Bainbridge Island Land Trust
Biological Inventory of Bainbridge Island Conservation Areas Final Report Winter 2019
Wildlife Corridor and Meigs Park Findings
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Summary

This camera trap and bird field survey study, focusing on the Wildlife Corridor and Meigs Park conservation areas of Bainbridge Island, can help inform biological activity and potential trail connections. With 36 sites, our cameras caught over 20 species of wildlife including coyotes, deer, barred owl, beaver, mink and river otter. Additionally, our bird surveys found over 28 avian species. Through these studies, we identified areas of high wildlife activity and the intensity of human use on various trail segments. We conclude that trails 2a, 2b and 1b are the most used Wildlife Corridor trails and that sites without human presence see more wildlife using the area.

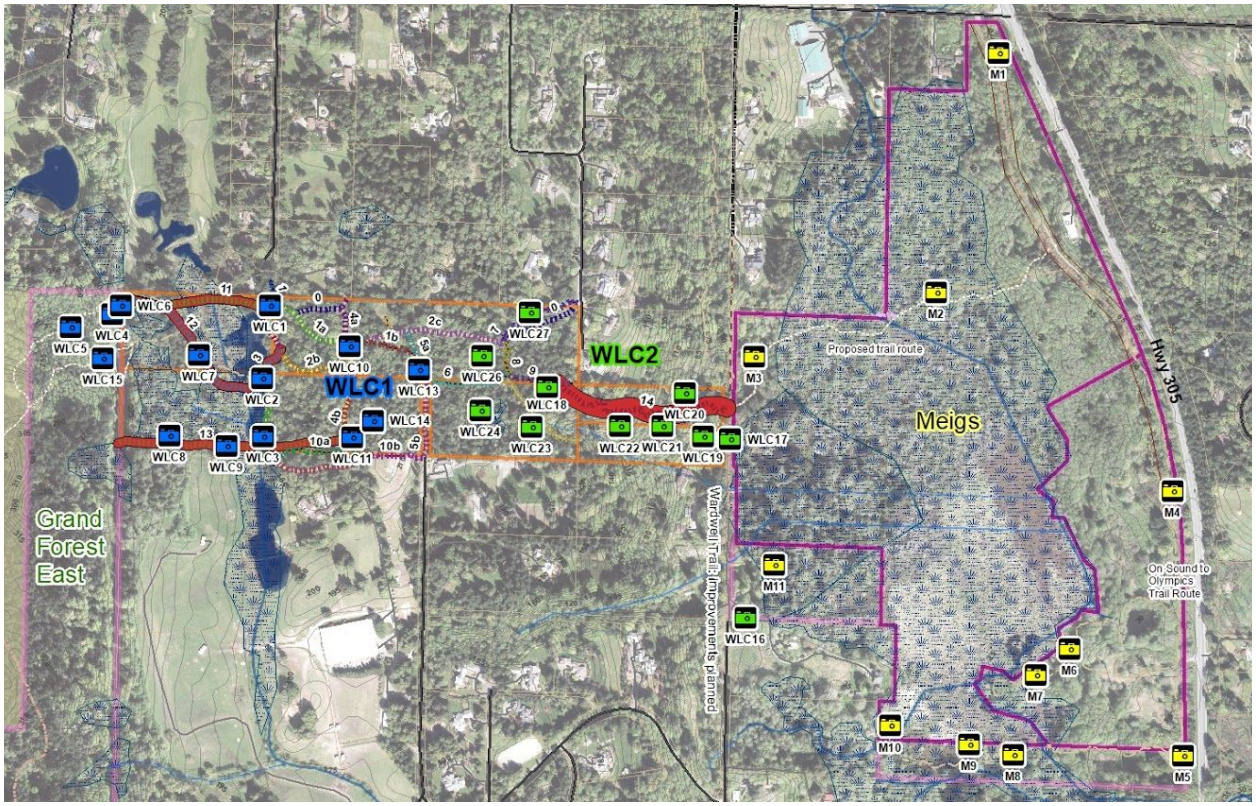

Figure 1: Overview of all camera sites across the three study areas.

Methods

The primary method of evaluating biological activity was trail cameras placed in strategic locations to capture wildlife and human use of the lands. Cameras, locked to trees on and off trail, were set to take 6 consecutive photos when motion was detected. Tree selection was based on angle to trail or opening, the amount of vegetation in front of it and bearing to avoid full sun. Depending on tree angle, trail route and camera ability, we placed the cameras from 1 foot to 5.5 feet up the tree. Field information including habitat type, location, bearing and camera height

was recorded, along with an ArcGIS GPS point. The cameras were then left out for three weeks, SD cards swapped, taken down and replaced in the next study area. With 16 cameras available, we deployed them in three different study areas for three weeks each. Over the course of 9 weeks, study areas WLC1, WLC2 and Meigs, moved east from the edge of the Grand Forest East through the Wildlife Corridor and finally into Meigs Park. Site habitat ranged from forest edges on roads, young mixed forest, mature cedar forest to wetland marsh. Area WLC1 had 15 sites, 6 off trail and 9 on trail. Minus one site which incurred a camera malfunction, WLC2 had 10 cameras with half on and half off trail. Meigs area had 9 on trail cameras and 2 off trail cameras, totaling 11 sites. The first cameras were deployed on WLC1 on January 4th, 2019. The last cameras were taken down from Meigs on March 17th.

		(filled out at initiation of survey and at conclusion)					
Property Name	Meigs						*5 second delay, 6-shot mode
Station ID#	M1	Placed by	AP, AW, GK	Description	Meigs park entrance		
Camera ID#	Habitat type	Date Placed	Time Placed	Camera Set Height (ft)	Camera Direction	Date Retrieved	Notes
1	young alder	3/2/19	13:03	4	NW	3/17/19	
Station ID#	M2	Placed by	AH, AP, AW	Description	located at a birding stop		
Camera ID#	Habitat type	Date Placed	Time Placed	Camera Set Height (ft)	Camera Direction	Date Retrieved	Notes
C12	decidious	2/24/19	18:20	4.5	S	3/17/19	BL 52%, SD12A to 12B
Station ID#	M3	Placed by	AH, GK	Description	mixed decidious conifers		
Camera ID#	Habitat type	Date Placed	Time Placed	Camera Set Height (ft)	Camera Direction	Date Retrieved	Notes
C15	mixed decidious conifer	2/24/19	10:30	3	NNE	3/17/19	SD14A to 5B
Station ID#	M4	Placed by	AH, AP, AW	Description	alternative to owl gate		
Camera ID#	Habitat type	Date Placed	Time Placed	Camera Set Height (ft)	Camera Direction	Date Retrieved	Notes
C7	mixed decidious and cedar	2/24/19	17:50	5	NW	3/17/19	BL70%, SD7B to 7A
Station ID#	M5	Placed by	AH, AP, AW	Description	old gate on trail		
Camera ID#	Habitat type	Date Placed	Time Placed	Camera Set Height (ft)	Camera Direction	Date Retrieved	Notes

Figure 2: Field data collected for each camera site.

Figure 3: Winkler and Puri setting up a camera.

Photos were processed by Ariana Winkler and Ankush Puri. Each set of 6 photos was coded with a species into a spreadsheet (Figure 4). Information on the date, time, number of individuals, number of photos it was in frame, number of youth, direction of travel and behavior was recorded each detection. To measure human disturbance on each site, number of leashed and unleashed dogs, bicycles and horses were recorded for each human occurrence. All numbers are based on each individual occurrence as long as the occurrence was more than one minute apart. This means even if the same individual passed by a camera going one way and returning on the same day at least a minute apart, it was recorded as two individuals.

For analysis, the number of individuals was normalized to individuals per week by dividing by the number of trapping days for that camera site and then multiplied by seven. For the map diagrams, bike, horse and human numbers were rounded to the nearest whole number or 0.5 if under 0.5. Time intervals were assigned to each detection to look at the timing of activity. Four intervals were defined as 02:00-07:59, 08:00-13:59, 14:00-19:59 and 20:00-01:59. The top 18 most disturbed sites were assigned disturbance levels of high, medium or low. With 6 of each disturbance level, the sites were sorted first by cars per week then by unleashed dogs per week, leashed dogs per week, humans per week, bikes per week and finally horses per week in that order. This disturbance order is based on the idea that unleashed dogs and humans are less predictable than bikes and horses and therefore cause more of a disturbance to wildlife (Ciuti et

al 2012). While horses and bikes generally need more infrastructure than humans and dogs, the trails on which horses and bikes were found in this study did not differ infrastructurally from the trails in which humans and dogs were found. Cars were ranked first because of the infrastructure required to find them on the site. The 6 sites ranked the highest were assigned high and the lowest 6 assigned low disturbance. The other 18 unranked sites did not have any human presence.

