PHE·NOL·O·GY

NOUN

1. THE STUDY OF CYCLIC AND SEASONAL NATURAL PHENOMENA, ESPECIALLY IN RELATION TO CLIMATE AND PLANT AND ANIMAL LIFE.
As climate events become more extreme and seasonal temperatures reach record highs and lows, less is understood about how these changing trends will impact the natural environment. Estuarine ecosystems are of critical importance, due to the habitat they provide for sensitive species and the key role they play in filtering nutrients before water flows into the oceans and Great Lakes. Although climate models examining sea level rise and other oceanic susceptibilities have garnered much attention in light of climate change, many are left considering what climatic changes might mean for the Great Lakes.

Lake Erie is especially susceptible to these impacts, as it is the shallowest and most productive of the Great Lakes. This is largely due to the fact that it is the most southern and it is surrounded by the most urban and agricultural lands, relative to the other Great Lakes (as opposed to predominantly wooded surroundings). These vulnerabilities make it difficult to quantify the scale of impacts upon multiple ecosystem services, including water quality, habitat, and species health/diversity.

While there are initiatives that assess the impacts of climate change on water quality (e.g. the NERRS System-Wide Monitoring Program (SWMP) records and draws correlations between water quality and weather data) and coastal habitat (e.g. shoreline softening techniques, native vegetation restoration), climatic impacts upon wildlife species are less understood.

Old Woman Creek Reserve is one of the two of Great Lakes reserves within the NERRS (National Estuarine Research Reserve System). In an evaluation of all reserves, the NERRS Climate Sensitivity Index concluded that Old Woman Creek Reserve rates highest in Overall Ecological Stress. The reserve is host to a number of wildlife species that serve as indicators of ecosystem health (e.g. ravine salamanders, great blue herons), as well as species that are a keystone to ecological functioning (e.g. bald eagles, muskrats, beavers). Phenology-based species monitoring at Old Woman Creek Reserve helps develop an understanding of how climate trends are affecting species that are indicators of or keystone to ecological success within the estuary, ultimately to inform Great Lakes coastal wetland management practices regarding wildlife.

While many phenology efforts tend to focus on vegetation phases – buds, blooms, and senescence – Old Woman Creek’s Phenological Species Monitoring Program seeks to monitor wildlife species that either play a key role in the Old Woman Creek environment (such as the bald eagle, an apex predator), or are indicative to other environmental conditions – for example, all amphibian species are considered indicator species, due to their sensitivity to temperature and moisture. Established in 2016, the program also monitors species based on their relationship to other species in the ecosystem (e.g. house sparrows out-compete tree swallows for habitat). Current keystone (K), indicator (I), and sensitive (S) species monitoring initiatives associated with the program include:

- BALD EAGLE NESTING ACTIVITY K
- TREE SWALLOW NEST BOXES S
- LUNGLESS SALAMANDERS I
- SECRETIVE MARSH BIRDS S/I
- FROGS AND TOADS I
- ALL-INCLUSIVE AVIAN SPECIES S/I
- MUSKRAT ACTIVITY I/K
- BEAVER ACTIVITY K

by ALAINA MCCLEARY

by EMILY KUEMICK
Historically endangered due to the use of the insecticide Dichlorodiphenyltrichloroethane (DDT), our nation’s symbol has since made an extraordinary come-back. The application of DDT on farm fields would run off into Lake Erie and its tributaries, where it was adsorbed by fish. Bald eagles (Haliaeetus leucocephalus) would then eat the fish, which caused the shells of eagle eggs to become extremely thin and consequently crushed upon incubation. After the banning of DDT in 1972, however, bald eagle populations began to rebound. Ohio went from hosting four nesting pairs of bald eagles to over 300 (reported in 1979 and 2014).

Bald eagle nest monitoring at Old Woman Creek was initiated by the State of Ohio in an effort to track eagle recovery in response to the DDT crisis and subsided around 1999. While it was apparent the species was thriving, Old Woman Creek staff acknowledged it was important to continue to track bald eagle nesting activity to determine the rate of successful fledglings (eaglets that leave the nest) in order to communicate their status to visitors and observe seasonal correlations to their nesting phases.

