

**Home range of northern Michigan coywolf (*Canis latrans x Canis lupus*)**

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A coyote-wolf hybrid (*Canis latrans x Canis lupus*) was collared by the Michigan Department of Natural Resources in 2010. The coywolf has displayed many aspects of the behavior of a wolf, hunting in packs to bring down large prey. In the winter of 2015-2016 a photograph suggested that the coywolf had lost a forefoot. We asked how the loss of its foot would affect its behavior. Specifically, we hypothesized that the hunting range of the coywolf would decrease in size and the habitat it prefers would change to be more open, so that it had easier terrain to traverse. These predictions were confirmed; the hunting range decreased, and habitat preference switched to be more open, less forested areas ( $p < 0.05$ ).

In 2010 a young coyote-wolf hybrid (*Canis latrans* x *Canis lupus*) was trapped near the University of Michigan Biological Station in the northern lower peninsula of Michigan (45° 33' 34" N, 84° 40' 31" W). It was fitted with a Telonics, Inc radio collar by biologists from the Michigan Department of Natural Resources (MDNR), and the collar is still active in summer, 2016. MDNR has periodically studied it from 2010 to present (2016).

The hybrid animal, colloquially referred to as a coywolf, contains the chromosomal DNA of *C. latrans* and the mitochondrial DNA of *C. lupus* (Wheeldon et al. 2012). The animal is larger than a typical coyote female, has large feet, a trait found in gray wolves, and has previously displayed behaviors of a wolf rather than a coyote. The coywolf is known to hunt in packs, and to hunt large prey including white tailed deer (*Odocoileus virginianus*).

A photograph taken in winter of 2015-2016 by Prof. Nyeema Harris of the University of Michigan showed that the collared coywolf may have lost its front right paw. Local anecdotal sightings as well as a set of tracks found by Phil Myers of the University of Michigan Biological Station in an area known to be frequented by the animal support the idea that the coywolf lost a paw. We hypothesized that if the coywolf lost a foot, then the average distance it travels during hunting hours will decrease, and the habitat types that it uses will change.

## **Materials and Methods**

In this study, we combined MDNR data, which consisted of once-monthly locations determined from an airplane flying only during daylight hours, with limited nocturnal, ground-based observations made in 2012 and 2014 by classes from the Biological Station.

We used 2 receivers and directional antennae obtained from Telonics Inc (Mesa, AZ) to triangulate locations. Radio-tracking was carried out from July 2, 2016 until August 2,

2016 using a network of roads in the area. As in previous years, most radio-tracking was done at night, with teams attempting to locate the animal between 10 PM - 5AM. Teams also went out from 5-7AM and occasionally during the day.

We tracked the animal SE of the Biological Station in a 14 km<sup>2</sup> area. Within the area the coywolf occupied, a mixture of hardwood forest, coniferous forest, deciduous forest, wetland, and agricultural open land was present, with a creek (Koviak Creek) running through part of it.

Coordinates of the animal's location garnered from tracking were input into Google Earth to create maps to allow comparison of our data with previous data, and to allow us to track the progression of the animal from week to week. We used the Michigan IFMAP/GAP Land Cover Data to analyze the habitat cover of the data points of coywolf location. ArcGIS was used with the Convex Hull Method for calculating home range to determine the home range. To satisfy the assumptions of a chi-square analysis, we combined similar habitat types into habitat groups (Table 2).

## **Results**

The 2016 home range (14 km<sup>2</sup>) is substantially smaller than the combined 2010 – 2015 range (36.1 km<sup>2</sup>; Figure 1; Figure 2). The average hunting range on a single night was 0.22 km<sup>2</sup>, and the maximum single night hunting range was 2.20 km<sup>2</sup> (Figure 3).

Habitat use before the summer of 2016 differed from that during summer of 2016 in that summer 2016 included more time spent in agriculture open areas, and less time spent in forested areas (Pearson Chi-Square;  $X^2 = 24.521$ ,  $df = 3$ ,  $p < 0.001$ ; Figures 4 through 8).

## **Discussion**

The coywolf's habitat shifted from mostly forested areas (78% forest, 11% agriculture) prior to summer 2016 to include more open and agricultural land types (54% forest, 40% agriculture). The home range of the coywolf was reduced substantially from previous years as well. These changes are possibly due to its missing foot. Wolves (*C. lupus*) are capable, however, of recovering from a leg injury (torn ligaments and dislocated shoulder; Thiel 2000). Thiel's study wolf demonstrated sufficient hunting capability by killing and consuming a 5kg fawn by itself post injury; overall, deer consisted of 76% of its diet. This animal associated with other wolves and maintained dominance despite its leg injury (Thiel 2000). Rio Maior et al. (2016) followed two wolves post severe injury. Both wolves showed an initial decrease in home range, but steadily built towards a home range typical of other wolves in the area. Both wolves recovered physical ability, movement patterns, and use of space. The decrease in home range we see in our coywolf might be only temporary, then, if it is in the process of recovery.

