams with Great Lakes access, although some were found in cool water systems (Table 38). No Coho salmon were found in large or very large streams; the highest proportion of occurrence and CPE across all random surveys was in medium cold streams. When encountered, electrofishing CPE of Coho salmon typically ranged between 7 and 32 fish per mile, with a maximum CPE of 97 fish per mile.

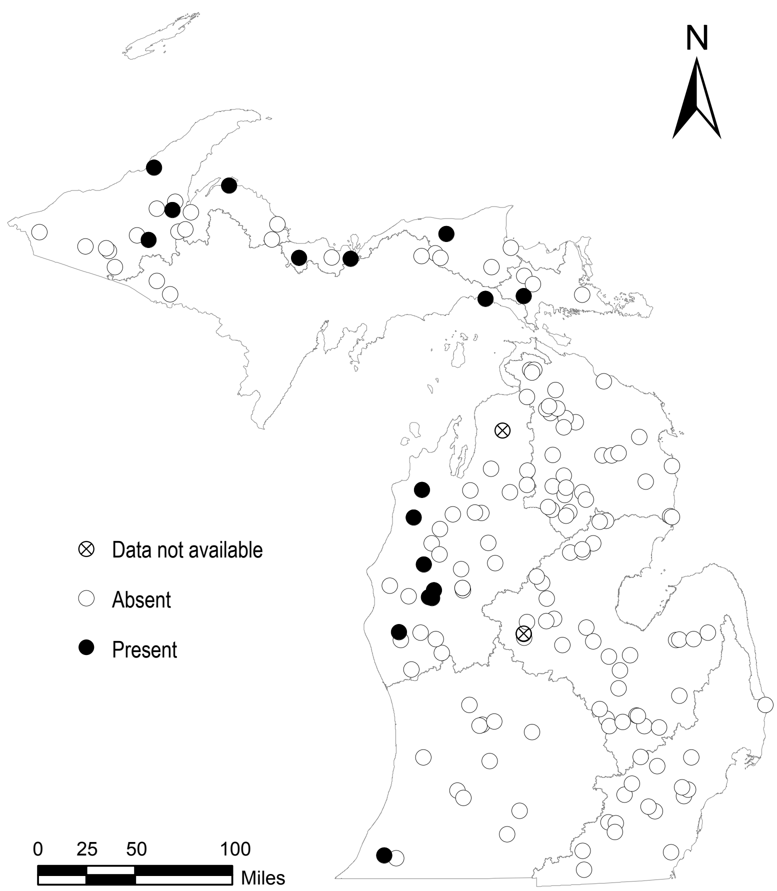

Figure 92.–Map of distribution of Coho salmon.

Table 38.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of Coho salmon. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.09	0	0	0.05	0.03	0.17	0.05	1.9	0	0	1.0
M	0.13	0.12	0	0.10	0	0.36	0.10	6.6	0.5	0	2.9
L	0	0	0	0	0	0	0	0	0	0	0
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.10	0.05	0	0.06	0.01	0.20	0.06	3.5	0.2	0	1.5

• Chinook salmon *Oncorhynchus tshawytscha* (CHS)

Chinook salmon, a non-native salmon species, occurred in 4% of random streams surveyed and at 8 fixed sites (Table 13). All reports of Chinook salmon were located in the Upper Peninsula or northern half of the Lower Peninsula, mostly in the Lake Michigan and Huron basins (Figure 93).

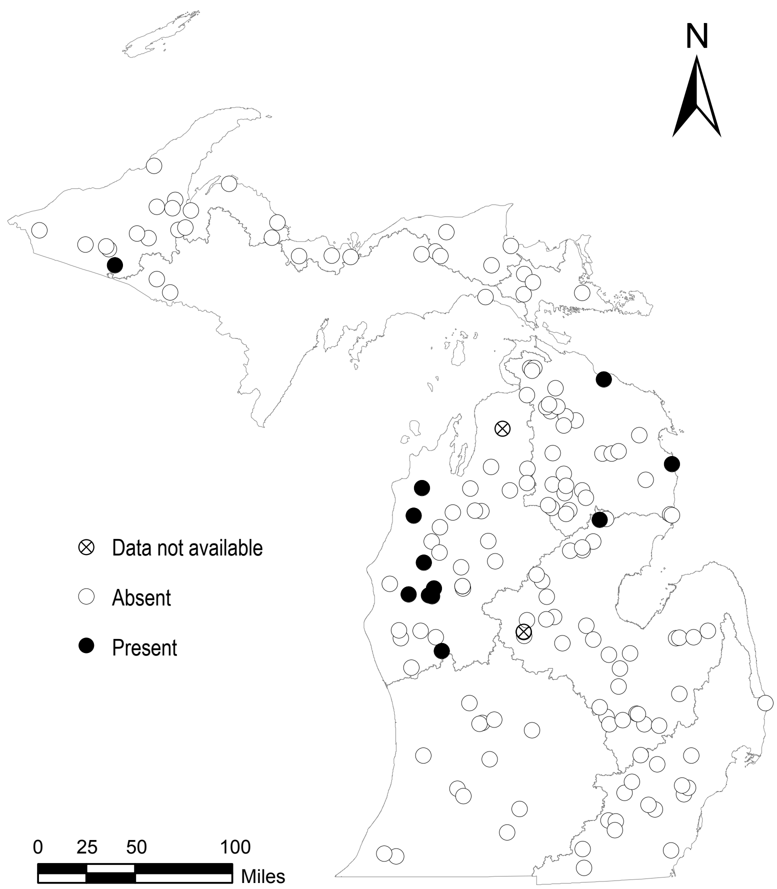

Figure 93.–Map of distribution of Chinook salmon.

• Rainbow trout *Oncorhynchus mykiss* (RBT)

Rainbow trout, a non-native salmonid species, were distributed throughout Michigan, with relatively frequent reports within the Lake Michigan and Huron basins in the northern Lower Peninsula and the Lake Superior basin in the western Upper Peninsula (Figure 94). They occurred in 20% of random stream surveys and at 27 of 57 fixed sites sampled throughout the state (Table 13).

Rainbow trout proportion of occurrence was variable by stream size, decreased with increasing temperature, and for most size classes was much higher in streams with Great Lakes access compared to those without (Table 39). The highest average CPE of rainbow trout across all random surveys was in medium cold streams. When encountered, electrofishing CPE of rainbow trout typically ranged between 13 and 128 fish per mile, with a maximum CPE of 1,672 fish per mile.

The size distribution of 917 rainbow trout measured during random stream surveys ranged from 1 to 28 in (Figure 95). Fish in the 2 in size group (young-of-year) comprised over 40% of the total catch; a second mode likely representing age-1 individuals was centered on 5 in. Larger individuals were captured much less frequently since the majority of rainbow trout smolt and emigrate from streams to the Great Lakes prior to age 3.

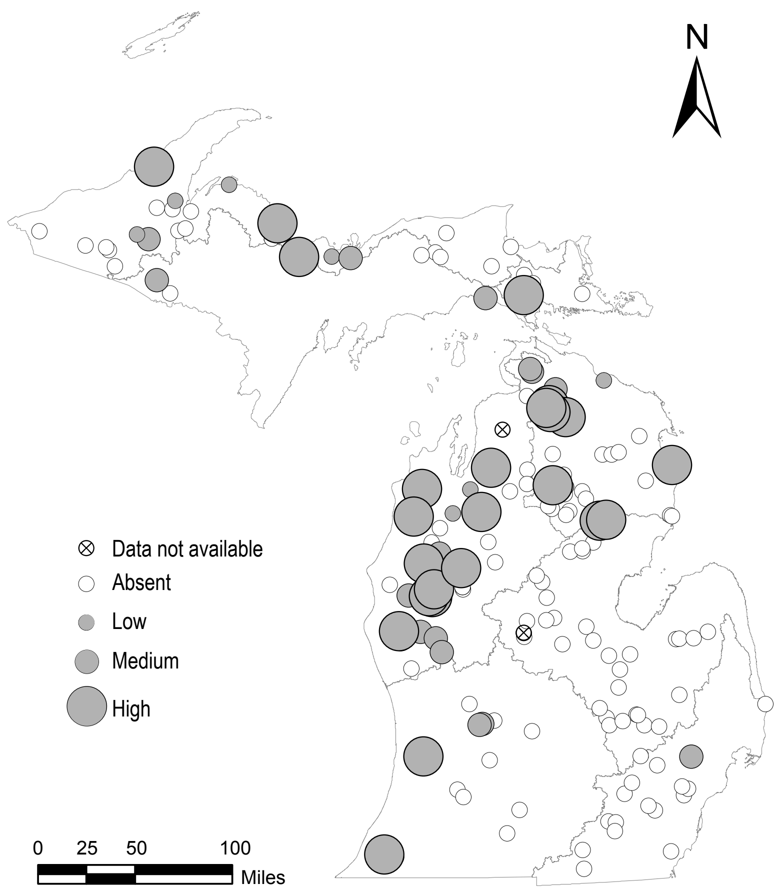

Figure 94.–Map of distribution of rainbow trout. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 39.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of rainbow trout. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.13	0	0	0.07	0.06	0.17	0.07	52.7	0	0	28.9
M	0.63	0.18	0	0.33	0.21	0.64	0.33	205.2	1.4	0	84.8
L	0.50	0.43	0	0.31	0.20	0.67	0.31	53.0	23.1	0	20.6
VL	1.00	0	0	0.11	0.25	0	0.11	3.0	0	0	0.3
All	0.36	0.15	0	0.20	0.14	0.40	0.20	109.6	4.7	0	46.5

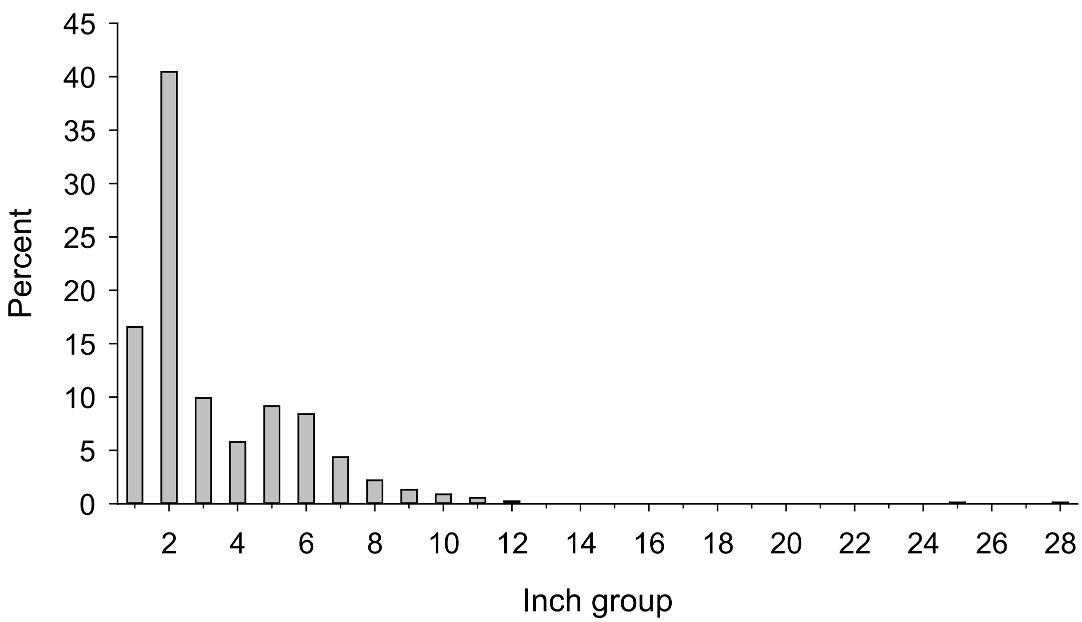

Figure 95.–Size distribution of rainbow trout.

• Round whitefish *Prosopium cylindraceum* (RWF)

Round whitefish (sometimes referred to as Menominee) occurred in only 1 random stream survey in the northern Lake Huron basin (Figure 96, Table 13).

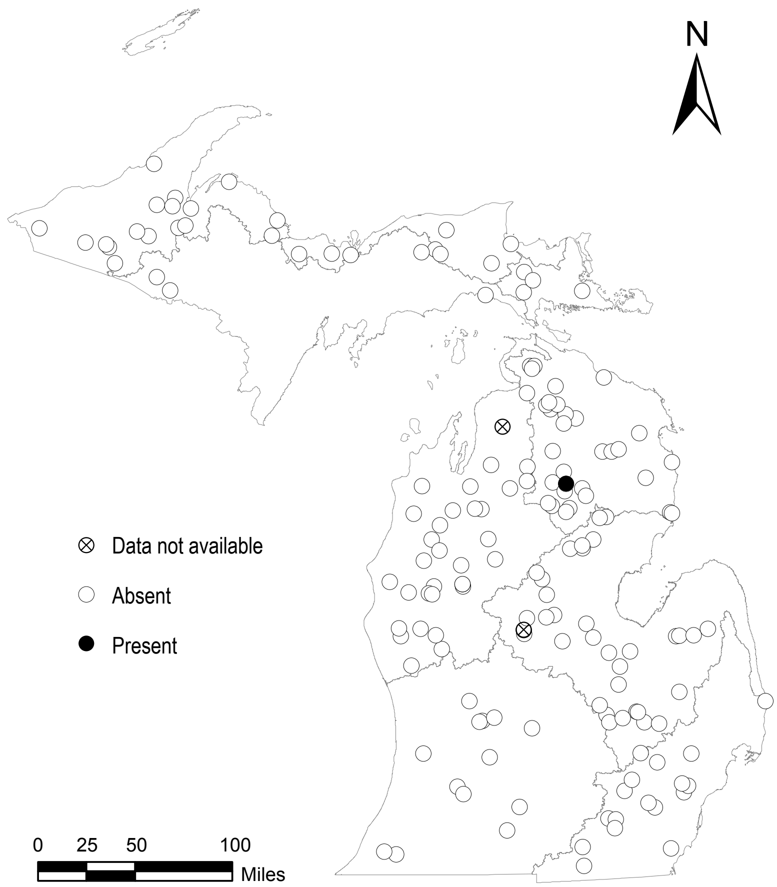

Figure 96.–Map of distribution of round whitefish.

• Brown trout *Salmo trutta* (BNT)

Brown trout, a non-native salmonid species, were scattered throughout the Upper Peninsula and widely distributed in the northern and southwestern Lower Peninsula (Figure 97). No brown trout were reported in the Lake Erie basin. They occurred in 32% of random stream surveys and at 36 of 57 fixed sites sampled throughout the state (Table 13).

Brown trout were reported in all size and temperature classes of streams and in similar proportion among waters with or without Great Lakes access (Table 40). Their proportion of occurrence varied by stream size, but decreased with increasing temperature. The highest average CPE of brown trout across all random surveys was in large cold streams, followed by medium and small cold waters. When encountered, electrofishing CPE of brown trout typically ranged between 39 and 548 fish per mile, with a maximum CPE of 2,756 fish per mile.

The size distribution of 2,449 brown trout measured during random stream surveys ranged from 1 to 22 in (Figure 98). Small, 2–3 in fish (young-of-year) comprised one third (33%) of the total catch, with a second mode centered on 6 in (likely age 1 individuals). Brown trout greater than 10 in were captured less frequently, comprising 11% of the total catch.

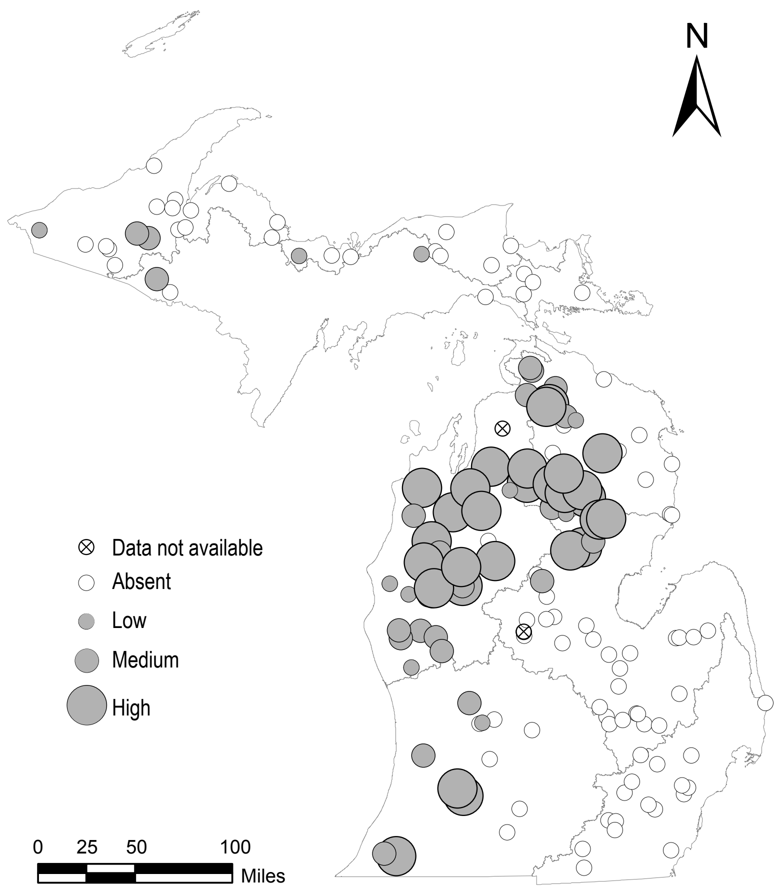

Figure 97.–Map of distribution of brown trout. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 40.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of brown trout. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.35	0.08	0.17	0.24	0.25	0.17	0.24	122.9	2.5	14.3	70.1
M	0.81	0.24	0	0.44	0.43	0.45	0.44	446.4	21.6	0	192.6
L	1.00	0.29	0	0.31	0.30	0.33	0.31	1,533.0	6.1	0	239.2
VL	1.00	0.50	0	0.22	0.25	0.20	0.22	37.0	1.0	0	4.3
All	0.57	0.21	0.05	0.32	0.32	0.32	0.32	311.2	11.4	3.9	132.1

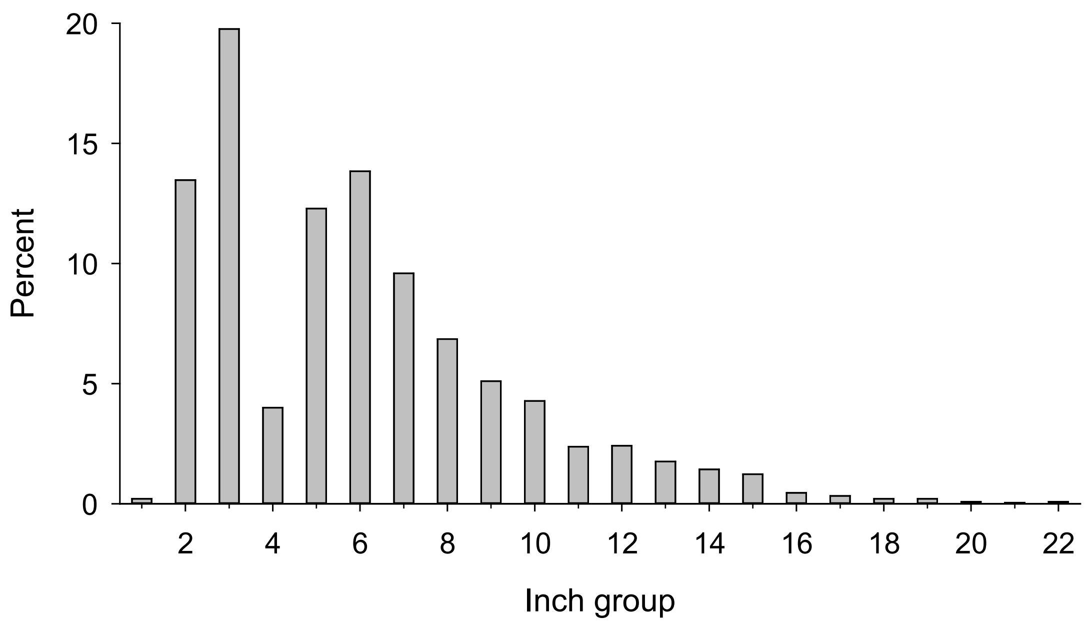

Figure 98.–Size distribution of brown trout.

- Brook trout *Salvelinus fontinalis* (BKT)

Brook trout were the ninth most frequently encountered species in Michigan streams, occurring in 34% of random surveys (Table 13). They were also reported at 39 of 57 fixed sites sampled throughout the state.

Brook trout were widely distributed across the Upper and northern Lower peninsulas, and in a few locations in the southwest Lower Peninsula (Figure 99). No brook trout were reported in the Lake Erie basin. Their proportion of occurrence decreased with increasing size and temperature, and was variable among waters with or without Great Lakes access (Table 41). The highest average brook trout CPE was in large cold waters, followed by small cold and cool streams. When encountered, electrofishing CPE of brook trout typically ranged between 12 and 560 fish per mile, with a maximum CPE of 2,439 fish per mile.

The size distribution of 1,708 brook trout measured during random stream surveys ranged from 1 to 17 in (Figure 100). Small, 2–3 in fish (young-of-year) comprised nearly half (45%) of the total catch, with a second mode (likely age 1 individuals) centered on 5 in. Brook trout greater than 8 in total length were relatively rare, comprising less than 3% of the total catch.

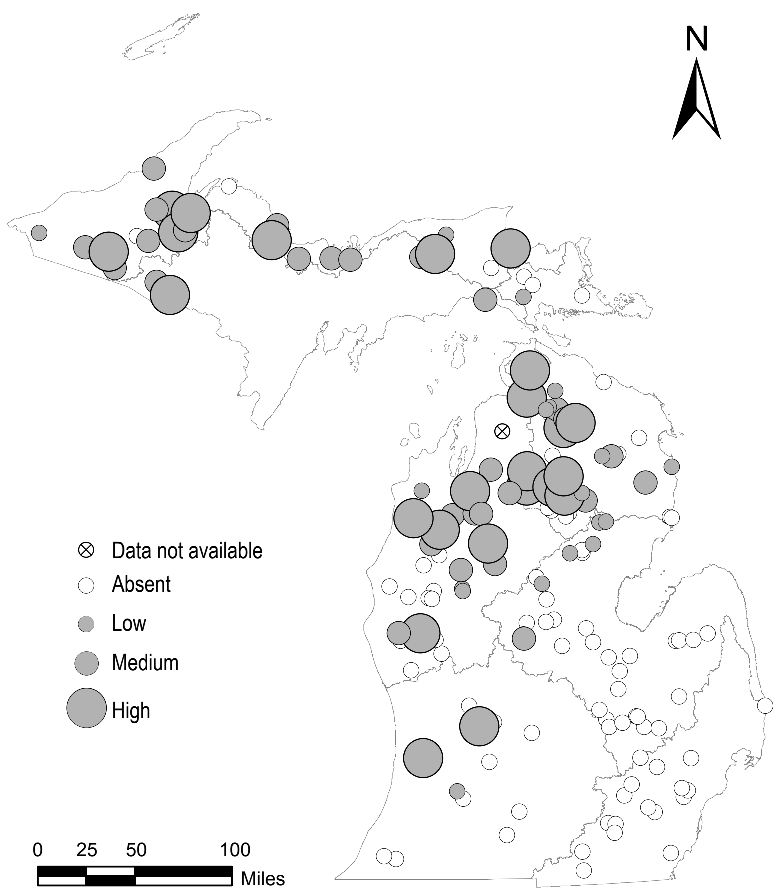

Figure 99.–Map of distribution of brook trout. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 41.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of brook trout. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.61	0.23	0.17	0.43	0.39	0.67	0.43	266.0	214.5	62.7	221.0
M	0.63	0.24	0	0.36	0.36	0.36	0.36	70.3	67.4	0	58.2
L	0.50	0.14	0	0.15	0.20	0	0.15	647.0	1.6	0	100.4
VL	1.00	0	0	0.11	0.25	0	0.11	46.0	0	0	5.1
All	0.62	0.21	0.05	0.34	0.35	0.32	0.34	204.3	101.1	17.1	125.3

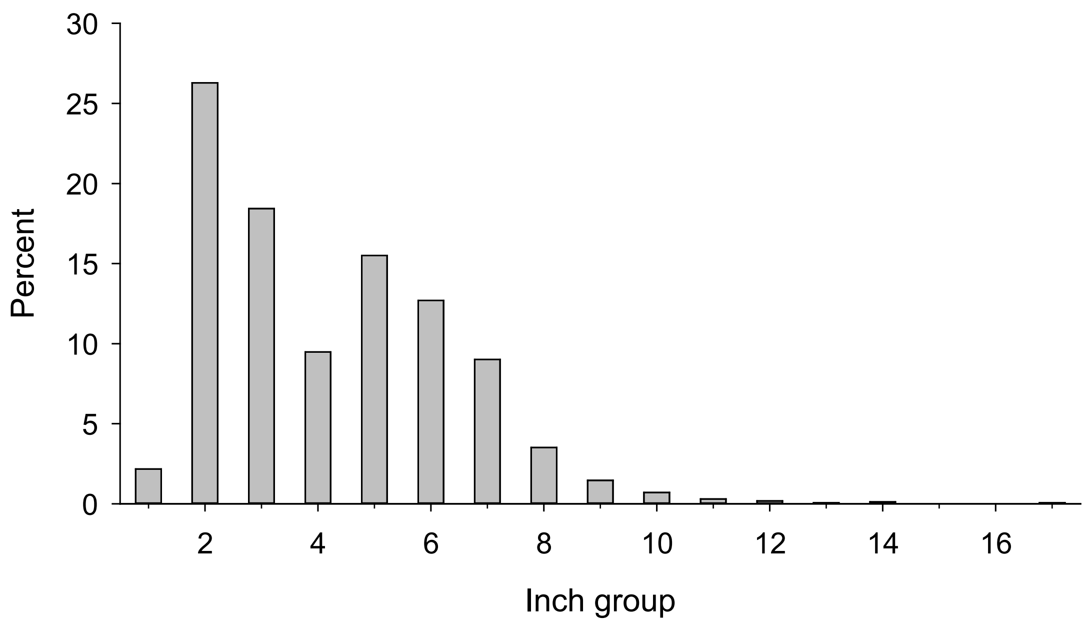

Figure 100.–Size distribution of brook trout.

- Tiger trout (Brook trout x brown trout hybrid, TIT)

  Tiger trout occurred in only 1 random stream surveyed and at 1 fixed site, both in the Lake Michigan basin (Figure 101, Table 13).

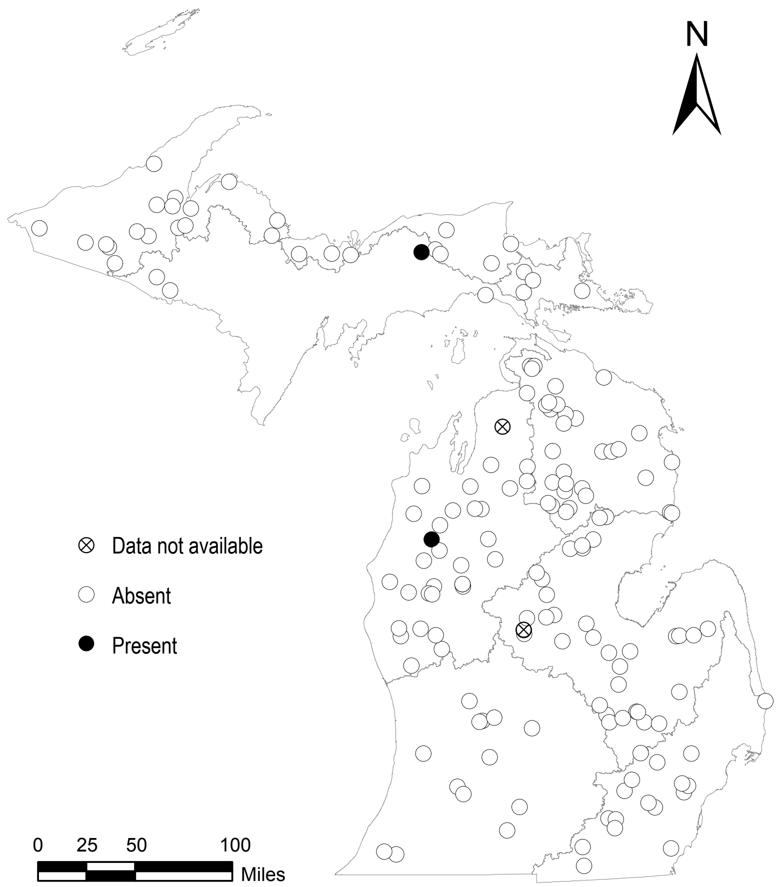

Figure 101.–Map of distribution of tiger trout.

Percopsidae

- Pirate perch *Aphredoderus sayanus* (PIP)

  Pirate perch are a state-listed species of greatest conservation need (Table 11). They were not widely distributed in Michigan (Figure 102), occurring in only 2% of random streams surveyed and at 1 fixed site (Table 13).

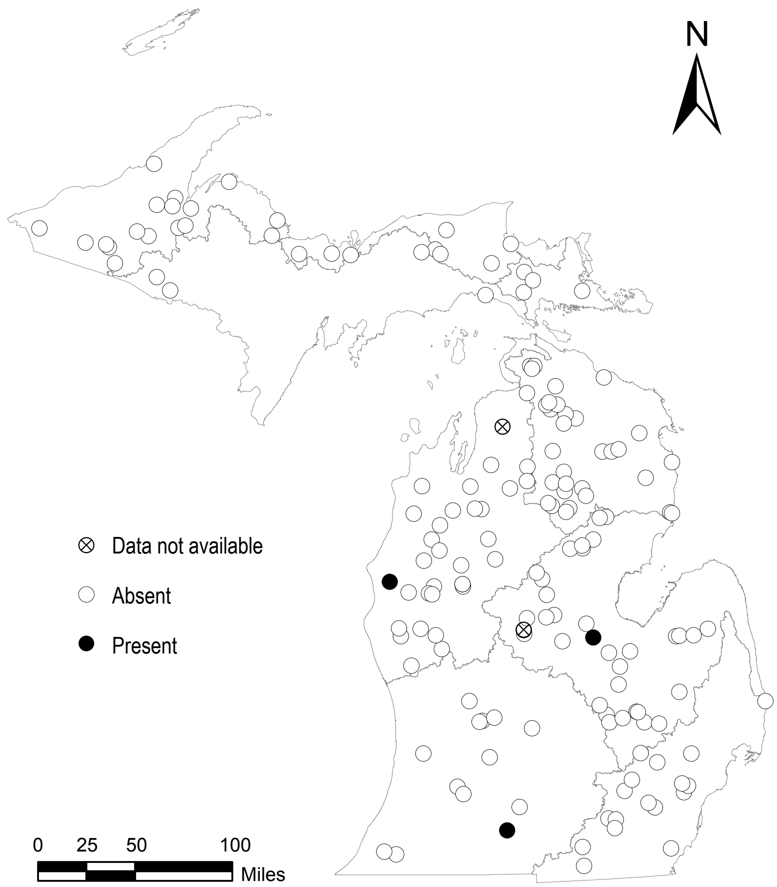

Figure 102.–Map of distribution of pirate perch.