In February 2016, bald eagle nest monitoring began again as the first monitoring initiative associated with the Old Woman Creek Phenological Species Monitoring Program. The 2016 nest was located on Star Island in the center of the estuary and was monitored almost daily throughout the months of March and April via a field scope. Behavioral changes observed suggested shifts in nesting phases from incubation, to hatching, to feeding:

- **EARLY MARCH:** PRESUMED INCUBATION START
- **APRIL 7TH:** PRESUMED HATCH DATE
- **APRIL 19TH:** LAST OBSERVATION OF EAGLES OCCUPYING NEST
- **APRIL 26TH:** NEST ABANDONED

Shortly after observations indicated feeding behavior, the adults ceased feeding and eventually abandoned the nest. Many reasons exist for the failure of this nest leading to abandonment, including parental neglect, external stressors from juvenile eagles, and unseasonable temperatures.
The 2017 nesting season delivered much more promising results: the eagles moved their nest to a new, more secluded location on the western side of the estuary. Monitoring from February – early July shows that the 2017 nest produced one successful fledgling.

Nesting activity data are also compared with climate data: in comparing the average temperature of each nesting phase across years, it appears that incubation can be reduced by up to 10 days in warmer temperatures. Since bald eagle egg incubation typically lasts approximately 35 days, shortened incubation could result in potential developmental abnormalities.

Monitoring will continue in upcoming years to evaluate nesting behaviors and patterns with changing climate conditions.
The tree swallow (*Tachycineta bicolor*) is a short-range migrant that nests in cavities created by other animals. These small insectivores will eat thousands of insects in one day, which makes them indicators of good habitat health. Human influences such as logging and urbanization have reduced natural cavities and the natural habitat of the tree swallow. Fortunately, tree swallows will nest in man-made nest boxes, which help to increase their population size. They still face alternative issues, however, such as competition with non-native/invasive species and the effects of a changing climate.

Nest boxes in the Old Woman Creek prairie habitat have been monitored weekly each season since 2013. Data are collected by checking the nest boxes multiple times a week from April through July and identifying the activity inside (empty; nest only; eggs; nestlings; fledglings), and the species responsible. These data assist in determining how climatic changes and invasive species are affecting tree swallows.

House sparrows are a non-native, invasive species that can kill tree swallows when competing for valuable nesting sites. The house sparrow will take over the nesting site and continue to compete with other tree swallows nesting in the area. A common management practice for fostering successful tree swallow populations involves the removal of house sparrow nests as soon as possible (preferably in the nest building stage). Over time, OWC NERR data shows an increasing amount of successful tree swallow nests in the nest boxes in direct correlation with the number of house sparrow nests removed.

Florida is one of the locations where tree swallows will spend the colder months; temperature data from the Rookery Bay NERR in Marco Island, Florida shows an increase in average temperature in Florida over the years, which might be one reason tree swallows seem to be migrating north earlier in the year. This may have a variety of potential implications for tree swallows, including limited food supply if certain insects have not yet emerged and failed incubation if temperatures in Ohio are too cold for successful hatching. In addition to climatic data, data on mayflies – one of the most prominent insects along Ohio’s Lake Erie coast in the spring – are being collected in an effort to examine possible impacts on tree swallow diet availability.

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**Total number of successful tree swallow nests compared with the total number of house sparrow nests removed each year. Many of the successful tree swallow nests were consequent of the removed house sparrow nests.**

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A tree swallow nest with eggs (bottom) compared with a house sparrow nest (top). Notice the neat, circular shape of the tree swallow nest compared with the sparrow nest, which consists of anything ranging from leftover nest material to pieces of trash.
Ohio is a biodiversity hotspot for salamanders, due to its typically wet springs and relatively humid summers. While there are many different species of salamanders found in Ohio, most are very secretive and difficult to find. Lungless salamanders, as their name indicates, do not have lungs – rather, they rely upon the exchange of oxygen through their skin to breathe. This makes them extremely sensitive to environmental conditions, since parameters such as acidity, moisture, and temperature all have drastic effects on their livelihood. An abundance or lack of lungless salamanders in an area could therefore indicate water pollution or soil that is simply unfit salamander habitat.

The most common species of lungless salamander found at Old Woman Creek is the northern ravine salamander (*Plethodon electromorphus*), which can be found under logs, branches, or leaf litter when the soil is moist. Lungless salamander monitoring at Old Woman Creek aims to assess the general population of species and individuals in different habitat types (lowland scrub-shrub forest and upland hardwood forest). Volunteers monitor activity underneath natural and artificial cover objects throughout the reserve’s trail system and record salamander presence and activity, soil temperature, and accompanying climate data. Soil pH, leaf litter, tree canopy cover, and other characteristics within each plot are measured each season. If salamanders are handled, they are handled with hands free of lotions, insect repellent, etc. and for a minimal amount of time to ensure the least impact.