Alternatively, the decrease in home range could be due the abundance of deer in the area. If an excess of food is available, the need to travel to find it would be reduced. Given that most of our data were taken during hunting hours in the night, another possibility is that the animal is more coyote-like in its behavior than originally believed. Much of the MDNR data were taken during the day and may be unrepresentative of the animal's actual hunting range. Lastly, our animal is 6 years of age. It could be unable to maintain former hunting ranges due to age. Both gray wolves and eastern coyotes, however, can live healthily much longer (8-13 yrs gray wolf, 9 yrs coyote) (Hoylan et al. 2005; Sacks 2005).

Data from 2010-2015 consisted of a combination of daytime points from MDNR and nighttime locations from Biological Station classes in 2012 and 2014. Our data in 2016 were primarily focused on the hunting hours, which is during the night (10 PM – 5 AM). A future

study of this animal should be done, tracking both during the day and the night. Comparisons should be made with our findings to see if the decrease in range we found remains consistent, or if the animal begins to expand its range to its former status. Comparisons should be distinguished between night and day, to see if daytime ranges (when MDNR gathers their data) differ from nighttime (hunting hours).

If the coywolf has changed its behavior in response to injury, then the ecological role it plays might have changed. Prior to leg injury, the coywolf displayed wolf-like behavior, including pack hunting, taking down large game like deer, and social communication via howling. Post leg injury, it is not apparent that any of those changed, but the home range has shrunk to a size more typical of a coyote (Baker, 1983). If other behaviors shift towards that of a coyote, then it would no longer be an apex predator, and instead be a potential risk to agriculture in the area. Increasingly found in agricultural lands, it may start hunting domesticated animals, though as of now we know of no reports of a coywolf attacking livestock in this area of Michigan.

Conversely, if the animal is not shifting to coyote behavior, its ecological impact would be different from that of a coyote. If instead of hunting like a coyote, it kept its current behavior of hunting wild deer like a wolf, then coywolves could fill the currently unoccupied role of an apex predator in Michigan's northern Lower Peninsula. If so, they would provide top-down control on the community, keeping deer populations in check. If that were the case, then they would functionally be a wolf, which is a protected species by the MDNR. More research needs to be done on coywolves, so that informed policy can be set in place, potentially protecting them as an apex predator.

Tables and Figures

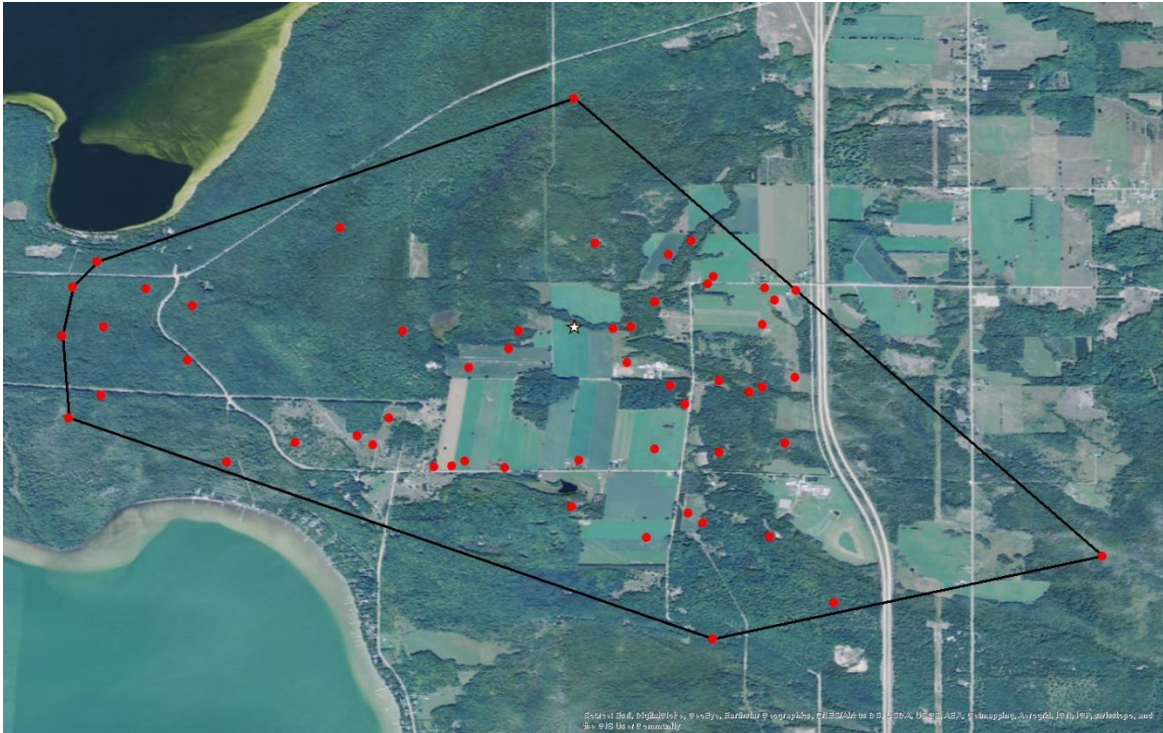
Table 1. Chi Square of Habitat Type ( $X^2 = 24.521$ ,  $df = 3$ ,  $p < 0.001$ ).

