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Modified Student Summer Scholars Program

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Abstract

The American marten (*Martes americana*) is a small carnivorous forest mammal with a long, slender body found throughout northern North America. 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. This astute research can be used by the Little River Band of Ottawa Indians (LRBOI), the United States Forest Service (USFS) and the Michigan Department of Natural Resources (MDNR) to effectively manage marten habitat in Michigan.

Introduction

The American marten (*Martes americana*) is a long, slender-bodied, carnivorous mammal of the forest found throughout northern North America. In the early 20th century, American marten were completely eliminated from Michigan due to pelt sales and habitat loss caused by extensive logging (Williams et al. 2007). Through the Michigan Department of Conservation

reintroduction efforts of American marten were initiated in 1955 (Williams et al. 2007). In general, the American marten prefer mature old growth coniferous or mixed forests with a thick, well established understory of coarse woody debris, such as abundant shrub vegetation and fallen logs (Clark et al. 1987). In order to sustain marten populations, it is important to understand home range sizes and habitat selection. Our study will be beneficial in determining the most accurate practices of data collection in the future. We hope to expand our knowledge of the differences in habitat selection due to GPS and VHF telemetry techniques and present these findings to the LRBOI, USFS, and MDNR as an insight on management recommendations. Our study was focused in the Manistee National Forest in Michigan's Lower Peninsula.

Field Methods

In June, 2015 we set live traps throughout the Manistee National Forest, MI, which were baited with smoked pork and fish. Due to the inquisitive nature of martens, using "Gusto," a scent lure consisting of ground up skunk glands, attracted the animals to the baited trap (Minnesota Trap Line, Pennock, MN). The traps were covered with leaf, pine needles, and bark debris for the animal to use as bedding and protection from rain and wind. Once traps were set they were marked with flagging and the GPS coordinates were recorded (Kujawa et al. 2014). When an animal was captured, the trap was covered with canvas to lessen the amount of stress and then moved to the bed of the truck (Kujawa et al. 2014). A denim cone (Desmarchelier et al. 2007) was fastened around the end of the trap and metal poles were used to pry the door open. Once the animal entered the cone, a hand was used to confine the marten, and a breathing mask was placed over the animal's snout. The mask supplied oxygen and isoflurane to the animal; once sedated, the cone was opened and the animal was fitted with a radio collar. Each radio collar had a distinct frequency that was documented. Different health tests were evaluated, including temperature, heart rate and respiratory rate, which were monitored through the process. Once we were finished handling the animal, we placed the marten in a box flat on the stomach. When the marten was fully awake, alert, and moving, the door of the box was opened and the animal was released into the woods where it was trapped.

Lab Methods

Once the GPS and VHF location data were downloaded, I brought the data into ArcMap, a geographic information systems (GIS) software. After determining that both the GPS points shapefile and the vegetation shapefile were in the same coordinate system, I used the draw tool to create a minimum complex polygon (MCP). The polygon was then converted to a shapefile and was used to clip the vegetation layer so it was just large enough to include the GPS points. A new layer appeared in the table of contents and was titled "Veg_stands clip". The sum of acres for each vegetation type was determined by opening the attribute table for the new layer and using the statistics tool; the numbers were then recorded. A spatial join was used to display an attribute table that showed the number of points within each vegetation type. The proportions for point count and acres for each vegetation type were calculated and recorded (Tables 1-8).

Random points were selected from each set of data to simulate the number of points a researcher would have collected if they were locating the animal once per day using a VHF collar to locate it. Home ranges for each animal were calculated based on the full number of points collected by the GPS collar and the simulated data set from a VHF collar (Figures 1-4). Habitat use (% of total locations per habitat type) was compared to habitat availability (% of home range per habitat type) to determine habitat selection (indication of importance of habitat type).

Results and Discussion

We were able to trap and collar two animals during our study. The two other martens' data points were from previous studies (Kujawa et al. 2014).

The four marten that were trapped each had an identifying pit tag number (Tables 1-8). Animal 314 showed no differences in habitat selection between the VHF compared to what the GPS data indicated. We calculated the probability of a marten going into each habitat type based on the number of acres of that vegetation type divided by the total number of acres in the home range. If the animal had no preference in which habitat they spent their time , then the proportion of the home range would be close to the proportion of points within in that vegetation type. For animal 314, Table 1 shows that the Mixed Northern Hardwoods and Red Pine areas were

avoided and Sugar Maple-Basswood were preferred. Table 2 specifies the same information. For animal 314, the GPS and VHF conclusions were not different.

