

An Illinois  
**Species Status Assessment**  
for  
**Mottled Sculpin**



Mottled Sculpin Recovery Team  
and  
Illinois Department of Natural Resources

**February 2022**

## SECTION 1. SPECIES DESCRIPTION

### Physical Characteristics and Ecology

Mottled Sculpin *Uranidea bairdii* is a small (to 15 cm) benthic fish in the family Cottidae. It inhabits relatively clear and cool waters with large substrates. It feeds primarily upon aquatic insect larvae, but also crustaceans, fish, and fish eggs. Most studies observe limited maximum and mean dispersal distance and relatively small home range. It may be intolerant of sedimentation and high temperature.

### Taxonomic Notes

The accepted scientific name for Mottled Sculpin is *Uranidea bairdii* (Kinziger et al. 2005, Metzke et al. 2022), although the Illinois Endangered Species Protection Board uses the former name *Cottus bairdii*.

## SECTION 2. QUALITATIVE CONSERVATION STATUS ASSESSMENTS

Mottled Sculpin conservation status has been synthesized at multiple spatial scales using qualitative assessment frameworks (Table 1).

**Table 1. Global, regional, and state conservation status of Mottled Sculpin.**

<b><u>Assessment</u></b>	<b><u>Status</u></b>
Global Rank (G-rank) <sup>1</sup>	G5 (secure)
Midwest Species of Greatest Conservation Need <sup>2</sup>	Not a SGCN
State Rank (S-rank), 2019 <sup>3</sup>	S2S3 (imperiled or vulnerable)
State Rank (S-rank), revised 2022 <sup>4</sup>	S3 (vulnerable)
Illinois Conservation Status <sup>4</sup>	Threatened

1. NatureServe (2022)

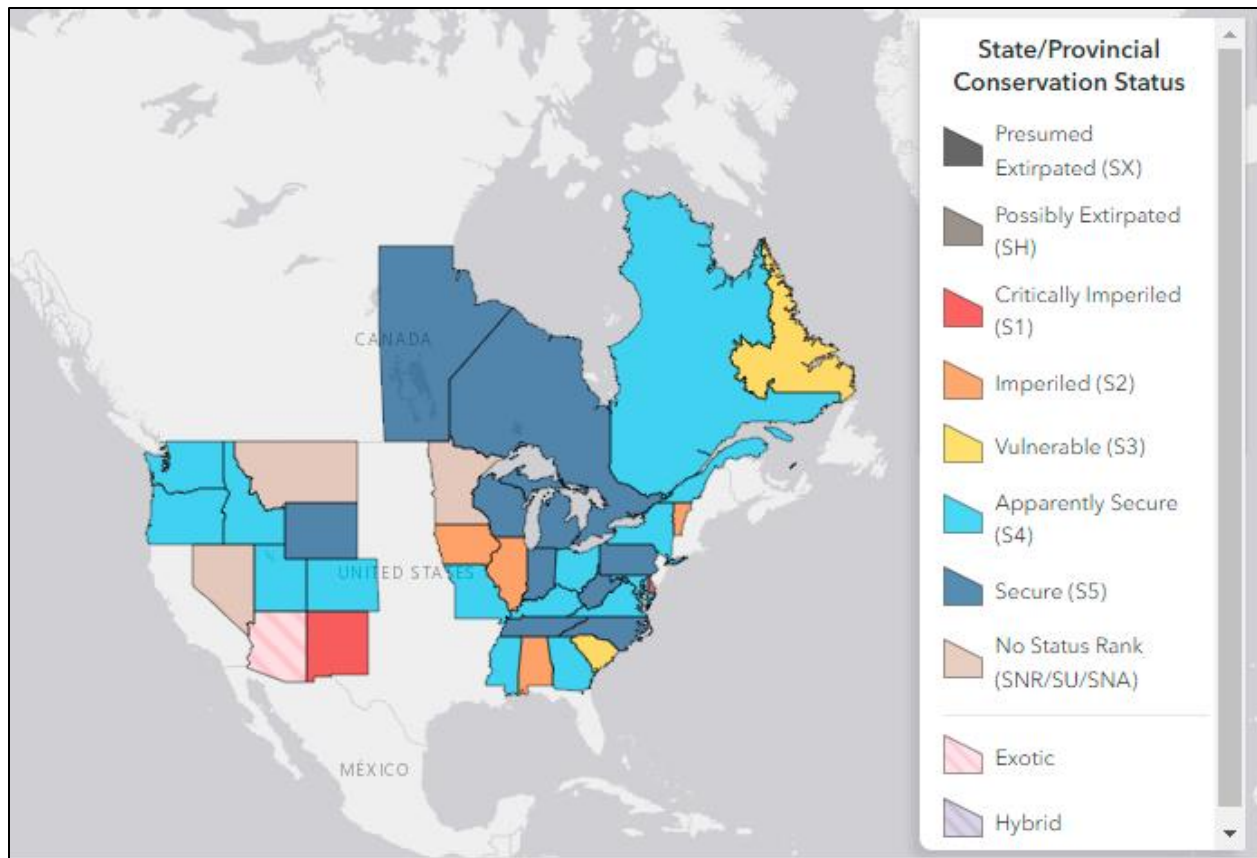
2. Terwillger Consulting (2021)

3. Feng et al. (2021). Assessment conducted using data through 2018.

4. Assessed using NatureServe (2015) guidance and incorporating records through 2021. See details below and Table 2.

5. Illinois Endangered Species Protection Board 2020

Mottled Sculpin is not a species of conservation concern globally or regionally. It is considered vulnerable, imperiled, or critically imperiled in eight of the 35 states and provinces where it occurs (Figure 1, NatureServe 2022). In 2020 the Illinois Endangered Species Protection Board (ESPB) added Mottled Sculpin to the Endangered and Threatened Species list. Per the listing petition presented to the ESPB, listing criteria met by the species includes restricted habitats and low populations, and disjunct populations. Feng et al. (2021) assessed the S-rank for the species as S2S3 (imperiled or vulnerable). The S-rank was reassessed with records collected more recently than those used for Feng et al. (2019) using guidance in NatureServe (2015). Range extent, area of occupancy, number of occurrences, and short-term trends in distribution were evaluated using records collected between 2011 and 2021. The S-rank for Mottled Sculpin is S3 (vulnerable; Table 2).



**Figure 1. State-ranks (S-ranks) for Mottled Sculpin (NatureServe 2022). The Illinois S-rank in this figure was assessed prior to Feng et al. (2021) using alternative methodologies.**

Between the Feng et al. (2019) S-rank assessment and this reassessment the number of occurrences factor improved one rank. This is likely due to additional survey effort rather than an increase in distribution.