		Year Class		
		2010-2015	2016	Total
Forest	Count	83	30	113
	Expected Count	74.6	38.4	113
Agriculture	Count	8	21	29
	Expected Count	19.2	9.8	29
Other Open	Count	9	1	10
	Expected Count	6.6	3.4	10
Wetland	Count	7	3	10
	Expected	6.6	3.4	10
Total	Count	107	55	162
	Expected	107	55	162

Table 2. Habitat group contents

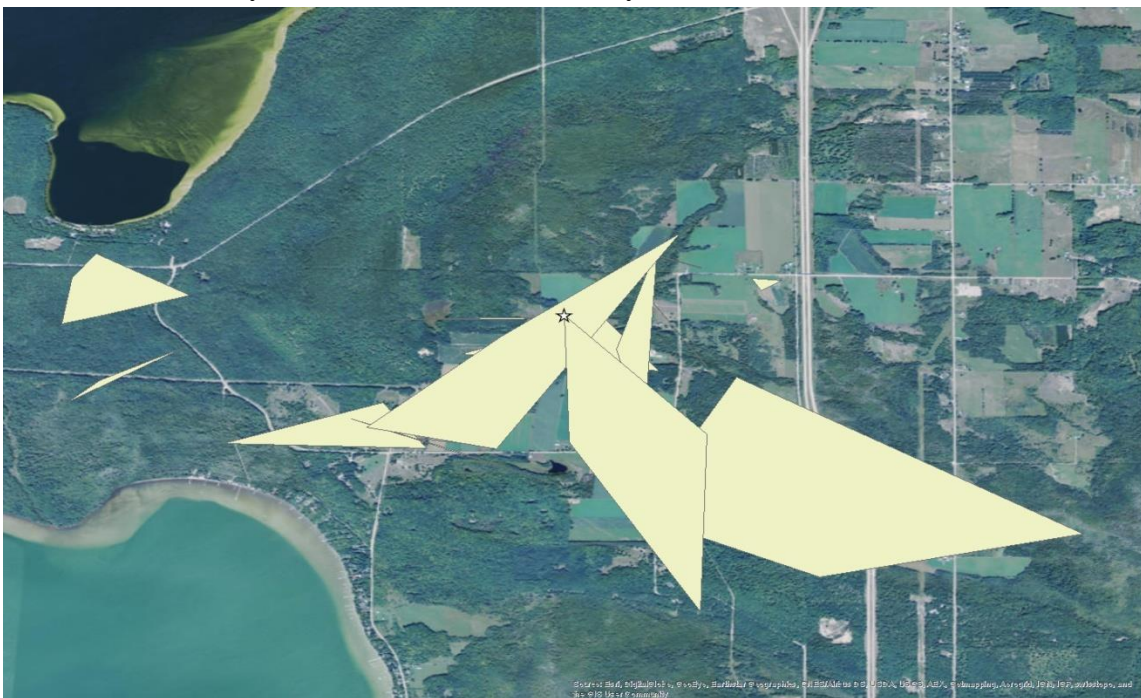
Group	Habitat Types
Forest	aspen types, lowland coniferous, lowland deciduous, lowland mixed, mixed upland coniferous, mixed upland deciduous, northern hardwoods, oak types, pine types, upland mixed conifer, other upland conifer
Wetland	emergent wetland, shrub wetland
Agricultural	forage crops, herbaceous open land, high intensity urban, roads, row crops
Other Open	sand/soil, shrub and low density trees





The white star is the animal's estimated den site.

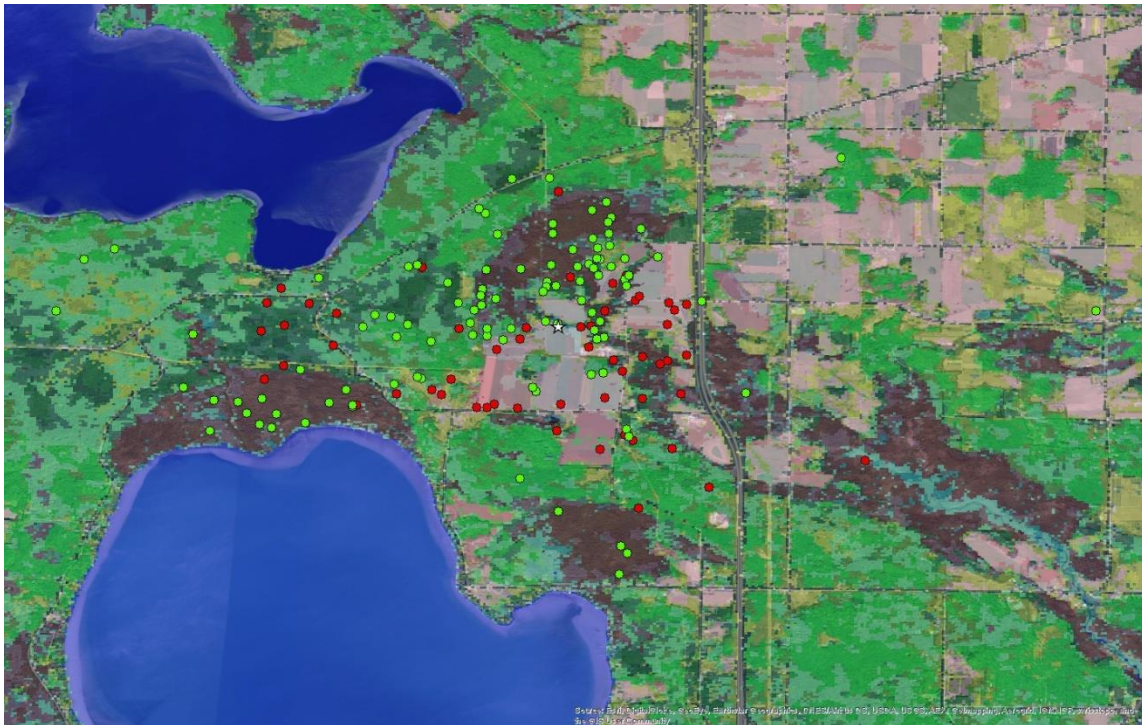
Figure 3. Area traversed by the coyote-wolf hybrid per day; Each green polygon represents the area traversed by the animal on a different day.



