American marten

American marten (*Martes americana*) are charismatic mammals in the weasel family. Clan members associated with marten are members of the Wabizhashi Dodem (Marten Clan), and are known as warriors, hunters, and gatherers. Marten are both ecologically and culturally significant to the Little River Band of Ottawa Indians (Little River) community and are a species of concern to Little River. Restoration and stewardship of native species, such as marten, is a high priority for Little River, as is the Native culture, harmony, and connectedness to the natural world.

Marten were once found throughout the Great Lakes Region, but were extirpated from Michigan during the early 20th century due to habitat loss and overharvest. In the late 20th century, marten were reintroduced to Michigan. Populations in the Upper Peninsula have thrived, but those in the Lower Peninsula have been less successful. Little River, in collaboration with other organizations, is researching marten to better understand the status of the reintroduced populations and enact proper management strategies to promote healthy marten populations in Michigan.

Marten in an oak tree.

Marten kit near its den.

Marten using a tree cavity for a resting site.

Remote camera image of radio-collared female marten with kit.

Collaborative research projects with
Grand Valley State University

Identification of American marten prey species using DNA barcoding

Work-in-progress

This project is a collaboration with Little River, University of Minnesota Duluth, and Grand Valley State University.

Marten occupy a variety of habitat types in the Great Lakes region ranging from typical boreal in NE Minnesota to earlier successional deciduous and plantation red pine in the NLP. The most likely commonality across the diverse habitats suitable to marten is an adequate prey base. Marten are highly sensitive to prey availability as limited fat reserves and high metabolic needs require them to hunt or forage frequently (Buskirk and Harlow, 1989), and population declines have been linked to prey availability in Ontario (Thompson and Colgan, 1987; Fryxell et al., 1999). However, we

have limited data on what prey species marten are consuming in the NLP and MN. Marten occupy a large geographical range, therefore, data from other regions may not be applicable across their entire range (Martin, 1994). Prey species often identified as being important food items for marten, such as red-backed voles (Bull, 2000), are not prevalent where marten occur throughout Michigan (Haskins et al., 2020). Grey squirrels, which played an important role in NLP marten diet (Kujawa pers. commun.) are not present in NE MN. Additionally, the information we do have (Kujawa pers. commun.) indicates that species not previously documented, as being part of marten diet (e.g. eastern mole) may be important to kit-rearing females in the NLP.

Climate change is predicted to shift the distributions of many ecological communities northward in the northern hemisphere (Lawler et al. 2009). This will require resource managers to adapt their management of wildlife species to maintain habitat providing food and cover in altered ecosystems. To do this, managers must have the most complete understanding of a species' ecology and life history requirements as possible. The less complete our understanding, the harder this adjustment will be. Climate change has apparently already caused range shifts in some marten prey species within the NLP (e.g. snowshoe hare, Burt et al., 2017) and will likely have more extreme impacts on the distribution and abundance of marten prey species in the future. This means that "typical" marten habitat in NE MN will almost certainly be altered by climate change, likely leading to habitat and prey bases more similar to what occurs currently in the NLP. A comparison between the diet of marten in NE Minnesota and the NLP will also provide insight into the impact that the presence of sympatric fishers potentially has on marten diet. Dietary competition with fishers has been suggested as a limiting factor for marten populations in WI (Manlick et al 2017). There is currently no known established population of fishers in the Lower Peninsula of Michigan, but a small number of individuals have been detected in the past few years (Jill Witt, pers. commun.). If a resident population of fishers become established in the NLP, a fuller understanding of marten diet before this competition begins will be invaluable.

Managing a sustainable population of marten across the Great Lakes region requires a better understanding of current marten diet. This understanding will inform marten habitat management prescriptions in the face of changing prey availability caused by climate change, natural succession, forest management practices, and other anthropogenic influences.

Factors influencing winter rest site selection of American marten in Western Great Lakes Region

Taylor Velander, MS Student work-in-progress

This project is a collaboration with Little River, University of Minnesota Duluth, and Grand Valley State University. Our objectives are to evaluate how differences in climate, snowpack, and tree cavity characteristics across the Western Great Lakes influence winter rest site selection of martens. We will focus on two different study areas where previous studies on marten rest site selection were conducted: 1) the Manistee National Forest in the lower peninsula of Michigan, where there is limited snowpack and martens primarily rest in tree cavities during winter (Sanders et al. 2017); and 2) the Superior National Forest in northeastern Minnesota, where the snowpack is deep and martens primarily rest under the snow during the winter (Joyce 2013). The mechanisms underlying differences in rest site selection of martens in these two study areas is not known but is predicted to relate to differences in snowpack or climate between the study areas.

