Moraine Mesocarnivores Project 2014-2015 Report to our Volunteers and Landowners

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Thank You

The *Moraine Mesocarnivores Project* is an Albertan team effort in the truest sense. This research could not be done without the backing of local landowners, who give us approval to research their properties, and who help us out with everything from advice to hot drinks on a cold day. It also couldn't be done without the Friends of Elk Island National Park, who have been unflagging in their volunteer efforts collecting camera and hair data within that Park. The Beaver Hills Initiative has also been a staunch supporter, supplying money and resources. Most importantly, the collective good will of people on the Moraine makes this research project not only successful, but so very rewarding. Thanks everyone!

If you are interested in wildlife photos from your land, or from a local protected area near you, please email us any time. We are happy to answer any questions you may have. We have also started a website that you may visit to see the most recent updates on this project as well as a collection of photos: www.mesocarnivore.weebly.com

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Executive Summary

Alberta's Land Use Framework assumes parks and protected areas (PAs) will play a pivotal role in maintaining biodiversity across the landscape. However, many PAs are islands of intact habitat in a sea of human land-use. To maintain biodiversity, they need to be functionally connected to one another. Are they?

The *Moraine Mesocarnivore Project* investigates whether protected areas, private woodlots, and anthropogenic patches within mixed-use landscapes are connected and working together to support mammalian diversity in Alberta's heartland. Our goals are:

1. Measure mesocarnivore diversity within this mixed multi-use landscape;
2. Determine how natural and anthropogenic habitat fragments - and their position relative to one another - affect this diversity;
3. Understand how PAs in a mixed-use landscape are functionally connected to one another, and to PAs elsewhere in the province, by examining the genetic structure of reintroduced fisher (*Pekania pennanti*) populations.

In 2013-2014 we designed the study; field operations were launched in November 2013. We deployed 64 sampling points across the Cooking Lake Moraine (CLM) in a systematic design of 4-km x 4-km grid cells, on public, private lands, and conservation areas, within a diverse landscape of varying connectivity and composition. At each site we sampled mammalian species using non-invasive hair- and camera-trapping, from December 2013 - June 2014. We continue sampling 8 sites within Elk Island National Park (EINP) with volunteer help from the Friends of Elk Island National Park (FEINP).

We collected 166,118 photos as of December 20th 2014. Fishers were detected *via* cameras at 35 of 61 sites checked (57% naïve occupancy), indicating that this reintroduced species is widespread across the Moraine landscape. In some cases more than one fisher was present at the same site. Moose (*Alces alces*), white tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), wolf (*Canis lupus*), least (*Mustela nivalis*), short-tailed *(Mustela erminea*) and long-tailed weasels (*Mustela frenata*), porcupine (*Erethizon dorsatum)*, striped skunk (*Mephitis mephitis*), wood bison (*Bison bison athabascae*), plains bison (*Bison bison bison*), elk (*Cervus canadensis*), black bears (*Ursus americanus*), domestic dog (*Canis lupis familiaris*), and striped skunk (*Mephitis mephitis*) were also detected, illustrating that mammalian diversity is high across this landscape.

A preliminary 1nalysis of camera data shows that fishers are ~ 4.5 times more likely to occur within a protected area than outside of a protected area, stressing the importance of protected areas in maintaining this *special concern*-listed species.

We have collected 605 hair samples, and are conducting microsatellite analysis to identify them to species and individual. We have located the Ontario and Manitoba source populations of fisher translocated to the CLM in 1990 and 1992; genetic samples from these areas have been donated. In addition, genetic samples have been contributed to this this research from northeast Alberta-Cold Lake area (Environment Canada), Willmore Wilderness (Alberta Innovates), as well as historical samples from central Alberta (Royal Alberta Museum). Together, these samples will help us assess gene flow within the CLM and across northern Alberta. We ask whether CLM animals descended from (1) animals re-introduced in 1990-1992, indicating a successful fisher re-introduction isolated from other populations; (2) animals that have dispersed from other parts of Alberta indicating high connectivity to other landscapes; or (3) a relic population on the CLM, not previously detected. Frances has begun mitochondrial DNA analyses at the University of Victoria, led by Dr. John Taylor, to answer this question. Additional microsatellite analyses will be conducted by Wildlife Genetics International (Nelson, BC) to investigate the source of these populations and examine the degree of gene flow within and between landscapes.

Finally, we contacted over 50 landowners on the CLM to discuss this project, and obtained the help of 26 of them. The FEINP has been checking National Park sites monthly. We are compiling fisher sighting reports from local landowners, creating a citizen science dataset to track fisher sightings and landowner participation across this landscape.