The white star is the animal's estimated den site. **Average Hunting Range= 0.2172 km<sup>2</sup>.**  
**Maximum Hunting Range= 2.1997 km<sup>2</sup>.**



Figure 4. Map of habitat use by the coyote-wolf hybrid.



Red dots are 2016 DNR and 2016 Field Mammalogy radio telemetry data points; Green dots are 2010-2015 DNR and 2014, 2012 UMBS Field Mammalogy radio telemetry data points; The white star is the animal's estimated den site.

Figure 5. Key for the land cover layer utilized in ArcGIS (See above). Courtesy of the Michigan GAP Analysis.



Figure 6. Percentage of habitat use from 2010-2015.

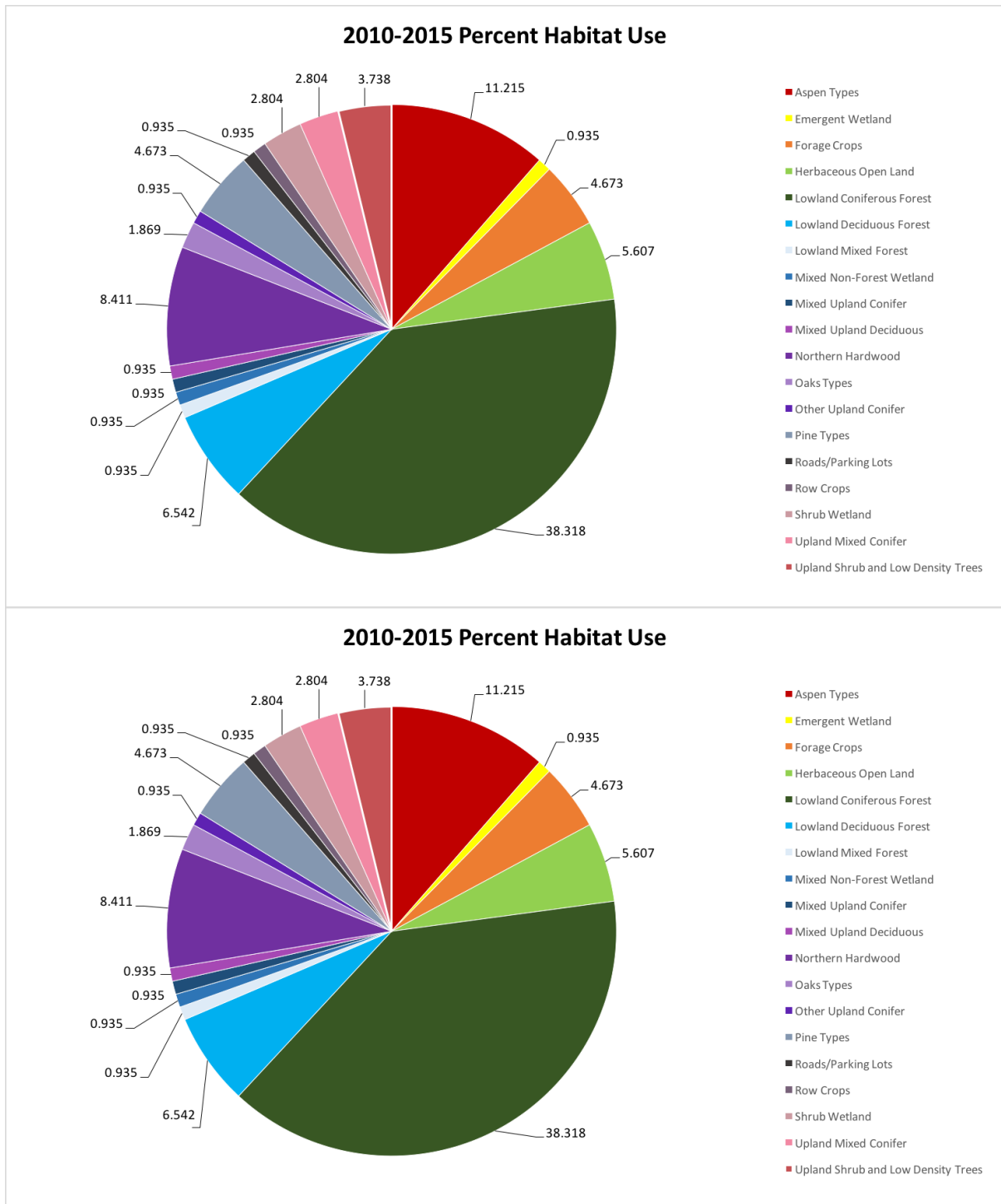
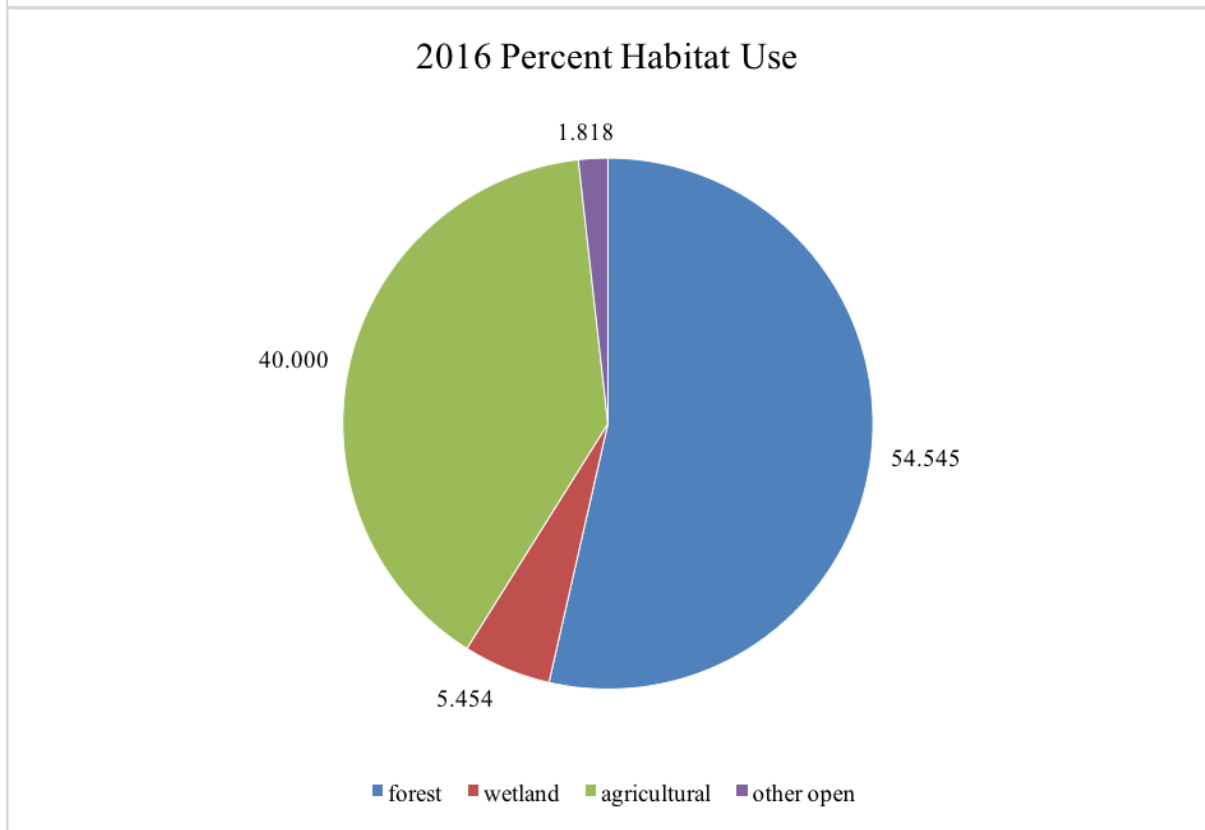
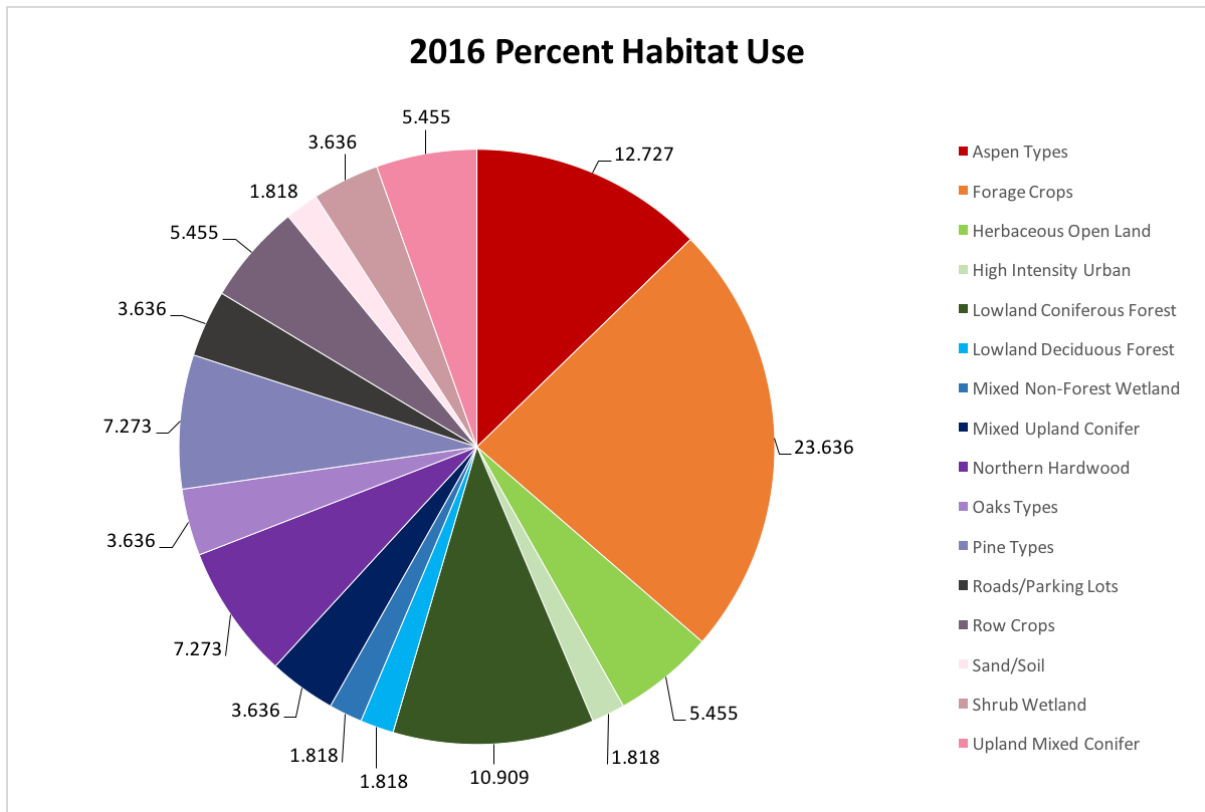