At each study area, we will collect field data on snow characteristics, weather, subnivean temperatures, and temperatures within tree cavities and leaf/branch nests. Field data will be used to develop and test mathematical models to estimate temperatures within rest sites that were identified during the previous studies and compare the temperatures within different types of rest sites between the two study areas.

Using occupancy modeling to estimate American marten distribution in Michigan's Lower Peninsula

Maria Weston, MS Student work-in-progress

Little River's Natural Resources Department (NRD) in, collaboration with Grand Valley State University (GVSU), is surveying the northern Lower Peninsula to model marten occupancy. This project will allow us to estimate marten distribution in Michigan and be better stewards.

In 2019, LRBOI began a three-year survey for marten in areas predicted to have a high probability of use by a resource selection function created for Michigan's northern LP. Each survey site consisted of a set of two remotely triggered cameras, each facing a tree painted with a reference scale to the north and south. The northern scale tree was lured with salmon oil to improve detection (Figure 2). Each set was left for four weeks and then moved to a new location between May-September. A total of 488 sites were sampled and 914,872 images were collected. Images were identified by two reviewers and discrepancies were resolved by a third reviewer. Currently, data from 2019 and 2020 have been processed and we are still working on 2021 data.

Occupancy modeling is useful in predicting where marten exist and also provides an estimate of detection probability. We created single-season site occupancy models with each week during the four-week camera deployment designated as a separate sampling period. Preliminary results from occupancy modeling estimate a 22% probability of marten being detected when present and indicate marten were present at 8% of the surveyed locations. These numbers may seem low but are realistic due to the low founding population (86 individuals) and distance between the two reintroduction sites (over 150km apart) in the LP. Additional data from the 2021 field season and adding habitat characteristics to the models will improve these results. Currently, marten have been detected at 14 sites, including areas outside of the original reintroduction locations (Figure 3).

To obtain detection of marten in known occupancy locations, we fitted marten with GPS collars with a VHF component (Figure 4). We estimated 95% fixed kernel density home-ranges for collared marten and randomly selected one location within each home-range. At each selected location, we deployed a camera set using the aforementioned methods and visited these sites every four weeks to reapply lure and exchange SD cards. At known occupancy sites marten were detected within four weeks approximately 75% of the time (Figure 5). We have not yet split these data into week-long sampling periods to match the occupancy model detection rates, but we expect detection rate to be higher in a known occupancy area. Cameras were set within established home-ranges and GPS collars with a VHF component allowed for telemetry and downloaded locations to confirm marten were still alive and within their estimated home-range during the survey period.

Impacts of timber harvest and natural disturbance on American marten habitat

Work-in progress

Recently, several silvicultural treatments and a severe storm with high winds altered forests known to be occupied by marten in Michigan's Manistee National Forest. Our objective is to evaluate how silvicultural treatments and natural disturbance impact marten habitat use. We quantified marten habitat use with VHF telemetry data prior to the forest changes. Currently, we are deploying GPS collars on marten in areas silvicultural treatments or tree blow downs have occurred and will compare that to previous marten habitat use data. We will use the fine-scale GPS data to analyze how marten are moving throughout the landscape. Since October 2019, 17 GPS collars have been deployed and collected over 5,000 locations. Additional timber harvests are scheduled to occur in the Manistee National Forest in areas occupied by marten. Knowledge on how silvicultural treatments impact marten will be valuable to managers as they plan future forest management. Knowing how extensive tree blow downs impact marten habitat use will be valuable as climate change is likely to cause more frequent extreme weather events.

Detection Probability of the American Marten (*Martes americana*) in Michigan's Lower Peninsula

Taylor Root, MS Student 2020

In order to accurately manage for the sustainability of wildlife populations, we must first determine how to locate individuals of a population with great consistency. Determining the efficiency of detection techniques is a challenge, especially when the study species are scarce or elusive. Such is the case with the American marten *(Martes americana)*, a small mustelid found across the Northern United States and Canada. In the lower peninsula of Michigan, the marten is considered a species of concern, and the full extent of its range remains largely unknown. Our goal was to test the efficacy of motion-triggered cameras for detecting the presence of a reintroduced population of American marten in the Manistee National Forest. Marten were live trapped (n=9), fitted with small radio collars, and tracked from May 2018 to September 2019 to determine the extent of their home ranges. We then set two baited, motion-triggered cameras within those home ranges for four weeks to test the probability of detection. Cameras were moved and rebaited after each four-week period and were deployed for a calendar year to test for any differences in detection rates due to seasonality or camera placement. Despite a hypothetical expectation of an approximately 1.0 detection probability, actual probabilities were much lower (0.625), supporting the idea that non-detections should not always be associated with an animal's absence. Additionally, we found that marten were more likely to be detected during the winter (Oct.-Mar. – 0.683, Apr.-Sept. – 0.561), when cameras were located near the core of the individuals home range (in core – 0.655, outside core – 0.546), and when camera locations were chosen instead of randomly placed (chosen – .692, random – .385). This study reveals that camera traps alone are not efficient enough to consistently confirm a martens' presence, even when the cameras are placed in the home range of at least one individual. We recommend high camera densities and selective camera placement, as well as additional detection techniques such as track and scat surveys for increasing the overall likelihood

of detecting a martens' presence. This research should be used to strengthen any inferences made using camera trap studies in the future and will ideally provide wildlife managers and biologists with a framework for better detecting the American marten in Michigan's lower peninsula.