Lungless salamanders are extremely sensitive to disturbance and therefore cannot be sampled more than once per week. Monitoring began in spring of 2016 and the program is still working to collect substantial sampling data. OWC NERR will continue monitoring to assess any changes in presence or activity over time, and to draw more definitive correlations between salamander presence and climate conditions.

**Total Number of P. electromorphus Individuals Observed Spring 2016 - Spring 2017**

![Graph showing total number of lungless salamanders observed in each temperature between spring 2016 and spring 2017. Monitoring will continue to determine whether there is a trend between salamander presence and temperature.](image)
SECRETIVE MARSH BIRDS

As development expands along the earth’s coasts, the habitat upon which marsh birds rely is becoming increasingly imperiled. Ohio is second only to the state of California in wetland loss in the United States – over 90% of Ohio’s native wetlands have suffered development or destruction. This habitat is important migratory stop-over territory for a variety of “secretive marsh” species, including Sandhill cranes, and resident territory for others, including the black-crowned night heron, a threatened species.

Secretive marsh bird monitoring began in spring of 2016 as a collaborative effort with Bird Studies Canada and the Ohio Wetlands Association, using international Marsh Monitoring Program (MMP) protocol. Volunteers monitor the Old Woman Creek estuary via a canoe route twice a year from May through early July using auditory cues.

The MMP protocol identifies 5 different species as “key” secretive marsh bird species; thus far, the sora (Porzana carolina) is the most dominant key species observed using MMP protocol. However, a variety of secondary species were observed during monitoring, including green and great blue herons, wood ducks, yellow warblers, and bald eagles.

In comparing 2016 and 2017 data, there were more total secondary species observed in 2016 than 2017, as well as a higher average temperature during monitoring. A significant trend can already be seen between the amount of cloud cover and the number of species seen (p < 0.05). Continuous monitoring is needed to determine if these trends continue and how other climatic factors are impacting these species.
Old Woman Creek Research Reserve is home to a variety of frog and toad species, including:

- NORTHERN CRICKET FROG (*Acris crepitans*)
- WESTERN CHORUS FROG (*Pseudacris triseriata*)
- SPRING PEEPER (*Pseudacris crucifer*)
- GRAY TREE FROG (*Hyla versicolor*)
- LEOPARD FROG (*Lithobates pipiens*)
- WOOD FROG (*Lithobates sylvaticus*)
- PICKEREL FROG (*Lithobates palustris*)
- AMERICAN BULLFROG (*Lithobates catesbeianus*)
- NORTHERN GREEN FROG (*Lithobates clamitans melanota*)
- AMERICAN TOAD (*Anaxyrus americanus*)
- FOWLER'S TOAD (*Anaxyrus fowleri*)

This species diversity is partially attributed to the diverse habitat within reserve property (prairie, upland forest, scrub-shrub forest, and wetland). Frogs' and toads' skin are very sensitive to chemicals and pollutants, so a lack or abundance of these species could suggest certain things regarding the area's water quality.

Monitors also use the Marsh Monitoring Program protocol to monitor frog and toad species at OWC NERR. Volunteers monitor species using auditory protocol three times throughout the spring at four different sites along a canoe route in the Old Woman Creek estuary. Weather and vegetation data are also collected to observe possible correlations to species presence, abundance, or diversity.

The above graph shows a greater diversity and abundance of species observed in 2017 than 2016 – this could possibly be due to the fact that the average temperature during sampling in 2016 was around 61°F, whereas the average temperature during sampling in 2017 was 67°F. The significantly warmer spring in 2017 could have also played a role in the abundance of spring peteers observed that season. Additional seasons of monitoring are needed to determine if these trends will continue.
ALL-INCLUSIVE AVIAN SPECIES

Old Woman Creek Reserve is at the intersect of two main migratory fly-ways, meaning it is a prime location for all different kinds of bird species to stop and take a break from their long migration between seasons. In an attempt to capture the abundance and diversity of these species, avian monitoring began in July of 2016. The program consists of four specific sites throughout the Old Woman Creek trail system, intended to survey birds in each different habitat. 15-minute point counts – a method in which every bird heard and seen in a 50-meter radius is recorded – are conducted by volunteer monitors throughout the year. To date, 76 bird species have been recorded at the reserve via this method.