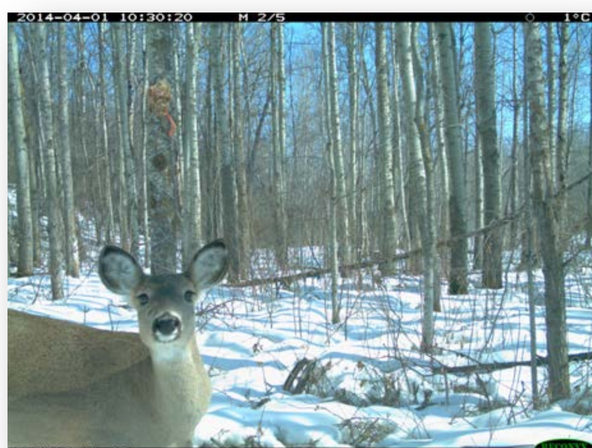
Contents

Introduction

Conserving biodiversity and ecological integrity is considered as primary goal for parks and protected areas (PAs) worldwide, though there is great variability in how well PAs are achieving this goal[1]. In Alberta, Canada, the “working landscape” has been impacted by agriculture for over a century; forest-harvesting for over fifty years; and more recently by petroleum exploration and extraction. Each sector is accompanied by marked increased in road and trail access. The cumulative effects of these various forms of landscape development are widespread across Alberta, contributing to declines of woodland caribou[2,3], range contraction of wolverines[4], and a suite of other ecological impacts[5]. Growing landscape impacts necessitated a provincial strategy to plan for land-use with a goal of maintaining biodiversity - Alberta's Land-use Framework[1] (LUF).

Protected areas are a key component of the LUF, which is designed to balance environmental sustainability with economic opportunity. The LUF assumes that Alberta biodiversity will be maintained by a combination of PAs and the "working landscape", functioning together to sustain viable wildlife populations and biotic communities. However, this assumption only holds if (1) PAs and adjacent patches of "working landscape" are functionally connected – operating together to support animal populations; and (2) large intact landscapes and PAs are functionally connected over large scales to allow immigration and emigration, and hence gene flow, among populations[6-9]. These assumptions have never been tested for Alberta, but are crucial to maintaining ecological integrity of a landscape.

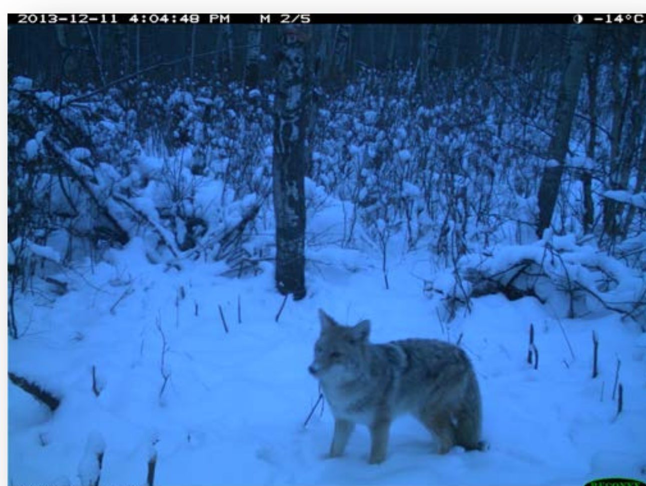
Ecological integrity is an evolving mandate for Alberta Parks, and understanding whether Alberta Parks is achieving it will require data on existing biodiversity within its many sites. Limited resources, however, will likely necessitate



[1] https://www.landuse.alberta.ca/Documents/LUF_Land-use_Framework_Report-2008-12.pdf

a triage approach, in which sites with expected high biodiversity value are identified as a focus for conservation of integrity. Large protected areas such as the Willmore Wilderness house diverse biotic communities of mammals[4,10-12] and other species. However, the biodiversity value and conservation role of the many small protected areas common throughout Alberta – in addition to protected parcels owned by environmental groups – has always been controversial. Most small PAs are embedded within mixed-use landscapes – patchworks of forested, protected areas, small-scale agriculture, rural residential areas, and natural fragments on private land. How valuable are these PA islands for maintaining biodiversity and ecological integrity?

In fact, increasing evidence shows they can be extremely valuable, particularly when patches of natural habitats are connected with one another. It is true that habitat fragmentation and loss adversely affect the persistence of many wildlife species[13-15]. However, habitat fragmented is not always lost. Mixed forested and agricultural landscapes can support viable and persistent wildlife populations in woodland patches within agricultural landscapes[16-18], provided habitat patches remain sufficiently connected for wildlife species[19]. In fact, agricultural habitat may actually provide complementary or supplementary resources to species living in wooded patches (*i.e.*, prey), facilitating their persistence[6,20]. Just as importantly, emerging research shows that protected areas can act as catalysts for integrated conservation between government and private lands in mixed-use landscapes[21]. Both ecologically and socially, small protected areas may be significant, even essential, in maintaining biodiversity in mixed-use landscapes.