Figure 7. Percentage of habitat use in 2016.



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Appendix 1. 2010-2016 DNR and UMBS 2012, 2014, 2016 Field Mammalogy radio telemetry data points for the coyote-wolf hybrid.

<b>Date</b>	<b>Average Time</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Habitat Use</b>
6/27/16 0:00	15:20	45.54879	-84.62489	Lowland Coniferous Forest
7/2/16 0:00	13:47	45.56046	-84.65583	Northern Hardwood
7/3/16 0:00	4:09	45.54465	-84.62322	Lowland Deciduous Forest
7/5/16 0:00	1:16	45.55288	-84.6512	Northern Hardwood
7/5/16 0:00	2:14	45.5529	-84.64273	Aspen Types
7/5/16 0:00	0:31	45.55315	-84.63452	Shrub Wetland
7/6/16 0:00	5:58	45.543325	-84.64669444	Row Crops
7/6/16 0:00	11:27	45.5447	-84.65908	Aspen Types
7/7/16 0:00	0:57	45.542925	-84.64893889	High Intensity Urban
7/7/16 0:00	0:31	45.54646667	-84.65221667	Herbaceous Open Land
7/7/16 0:00	1:13	45.54327	-84.66408	Lowland Coniferous Forest
7/10/16 0:00	3:08	45.54297	-84.64762	Row Crops
7/10/16 0:00	3:40	45.5452	-84.65457	Oaks Types
7/10/16 0:00	1:28	45.54	-84.63888	Aspen Types
7/11/16 0:00	11:51	45.5475	-84.63056	Roads/Parking Lots
7/12/16 0:00	4:13	45.5502	-84.6464	Forage Crops
7/12/16 0:00	2:39	45.5489	-84.63167	Shrub Wetland
7/12/16 0:00	1:12	45.55305556	-84.63583333	Sand/Soil
7/14/16 0:00	0:27	45.54926	-84.62809	Lowland Coniferous Forest
7/14/16 0:00	0:43	45.55504444	-84.63279444	Lowland Coniferous Forest
7/19/16 0:00	0:32	45.550542	-84.634783	Forage Crops
7/19/16 0:00	1:03	45.5442	-84.63275	Forage Crops
7/19/16 0:00	1:57	45.558503	-84.631733	Forage Crops

7/21/16 0:00	23:23	45.537783	-84.624339	Aspen Types
7/22/16 0:00	1:49	45.537739	-84.633364	Row Crops
7/22/16 0:00	1:11	45.532975	-84.619678	Northern Hardwood
7/22/16 0:00	0:14	45.538828	-84.629275	Oaks Types
7/22/16 0:00	22:23	45.548433	-84.625836	Lowland Coniferous Forest
7/22/16 0:00	1:39	45.536325	-84.6	Mixed Non-Forest Wetland
7/25/16 0:00	22:42	45.555839	-84.622464	Forage Crops
7/25/16 0:00	23:18	45.555119	-84.624011	Forage Crops
7/25/16 0:00	23:45	45.556025	-84.624714	Forage Crops
7/26/16 0:00	0:06	45.553358	-84.624872	Forage Crops
7/28/16 0:00	22:32	45.55635	-84.628917	Roads/Parking Lots
7/29/16 0:00	0:33	45.55685	-84.6285	Forage Crops
7/29/16 0:00	0:06	45.559336	-84.637128	Aspen Types
7/30/16 0:00	22:48	45.55073	-84.66697	Herbaceous Open Land
7/30/16 0:00	23:54	45.54817	-84.67331	Mixed Upland Conifer
7/30/16 0:00	23:08	45.54649	-84.67567	Lowland Coniferous Forest
7/31/16 0:00	0:56	45.55601	-84.67003	Aspen Types
7/31/16 0:00	2:16	45.55793	-84.67357	Aspen Types
7/31/16 0:00	1:25	45.5532	-84.67314	Pine Types
7/31/16 0:00	1:51	45.55251	-84.67613	Pine Types
7/31/16 0:00	2:46	45.55611	-84.67536	Pine Types
7/31/16 0:00	0:32	45.55472	-84.66658	Mixed Upland Conifer
8/1/16 0:00	22:52	45.54287	-84.64378	Forage Crops
8/1/16 0:00	23:19	45.55154	-84.64347	Forage Crops
8/1/16 0:00	23:52	45.54451	-84.65341	Forage Crops
8/1/16 0:00	0:33	45.559489	-84.630083	Upland Mixed Conifer