Study Area	Camera	Site	On Trail	Disturbance Level	Humans	Trapping Days	Date	Start Time	Time Interval	Species	# Individuals	# Individuals / wk	# Young	# in Sequence	# Leashed Dogs	# Unleashed Dogs	# Horses	# bikes	Direction of Travel	Running Y?	Prey Vigilance Y?	Notes	Good Photos
Meigs	C1	M1	On	high	Y	16	3/2/19	15:12	2	human	1	0.4375		4	1				left				
Meigs	C1	M1	On	high	Y	16	3/2/19	15:27	2	human	1	0.4375		2	1				right			same as above	
Meigs	C1	M1	On	high	Y	16	3/3/19	4:29	1	coyote	1	0.4375		1					right				
Meigs	C1	M1	On	high	Y	16	3/3/19	7:14	1	human	1	0.4375		1					right	y			
Meigs	C1	M1	On	high	Y	16	3/3/19	11:33	2	human	1	0.4375		2					left				
Meigs	C1	M1	On	high	Y	16	3/3/19	12:48	2	human	4	1.75		11		1			left				
Meigs	C1	M1	On	high	Y	16	3/3/19	15:13	3	human	2	0.875		7					right				
Meigs	C1	M1	On	high	Y	16	3/3/19	15:20	3	human	1	0.4375		2		1			right				
Meigs	C1	M1	On	high	Y	16	3/3/19	15:23	3	human	1	0.4375		2					right				
Meigs	C1	M1	On	high	Y	16	3/3/19	15:31	3	human	1	0.4375		3		2			left				
Meigs	C1	M1	On	high	Y	16	3/3/19	15:44	3	human	1	0.4375		6		2			right			same as above	
Meigs	C1	M1	On	high	Y	16	3/3/19	16:53	3	human	1	0.4375		1	1				left				
Meigs	C1	M1	On	high	Y	16	3/3/19	17:09	3	human	1	0.4375		3	1				right			same as above	
Meigs	C1	M1	On	high	Y	16	3/4/19	10:50	2	human	1	0.4375		1	1				left				
Meigs	C1	M1	On	high	Y	16	3/4/19	10:55	2	human	1	0.4375		1	2				left				
Meigs	C1	M1	On	high	Y	16	3/4/19	11:00	2	human	1	0.4375		3	1				right				
Meigs	C1	M1	On	high	Y	16	3/4/19	11:12	2	human	1	0.4375		2	2				right				
Meigs	C1	M1	On	high	Y	16	3/4/19	11:33	2	human	2	0.875		1					left				
Meigs	C1	M1	On	high	Y	16	3/4/19	12:05	2	human	2	0.875		3					right			same as above	
Meigs	C1	M1	On	high	Y	16	3/4/19	15:24	3	human	1	0.4375		1	1				left				
Meigs	C1	M1	On	high	Y	16	3/4/19	15:38	3	human	1	0.4375		2	1				right			same as above	
Meigs	C1	M1	On	high	Y	16	3/4/19	15:50	3	human	1	0.4375		1					left				
Meigs	C1	M1	On	high	Y	16	3/4/19	16:35	3	human	1	0.4375		2					right			same as above	
Meigs	C1	M1	On	high	Y	16	3/4/19	17:01	3	human	1	0.4375		1	2				left				
Meigs	C1	M1	On	high	Y	16	3/4/19	17:28	3	human	1	0.4375		2	2				right			same as above	
Meigs	C1	M1	On	high	Y	16	3/5/19	10:14	2	human	1	0.4375		1					left				
Meigs	C1	M1	On	high	Y	16	3/5/19	10:42	2	human	1	0.4375		1					left				
Meigs	C1	M1	On	high	Y	16	3/5/19	10:47	2	human	1	0.4375		2					right			same as above	
Meigs	C1	M1	On	high	Y	16	3/5/19	13:04	2	human	1	0.4375		3		1			right, left				IMG_0247
Meigs	C1	M1	On	high	Y	16	3/5/19	13:20	2	human	1	0.4375		1					left				
Meigs	C1	M1	On	high	Y	16	3/5/19	13:24	2	human	1	0.4375		2		1			right				
Meigs	C1	M1	On	high	Y	16	3/5/19	13:36	2	human	1	0.4375		2					right				
Meigs	C1	M1	On	high	Y	16	3/5/19	15:46	3	human	1	0.4375		1					left				
Meigs	C1	M1	On	high	Y	16	3/5/19	16:07	3	human	1	0.4375		1	1				left				
Meigs	C1	M1	On	high	Y	16	3/5/19	16:16	3	human	1	0.4375		3		2			left				
Meigs	C1	M1	On	high	Y	16	3/5/19	16:20	3	human	1	0.4375		2	1				right				
Meigs	C1	M1	On	high	Y	16	3/5/19	16:25	3	human	1	0.4375		3					right				
Meigs	C1	M1	On	high	Y	16	3/5/19	16:39	3	dog	1	0.4375		7		1			right, left				IMG_0302

Figure 4: Final photo data which was used for analysis.

Four bird surveys took place during this study. Each one was guided by an expert birder who named birds they saw or heard. While we experimented with transect 5 minute sample surveying, all surveys involved walking slowly down the trails and listening for all birds. Each trail was sampled twice, once on the way through and once on the way back. Researchers did pause at places of high activity until all sounds were identified. Because our data is focused on presence and absence as opposed to abundance, this sampling procedure was deemed appropriate. To supplement this data, two of the experts provided us with bird habitat evaluations.

The Wildlife Corridor property has had previous amphibian surveys conducted on it. The locations where amphibians or their egg masses were detected is shown in Figure 8. Although this did not occur during our study period, time did not allow us to conduct our own and it is still a good indication of areas amphibians may reuse. Therefore, it was included in our analysis.

No previous amphibian survey has been done in Meigs. So we prioritized Meigs and completed one amphibian survey in Meigs Parks. With the guidance of a local herpetologist, we walked along the Meigs trail starting from the north to south then west into the wetland. We examined adjacent ponds and explored off trail habitats. Because of the late snow and cold of the season, we did not see any frogs, salamander or egg masses on our survey. During camera set up and take down, however, interns Puri and Winkler did search for egg masses without the guidance of a herpetologist; producing results on March 17th. More surveys will occur with BILT in the upcoming spring months.

Results

With 36 sites, our cameras recorded 1,348 detections and 6,793 photos with an animal or person in frame. The majority of sites had 22 or 23 trapping days but our first three sites had 30 trapping days. WLC22 site experienced a camera malfunction and only ran for 11 days. M1 site was only left up for 16 days due to camera logistics but was focused on capturing human trail usage so two weeks was thought to be sufficient.

There were over 20 different wildlife species captured on the trail cameras including barred owl, beaver, coyote, deer, douglas and eastern grey squirrels, mallard duck, mink, muskrat, pheasant, raccoon, red-tailed hawk, river otter, wood duck and various small birds. In the following paragraphs, results will be analyzed for each study area. All results will then be combined to look at the relationship between wildlife and people on Bainbridge Island conservation lands. See Appendix for the best wildlife photos.

WLC1

Wildlife Legend		WLC1 1st deployment	WLC2 2nd deployment	Meigs 3rd deployment	People
	Horse	Bicycle	Deer	Douglas Squirrel	Eastern Grey Squirrel
	Coyote	Raccoon	Various Birds	Barred Owl	Pheasant
	Domesticate Cat	Opossum	Beaver	River Otter	Muskrat and Mink

Figure 5: Camera site locations and species seen at those sites for study area WLC1. Red trails are potential future trail connections.

The first study area has an extensive trail system and human usage with 147.40 humans per week. It also have the fewest wildlife per week, 28.59 individuals per week. Sites WLC10, WLC13 and WLC1 were three of the six highest disturbed sites. WLC11 and WLC4 were

assigned medium and low disturbance respectively. Unleashed dogs exceeded leashed dogs and outnumbered even their human owners (Figure 6). By far, this area experienced the most unleashed dogs of any study area. Many times, they were seen going off trail or being minutes ahead of their owners.

This was the only study area with horses. Two horses and riders were at WLC1 midday then the next day one horse and rider were seen again. Because they were not caught on any other camera, they may have entered from the north neighborhood entrance and used trail 1a. About a week later, the same horse and rider were seen traveling from WLC11 to WLC10, WLC1 then back. Presumably, they entered from the southern neighborhood and used trails 10b, 4b, 2b, 2a and 1a. For a third time, two riders and horses took a similar path from WLC10 and WLC11, again presumably entering from the south. Below are the routes taken by horses, the underlined portion being assumed without any photo evidence.

- 1 to 1a to 1
- 10b to 4b to 2b <u>to 2a</u> to 1a to 2b back to 4b to 10b
- 4b to 1b back to 4b to 10a back to 4b to 10b