Characteristics of American marten habitat: A resource selection function for Michigan's northern Lower Peninsula

Angela Kujawa, MS student 2018

I sought to create a resource selection function for American marten (*Martes americana*) to predict areas in Michigan's northern Lower Peninsula marten have a higher probability of using. I used radio collar data to estimate 95% fixed kernel home-ranges for marten in the Manistee National Forest. Using ArcGIS, I measured characteristics potentially indicative of marten resource selection within the home-ranges marten selected and areas within the Manistee National Forest marten did not select. To validate my resource selection function I used cameras and credible sightings, which confirmed at least ten marten sightings in areas predicted to have a high probability of use and none in medium or low probability of use areas. My resource selection function predicted 37.6% of Michigan's northern Lower Peninsula had a high probability of use by marten.

Diets of kit-rearing female American martens in west Michigan: she ate what?

Cory Highway, Undergraduate student 2016

We studied the diet of kit-rearing female American martens due to the fact that their high metabolic rate makes caloric intake their largest limiting factor. Prey remains and scat were collected at den sites and remotely triggered cameras were deployed to collect data on preferred prey items. With this data we are able to understand the dietary needs of a female marten who is hunting for herself and up to 5 kits. The data shows that martens selected prey items that were easy to capture while still hunting for larger prey items which provided the bulk of their caloric intake. Gray squirrels (*Sciurus*

carolinensis) were found to provide the most calories in the martens' diet but small mammals such as white-footed mice (*Peromyscus leucopus*) were found most frequently in the diet analysis.

American marten denning behavior in Michigan

Melissa Nichols, MS student 2016

For my Master's I explored female marten denning behavior in both the Upper and Lower Peninsulas. We used radio telemetry to track female marten to den sites where we analyzed both the den structures used and the habitat surrounding those den structures. Additionally, we set up trail cameras at den sites to estimate litter size and activity patterns. We found that den trees were significantly larger than the trees that surround the den, bigger litters used larger den structures, and the basal area around den structures was significantly higher than the basal area of paired, randomly selected plots.

A comparison of American marten habitat use from data collected using VHF radio telemetry versus GPS telemetry

Macy Doster, Undergraduate student 2015

Our study focused on home range size and habitat use of individuals in the Manistee National Forest in Michigan's Lower Peninsula. Marten home range sizes vary from animal to animal, as population density, climate, and food availability are all factors to consider (Smith et al. 2002). Our understanding of wildlife habitat use and selection, and therefore our efforts to create or manage suitable habitat are based almost exclusively on research conducted using very high frequency (VHF)-based radio telemetry. We compared the habitat use for each animal based on conventional VHF telemetry and Global Positioning System (GPS) telemetry. The habitat type in which each point was in was used as an indication of habitat preference. VHF-based radio telemetry generally allows the researcher to locate an animal once a day up to once a week. GPS-based telemetry allows the researcher to collect locations as often as once

every half an hour, but the increased frequency comes with an increased cost of roughly ten times the cost of VHF transmitters. We conducted GPS telemetry by attaching GPS transmitters, small enough to use on an American marten, to a collar. The use of GPS collars increases the frequency of locations which will likely increase accuracy in our understanding of habitat selection. We evaluated whether the inferences regarding marten habitat use vary between VHF and GPS derived data. We found that these inferences do vary, which justifies the increased cost of GPS transmitters.

Resting site characteristics of American marten in the northern Lower Peninsula of Michigan

Bob Sanders, MS student 2014

The purpose of my research was to determine habitat structures important to American martens, identify characteristics influencing resting site use within marten home ranges, and to provide forest management recommendations to maintain and improve marten habitat in Michigan's Norther Lower Peninsula. Twenty-five martens were monitored using radio telemetry to identify what types of resting sites structures were used. We identified 522 unique resting site structures; tree cavities (n = 255), branches (n = 162), and nests (n = 90) were the three most commonly observed structures being used. During the summer season (April-September) marten used more exposed tree branches (41.8%), while in the winter (October-March) they used more cavities (64.5%). Martens were observed using structures in live trees 86% of the time. Live trees used by marten included oak species (*Quercus spp*.), maple species (*Acer spp.),* and red pine (*Pinus resinosa*). Trees used as resting sites had significantly larger mean diameter at breast height (DBH) than the average DBH of non-resting site trees found at resting site locations. We also found that the average basal area in resting site plots was significantly larger than that found at control plots.