Mixed-use landscapes may be particularly suited to generalist species, including some mammalian mesocarnivores. Mesocarnivores – mid-sized mammalian predators, such as marten, fishers, foxes, coyotes, lynx, and raccoons – may persist in forest landscapes with a degree of agricultural incursion or fragmentation. First, these landscapes often have reduced or absent top predator populations (such as bears and wolves). In the absence of top predators, mesocarnivores are released from predation and competition, and their populations can increase[22,23]. Second, fragmented landscapes often support diverse small-mammal populations, which provide abundant prey for mesocarnivores. Where wooded patches are large enough to provide breeding habitat, but are interspersed with "novel" agricultural patches that provide a resource subsidy, fragmented forest landscapes may support persistent populations of mesocarnivores. The landscape features allowing species' persistence is both landscape and species-specific[24], preventing generalities from other parts of the continent. In western Canadian landscapes, we know little about mesocarnivore species persistence in fragmented, mixed-use forest-agricultural systems, but this information is vital to evidence-based decision-making designed to maintain ecological integrity within small protected areas.

We seek to help supply this information by examining the diversity, distribution, and connectivity of mesocarnivores on the Cooking Lake Moraine in central Alberta: a matrix of patches of protected areas and private land with natural habitats contiguous with areas of significant anthropogenic disturbance. We ask several related questions:

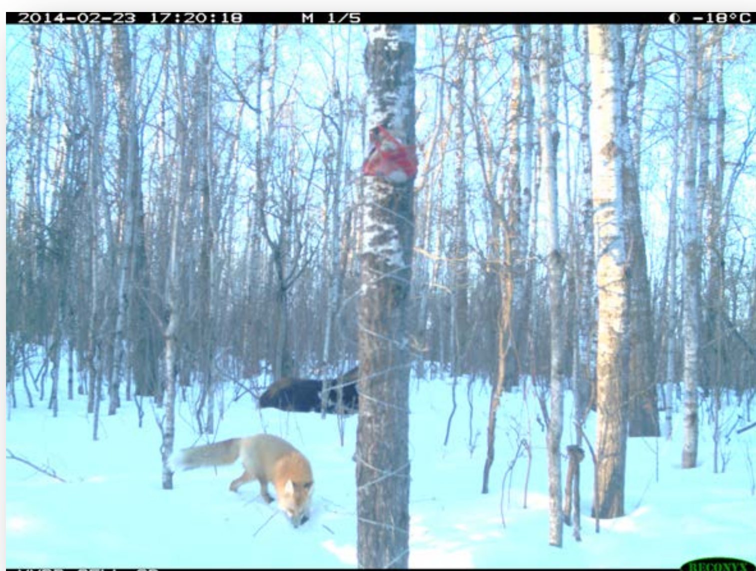
1. What mesocarnivore species occupy this mixed natural-agricultural system?
2. What landscape elements – including natural and anthropogenic features – positively or negatively affect species occurrence and movement?
3. How functionally connected is this protected and mixed-use landscape to other biodiverse landscapes to the west and north, separated by intensive development? Specifically, are fishers (*Pekania pennanti*) occurring on the Moraine more

genetically related to re-introduced ancestors from Ontario and Manitoba, or is there evidence of genetic contribution from adjacent landscapes indicating functional connectivity?

Methods

Study Area

The Cooking Lake Moraine is approximately 600 km^2 of primarily aspen forest with patches of white spruce, open meadows, and small permanent water bodies (Pybus *et al.* 2009). This (relatively) intact and heterogeneous complex sits in a matrix of agricultural land. Our study area covers the moraine and its agricultural environs, an area over 960 km^2 in size. The moraine is, to a large degree, spatially disjunct from tracts of contiguous forests to the north and west. Several parks and protected areas cover this landscape, limiting development and human activity (Figure 1). As such, the moraine may be an important source of biodiversity for the entire region. Elk Island National Park, within the moraine, is a fenced park with large populations of ungulates, wolves, coyotes and other mesocarnivores, as well as diverse bird and plant communities. This Park, together with the many provincial protected areas and conservation properties (*i.e.*, ACA, DU, ABFG and NCC) on the moraine, support high biodiversity, but an empirical, multi-species analysis of the composition of the mammalian community has not been conducted.