• Trout-perch *Percopsis omiscomaycus* (TRP)

Trout-perch occurred in 3% of random streams surveyed (Table 13), all of which were located within the Lake Superior basin in the western Upper Peninsula (Figure 103).

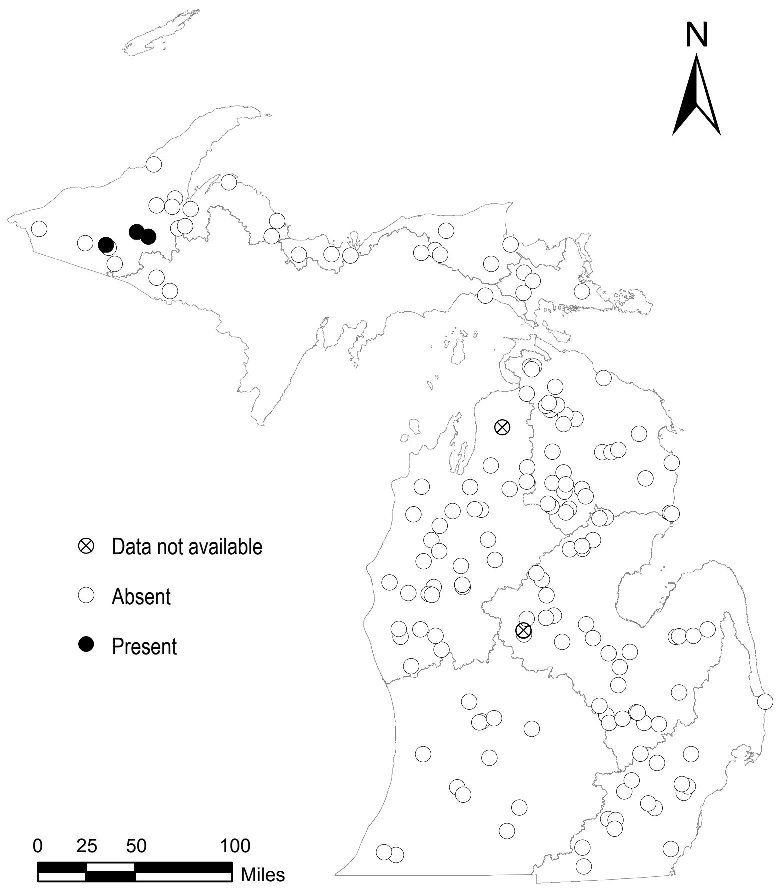

Figure 103.–Map of distribution of trout-perch.

Gadidae

- Burbot *Lota lota* (BUR)

Burbot were encountered at streams scattered across the Upper Peninsula and northern half of the Lower Peninsula (Figure 104), occurring in 7% of all random streams surveyed (Table 13). They were also captured at 3 fixed sites. No burbot were reported in the Lake Erie basin.

Although they were found in all size classes of streams, burbot only occurred in those with cold and cool water temperatures and (on average) were more likely to be captured in streams with Great Lakes access compared to those without (Table 42). Although the highest proportion of occurrence across all random surveys was in very large cool streams, the highest average CPE was in large cool streams. When encountered, electrofishing CPE of burbot typically ranged between 5 and 32 fish per mile, with a maximum CPE of 53 fish per mile.

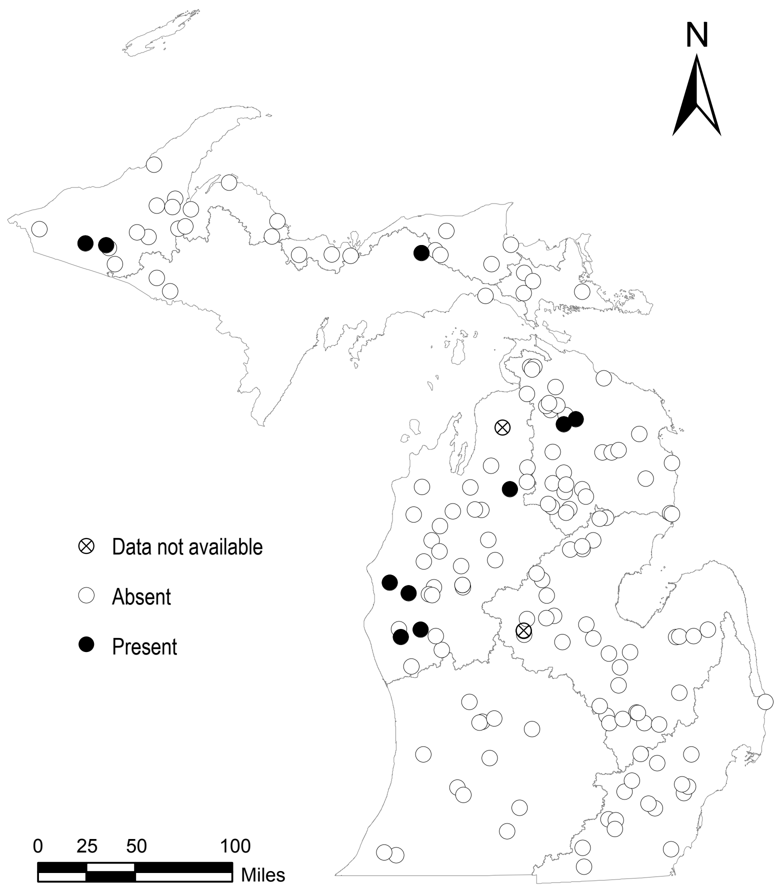

Figure 104.–Map of distribution of burbot.

Table 42.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of burbot. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.13	0	0	0.07	0.08	0	0.07	3.9	0	0	2.1
M	0.13	0	0	0.05	0.04	0.09	0.05	1.6	0	0	0.6
L	0	0.14	0	0.08	0	0.33	0.08	0	4.6	0	2.5
VL	0	0.50	0	0.11	0	0.20	0.11	0	0.5	0	0.1
All	0.12	0.05	0	0.07	0.05	0.12	0.07	2.7	0.8	0	1.4

Fundulidae

- Banded killifish *Fundulus diaphanous* (BKF)

  Banded killifish occurred in only 1 random stream surveyed and at 1 fixed site (Figure 105).

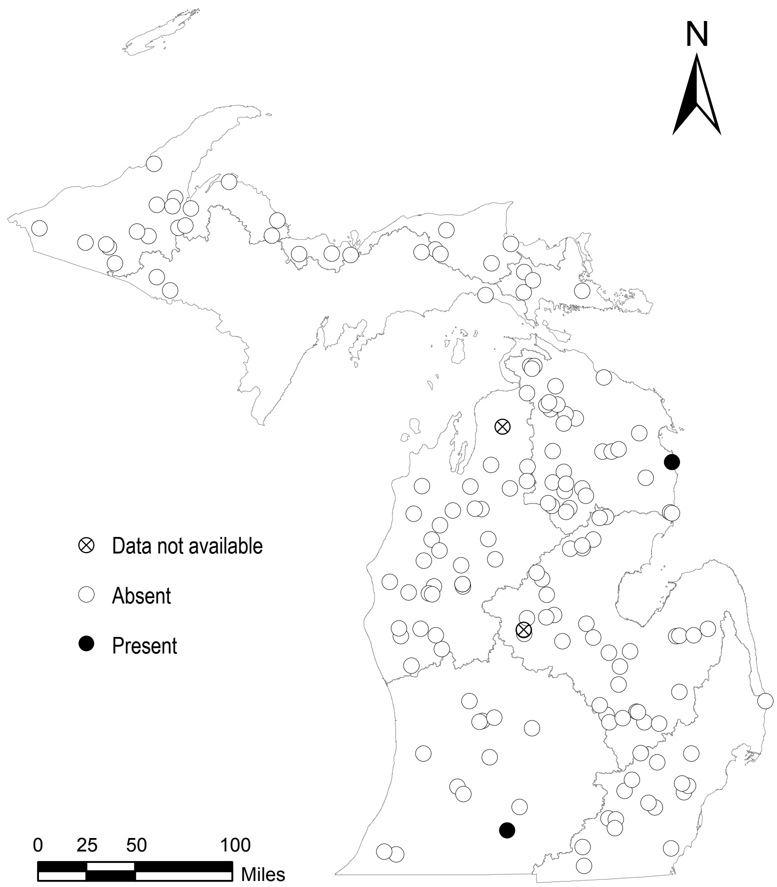

Figure 105.–Map of distribution of banded killifish.

Gasterosteidae

- Brook stickleback *Culaea inconstans* (BSB)

  Brook sticklebacks were scattered throughout Michigan, mostly in the Upper and northern Lower peninsulas (Figure 106). They were reported in each Great Lakes basin, occurring in 13% of random stream surveys and at 12 of 57 fixed sites sampled throughout the state (Table 13).

  Brook sticklebacks were reported in similar proportion among all size and temperature classes of streams except very large waters (where they were not captured), and mostly in greater proportion in streams without Great Lakes access (Table 43). The highest average CPE of brook sticklebacks across all random surveys was in small cool streams. When encountered, electrofishing CPE of brook sticklebacks typically ranged between 11 and 58 fish per mile, with a maximum CPE of 253 fish per mile.

  The size distribution of 70 brook sticklebacks captured during random stream surveys was narrow and only included individuals in the 1 and 2 in size groups (Figure 107).

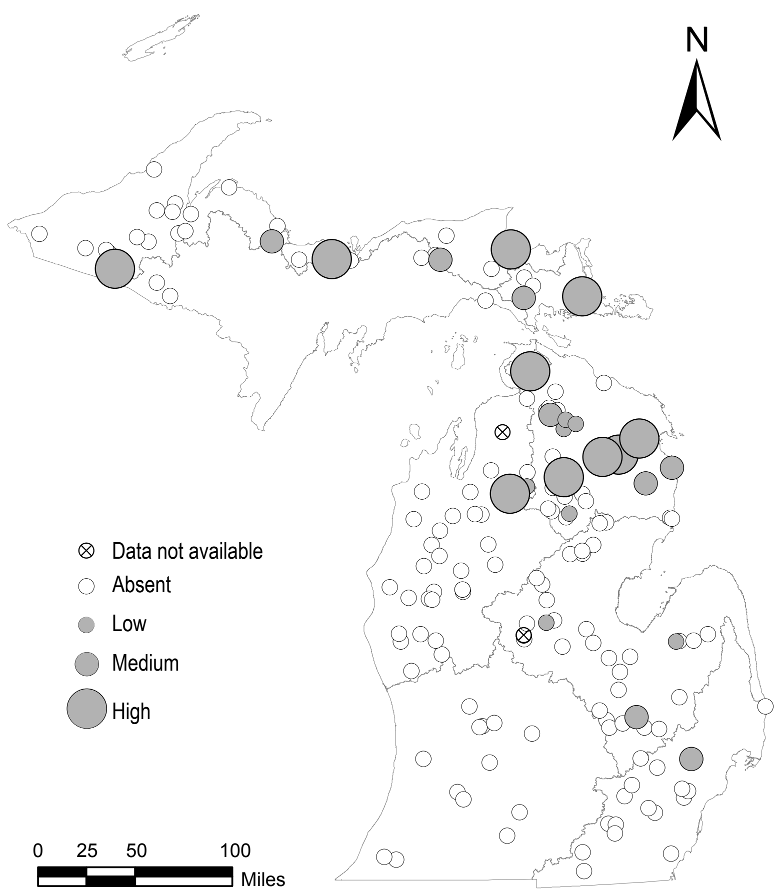

Figure 106.–Map of distribution of brook sticklebacks. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 43.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of brook sticklebacks. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.17	0.15	0.17	0.17	0.19	0	0.17	6.9	21.1	8.8	11.6
M	0.06	0.06	0.33	0.10	0.07	0.18	0.10	0.8	1.5	11.7	2.8
L	0.50	0.14	0	0.15	0.20	0	0.15	5.5	7.6	0	4.9
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.14	0.10	0.14	0.13	0.14	0.08	0.13	4.4	9.1	5.6	6.4

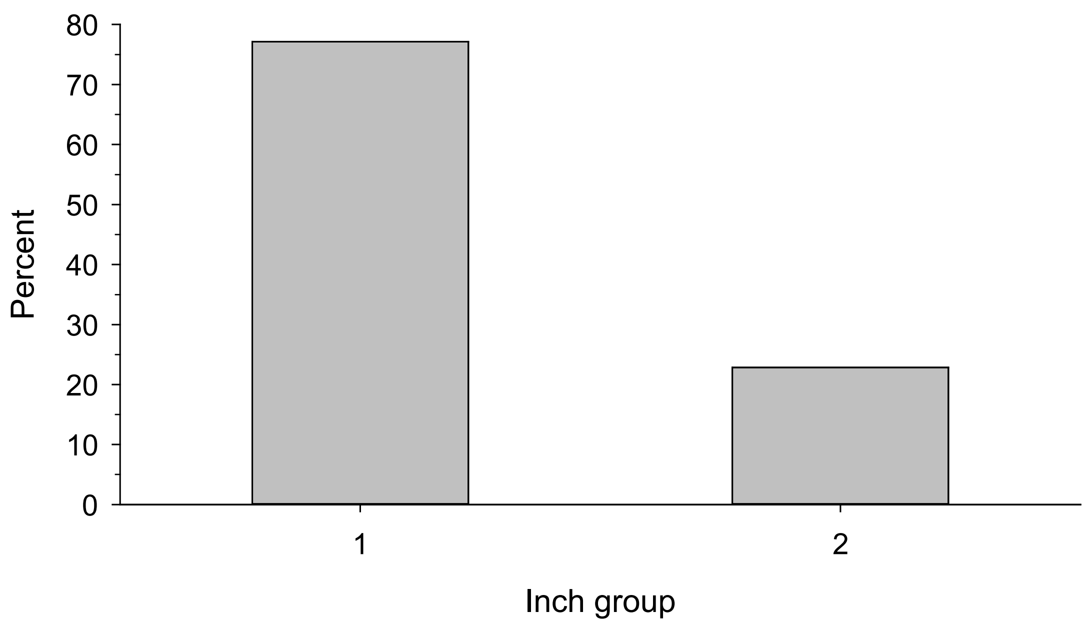

Figure 107.–Size distribution of brook sticklebacks.

- Unidentified stickleback (STI FA)

  Unidentified sticklebacks were reported in 4 random stream surveys and at 2 fixed sites (Figure 108, Table 13). We did not calculate proportion of occurrence or typical catch rates for these unidentified specimens.

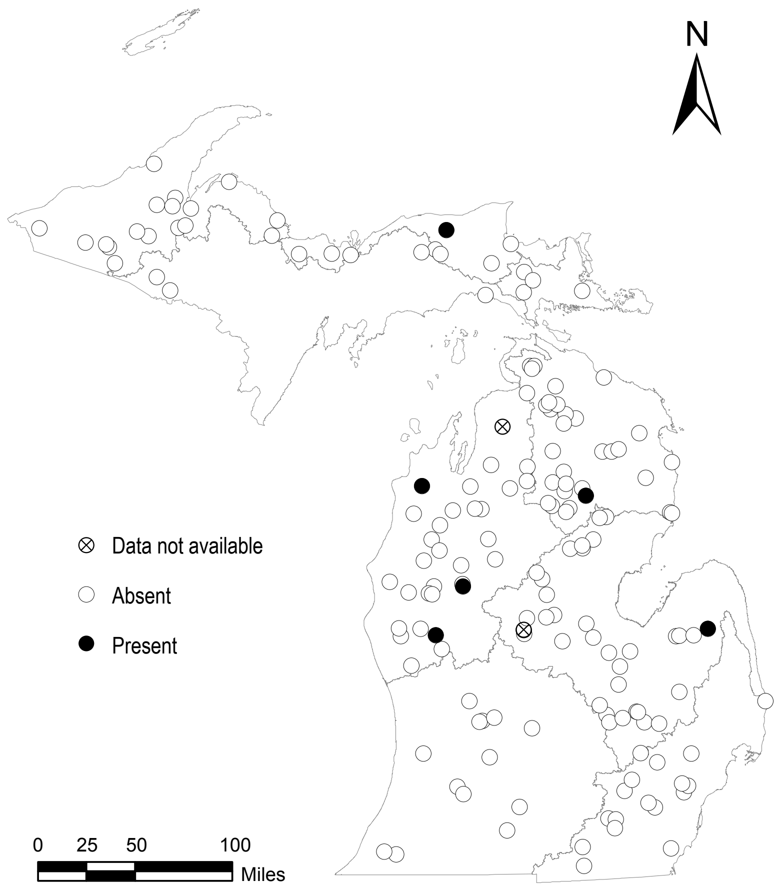

Figure 108.–Map of distribution of unidentified sticklebacks.

Cottidae

- Mottled sculpin *Cottus bairdii* (MOS)

Mottled sculpin were widely distributed throughout the Upper and Lower peninsulas (Figure 109). They occurred in 26% of random stream surveys and at 22 of 57 fixed sites sampled throughout the state (Table 13).

Mottled sculpin were reported in each Great Lakes basin, all size and temperature classes of streams, and in relatively similar proportion among waters with or without Great Lakes access (Table 44). In general, their proportion of occurrence tended to decrease with increasing size and temperature, although the proportion of occurrence in very large streams was higher than large streams. The highest average CPE of mottled sculpin across all random surveys was in small cool streams. When encountered, electrofishing CPE of mottled sculpin typically ranged between 32 and 458 fish per mile, with a maximum CPE of 1,683 fish per mile.

The size distribution of 1,182 mottled sculpin measured during random stream surveys ranged from 1 to 5 in (Figure 110). Fish in the two-inch size group comprised more than half (52%) of the total catch.

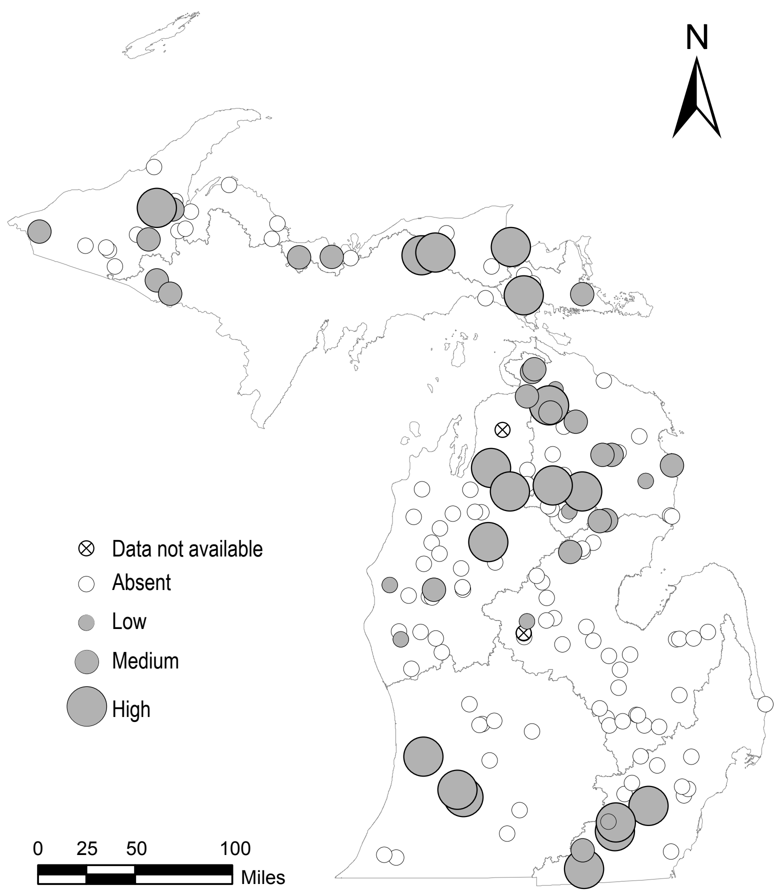

Figure 109.–Map of distribution of mottled sculpin. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 44.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of mottled sculpin. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.26	0.54	0	0.31	0.31	0.33	0.31	64.8	440.0	0	171.7
M	0.50	0.12	0.17	0.28	0.25	0.36	0.28	131.6	6.2	56.3	65.4
L	0	0.14	0	0.08	0.10	0	0.08	0	13.6	0	7.3
VL	1.00	0.50	0	0.22	0.25	0.20	0.22	2.0	3.5	0	1.0
All	0.36	0.28	0.05	0.26	0.26	0.28	0.26	85.7	152.0	15.4	95.8

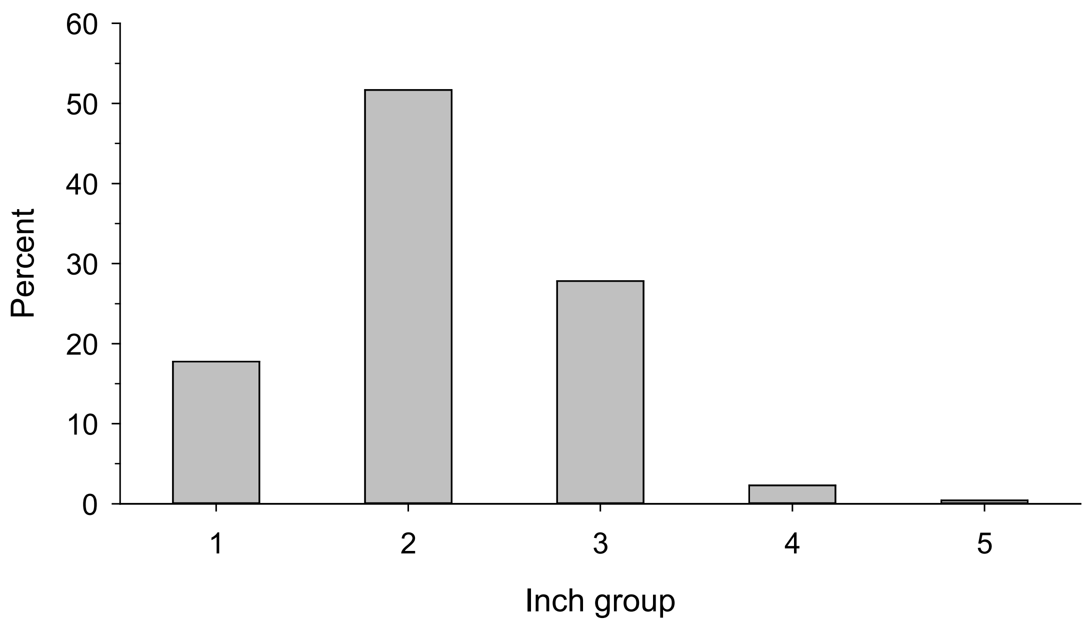

Figure 110.–Size distribution of mottled sculpin.

- Slimy sculpin *Cottus cognatus* (SLS)

  Slimy sculpin were widely distributed across the northern half of the Lower Peninsula (Lake Michigan and Huron basins) and the western Upper Peninsula (Lake Superior basin, Figure 111), but occurred in only 4% of random streams surveyed and at 7 fixed sites (Table 13).

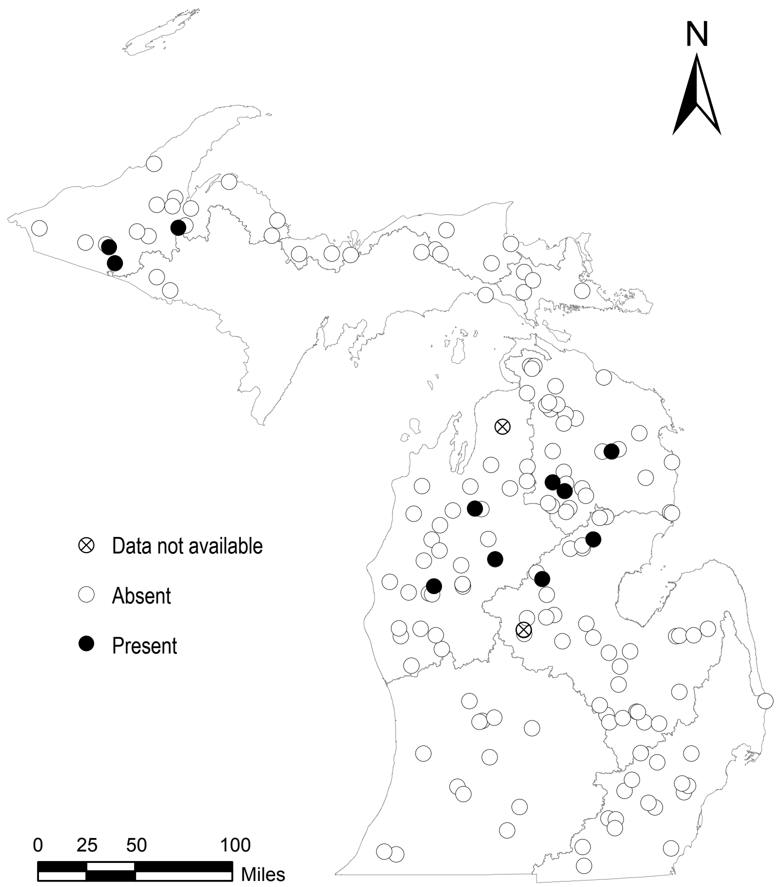

Figure 111.–Map of distribution of slimy sculpin.

• Unidentified sculpin (SCU FA)

Many sculpin are classified as unidentifiable due to the inherent difficulty in distinguishing between the two species (mottled and slimy) that inhabit Michigan streams. These unidentified sculpin were distributed throughout the Upper Peninsula and northern Lower Peninsula (Figure 112), occurring in 23% of random stream surveys and at 21 of 57 fixed sites sampled throughout the state (Table 13).

Unidentified sculpin were reported in cold and cool water small, medium, and large streams, and in relatively similar proportion among waters with or without Great Lakes access (Table 45). Their proportion of occurrence was similar by stream size, but higher in cold water streams. The highest average CPE of unidentified sculpin across all random surveys was in large cold streams, followed by medium and small cold waters. When encountered, electrofishing CPE of unidentified sculpin typically ranged between 48 and 499 fish per mile, with a maximum CPE of 1,859 fish per mile.

The size distribution of 1,081 unidentified sculpin measured during random stream surveys ranged from 1 to 4 in (Figure 113) and was very similar to that of mottled sculpin (Figure 110). Fish in the two-inch size group comprised more than half (58%) of the total catch.

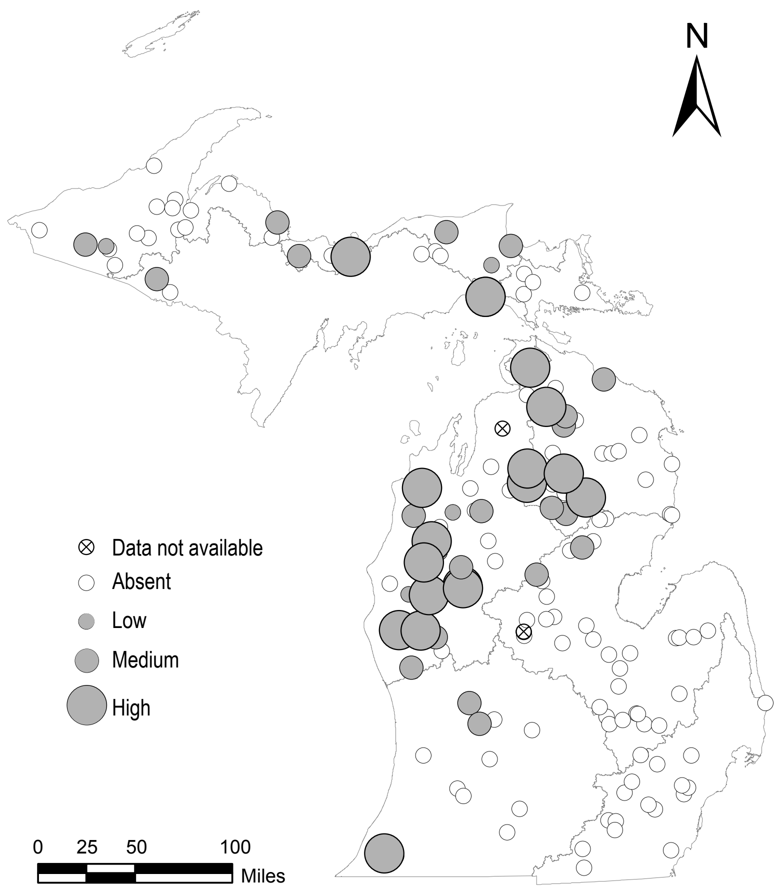

Figure 112.–Map of distribution of unidentified sculpin. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 45.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of unidentified sculpin. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.43	0	0	0.24	0.22	0.33	0.24	162.3	0	0	88.9
M	0.38	0.29	0	0.28	0.29	0.27	0.28	184.9	36.1	0	91.6
L	1.00	0.14	0	0.23	0.20	0.33	0.23	281.5	4.6	0	45.8
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.43	0.15	0	0.23	0.23	0.24	0.23	172.7	16.6	0	76.7

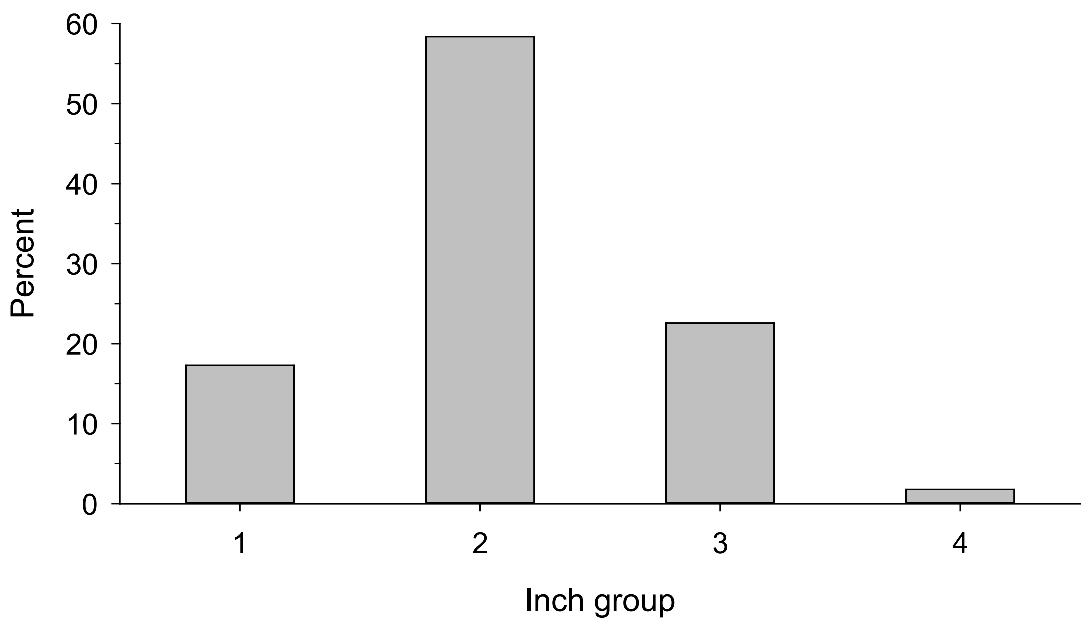

Figure 113.–Size distribution of unidentified sculpin.