**Table 2. Reassessment of Mottled Sculpin S-rank using a record period of 2011-2021.**

<b><u>Factor</u></b>	<b><u>Value</u></b>	<b><u>Factor Rank Category*</u></b>	<b><u>Factor Rank Description</u></b>
Range Extent (km <sup>2</sup> )	10,712	E	
Area of Occupancy (1km <sup>2</sup> cells)	31	D	
Number Occurrences (extant EOs)	26	C	
Threats <sup>1</sup>	6	AC	Very high severity and scope of threats, medium species vulnerability to threats.
Short-term Trends (10 years, occupancy of cells)	+68%	I	Increase >25%.

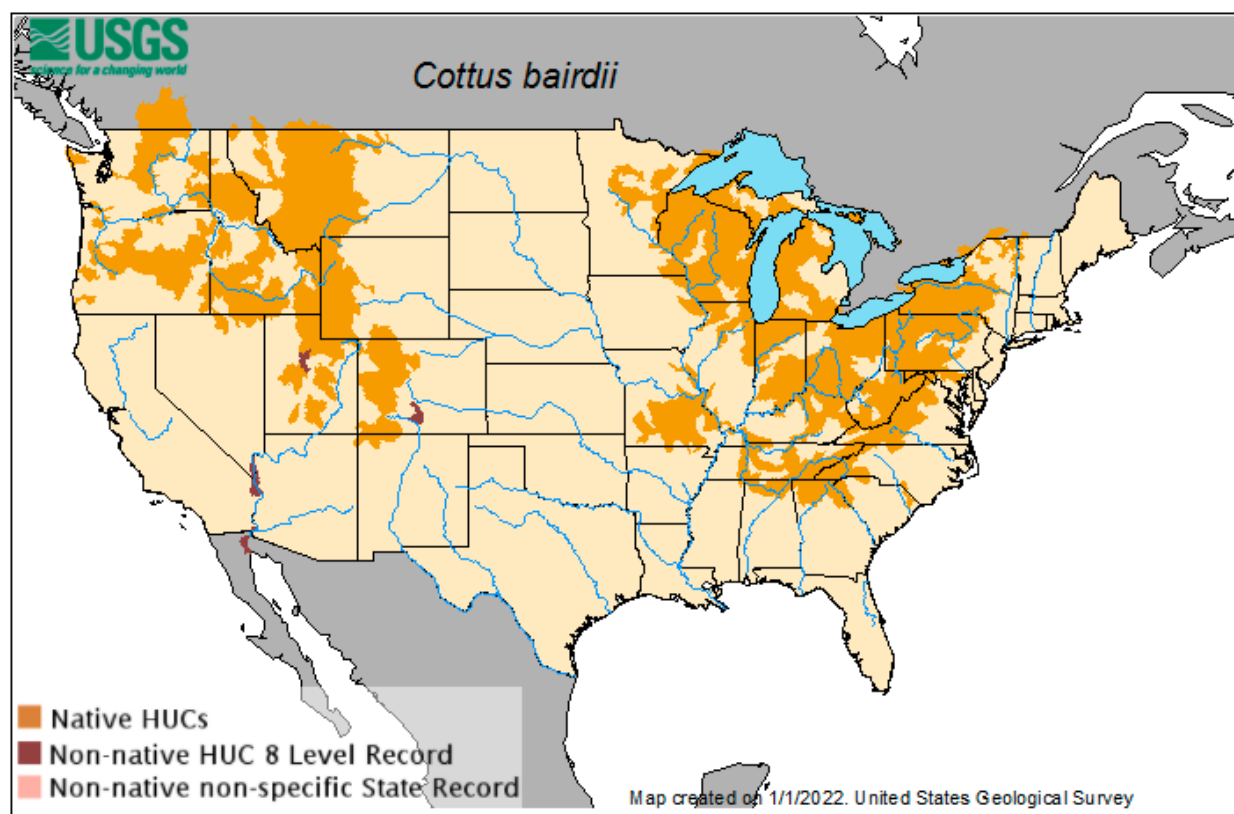
\*higher letters indicate better category.

<sup>1</sup>Illinois Department of Natural Resources 2015

## SECTION 3. DISTRIBUTION

### North American Range and Status

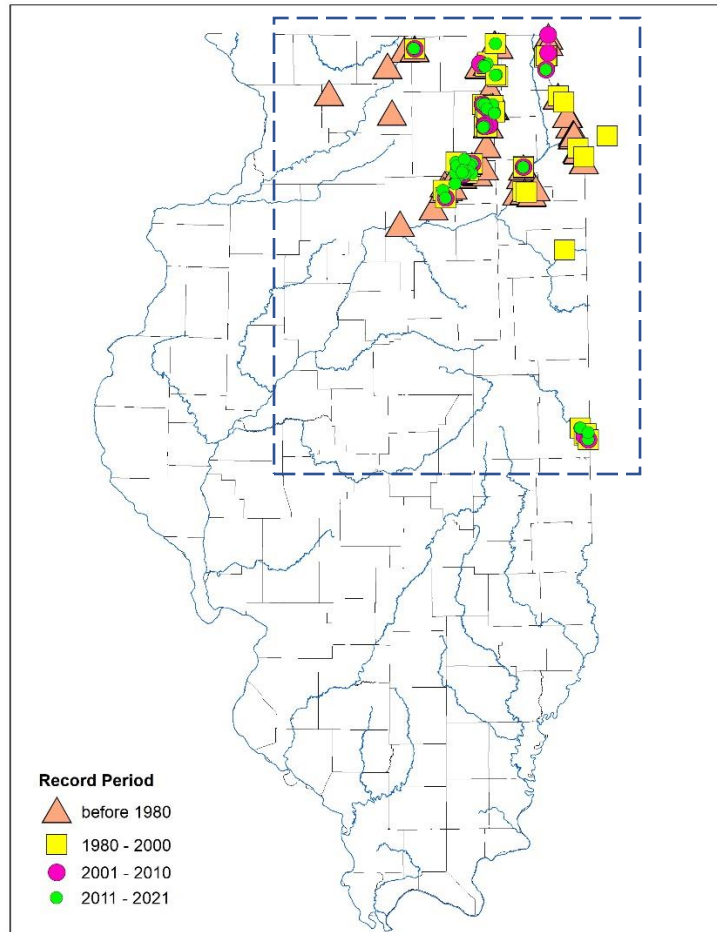
Mottled Sculpin is native to the Pacific Northwest, central and northern Rocky Mountain region, Appalachian region, northern Ozark region, and Great Lakes region of the U.S. and Canada (Figure 2). The species has been introduced to parts of northern Mexico, New Mexico, Colorado, and Utah where it is considered exotic.