Animal 124's location information is in Tables 3 and 4. Table 3, showing 124's GPS data, indicates that Jack Pine habitat was preferred compared to the home range proportion. Out of 124's total number of GPS locations, 73.85% of them were located in habitat consisting of Red Pines. Whereas Table 4, shows no points in Red Pine. Table 4 also shows 124's VHF data, indicating that Jack Pine-Oak was heavily preferred.

In Table 5, animal 427's GPS data indicated that Red Pine is avoided, Sugar Maple-Basswood areas and Sugar Maple-Beech/Yellow Birch are preferred. Table 6 showed similar patterns when looking at the comparison between proportion of total locations and the proportion of home range. However, when looking at the comparisons between highlighted cells in Table 5 and Table 6, we can tell that they were different.

The final set of data that was analyzed came from animal 317. Animal 317's GPS data indicated that Jack Pine-Oak areas were avoided, where Mixed Pines and Red Pine were heavily preferred. From the VHF data we can infer that Jack Pine-Oak was preferred, along with Mixed Pines and Red Pine areas.

These differences in vegetation selection are variable and are primarily due to the random selection of the VHF points. Animal 314 data had little to no differences in data, overall. This contradicts our previous understanding of the increased accuracy in using GPS transmitters over the use of VHF telemetry. Although the values did change, there were not significant differences between the GPS and the VHF data. The overall acreage for the home range of the VHF points and GPS points had a difference that was less than 18% of the total number of acres.

The data for animal 124, had a higher variability than 314. The GPS data showed that the marten strongly preferred the Red Pine over anything else, but the VHF data had no points that were within the Red Pine areas. The VHF data also showed that Jack Pine was the highest preferred habitat type, but we have to consider the fact that there was no data for Red Pine areas. Also, the total acreage of the home ranges in the GPS data was more than 6 times greater than the home range of the VHF data. From this, we can infer that when home ranges are calculated from less points (data from VHF collars), it can underestimate the actual area that is being used by a marten.

The differences of the proportions of each animal varied greatly. This can be due to the completely randomized VHF points that were created, or it could even be possible that each animal had their own individual preferences that were not consistent with the other martens. There were differences both in habitat selection between martens and between estimates of habitat selection calculated from each data set. The avoidance of privately owned land illustrates the importance of US Forest Service ownership and of appropriate management of it. This can lead to underestimating the amount of suitable habitat needed to sustain a viable population of martens.

Based on our findings, it is vital to continue to gain insight in this area of research and to expand our knowledge on the efficiency of the tools and techniques that we use to conduct research. It is important to confirm that we are using the most accurate and effective practices, because if our practices are not accurate, then neither will our data. Also, we must remember that the American marten was reintroduced to Michigan for a reason, because the species had been eliminated. We must make knowledgeable decisions on management plans for their habitat because it is possible that if we don't maintain the marten's habitat appropriately, then they could be in danger yet again.

Acknowledgements

This project would not have been possible without the collaborative efforts of the Little River Band of Ottawa Indians, The Detroit Zoological Society, and The United States Forest Service and funding from the Student Summer Scholars program of Grand Valley State University.

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Table 1. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2015.

314 GPS Statistics

Veg. Type	Point Count	Proportion of total locations	Sum (Acres)	Proportion of home range
Bigtooth Aspen	1	0.33	26.17	1.07
Mixed Northern Hardwoods	2	0.67*	477.31	19.61*
Open	21	7.02	129.66	5.33
Quaking Aspen	0	0	10.27	0.42
Red Pine	29	9.7*	517.57	21.27*
Sugar Maple-Basswood	162	54.18*	747.88	30.73*
Sugar Maple-Beech/ Yellow Birch	84	28.09	519.46	21.34
Upland Shrubs	0	0	5.49	0.23
	299	**99.99**	**2433.81**	**100**

The * indicates that there was selection for or against that habitat type

Table 2. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2015.

314 VHF Statistics

Veg. Type	Point Count	Proportion of total locations	Sum (Acres)	Proportion of home range
Bigtooth Aspen	1	1.18	26.17	1.26
Lowland Shrubs	0	0	0.47	0.02
Mixed Northern Hardwoods	0	0*	363.53	17.56*
Open	4	4.7	115.21	5.57
Quaking Aspen	0	0	17.13	0.83
Red Pine	8	9.41*	420.45	20.32*
Sugar Maple-Basswood	49	57.65*	535.09	25.86*
Sugar Maple-Beech/Yellow Birch	23	27.06	586	28.32
Upland Shrubs	0	0	5.49	0.26
	85	**100**	**2069.54**	**100**

The * indicates that there was selection for or against that habitat type

Table 3. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2015.