Moronidae

- White perch *Morone americana* (WHP)

  White perch, an invasive species (Table 12), occurred in only 1 random stream survey in the southern Lake Huron basin (Figure 114, Table 13).

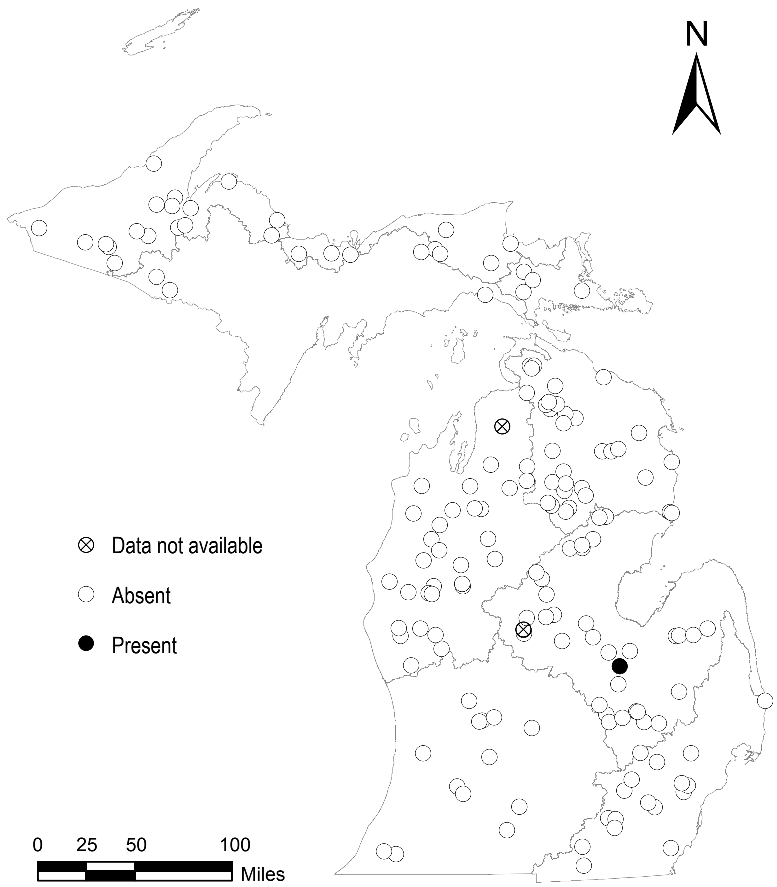

Figure 114.–Map of distribution of white perch.

- White bass *Morone chrysops* (WHB)

  White bass occurred in only 1 random stream survey in the southern Lake Huron basin (Figure 115, Table 13).

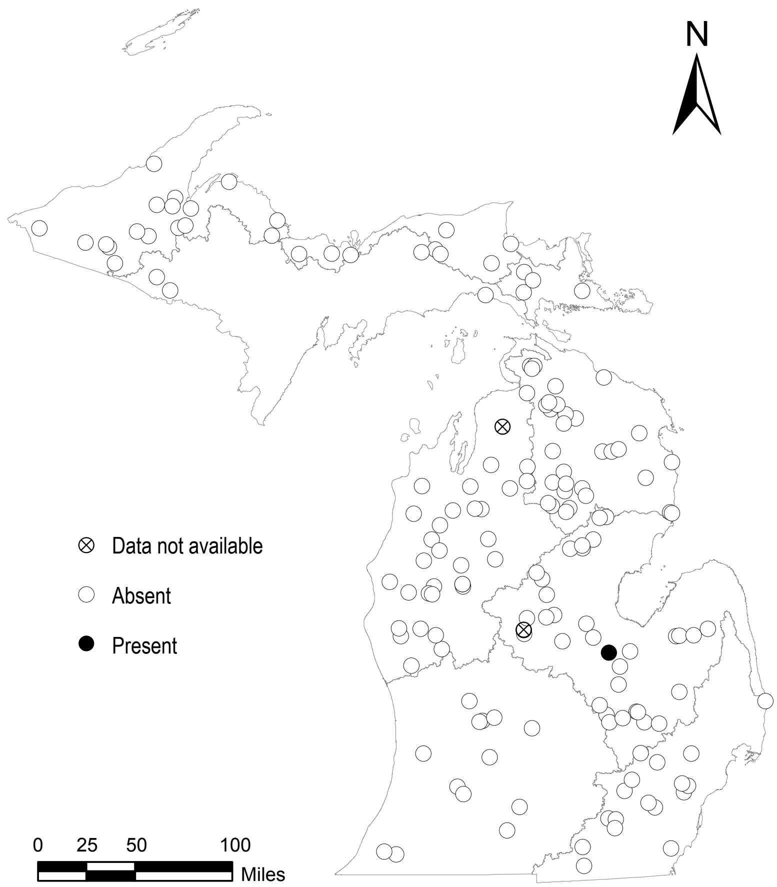

Figure 115.–Map of distribution of white bass.

Centrarchidae

- Rock bass *Ambloplites rupestris* (RKB)

  Rock bass were the seventh most frequently encountered species in Michigan streams, occurring in 36% of random surveys (Table 13). They were also reported at 15 of 57 fixed sites sampled throughout the state.

  Rock bass were widely distributed across the Lower Peninsula, but were less frequently reported in the Upper Peninsula (Figure 116). They occurred in each Great Lakes basin, all size and temperature classes of streams, and (for most size classes) in greater proportion among waters without Great Lakes access (Table 46). Rock bass proportion of occurrence and CPE tended to increase with increasing stream size and temperature; the highest average CPE was in large warm waters. When encountered, electrofishing CPE of rock bass typically ranged between 13 and 132 fish per mile, with a maximum CPE of 442 fish per mile.

  The size distribution of 692 rock bass measured during random stream surveys ranged from 1 to 9 in (Figure 117). The bell-shaped curve of the distribution was somewhat skewed towards smaller individuals; fish in the 3–4 in size range occurred most frequently (43% of the total catch).

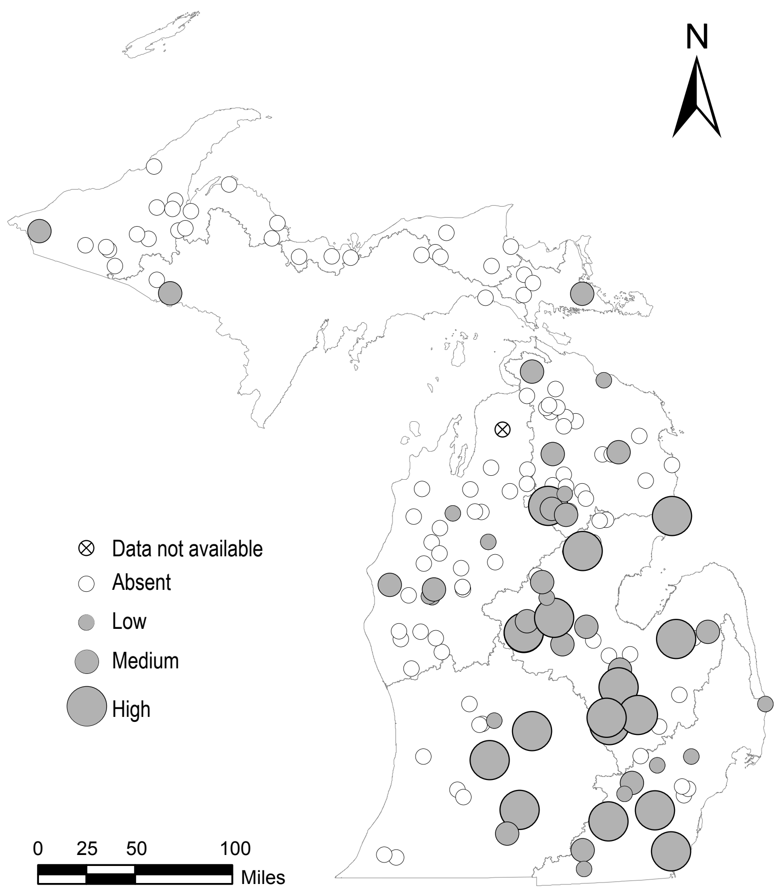

Figure 116.–Map of distribution of rock bass. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 46.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of rock bass. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi², M = medium catchment 40–179 mi², L = large catchment 180–620 mi², VL = very large catchment >620 mi². Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.09	0.15	0.17	0.12	0.14	0	0.12	6.9	2.1	3.5	4.9
M	0.31	0.53	0.50	0.44	0.46	0.36	0.44	31.7	26.0	113.3	41.8
L	0	0.71	0.75	0.62	0.70	0.33	0.62	0	107.6	115.0	93.3
VL	0	1.00	0.83	0.78	0.75	0.80	0.78	0	24.5	78.2	57.6
All	0.17	0.46	0.55	0.36	0.36	0.36	0.36	15.9	32.6	74.1	34.6

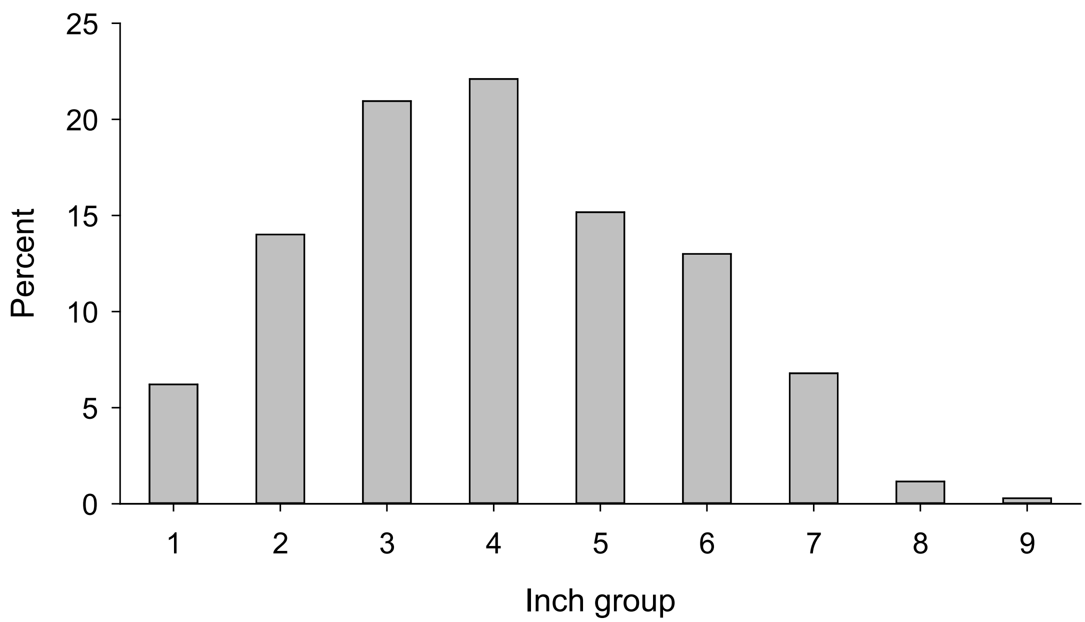

Figure 117.–Size distribution of rock bass.

- Green sunfish *Lepomis cyanellus* (GSF)

Green sunfish were widely distributed across the Lower Peninsula, but were not reported in the Upper Peninsula (Figure 118). They occurred in 33% of random stream surveys and at 18 of 57 fixed sites sampled throughout the state (Table 13).

Green sunfish occurred in all size and temperature classes of streams and usually in greater proportion among waters without Great Lakes access (Table 47). Their proportion of occurrence decreased with increasing stream size, increased with temperature, and accordingly was greatest in small warm streams. The highest average CPE of green sunfish was in small cool waters, followed by small warm waters. When encountered, electrofishing CPE of green sunfish typically ranged between 13 and 53 fish per mile, with a maximum CPE of 454 fish per mile.

The size distribution of 340 green sunfish measured during random stream surveys ranged from 1 to 5 in (Figure 119). Two- and three-inch fish comprised more than three quarters (79%) of the total catch.

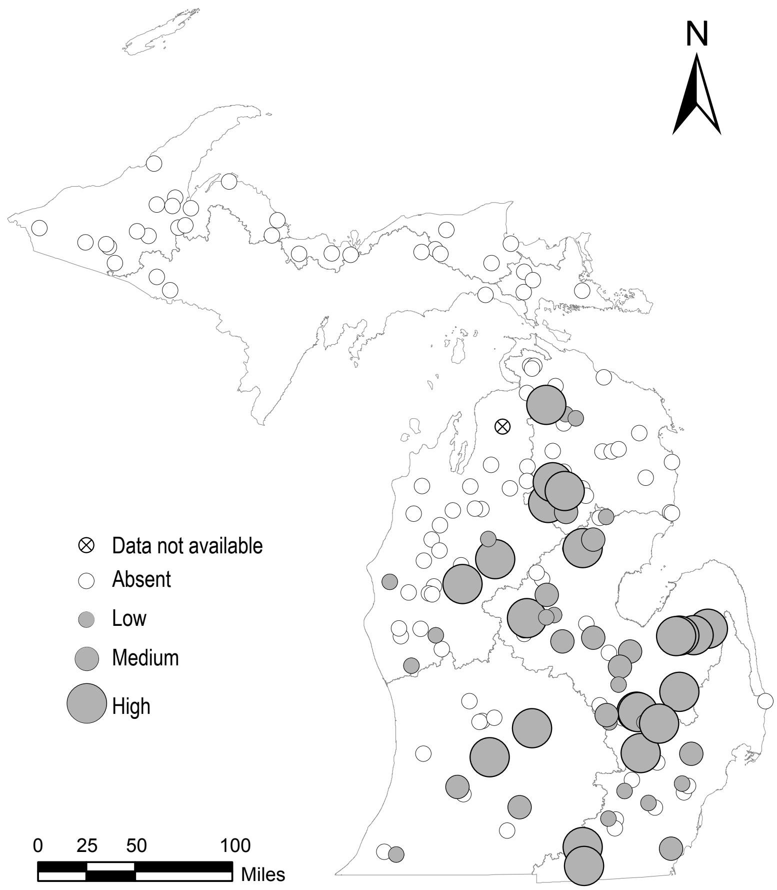

Figure 118.–Map of distribution of green sunfish. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 47.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of green sunfish. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.22	0.46	0.83	0.38	0.42	0.17	0.38	6.4	86.2	70.3	40.3
M	0.19	0.41	0.50	0.33	0.39	0.18	0.33	6.9	31.3	6.3	17.4
L	0	0.14	0.50	0.23	0.30	0	0.23	0	2.9	14.0	5.8
VL	0	0.50	0.17	0.22	0	0.40	0.22	0	2.0	7.0	5.1
All	0.19	0.38	0.50	0.33	0.37	0.20	0.33	6.1	43.0	25.4	24.2

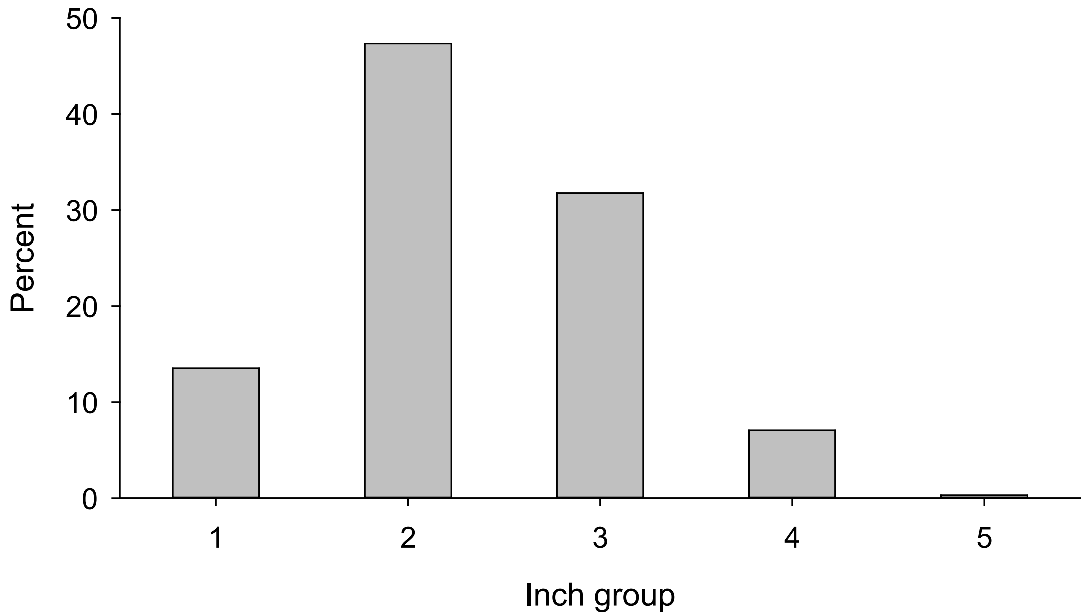

Figure 119.–Size distribution of green sunfish.

- Pumpkinseed *Lepomis gibbosus* (PSF)

Pumpkinseeds were widely distributed throughout the Lake Michigan, Huron, and Erie basins in the Lower Peninsula, but were only reported at one location in the Upper Peninsula (Figure 120). They occurred in 30% of random stream surveys and at 12 of 57 fixed sites sampled throughout the state (Table 13).

Pumpkinseeds were reported in all size and temperature classes of streams and (on average) in greater proportion among waters without Great Lakes access (Table 48). Their proportion of occurrence varied by stream size and increased with temperature. CPE was variable by both stream size and temperature, with the highest average CPE of pumpkinseeds across all random surveys occurring in small cool streams. When encountered, electrofishing CPE of pumpkinseeds typically ranged between 7 and 26 fish per mile, with a maximum CPE of 112 fish per mile.

The size distribution of 105 pumpkinseeds measured during random stream surveys ranged from 2 to 6 in (Figure 121). Fish in the 3 in size group occurred most frequently and comprised more than one third (36%) of the total catch.

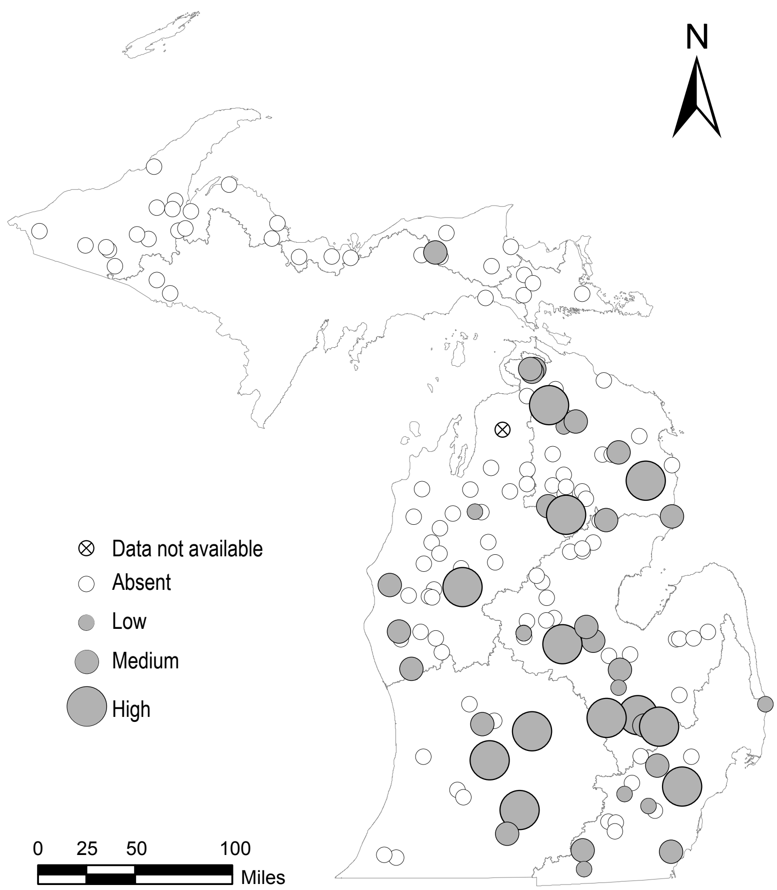

Figure 120.–Map of distribution of pumpkinseed. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 48.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of pumpkinseed. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.30	0.31	0.50	0.33	0.36	0.17	0.33	6.0	11.2	6.8	7.8
M	0.25	0.24	0.17	0.23	0.29	0.09	0.23	7.4	7.8	1.2	6.6
L	0	0.29	0.25	0.23	0.20	0.33	0.23	0	2.6	8.0	3.8
VL	0	1.00	0.50	0.56	0.50	0.60	0.56	0	5.0	3.8	3.7
All	0.26	0.31	0.36	0.30	0.32	0.24	0.30	6.1	7.8	4.7	6.5

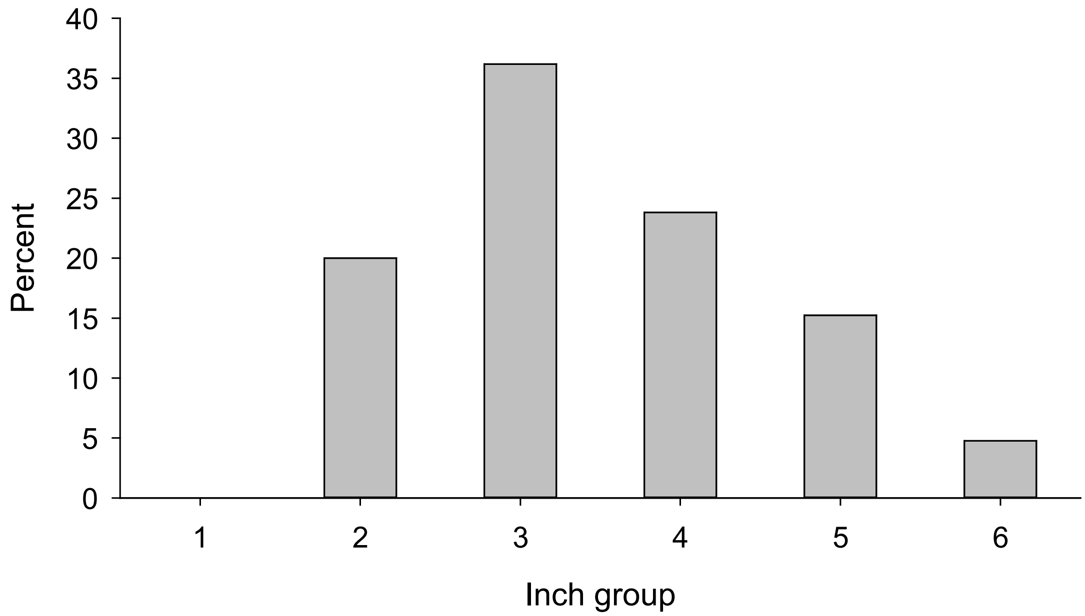

Figure 121.–Size distribution of pumpkinseed.

- Warmouth *Lepomis gulosus* (WAR)

  Warmouths occurred in only 1 random stream survey in the Lake Michigan basin (Figure 122, Table 13).

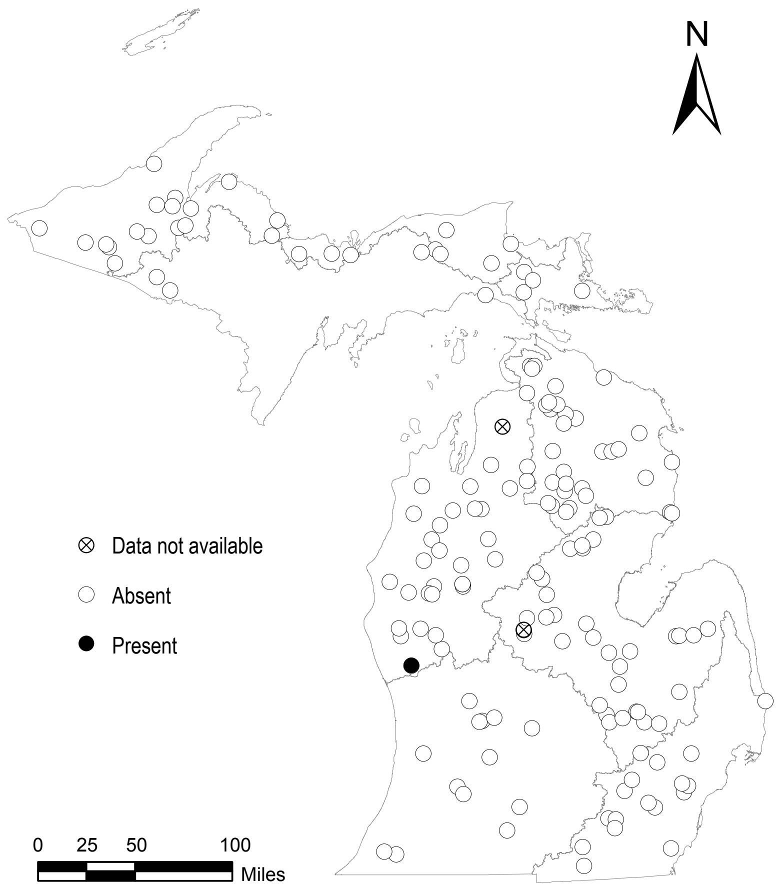

Figure 122.–Map of distribution of warmouths.

- Orangespotted sunfish *Lepomis humilis* (OSF)

  Orangespotted sunfish, an invasive species (Table 12), were not captured in any random stream surveyed but occurred at 1 fixed site in the Lake Erie basin (Figure 123, Table 13).

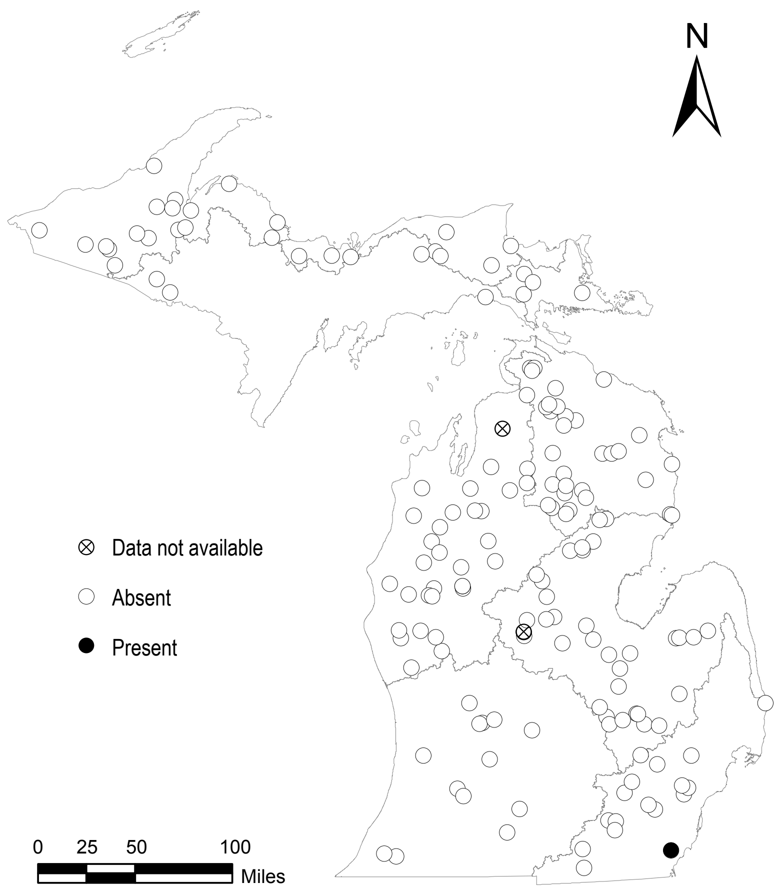

Figure 123.–Map of distribution of orangespotted sunfish.

- Bluegill *Lepomis macrochirus* (BLG)

  Bluegills were the sixth most frequently encountered species in Michigan streams, occurring in 38% of random surveys (Table 13). They were also reported at 18 of 57 fixed sites sampled throughout the state.

  Bluegills were widely distributed across the Lower Peninsula, but rarely occurred in the Upper Peninsula (Figure 124). They occurred in each Great Lakes basin, all size and temperature classes of streams, and (across all surveys) in higher proportion among waters without Great Lakes access (Table 49). Bluegills' proportion of occurrence increased with increasing stream size and temperature; CPE was highest in very large, warm streams. When encountered, electrofishing CPE of bluegills typically ranged between 12 and 57 fish per mile, with a maximum CPE of 444 fish per mile.