**Figure 2. Hydrologic Unit Code 8 (HUC-8) distribution map for Mottled Sculpin (Fuller and Neilson 2022).**

### Illinois Distribution

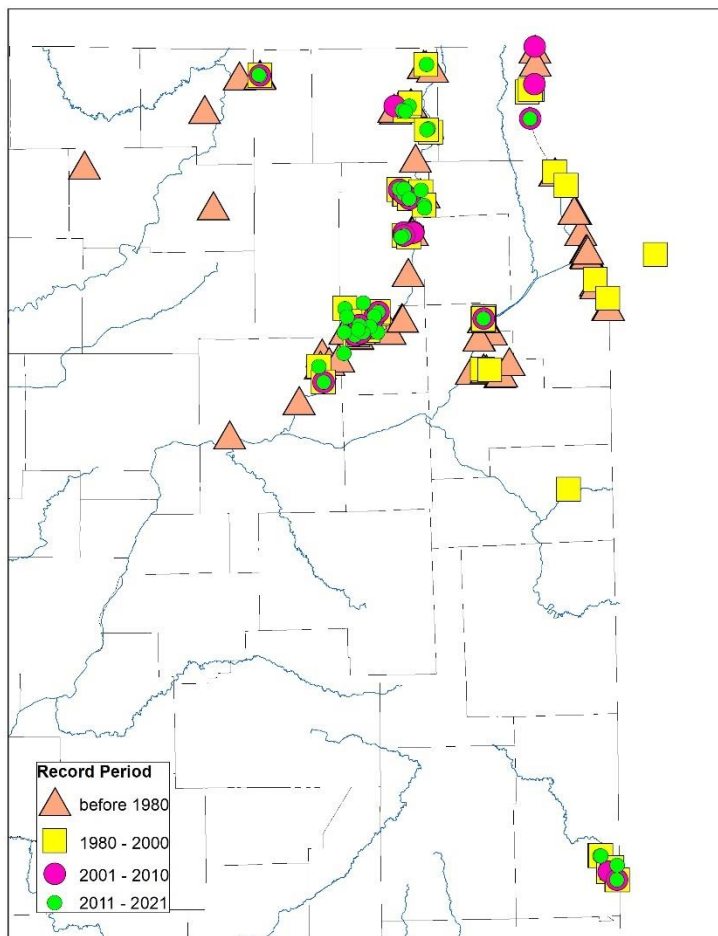
The historic range of Mottled Sculpin in Illinois included Lake Michigan, the Des Plaines River basin, the Fox River basin, the upper Illinois River basin, the Kankakee River basin, the Rock River basin, and the Vermilion River of the Wabash River basin (Figure 3).



**Figure 3. Occurrence records for Mottled Sculpin in Illinois. Sources include Illinois DNR Fisheries Database and Lake Michigan database, Illinois Natural History Survey Fish Collection database, Illinois DNR Natural Heritage database, McHenry County Conservation District, Forest Preserve District of Cook County, Willink (2017), and Metzke et al. (2022). Record periods are the most recent decade of survey records (2011-2021), the previous decade (2001-2010), records prior to 2001, but within the modern survey era (1980-2000), and records prior to the modern survey era (before 1980).**

Mottled Sculpin distribution in Illinois has decreased in extent (i.e., the species' range) over the history of occurrence records (Figure 3, Figure 4). The most recent occurrence record for Mottled Sculpin in Lake Michigan is from 2015 (Illinois Natural History Survey, Zion Field Station, survey records). In 2014 the species was recorded off the shore of Lake Bluff, and at the Waukegan Generation Station in 2005. Records were more frequent and widespread in Lake Michigan prior to 2001. It is likely Mottled Sculpin is extirpated from the Illinois portion of Lake Michigan given it has not been recorded in seven years and that a large amount of survey effort occurs in the lake. In the Des Plaines River watershed the species is extant in only one stream and appears extirpated from two others despite repeated surveys (Willink 2017). The species was recorded in one tributary of the Kankakee River in 2001, but recent surveys failed to detect it (Willink 2017). Mottled Sculpin had been recorded in four streams in the Rock River basin, but Willink (2017) failed to detect it at three of those four streams. Mottled Sculpin was recorded

in one tributary of the Illinois River, but repeated surveys, including one high-effort survey in 2020, have failed to detect the species. Most Mottled Sculpin occurrence records are in the Fox River basin. Although the species appears extirpated from several streams in the basin, new records have occurred in multiple streams, including several in the past decade. The species also is found in several tributaries of the Vermilion River (Wabash) basin. It is likely the species exists in other small tributaries of the Fox and Vermilion River basins as many of these streams are not surveyed.



**Figure 4. Inset (Figure 3).**

Metzke et al. (2012) reported Mottled Sculpin exhibited a decreasing distribution when counting the number of Hydrologic Unit Codes level 8 (HUC-8s) occupied by the species when comparing records collected between 2000 and 2010 to those collected between 1977 and 1999. Using a similar coarse-resolution approach to evaluating distribution, between the 2001 to 2010 period and the 2011 to 2021 period Mottled Sculpin have decreased in distribution (six HUC-8s vs five HUC-8s, respectively).

#### Limitations of Surveys and Occurrence Records

Mottled Sculpin typically inhabit small streams which are underrepresented by survey programs (e.g., Illinois Environmental Protection Agency [IEPA] Basin Surveys) and so streams with suitable habitat may

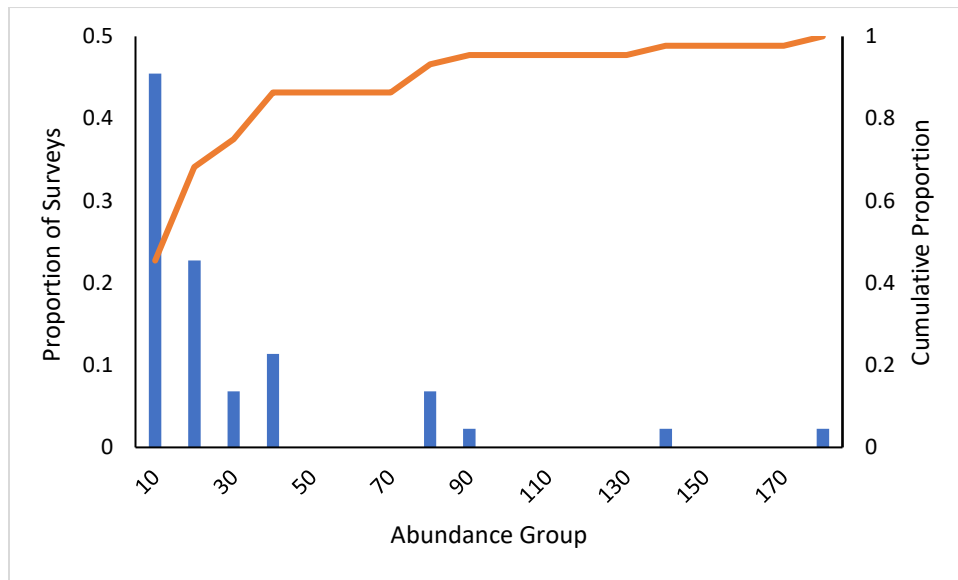
not be surveyed. New (2020 and 2021) occurrence records from four previously unsurveyed streams exemplify this gap in information for small streams that may harbor Mottled Sculpin. The exception may be Lake Michigan where several agencies and institutions conduct surveys in areas of the lake where suitable habitat is likely to be present and at a frequency that is likely sufficient for detecting the species. Overall, caution should be used when interpreting spatiotemporal distribution patterns given the incomplete nature of occurrence information and the biases that exist within those data which are available.