124 GPS Statistics

Veg. Type	Point Count	Proportion of total locations	Sum (Acres)	Proportion of home range
Aspen	4	0.14	430.7	6.95
Eastern White Pine	13	0.45	116.06	1.87
Jack Pine	629	21.6*	628.34	10.14*
Lowland Shrubs	1	0.03	15.73	0.25
Mixed Oaks	14	0.48	183.36	2.96
Northern Red Oak	12	0.41	243.97	3.94
Open	5	0.17	63.5	1.03
Red Maple (Dry)	0	0	26.19	0.42
Red Maple (Wet)	0	0	2.41	0.04
Red Pine	2146	73.85	4260.43	68.78
Red Pine-Oak	81	2.79	47.46	0.77
Upland Shrubs	1	0.03	1.49	0.02
Swamp Conifer	0	0	39.3	0.63
Mixed Northern Hardwoods	0	0	96.49	1.56
Private	0	0	38.64	0.62
	2906	**99.95**	**6194.07**	**99.98**

The * indicates that those habitat types were selected for or avoided

The teal highlighted habitat types are those that the VHF data indicated different selection for or avoidance of compared to what the GPS data indicated. For example almost 74% of 124's GPS locations were in red pine, while none of the simulated VHF data points were in red pine.

Table 4. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2015..

124 VHF Statistics

Veg. Type	Point Count	Proportion of total locations	Sum (Acres)	Proportion of home range
Bigtooth Aspen	1	2.2	31.22	3.25
Eastern White Pine	1	2.2	76.94	8
Jack Pine	33	73.3	683.85	71.16
Jack Pine-Oak	8	17.78*	26.19	2.72*
Mixed Oaks	1	2.2	24.92	2.59
Mixed Swamp Conifer	0	0	36.84	3.83
Open	1	2.2	34.28	3.57
Private	0	0	37.74	3.93
Quaking Aspen	0	0	9.01	0.94
	45	**99.88**	**960.99**	**99.99**

The * indicates that those habitat types were selected for or avoided

The teal highlighted habitat types are those that the VHF data indicated different selection for or avoidance of compared to what the GPS data indicated. For example almost 74% of 124's GPS locations were in red pine, while none of the simulated VHF data points were in red pine.

Table 5s. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2014.

427 GPS Statistics				
Veg. Type	**Point Count**	**Proportion of total locations**	**Sum (Acres)**	**Proportion of home range**
Beech	7	2	117.53	1.8
Bigtooth Aspen	4	1.15	281.2	4.37
Black Cherry-White Ash/Yellow Poplar	0	0	28.85	0.45
Eastern White Pine	0	0	11.68	0.18
Jack Pine	1	0.29	16.5	0.25
Lowland Shrubs	0	0	0.8	0.01
Mixed Northern Hardwoods	38	10.9	246.62	3.84
None	2	0.57	934.01	14.5
Northern Red Oak	0	0	45.45	0.7
Open	5	1.43	241.17	3.76
Quaking Aspen	6	1.72	55.8	0.87
Red Maple (Dry Site)	1	0.57	27.99	0.43
Red Pine	54	15.47 *	1100.5	17.14 *
Sugar Maple	13	3.72	2.7	2.7
Sugar Maple-Basswood	76	21.78 **	877.8	13.67 **
Sugar Maple-Beech/Yellow Birch	142	40.69 **	2260.94	35.2 **
	349	**100.29**	**6249.54**	**99.87**

** Indicates habitat vegetation/habitat category being selected by marten calculated from data set Vegetation category “none” indicates privately owned land which was avoided calculated from either data set.

Table 6. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2014.