  The size distribution of 439 bluegills measured during random stream surveys ranged from 1 to 7 in (Figure 125). Small, 2–4 in fish (likely young-of-year and age 1) comprised more than three quarters (78%) of the total catch.

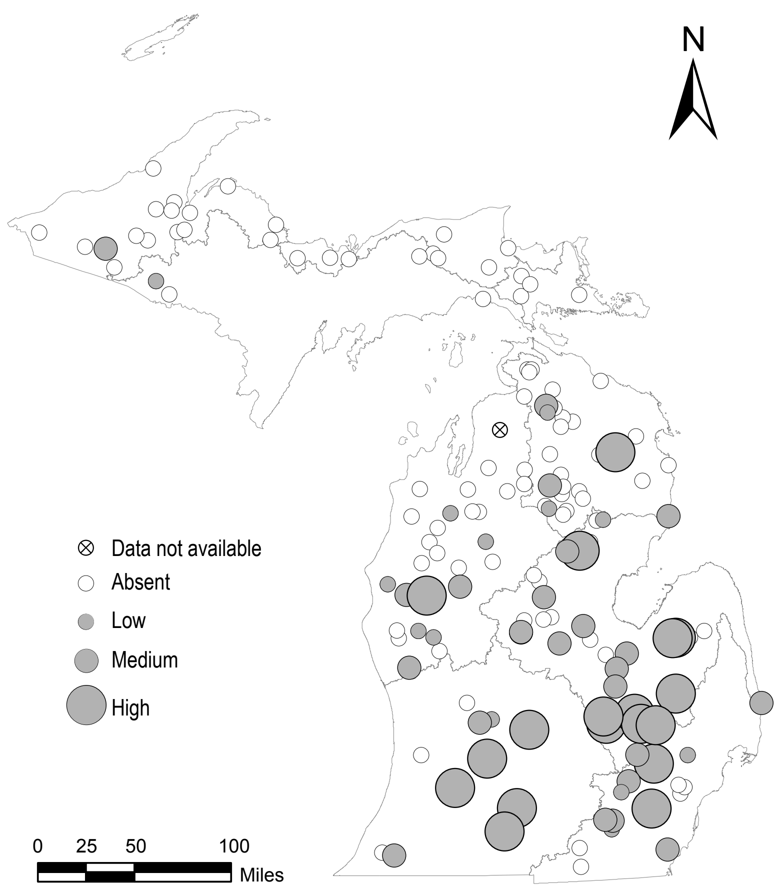

Figure 124.–Map of distribution of bluegills. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 49.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of bluegills. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.22	0.23	0.50	0.26	0.28	0.17	0.26	12.2	19.1	24.2	16.0
M	0.38	0.35	0.33	0.36	0.46	0.09	0.36	9.3	53.7	7.0	28.3
L	0	0.71	0.75	0.62	0.60	0.67	0.62	0	21.0	25.5	19.2
VL	0	1.00	0.83	0.78	0.75	0.80	0.78	0	1.5	60.2	40.4
All	0.26	0.41	0.59	0.39	0.41	0.32	0.39	10.2	33.6	29.5	23.2

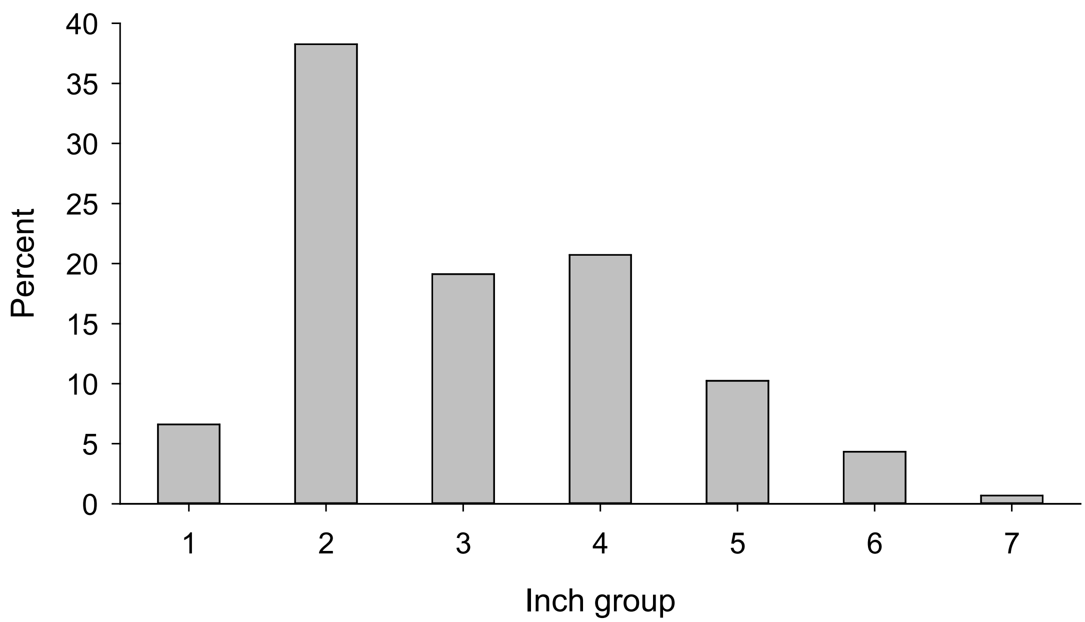

Figure 125.–Size distribution of bluegills.

- Redear sunfish *Lepomis microlophus* (RSF)

    Redear sunfish were not captured in any random stream survey but occurred at 1 fixed site in the Lake Erie basin (Figure 126, Table 13).

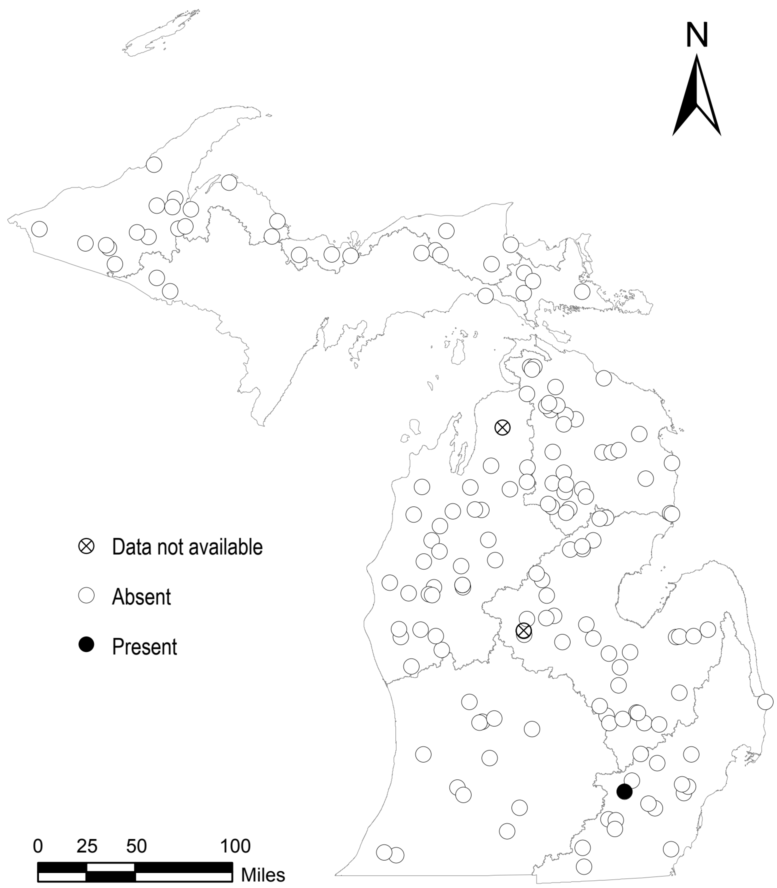

Figure 126.–Map of distribution of redear sunfish.

- Longear sunfish *Lepomis peltastes* (LSF)

  Longear sunfish were distributed across the Lake Huron and Erie basins in the southeastern quarter of the Lower Peninsula (Figure 127), but occurred in only 5% of all random streams surveyed (Table 13). They were also encountered at 1 fixed site.

  Longear sunfish were found in cool medium streams, and in cool and warm water large streams (Table 50). They were not reported in any streams with Great Lakes access. Average CPE across all random surveys ranged from approximately 3 to 8 fish per mile. When encountered, electrofishing CPE of longear sunfish typically ranged between 15 and 40 fish per mile, with a maximum CPE of 48 fish per mile.

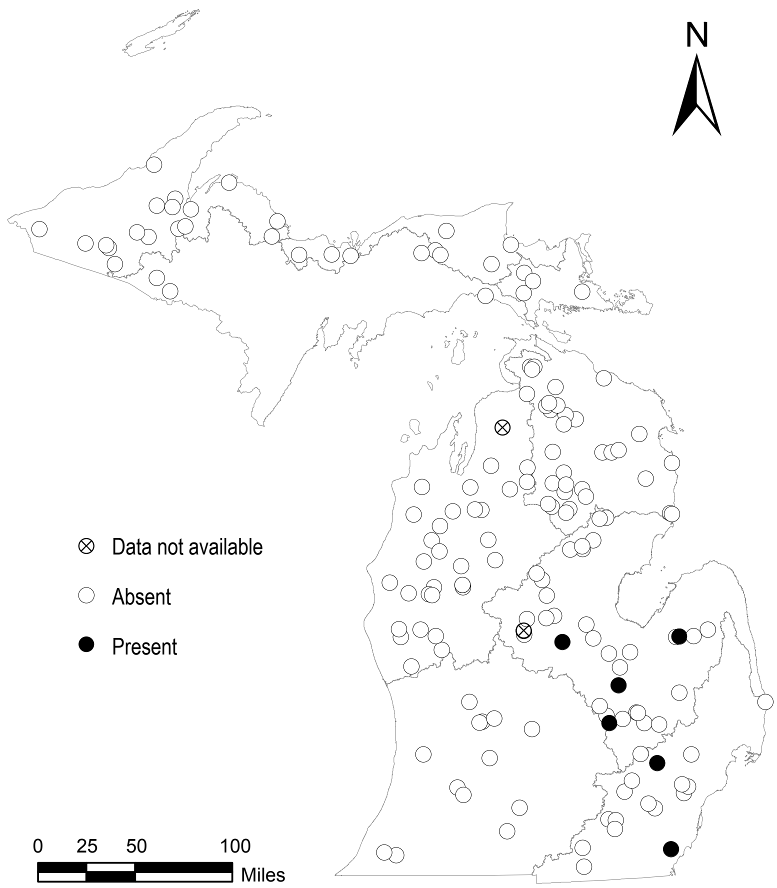

Figure 127.–Map of distribution of longear sunfish.

Table 50.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of longear sunfish. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0	0	0	0	0	0	0	0	0
M	0	0.12	0.17	0.08	0.11	0	0.08	0	3.1	6.7	2.4
L	0	0	0.50	0.15	0.20	0	0.15	0	0	7.8	2.4
VL	0	0	0	0	0	0	0	0	0	0	0
All	0	0.05	0.14	0.05	0.06	0	0.05	0	1.4	3.2	1.2

- Smallmouth bass *Micropterus dolomieu* (SMB)

  Smallmouth bass occurrence was concentrated in the southern half of the Lower Peninsula with a limited number of reports in the Upper and northern Lower peninsulas (Figure 128). They occurred in 21% of random stream surveys and at 11 of 57 fixed sites sampled throughout the state (Table 13).

  Smallmouth bass were reported in each Great Lakes basin, all size and temperature classes of streams, and mostly in greater proportion among waters with Great Lakes access (Table 51). Their proportion of occurrence and relative abundance increased with stream size and temperature; the highest average CPE of smallmouth bass across all random surveys was in very large warm streams. When encountered, electrofishing CPE of smallmouth bass typically ranged between 13 and 69 fish per mile, with a maximum CPE of 1,505 fish per mile.

  The size distribution of 614 smallmouth bass measured during random stream surveys ranged from 1 to 16 in (Figure 129). Fish in the 3 in size group (young-of-year) comprised one third (33%) of the total catch. A second mode in the size distribution, likely representing age 1 and 2 individuals, was centered on 8 in. Smallmouth bass greater than 10 in were captured less frequently, collectively comprising less than 10% of the total catch.

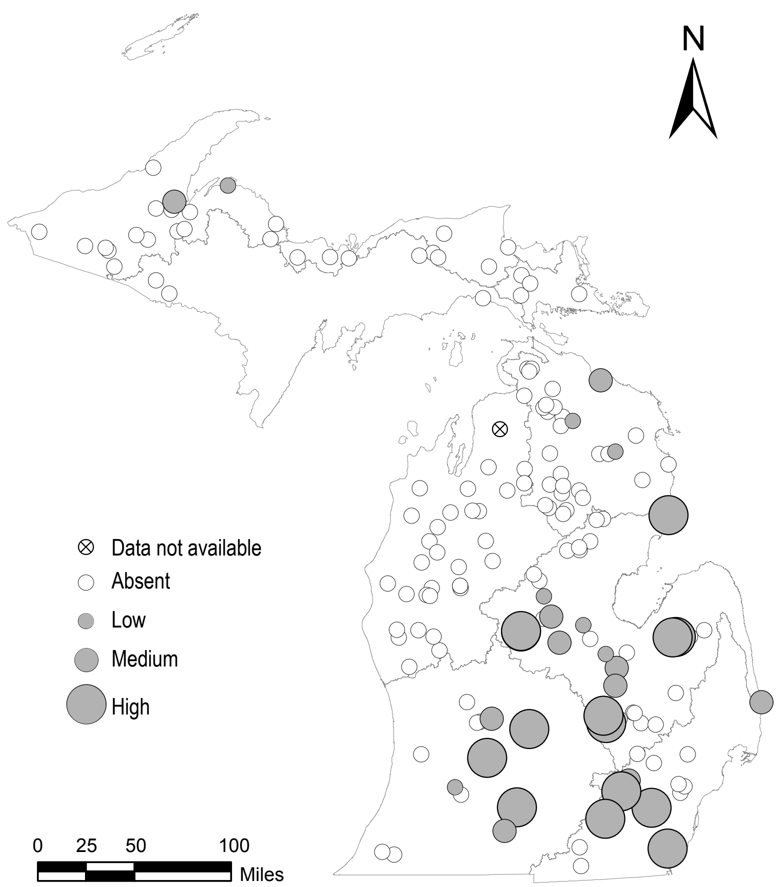

Figure 128.–Map of distribution of smallmouth bass. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75[th] percentile, medium = 25[th]–50[th] percentile, low = <25[th] percentile.

Table 51.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of smallmouth bass. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.08	0	0.05	0.06	0	0.05	0.5	1.5	0	0.7
M	0	0.24	0.33	0.15	0.14	0.18	0.15	0	6.1	11.3	4.4
L	0	0.57	0.75	0.54	0.50	0.67	0.54	0	89.4	44.3	61.8
VL	0	0.50	1.00	0.78	0.75	0.80	0.78	0	4.5	269.2	180.4
All	0.02	0.26	0.50	0.21	0.18	0.32	0.21	0.3	19.4	84.5	25.5

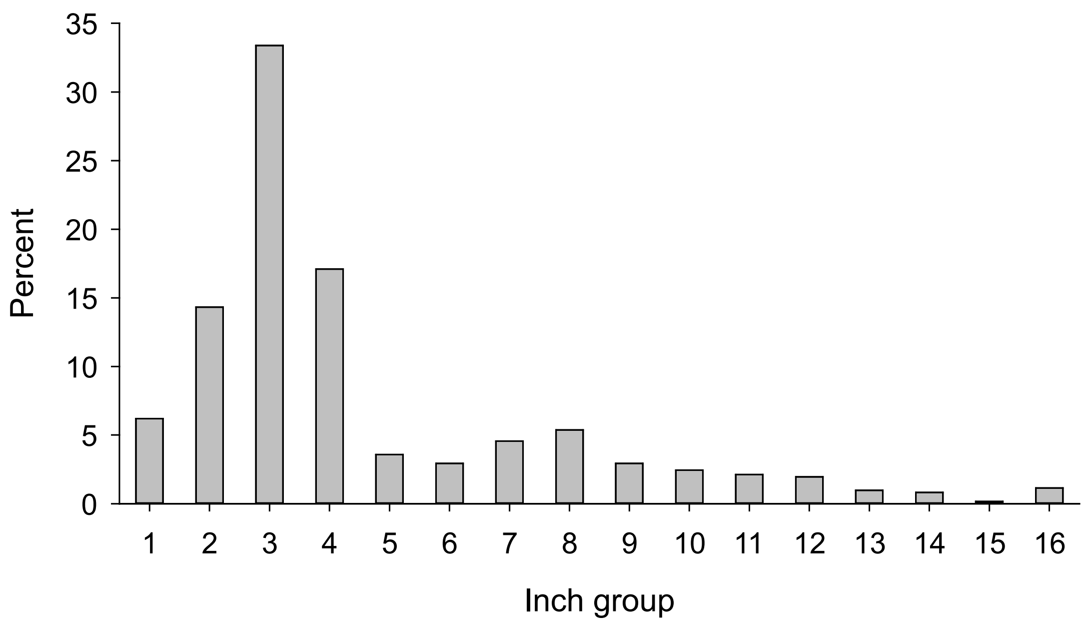

Figure 129.–Size distribution of smallmouth bass.

- Largemouth bass *Micropterus salmoides* (LMB)

  Largemouth bass were widely distributed within the Lake Michigan, Huron, and Erie basins in the Lower Peninsula, but were reported at only one location in the Upper Peninsula (Lake Superior basin, Figure 130). They occurred in 28% of random stream surveys and at 14 of 57 fixed sites sampled throughout the state (Table 13).

  Largemouth bass were reported in all size and temperature classes of streams and (on average) in slightly greater proportion among waters without Great Lakes access (Table 52). Their proportion of tended to increase with stream size and temperature; however, the highest average CPE of largemouth bass across all random surveys was in medium cool streams. When encountered, electrofishing CPE of largemouth bass typically ranged between 7 and 41 fish per mile, with a maximum CPE of 227 fish per mile.

  The size distribution of 195 largemouth bass measured during random stream surveys ranged from 1 to 15 in (Figure 131). Small, 2–3in fish (young-of-year) comprised nearly three quarters (73%) of the total catch. Individuals greater than 4 in were captured less frequently, with each individual size group comprising less than 4% of the total catch.

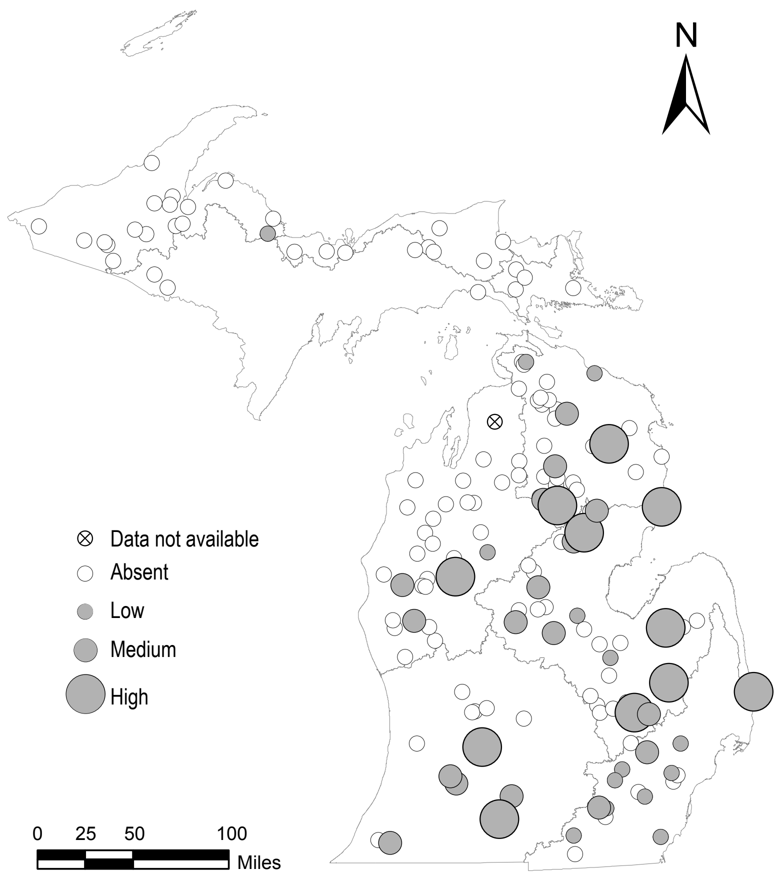

Figure 130.–Map of distribution of largemouth bass. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75[th] percentile, medium = 25[th]–50[th] percentile, low = <25[th] percentile.

Table 52.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of largemouth bass. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.17	0.31	0.17	0.21	0.25	0	0.21	7.3	11.8	9.8	9.0
M	0.06	0.53	0	0.26	0.29	0.18	0.26	0.7	24.4	0	10.9
L	0	0.57	0.50	0.46	0.40	0.67	0.46	0	21.4	10.5	14.8
VL	0	0	0.67	0.44	0.50	0.40	0.44	0	0	9.8	6.6
All	0.12	0.44	0.32	0.28	0.29	0.24	0.28	4.2	18.4	7.3	10.2

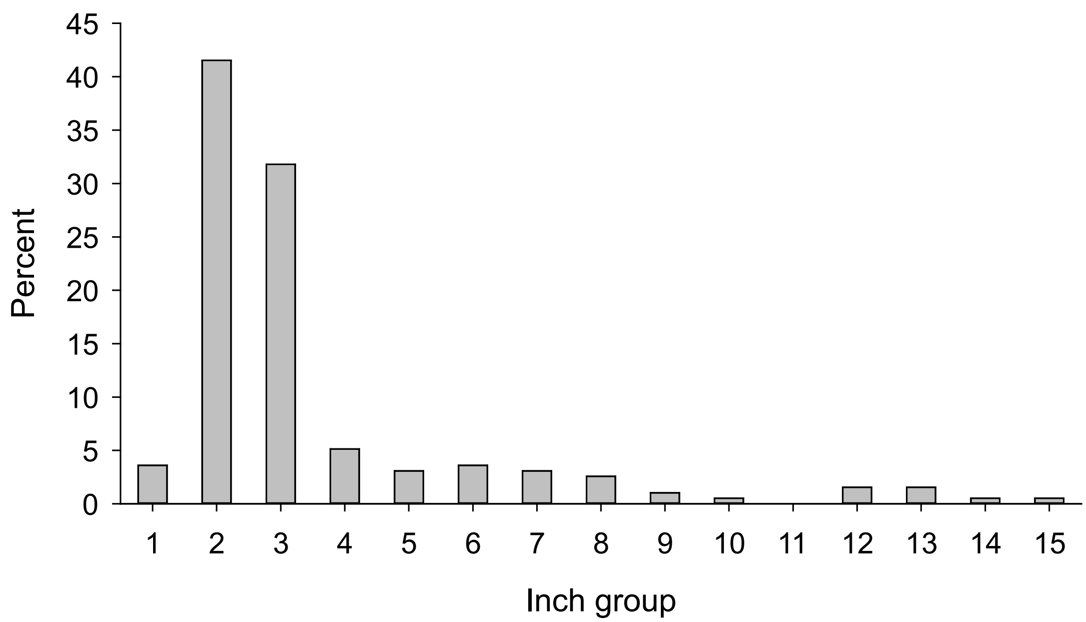

Figure 131.–Size distribution of largemouth bass.

• Black crappie *Pomoxis nigromaculatus* (BCR)

Black crappies were widely distributed throughout the Lake Michigan, Huron, and Erie basins in the southern half of the Lower Peninsula (Figure 132), but occurred in only 9% of all random streams surveyed (Table 13). They were also encountered at 3 fixed sites.

Black crappies were found in all size classes of streams, and occurred in relatively similar proportion among those with cool and warm water temperatures (Table 53). Their proportion of occurrence in large and very large streams was higher in waters with Great Lakes access. Although the highest proportion of occurrence across all random surveys was in large cool streams, the highest average CPE was in medium cool streams. When encountered, electrofishing CPE of black crappies typically ranged between 4 and 9 fish per mile, with a maximum CPE of 32 fish per mile.

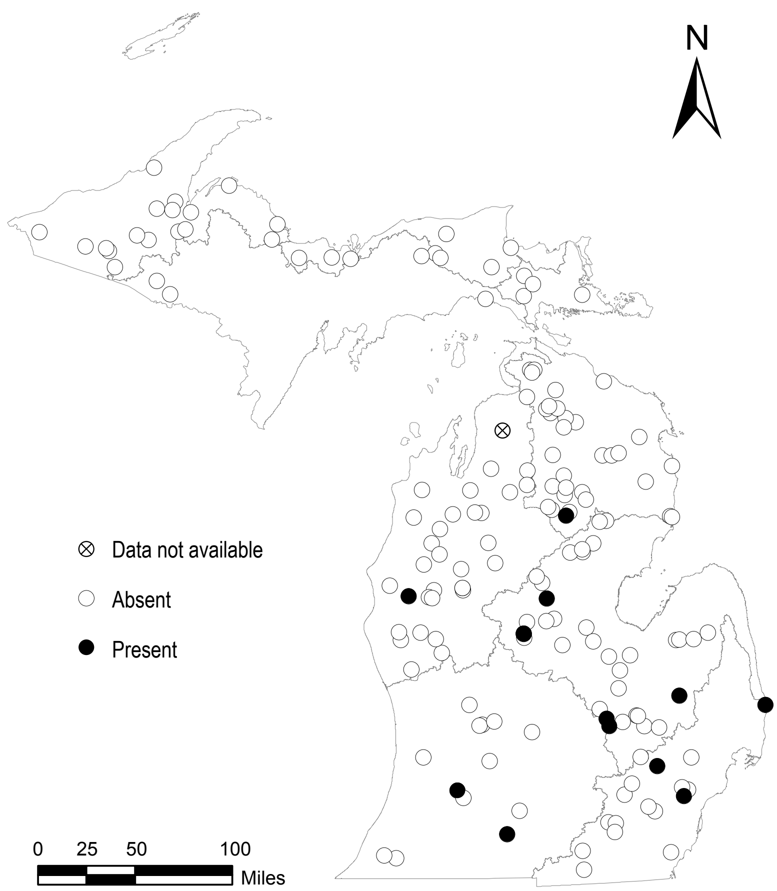

Figure 132.–Map of distribution of black crappies.

Table 53.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of black crappies. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.08	0	0.02	0.03	0	0.02	0	0.5	0	0.2
M	0	0.18	0.17	0.10	0.14	0	0.10	0	3.4	0.7	1.6
L	0	0.29	0.25	0.23	0.20	0.33	0.23	0	1.1	2.0	1.2
VL	0	0	0.17	0.11	0	0.20	0.11	0	0	1.3	0.9
All	0	0.15	0.14	0.09	0.09	0.08	0.09	0	1.8	0.9	0.9

- Hybrid sunfish (HSF)

Hybrid sunfish were widely distributed in the southeastern quarter of the Lower Peninsula (Figure 133), but occurred in only 3% of random streams surveyed and at 4 fixed sites (Table 13).

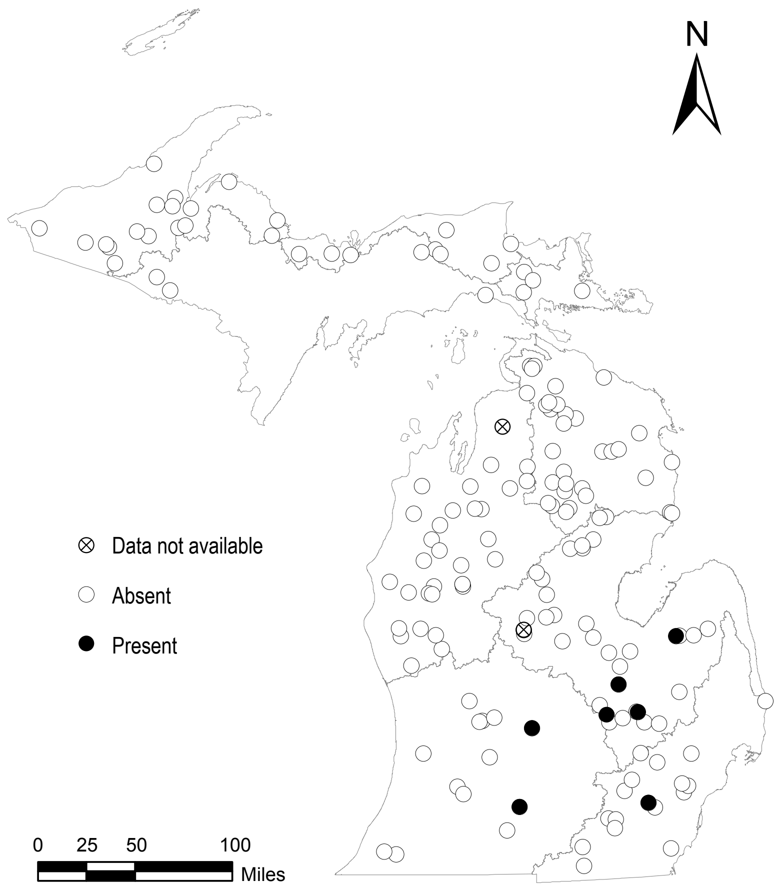

Figure 133.–Map of distribution of hybrid sunfish.

Percidae

- Greenside darter *Etheostoma blennioides* (GSD)

  Greenside darters were scattered throughout the southeastern Lower Peninsula (Figure 134). They occurred in 10% of random stream surveys and at 6 of 57 fixed sites sampled throughout the state (Table 13).

  Greenside darters were reported in all size classes of streams and in those classified as having cool or warm temperatures (Table 54). Regardless of stream size, they were more likely to occur in waters without Great Lakes access. Their proportion of occurrence was greatest in small, cool streams; the highest average CPE of greenside darters across all random surveys was in very large warm streams. When encountered, electrofishing CPE of greenside darters typically ranged between 18 and 248 fish per mile, with a maximum CPE of 6,565 fish per mile.

