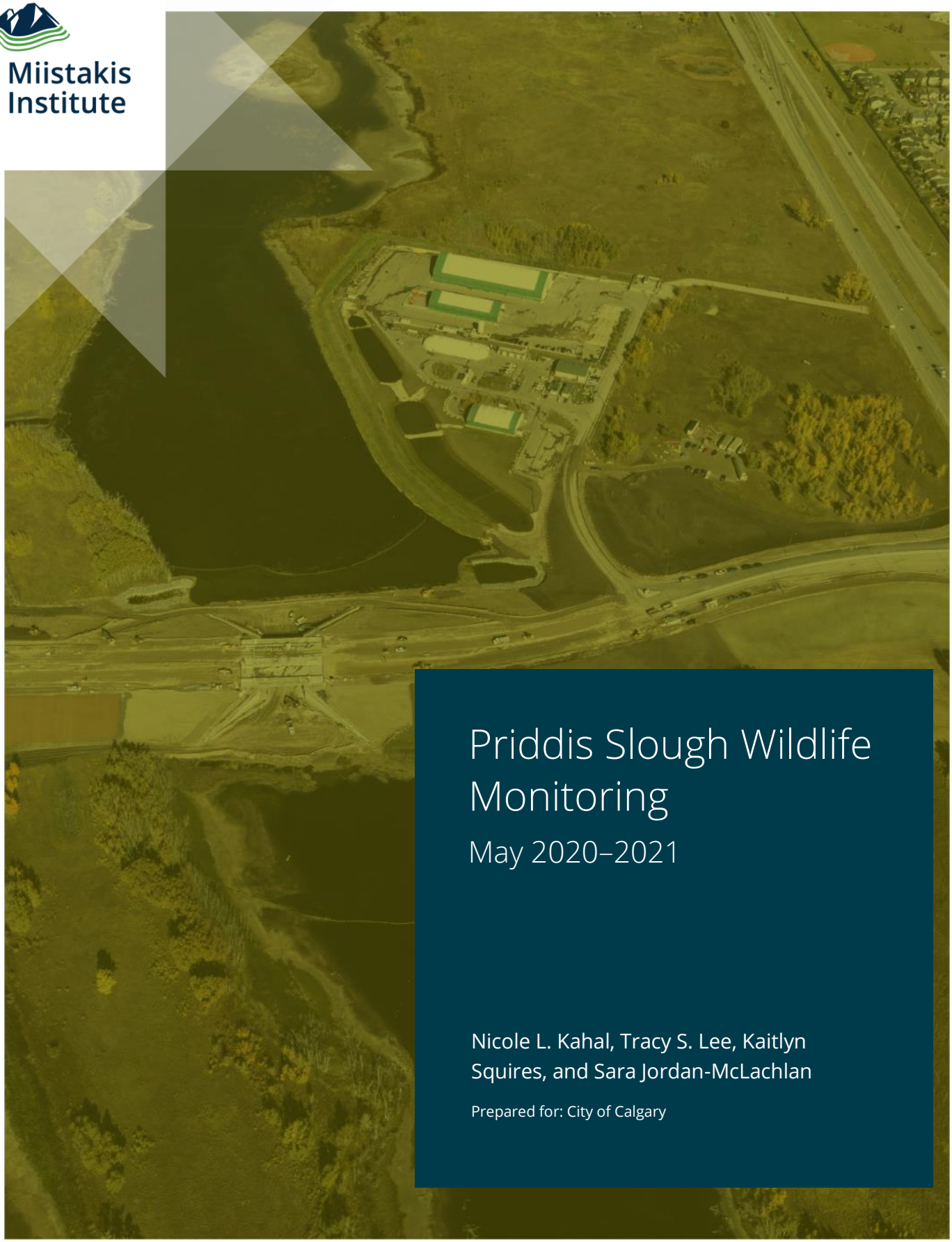
Miistakis Institute



Priddis Slough Wildlife Monitoring

May 2020–2021

Nicole L. Kahal, Tracy S. Lee, Kaitlyn Squires, and Sara Jordan-McLachlan

Prepared for: City of Calgary

Priddis Slough: Wildlife Monitoring

Analyses May 2020–2021

Prepared by Nicole L. Kahal, Tracy S. Lee, Kaitlyn Squires and Sara Jordan-McLachlan

