

Understanding the herpetofauna of Michigan State University's Corey Marsh Ecological Research Center for future restoration efforts

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Abstract

Reptiles and amphibians, or herpetofauna, have the highest extinction rates of any vertebrate group. We established a herpetofauna monitoring research project at Michigan State University's Corey Marsh Ecological Research Center (CMERC) to better understand the diversity and abundance of local herpetofauna populations. The two focal survey methods were passive acoustic recording of frogs and capture-mark-recapture of turtles using aquatic traps. Additionally, we implemented salamander false cover surveys in partnership with the Salamander Population Adaptation Research Collaborative Network (SPARCnet). We identified eight species of frogs and three species of turtles in total between 2022 - 2024. Frog species at CMERC included spring peepers (*Pseudacris crucifer*), western chorus frogs (*Pseudacris triseriata*), eastern gray treefrogs (*Hyla versicolor*), green frogs (*Lithobates clamitans*), wood frogs (*Lithobates sylvaticus*), northern leopard frogs (*Lithobates pipiens*), bullfrogs (*Lithobates catesbeianus*), and American toads (*Anaxyrus americanus*). Turtle species at CMERC included painted turtles (*Chrysemys picta*), common snapping turtles (*Chelydra serpentina*), and Blanding's turtles (*Emydoidea blandingii*). Salamander species at CMERC solely included the blue-spotted salamander (*Ambystoma laterale*). We also assessed frog reproductive phenology (timing of calling) for *P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans*. We found that calling frequency is related to the time of year for all four species, but most strongly with early spring breeders such as *P. crucifer* and *P. triseriata*. Similarly, *P. crucifer* calling frequency has a low negative correlation with temperature, suggesting that *P. crucifer* is especially reliant on low early spring temperatures and may be more sensitive to the effects of climate change. Our results provide important baseline herpetofauna data for CMERC and will help guide future habitat restoration, wildlife conservation, and monitoring efforts on the site. Finally, the project has collectively engaged ~500 students, postdocs, faculty, and community partners, providing both research professional development and networking opportunities.

Introduction

Reptiles and amphibians, or herpetofauna, are vital components of the food webs of both aquatic and terrestrial ecosystems. Because they are both more sensitive to changes in the environment due to their ectothermic nature, their combined study is common. In Michigan, there are 13 species of frogs and toads, 18 species of snakes, 10 species of salamanders, and 10 species of turtles; out of these species, 15 are considered either threatened, endangered, or of special concern (Michigan DNR). The reptiles and amphibians of Michigan exist in many roles similar to

those around the world as prey, predators, and indicator species. Amphibians in particular are used as indicators of environmental health as a result of their sensitivity to pollution (Sumanasekara et al., 2015). Amphibians' methods of both drinking and breathing utilize their skin; for this to be possible, their skin needs to be permeable. As a result, any substance their skin comes in contact with is absorbed into their system, which causes their sensitivity to pollution (Fenoglio, 2006). Currently, amphibians are under threat of mass extinction and experience the highest rates of extinction compared to all other vertebrate

groups (Collins, 2010). Not only are amphibians sensitive to pollution, but both amphibians and reptiles, due to their ectothermic nature, are especially sensitive to temperature changes (Griffis-Kyle et al., 2018). Herpetofauna thermoregulation and breeding patterns are closely related to their climate, and thus, tracking the changes in distributions of these species is necessary for their conservation.

Fifty percent of wetlands have been lost in the lower 48 states from 1780 to 2019 (Lang et al., 2024). Wetlands are vital ecosystems for the wildlife habitat and ecosystem services they provide (Erwin, 2008). This immense loss of a vital ecosystem, such as wetlands, makes understanding how to restore those ecosystems crucial. Michigan State University's Corey Marsh Ecological Research Center (CMERC) offers a unique wetland site to study changes in herpetofauna populations during habitat restoration efforts and a changing climate. CMERC's purpose has not always been ecological research. Before the research center officially opened in 2018, the center was a muck farm where soil types were tested for agricultural use. The previous muck farm status of CMERC allows for questions to be answered regarding the effects of agriculture on restored land and the organisms that repopulate the area.