  The size distribution of 1,662 greenside darters measured during random stream surveys ranged from 1 to 4 in (Figure 135). Fish in the 2 in size group comprised over three quarters (78%) of the total catch.

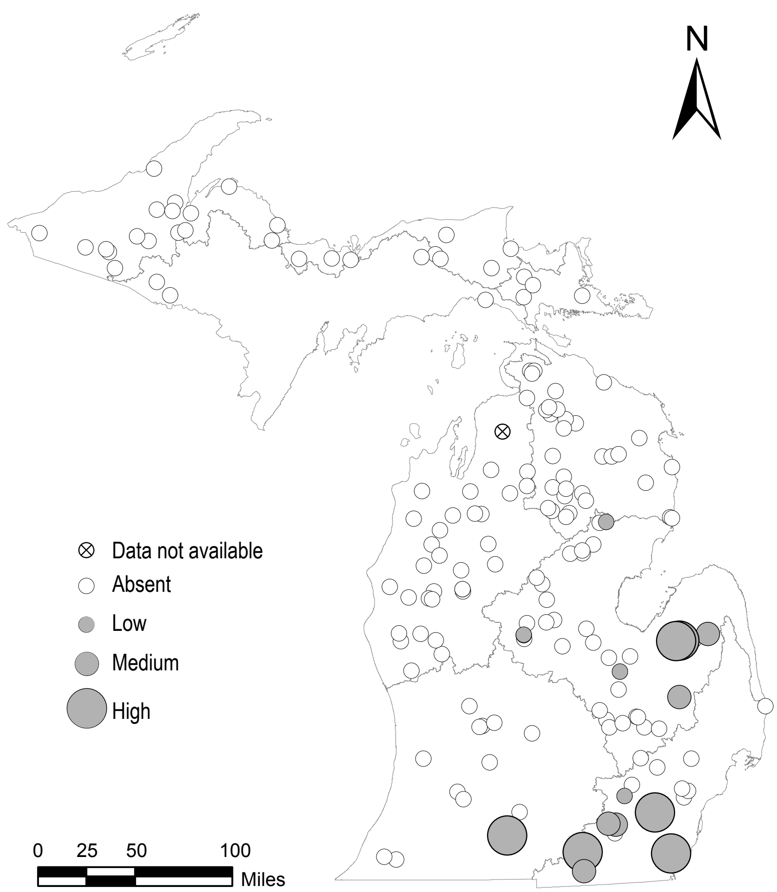

Figure 134.–Map of distribution of greenside darters. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 54.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of greenside darters. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0.38	0.17	0.14	0.17	0	0.14	0	54.2	14.0	18.8
M	0	0.06	0	0.03	0.04	0	0.03	0	14.6	0	6.4
L	0	0.14	0	0.08	0.10	0	0.08	0	2.6	0	1.4
VL	0	0	0.33	0.22	0.25	0.20	0.22	0	0	1,096.0	730.7
All	0	0.18	0.14	0.10	0.12	0.04	0.10	0	24.9	302.7	74.1

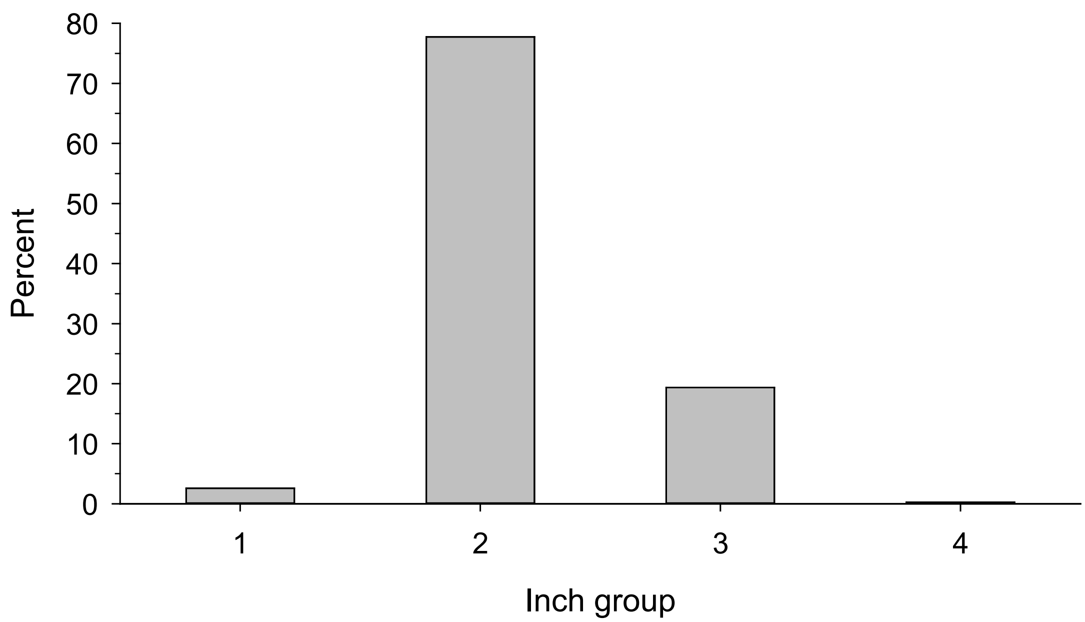

Figure 135.–Size distribution of greenside darters.

- Rainbow darter *Etheostoma caeruleum* (RBD)

Rainbow darters occurrence was concentrated in the Lower Peninsula, within the southern Lake Michigan, Huron, and Erie basins (Figure 136). They were reported in 17% of random stream surveys and at 11 of 57 fixed sites sampled throughout the state (Table 13).

Rainbow darters were encountered more frequently in medium- and large-sized streams, and in nearly equal proportion among cool and warm waters (Table 55). They were much more likely to be reported in streams without Great Lakes access. Rainbow darters' proportion of occurrence and average CPE was greatest in medium warm streams. When encountered, electrofishing CPE of rainbow darters typically ranged between 16 and 139 fish per mile, with a maximum CPE of 716 fish per mile.

The size distribution of 307 rainbow darters measured during random stream surveys ranged from 1 to 5 in (Figure 137). Fish in the 2 in size group comprised nearly two thirds (63%) of the total catch.

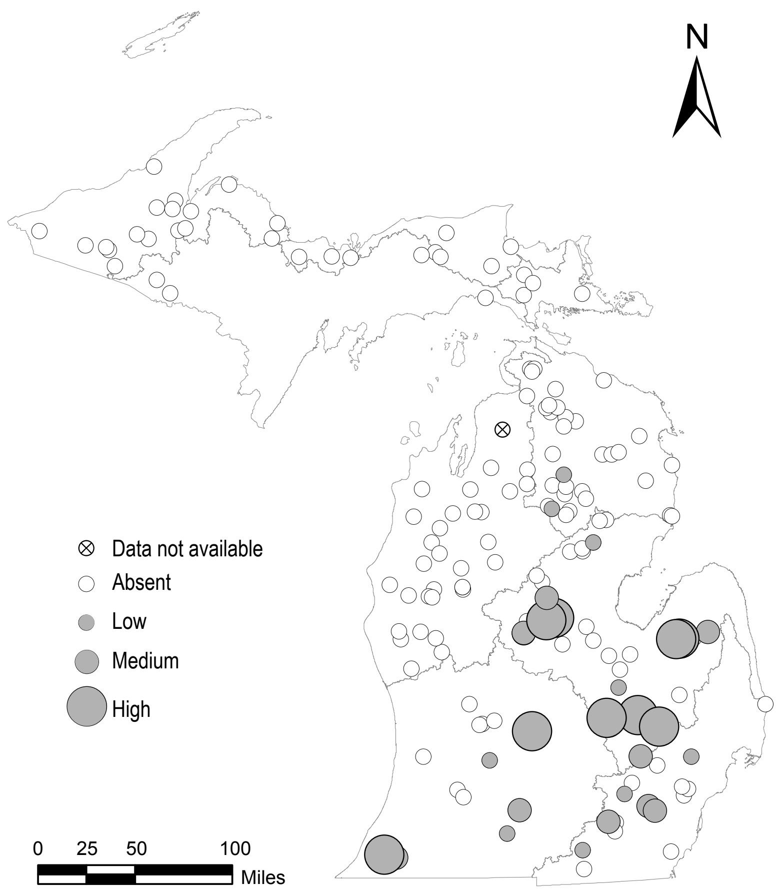

Figure 136.–Map of distribution of rainbow darters. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 55.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of rainbow darters. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi², M = medium catchment 40–179 mi², L = large catchment 180–620 mi², VL = very large catchment >620 mi². Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.15	0.17	0.10	0.11	0	0.10	6.0	6.1	17.7	7.7
M	0	0.35	0.50	0.23	0.25	0.18	0.23	0	52.3	148.0	45.6
L	0	0.43	0.25	0.31	0.40	0	0.31	0	14.0	5.8	9.3
VL	0	0	0.17	0.11	0.25	0	0.11	0	0	3.7	2.4
All	0.02	0.28	0.27	0.17	0.21	0.08	0.17	3.3	27.3	47.2	21.8

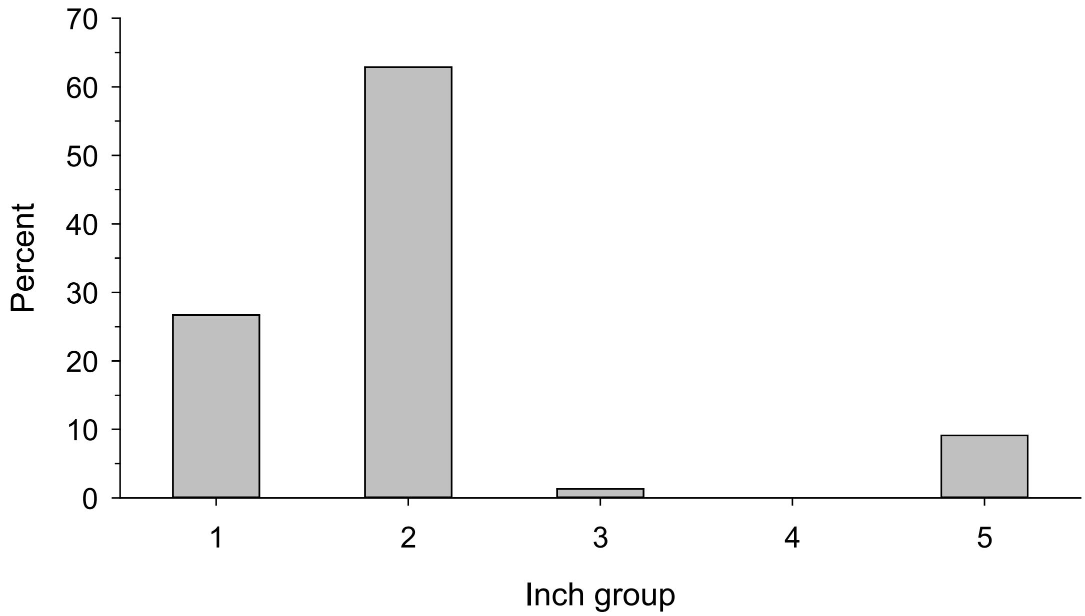

Figure 137.–Size distribution of rainbow darters.

- Iowa darter *Etheostoma exile* (IOD)

  Iowa darters occurred in only 2% of random streams surveyed (Table 13), and were not widely distributed throughout Michigan (Figure 138).

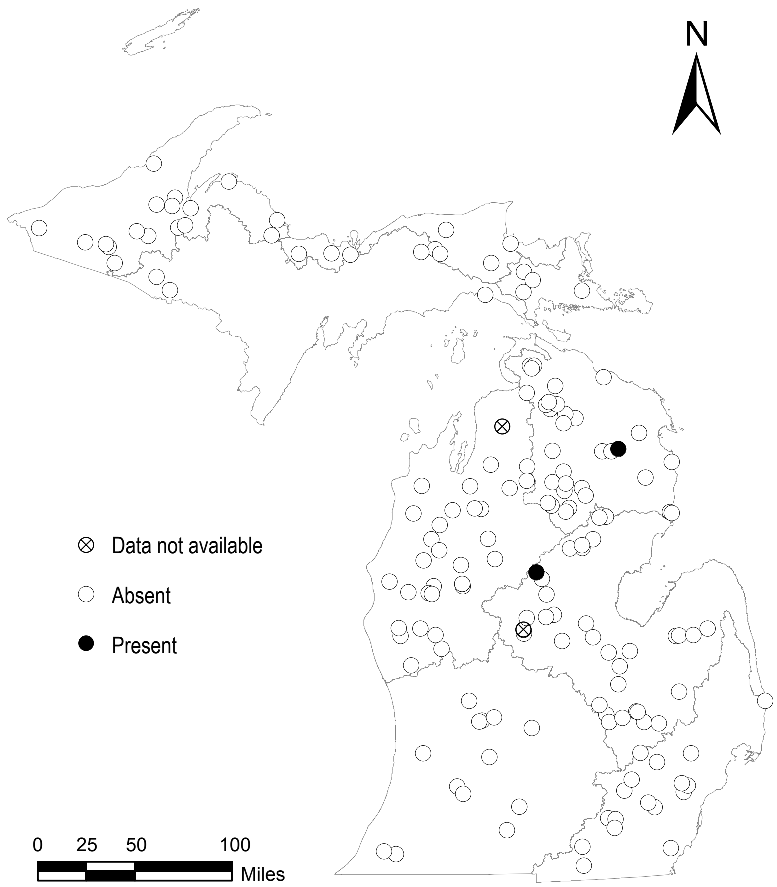

Figure 138.–Map of distribution of Iowa darters.

- Fantail darter *Etheostoma flabellare* (FTD)

Fantail darters are a state-listed species of greatest conservation need (Table 11). They were scattered throughout the Lake Huron and Lake Erie basins in the eastern Lower Peninsula (Figure 139), occurring in 5% of all random streams surveyed (Table 13). They were also encountered at 1 fixed site.

Fantail darters were found in all temperature classes of streams and in all size classes except very large (Table 56). No fantail darters were encountered in streams with Great Lakes access. Although the highest proportion of occurrence across all random surveys was in small cool streams, the highest average CPE was in small warm streams. When encountered, electrofishing CPE of fantail darters typically ranged between 26 and 48 fish per mile, with a maximum CPE of 253 fish per mile.

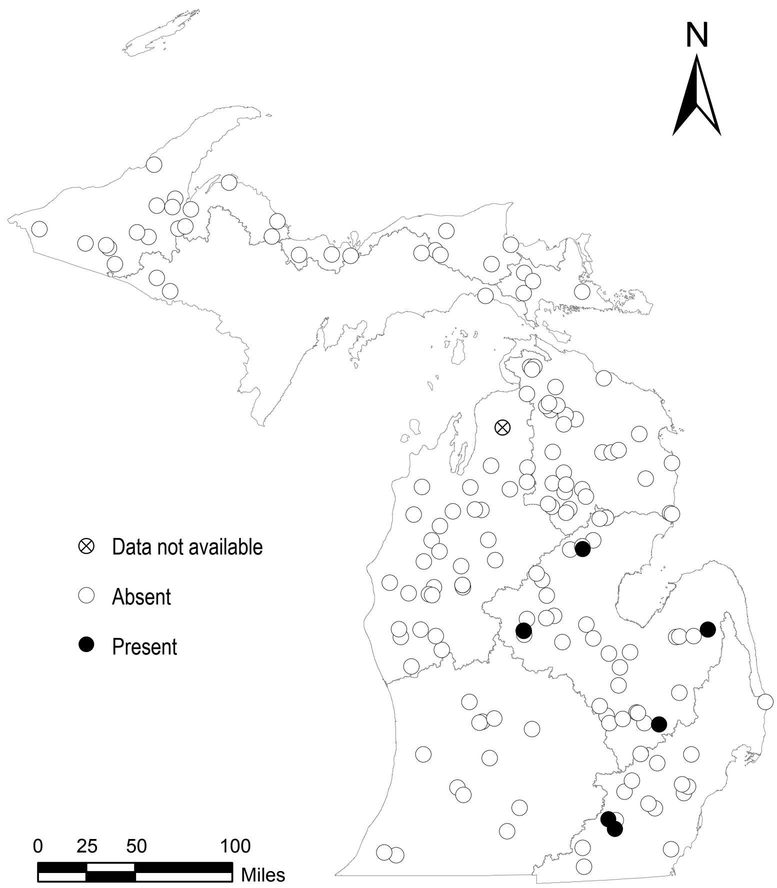

Figure 139.–Map of distribution of fantail darters.

Table 56.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of fantail darters. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.08	0.17	0.07	0.08	0	0.07	1.1	19.5	5.3	7.4
M	0.06	0	0	0.03	0.04	0	0.03	3.0	0	0	1.2
L	0	0.14	0	0.08	0.10	0	0.08	0	3.0	0	1.6
VL	0	0	0	0	0	0	0	0	0	0	0
All	0.05	0.05	0.05	0.05	0.06	0	0.05	1.8	7.0	1.5	3.7

- Johnny darter *Etheostoma nigrum* (JOD)

Johnny darters were the third most frequently encountered species in Michigan streams, occurring in 50% of random surveys (Table 13). They were also reported at 20 of 57 fixed sites sampled throughout the state.

Johnny darters were widely distributed across Michigan, with the exception of the central Upper Peninsula (Figure 140). They occurred in each Great Lakes basin, all size and temperature classes of streams, and (on average) in nearly equal proportion among waters with or without Great Lakes access (Table 57). The highest proportion of occurrence and CPE across all random surveys was small, warm streams. When encountered, electrofishing CPE of Johnny darters typically ranged between 21 and 174 fish per mile, with a maximum CPE of 1,368 fish per mile.

The size distribution of 1,076 Johnny darters measured during random stream surveys ranged from 1 to 3 in, with the majority of fish belonging to the 2 in size class (Figure 141).

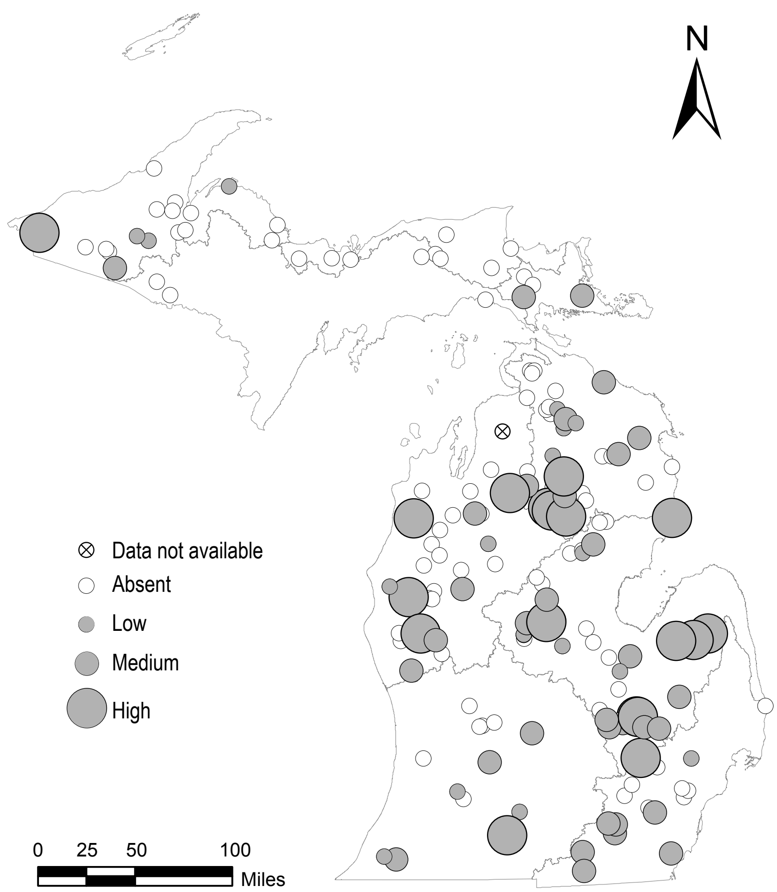

Figure 140.–Map of distribution of Johnny darters. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 57.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of Johnny darters. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.35	0.69	0.83	0.52	0.58	0.17	0.52	26.3	70.0	222.7	67.9
M	0.25	0.65	0.50	0.46	0.39	0.64	0.46	51.1	141.8	107.8	99.4
L	0.50	0.71	0.50	0.62	0.60	0.67	0.62	50.0	96.9	12.8	63.8
VL	0	1.00	0.33	0.44	0.50	0.40	0.44	0	3.0	9.7	7.1
All	0.31	0.69	0.55	0.50	0.51	0.48	0.50	36.3	102.7	95.1	74.0

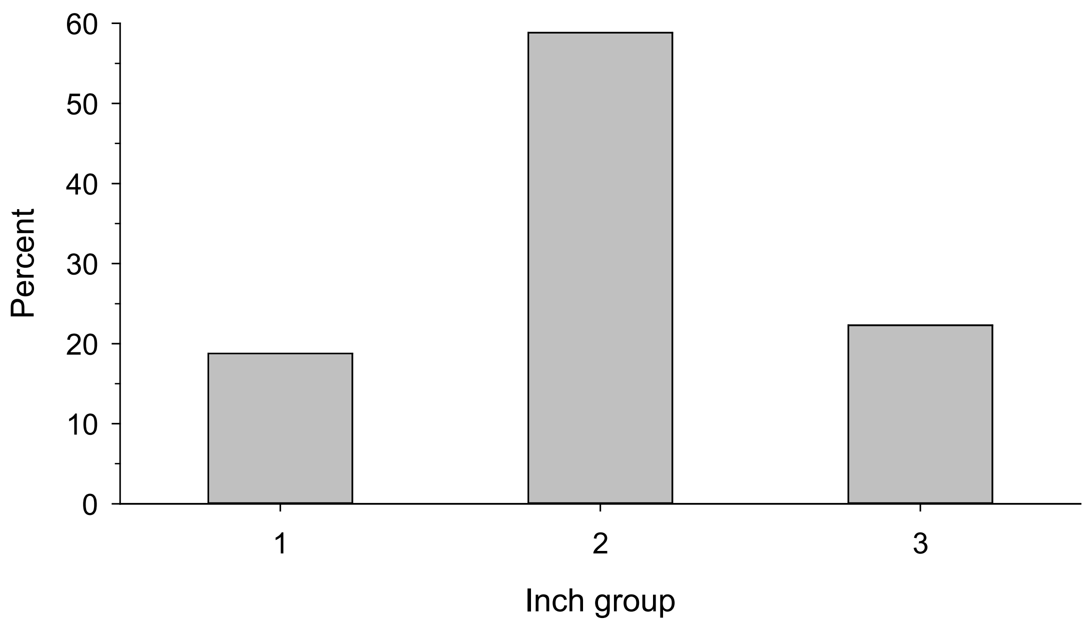

Figure 141.–Size distribution of Johnny darters.

• Yellow perch *Perca flavescens* (YEP)

Yellow perch were scattered throughout the Upper and Lower peninsulas (Figure 142). They occurred in 22% of random stream surveys and at 9 of 57 fixed sites sampled throughout the state (Table 13).

Yellow perch were reported in each Great Lakes basin and all size and temperature classes of streams, with variable proportion of occurrence by stream size, temperature, and Great Lakes access (Table 58). The highest average CPE of yellow perch across all random surveys was in very large warm streams. When encountered, electrofishing CPE of yellow perch typically ranged between 4 and 26 fish per mile, with a maximum CPE of 757 fish per mile.

The size distribution of 309 yellow perch measured during random stream surveys ranged from 1 to 9 in (Figure 143). Fish in the 2 in size group comprised nearly three quarters (74%) of the total catch. Yellow perch greater than 5 occurred infrequently, comprising 4% of the total catch.

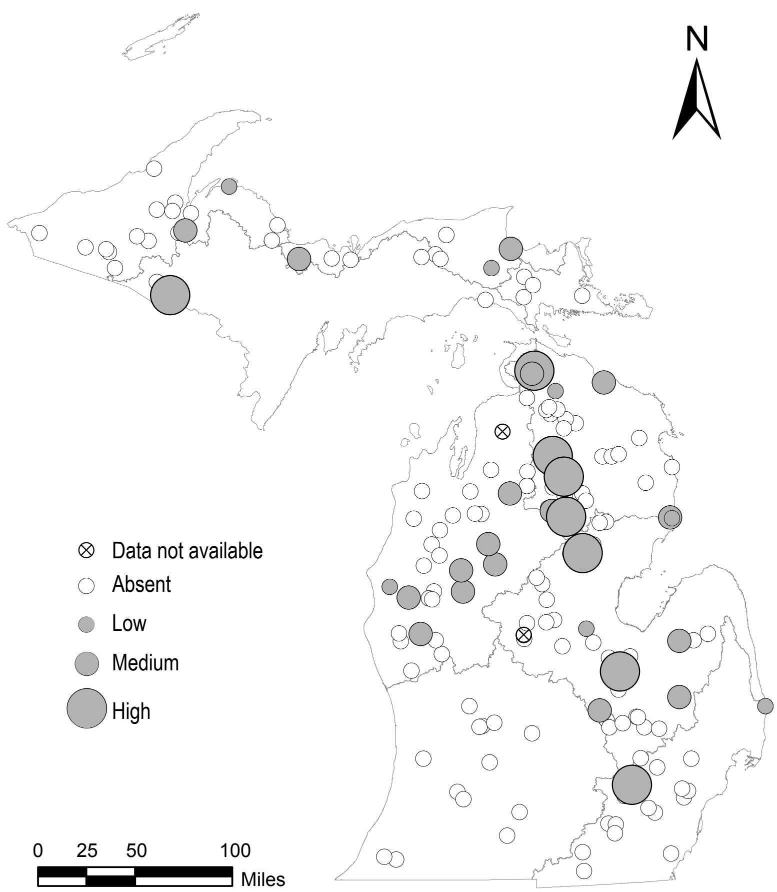

Figure 142.–Map of distribution of yellow perch. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 58.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of yellow perch. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.09	0.08	0	0.07	0.08	0	0.07	1.6	1.0	0	1.2
M	0.19	0.47	0.17	0.31	0.36	0.18	0.31	3.2	11.5	2.2	6.7
L	0	0.29	0.25	0.23	0.10	0.67	0.23	0	2.6	9.3	4.2
VL	0	1.00	0.50	0.56	0.50	0.60	0.56	0	12.5	127.0	87.4
All	0.12	0.33	0.23	0.22	0.21	0.28	0.22	2.1	6.5	36.9	11.2

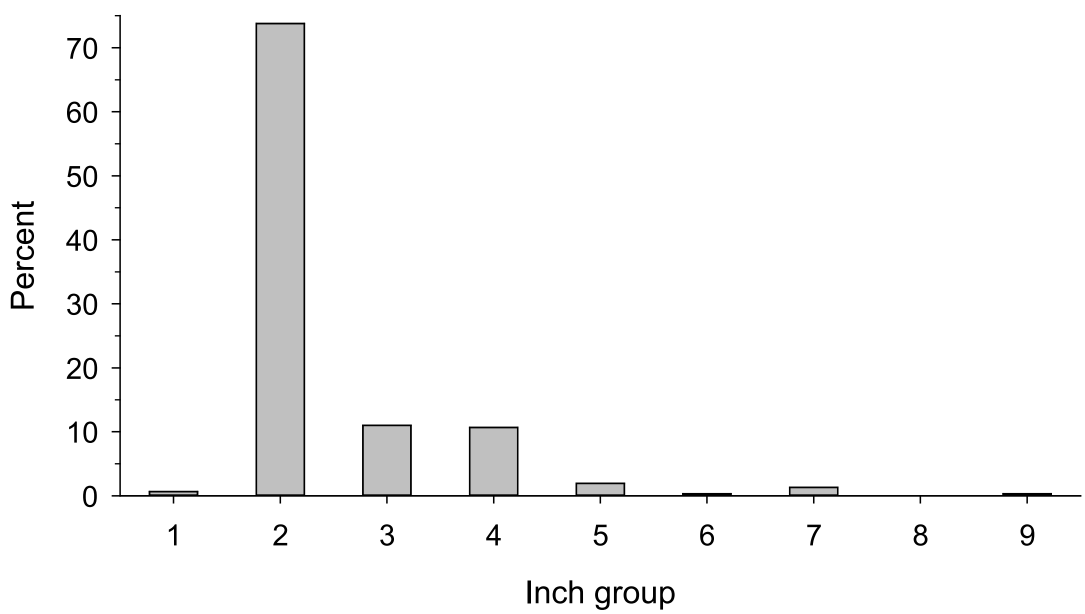

Figure 143.–Size distribution of yellow perch.

• Logperch *Percina caprodes* (LOG)

Logperch were distributed throughout the Upper and Lower peninsulas (Figure 144). They occurred in 13% of random stream surveys and at 12 of 57 fixed sites sampled throughout the state (Table 13).

Logperch were reported in each Great Lakes basin, all size and temperature classes of streams, and in greater proportion among waters with Great Lakes access (Table 59). Their proportion of occurrence increased with stream size and temperature; accordingly, the highest average CPE of logperch across all random surveys was in very large warm streams. When encountered, electrofishing CPE of logperch typically ranged between 16 and 62 fish per mile, with a maximum CPE of 2,671 fish per mile.

The size distribution of 715 logperch measured during random stream surveys ranged from 1 to 5 in (Figure 145). The bell-shaped curve was centered on 3 in fish, which comprised over one half (57%) of the total catch.