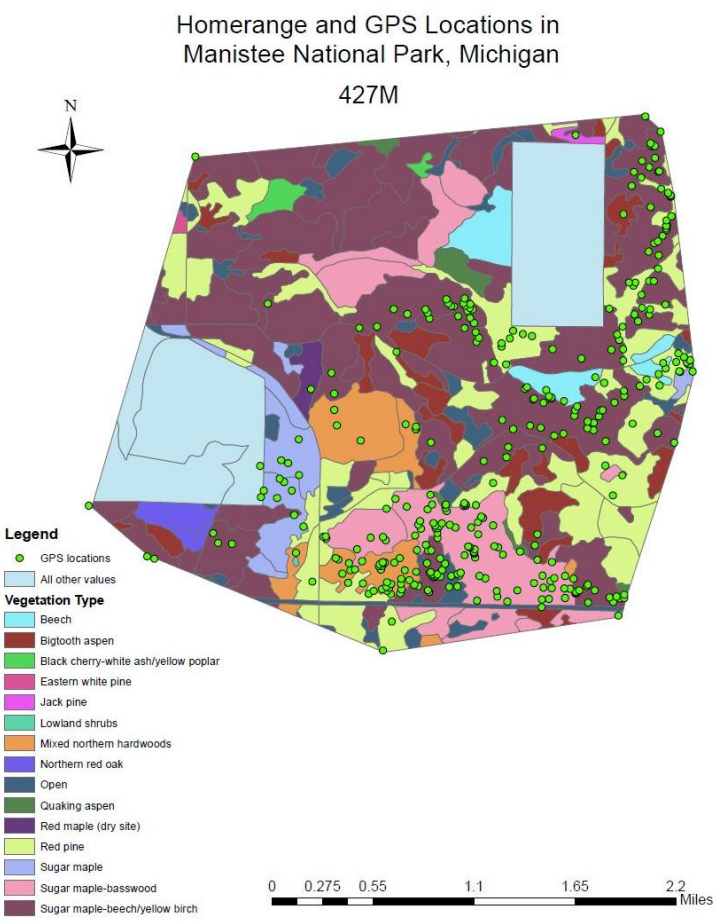
427 VHF Statistics				
Veg. Type	**Point Count**	**Proportion of total locations**	**Sum (Acres)**	**Proportion of home range**
Beech	0	0	117.53	4
Bigtooth Aspen	0	0	176.87	5.5
Mixed Northern Hardwoods	5	10.2	224.38	7
None	0	0	590.9	18.2
Open	0	0	112.12	3.4
Quaking Aspen	1	2	30.86	1
Red Pine	11	22.4 *	586.07	18 *
Sugar Maple	2	4	147.95	5
Sugar Maple-Basswood	9	18.4 **	287.8	8.9 **
Sugar Maple-Beech/Yellow Birch	21	42.8 **	960.14	29.7 **
	49	**99.8**	**3234.62**	**100.7**

Table 7. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2014.

317 GPS Statistics				
Veg. Type	**Point Count**	**Proportion of total locations**	**Sum (Acres)**	**Proportion of home range**
Black Oak/Scarlet Oak/Hickory	5	0.9	300.27	10
Jack Pine	76	13.7	704.67	23.8
Jack Pine-Oak	78	14*	480.87	16.3*
Mixed Oaks	2	0.4	48.55	1.6
Mixed Pines	39	7 **	63.56	2 **
None	21	3.8	448.99	15.2
Northern Red Oak	30	5.4	38.4	1
Open	0	0	24.26	0.8
Red Pine	290	52 **	781.35	26.4 **
Red Pine-Oak	14	2.5	45.85	1.5
Upland Shrubs	0	0	20.54	0.6
	555	**99.7**	**2957.31**	**99.2**

Table 8. Number of points, proportion of total locations, sum (acres), and proportion of home range were recorded in the forest ecosystem of Manistee National Forest in Michigan's Lower Peninsula. Data were collected in 2014.

317 VHF Statistics				
Veg. Type	**Point Count**	**Proportion of total locations**	**Sum (Acres)**	**Proportion of home range**
Black Oak/Scarlet Oak/Hickory	1	1.4	103.59	3.8
Jack Pine	8	10.9	686.2	25.8
Jack Pine-Oak	16	21.9*	442.37	16.6*
Mixed Oaks	0	0	48.55	1.8
Mixed Pines	8	10.9 **	63.56	2.4 **
None	2	2.7	448.99	16.9
Northern Red Oak	2	2.7	38.4	1.4
Open	0	0	16.49	0.6
Red Pine	35	47.9 **	744.34	27.99 **
Red Pine-Oak	1	1.4	45.85	1.7
Upland Shrubs	0	0	20.54	0.7
	73	**99.8**	**2658.88**	**99.69**