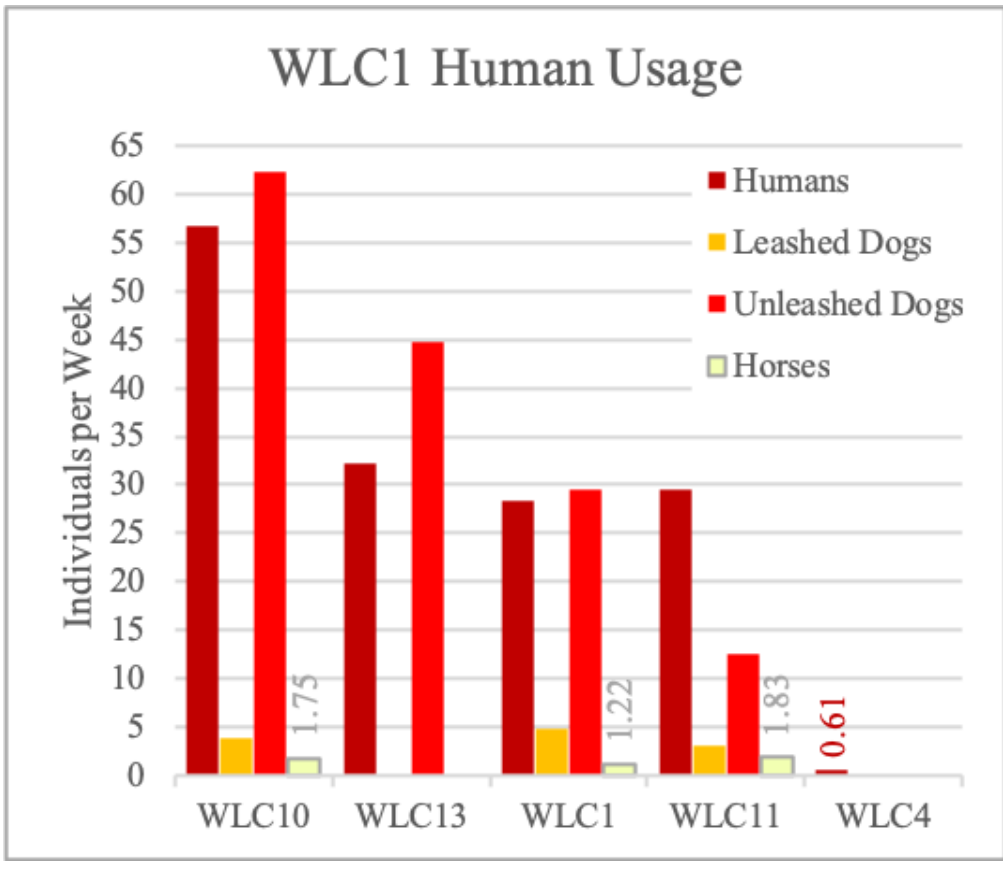

Figure 6: Human usage on all WLC1 sites normalized into per week by trapping days.

The most productive sites with the most wildlife detections were WLC6, WLC9 and WLC15. Notable species include a pheasant and a river otter both at WLC6 which was a wet alder cedar mix. Raccoons and coyotes were seen more on trail than off while deer, douglas squirrels and eastern grey squirrels prefered off trail sites. Various birds like Steller's jay,

American robin, Pacific wren and hermit thrush were seen only on off trail cameras. See Figure 7 for more.

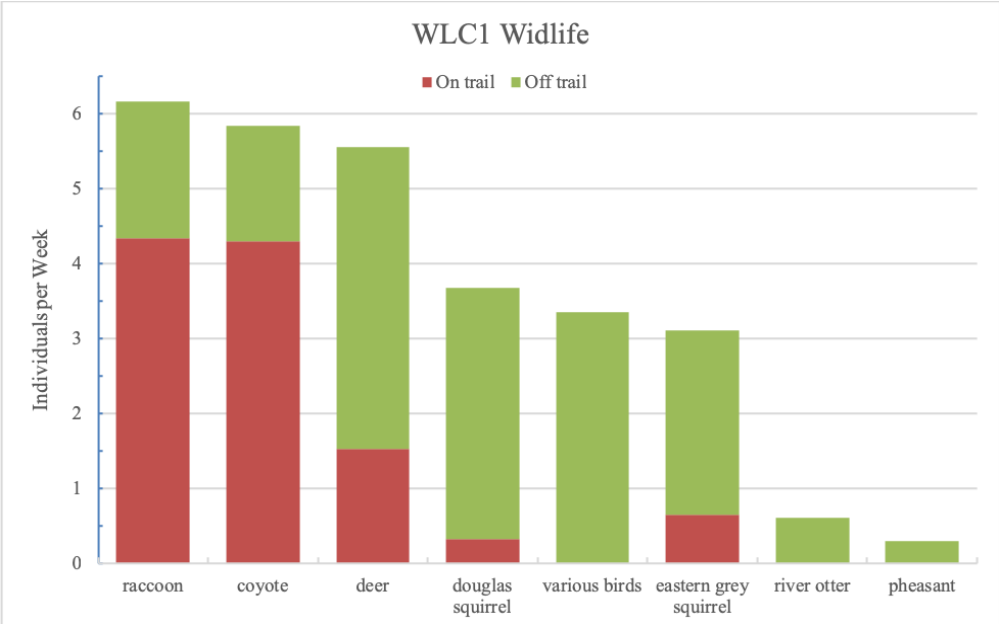

Figure 7: Total number of individuals seen in WLC1 study area normalized into per week by site trapping days.

WLC1 bird surveys occurred on January 19th, February 28th and March 10th, 2019. Most of the species encountered were common, adaptable species. This study area provides good bird habitat with acceptable vegetation density. Below are the 23 species and the number of trail sections the species was seen or heard across all three surveys.

- Pacific wren, 5
- Song sparrow, 4
- Spotted towhee, 4
- Anna's hummingbird, 3
- Canada goose, 3
- Chestnut-backed chickadee, 3
- Red-winged blackbird, 3
- Varied thrush, 3
- Black-capped chickadee, 2
- Brown creeper, 2
- Dark-eyed junco, 2
- Golden-crowned kinglet, 2
- Pine siskin, 2
- Red-breasted nuthatch, 2
- Steller's jay, 2
- American crow, 1
- American robin, 1
- Downy woodpecker, 1
- Hutton's vireo, 1
- Marsh wren, 1
- Northern flicker, 1
- Purple finch, 1
- Red-breasted sapsucker, 1

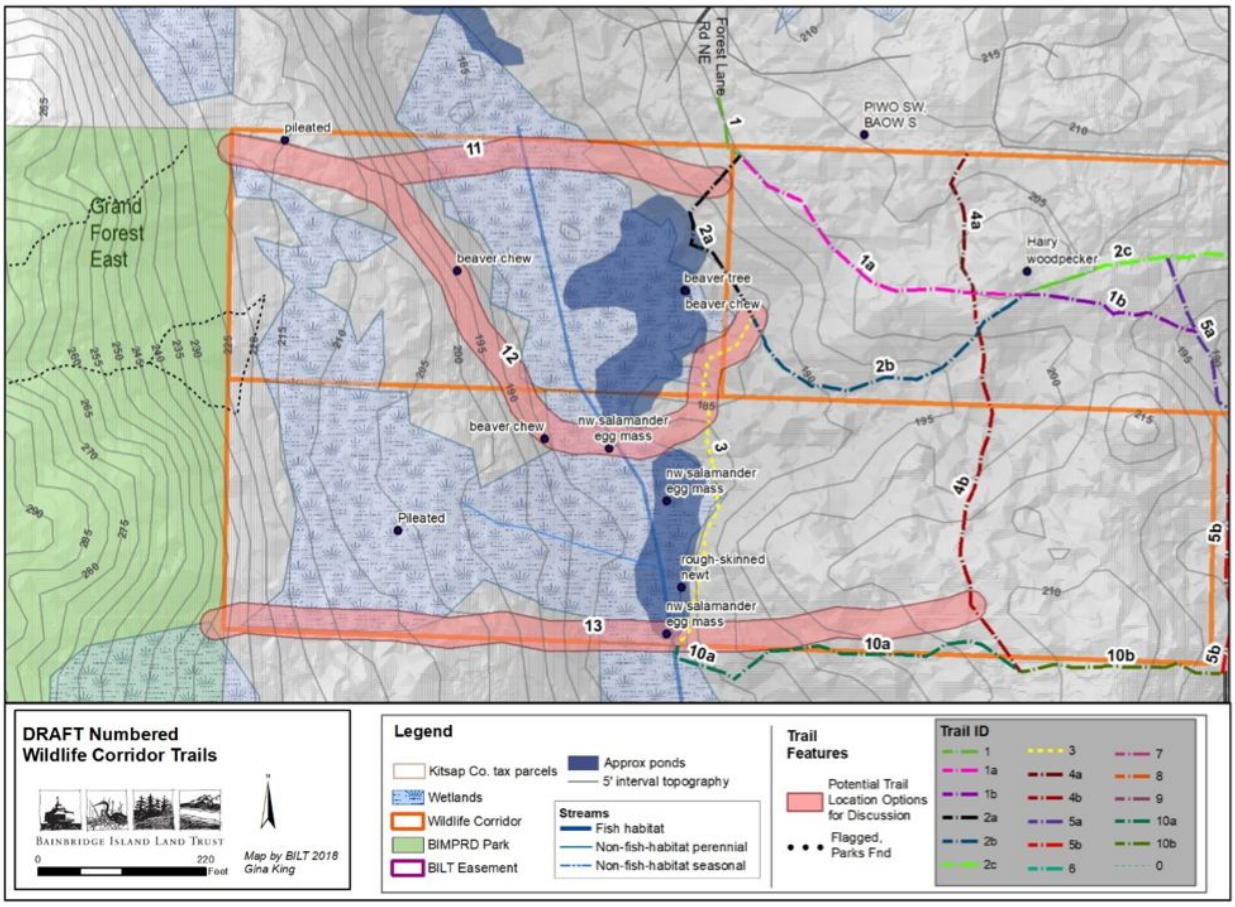

Figure 8: Amphibian detections in WLC1 done before this study by BILT researchers.

The majority of amphibian detections occurred in the wetland, along Trail 3 and Potential Trail 12. These detections included the northwestern salamander egg masses and a rough-skinned newt. This makes sense as most detections occurred near pond edges or in the wetland where shallow waters surrounded by forests may occur.