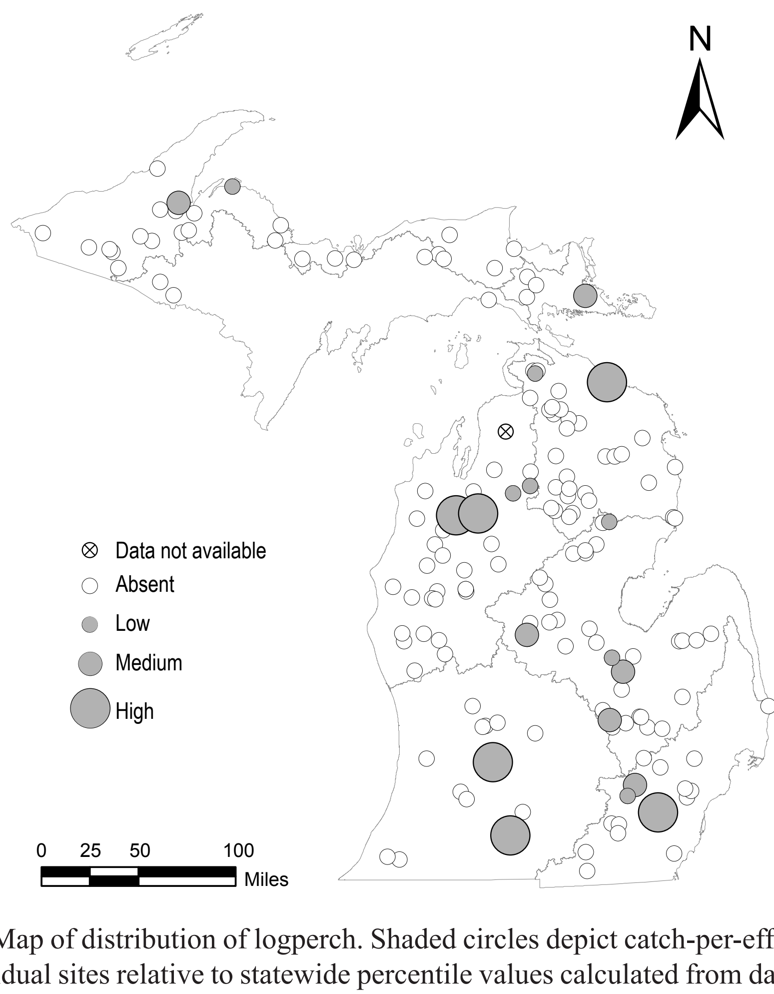

Figure 144.–Map of distribution of logperch. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 59.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of logperch. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0.17	0.02	0.03	0	0.02	0	0	27.5	3.9
M	0.13	0.12	0.17	0.13	0.07	0.27	0.13	4.2	15.2	3.5	8.9
L	0.50	0.29	0.25	0.31	0.30	0.33	0.31	8.0	5.7	9.3	7.2
VL	0	0	0.50	0.33	0.25	0.40	0.33	0	0	450.7	300.4
All	0.07	0.10	0.27	0.13	0.09	0.24	0.13	2.0	7.6	133.0	32.1

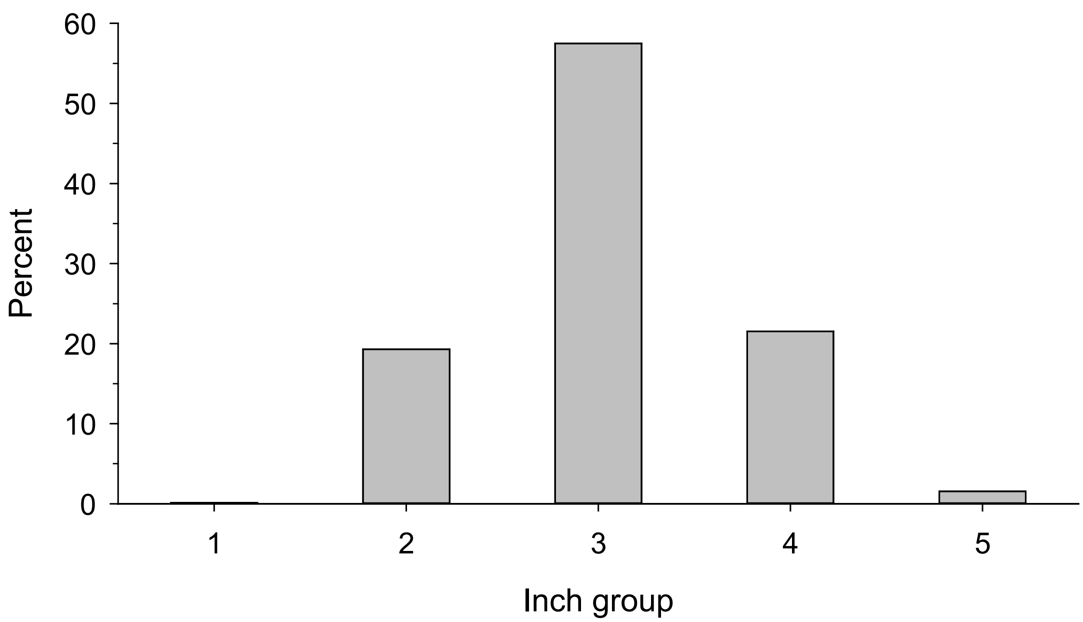

Figure 145.–Size distribution of logperch.

• Blackside darter *Percina maculate* (BSD)

Blackside darters were widely distributed throughout the Lake Michigan, Huron, and Erie basins in the Lower Peninsula, but were not reported in the Upper Peninsula (Figure 146). They occurred in 25% of random stream surveys and at 10 of 57 fixed sites sampled throughout the state (Table 13).

Blackside darters were reported in all size and temperature classes of streams and mostly in greater proportion among waters without Great Lakes access (Table 60). With the exception of very large streams their proportion of occurrence tended to increase with size and was lowest in cold streams. The highest average CPE of blackside darters across all random surveys was in small warm streams, followed by large and medium and cool waters. When encountered, electrofishing CPE of blackside darters typically ranged between 13 and 60 fish per mile, with a maximum CPE of 201 fish per mile.

The size distribution of 189 blackside darters measured during random stream surveys ranged from 1 to 5 in (Figure 147). Fish in the 2–3 in size group comprised nearly all (89%) of the total catch.

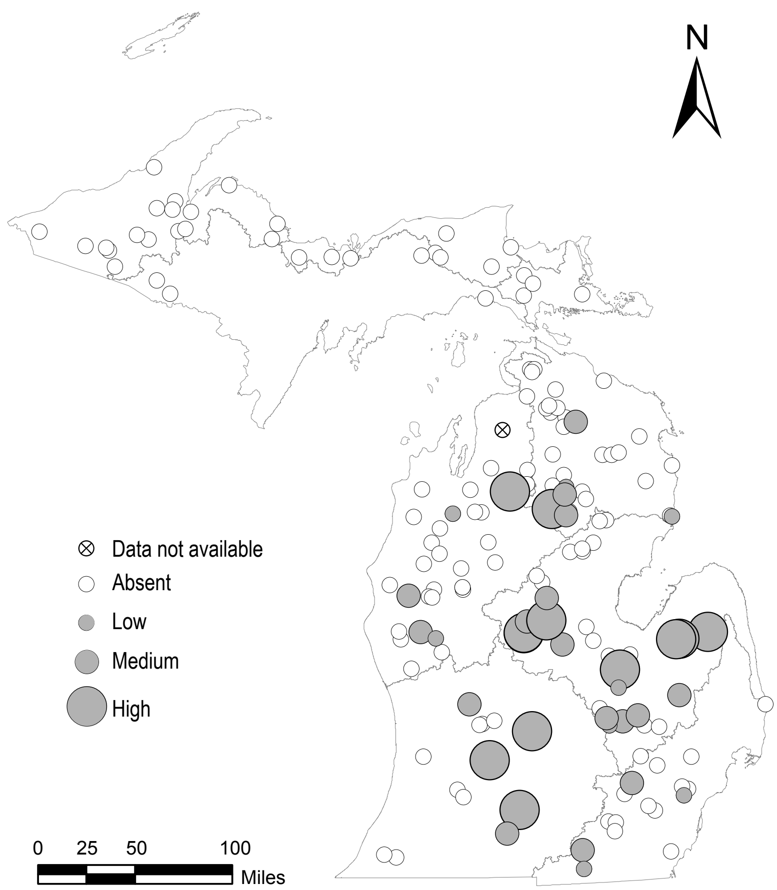

Figure 146.–Map of distribution of blackside darters. Shaded circles depict catch-per-effort (number of fish per mile) at individual sites relative to statewide percentile values calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Table 60.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of blackside darters. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0.04	0.31	0.17	0.14	0.17	0	0.14	0.9	6.7	33.5	7.4
M	0.13	0.35	0.50	0.28	0.36	0.09	0.28	1.1	21.2	12.8	11.6
L	0	0.57	0.75	0.54	0.50	0.67	0.54	0	26.0	14.0	18.3
VL	1.00	0	0.17	0.22	0.25	0.20	0.22	4.0	0	10.0	7.1
All	0.10	0.36	0.36	0.25	0.28	0.16	0.25	1.0	16.1	17.9	10.3

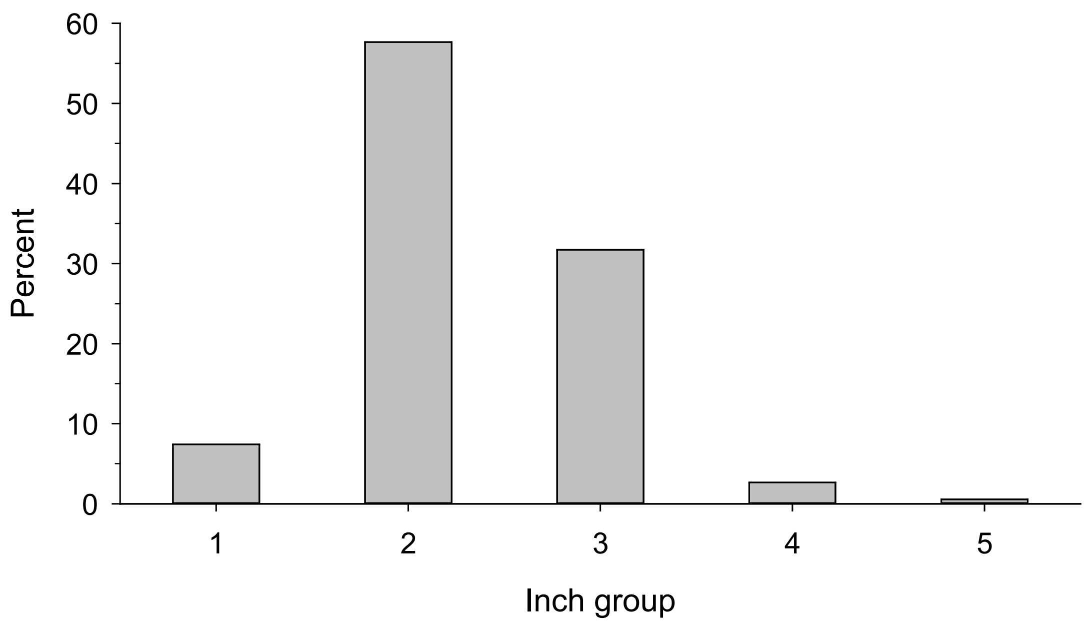

Figure 147.–Size distribution of blackside darters.

- River darter *Percina shumardi* (RID)

  River darters are a state-listed endangered species and species of greatest conservation need (Table 11). They occurred in only 1 random stream survey in the Lake Erie basin (Figure 148, Table 13).

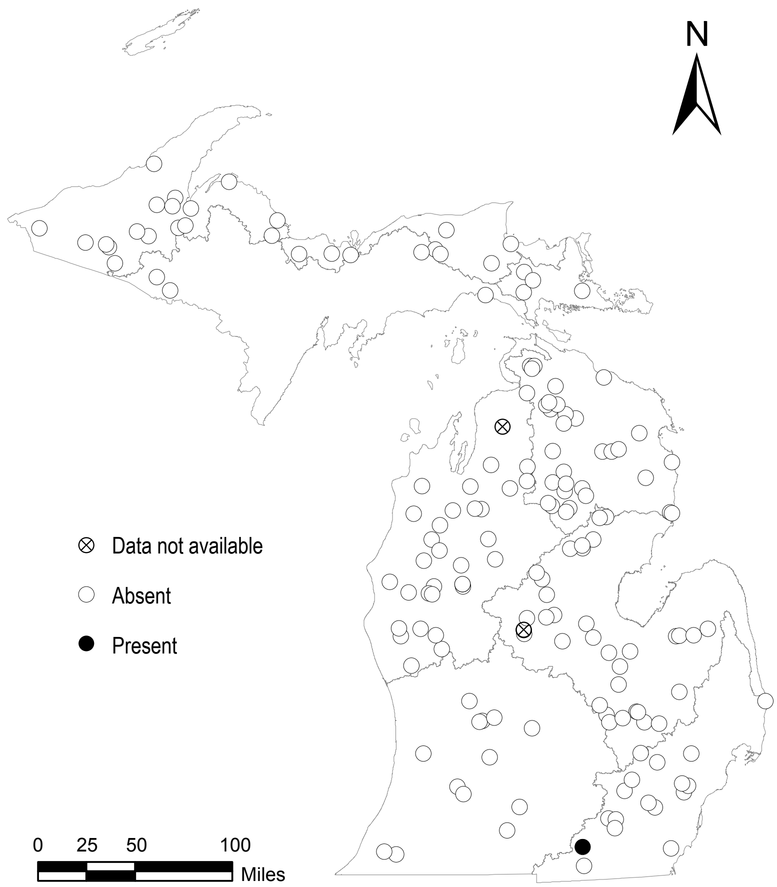

Figure 148.–Map of distribution of river darters.

- Walleye *Sander vitreus* (WAE)

Walleyes were scattered throughout the state, mostly in the Lower Peninsula (Figure 149). They occurred in 6% of all random streams surveyed (Table 13). No walleye were reported from SSTP surveys in the Lake Michigan basin.

Although walleyes were found in all temperature classes of streams, they did not occur in the small or medium size classes and (on average) were somewhat more likely to be found in waters with Great Lakes access (Table 61). The highest average CPE of walleyes across all random surveys was in very large warm streams; when walleyes were encountered, electrofishing CPE typically ranged between 3 and 5 fish per mile, with a maximum CPE of 6 fish per mile.

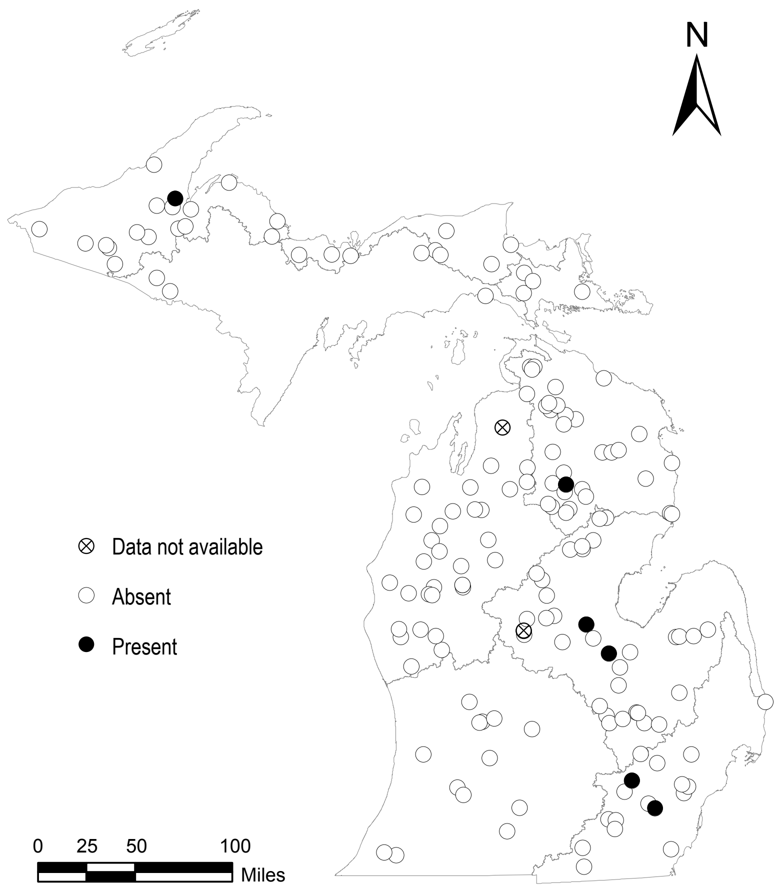

Figure 149.–Map of distribution of walleyes.

Table 61.–Proportion of occurrence and mean catch-per-effort (CPE, number of fish per mile) of walleyes. Proportion of occurrence is stratified by stream size, temperature, and Great Lakes access; mean CPE is stratified by stream size and temperature. Abbreviations are: S = small catchment <40 mi^2, M = medium catchment 40–179 mi^2, L = large catchment 180–620 mi^2, VL = very large catchment >620 mi^2. Temperature classes, as based on mean July stream temperatures, are: cold <66.2°F, cool 66.2–71.5°F, warm >71.5°F.

	Proportion of occurrence							Mean CPE			
	Temperature				Great Lakes access			Temperature			
Size	Cold	Cool	Warm	All	No	Yes	All	Cold	Cool	Warm	All
S	0	0	0	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0	0	0	0
L	0	0.14	0.25	0.15	0.10	0.33	0.15	0	0.4	1.3	0.6
VL	1.00	0	0.50	0.44	0.75	0.20	0.44	1.0	0	2.3	1.7
All	0.02	0.03	0.18	0.06	0.05	0.08	0.06	0	0.1	0.9	0.2

Sciaenidae

- Freshwater drum *Aplodinotus grunniens* (DRU)

    Freshwater drum occurred in 4% of random streams surveyed (Table 13), and were not widely distributed throughout Michigan (Figure 150).

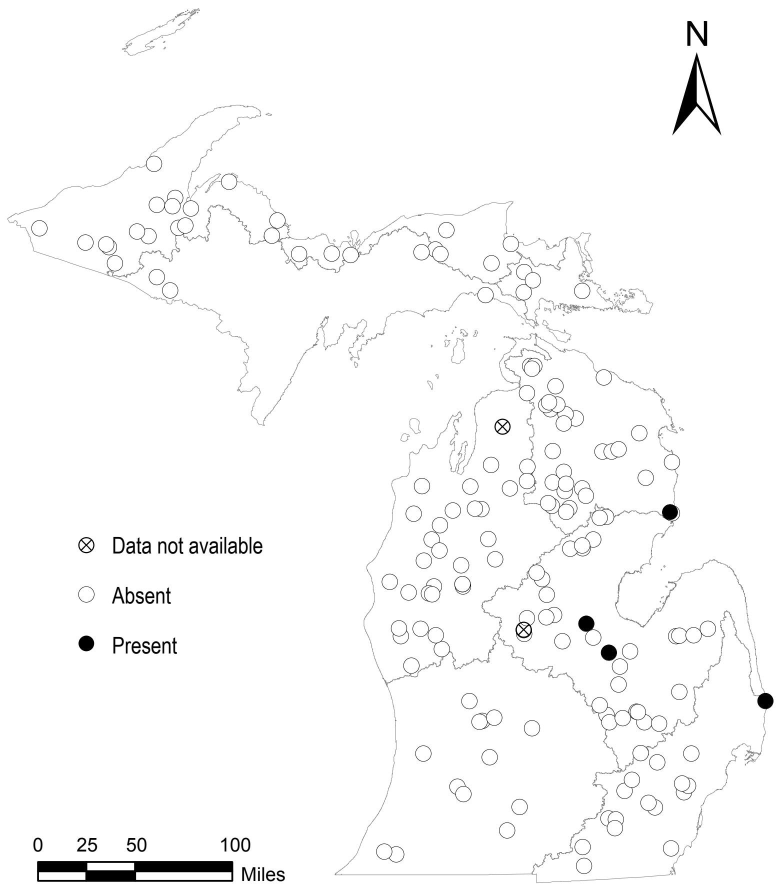

Figure 150.–Map of distribution of freshwater drum.

Gobiidae

- Unidentified goby (GOB FA)

    Gobies, an invasive species (Table 12), occurred in only 1 random stream survey in the Lake Huron basin (Figure 151, Table 13).

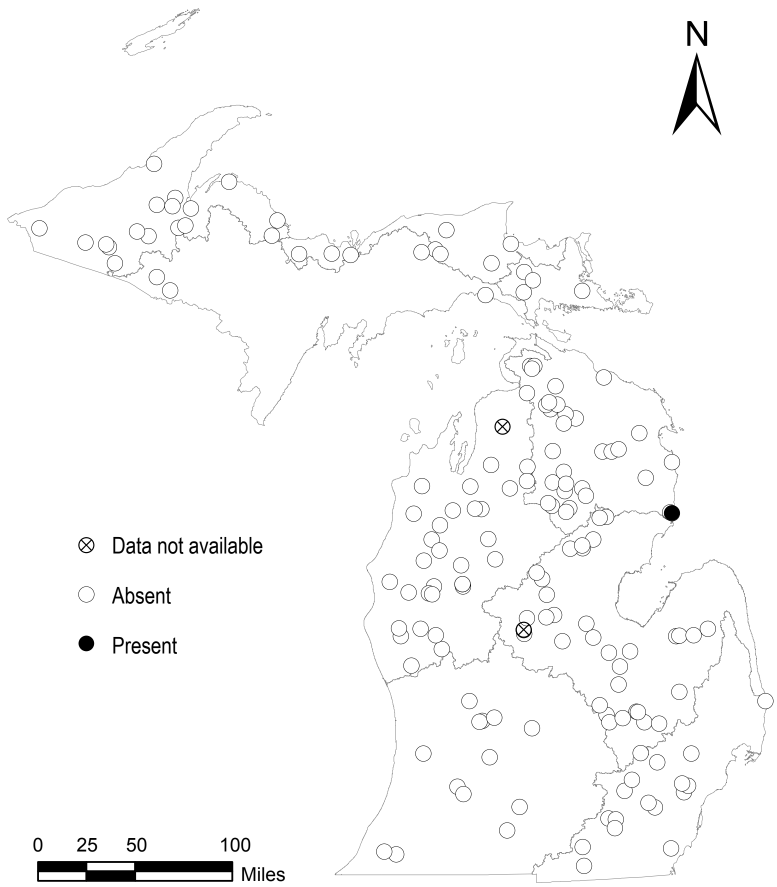

Figure 151.–Map of distribution of gobies.

Trends in Fishery Resources

Michigan's stream fisheries for smallmouth bass and several species of salmonids are unique and special resources, highly valued by anglers and the communities and businesses that benefit from them. Because of the heightened interest and concern for these resources, there is great interest in documenting trends in these populations, protecting them from adverse influences, and using available fisheries management tools such as fishing regulations, habitat protection, and habitat improvement to ensure populations are sustainable, productive, and provide greatest benefits to Michigan anglers. Repeated measurements of fish population levels at the same site (i.e., a fixed index site) year after year provide a sensitive index of fish population levels and useful way to monitor population trends.

Tracking stream trout populations at fixed index stations began in the 1950's on some waters, and such long-term data have played an important role in guiding the management of Michigan's trout streams. Before the SSTP, long-term sampling of trout and salmon populations occurred on only a few streams in Michigan (namely Hunt Creek and the Main, North, and South branches of the Au Sable River), where thirty or more years of annual trout population estimate data have been collected to date. Though collected at only a few sites, these data have proven useful for documenting the effects of sediment input and removal (Alexander and Hansen 1988), changes to fishing regulations (Shetter and Alexander 1965; Shetter and Alexander 1966; Alexander and Ryckman 1976; Clark and Alexander 1985; Clark and Alexander 1992), and changes in water quality or quantity (Merron 1982, Nuhfer et al. 1994; Nuhfer and Baker 2004). Long-term monitoring of smallmouth bass populations in the Huron River began in 1985 and has proved valuable for evaluating sampling methods, regulation changes, and documenting the effects of spring floods on recruitment (Lockwood et al. 1995). However, since data were from only a few sites, similar sampling was needed for trout and smallmouth bass populations elsewhere in Michigan to provide representative information on population trends, fish growth and survival rates, and to enable testing of potential causes for the changes observed through time.

The fixed site component of the SSTP builds upon the foundational, long-term data collected from select Michigan streams with high-quality fisheries by 1) increasing the number and location of sites that are monitored across the state, and 2) ensuring a sampling frequency that is adequate to detect change. Observed trends in fish populations at sites with pre-existing long-term data have emphasized the need to determine the spatial extent of patterns in fish abundance. For example, the apparent declines in brown trout on both the Main and North branches of the Au Sable River suggest that larger-scale factors occurring across the landscape (e.g. regional changes in climate or flow regime) play important roles in explaining abundance patterns (Zorn and Nuhfer 2007a); thus, data collected concurrently on other cold water streams are needed to determine the spatial extent to which population trends observed at one site apply to other rivers in the region (Zorn and Nuhfer 2007b). Analyses of data from other long-term studies suggest that relatively frequent sampling is needed to describe variation and trends in fish populations at spatial and temporal scales pertinent to fishery managers, and that past sampling efforts, which typically involved revisiting index stations at 5–10 year intervals under the assumption that each sample represented "typical" conditions for the period between samples, were too infrequent. The dynamic nature of wild salmonid populations suggests that such samples may provide little information beyond describing the status of fish populations at the moment when sampling occurred (Wiley et al. 1997). Collecting samples at the same site for consecutive years enables estimation of annual survival rates for the population, which are useful for reasons discussed below.

Because of the relatively recent implementation of the SSTP, the fixed site data are currently in their infancy. However, as time progresses and the data from SSTP fixed sites accumulate, their value increases, because hypotheses relating to changes (whether expected or unexpected) in the fish community can be tested. By having pre-data on parameters such as fish growth, survival, distribution, and abundance, fisheries managers will be in a position to evaluate the effects of various changes to Michigan's aquatic systems. Such changes may include watershed development or increased protection, changes to riparian habitats, instream habitat enhancement, fishing regulations changes,

changes in forestry practices, changes in water quality standards, changes in dam operation, dam removal, movement or removal of sea lamprey barriers, and global climate change. With information documenting human impacts on aquatic communities, managers will be better equipped for protecting aquatic systems and identifying types of corrective measures needed.

Period of Record and Data Sources

The modern period of record for fixed sites began in 2002 with the start of the SSTP. Since that time, 57 of the 59 fixed sites throughout Michigan have been sampled for at least 1 consecutive 3-year time period. Nearly half (46%) of these locations have some historical data from fisheries surveys that were completed prior to 2002, with the earliest survey on record dating back to 1947, more than five decades before the SSTP began. Although the number of historical surveys available ranges from 1 to 41 years, only ten sites (17% of total) have more than 10 years of historical data. A total of four stations (7% of total) have more than 20 years of population estimates available (Table 62).

Table 62.–Location and period of record (including historical surveys conducted prior to the Stream Status and Trends Program) for fixed sites throughout Michigan. Rotation refers to whether the site is sampled in the first or second 3-year sampling rotation. Abbreviations are: FMU = Fisheries Management Unit; R. = River; Hist. = Historic; SLWT = small, landlocked, wild trout; SGLWT = small, Great Lakes access, wild trout; MLWT = medium, landlocked, wild trout; MGLWT = medium, Great Lakes access, wild trout; MSMB = medium smallmouth bass.

Great Lakes basin and FMU	Water body	County	Strata	Hist. surveys (number)	Rotation	First survey year
Superior						
Western	Elm R.	Houghton	SGLWT		2	2004
	Middle Branch Ontonagon R.	Gogebic	SGLWT		1	2003
	Two Mile Creek	Ontonagon	SLWT		2	2004
Eastern	Chocolay R.	Marquette	SGLWT	14	1	1984
	Naomikong Creek	Chippewa	SGLWT		2	2006
	Rock R.	Alger	SGLWT		1	2002
	Tahquamenon R.	Luce	SLWT		1	2003
	Anna River	Alger	SGLWT		2	2006
Michigan						
Northern	Davenport Creek	Mackinac	SGLWT		2	2006
	East Branch Fox R.	Schoolcraft	SLWT		1	2002
	Iron R.	Iron	SLWT	6	1	1996
	South Branch Paint R.	Iron	MLWT	11	1	1990
Central	Baldwin R.	Lake	SGLWT	2	1	2000
	Bear Creek	Manistee	SGLWT	1	2	1997
	Bigelow Creek	Newaygo	SGLWT		2	2005
	Boardman R.	Grand Traverse	MLWT	7	1	1960
	Clam R.	Missaukee	SLWT		2	2005
	Hersey R.	Osceola	MLWT	2	2	2000
	Hopkins Creek	Missaukee	SLWT		2	2005
	River Raisin	Washtenaw	MSMB		2	2007
	Jordan R.[1]	Antrim	SGLWT	1	1	1987
	Little Manistee R.	Lake	MGLWT	3	1	1979
	Manistee R.	Crawford	MLWT	13	1	1988
	Middle Branch R.	Osceola	SLWT	8	1	1981

Table 62.–Continued.

Great Lakes basin and FMU	Water body	County	Strata	Hist. surveys (number)	Rotation	First survey year
Central–continued	North Branch Manistee R.	Kalkaska	SLWT		1	2002
	Pere Marquette R.	Lake	MGLWT	18	1	1973
	Pine R.	Osceola	MLWT		2	2005
	Platte R.	Benzie	MGLWT	3	1	1985
Southern	Bear Creek	Kent	SLWT		2	2005
	Kalamazoo R.[1]	Calhoun	SLWT		1	2002
	Kopf Creek	Kent	SGLWT		1	2002
	Looking Glass R.	Clinton	MSMB		1	2002
	Pokagon Creek	Cass	SLWT		1	2002
	Silver Creek	Allegan	SGLWT	1	1	1991
	Silver Creek	Kalamazoo	SLWT	9	2	1991
	Spring Brook	Kent	SGLWT		2	2005
	Spring Brook	Kalamazoo	SLWT	9	1	1991
	St. Joseph R.	Calhoun	MSMB		2	2005
	Thornapple R.	Barry	MSMB		2	2005
	Townsend Creek	Berrien	SGLWT	1	2	1992
Huron						
Northern	Au Sable R.	Crawford	MLWT	33	1	1960
	Black R.	Montmorency	MLWT	6	2	1975
	Gilchrist Creek	Montmorency	SLWT		2	2004
	North Branch Au Sable R.	Crawford	MLWT	41	2	1957
	North Branch Carp R.	Mackinac	SGLWT		1	2003
	Pigeon R.	Otsego	MLWT	21	1	1949
	South Branch Au Sable R.	Crawford	MLWT	26	1	1972
	Sturgeon R.	Cheboygan	MLWT	1	2	1993
	West Branch Big Creek	Oscoda	SLWT		1	2002
	West Branch Maple R.	Emmet	SLWT	1	1	1982
	West Branch Sturgeon R.	Cheboygan	SLWT		2	2005
Southern	Cass R.	Tuscola	MSMB		2	2005
	Chippewa R.[2]	Isabella	MSMB		2	-
	Gamble Creek	Ogemaw	SGLWT	24	2	1947
	Houghton Creek	Ogemaw	SGLWT	2	1	2000
	North Branch Tobacco R.	Clare	SLWT	12	1	1970
	Shiawassee R.[1]	Shiawassee	MSMB		1	2002
Erie						
Erie	Huron R.	Washtenaw	MSMB	13	2	1985
	River Raisin	Monroe	MSMB		1	2002
	River Raisin	Washtenaw	MSMB		2	2007

[1]Station switched from original location sampled during first rotation (2002–2004).
[2]Station start delayed until 2011.