Homerange and GPS Locations in
Manistee National Park, Michigan
427M
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GPS locations
All other values
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Black cherry-white ash/yellow poplar
Eastern white pine
Jack pine
Lowland shrubs
Mixed northern hardwoods
Northern red oak
Open
Quaking aspen
Red maple (dry site)
Red pine
Sugar maple
Sugar maple-basswood
Sugar maple-beech/yellow birch
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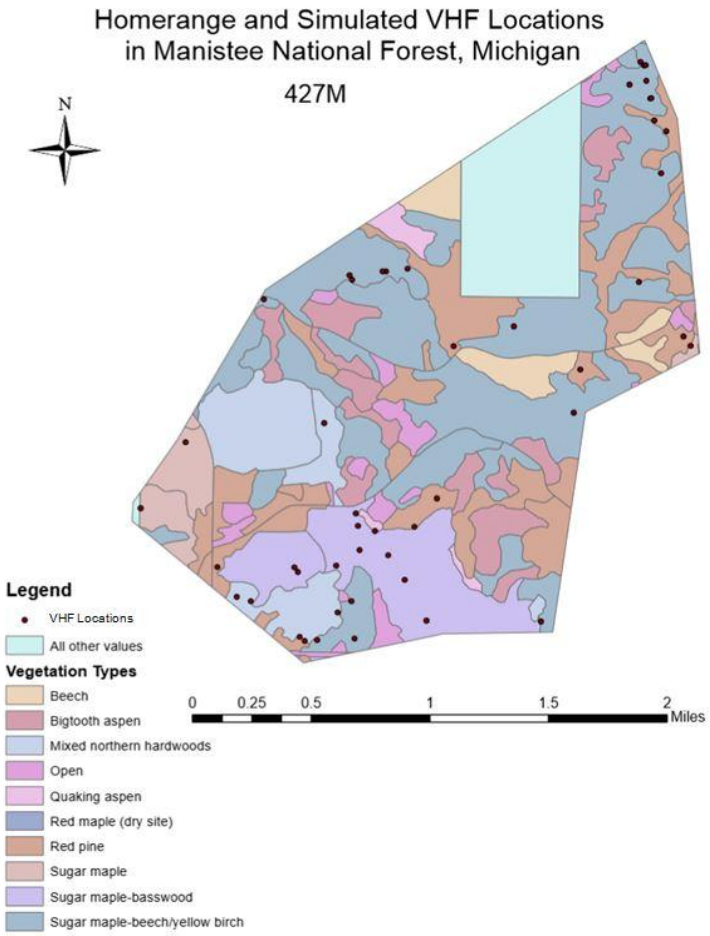
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All other values
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Open
Quaking aspen
Red maple (dry site)
Red pine
Sugar maple
Sugar maple-basswood
Sugar maple-beech/yellow birch
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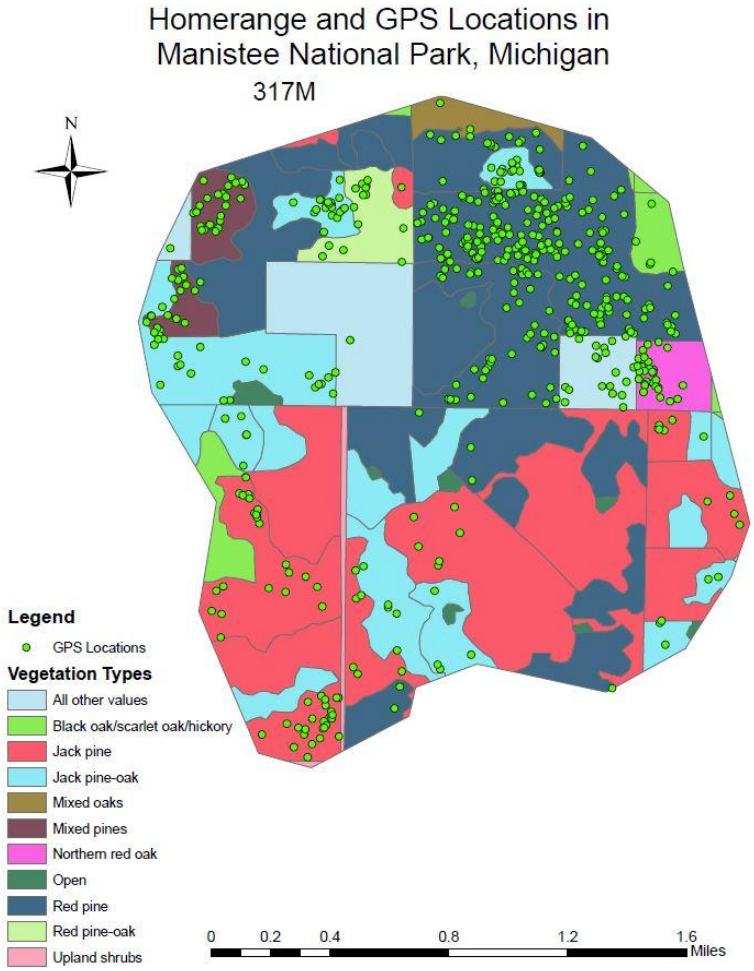
Miles