8/2/16 0:00	0:48	45.54338	-84.63832	Forage Crops
8/2/16 0:00	1:26	45.53028	-84.62854	Northern Hardwood
8/2/16 0:00	3:03	45.53952	-84.63031	Pine Types
8/2/16 0:00	3:31	45.54401	-84.62807	Upland Mixed Conifer
10/21/10 0:00	18:20	45.55201	-84.64945	Aspen Types
10/28/10 0:00	12:20	45.56673	-84.63203	Lowland Coniferous Forest
11/2/10 0:00	12:20	45.56673	-84.63203	Lowland Coniferous Forest
11/10/10 0:00	11:35	45.56149	-84.63342	Herbaceous Open Land
11/17/10 0:00	13:30	45.5616	-84.6338	Herbaceous Open Land
12/3/10 0:00	10:00	45.55859	-84.65262	Upland Shrub and Low Density Trees
12/16/10 0:00	10:30	45.54226	-84.67789	Lowland Coniferous Forest
12/22/10 0:00	12:58	45.54407	-84.67598	Lowland Coniferous Forest
12/29/10 0:00	10:43	45.54516	-84.66542	Lowland Coniferous Forest
1/7/11 0:00	9:00	45.5534	-84.63876	Mixed Non-Forest Wetland
1/12/11 0:00	11:00	45.56869	-84.63262	Lowland Deciduous Forest
2/3/11 0:00	14:45	45.54356	-84.6675	Lowland Coniferous Forest
2/16/11 0:00	14:00	45.54046	-84.67474	Shrub Wetland
2/25/11 0:00	14:00	45.54107	-84.67054	Lowland Coniferous Forest
3/2/11 0:00	13:00	45.55578	-84.64834	Lowland Coniferous Forest
3/8/11 0:00	13:30	45.55282	-84.64465	Aspen Types
3/31/11 0:00	13:45	45.56028	-84.64344	Lowland Coniferous Forest
4/7/11 0:00	14:45	45.56087	-84.63482	Lowland Coniferous Forest
4/21/11 0:00	17:15	45.56294	-84.63373	Herbaceous Open Land
4/29/11 0:00	13:45	45.56155	-84.69843	Northern Hardwood
5/4/11 0:00	17:00	45.56725	-84.64787	Northern Hardwood

5/12/11 0:00	13:00	45.5628	-84.69461	Aspen Types
5/20/11 0:00	10:17	45.55923	-84.66882	Aspen Types
5/25/11 0:00	15:50	45.55603	-84.6513	Pine Types
5/31/11 0:00	13:00	45.55434	-84.65975	Aspen Types
6/10/11 0:00	13:45	45.55185	-84.65901	Herbaceous Open Land
6/15/11 0:00	15:10	45.55871	-84.64005	Lowland Coniferous Forest
6/27/11 0:00	19:45	45.54382	-84.68207	Shrub Wetland
7/13/11 0:00	13:00	45.5421	-84.67413	Lowland Coniferous Forest
7/26/11 0:00	16:50	45.5647	-84.63229	Lowland Coniferous Forest
8/10/11 0:00	16:00	45.56538	-84.62825	Lowland Coniferous Forest
8/23/11 0:00	8:10	45.55171	-84.63287	Lowland Coniferous Forest
9/6/11 0:00	15:30	45.55948	-84.63355	Lowland Coniferous Forest
9/14/11 0:00	13:30	45.5606	-84.63624	Lowland Deciduous Forest
10/5/11 0:00	10:30	45.56025	-84.64774	Emergent Wetland
10/21/11 0:00	14:30	45.54369	-84.67907	Lowland Coniferous Forest
10/28/11 0:00	8:00	45.54766	-84.67117	Pine Types
11/14/11 0:00	8:20	45.55482	-84.63441	Lowland Coniferous Forest
11/22/11 0:00	10:30	45.55778	-84.64821	Lowland Coniferous Forest
12/2/11 0:00	8:30	45.52557	-84.6308	Lowland Coniferous Forest
1/4/12 0:00	10:15	45.522	-84.63099	Lowland Coniferous Forest
2/8/12 0:00	9:04	45.56084	-84.63953	Lowland Coniferous Forest
3/16/12 0:00	15:00	45.55379	-84.64024	Other Upland Conifer
5/29/12 0:00	13:20	45.557	-84.64841	Lowland Coniferous Forest
6/27/12 0:00	14:50	45.54481	-84.61507	Lowland Mixed Forest
7/23/12 0:00	0:00	45.546617	-84.655933	Northern Hardwood
7/25/12 0:00	22:00	45.5402	-84.630067	Pine Types