## SECTION 4. ABUNDANCE

### Site Abundance

Although 81 Mottled Sculpin occurrence records include abundance information, these records vary in which effort measure was recorded. Records with abundance information were placed into one or more groups based on effort measure: basin survey, survey length, or survey area.

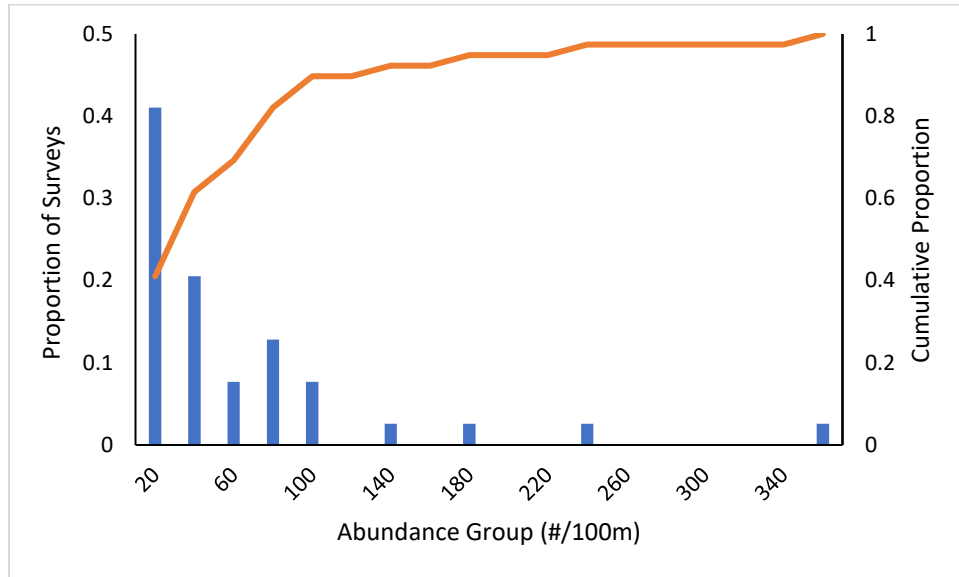
Illinois Department of Natural Resources (IDNR) survey stream fish assemblages as part of the IEPA Basin Survey Program. These surveys use electrofishing to collect fishes in a stream reach that is approximately the greater of twenty times the wetted stream width or 300 feet. Forty-four Basin Survey samples conducted between 1982 and 2013 recorded Mottled Sculpin. The mean abundance of Mottled Sculpin in these surveys is 26.2 per survey reach, median is 14.5, and range is 1-171 (Figure 5).



**Figure 5. Frequency distribution of Mottled Sculpin abundance recorded from IDNR Basin Surveys.**

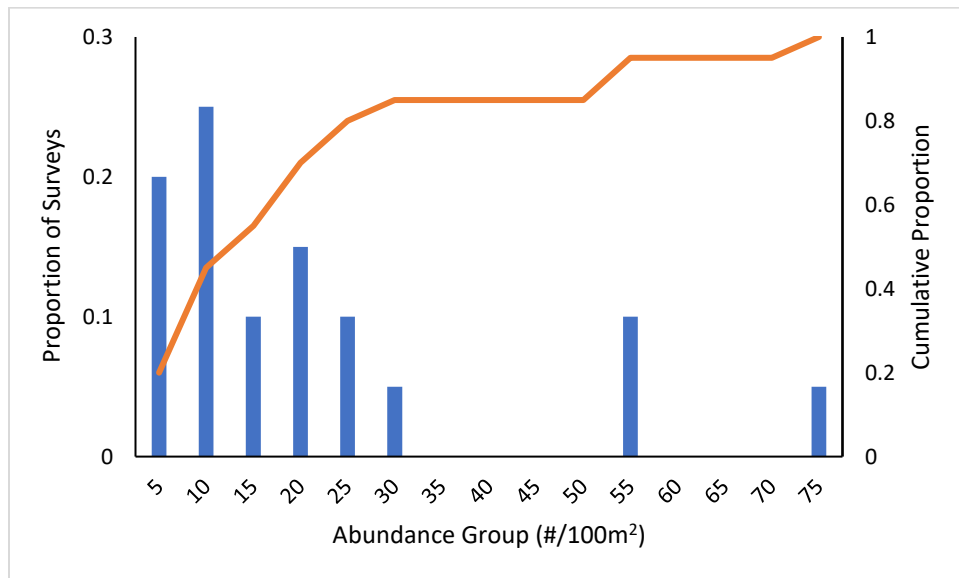
Sample length was recorded for 39 surveys conducted by IDNR, Cook County Forest Preserve District, and the McHenry County Conservation District. All surveys used electrofishing gear. Although stream width varies among surveyed streams, length measures can be used to estimate Mottled Sculpin

density. Mean Mottled Sculpin density is 51.9 per 100m of sample length, median is 28.2/100m, and the range is 1-345/100m (Figure 6).