Figure 1.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N
Legend
GPS Locations
Vegetation Types
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Jack pine
Jack pine-oak
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Northern red oak
Open
Red pine
Red pine-oak
Upland shrubs
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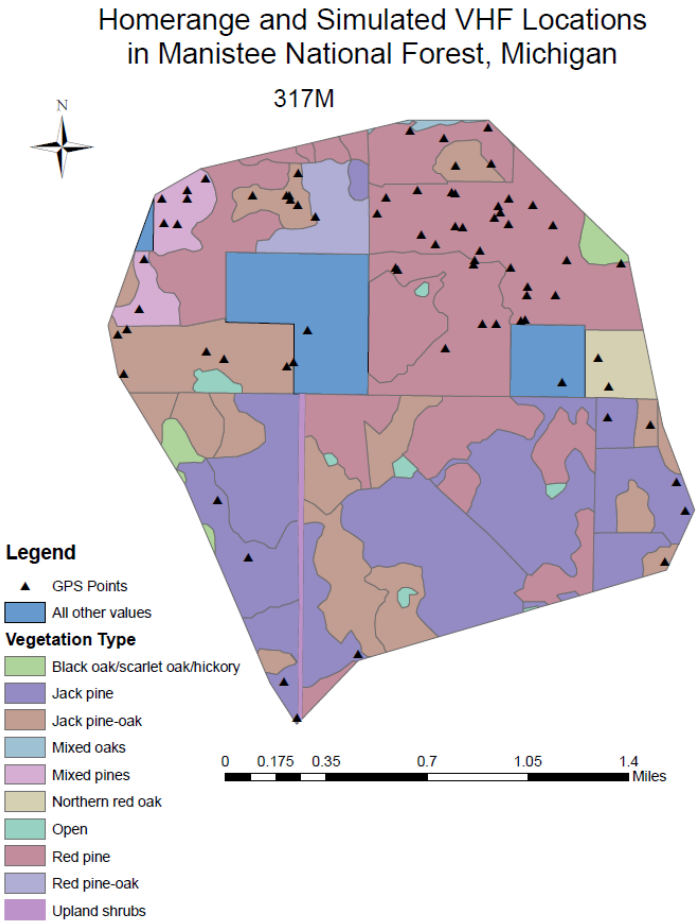
Miles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Legend
GPS Points
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Jack pine
Jack pine-oak
Mixed oaks
Mixed pines
Northern red oak
Open
Red pine
Red pine-oak
Upland shrubs
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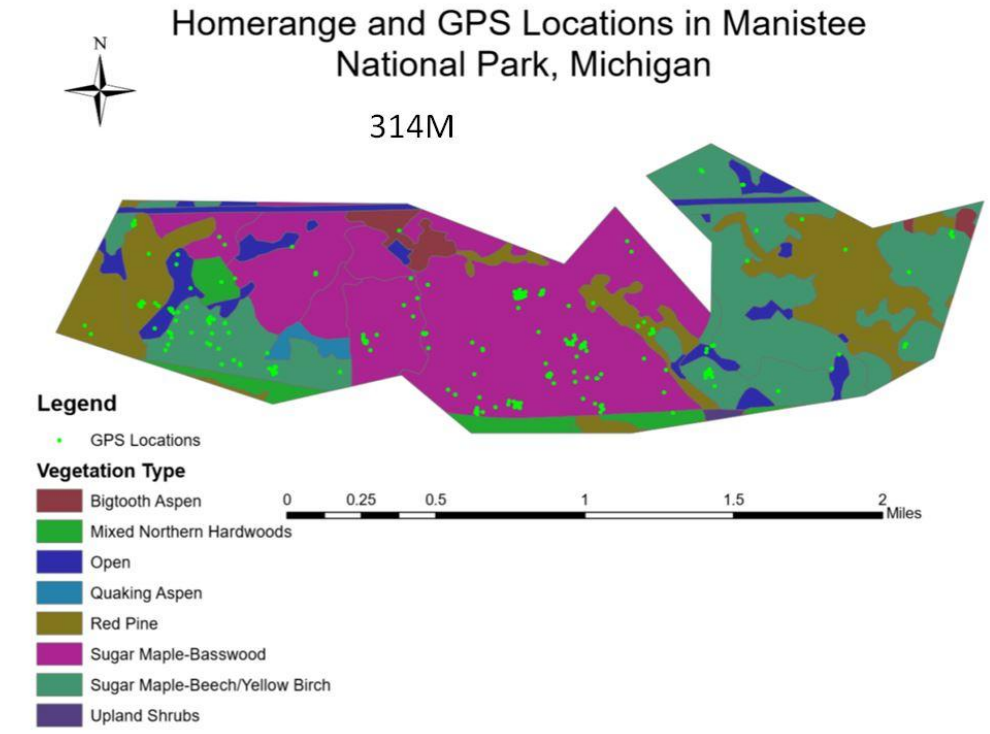
Miles