This project tested the implementation of multiple herpetological surveying techniques to establish a long-term monitoring project at CMERC. The goal of this project is to establish baseline data and understanding of herpetofauna diversity and abundance at CMERC, along with their interactions with climate and land use, to improve herpetofauna conservation efforts. To accomplish this goal, we established five objectives.

- 1) Establish herpetofauna monitoring methods that can feasibly be carried out long-term by alternating lead undergraduate research assistants.
- 2) Measure herpetofauna diversity, abundance, and seasonality at CMERC.
- 3) Identify conservation needs of herpetofauna at CMERC with a focus on the state species of special concern, Blanding's turtle and federally threatened

eastern massasauga rattlesnake.

- 4) Collaborate with diverse institutions to build capacity for replicated herpetofauna monitoring programs across the United States.
- 5) Provide education and outreach opportunities for students and the general public.

Surveying Methods

Anuran Passive Acoustic Monitoring

In our pilot year, 2022, we deployed two Wildlife Acoustic SongMeter4 (SM4) passive acoustic monitors at CMERC with standard settings (Wildlife Acoustics, 2024), recording at 5-minute intervals from 1900 to 0700 hours from February to October to detect frog and toad (anuran) calling activity. We used settings supported by the literature for similar studies using SM4 recorders (e.g., Larsen et al., 2021; Tabak et al., 2022). In 2023 and 2024, we decreased the amount of data gathered by shortening the recording interval to 2-minute intervals from 2100 to 0700 based on the most common times anurans were calling.

To calculate common calling times, we added the total amount of calls detected at each hourly interval and saw an average increase in calls detected from 1900 vs. 2100 (~200 calls vs. ~900 calls). The average number of calls throughout the entire time period was 917, and from 2100 to 0700, all of these hours detected at least 800 calls. The 1900 and 2000 time slots found less than 25% of the average call amount. As a result, we removed the 1900 and 2000 time slots. Less data also reduced future data analysis burden to new undergraduate students entering the position (Objective 1).

We used Kaleidoscope analysis software to automate frog call identification for four frog species (*P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans*). We trained Kaleidoscope software through manual identification of detected frog calls to create a training set. Through this manual identification, we also tested the accuracy of the automated identification based on a parameter within the software called "distance from". This parameter indicated how close the identified audio clip was to the training set. We randomly generated 100

numbers corresponding to identified audio clips by Kaleidoscope within the 0 - 1 distance from value, and a second set associated with a distance from value greater than 1. Overall, the identifications associated with a distance from score less than 1 had an accuracy of 77%, while those with a distance from value greater than 1 had 0% accuracy. This, combined with personal correspondence from collaborators at Laurentian University, led us to exclusively consider identifications associated with a distance from value of 0 - 1.

We collected temperature data from NOAA's Lansing area online climate data tables to test for temperature correlations (US Department of Commerce; NOAA).

Turtle Mark Recapture

From 2022 to 2025, we conducted a 7-12-day sampling session for three seasons: fall, spring, and summer. This method is supported by previous literature and the standard operating procedure used by the Michigan Natural Feature Inventory for turtle sampling (Badra et al., 2020). We deployed two types of aquatic turtle traps - a smaller Promar crayfish trap and a larger hoop net. Between 6 - 13 traps were deployed each session, depending on water levels and volunteer availability. We recorded water and air temperatures to compare captures with environmental characteristics. For each captured turtle, we collected morphological measurements (carapace length and width, plastron length and width, total shell height), sex, and assigned a recapture code (Figs. 1 and 2). We marked turtles using a nail file on scute corresponding to a unique two-letter code.