WLC2

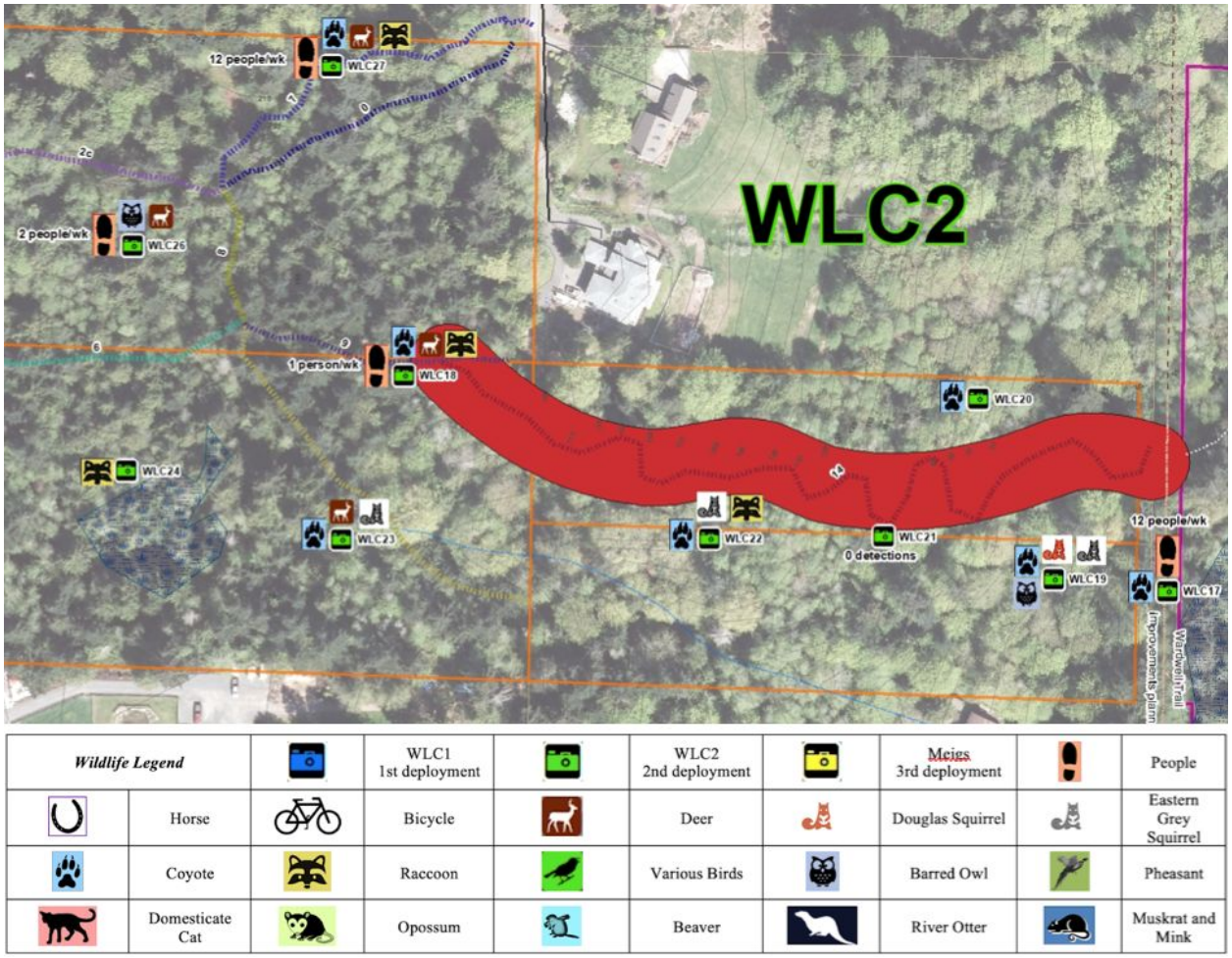

Figure 9: Camera site locations and species seen at those sites for study area WLC2. Red trails are potential future trail connections.

Continuing from WLC1, WLC2 is a smaller parcel with old smaller trails continuing from WLC1. These trails makeup Potential Trail 14 but some sections of it are partially or entirely overgrown. Although this potential trail exists to connect the southeastern parcel from WLC18 to the Wardwell Trail, the trail is a system of poorly defined unofficial trails and segments of old roads that may rarely be used by humans, evident in the fact we saw no people using that part of WLC2. The Wardwell Trail is set to be improved and connects to the eastern portion of this site. This study area had the highest wildlife detections with 161.24 individuals per week. With only 31.84 humans per week, this area was the least used. People did not go into the interior of the site and instead stayed to the sites that were near WLC1 or Meigs Park. Three of the six medium disturbed sites were WLC27, WLC26 and WLC18 while WLC17 experienced low disturbance (Figure 10). Seen in Figure 12, WLC16 was placed south at a parking lot entrance to Meigs park which connected to the Wardwell Trail. With high vehicle traffic and trail users going both to the park and along the Wardwell Trail, this site was highly disturbed.

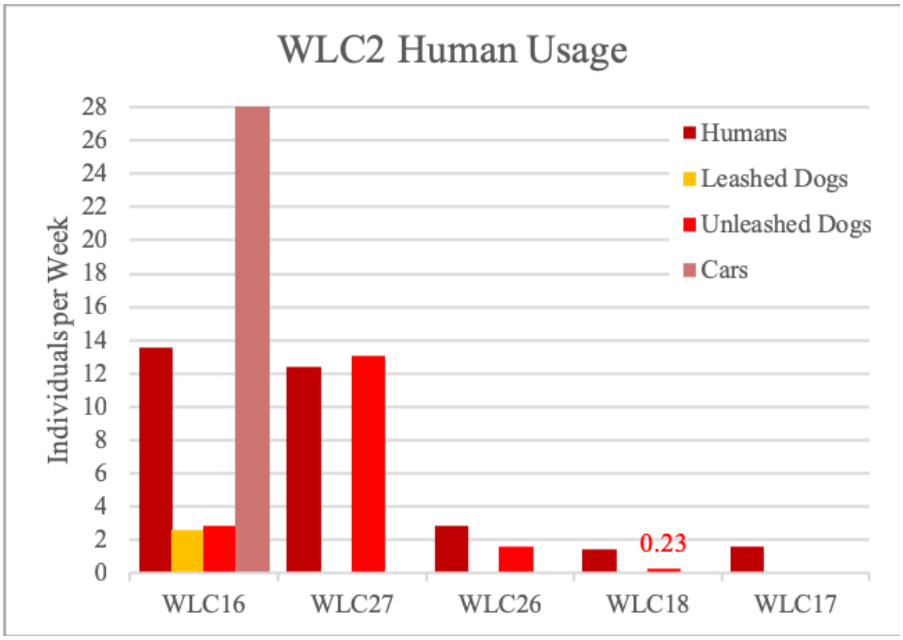

Figure 10: Human usage on all WLC2 sites normalized into per week by trapping days.

In terms of wildlife, the most productive sites were WLC22, WLC19 and WLC27. Coyotes were very active at this site, detected on 8 of the 11 sites. Mostly off trail, 36.29 coyotes per week were seen running, sniffing around, looking up trees and even stalking.

Eastern grey squirrels were also very prevalent. We pointed WLC22's camera at some exposed soil, hoping to catch whatever was digging around. This resulted in 671 photos of eastern grey squirrels foraging. Up to 4 squirrels at once can be seen digging, foraging, running and climbing up trees.

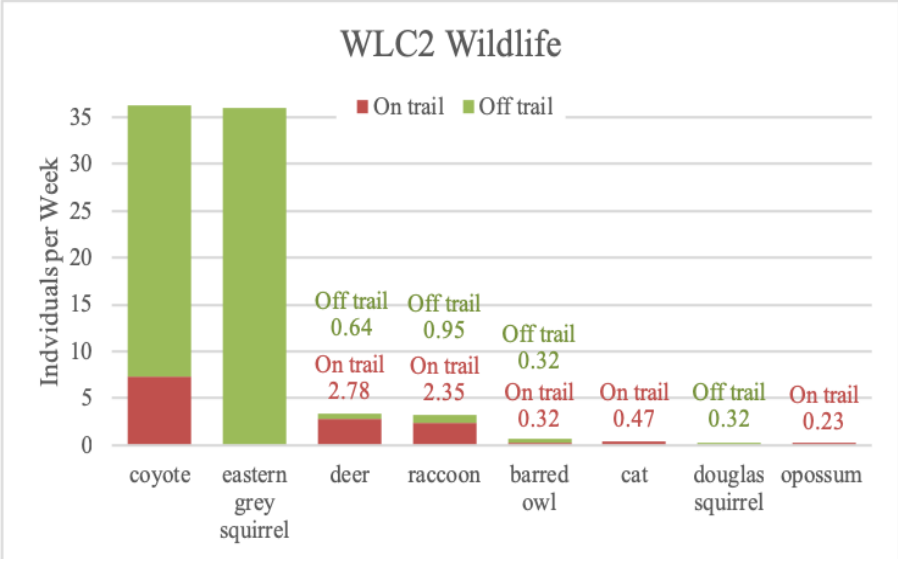

Figure 11: Total number of individuals seen in WLC2 study area normalized into per week by site trapping days.

Notable species include a domesticated cat and an opossum on the road at WLC16. At two sites, off trail at WLC19 and on trail at WLC26, a barred owl landed in the snow possibly after catching some prey.

WLC21 was placed on the unofficial trail but had no detections over the three weeks. This may mean wildlife have found a different route through the area. That location was not on the regular route that the active coyotes took during our sampling interval.

Bird surveys from WLC1 continued into the northwestern part of this study area but combined into one analysis which is summarized above.