Figure 2.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GPS Locations
Vegetation Type
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Mixed Northern Hardwoods
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Quaking Aspen
Red Pine
Sugar Maple-Basswood
Sugar Maple-Beech/Yellow Birch
Upland Shrubs
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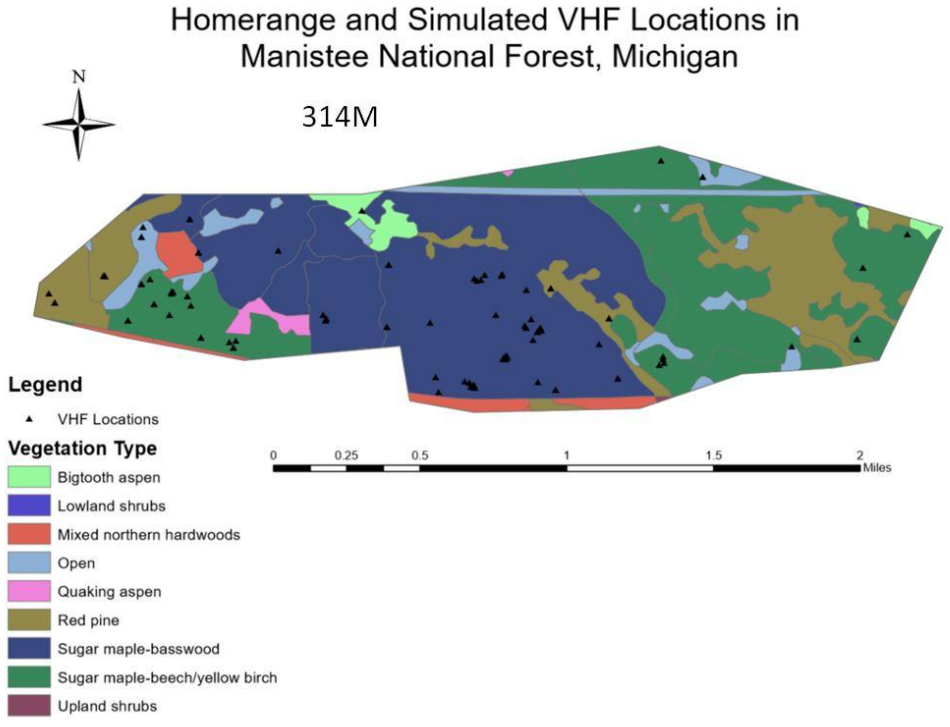
Miles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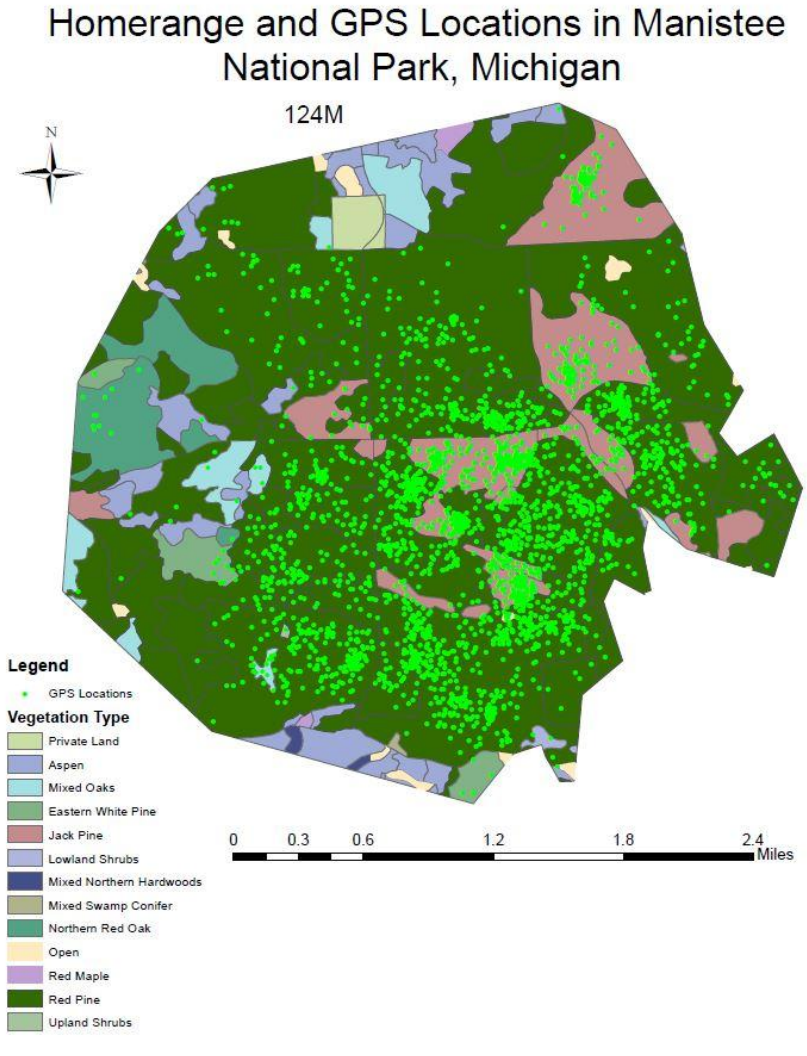
314M
N
Legend
VHF Locations
Vegetation Type
Bigtooth aspen
Lowland shrubs
Mixed northern hardwoods
Open
Quaking aspen
Red pine
Sugar maple-basswood
Sugar maple-beech/yellow birch
Upland shrubs
0 0.25 0.5 1 1.5 2
Miles