In 2022, we established two 50-board false cover plots for salamander sampling as described in Grant et al. 2024. We checked these plots periodically alongside other Salamander Population Research Collaborative Network (SPARCnet) sampling efforts and with class field trips.

Analysis Methods

All analyses were performed in R Studio. ANOVAs were run on a subset of data corresponding to four frog species: *P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans*, to determine whether time of year and

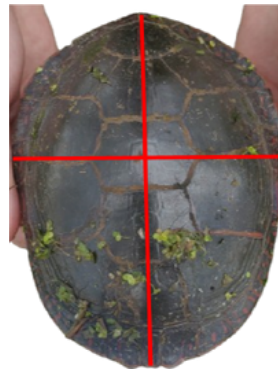


Figure 1. Example of *C. picta* carapace length and width.

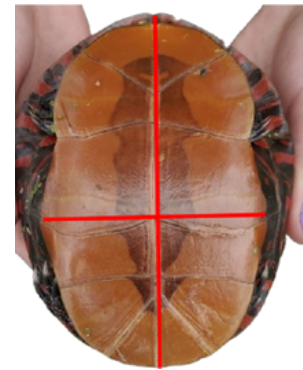


Figure 2. Example of *C. picta* plastron length and width.

amount of detected frog calls were dependent. Pearson correlation tested whether the average daily temperature and detected frog calls were correlated.

Results

Anuran Passive Acoustic Monitoring

Passive acoustic loggers were deployed for 513 days from 2022 - 2024. Eight species were detected, including: spring peepers (*Pseudacris crucifer*), western chorus frogs (*Pseudacris triseriata*), eastern gray treefrogs (*Hyla versicolor*), green frogs (*Lithobates clamitans*), wood frogs (*Lithobates sylvaticus*), northern leopard frogs (*Lithobates pipiens*), bullfrogs (*Lithobates catesbeianus*), and American toads (*Anaxyrus americanus*).

We calculated calling amounts for four species (*P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans*). *Pseudacris crucifer* and *P. triseriata* calling peaked in April, *H. versicolor* calling peaked in May, and *L. clamitans* calling peaked in September (Fig. 3).

ANOVA tests for independence between the time of year and the calling frequency of individual species showed that *P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans* calling frequencies are not independent of month (*P. crucifer*, $p=2.554e-5$; *P. triseriata*, $p=0.002178$; *H. versicolor*, $p=0.03653$; and *L. clamitans*, $p=0.02698$). Pearson correlation tests comparing the average daily temperature to the daily calling frequency of individual species were insignificant for every species except *P. crucifer* ($p=1.623e-8$; $cor=-0.326223$).

Turtle Mark Recapture

We conducted eight sampling periods, each with 7-12 days of effort, depending on water levels and volunteer availability. A total of 72 sampling days