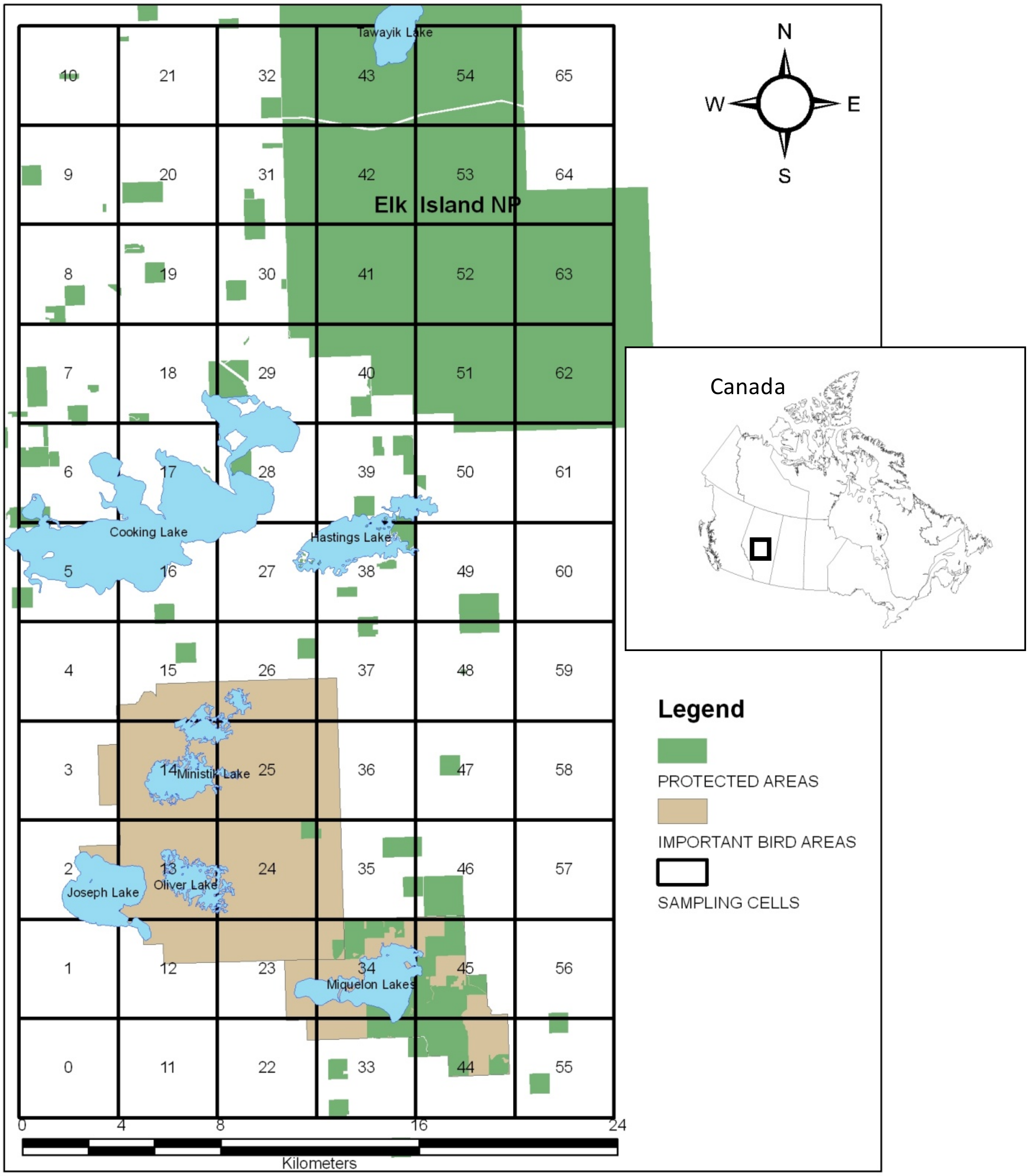


Figure 1. Mesocarnivore diversity is being sampled within a systematic design on the Cooking Lake Moraine area of Alberta, Canada. 66, 4km x 4km sampling cells were designated in GIS. Within 64 of these cells, a sampling site was subjectively placed within a forested area a minimum of 1-ha in size.

Species sampling

Mesocarnivore occurrence is being surveyed using a multi-method approach[25] involving a combination of non-invasive genetic tagging (NGT)[26] *via* hair sampling and infra-red remote cameras (IRCs)[27]. This double-method sampling has proven effective for mammals elsewhere in Alberta[4,10,11] and has a high probability of detecting mesocarnivores, including fishers [28].

Hair samples for NGT were collected using Gaucho barbed wire wrapped around a tree baited with beaver fat and O'Gorman's scent lure. At each station, we also deployed one Reconyx™ infrared-triggered digital camera. Cameras are placed *ca.* 6-10 metres from the tree such that the camera's detection cone and field of view includes the NGT hair trap and the area surrounding it (Figure 2).

DNA from collected hairs will be extracted and analysed to identify species using mitochondrial DNA (mtDNA), which is then compared against a DNA reference library of all known mammal species in the region. For fishers, individuals and gender will be identified. Individual capture histories can be used in mark-recapture models to estimate population sizes and densities.

With additional microsatellite analysis, we will quantify the genetic structure of the population. We will determine the degree of relatedness between Moraine fishers and those from neighbouring populations (the Rocky Mountains, with samples collected by Fisher, et al. [11], as well as from trappers in northern Alberta) as well as re-introduction source populations (Manitoba and Ontario samples). Frances Stewart (University of Victoria) will use the same samples to conduct a mitochondrial genetic analysis to explore relatedness in a different way, for robust conclusions.