Meigs

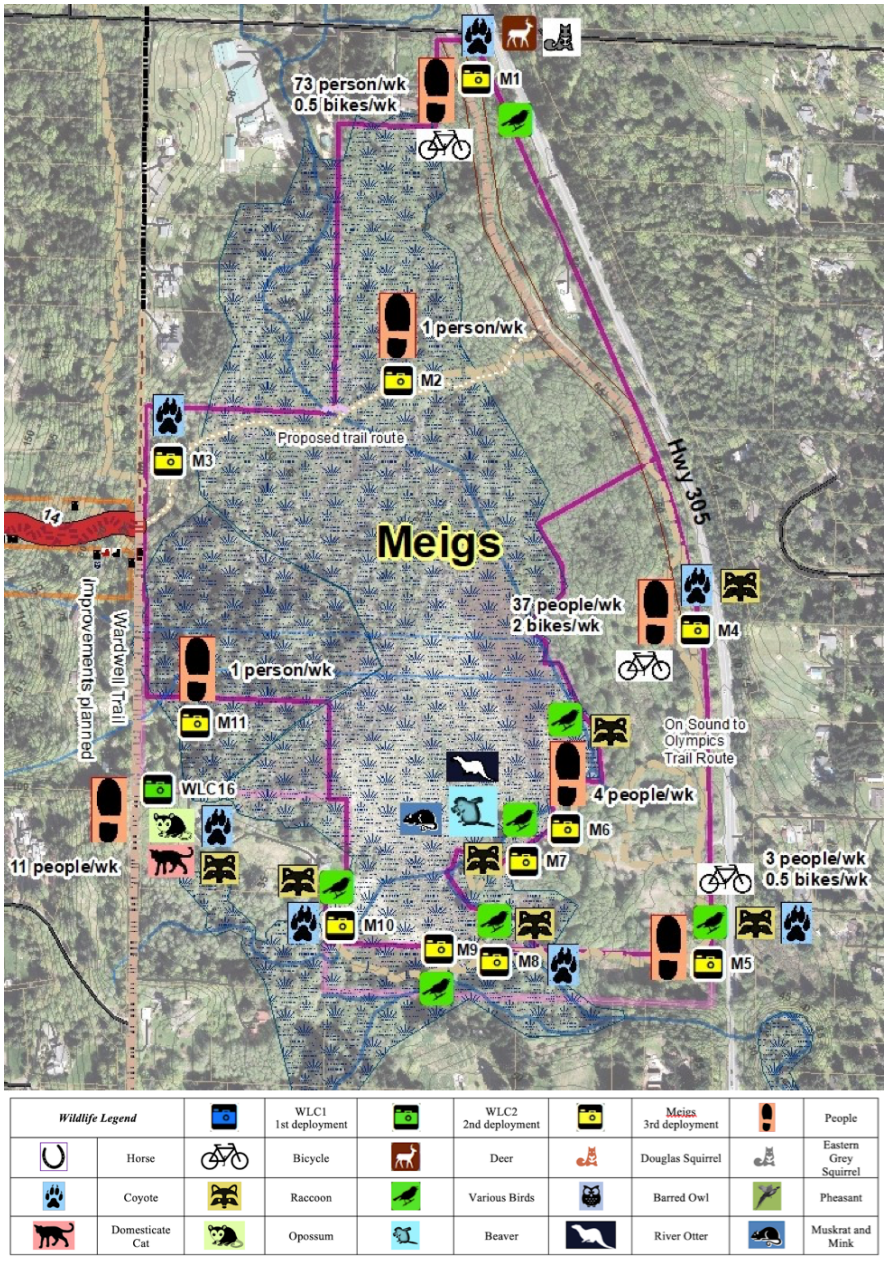

Figure 12: Camera site locations and species seen at those sites for study area Meigs. Red trails are potential future trail connections. Blue graphic layer depicts wetland.

Meigs Park is comprised of an extensive wetland which was entrenched with water during our survey. East of the wetland is the proposed site for the Sound to Olympics Trail, running south and then west with two side trails. The northern portion is open for public use but continues into the Meigs Farm in the southeastern corner which is private and not open to the public. East of that, a busy highway runs north to south, adding road noise to much of the main trail. The Meigs study area had the second most wildlife detections with 143.04 individuals per week. Nonetheless, it had the most human activity with 161.76 people per week. This area had far more leashed dogs than any other area. Still the unleashed dogs just slightly exceeded the number of leashed dogs (Figure 13).

Bicycles are used at this site with a total of 2.78 per week. Seen on three different dates, they only traveled on the main north to south trail. With that in mind, Meigs had two highly disturbed sites, M1 and M4, two medium disturbed sites, M5 and M2, and four low disturbed sites, M6, M9, M8 and M11.

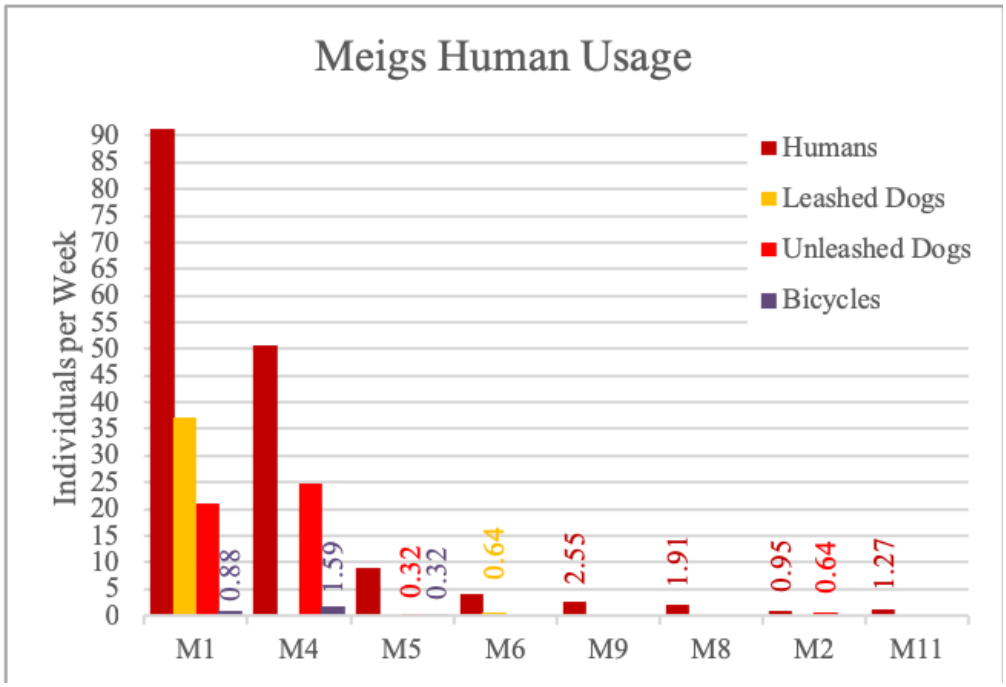

Figure 13: Human usage on all Meigs sites normalized into per week by trapping days.

With over 15 species caught on camera, this study area was the most biodiverse. The most productive sites were M7, M8 and M5. Because of the water features, mallard ducks were the most prevalent. Coyotes were the second most active species but did not compare to their WLC2 activity. Notable species included wood ducks, a red-tailed hawk and red-winged blackbirds. Birds including the American robin and unknown small forest birds were seen mostly on the edge habitat of the side trails. In this area, coyotes and deer exclusively used the trails probably due to the wet and/or dense nature of the off trail sites (Figure 14a and 14b).

The camera at M7 required waders to place and was positioned over water to capture wildlife using a large pond. This produced exciting results with proof of beavers, river otters, mink and muskrats. Along with dams and chewed vegetation, our study provides clear evidence that beavers are active in the area currently.

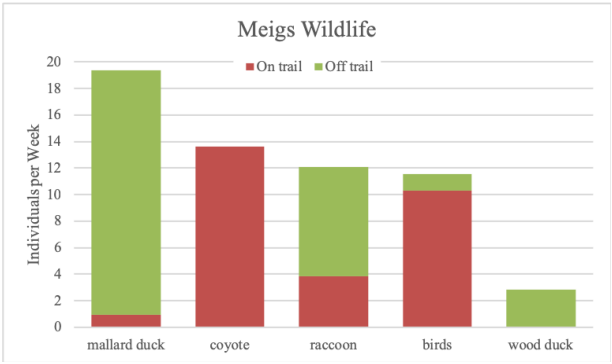

Figure 14a: Upper range of the total number of individuals seen in Meigs study area normalized into per week by site trapping days.

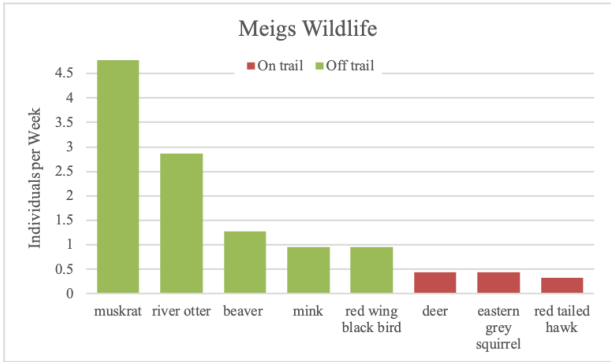

Figure 14b: Lower range of the total number of individuals seen in Meigs study area normalized into per week by site trapping days.