Figure 3.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Legend
GPS Locations
Vegetation Type
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Jack Pine
Lowland Shrubs
Mixed Northern Hardwoods
Mixed Swamp Conifer
Northern Red Oak
Open
Red Maple
Red Pine
Upland Shrubs
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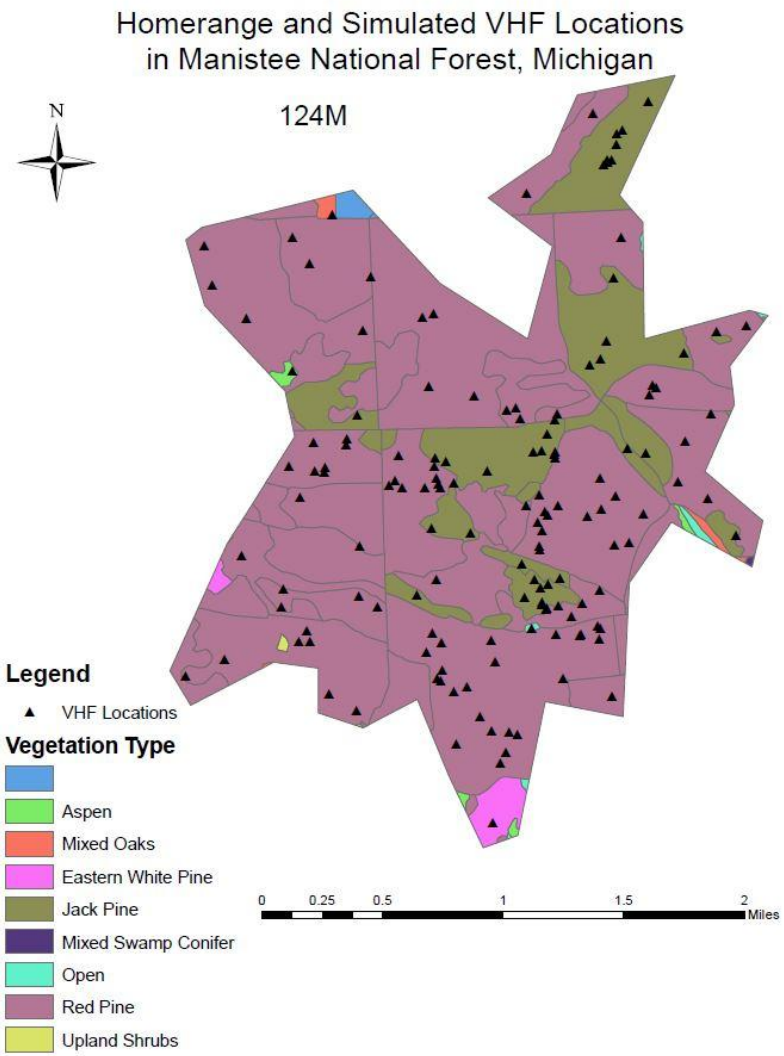
Miles


Homerange and Simulated VHF Locations in Manistee National Forest, Michigan
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Legend
VHF Locations
Vegetation Type
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Mixed Oaks
Eastern White Pine
Jack Pine
Mixed Swamp Conifer
Open
Red Pine
Upland Shrubs
0 0.25 0.5 1 1.5 2
Miles

Figure 4.