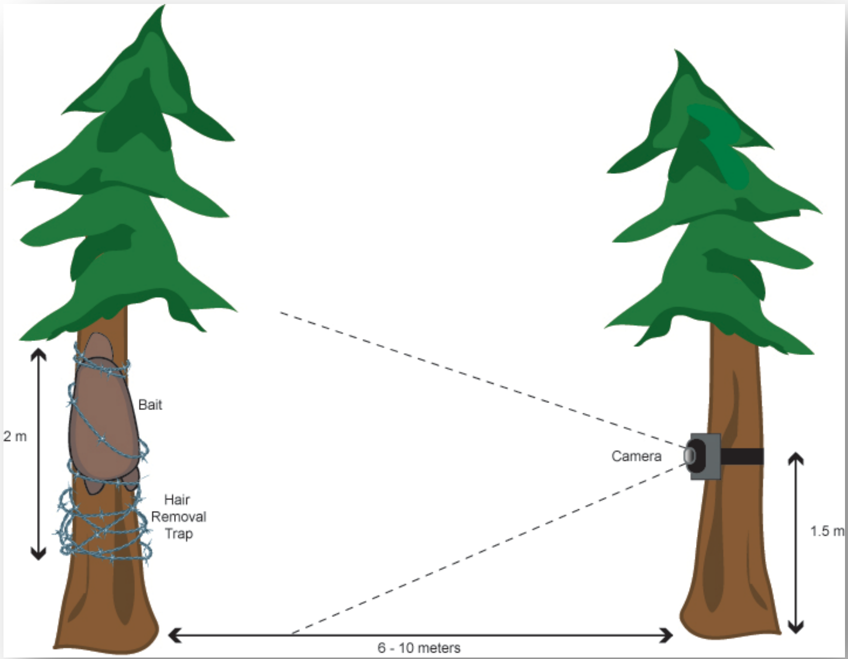


Figure 2. Mammal diversity is being surveyed at sampling sites using two methods: hair trapping for noninvasive genetic tagging, and camera trapping. The hair trap consists of barbed wire loosely wrapped around a baited tree. The Reconyx™ passive infrared-triggered digital camera is positioned on a tree 6-10m away to photograph the hair trap and the area around it (Fisher and Bradbury 2014).

NGT provides unique information, but may underestimate species' occurrence. Absence of hair may result from (1) an absent individual, or (2) a present, but undetected individual. Such imperfect detection has ramifications for estimates of species occupancy, density, and habitat use[29,30]. To maximise detectability, we are surveying mesocarnivore occurrence using camera traps and hair traps. Cameras are triggered by heat-in-motion and are set to take a series of 5 photographs at each detection event. Camera data are downloaded monthly in conjunction with hair data collection. Images are imported into *Timelapse*, a program for managing and analysing cameras data images in widespread use in Parks Canada and Kananaskis Country. Images containing human activity are permanently deleted immediately; following this, all other images are being triple-redundant stored for analysis. Images are analysed and summarised for species presence, creating a serial detection-nondetection dataset for each site. Camera data on the mesocarnivore community will inform landscape-scale species-distribution models.

Finally, (pending funding) in 2015-2016 we plan to capture and radio-collar adult fishers. Genetic structuring within the study area, and between the study area and adjacent landscapes, tells us part of the picture, but not the whole. To understand how animals use multiple protected and anthropogenic patch types in this landscape, we will examine individual fisher movements. Movement data will allow us to test hypotheses about functional connectivity within this landscape in a way that genetic data cannot (but which likewise tells us things telemetry cannot). Resource selection functions[31] built from location data will enable us to test hypotheses about the connectivity between protected areas in this multi-use landscape.

Statistical analysis

Camera surveys, like any survey, are challenged by the possibility of false absences: failing to detect a species that is, in fact, present. To assess the reliability of camera data, we must first estimate the probability of detecting that species if it is present at a site[29]. The frequency of repeated species detections at a camera can be used much like a mark-recapture history to estimate this probability of detection. Given this probability, we can correct for potential false absences and thus more accurately estimate the probability that fishers occupied a site during a sampling period. This *probability of site occupancy* takes into account missed detections, and because it describes the *likelihood* that a fisher uses a site, it is a more ecologically meaningful measure of a species' site-use than simply presence or absence, which is an all-or-none measure. Detectability and occupancy are estimated using hierarchical occupancy models[30], which are gaining widespread use for examining species' distributions ranging from wolverines[4] to salmon[32] and grizzly bears[12].

Occupancy is not a static measure; it is expected to change through time[33]. For example, sites without fisher can become occupied in the following season, whereas sites with fishers in one season may have no fishers in the next season, as they die, or emigrate to better habitat. Examining how occupancy changes among seasons helps us better understand the influence of environmental conditions on fisher distribution.

We used multi-season occupancy models[30,33] for a preliminary assessment of detectability and occupancy of fishers. We assumed that each month of camera sampling represents a distinct and independent survey. We assumed that fisher occupancy could change between seasons, however, as individuals give birth, die, immigrate or emigrate between patches. We therefore divided the sampling period into 4 seasons, with 2 monthly surveys within each: Nov-Dec (autumn), Jan-Feb (winter), Mar-Apr (breeding), and May-Jun (kit emergence). Each season is assumed to be closed to changes to occupancy at the species level – that is, fishers will not disappear completely from a site, appear if absent, within each season, but can change between seasons. The assignment of seasons here is somewhat arbitrary and can change to suit species biology.