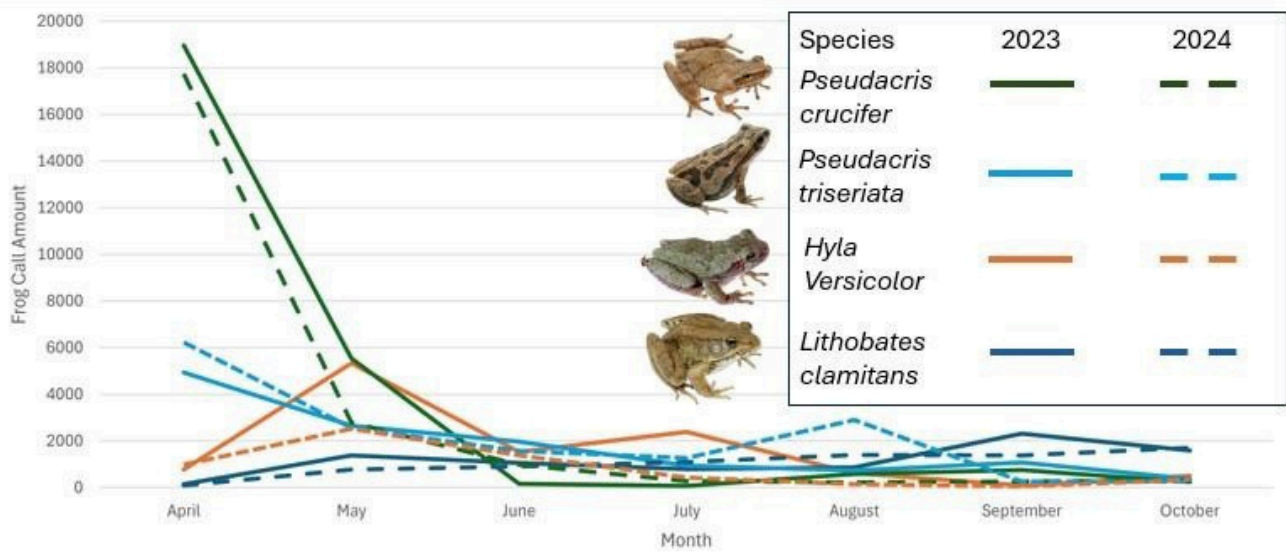


Figure 3: Monthly calling frequency of *P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans* for 2023 and 2024.

resulted in 123 turtles captured, representing three different species: painted turtle (*Chrysemys picta*), common snapping turtle (*Chelydra serpentina*), and Blanding’s turtle (*Emydoidea blandingii*). Across all sampling periods, the most commonly captured species was *C. picta* (Fig. 4). Of the 115 *C. picta* captured, 4 were recaptured, and 75% were males. In total, only five Blanding’s were captured in traps, although additional individuals were marked from incidental capture.

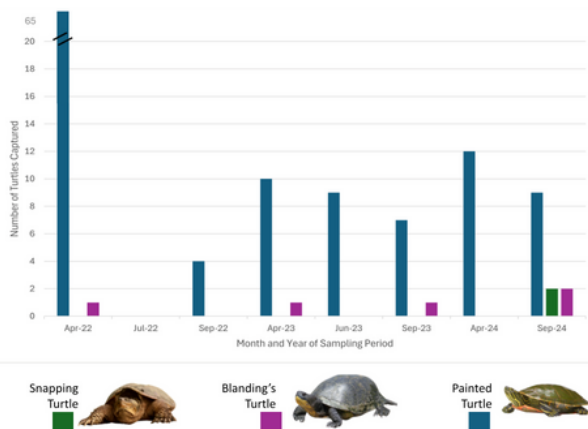


Figure 4: Turtle capture rates for every detected species at CMERC: snapping turtle (*Chelydra serpentina*), Blanding’s turtle (*Emydoidea blandingii*), and painted turtle (*Chrysemys picta*) from April 2022 - September 2024.

Salamander False Cover Surveys

From 2022 - 2024, the only salamander species we found was *A. laterale*. As this sampling was in collaboration with SPARCnet, and SPARCnet exclusively collects data on the red backed salamander

(*Plethodon cinereus*), we did not record any data regarding *A. laterale*.

Discussion

Our anuran passive acoustic monitoring, turtle trapping efforts, and salamander sampling at CMERC described present herpetofauna species and provided further knowledge on anuran responses to climate variables at CMERC. Anuran breeding periods, when they are most likely to be found calling, are dependent on time of year and climatic variables (Green, 2017; Larsen et al. 2021). At CMERC, we found the same to be true for our four species: *P. crucifer*, *P. triseriata*, *H. versicolor*, and *L. clamitans*; however, this association was stronger for some species (Fig. 3). These species are *P. crucifer* and *P. triseriata*. This association with time of year was weakest for *H. versicolor* ($p=0.03653$), which may indicate a stronger resilience towards climate change impacts on seasonality (Objs. 2 and 3). Previous literature has documented that early spring breeders, such as *P. crucifer* and *P. triseriata*, are stronger indicators of environmental health due to their reliance on time-sensitive environmental and climatic conditions that are found in early spring (Blaustein, 2002; Green, 2017). *Pseudacris crucifer*, in particular, displays extremely high call rates early in the season, which drop drastically after mid-May (Fig. 3). *Pseudacris crucifer*’s association with these months may partially be related to temperature, as we showed a slight negative correlation with temperature ($p=1.623e-8$; $cor=-0.326223$). Other

