Turtles

Turtles are culturally and ecologically important to the Little River Band of Ottawa Indians (Little River) community. Clan members that are associated with turtles are part of the Miishiki Dodem (Turtle Clan), and eastern box turtles (*Terrapene carolina carolina*) are a species of species concern to Little River and the state of Michigan. In the Great Lakes region, eastern box turtle numbers have been declining in recent years due to disturbance, habitat loss, and predation. Though the adult turtles have a hard shell that protects them from predators, individuals are extremely vulnerable as neonates and before hatching.

Mostly found in mixed forests, the female eastern box turtle will dig a hole in sandy soil to lay her eggs in early summer. After she deposits the eggs in the nest, she covers them back up with the soil and departs, leaving the eggs unguarded until they hatch in the fall. As the nest is not very deep, the eggs inside are susceptible to being dug up and eaten by local predators. The most common nest predators are raccoons, opossums, and foxes, but there are many more. Frequently, the eggs are dug up and predated as soon as the mother leaves the nest. However, they remain defenseless throughout the entire period in the nest. Neonates are not much larger than a quarter when they emerge, leaving them very vulnerable to predators.

To combat this predation risk, the Little River Wildlife program build exclosures to place around the nest, protecting the eggs from predators. By burying the exclosures around the nest, predators are unable to access the eggs, and the turtles are given ample opportunity to fully develop and hatch safely. Once hatched, the Wildlife biologists dig up the exclosure and release the newly hatched turtles in a safe place. This allows the developing turtles to avoid their highest risk of mortality in their most vulnerable state, and adds new individuals to the local eastern box turtle populations.

In 2019, Little River's Wildlife program surveyed for turtles 32 days and was able to safeguard 18 total nests with exclosures. Ten of the protected nests hatched, yielding 42 turtle neonates that were protected from nest predation. In 2020, Wildlife surveyed for 13 days and nine nests were protected with exclosures. Five of the protected nests hatched, yielding 22 neonates. This conservation work strives to increase the number of breeding adult turtles to help the eastern box turtle populations rebound from recent losses.

Little River Wildlife staff will also place protective exclosures on other turtle species of special concern, including wood, Blanding's, and spotted if found. Efforts are also being made to research habitat needs of these turtles to better manage for long-term sustainable populations.

Exclosure to protect nests from predation.

Recently hatched eastern box turtle neonates.

Adult female eastern box turtle.

Adult wood turtle.

Collaborative research projects with Grand Valley State University

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Work-in-progress

Eric McCluskey PhD, Grand Valley State University Post Doc

Modern landscape management for rare species requires addressing current threats associated with habitat loss and fragmentation while considering the ongoing impacts of climate change. Conservation actions aimed at mitigating the negative impacts of fragmentation such as corridor creation can also contribute to adaptation strategies for climate change by providing dispersal routes to newly suitable habitats. In many cases, however, the rapidity and breadth of climate change induced loss of habitat suitability may outpace the dispersal capabilities of at-risk species. For these species, climate change adaptation strategies will need to focus on in situ habitat management to boost the resiliency of local populations. Potential actions include landscape management that enhances habitat features most likely to be negatively impacted by climate change or assists predicted behavioral modifications of the resident population. Enacting these strategies requires detailed knowledge of where populations of rare species occur, habitat connectivity, and how predicted climate change may alter the suitability of occupied areas.

Four of Michigan's turtle species (Blanding's, box, spotted, wood) may be particularly vulnerable to impacts of climate change as they are already experiencing widespread population declines and have been designated as Species of Greatest Conservation Need (SGCN) in Michigan. Three of these species (Blanding's, spotted, wood) are candidates for federal listing under the Endangered Species Act (ESA). Michigan is the only Midwest state with populations of all four species, placing it at the forefront of regional conservation efforts for these imperiled turtles. The Manistee National Forest (MNF) and LRBOI Tribal Land region in northwest MI is one of the few

places in North America where these species co-occur, offering a unique opportunity to evaluate habitat availability, connectivity, and predicted climate change impacts for each species within the same landscape context. Regional impacts of climate change will likely affect each species differently due to specialized habitat requirements and the relative position of this region within each species' range. The ranges of box and spotted turtles extend into the southern US and are close to the northern limits of their statewide distribution in the MNF/LRBOI region whereas Blanding's and wood turtles have temperate distributions from the Great Lakes region into New England. Wood turtles are close to their southern statewide limit within MNF/LRBOI Tribal Lands making them perhaps the most sensitive species of this group to rising temperatures.