June 2021

Miistakis Institute
Rm U271, Mount Royal University
4825 Mount Royal Gate SW
Calgary, Alberta T3E 6K6

Phone: (403) 440-8444
Email: institute@rockies.ca
Web: www.rockies.ca

Acknowledgements

We would like to thank those who contributed to this project through the completion of snow tracking transects and image classification including Miistakis Institute for the Rockies interns Spencer Howe and Alexa Romano, and City of Calgary employees, Conor Boyd, Jasmine Qureshi, Kamran Faisal, Erika Almasi-Klausz and Ethan Askey.

The Priddis Slough wildlife monitoring project was supported by The City of Calgary and the Calgary Captured Program. Calgary Captured is a partnership project between The City of Calgary, Miistakis Institute, Alberta Parks, Friends of Fish Creek, and Glenmore Weaselhead Preservation Society to monitor wildlife using camera traps in Calgary's natural areas and ecological network. The Calgary Captured program is supported by The Calgary Foundation, Alberta Ecotrust Foundation and TD Friends of the Environment Foundation.

Contents

Executive Summary

The Priddis Slough is a large permanent wetland situated in southwest Calgary and is a component of Calgary's Ecological Network. The slough occurs in an ecological secondary corridor supporting wildlife habitat and movement between the Pine Creek primary corridor and the Priddis Slough. In 2018, The City of Calgary built 194 Ave SW and included a bridge over the slough to retain hydrological function of the wetland. The bridge potentially provides a safe opportunity for terrestrial mammals to cross 194 Ave SW. The intersection of wildlife and roads raises two critical issues: movement and mortality of wildlife, and vehicle collisions with wildlife impacting motorist safety and property. Strategies to address these issues include providing alternative movement areas for wildlife (such as under a bridge) that remove animals from the road surface. This report summarizes the results of a monitoring program to determine the efficacy of the bridge over the Priddis Slough to facilitate wildlife movement.

The Priddis Slough bridge structure is herein referred to as the "slough underpass" as we aim to understand whether and when the bridge is used by wildlife to cross 194 Ave SW safely. The slough underpass is 24-meter span between bridge abutments, with embankments on either side comprised of rip rap with no ground surface, no soil or vegetation. Currently there is no wildlife fencing installed to direct animals toward the underpass.

By deploying camera traps and tracking wildlife footprints in the snow along 194 Ave SW, we aimed to:

- determine which species of wildlife occur in the area;
- determine how animals cross 194 Ave SW (road, slough underpass or rail underpass);
- determine which terrestrial wildlife use the slough underpass to cross; and

- develop recommendations for future road mitigation in relation to terrestrial mammal movement.

We positioned six camera traps at the slough underpass, rail underpass and north and south of the road in the Priddis Slough area and recorded 1,034 wildlife detections over one year (May 2020 – May 2021) of monitoring. We identified a diverse range of terrestrial mammal species in the area including white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), moose (*Alces alces*), skunk (*Mephitis mephitis*) and long-tailed weasel (*Mustela frenata*). Camera trap data identified that both deer species, coyote, and red fox successfully crossed 194 Ave using the slough underpass. However, a temporal analysis indicated deer species are only crossing during the winter months. Our results indicate the current substrate, large boulders (rip-rap), prevent deer species from crossing during most of the year, and that successful crossings are limited to when ice and snow provide optimal travel conditions under the slough underpass.

We completed 20 snow-tracking surveys with 172 tracks observed from late-November to mid-April. Results indicate that animals are moving across 194 Ave SW and using all three crossing options. The above-grade road is used most frequently, followed by the slough underpass and railway underpass. In addition, snow tracking results highlight that the deer species using the slough underpass crossed on the ice and not on the rip-rap.

There was no animal roadkill reported to the City of Calgary during the monitoring period and therefore motorist safety risk of animal vehicle collision is low at this time.