Only 1 of the 27 fixed sites where historical survey data are available is a smallmouth bass index station (the Huron River, Table 62). The remaining 26 fixed sites that were sampled before the SSTP are trout population index stations, where mark–recapture population data were collected for research studies or during discretionary field surveys. Fish community data including species other than trout, salmon, and smallmouth bass are rare. No habitat data other than anecdotal observations made by field crews at the time of sampling (i.e., good cover present, water level lower than normal, etc.) are available for any historical survey.

Changes in Habitat

Habitat data collected at fixed sites between 2002 and 2007 serve as a baseline measurement of the conditions present at these long-term monitoring stations and the foundation for testing hypotheses about the mechanisms responsible for any future changes that are observed in the fish community. Since only one habitat survey occurs during each 3-year sampling rotation, it is impossible to make any inference regarding changes in habitat that have occurred during the first six years of the SSTP. However, it is possible to compare baseline habitat characteristics at fixed sites to the medium ranges determined from random sites statewide to make inference about their collective physical condition.

Collectively, the habitat conditions at fixed sites throughout Michigan are good. Pool-type bed features occur at or above the medium range (Figure 152), indicating good hydraulic diversity. Although one third of the fixed sites have a lower than medium frequency of forested riparian zones (Figure 153), closer examination of the data revealed that this is due to the number of locations that were classified as having grassland–forb type riparian areas, which were rare during random stream surveys. Approximately 10% of fixed sites, mostly in the southern portion of the Lower Peninsula, had lower than medium bank stability, fewer than medium undercuts and less coarse substrate (figures 154–156). More intense urban or agricultural land use and a higher frequency of runoff-driven streams in this area of the state (Seelbach et al. 1997) are undoubtedly contributing factors to this observation. Instream cover was at or above the medium range at 85% of the fixed sites; those with a lower than medium density of instream cover were scattered across the state (Figure 157). The fact that habitat conditions at the majority of the fixed sites fall within or above the medium ranges observed in randomly sampled streams is not surprising, given the expectation of fixed sites to support high-quality fisheries, and accordingly contain high-quality habitat.

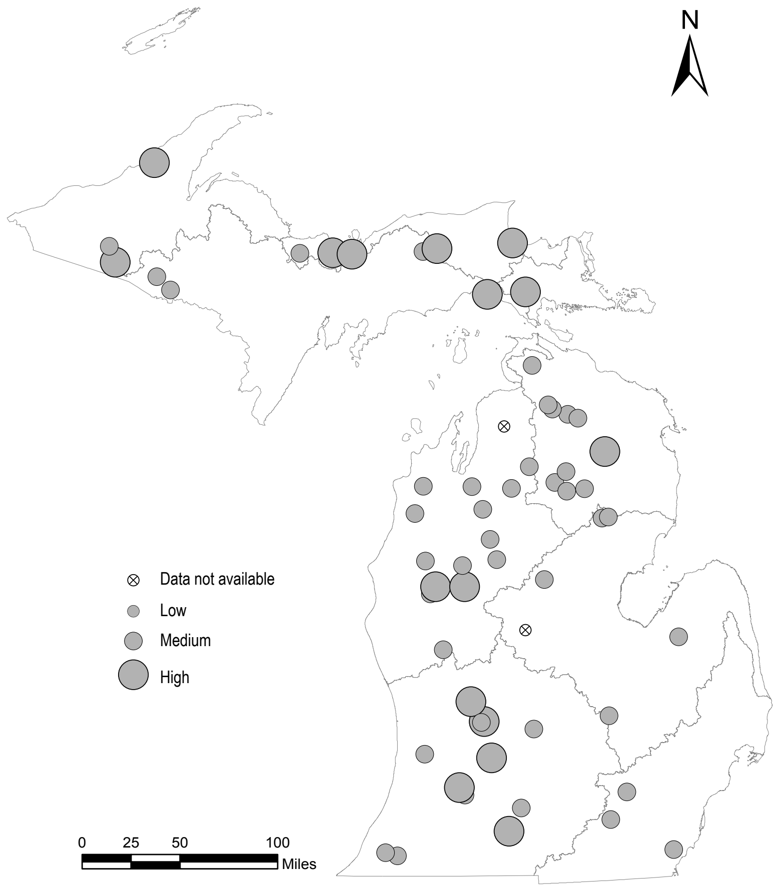

Figure 152.–Percent occurrence of pool habitats at fixed sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

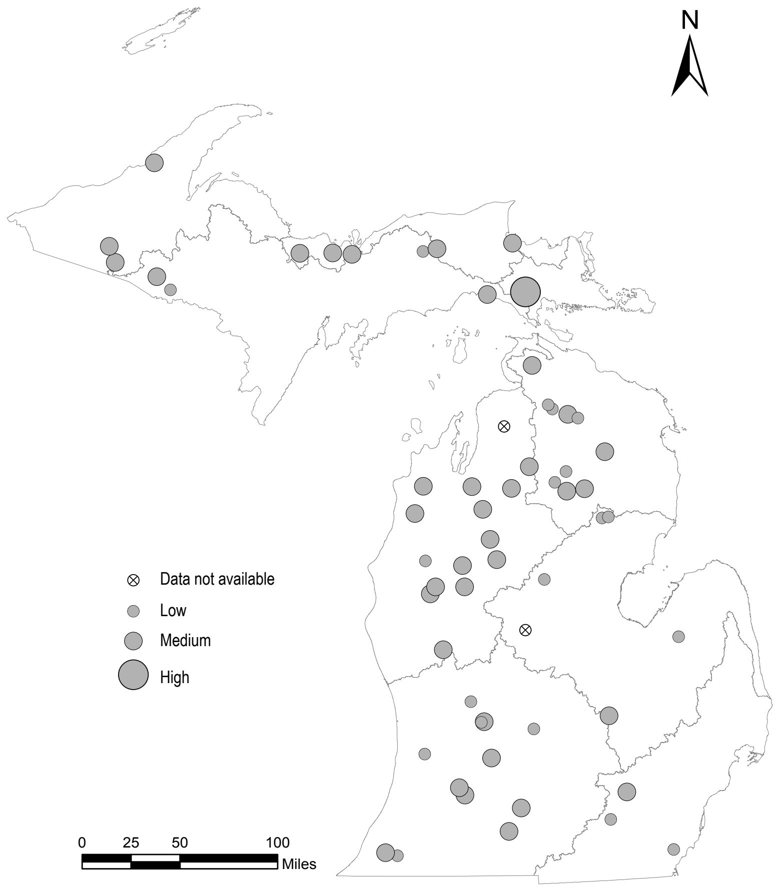

Figure 153.–Percent occurrence of forested riparian zone types at fixed sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

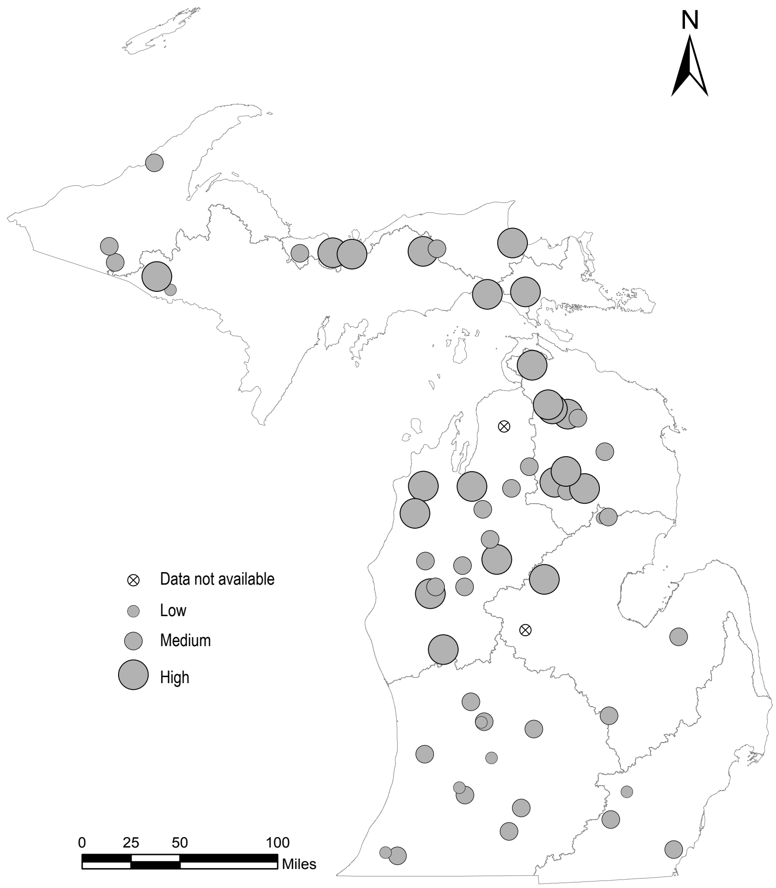

Figure 154.–Percent occurrence of “good” bank stability (<25% of stream bank is bare soil) at fixed sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

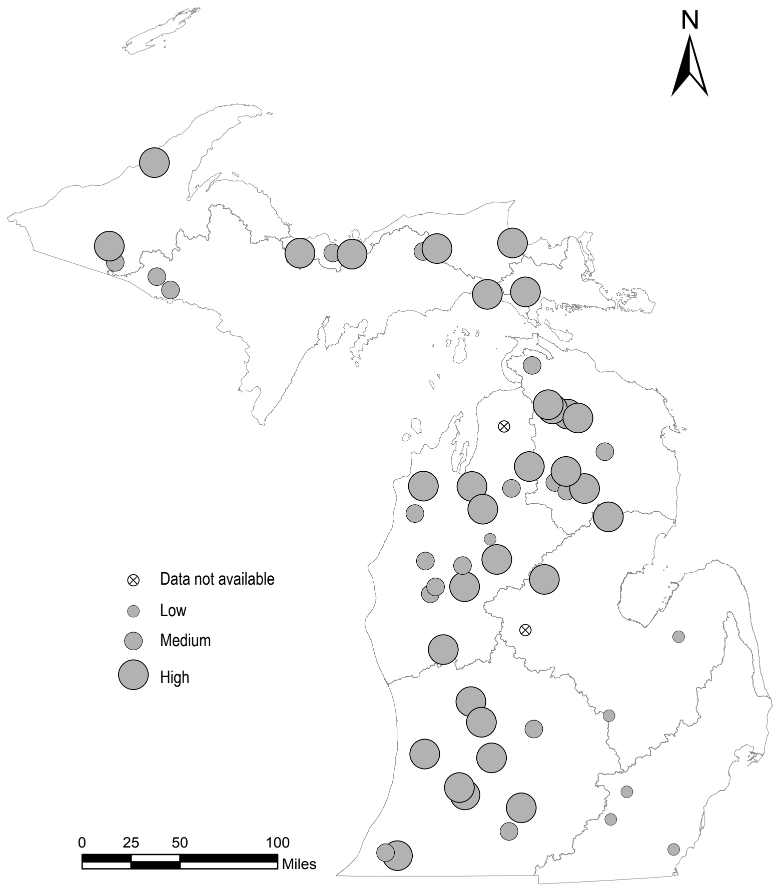

Figure 155.–Number of undercut banks at fixed sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

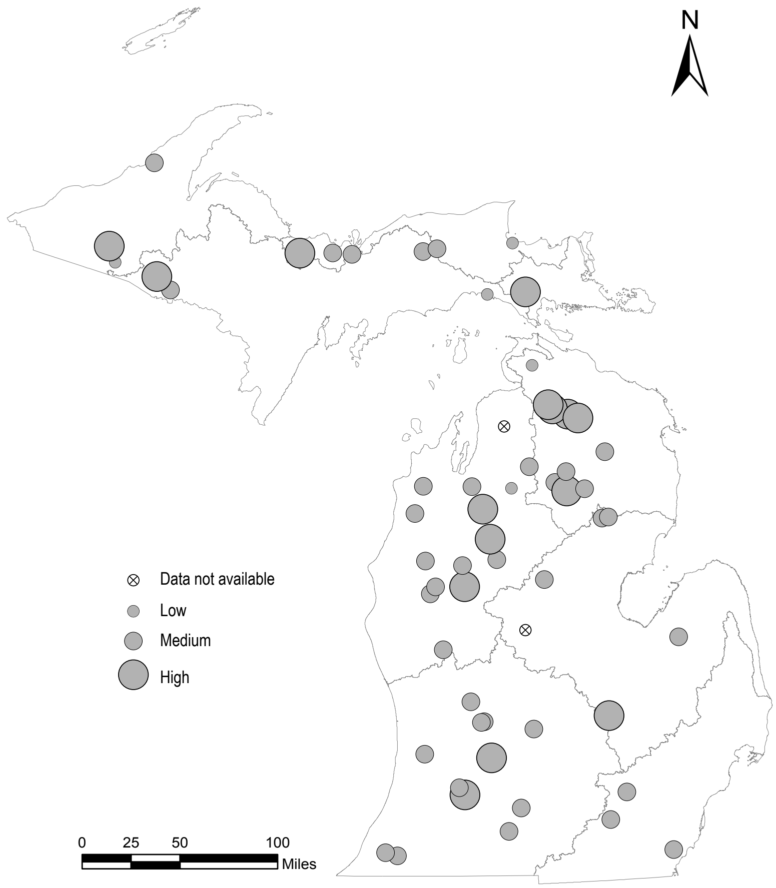

Figure 156.–Percent occurrence of coarse substrate types at fixed sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

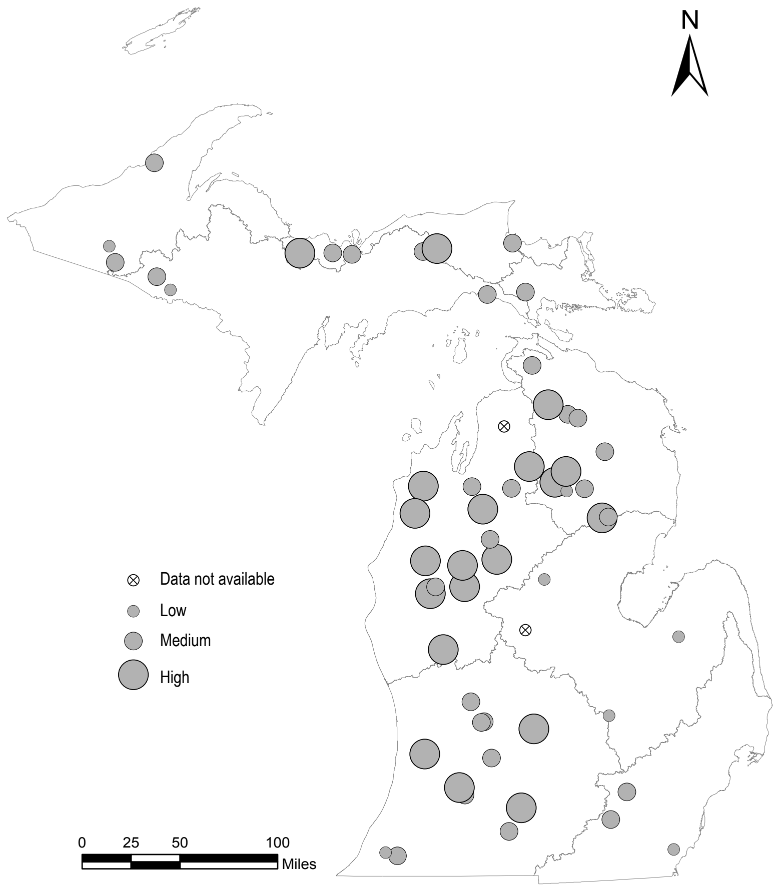

Figure 157.–Density of total instream cover (ft^2/ac) at fixed sites relative to statewide percentile values calculated from Stream Status and Trends Program random site surveys completed during 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

Changes in Fishery Resources

Before describing changes to fishery resources at fixed sites through time we must accurately describe their current status as a reference condition for future comparisons. This reference condition can be determined relative to other similar streams throughout the state, or relative to past conditions at individual sites. Therefore, we first describe the current status of the fishery resources at fixed sites relative to other streams throughout the state by comparing species richness and relative abundance data (for salmonids and smallmouth bass) from the most recent fishery survey at each fixed site to the statewide medium ranges for all random stream surveys. We then compare abundance data from the most recent survey to the site's overall average since the beginning of the SSTP to document the current status of an individual fixed site relative to past conditions. Because we suspect many abundance measures (particularly for trout) to be annually synchronous (Zorn and Nuhfer 2007b), we provide separate map-based summaries for each of the two sampling rotations to better illustrate regional patterns during the alternating 3-year sampling cycles. We did not compare abundance data from the most recent survey to the entire period of record at each site because we were concerned that differences in the time period covered (Table 62) would give each stream a different baseline for comparison (we excluded data from years that overlapped rotations at some fixed sites for the same reason). Since the SSTP is relatively new, we realize that the overall average at these locations will be calculated from, at most, the 3 years of data available during this reporting period. Thus, the reported current condition at index stations may be influenced by exceptionally high or low measurements within one sampling rotation. Nevertheless, this condition provides a benchmark to which future comparisons can be made to track changes through time.

The values for species richness and smallmouth bass or salmonid CPE at fixed sites were often within or above the statewide medium ranges determined from random stream surveys. Species richness at 35 (61%) of the 57 fixed sites sampled during this reporting period was within the medium range determined from randomly-sampled streams with similar size and temperature (Figure 158). Like random streams, the remaining 22 fixed sites were divided evenly between lower than medium or higher than medium species richness. All 7 fixed sites with smallmouth bass, 87% of 39 fixed sites with brook trout, 92% of 36 fixed sites with brown trout, 82% of 11 fixed sites with Coho salmon, and 93% of 27 fixed sites with rainbow trout were within or above the medium range of relative abundance for each species.

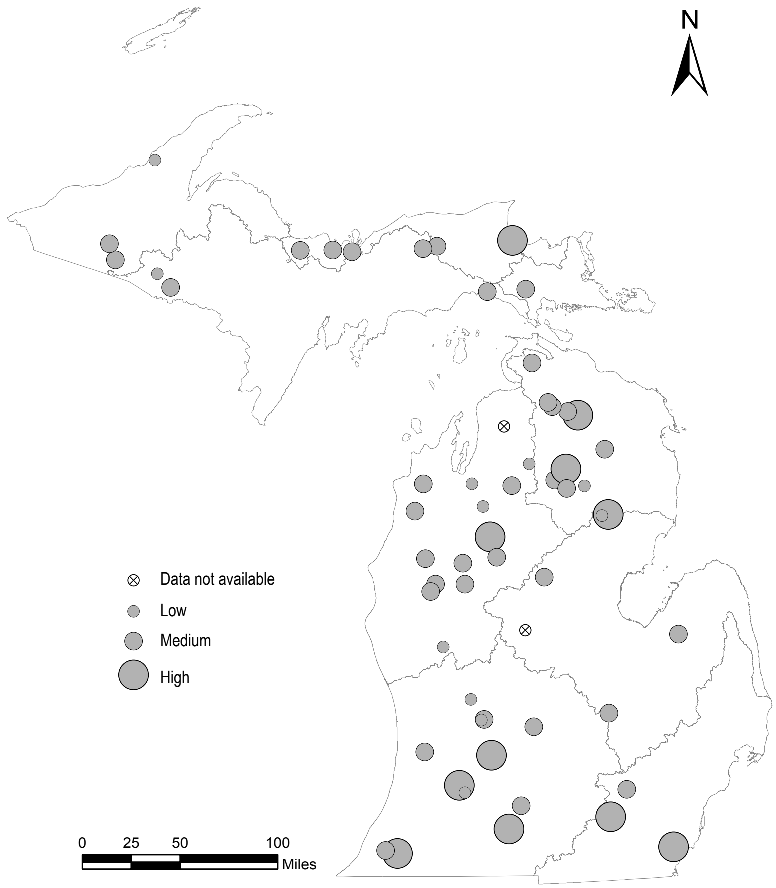

Figure 158.–Species richness (number of species sampled) at fixed sites relative to statewide percentile values (from streams with similar size and temperature) calculated from data collected during random Stream Status and Trends Program surveys, 2002–2007. High = >75th percentile, medium = 25th–50th percentile, low = <25th percentile.

When compared to individual site averages the total weight (biomass) of smallmouth bass per mile of stream was lower than the site average at 3 out of 4 fixed index stations at the end of the first sampling rotation and 1 out of 3 sites at the end of the second sampling rotation (figures 159 and 160). During the 2002–2007 reporting period, total salmonid biomass (the combined weight of brook trout, brown trout, Chinook salmon, coho salmon, and rainbow trout per surface acre stream) was relatively stable. During the last year of their respective sampling rotations, few index stations were more than 25% above or below the site's average total biomass for the 2002–2007 reporting period (figures 161 and 162). Total salmonid biomass from the most recent survey at 2 of 26 fixed sites sampled during the first rotation was more than 25% greater than the overall average for each location; similarly, 2 sites were more than 25% below their overall average. There were no sites sampled within the second rotation where the most recent survey deviated more than 25% above or below the overall average.

It is not surprising that very little deviation in total salmonid biomass was observed at SSTP fixed sites during this reporting period. Although total biomass (rather than total numbers) is often used as an indicator of overall abundance because is less susceptible to variability from large year-classes of juvenile fish, it can be confounded by site- and species-specific effects such as fish movement and physical habitat. Therefore, we also use smallmouth bass and salmonid abundance patterns on a species-by-species basis using CPE or density (the number of fish per surface acre of water) as a response variable in order to begin discerning annual, year-class specific effects such as flow variability (Zorn and Nuhfer 2007b). Because of these year-class specific effects, we illustrate regional patterns with focus on a single age class (age 1) for all species except Chinook and coho salmon. Since the timing of outmigration for these two salmon species during summer may not always coincide with SSTP sampling, we have excluded them from further descriptions.

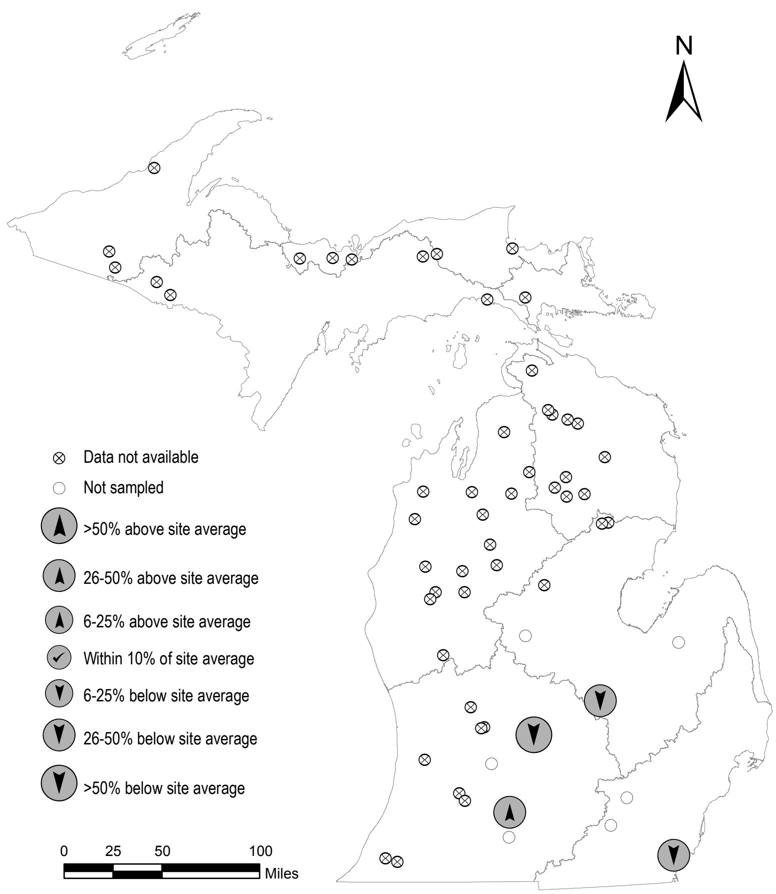

Figure 159.–Most recent estimate of total smallmouth bass relative abundance (pounds per mile) at Michigan fixed sites sampled during rotation 1 relative to the site average for each individual location.

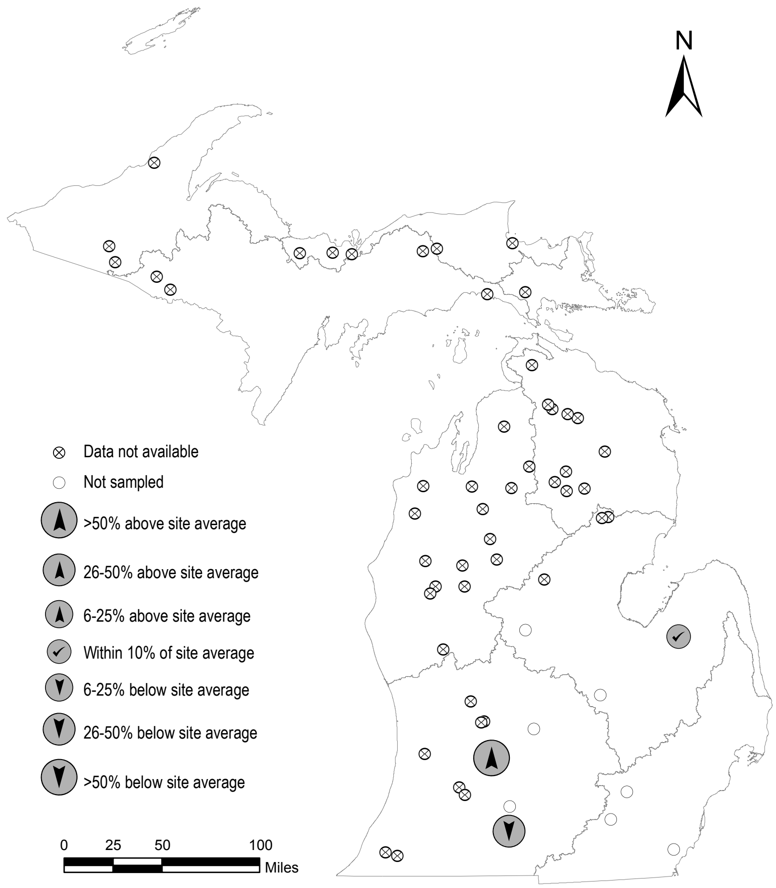

Figure 160.–Most recent estimate of total smallmouth bass relative abundance (pounds per mile) at Michigan fixed sites sampled during rotation 2 relative to the site average for each individual location.

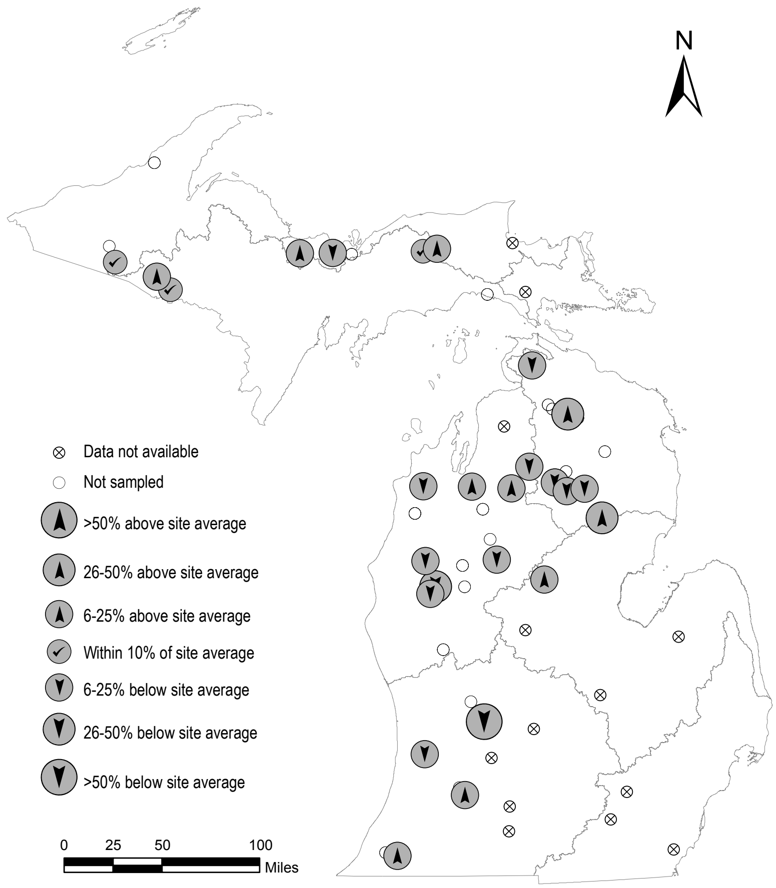

Figure 161.–Most recent estimate of total salmonid abundance (pounds per acre of brook trout, brown trout, Chinook salmon, coho salmon, and rainbow trout combined) at Michigan fixed sites sampled during rotation 1 relative to the site average for each individual location.