Genetic diversity of reintroduced American martens in Michigan's Lower Peninsula

Tamara Hillman, MS student 2014

My master's research focused on the genetic health of the reintroduced marten population in Michigan's Lower Peninsula. We genotyped marten from the two reintroduction sites, Manistee National Forest and Pigeon River Country State Forest, using 11 microsatellite loci. In particular we were interested in genetic diversity (measured through allelic richness), inbreeding, effective population size, and population structure. We found low average allelic richness, moderate levels of inbreeding, significant heterozygote deficiencies at multiple loci, and small effective population size estimates. Our results indicate the Lower Peninsula populations have the potential to further lose genetic diversity and continue to diverge. My thesis research served to highlight the importance of long term genetic monitoring in reintroduced populations.

Diet of kit-rearing female martens in northern Michigan

Angela Kujawa, Undergraduate student 2014

Our study focused on the populations in the Manistee National Forest in Michigan's Lower Peninsula and the Hiawatha National Forest in Michigan's Upper Peninsula. Food availability is a large limiting factor to American marten populations due to their high metabolism and low fat storage. This can be especially important for lactating females that may have up to five kits to sustain. Kit-rearing female martens were fitted with radio collars and radio telemetry was used to track them to den sites. Scat, prey remains and remotely-triggered cameras were used to identify diet components. We sought to obtain an understanding of reproducing female marten diets in order to maintain optimal marten habitat. We observed martens behaving as generalists, consuming many types of prey. Small prey were consumed more often, but large prey provided the majority of their caloric intake. Gray squirrels were especially important prey for lactating females. We documented consumption of eastern moles and the delivery of multiple prey to the den at the same time, both previously unreported for this species.

Den site characteristics and kit survival of American marten in Manistee National Forest Michigan

Rachel Hughart, Undergraduate student 2013

We tracked and documented the den sites and number of kits for three female American marten within Manistee National Forest from April through August 2013. Kits were monitored using remote, motion-triggered trail cameras, and kit activity times were documented. The mothers were located two to three times per week using radio telemetry. A total of 7 kits documented with only 6 surviving into the rigorous tracking season and only 4 known survivors into mid-July. Nineteen unique den sites were documented in three different areas of marten use (Olga Lake, Pine River and Caberfae), and 12 of those had cavities at ground level. All of the den structures were in live trees (84.2%), snags (10.5%) and fallen logs (5.3%). The average diameter at breast height (DBH) of den trees in each area were: Olga Lake-61.95cm, Pine River- 38.88cm and Caberfae-47.58cm. When each was compared to a randomly chosen tree within a random plot in the same area a significant difference was found for all three areas indicating selection for trees with a larger diameter. Basal area was not found be significantly different and neither did a comparison of the DBH of trees surrounding the den tree in comparison to the random plot (Caberfae is the exception to the latter, a significant difference was found.) Kit survival may be limiting the population but denning sites do not; however, management for mature hardwoods and pine stands is recommended.

Den site characteristics and kit survival of American marten in west Michigan

Danielle Bradke, Undergraduate student 2012

We documented kit survival and identified den sites used by six female marten in the Manistee National Forest from April through August 2012. Dens were located with radio telemetry and kits were monitored using remotely triggered cameras. Den site attributes were compared to random sites at the local and landscape levels. We

confirmed 28 unique den structures, including cavities in live trees (25), snags (2) and one down log. The mean diameter at breast height of den trees was approximately 55cm. Marten utilized dens within red pine stands significantly more than expected based on abundance. Kit survival does not appear to be limiting the population. However, we recommend maintaining large diameter hardwood trees with cavities and red pine stands as a management priority.

Status of reintroduced American marten in the Manistee National Forest within Michigan's northern Lower Peninsula

Julie Watkins, Undergraduate student 2011

We conducted a pilot study investigating the genetic structure of American marten (*Martes americana*) populations in Ward Hills and Caberfae in the Manistee National Forest. Using live traps, we captured 5 females and 6 males and drew blood samples for genetic analysis. Hair snares were also deployed in Caberfae resulting in samples from 17 red squirrels, 10 rodent and 8 possible marten. We extracted DNA from blood samples and amplified 5 microsatellite loci using the polymerase chain reaction. Using the program KINSHIP, we determined whether pairs of individuals were more likely to be parent-offspring, siblings or unrelated. We found 3 in Caberfae and 2 in Ward Hills who were likely to be parents and offspring, and 5 in Ward Hills that were more likely to be full-siblings. We calculated FST and found it was 0.14 with a p-value of 0.05, indicating that there was moderate genetic differentiation between the sites which suggests restricted dispersal and some loss of genetic diversity.