Raccoons were most active in this study area. They regularly used trails but also used the off trail M7 as a route to travel and seemingly to search for food in the water. Muskrats were seen swimming behind raccoons, following them closely. Figure 15 alludes to when sensitive target species like beavers are active and when wetland areas may want to be avoided by people.

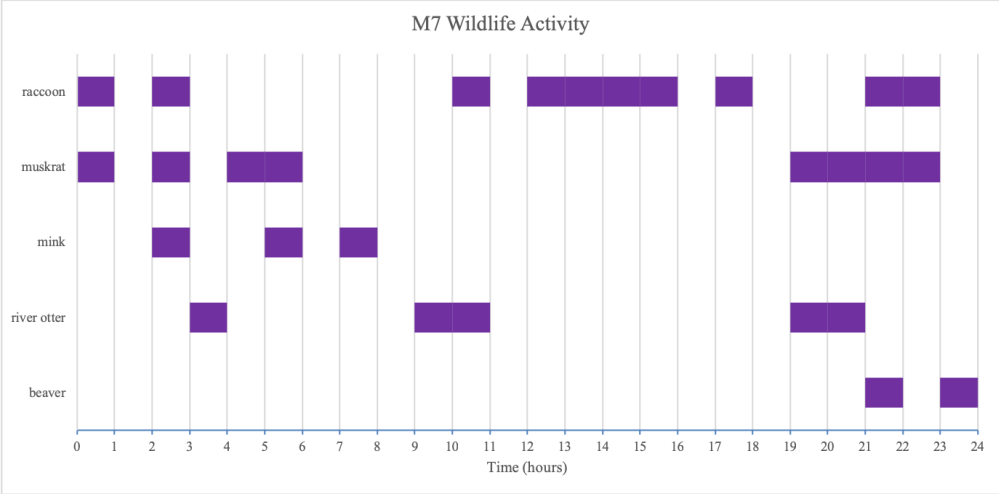

Figure 15: The activity of wildlife found at site M7 organized by time of day.

On January 31st, February 28th and March 10th, bird surveys occurred on Meigs Parks, examining the northern side trail and southern trail into the wetland. One expert thought the area would be appropriate habitat for the green heron. While the other expert mentioned how disturbed areas like trail infrastructure or trails along roads change the species composition, the Bewick's wren can overtake and push out the Pacific wren (Farwell and Marzluff 2013). However, this area still has Pacific wrens. The downy woodpecker was encountered four different times. A migrant bird, the Pacific-slope flycatcher, was heard on the side trail during the March survey. The wetland brought the American wigeon, green-winged teal and hooded merganser to our attention. Below are the 28 species and the number of trail sections the species was seen or heard across all three surveys.

- Black-capped chickadee, 5
- Red-winged blackbird, 5
- Spotted towhee, 5
- American robin, 4

- Anna's hummingbird, 4
- Downy woodpecker, 4
- Song sparrow, 4
- Dark-eyed junco, 3
- Marsh wren, 3
- Pacific wren, 3
- Pine siskin, 3
- Red-tailed hawk, 3
- Ruby kinglet, 3
- Steller's jay, 3
- Brown creeper, 2
- Fox sparrow, 2
- Golden-crowned kinglet, 2
- Northern flicker, 2
- Red-breasted nuthatch, 2
- American robin, 1
- American wigeon, 1
- Bushtit , 1
- Chestnut-backed chickadee, 1
- Green-winged teal, 1
- Hooded merganser, 1
- Hutton's vireo, 1
- Mallard, 1
- Pacific-slope flycatcher, 1
- Turkey vulture, 1
- Varied thrush, 1

During the interns' amphibian survey of Meigs on the way of putting up and taking down trail cameras, 2 dead red-legged frogs were seen near site M7. Just southwest of M9, two rough-skinned newt salamanders, 1 alive and 1 dead, frogs and frog egg masses were observed.

Wildlife and People

This study produced mixed results in terms of effects of disturbance on wildlife. The following paragraphs will break it down into three analyses and make unbiased conclusions.

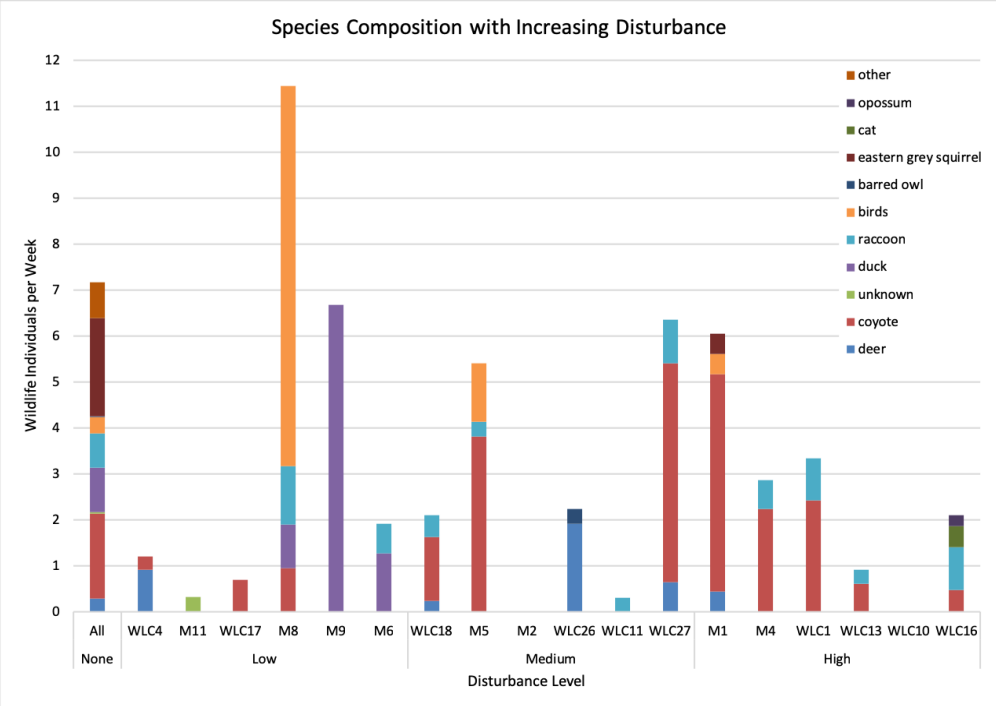

Figure 16: Sites from all study areas organized by disturbance to display species composition trends. The All site is combines all 18 undisturbed sites, normalized into individuals per camera per week.

Figure 16 compares all disturbed sites with the average wildlife detections for the 18 undisturbed sites. With the exception of M8, all disturbed sites detected less wildlife than the

undisturbed sites. The birds from M8 were often found off trail inside the thick wooded forest. M9 also came close to the undisturbed 7.18 individuals per week but was skewed by the flock of 12 mallards flying by it.

While most disturbed sites do seem to be biodiverse with multiple species, their composition can rely heavily on species like coyotes, deer and raccoon. These species may not be sensitive to disturbance. Examining the timing of activity, coyotes are active throughout the day and do not seem to care about when humans may be around (Figures 17 and 18). Figures 18, 19a and 19b combine all sites in this study to examine when animals are active. An animal just has to be active once at that time over the 9 weeks to count. Humans were present mostly during time intervals 2 and 3. Animals, however, were still very active during these time intervals. This shows that most animals do not change their behavioral timing to avoid humans but may change where they are active and/or wait to enter an area after a human has been there. Coyotes were seen just an hour after humans were at a site. Raccoons, deer and eastern grey squirrels were seen at least 5, 6 and 14 hours after humans respectively.

Coyotes and deer may switch to use both off and on trail when humans are present (Figure 18). Deer were not active off trail when people were active off trail which could have to do with limited sightlines and escape routes in off trail areas (Figure 19b). Eastern grey and Douglas squirrels were more active off trail.

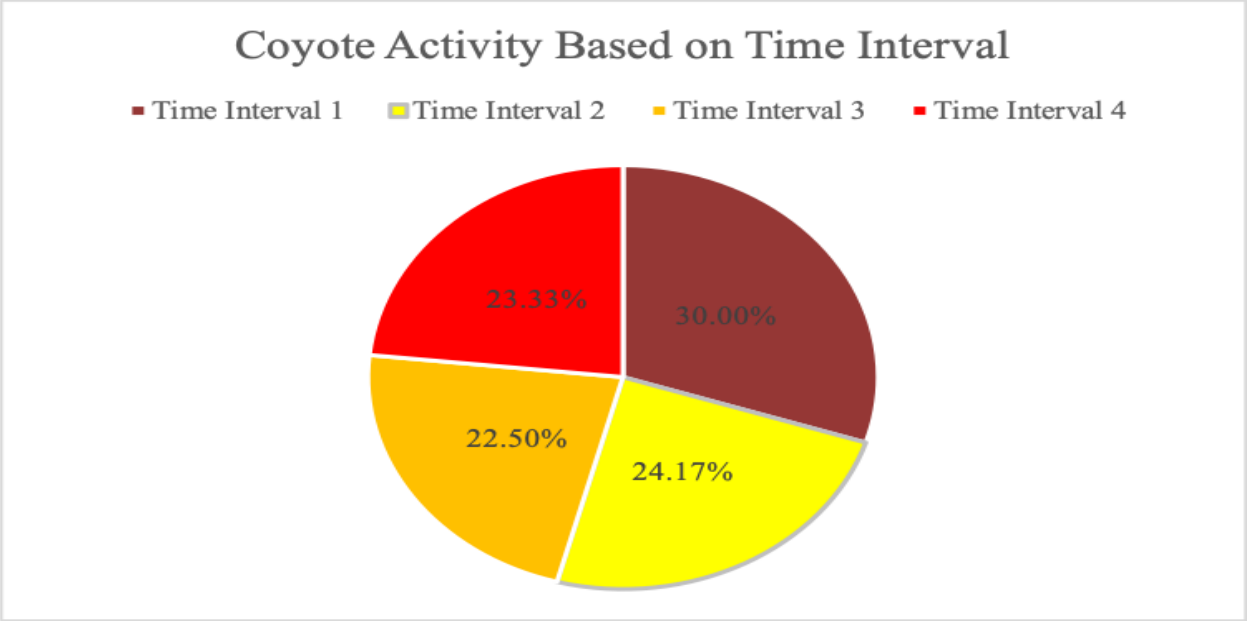

Figure 17: Coyote occurrences organized by time interval.