**Figure 6. Frequency distribution of Mottled Sculpin density measured as number of individuals collected per 100m of sampled stream.**

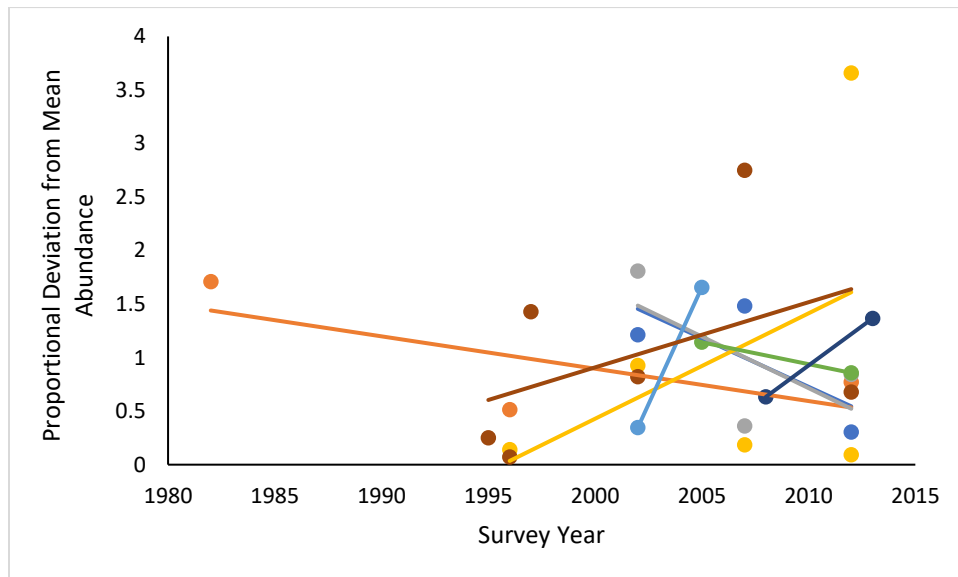
Sample area was recorded for 20 surveys conducted by IDNR and was used to estimate Mottle Sculpin density. Mean Mottled Sculpin density is 18.5 individuals per 100m<sup>2</sup>, median is 11.7/100m<sup>2</sup>, and range is 0.8-71.3/100m<sup>2</sup> (Figure 7).



**Figure 7. Frequency distribution of Mottled Sculpin density measured as number of individuals collected per 100m<sup>2</sup> of sampled stream.**



Many locales with Mottled Sculpin abundance records have been surveyed multiple times and so temporal trends in abundance can be evaluated and variation in site-specific abundance can be estimated. Eight Basin Survey sites have been sampled in multiple years. The Rock River basin, Fox River basin, and Vermilion River (Wabash) basin are represented by these sites. Proportional deviation from mean abundance was calculated for each sample within each survey site and a linear trendline was fit to those points to visualize coarse trends in abundance over time. Half of the repeatedly sampled survey sites exhibited a positive temporal trend and half a negative trend (Figure 8), so no statewide pattern of change in abundance can be discerned. Six of the evaluated survey sites are within the Fox River basin, and of those sites half exhibited positive abundance over time and half negative.

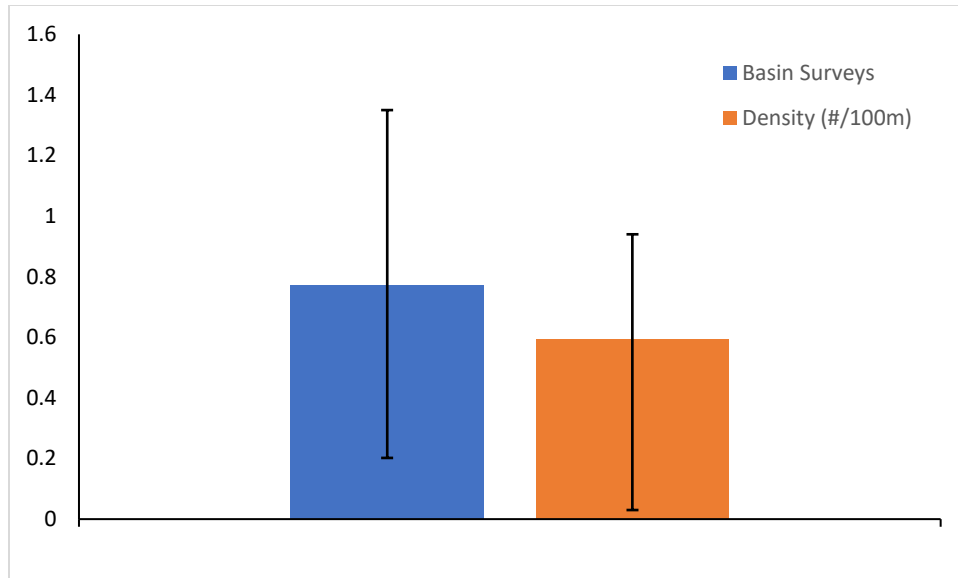


**Figure 8. Proportional deviation from the mean site-specific abundance using Basin Survey sites. Each color (dots and trendline) represent a single survey site that was sampled multiple times.**

Variation around a mean can be measured using the Coefficient of Variation (CV), which is calculated as the standard deviation of site-specific abundance divided by the site-specific mean abundance. The larger the CV value the greater the relative variation in abundance records. Eight IDNR Basin Survey sites have been sampled more than once (mean number of surveys per site = 3.25, range = 2-5), and mean CV of abundance per survey reach is 0.77 (Figure 9). Density (individuals/100m) could be calculated at seven sites with multiple surveys over time (mean number of surveys per site = 3.0, range = 2-5). Mean CV of abundance for these sites is 0.59 (Figure 9). CV values for both measures of abundance indicate relatively high temporal variation in abundance.

#### Population and Statewide Abundance

Mottled Sculpin populations have not yet been identified and so no abundance estimates may be attempted. No reasonable estimate of total Mottled Sculpin abundance in Illinois is possible given the limitations of existing distribution and abundance records.



**Figure 9. Mean (and range) coefficient of variation for abundance at survey sites sampled multiple times. Bars depict range in coefficient of variation.**

## **SECTION 5. POPULATION VIABILITY**

### Population Delineation

No estimates of dispersal between survey sites or streams has been attempted for Mottled Sculpin in Illinois, nor is general ecological knowledge of the species sufficient for estimating dispersal patterns. Accordingly, no reasonable delineation of Mottled Sculpin populations has been proposed. It is likely the Rock River basin, Fox River basin, and Vermilion River (Wabash) basin individuals are isolated from each other, and Willink (2017) suggests the Rock River individuals are a different subspecies than those of other inland waters. But, further within-basin spatial grouping of individuals may occur only with greater refinement of dispersal, such as with mark-recapture studies or evaluation of spatial patterns in genetic heterogeneity.