Monitoring is conducted throughout the year. The data are then categorized by time period (morning, afternoon, evening) and analyzed. The program takes a special interest in keystone, indicator, and sensitive species, as well as weather conditions and patterns. These are analyzed in order to determine what implications changing weather conditions could have on bird species at the reserve. In Ohio, the presence of marsh wren and least bittern, species on concerned and threatened lists respectively, are of particular interest. These two species have been recorded while conducting avian monitoring and are found to use the resources the estuary provides.

The Simpson’s Index of Diversity gives a probability that two individuals selected from a sample area will be different species. Data were used to calculate a Simpson’s Diversity for observations made in each habitat type – the habitat with the higher number is host to the most diversity. This index shows an increase in diversity from 2016 to 2017 in all but the prairie habitat. To date, the forest habitats seem to host the most diverse avian species. Monitoring will continue in an attempt to identify changes in bird species presence over time in varying climate and habitat conditions.

### HABITAT

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Simpson’s Diversity Index for avian species observed in each OWC habitat during 2016 and 2017.
MUSKRAT ACTIVITY

The common muskrat (*Ondatra zibethicus*) is a crepuscular – meaning active primarily during dawn and dusk – semi-aquatic species that lives in wetland areas. They get their name for their rat-like appearance and the “musky” odor they produce during breeding season. Adult muskrats can weigh between 2 - 5 pounds and are around 16 - 25 inches in length. They have dark brown fur, strong back legs for swimming, and a thin, hairless tail to keep them balanced in the water. The muskrat diet consists mostly of aquatic vegetation, but can also include mollusks, fish, frogs, and small turtles.

Muskrats construct lodges out of aquatic vegetation such as native and non-native cattail, water lilies, lotus leaves, arrowhead, coontail, aquatic weeds, and the invasive reed *Phragmites australis*. An active lodge, or one that is currently home to a muskrat family, will be a well-structured dome with fresh vegetation woven throughout and feeding platforms nearby where the muskrats can eat.

Muskrats are both indicator and keystone species: they are sensitive to environmental changes – especially when it comes to water depth – and they create patches of disturbance due to their impact on aquatic vegetation. In the Old Woman Creek estuary, the mouth of the estuary opens and closes naturally, which affects how much water is coming into and leaving the estuary. Since muskrats need a precise water depth to build their lodge (between .30 and 1 meter), this makes them very sensitive to changing water depths.

To monitor muskrat activity, volunteer monitors search the estuary by zone in a kayak or canoe to locate lodges. Monitors record lodge coordinates and dimensions, whether the lodge is active or inactive, the type of vegetation used, water depth, and weather data. Comparing data across years helps Old Woman Creek NERR understand how the type of vegetation used to construct lodges might change over time and how water depth and climate conditions might impact muskrat activity.

**VEGETATION USED TO CONSTRUCT LODGE 2016**
Percent of each aquatic vegetation species used to construct muskrat lodges in the OWC estuary in 2016. These data reflect that muskrats prefer to use dominantly cattail for lodge composition.

![Vegetation Used to Construct Lodge 2016](image)

**Water depth compared with volume for lodges recorded in the OWC estuary in 2016 and 2017. These graphs show a concentration of lodges between 0.4 and 0.8 m, with some of the largest lodges recorded in approximately 0.6 and 0.7 m water depth.**

![Water Depth vs Lodge Volume Graphs](image)
The North American beaver (*Castor canadensis*) is the largest rodent in America, weighing up to 60 pounds. Beavers are also excellent swimmers but unlike muskrats, beavers have wide, flat tails that act as a rudder to swim and stabilize themselves. Beavers are second only to humans in terrestrial engineering, since they can quickly modify the environment. This is attributed to their large, strong teeth that are efficient at felling, or cutting down, trees, as well as their semi-opposable thumbs, which allow them to manipulate landscapes in a short period of time. Their extreme impact on the surrounding environment makes them a keystone species.

Beaver lodges and dams are made out of sticks and branches and are packed down with mud. Lodges usually consist of a central chamber and an underwater entrance. If fully constructed, dams can reach the other side of a water body and significantly reduce water flow causing a pond of still, deeper water to form. This can create a very unique habitat for other types of organisms, like fish.