We also assumed the probability of detecting a fisher on camera – given it is present – could stay the same, vary among surveys or seasons, or vary monthly within seasons. Finally, we tested whether fishers were more likely to occupy sites within protected areas or outside protected areas. We ran a model with each set of assumptions, and ranked each model by its AIC score (Akiake's Information Criterion) – a measure of how well each model fit the data[34]. AIC scores weights were normalised to sum to 1.0 to create AIC weights, analogous to the probability that a model best explained the data, compared to other models in the set.

In the coming year, landscape structure will be quantified from available GIS data. We will use a combination of occupancy modelling[29,30] and generalised linear modelling[35] to examine relationships between species occurrence and habitat features. Multiple competing hypotheses will be represented as multiple statistical models, which we will rank[34] based on how well each model fits the data. The best-supported models indicate those natural landscape features and agricultural patches that best explain mesocarnivore occurrence on the moraine, and model parameter estimates will allow us to map the probability of occurrence of species across this landscape.

Results

We deployed a total of 64 sampling sites across the Cooking Lake Moraine and sampled them monthly from November 2013 to June 2014. Monthly sampling has continued on a subsample of eight of these sites in EINP from July 2014 to March 2015. To date we have collected 166,118 photos and 605 hair samples across the study area. Fishers were detected *via* cameras at 35 of 61 sites checked to date (57%), indicating that this species is widespread across the Moraine landscape and occupying a variety of habitat types.

The probability of detecting fishers within a month-long camera survey (given they were present at a site; *p*) varied across time. The probability of fisher occupancy was also highly variable across the study area. The best-supported model, which carried almost all of the weight of evidence (AICw = 0.9997), indicates that *p* was different for each monthly survey (Table 1). There was a low probability of detecting fishers on cameras at the onset of the study, in November and December. This probability improved throughout the winter, peaking in February and March. Detectability in May and June was very low (Figure 3).

Table 1. Selection of competing occupancy models of fisher distribution, each with different assumptions about probability of detection and fisher occupancy. The best-supported model is highlighted.

Detectability varies:	Occupancy varies:	AIC	ΔAIC	AIC weight	Model Likelihood	# parameters
Constant	Constant	472.45	89.97	0.00	0.00	3.00
Seasonally	Constant	428.63	46.15	0.00	0.00	6.00
Among survey months	Constant	398.54	16.06	0.00	0.00	10.00
Within seasons	Constant	474.37	91.89	0.00	0.00	4.00
Constant	Protected areas	461.44	78.96	0.00	0.00	4.00
Seasonally	Protected areas	409.20	26.72	0.00	0.00	7.00
Among survey months	***Protected areas***	***382.48***	***0.00***	***1.00***	***1.00***	***11.00***
Within seasons	Protected areas	463.38	80.90	0.00	0.00	5.00
Constant	Seasonally	469.33	86.85	0.00	0.00	6.00
Seasonally	Seasonally	458.00	75.52	0.00	0.00	9.00
Among survey months	Seasonally	457.81	75.33	0.00	0.00	13.00
Within seasons	Seasonally	471.32	88.84	0.00	0.00	7.00