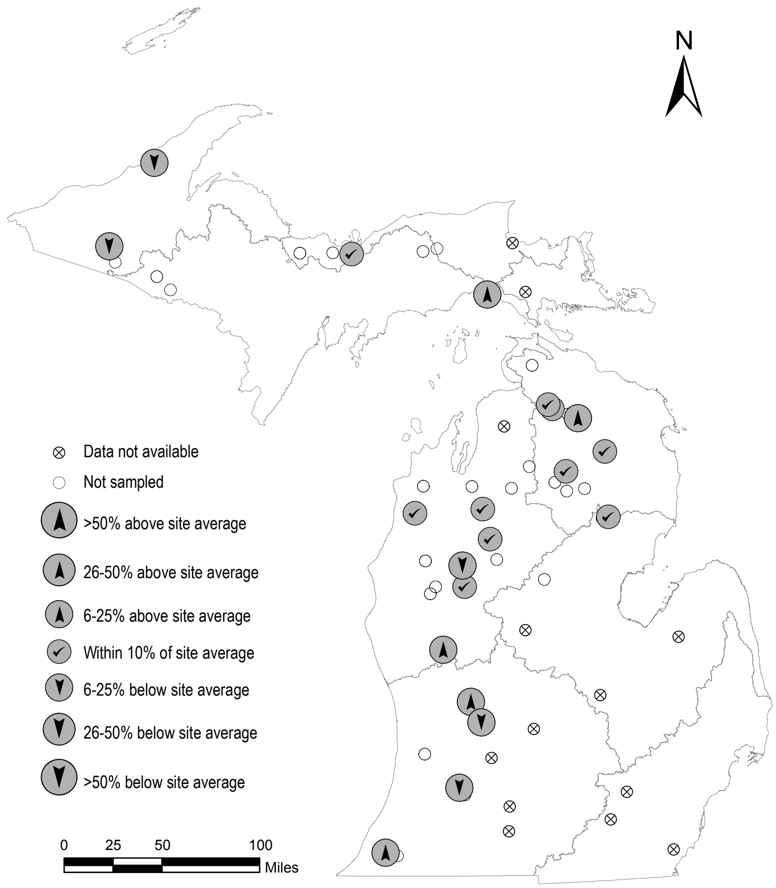

Figure 162.–Most recent estimate of total salmonid abundance (pounds per acre of brook trout, brown trout, Chinook salmon, coho salmon, and rainbow trout combined) at Michigan fixed sites sampled during rotation 2 relative to the site average for each individual location.

The CPE of age-1 smallmouth bass, relative to the overall average for each fixed site, tended to be lower at the completion of the first sampling period while patterns in the density of age-1 trout varied across the state (figures 163–166). In the Lake Superior and northern Lake Michigan basins of the Upper Peninsula the number of age-1 fish at 5 of 7 (71%) brook trout sites and 2 of 3 (66%) brown trout and rainbow trout index stations was near or above the site average for the 2002–2004 time period. In the Lower Peninsula, patterns in age-1 density differed by species. The number of brook trout at 8 of 14 (57%) fixed sites tended to be lower at the end of the first sampling rotation, with the exception of a cluster of index stations in the north-central portion of the peninsula in the central Lake Michigan and northern Lake Huron basins. Although 6 of the 8 sites with lower density were more than 50% below the overall average at each location, all but one has a brook trout population that typically occurs at a very low density (therefore, slight changes in population density can appear large relative to the overall average). Age-1 brown trout density at more than half (58%) of the 19 brown trout sites in the Lower Peninsula tended to be higher at the end of the 2002–2004 time period relative to the overall average; density at 6 of the remaining 8 sites was lower relative to the site average. The number of rainbow trout at the majority (70%) of the ten fixed sites where they occur was low at the end of the first sampling rotation. Only one rainbow trout population in the Lower Peninsula was high relative to the overall site average.

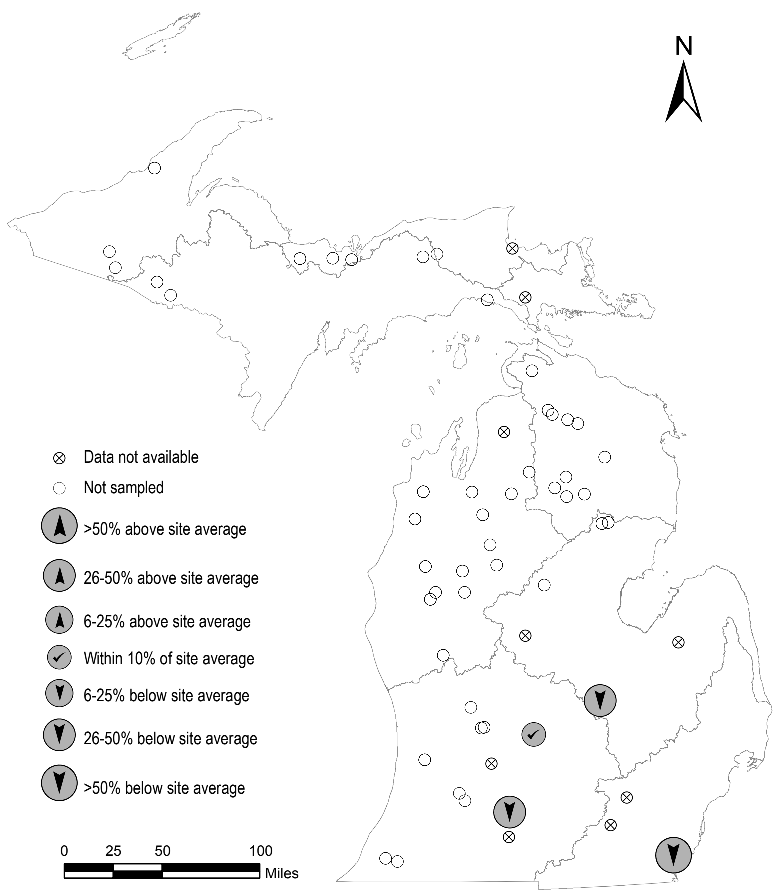

Figure 163.–Most recent estimate of age-1 smallmouth bass relative abundance (number per mile) at Michigan fixed sites sampled during rotation 1 relative to the site average for each individual location.

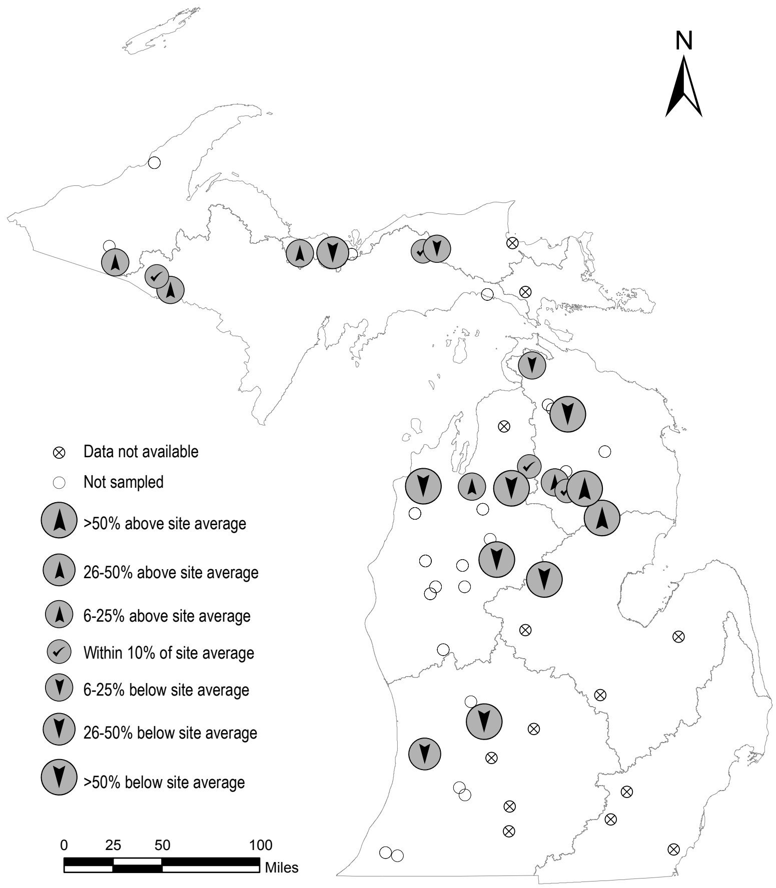

Figure 164.–Most recent estimate of age-1 brook trout abundance (number per acre) at Michigan fixed sites sampled during rotation 1 relative to the site average for each individual location.

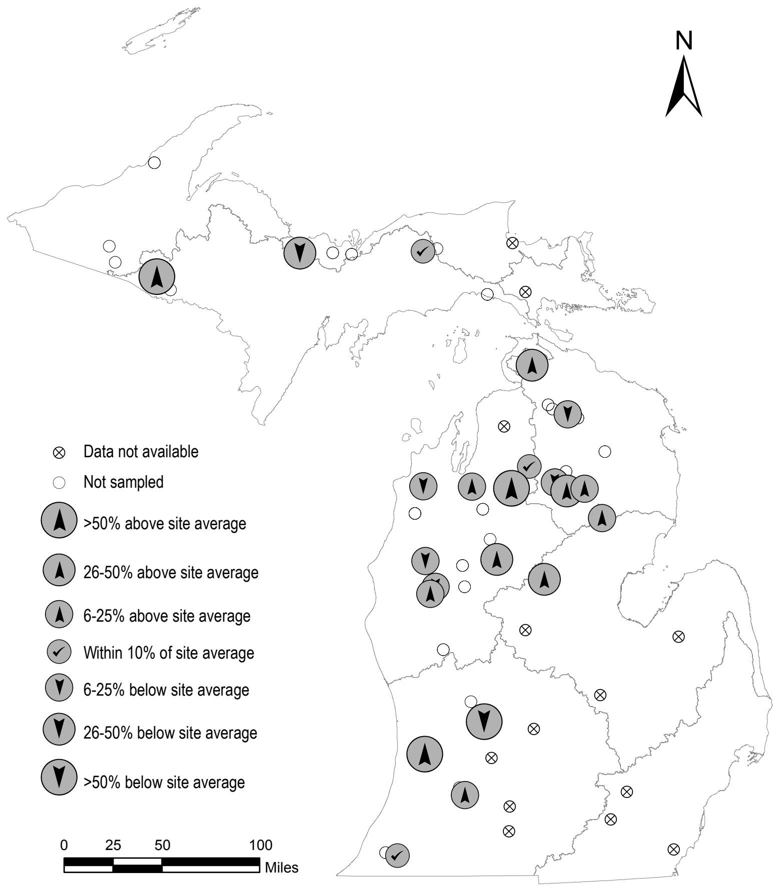

Figure 165.–Most recent estimate of age-1 brown trout abundance (number per acre) at Michigan fixed sites sampled during rotation 1 relative to the site average for each individual location.

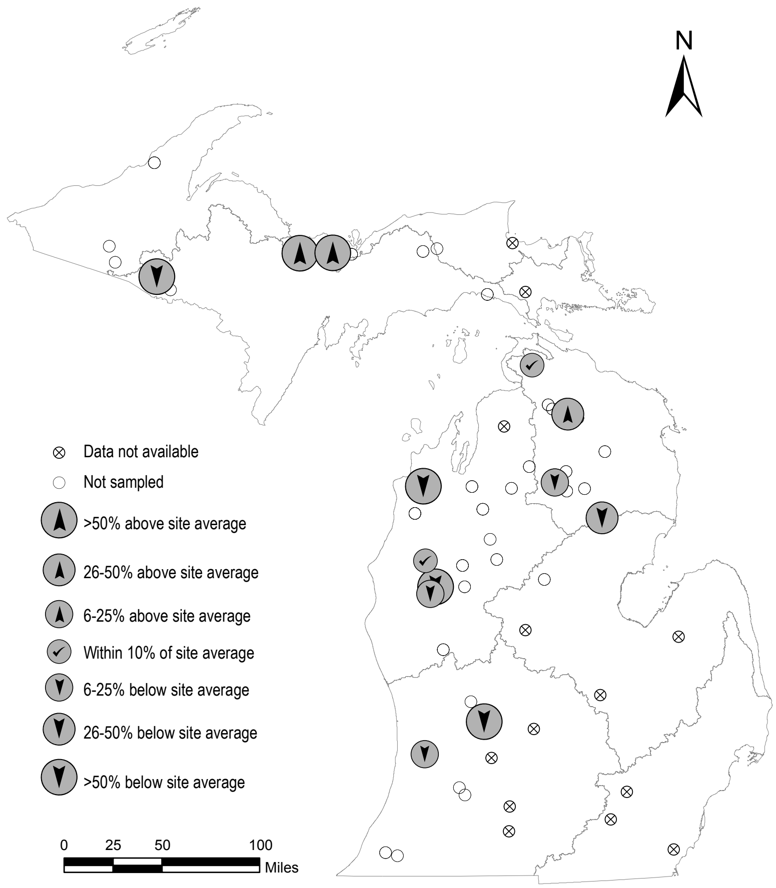

Figure 166.–Most recent estimate of age-1 rainbow trout abundance (number per acre) at Michigan fixed sites sampled during rotation 1 relative to the site average for each individual location.

At the completion of the second sampling rotation, age-1 smallmouth bass CPE continued to be below the site average for 2 of the 3 sites sampled (Figure 167). The number of index stations where age-1 salmonid density was below the overall site average was nearly equal to the number of sites above the site average during the same time period (figures 168–170). Age-1 brook trout density was higher than the 2005–2007 average at 3 of 4 sites (75%) in the Upper Peninsula, but only at 3 of 9 sites (33%) in the Lower Peninsula. No brown trout were encountered at fixed sites in the Upper Peninsula during the second sampling rotation; 7 of 13 sites (54%) in the Lower Peninsula were below the average for each individual location. Index stations where age 1-brook trout and brown trout density was lower than average were clustered in the north-central region of the lower peninsula in the central Lake Michigan and northern Lake Huron basins. For rainbow trout, 2 of the 3 fixed sites in the Upper Peninsula (both in the Lake Superior basin) were below their overall average age-1 density. Slightly more than half (56%) of the nine index stations with rainbow trout in the Lower Peninsula were above their individual site averages. All fixed sites where age-1 rainbow trout were above the site average at the end of the second sampling rotation were located in the Lake Michigan basin.

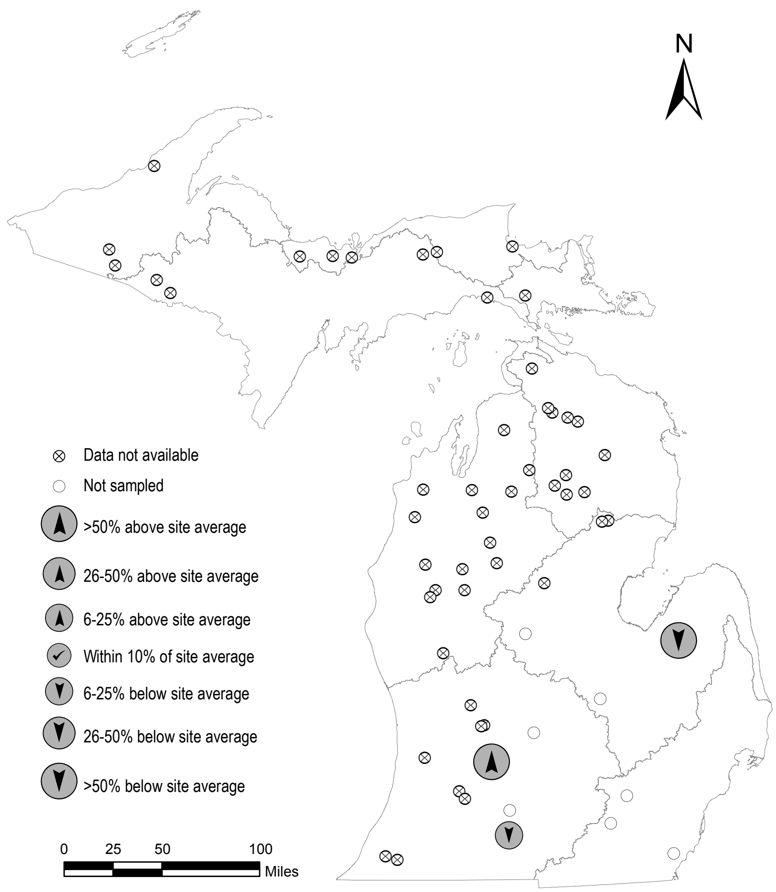

Figure 167.–Most recent estimate of age-1 smallmouth bass relative abundance (number per mile) at Michigan fixed sites sampled during rotation 2 relative to the site average for each individual location.

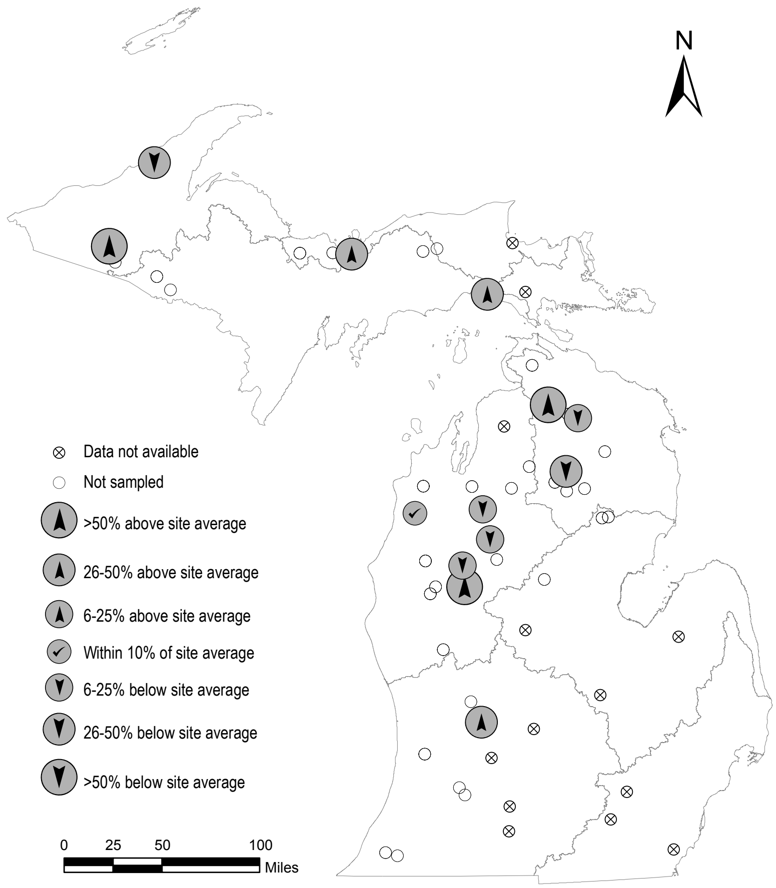

Figure 168.–Most recent estimate of age-1 brook trout abundance (number per acre) at Michigan fixed sites sampled during rotation 2 relative to the site average for each individual location.

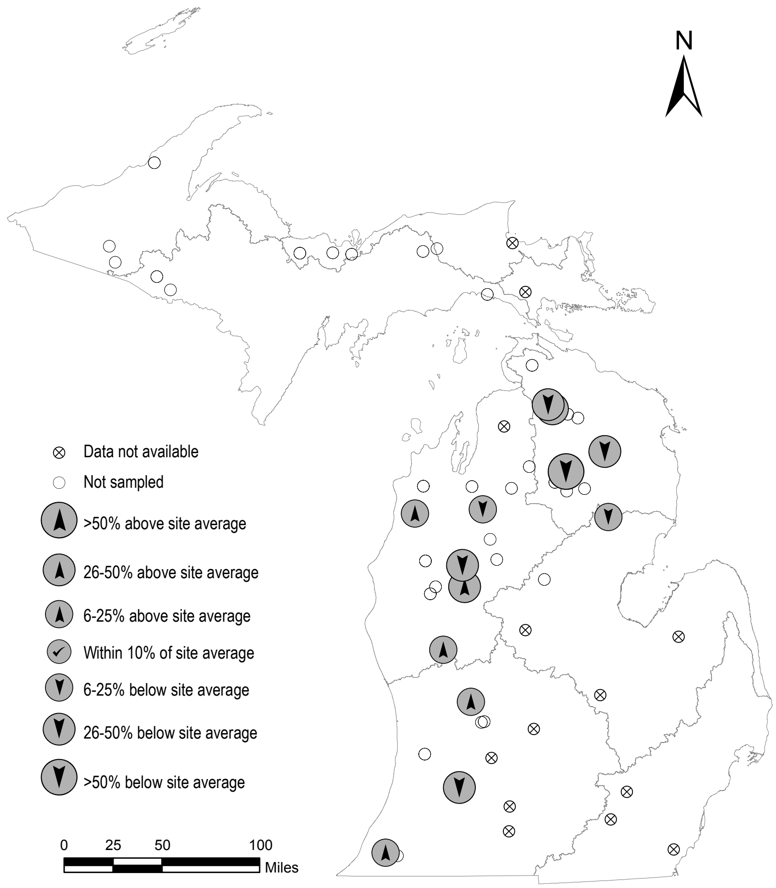

Figure 169.–Most recent estimate of age-1 brown trout abundance (number per acre) at Michigan fixed sites sampled during rotation 2 relative to the site average for each individual location.

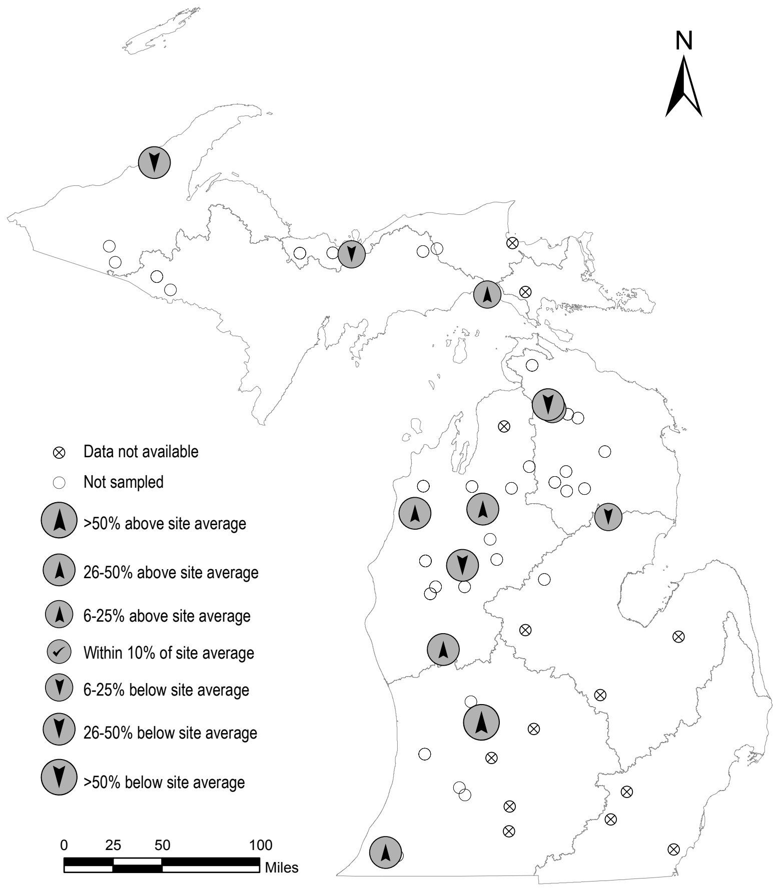

Figure 170.–Most recent estimate of age-1 rainbow trout abundance (number per acre) at Michigan fixed sites sampled during rotation 2 relative to the site average for each individual location.

Any observed decrease in the density of age-1 smallmouth bass or salmonids relative to the 3-year average at each site during the first and second sampling rotations is not an immediate cause for alarm. The limited period of record during this first reporting period precludes rigorous analysis of trends in abundance; the current baseline conditions and continued monitoring during the next reporting period will provide data to better determine the direction of trends (and reasons for their cause) over the past decade. Recent research that includes historical data from a subset of fixed sites currently sampled by the SSTP (nine fixed sites already have more than ten years of historical trout population estimates available; the period of record at four of these sites [Figure 171] begins in 1960 or earlier and includes at least 20 years of measurements) has shown that year-class strength, large woody material abundance, nutrient levels, and variation in climate (e.g., cool summers and warm winters) have all played a role in observed trends (Zorn and Nuhfer 2007a). Given the high level of regional synchrony observed in Michigan's trout populations (Figure 171) and stream flows (Zorn and Nuhfer 2007b), it is not unreasonable to expect predictable patterns in fish abundance due to factors that influence year-class strength, such as spawning adult abundance and high stream flows. For example, the increase in age-1 brown trout density in the north-central portion of the Lower Peninsula observed at the completion of the first sampling rotation (Figure 165) may be linked to relatively low spring streamflows during 2003 (U.S. Geological Survey 2009), when the fish were emerging from redds as fry. Knowledge and description of such regional synchrony in Michigan's valuable stream fisheries, as well as the factors responsible for their causes, will allow fisheries managers to better address current problems and plan for future threats.

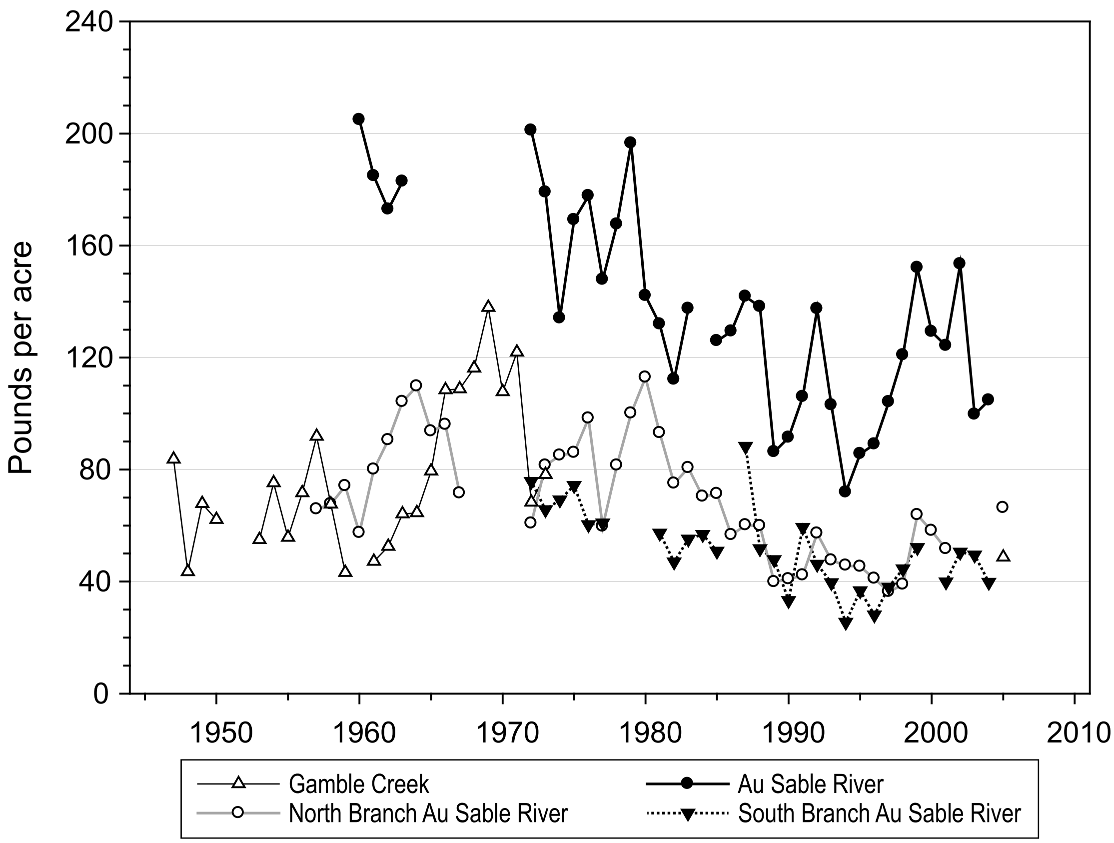

Figure 171.–Total salmonid abundance (brook trout, brown trout, Chinook salmon, coho salmon, and rainbow trout combined) in Gamble Creek and the Au Sable, North Branch Au Sable, and South Branch Au Sable rivers, 1947–2007.

Concluding Remarks

The Status and Trends Program provides valuable information needed for science-based resource management. Habitat and fish community data collected using standardized sampling methods enables resource managers to make ecosystem-level comparisons among water bodies and to the statewide reference points presented in this report. These data provide the foundation for interpreting field observations, identifying limiting factors, and developing defensible management recommendations. As collection of assessment data continues into the future, the value of status and trends information will only increase. Aquatic systems are responsive to many factors and exhibit considerably variability over time. Long-term data collection will enable resource managers to determine how variable aquatic systems are, identify the regional and temporal factors that control this variability, and distinguish the influence of natural processes from human activities.

Continued assessment and communication of the status and trends of Michigan's streams is a necessity given the growing list of environmental issues that will potentially threaten aquatic resources. For example, changes in stream habitats resulting from increased sedimentation of pools and loss of large woody debris resulting from dam failure, eroding road-stream crossings, residential and urban development, or poor forestry and agriculture practices is of great concern to resource managers and users alike. Invasive species are already competing with native organisms for food and habitat in Michigan's streams. Threats from future introductions of invasive species on the verge of entering the Great Lakes watershed, or those that are yet unknown, may also affect aquatic communities. Climate change is projected to affect aquatic ecosystems through changes in thermal regimes and hydrological cycles (U.S. Environmental Protection Agency 2008). Because temperature is one of the most important factors determining the occurrence and distribution of stream fishes, the distribution and abundance of fishes, especially cold and coolwater species, are expected to change in response to climate warming. Comparing and contrasting changes in a number of independent, concurrently sampled streams throughout Michigan will provide insights into cause and effect relationships between these potential threats and fish community structure.

Michigan's streams and their diverse aquatic communities are a valuable resource in need of wise management. Such management requires understanding the processes that shape stream communities as well as recognition and response to future threats that originate from growing human populations and the increased pressure they exert on aquatic resources. Habitat changes resulting from barriers, poor land use practices, invasive species, and climate change have the potential to alter fish communities and habitat in streams and reduce the societal benefits that these systems provide. Awareness of such threats and continued long-term assessment by the SSTP will ultimately lead to management practices designed to reduce or mitigate these threats, ensuring that Michigan's streams are wisely managed well into the future.

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