Beavers had not been recorded in the Old Woman Creek estuary for years until 2015, when signs of activity and lodge construction indicated their presence. Currently, beaver activity monitoring consists of recording lodge dimensions, water depth, and checking motion-capture trail cameras. Monitors also record weather data and write down any signs of new chews, felled trees, slides, and tracks to indicate recent activity.

In July of 2017, the camera traps revealed that not only was one beaver living in the estuary, but it had a mate and three kits, or young. Monitoring takes place year-round – further data collection intends to assess how the beavers respond to a changing environment. Preliminary data suggest an increase in lodge construction activity as water depth decreases.
FUTURE MONITORING

The species monitoring program is planning for its annual trainings on species monitoring protocol and recruitment of volunteers. With enough support, Old Woman Creek staff hopes to eventually incorporate additional species initiatives into the program, such as reptiles.

The Old Woman Creek NERR Phenological Species Monitoring Program would not exist if it were not for the dedicated individuals who have devoted so much of their time to monitoring these important species and assessing their findings. Volunteers fluctuate by initiative and through the seasons but the program typically has about 20 participating volunteers each year, although many interested citizens attend the seasonal trainings. Old Woman Creek NERR staff would like to thank all of the volunteers who have devoted their time and efforts to this program – particularly Steve and Mary Hill – as well as the seasonal interns who helped develop and modify protocol, including Holly Latteman, Kelly McCurry, Alaina McCleary, and Andrew Wilk. Special thanks to Bill Pifer for his help with establishing salamander and bald eagle monitoring sites.

ABOUT THE AUTHORS

Holly Latteman is a graduate student in the Environmental Studies Program at the Ohio University Voinovich School of Leadership and Public Affairs in Athens, Ohio; Alaina McCleary is an Environmental Studies undergraduate at Washington College in Chestertown, Maryland. Both students worked as phenological species monitor interns at Old Woman Creek NERR and used their knowledge of and passion for the environment to contribute to this technical bulletin. Content compiled and submitted by the Old Woman Creek NERR Coastal Training Program.

REFERENCES


Ohio Department of Natural Resources Division of Wildlife. 2017 (updated). Ohio’s Listed Species: Wildlife that are Considered to be Endangered, Threatened, Species of Concern, Special Interest, Extirpated, or Extinct in Ohio. Publication 5356 (R0917) Web: http://wildlife.ohiodnr.gov/portals/wildlife/pdfs/publications/information/pub536.pdf


Additional Resources

The National Estuarine Research Reserve System – NOAA Office of Coastal Management
Web: https://coast.noaa.gov/nerrs/

Ohio Department of Natural Resource Office of Coastal Management
Web: http://coastal.ohiodnr.gov/
Old Woman Creek National Estuarine Research Reserve (OWC NERR) is managed as a cooperative partnership between the Ohio Department of Natural Resources (ODNR) Office of Coastal Management and the National Oceanic and Atmospheric Organization (NOAA), located on land owned by ODNR Division of Natural Areas and Preserves. OWC NERR is one of 29 coastal reserve connected nationally through NOAA to address state and regional coastal management needs through research, education, and stewardship. The National Estuarine Research Reserve System uses its network of living laboratories to help understand and find solutions to crucial issues facing America’s coastal communities.

The mission of OWC NERR is to improve the understanding, stewardship, and appreciation of Great Lakes estuaries and coastal wetland ecosystems. Integrated Reserve research, education, training, and stewardship programs address threats to Great Lakes coastal wetland ecosystems including nonpoint source pollution, aquatic invasive species, habitat loss, and climate change. OWC NERR provides laboratories for ecological research, education, and training to support decisions and actions that benefit Lake Erie ecosystems.

OWC NERR publishes the OWC NERR Technical Bulletin series to provide constituents with information derived from Great Lakes coastal research, management, education, and outreach projects conducted in partnership with and/or at OWC NERR.

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The Old Woman Creek National Estuarine Research Reserve is part of the National Estuarine Research Reserve System (NERRS), established by Section 315 of the Coastal Zone Management Act, as amended. Additional information about the system can be obtained from the National Ocean Service Office for Coastal Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 1305 East West Highway – N/ORM5, Silver Spring, MD 20910.