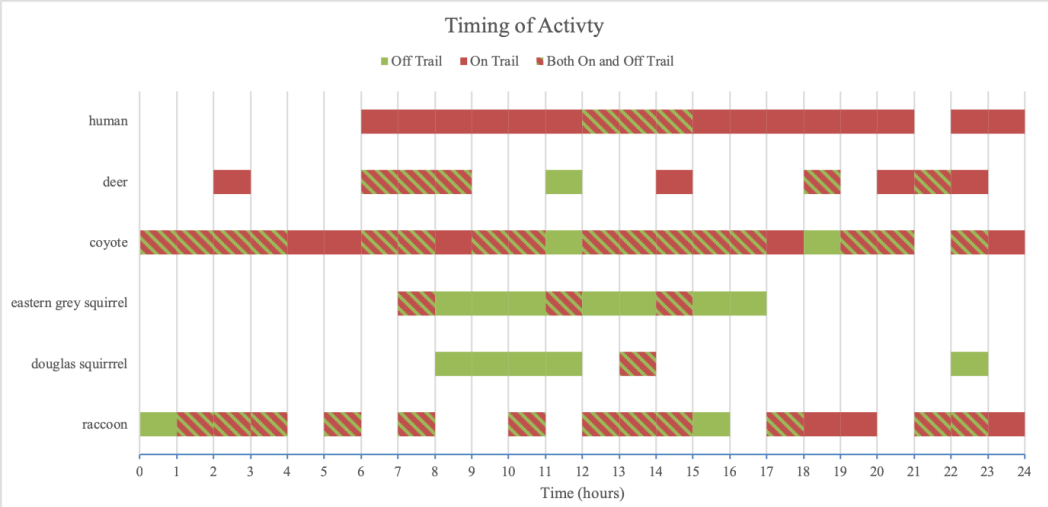

Figure 18: Activity of species if they were on or off trail.

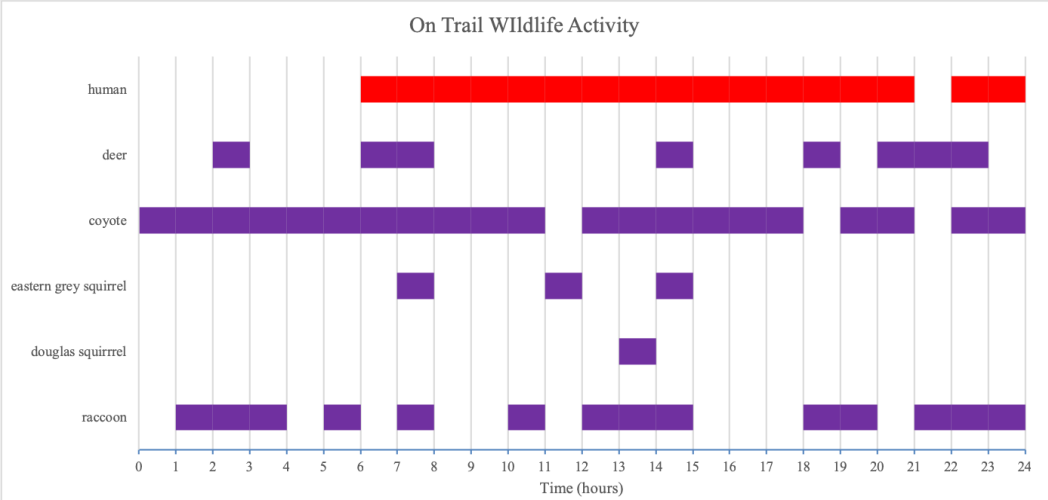

Figure 19a: Wildlife from all on trail sites organized by time of day.

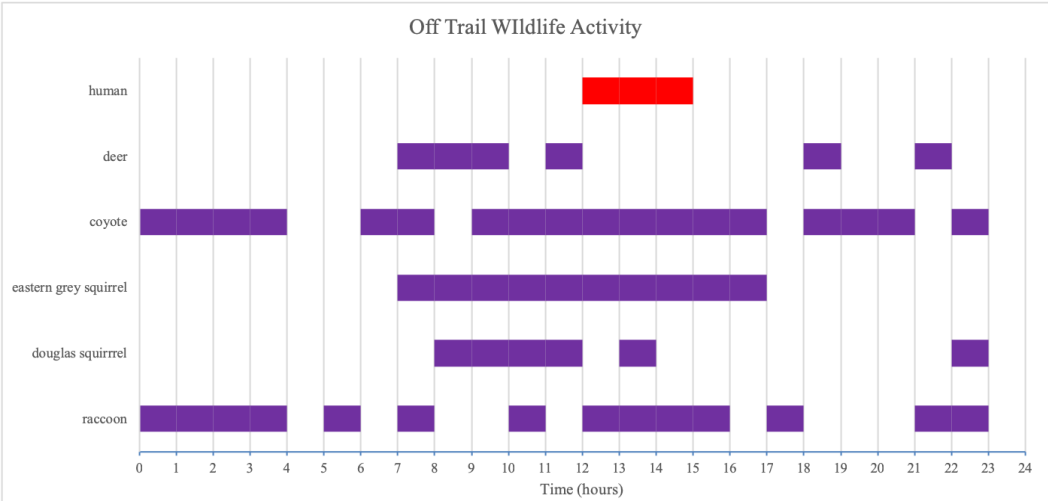

Figure 19b: Wildlife from all off trail sites organized by time of day.

With the exception of the combined measure of all birds except mallards, wildlife species were seen more on sites without people than with (Figure 20). This implies that human disturbance may negatively impact habitat usage by wildlife species. However, habitat features and distance from trail were not factored into this analysis. Having people use trails nearby may not impact the neighboring habitat's usage. Various forest birds and deer do not seem to show that trend. Barred owls were evenly disturbed across these sites but were only seen in the middle of the night without humans nearby. Coyotes were very active in WLC2 which was devoid of human usage. Yet they used the same route multiple times possibly indicating use of the area as a corridor to get other places.

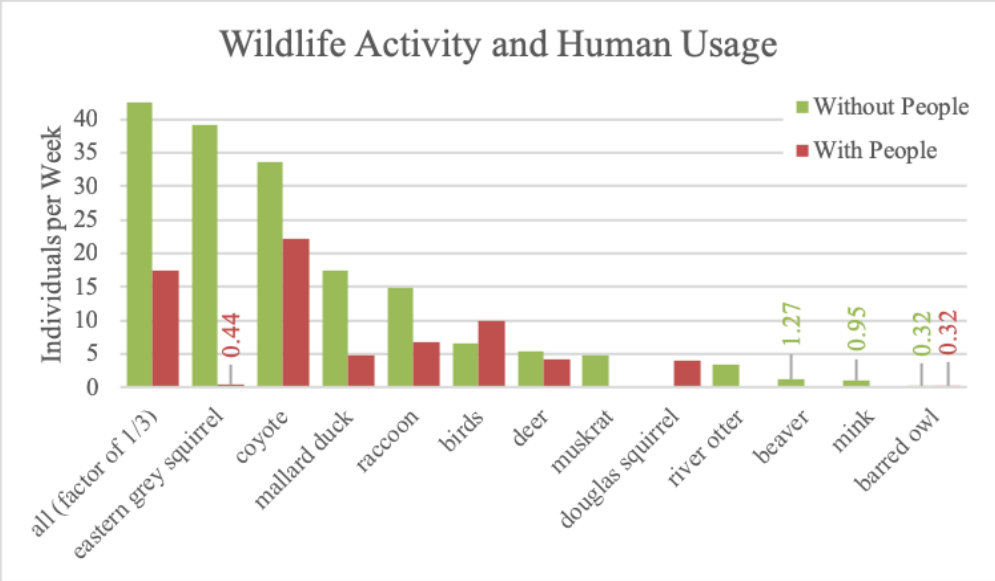

Figure 20: Sites without any human activity and sites with human activity combined for all species. A site was defined as with people if a person crossed its camera at least once during its three week sampling.