We will use species distribution modeling (SDM) to map suitable habitat and assess the potential impacts of climate change on these species with an emphasis on predicted changes within the MNF/LRBOI Tribal Lands region. Statewide habitat-focused SDMs will be developed for each species with the software program MAXENT using statewide occurrence data and biologically relevant remotely sensed/GIS layers. These will be used for subsequent surveys to validate model predictions and update distribution maps for each species. Resulting habitat maps will be used for patch-based connectivity assessments. A subset of individuals located during our surveys will be outfitted with radio-transmitters and tracked to obtain movement data that will improve our connectivity assessments by showing how individual turtles navigate barriers and locate resources. The climate SDMs will incorporate range-wide occurrence data for each species to represent the range of climatic conditions in which they can persist. These will be constructed based on current climatic conditions and then projected under different future climate scenarios to visualize potential shifts in species distribution. This will enable us to evaluate how suitable the MNF/LRBOI Tribal Lands region will remain for each species under a range of potential climate change scenarios and identify the primary climatic attributes responsible for range limitations. This may be especially important for the three species (box, spotted, wood) at/near statewide range edges within the MNF/LRBOI Tribal Lands region.

Spatial ecology of the adult and neonate eastern box turtle in a forested landscape

Patrick Laarman, MS student 2017

A thorough understanding of spatial ecology is fundamental when developing and implementing conservation strategies for imperiled turtle species. I investigated spatial ecology of adult and neonate eastern box turtles in the Manistee National Forest (MNF), Michigan. My primary objectives were to evaluate relative habitat preferences of adults and document residency time of neonates in natal openings. I radio-fitted 25 adults, protected 64 nests, and radio-fitted 66 neonates. Mean home range size for adults (n = 25 turtles) was 16.4 ha ± 2.4 SE (100% Minimum Convex Polygon). I detected non-random habitat use by adults (Wilks $\Lambda = 0.202$, df = 4, P = 0.001 by randomization) at the home range versus available landscape scale. Upland broadleaf forest ≤250 m to wetland and upland openings were most preferred relative to 5 available habitat types. Most (23/25, 92.0%) adult turtles were initially captured in uplands but 21/25 (84.0%) subsequently maintained home ranges that included wetland habitat. Distances to edge and water within adult home ranges were closer than distances to edge and water within available landscape (Wilcoxon signed-rank tests, $P < 0.001$). Mean nest emergence date was 18 September. Neonates did not move far (= 19.9 m ± 2.4 SE) before overwintering and 24/46 (52.1%) overwintered within their natal opening. Neonate dispersal and overwintering habitat use were associated with distance from nest to nearest forest edge and date of nest emergence. In their second activity season, neonates were sedentary in early spring (= 0.7 m/d ± 0.1 SE) but movements increased >600.0% in June and July. By 1 July, all radio-fitted neonates had vacated their natal openings. Maintenance of existing nesting habitat and creation additional nesting habitat near wetlands should be a priority when considering conservation approaches for box turtle populations in the MNF. Land managers should be aware neonates reside in or very near natal openings for several months after nest emergence.

Nest-site selection and neonate survival of eastern box turtles (*Terrapene carolina carolina*) in Michigan's northern Lower Peninsula

Joseph Altobelli, MS student 2017

Turtles (Order Testudines) are experiencing global declines largely due to anthropogenic influences such as habitat fragmentation, illegal collection and sales, and the threat of global climate change. Removal of individuals from the adult age-classes means there is now a greater need to understand the survival of neonate and juvenile turtle age-classes. In this study I examined a population of eastern box turtles (*Terrapene carolina carolina*) at the northern limit of their range in Michigan's lower peninsula. The objectives of my thesis were 1. to determine the microhabitat factors that influence nestsite selection by female box turtles and how selected microhabitat and environmental factors affect box turtle nest success and 2. create known-fate annual survival estimates for hatchling box turtles through the first year of life. Box turtles select nest sites with a higher percent of bare soil and lower amounts of understory vegetation compared to random sites and avoid nesting on north facing slopes. Larger clutch sizes as well as a lower percent of bare soil at the nest site increased the probability of nest success. Depredation and exposure to suboptimal environmental conditions were the primary sources of neonate mortality from 2013-2015, and annual survival estimates for neonate box turtles predicted survival to decrease through the first year of life with a steep drop in the probability of survival from nest emergence in the fall, before leveling off at 50% for overwintering (day 50 = .503; SE = 0.067), then gradually decreasing again with spring emergence till reaching 0% survival short of the 1 year mark (day 335 = 0.0). Similar studies should be conducted across the geographic range of eastern box turtles to better understand the major threats to the survival of other box turtle populations.

Growth rates and climate influences on neonatal eastern box turtles after egress following their first overwintering

Kirk Luca, Undergraduate student 2014

Eastern box turtles (*Terrapene carolina carolina*; EBT) are uncommon in the Great Lakes region and are protected in Michigan as a species of special concern. Like many reptiles, little is known about hatchling EBTs, particularly growth and survival of neonates following egress from overwintering. We monitored growth in neonatal EBTs in Manistee National Forest using radio telemetry to locate turtles. During the neonates first overwintering they lost approximately 10% of their body weight. Each neonate had overwintering refugia of varying depths; these depths did not correlate with how much mass was lost. The mean weight for turtles alive four weeks after egress was 7.9936 g with a 0.142 standard error. The absence of a significant weight gain may be the result of adverse weather conditions during the study. This may have led to a lack of readily available food and difficulty in foraging. It is critical to understand those factors that affect growth rates to promote longevity in EBTs to ensure they reach maturity.