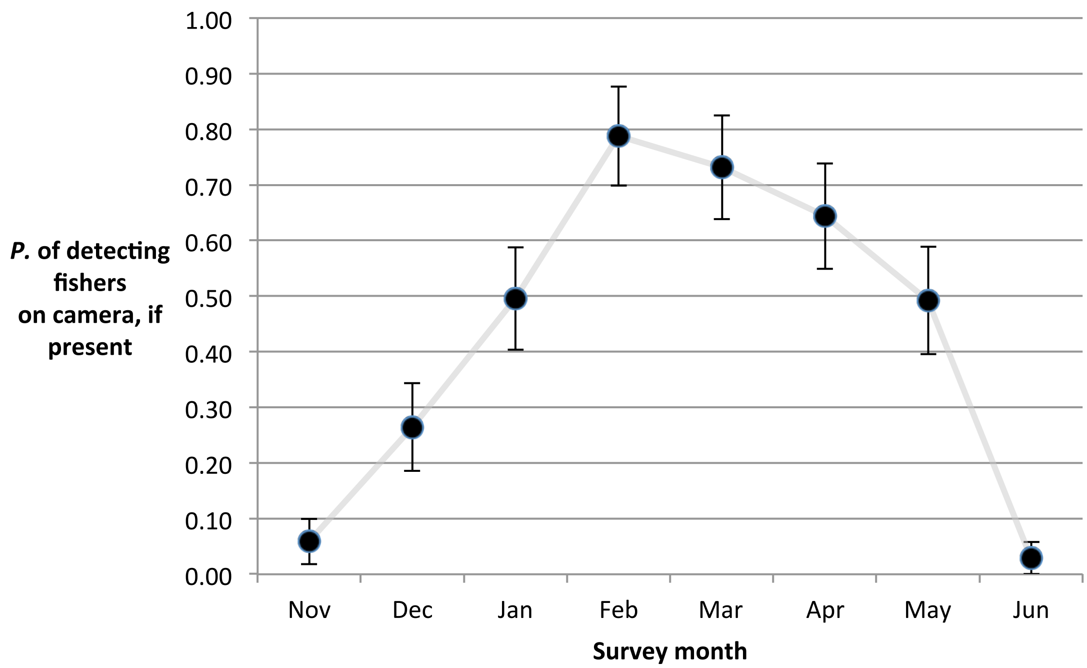


Figure 3. The probability of detecting fishers on cameras (*p*) varied with survey month. As with many studies, *p* started low, then generally increased through time. Bars represent standard errors. High *p* gives us confidence in conclusions about fisher distribution.

After accounting for imperfect detectability, there was a significant difference in fisher occupancy inside and outside of protected areas. Fishers were ~ 4.5 times more likely to occur at camera sites within protected areas (ψ = 0.76, s.e. = 0.11) than sites outside of protected areas (ψ = 0.16, s.e. = 0.07). There was no evidence that fisher occupancy varied among seasons, and their distribution was stable throughout the study period. These are preliminary models without spatial covariates derived from GIS data, and with assumptions about seasons and surveys that deserve scrutiny[36]. These models will be supplemented with data from the 2015-2016 field season, and with data quantifying anthropogenic and landscape features, to yield final results of

fisher and competitor mesocarnivore species occupancy across the CLM across two years.

We will also determine whether CLM fishers are outbreeding with individuals north and west of our study. Preliminary mitochondrial DNA analyses suggest that there is no difference between genetic samples from Alberta's Cold Lake are and a single sample from CLM (Figure 4), more testing is needed with our full complement of samples.

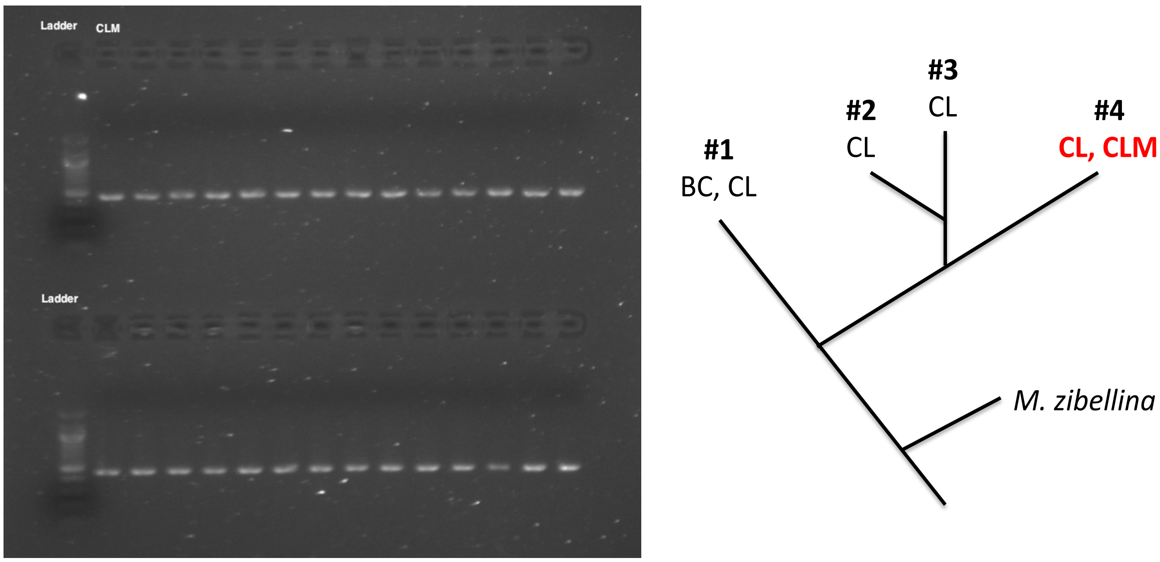


Figure 4. Electrophoretic gel of PCR product from *Pekania pennanti* D-loop mitochondrial DNA conducted by Frances Stewart (**left panel**). The first sample was collected from a road kill fisher in the Cooking Lake Moraine (CLM) and is not significantly larger than all other samples collected from the Cold Lake Area, as represented here. DNA sequencing later confirmed that the CLM sample represents the same haplotype as many other samples collected from Cold Lake as demonstrated by a phylogenetic tree (**right panel**) where the CLM clusters into the same haplotype (#4) as Cold Lake samples (CL). This analysis has yet to be repeated across all CLM samples collected to confirm this preliminary result.

Wildlife such as moose (*Alces alces*), white tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*) red fox (*Vulpes vulpes*), coyote (*Canis latrans*), wolf (*Canis lupus*), least (*Mustela nivalis*), short-tailed *(Mustela erminea*) and long-tailed (*Mustela frenata*) weasels, porcupine (*Erethizon dorsatum)*, striped skunk (*Mephitis mephitis*), wood bison (*Bison bison athabascae*), elk (*Cervus canadensis*), black bear (*Ursus americanus*), striped skunk (*Mephitis mephitis*), and domestic animals such as the domestic dog (*Canis lupis familiaris*) were also detected, illustrating that mammalian diversity is high across this landscape.