Trail Recommendations

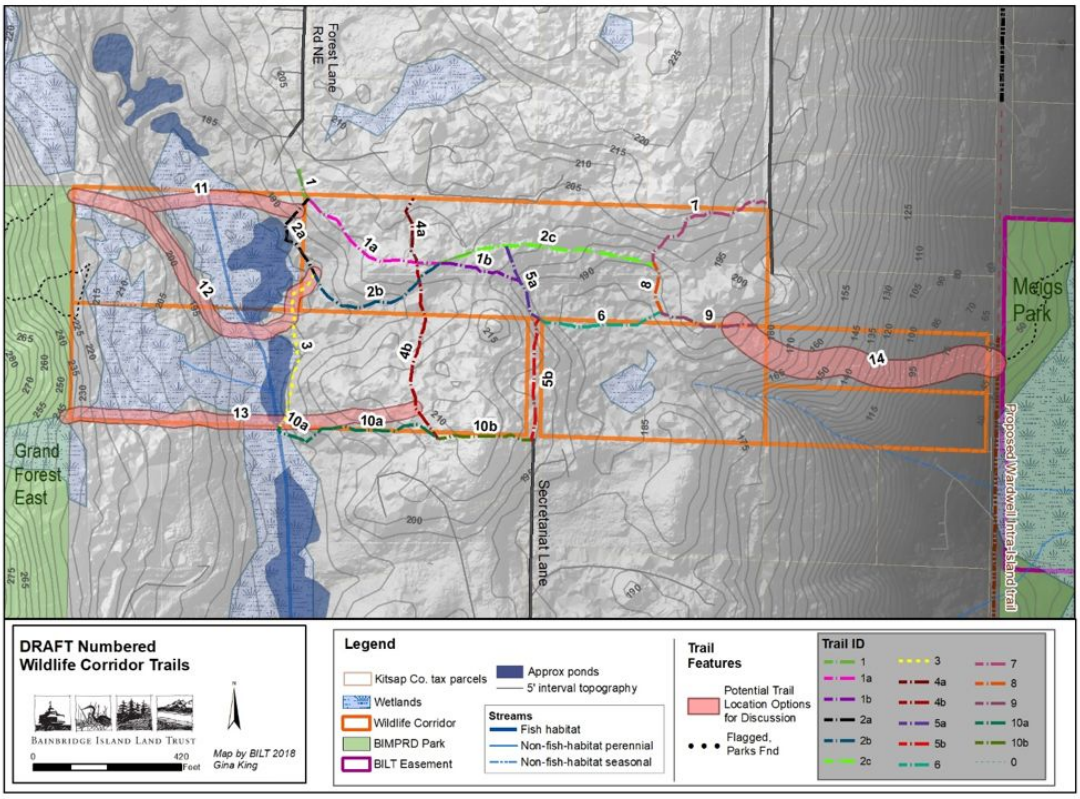

Figure 21: Overview of the numbered trails including all established, unofficial social and proposed trails.

Our study did not track an individual's path through the study area but instead looked at the intensity of use on each trail segment. Based on the preference of trail users and wildlife detections during our sampling intervals, some general trail expansion recommendations arise.

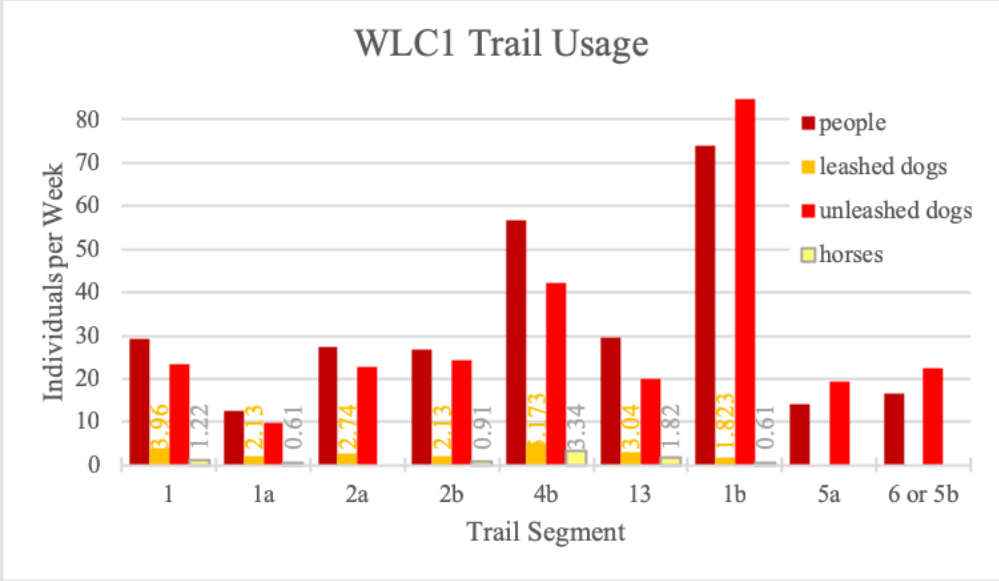

Figure 22: Human activity intensity organized by trail segments normalized into per week by trapping days.

In considering the simplification of WLC1 trails into one west to east trail, current preference seems to lean towards 2a, 2b and 1b (Figures 21 and 22). Although 1b had more users than 4b, 4b was prefered by horse riders who seemed to enter the area from the south. Because they did enter from the north onto Trail 1 once, investigation into if Trail 1, 2a and 2b could work for horse riders may be beneficial.

Closure of Trails 1a and 4b along with avoiding new trail construction on Proposed Trail 13 would work to provide more habitat for coyotes, deer, raccoons and squirrels seen at sites WLC1, WLC3, WLC9 and WLC14 while further protecting the wetland area which is a known amphibian breeding area (Figure 8). Should a westward trail connecting the Wildlife Corridor and the Grand Forest East be deemed desirable, westward expansion would be left to trails 11 and 12. From being out in the field, I know this may depend on accessibility and the extent of wetlands. Our camera traps in forested areas along Proposed Trail 12 detected only raccoon and deer, but amphibians are known to breed in the wetland portion of this route. Furthermore, Proposed Trail 11 does cross Class I wetlands, containing extensive deep ponds, which have not been surveyed. The ending of both 11 and 12 proposed trails at WLC6, however, is wet, dense and biodiverse with birds, river otter, deer, squirrels and raccoon.

In the eastern parcels of WLC2, no humans were detected. Meaning the Proposed Trail 14 system of undefined, partially overgrown trails is not currently utilized by people. However, 12 people per week did use the Wardwell Trail and with high usage at Meigs Park, trail users may appreciate a connection. WLC2 is an open and easily transversable area with old road beds that could form portions of an eastward trail. WLC20 was located on a segment of old road where a trail could easily be improved and only coyotes were detected. While coyote activity is very high, the lack of detections at WLC22 may show that wildlife do not depend on the Proposed Trail 14 system of trail segments. Additionally, the species detected in the eastern parcels are not highly sensitive to disturbance. This species composition and the exclusion of any wetland areas suggests that a single east-west trail would be less disruptive than previously thought and may not have a large impact on wildlife.

If Proposed Trail 14 is to be constructed, an east to west trail in Meigs has been proposed to connect the main trail on Meigs to both the Wardwell Trail and to WLC2 (Figure 12). Of the three existing east to west trails on Meigs, the northernmost one got the second most human usage and the least amount of wildlife detection. The trail is thick with salmonberry and ends with a stream before it can connect all the way west. Still, that trail would also be easiest to connect to WLC2. The middle side trail did receive more human traffic, providing scenic views of the wetland as opposed to trail connection. It also nears an area with locally rare species like beavers, otters, mink and muskrats which occupy the wetlands. Impacts on locally rare wetland species should be considered before any trail improvements are implemented. The southern side trail is thick with vegetation and gets inundated with deep waters, making passage somewhat difficult and dangerous. Furthermore, it crosses near beaver dams, recent beaver chews and amphibian breeding grounds, entering into an extensive wetland, diverse with many bird species.

Being near to a highway and other established trail systems, Meigs also hosted some bicyclists, their desire to use the Wildlife Corridor connection trails should be considered when planning expansion because of the safety infrastructure needed and possible addition of disturbance.

Study Limitations

Our study on wildlife activity and human trail usage occurred during the winter. Extreme snow events did occur, causing trees to fall and temperatures to drop. This most likely had an effect on both wildlife and human activity. With just three weeks in a study area and with west to east progression of our study areas, as opposed to temporal staggering, our study does not capture seasonal variation in wildlife activity, habitat or trail usage.

With only five occurrences of vigilance, our data richness also did not allow us to examine predator-prey impacts or the extent of human disturbance. Therefore, our definition of disturbance was based solely on human activity, not based trail infrastructure. This means an on trail site that experienced no human presence was viewed the same as an off trail site. For certain species, this may be appropriate but not for all.

Focusing on presence absence and relying on volunteer birders, we did not implement a strict scientific bird survey procedure. We also played bird calls in the field to determine bird species. Our bird data should not be extrapolated for other studies.

Still, our study did inventory a lot of wildlife, trail usage and trail conditions. It got a winter snapshot of the conservation lands and can help inform trail expansion and habitat protection.

Acknowledgements

Thank you to Gina King for mentoring two interns and working so hard to design and implement this study. Thank you to Ankush Puri taking half of any blame put on the interns, giving field directions to get us unlost, and processing endless photos. Bird data is due to the knowledge and willingness of volunteer birders Don Willcott, Lee Robinson, Tim Billo and Avery Meeker. Thank you to Christina Doherty for teaching us how to survey for and identify amphibians. M7 photos and beaver confirmation thanks to the waders provided by Deb Rudnick and Matt Otepka, and thanks to the use of those waders by Ankush Puri.

Citations

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Appendix

WLC20 Coyote

WLC26 Barred Owl

M7 Beaver

M7 Male mallard taking off

M7 Otters

M10 Raccoon