climatic and environmental variables associated with early spring most likely also play a part, as indicated by previous literature (Benard, 2023). Variables that we did not account for include days since the last rainfall and the status of vernal pools. *Pseudacris crucifer* is known to use vernal pools, which are created by spring rains (Korfel et al., 2010). These pools dry later in the season and are most likely connected to the decline in *P. crucifer* call rates. However, temperature cannot be removed from this relationship because high temperatures dry up vernal pools (Keeley and Zedler, 1998). *Pseudacris crucifer*'s reliance on low early spring temperatures suggests that it may be more sensitive to climate change, and thus, it is important to continue monitoring, as its population health may be an early indicator of overall ecosystem health (Objs. 2 and 3).

Across our turtle trapping seasons, we tested aquatic turtle trapping techniques and standardized our trapping protocol for CMERC, which will allow for more efficient and robust future data collection. During this time, we also found turtle species presence, including the state species of special concern, Blanding's turtle. Now that we know this species is at CMERC, future efforts will focus on movement ecology to better inform nesting behavior and increase broader awareness of its population status. Other than the Blanding's turtle, we largely found painted turtles. This is as expected since they are the most commonly found turtle species in Michigan (Objs. 2 and 3). However, it is unclear why we had such a large drop in trapped turtles from the first sampling period in spring 2022 as compared to later sampling periods (Fig. 4). We collaborated with SPARCnet for our salamander sampling efforts, aligning with Objective 4 to collaborate with diverse institutions. However, as SPARCnet solely collects data on *P. cinereus*, and we did not find any *P. cinereus* at CMERC, we did not collect any salamander data other than species presence. The lack of *P. cinereus* at CMERC is a conundrum, as similar sites near CMERC have *P. cinereus*. Further efforts to understand this conundrum are underway.

Along with our herpetofauna monitoring efforts, we

supported the education of future wildlife professionals by involving 79 volunteers and 21 MSU lab classes. We also participated in environmental education events open to the general public, such as the ecology extravaganza event held at CMERC. This connects with our objective of outreach and education, and shows the potential of this project to be an educational experience for a large group of undergraduates (Objective 5).

Conclusion

We successfully implemented turtle, frog, and salamander surveys at Corey Marsh Ecological Research Center, carried out by a lead undergraduate organizer and volunteers (Objective 1). This project increased our understanding of the diversity of herpetofauna species at CMERC and the environmental conditions associated with their presence (Objective 2). Early spring breeders such as the spring peeper and western chorus frog are more sensitive to seasonality and have potential to act as environmental health indicators; continued monitoring of these groups is valuable for understanding the health of the entire marsh (Objective 3).

Our establishment of this herpetofauna monitoring project at CMERC provides future research opportunities for undergraduates at MSU (Objective 5). Additionally, this project offers baseline herpetofauna population data to measure the impact of restoration efforts at CMERC on these valuable communities (Objective 3).

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About the Author

Proudfoot is a May 2025 Fisheries and Wildlife BS graduate from Michigan State University with interests in reptile and amphibian conservation. This paper details their undergraduate work creating a reptile and amphibian monitoring project at Michigan State University's Corey Marsh Ecological Research Center. Proudfoot hopes that this paper will provide guidance for future undergraduate researchers interested in wildlife as a whole and inspire others to appreciate reptiles and amphibians.