### Element Occurrence Ranks

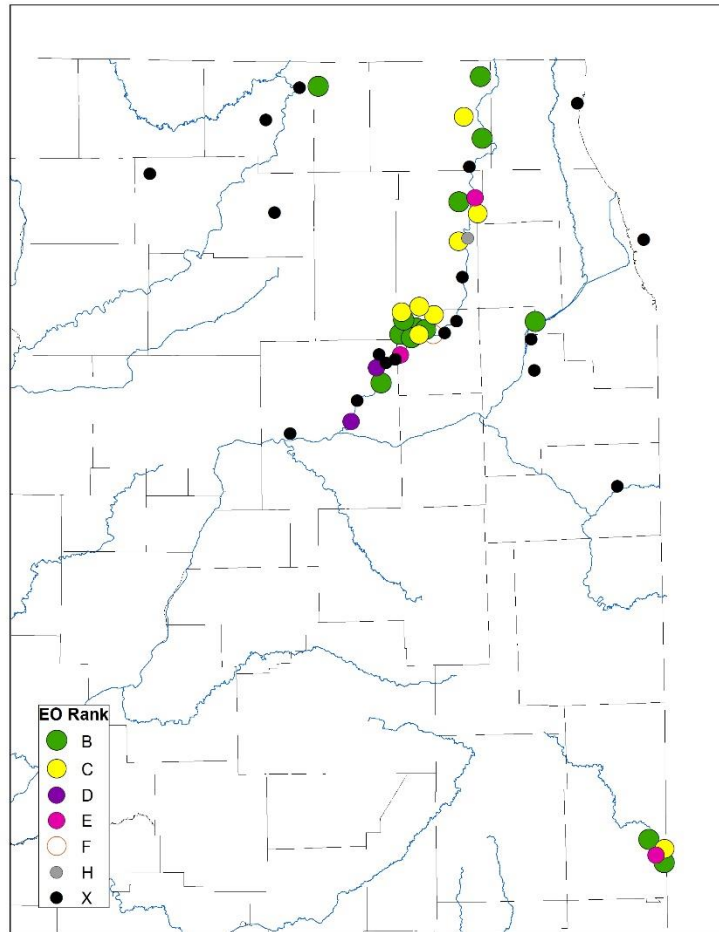
Element Occurrences (EOs), or occurrence records grouped by proximity, can be used as surrogates for populations. NatureServe provides guidance for ranking the viability, or likelihood of continued persistence over the next 20-30 years, of EOs (Hammerson et al. 2020). Forty-seven Mottled Sculpin EOs are in Illinois (Table 3, Figure 10). Nineteen EOs are presumed or confirmed extirpated. One EO is ranked “failed to find”, indicating recent surveys did not detect Mottled Sculpin, but other evidence suggests its continued persistence. One EO is ranked “historic” meaning the most recent occurrence record is more than ten years old, but the species is presumed extant. Three EOs are ranked “extant” meaning the species has been recorded within the past ten years, but further information is not available and so the

EO could not receive a more detailed rank. Two EOs are ranked D (poor viability), eight are C (fair viability), and 13 are B (good viability). Of those extant EOs, at least 0.75 have at a fair or better likelihood of persisting for the next 20-30 years.

**Table 3. Mottled Sculpin Element Occurrence (EO) ranks.**

<u>EO ID</u>	<u>EO_NUM</u>	<u>EO Name</u>	<u>Last Survey Date</u>	<u>EO Rank</u>	<u>Justification*</u>
11956	1	Big Rock Creek	2021	B	Multiple moderate density/abundance samples over long period of time. Large spatial extent of EO. Some development that could threaten long-term persistence.
12366	15	Black Partridge Creek	2021	B	Moderate density/abundance. Light watershed development, protected site.
not listed		Blackberry Creek	2013	F	Failed to find, but not yet presumed extirpated. Not found in 2014, or prior to 2013.
11961	6	Boone Creek	2020	C	Mixed density/abundance. In moderate urban area.
new		Dayton Bluffs unnamed stream	2021	D	Two samples that observed just one individual each. Small stream that may dry periodically.
11959	4	Ferson Creek	2021	C	Mixed density/abundance, including a did-not-detect. In moderate urban area.
12336	14	Grape Creek	2020	B	Moderate to high density. Light watershed development.
12446	16	Harvey Creek	2020	B	Density unknown, but abundance very high (>95th percentile). Some watershed development may threaten EO.
not listed		Hickory Creek	1997	X	Extirpated
new		Horse Fair Creek	2020	B	Moderate density/abundance. Light watershed development.
not listed		Indian Creek	1978	X	Presumed extirpated
12249	11	Kinnikinnick Creek	2020	B	Multiple moderate density/abundance samples over long period of time. Unknown extent of EO due to insufficient sampling. Isolated from other populations.
not listed		Kinnikinnick Creek downstream	1948	X	Last recorded in 1948.
not listed		Lake Michigan	2005	X	Last record in 2015, but presumed extirpated. Note - all Lake Michigan EOs lumped into this EO.
not listed		Leaf River	1978	X	2016 survey failed to find. Last recorded in 1948.
11957	2	Little Rock Creek downstream	2012	B	Mixed density/abundance. In light urban area, but close to other EOs.
11958	3	Little Rock Creek mid	2012	C	Multiple low density/abundance samples over long period of time. Some development that could threaten long-term persistence.
new		Little Rock Creek upstream	2021	B	Moderate density. Some development of watershed.
not listed		Long Run	1955	X	Presumed extirpated
not listed		McFadyen Branch	1948	X	2016 survey failed to find. Last recorded in 1948.
not listed		Mission Creek	2021	B	Moderate density/abundance. Light watershed development.
not listed		Morgan Creek	1978	X	Presumed extirpated
12250	12	Norton Creek	2009	H	No samples for 12 years.
not listed		Percumsaugan Creek	1962	X	2020 survey did not detect. Not found since 1962.
11963	8	Poplar Creek and Bluff Spring Fen	2021	C	Mixed density/abundance. In moderate urban area.
new		Rob Roy Creek downstream	2021	C	Low to Moderate density. Moderate watershed development.
new		Rob Roy Creek mid	2021	B	Moderate to high density. Moderate watershed development.
11964	9	Rob Roy Creek upstream	2021	C	Low to Moderate density. Increasing watershed development. No juveniles captured.
11962	7	Silver Creek	2020	B	Moderate to high density. Moderate watershed development.
11965	10	Somonauk Creek	2012	D	Very low density. Stream not sampled since 2012.
not listed		Somonauk River upstream	1956	X	Presumed extirpated
not listed		South Branch Waukegan River	1995	X	Failed to find in 2000, 2001, 2002, 2006
not listed		Stillman Creek	1948	X	2016 survey failed to find. Last recorded in 1948.
not listed		Tower Creek	2000	X	Presumed extirpated. Did not find in 2016.
11960	5	Tyler Creek	2021	B	Mixed density/abundance, but core area stable and abundant. Watershed experiencing development.
not listed		unknown Fox River basin	1978	X	Presumed extirpated
not listed		unknown Fox River basin	1978	X	Presumed extirpated
not listed		unknown Fox River basin	1978	X	Presumed extirpated
not listed		unnamed trib to Fox River	2014	E	Extant. No data associated with specimen, but record is recent
not listed		unnamed trib to Fox River	2016	E	Extant. No data associated with specimen, but record is recent
not listed		unnamed trib to Fox River	1978	X	Presumed extirpated
not listed		upstream Big Rock Creek	2021	C	Low abundance/density. Light watershed development.
not listed		Waubensee Creek	1976	X	Presumed extirpated
not listed		Waukegan River	1995	X	Failed to find in 9 surveys since 1995.
12335	13	Whippoorwill Branch	2020	B	Moderate density/abundance. Light watershed development.
new		White Branch	2021	C	Moderate density, but small stream vulnerable to drying.
not listed		Willow Creek	2006	E	Only surveyed once.