7/26/12 0:00	21:00	45.55655	-84.6465	Upland Mixed Conifer
7/27/12 0:00	5:00	45.539283	-84.629717	Aspen Types
7/28/12 0:00	5:00	45.547067	-84.63455	Forage Crops
7/28/12 0:00	5:00	45.5473317	-84.633017	Forage Crops
7/28/12 0:00	6:00	45.55635	-84.635683	Upland Mixed Conifer
7/28/12 0:00	21:00	45.5537	-84.6334	Lowland Coniferous Forest
7/30/12 0:00	1:00	45.55505	-84.5709	Herbaceous Open Land
7/30/12 0:00	5:00	45.560783	-84.6564	Aspen Types
7/31/12 0:00	6:00	45.560433	-84.63425	Lowland Coniferous Forest
7/31/12 0:00	21:00	45.552633	-84.634057	Shrub Wetland
8/2/12 0:00	14:30	45.53405	-84.64354	Northern Hardwood
8/31/12 0:00	14:00	45.5459	-84.6593	Lowland Deciduous Forest
10/12/12 0:00	8:50	45.55508	-84.70195	Aspen Types
11/13/12 0:00	13:00	45.55143	-84.6456	Forage Crops
12/11/12 0:00	13:30	45.55191	-84.64765	Herbaceous Open Land
1/23/13 0:00	8:50	45.56791	-84.64868	Northern Hardwood
2/25/13 0:00	15:10	45.55452	-84.66177	Aspen Types
4/17/13 0:00	8:45	45.54677	-84.65644	Oaks Types
5/20/13 0:00	13:30	45.55307	-84.66332	Aspen Types
6/19/13 0:00	15:40	45.56321	-84.63219	Upland Shrub and Low Density Trees
7/25/13 0:00	8:15	45.54547	-84.6859	Pine Types
8/28/13 0:00	16:00	45.55216	-84.68463	Lowland Coniferous Forest
10/25/13 0:00	14:05	45.54081	-84.67629	Lowland Coniferous Forest
12/5/13 0:00	14:00	45.52466	-84.62992	Lowland Coniferous Forest
2/28/14 0:00	13:30	45.55287	-84.64765	Lowland Deciduous Forest

4/22/14 0:00	15:25	45.55125	-84.65472	Northern Hardwood
6/20/14 0:00	8:00	45.56058	-84.65749	Oaks Types
7/25/14 0:00	16:00	45.545509	-84.641914	Upland Shrub and Low Density Trees
7/25/14 0:00	23:00	45.571663	-84.639748	Northern Hardwood
7/25/14 0:00	13:45	45.565992	-84.639373	Lowland Coniferous Forest
7/25/14 0:00	14:00	45.5647	-84.63933	Lowland Coniferous Forest
7/25/14 0:00	14:30	45.558124	-84.640179	Mixed Non-Forest Wetland
7/26/14 0:00	22:38	45.567646	-84.634383	Lowland Coniferous Forest
7/26/14 0:00	23:56	45.551563	-84.633755	Lowland Coniferous Forest
7/26/14 0:00	16:13	45.558155	-84.638975	Mixed Non-Forest Wetland
7/27/14 0:00	16:00	45.561655	-84.630248	Row Crops
7/27/14 0:00	10:56	45.571661	-84.64448	Mixed Upland Conifer
7/27/14 0:00	1:45	45.540035	-84.682606	Lowland Deciduous Forest
7/27/14 0:00	2:00	45.540036	-84.6826048	Lowland Deciduous Forest
7/27/14 0:00	8:20	45.564182	-84.634279	Lowland Deciduous Forest
7/28/14 0:00	16:25:00	45.556263	-84.620597	Roads/Parking Lots
7/28/14 0:00	22:43	45.564664	-84.646269	Northern Hardwood
7/28/14 0:00	23:33	45.574283	-84.603044	Northern Hardwood
7/28/14 0:00	22:50	45.55751	-84.640606	Aspen Types
7/28/14 0:00	17:05:00	45.558955	-84.630252	Lowland Coniferous Forest
7/28/14 0:00	17:20:00	45.559491	-84.629772	Lowland Coniferous Forest
7/29/14 0:00	6:01	45.561811	-84.626173	Forage Crops
7/29/14 0:00	6:20	45.560611	-84.632001	Upland Shrub and Low Density Trees
7/29/14 0:00	5:45	45.558749	-84.635947	Pine Types
7/29/14 0:00	5:54	45.566155	-84.632345	Lowland Coniferous Forest

7/29/14 0:00	6:13	45.558208	-84.63011	Lowland Coniferous Forest
7/29/14 0:00	16:12	45.543199	-84.664627	Lowland Coniferous Forest
7/29/14 0:00	16:17	45.543049	-84.664627	Lowland Coniferous Forest
7/29/14 0:00	16:26	45.543199	-84.664627	Lowland Coniferous Forest
11/26/14 0:00	11:00	45.55512	-84.64929	Mixed Upland Deciduous
1/26/15 0:00	8:20	45.55357	-84.64977	Aspen Types
4/17/15 0:00	8:10	45.55334	-84.65759	Upland Mixed Conifer
7/24/15 0:00	9:20	45.56271	-84.63685	Lowland Coniferous Forest
9/17/15 0:00	10:00	45.54499	-84.64145	Forage Crops
11/20/15 0:00	9:00	45.52996	-84.63869	Lowland Coniferous Forest