Discussion

Fishers were more widespread than expected. After accounting for imperfect detectability, fishers occupied an estimated 75% of sites within protected areas, and only 16% of sites outside of protected areas. The models require some refining based on assumptions about seasonality and movement[36], as well as the inclusion of spatial covariates describing landscape composition and configuration. However, these initial results provide strong evidence that protected areas play an important role in fishers' distribution.

Through camera photos we have been able to document multiple fisher individuals at some locations, indicating that we may able to observe male and female overlapping territories using wildlife cameras. Mammalian diversity was also high across multiple landcover types in this mixed-use landscape. To date, we have also observed that co-occurrences of domestic dog and fisher are rare, whereas there seems to be no pattern in occurrences of fisher and both coyote and red fox. We plan to further investigate interspecific interactions between mesocarnivores as our study continues.

NGT hair sample collection, IRC photo collection, and community involvement and collaboration, have exceeded expectations. The number of samples collected during each monthly check increased from 50 (January) to 150 (April) hair samples and 18,050 (January) to 31,353 (April) photos between the months of January 2014 and December 2014. These are mirrored in the probability of detection, which varies among surveys but is very high is later winter / early spring, similar to Fisher and Bradbury [28]. This suggests the method is quite sound and the data can be reliably used for species-habitat models to answer our primary questions.

Community Involvement

We have contacted over 50 landowners and received the support of 26 of them for this project. The support of private land-owners has been very encouraging throughout 2014, and the project has been the focal point for community discussions about conservation. We also incorporated three CSL (Community Service Learning) students from Augustana Campus, University of Alberta, to help us input data from camera pictures and complete some basic fieldwork in spring 2014. We have engaged *Friends of Elk Island National Park* in this project, and they have assisted with camera deployment and checking (see http://www.elkisland.ca/conservation-research/mesocarnivore-monitoring). We have also engaged the *Beaver Hills Initiative*, securing financial and in-kind (GIS data) support, and their help in engaging their membership with outreach activities.

This work to date was presented at the annual meeting of the FEINP to an audience of 70 people; the Alberta Trail Rider's Association; and the Friends of Cooking Lake / Blackfoot Provincial Recreation Area. We received very positive feedback from the local community, with several people offering their time for fieldwork in 2015. One of the things we like best about this research is the opportunity to involve local Albertans in ecological research in their own backyards.

Preliminary Conclusions

Although the project is ongoing and much more work needs to be done, we can (cautiously) make some preliminary conclusions.

Most importantly, initial analyses suggest protected areas play a key role in maintaining fishers in this mixed-use landscape. Fishers were ~ 4.5 times more like to occur within a protected area, than outside a protected area. Movement data from GPS collars will markedly increase our ability to resolve the importance of protected areas in fisher habitat selection.

To date, the quantity of both hair samples and photos collected increased from January to April of this study, but decreased across the summer months. This observation is confirmed by the analysis of detectability via cameras; detectability peaked during late-winter months. This suggests that animals acclimated to the sites, climbing the barb-wired tree more frequently as daylight and temperature increased; however alternate food sources were available during the summer months and caused a decrease in both animal occurrence and hair samples at the baited sites.

Importantly, the quality of the hair samples collected has also increased across our spring sampling period, which suggests that NGT hair sampling may be most effective during the months where fishers' pelts are losing their prime. This observation could have implications for other studies using hair-trapping to obtain fisher genetic samples. If funds are limited for a study, the most effective time to sample for fisher hair using our techniques appears to be between March and May. However, food stress in early winter may be the best period for luring fishers to camera sites. A full analysis of these data will tease out these methodological questions.

In addition, we have been able to potentially observe overlap in fisher territories by documenting two different individuals on camera photos within the same month, as well as two different animals within the same photo at one site. Capture and collaring, as well as individual and gender ID, will help us further resolve local density in relation to protected areas and other natural patches in the landscape.

The plan forward, pending funding, is to re-initiate camera and hair trapping starting fall 2015 through to spring 2016, using existing sampling sites, as well as a live-trapping and GPS collaring study. We continue to receive unwavering support from the Friends of Elk Island National Park as well as the landowners involved in this study. Collaboration is vital to the completion of our upcoming, largest, and final field study for this project, so we can better understand how mixed-use landscapes of protected areas and agricultural areas contribute to mammalian biodiversity and ecosystem function.

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Frances Stewart, University of Victoria	Ph.D. student
Dr. Margo Pybus, Alberta ESRD	Advisor
Drajs Vujnovic, Alberta Parks	Advisor
Dr. John Volpe, Assoc. Professor, University of Victoria	Student supervisor
Dr. John Taylor, Assoc. Professor, University of Victoria	Student advisor

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