\* Density and abundance categories based on frequency distribution of relative abundance or density estimates. Watershed development used as surrogate for threat intensity.

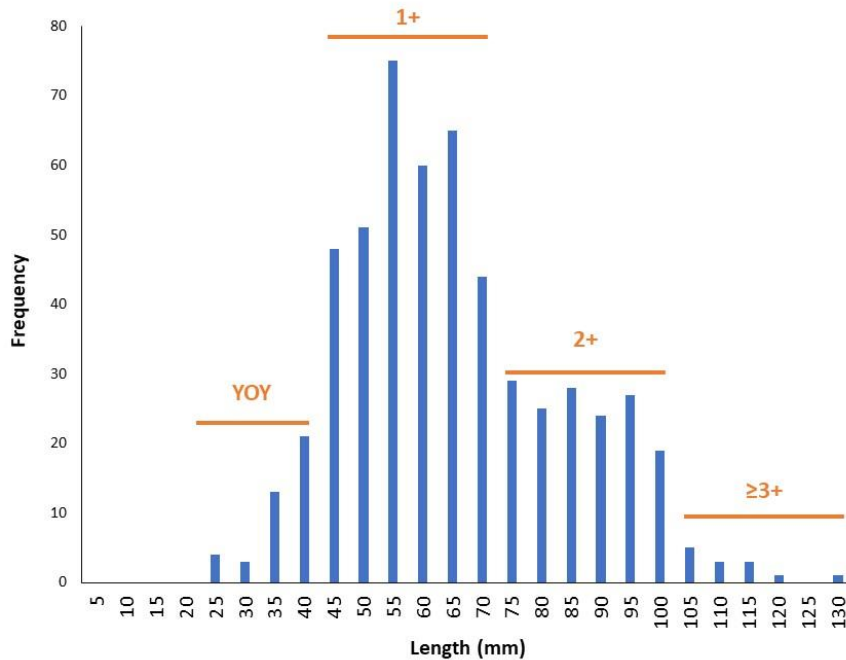


**Figure 10. Mottled Sculpin Element Occurrence (EO) Ranks.**

### Demographic Evaluation

Total length of 549 Mottled Sculpin collected during 2020 and 2021 surveys was measured. Minimum recorded length was 20mm and maximum was 121mm. The frequency distribution of total length indicates presence of multiple cohorts (Figure 11): one with a mean of approximately 30mm (young-of-year individuals), one with a mean of approximately 60mm (1+ aged individuals), one with a mean of approximately 90mm (2+ aged individuals), and those greater than 100mm (3+ and older individuals). Bailey (1952) observed young-of-year individuals had a mean length of 31mm in fall of their first year, were 41-56mm at age 1+, 70-80mm at age 2+, 88-98mm at age 3+, and 85-120mm at age  $\geq 4+$ . This differs some to the age groupings suggested by length data presented here: there may be more age classes than inferred by the frequency distribution (Figure 11) as some peaks may contain multiple cohorts.

Descriptions of Mottled Sculpin life history vary in estimates of maximum life span. Baily (1952) observed 5+ age class individuals, while Grossman et al. (2002) observed 7+ age class individuals. The frequency distribution of total length suggests Illinois Mottled Sculpin can live at least three years (Figure 11).



**Figure 11. Frequency distribution of Mottled Sculpin total length. Orange bars and labels indicate approximate length breadth of age cohorts.**

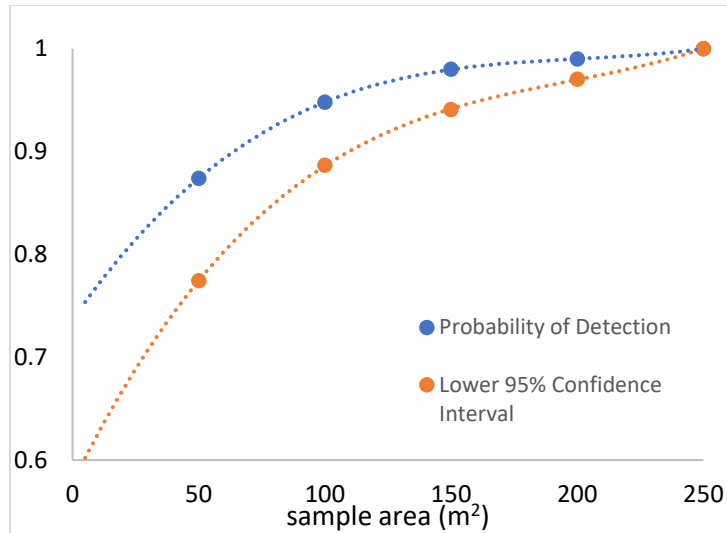
Of the 21 survey sites where Mottled Sculpin length was recorded, young-of-year individuals were observed at 14. Young-of-year individuals made up 0.19 of the total catch. All surveys were conducted with electrofishing gear, which is known to be biased towards larger individuals, so the observed frequency of young-of-year individuals is likely under-counted.

Bailey (1952) observed female Mottled Sculpin began reaching maturity at 65mm and all were mature by 75mm. Of those individuals measured in Illinois approximately 0.30 of are sexually mature.

## **SECTION 6. CURRENT RESEARCH, MONITORING EFFORTS, AND DATA NEEDS**

Most contemporary Mottled Sculpin records originate from IEPA/IDNR Basin Survey Program surveys, but the resolution of information from these surveys is inadequate for some assessments. Targeted surveys for Mottled Sculpin that emphasize collection of density and demographic information would aid a more robust species status assessment. Surveys in previously unsurveyed suitable habitat would improve resolution of Mottled Sculpin distribution information. A select number of these sites could be surveyed annually for improved trend analysis. Surveys conducted in 2020 and 2021 for this species status assessment were performed in such a way that detection probabilities were calculated (Figure 12). Sampling approximately 100m<sup>2</sup> of suitable habitat resulted in a >90% probability of detecting Mottled Sculpin when they were present in a survey extent. This information can be used to develop

targeted survey protocols. State Wildlife Grant T-133, Updating Illinois Stream Biological Characterizations, will develop species distribution models for Illinois fishes, including Mottled Sculpin. A distribution model for this species will fill information gaps caused by incomplete spatial and temporal survey coverage and facilitate population and statewide abundance estimates.



**Figure 12. Detection probability of Mottled Sculpin in Illinois streams where the species is present.**

Although Mottled Sculpin literature suggests the species has a limited home range and small lifetime dispersal distance little is known regarding how this pattern translates to spatial arrangement of populations. Several theoretical frameworks for delineating populations, based on knowledge of Mottled Sculpin ecology, can be presented: 1) distance-based, large rivers as dispersal barriers, dams as dispersal barriers, and watershed boundaries as dispersal barriers. In 2020 and 2021 tissue samples from 246 individuals in 18 stream reaches were collected for future genetic analysis that will elucidate patterns of spatial arrangement of populations, estimate effective population size, and assist identification of an accurate dispersal framework. Conclusions from this study will be available in 2023.

A common perception of Mottled Sculpin ecology is that they require cool temperatures. Hinz, Jr. et al. (2011) defined “cool” streams as those with mean daily July temperatures of <23.8°C. That study recorded stream temperature at 18 stream reaches in watersheds where Mottled Sculpin were present. There was much overlap in mean daily temperature and mean daily temperature variation between reaches with Mottled Sculpin and those without (Figure 13). One occurrence record exceeds the cool threshold. This analysis fails to confirm that Mottled Sculpin require cool temperatures, although there are limitations to this conclusion. For example, it may be that a large proportion of streams in these watersheds are relatively cool. It is also possible that Mottled Sculpin distribution is limited by some other measure of temperature, like maximum temperature. The relationship between Mottled Sculpin distribution and stream temperature should be further evaluated.

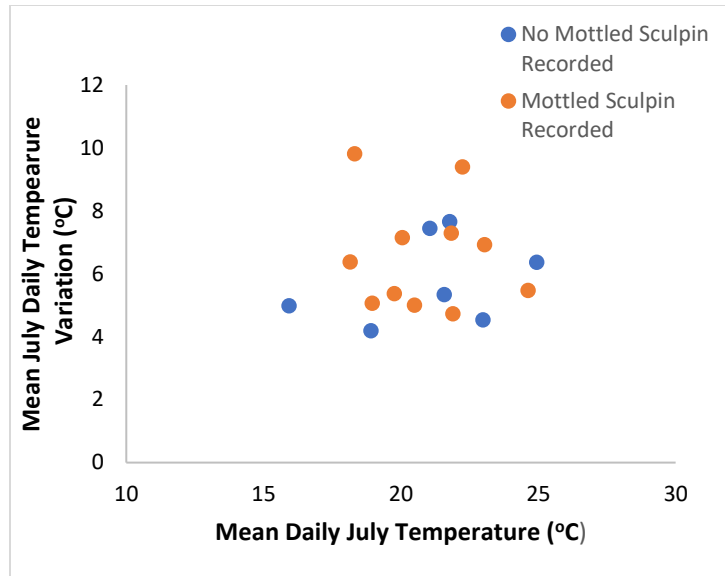


Figure 13. Stream temperature in watersheds where Mottled Sculpin occurs (Hinz et al. 2011).

## SECTION 7. LITERATURE CITED

- Bailey, J.E. 2002. Life history and ecology of the Mottled Sculpin *Cottus bairdi punctulatus* in southwestern Montana. *Copeia* 1952(4):243-255.
- Feng, M-L., T.E. Schartel, E. South, B. Henning, Y. Cao, and L.C. Hinz, Jr. 2021. Effectiveness of Illinois' protected lands network at supporting SGCN and their habitats. INHS Technical Report 2021(19).
- Fuller, P. and M. Neilson. 2022. *Cottus bairdii* Girard, 1850: U.S. Geological Survey Nonindigenous Aquatic Species Database. USGS Gainesville, FL. Available: <https://nas.er.usgs.gov/factsheet.aspx?SpeciesID=502>. Revised 3/5/2012. Accessed February 2022.
- Grossman, G.D., K. McDaniel, and R.E. Ratajczak, Jr. 2002. Demographic characteristics of female Mottled Sculpin, *Cottus bairdi*, in the Coweeta Creek Drainage, North Carolina. *Environmental Biology of Fishes* 63:299-308.
- Hammerson, G.A., D. Schweitzer, L. Master, J. Cordeiro, A. Tomaino, L. Oliver, and J. Nichols. 2020. Ranking species occurrences: A generic approach and decision key. Version 1.0. Published 2008, revised 2020. Available: [https://www.natureserve.org/sites/default/files/eo\\_rank\\_specifications-generic\\_guidelines\\_and\\_decision\\_key\\_05.08.2020.pdf](https://www.natureserve.org/sites/default/files/eo_rank_specifications-generic_guidelines_and_decision_key_05.08.2020.pdf)
- Hinz, Jr., L.C.B.A. Metzke, and A.M. Holtrop. 2011. Evaluating water temperature, habitat, and fish communities in candidate coolwater streams in Illinois. INHS Technical Report 2011(21).
- Illinois Department of Natural Resources. 2015. 2015 implementation guide to the Illinois Wildlife Action Plan. Available: <https://www2.illinois.gov/dnr/conservation/IWAP/Documents/IWAPImplementationGuide2015.pdf>

Illinois Endangered Species Protection Board. 2020. Checklist of Illinois Endangered and Threatened Animals and Plants. May 28, 2020. Available:  
<https://www2.illinois.gov/dnr/ESPB/Documents/ET%20List%20Review%20and%20Revision/IllinoisEndangeredandThreatenedSpecies.pdf>

Kinziger, A.P., M. Wood, and D.A. Neely. 2005. Molecular systematics of the genus *Cottus* (Scorpaeniformes: Cottidae). *Copea* 2005:303-311.

Metzke, B.A., B.M. Burr, L.C. Hinz, Jr., L. M. Page, and C.A. Taylor. 2022. An atlas of Illinois fishes. University of Illinois Press, Urbana, IL. 406+xviii pp.

Metzke, B.A., L.C. Hinz, Jr., and A.C. Hulin. 2012. Status revision and update for Illinois' fish species in greatest need of conservation. INHS Technical Report 2012(19).

NatureServe. 2015. NatureServe conservation status assessments: Rank calculator version 3.185. NatureServe Arlington, Va. Available:  
[http://connect.natureserve.org/publications/StatusAssess\\_RankCalculator](http://connect.natureserve.org/publications/StatusAssess_RankCalculator)

NatureServe. 2022. NatureServe Explorer (web application). NatureServe, Arlington, Virginia. Available  
<https://explorer.natureserve.org>. Accessed February 2022.

Terwilliger Consulting. 2021. Regional species of greatest conservation need in the Midwestern United States. Prepared for the Midwest Association of Fish and Wildlife Agencies and the Midwest Landscape Initiative, August 2021.

Willink, P.W. 2017. Assessing the status of potential Illinois endangered and threatened fish species. Final project report for Illinois State Wildlife Grant T-106-R-1.