Based on these results for the slough underpass developed under 194 Ave SW we recommend:

- Continue camera trap monitoring of the area to better understand spatial and temporal wildlife activity patterns.
- Review animal-vehicle collisions reports from 311 and from city road maintenance crews annually to identify change in the magnitude of animal vehicle collisions (AVCs) and to inform risk management.
- If AVCs start to occur (for terrestrial mammals such as deer spp., moose, coyote or red fox) consider the following actions to improve use of the slough underpass to improve animal movement and motorist safety:

- install fencing to direct animals to the slough underpass or railway underpass and to the east side of the slough to MacLeod Trail; and,
- placing additional small diameter drainage rock and/or soil along the abutments for ease of wildlife crossing" during ice free months.
- Continued/increased efforts of transportation planners and designers working with ecologists to better understand and facilitate wildlife movements in the ecological network.

This study also informs City of Calgary best management practices for road mitigation, such as:

- Highlighting the value of investing in infrastructure to facilitate wildlife movement across roads to reduce landscape fragmentation and support Calgary's ecological network.
- Designing improvements to bridge structures to facilitate terrestrial mammal movement by incorporating fencing to direct animals to the crossing structure.
- Designing improvements to bridge structures to facilitate terrestrial mammal movement by developing a substrate that facilitates terrestrial species movement.

Introduction

Project Overview

A wildlife monitoring program was developed to determine if terrestrial mammal species are using the Priddis Slough underpass along 194 Ave SW. By deploying camera traps and tracking animal footprints in the snow along 194 Ave SW, we aimed to:

- determine which species of wildlife occur in the area;
- determine how animals cross 194 Ave SW (over the road, slough underpass or rail underpass);
- determine which terrestrial wildlife use the slough underpass to cross; and
- develop recommendations for future road mitigation in relation to terrestrial mammal movement.

We used camera traps and snow tracking to document wildlife activity in the Priddis Slough area. Camera traps have been used extensively in wildlife monitoring to detect presence of wildlife species, highlight animal diversity, document wildlife activity patterns, and detect elusive species (Liu *et al.* 2013).

Snow tracking is a non-invasive technique to understand animal responses to modified habitats and human infrastructure. The use of snow tracking in roadway surveys identifies both the species and their precise crossing locations (Singleton and Lehmkuhl 2000). It has also been successfully used in large landscapes (Heinemeyer *et al.* 2008). Snow tracking has been used in many studies to determine the effects that roads have on animal movement (Alexander and Waters 2000; Singleton and Lehmkuhl 2000; Schuster *et al.* 2013), as well as to evaluate the efficacy of road mitigation measures (Bellis *et al.* 2013). It can be used both on its own or in combination with other techniques (e.g., GIS and camera trap sensing) to develop an accurate depiction of animal habitat use.

Background

Priddis Slough is a large permanent wetland in southwest Calgary. In 2018 the City built a new road (194 Ave SW) over the slough to provide a link between MacLeod Trail and Sheriff King St. to service the residential communities of Belwood Park, and Silverado. The City of Calgary installed a bridge structure (herein referred to as the slough underpass) within the earth fill embankment supporting 194 Ave SW to

primarily retain hydrologic connectivity of the slough and to provide an opportunity for semi-aquatic species to cross 194 Ave SW (The City of Calgary 2020b). We set out to explore if terrestrial mammals were using the slough underpass as the area occurs within The City of Calgary's ecological network.

In 2020, The City of Calgary release an updated Municipal Development Plan (MDP) and included reference to and support for maintaining an ecological network. The MDP defines an ecological network as "a network of natural areas and open space that provides the conditions necessary for ecosystems and species populations to survive in a human-dominated landscape." The system includes core habitat (> 30 hectares in size), stepping stone habitat (< 30 hectares in size), primary corridors (connect Calgary to the region and consist of linear riparian zones along Calgary's major waterways) and secondary corridors (connect other ecological network elements to a primary corridor, through a configuration of stepping stone habitats) (The City of Calgary 2020a). Priddis Slough is a component of the City of Calgary's ecological network and has been identified as a secondary corridor which connects into the Pine Creek primary corridor (Figure 1). In addition, portions of the Priddis slough are characterized as open space defined in the MDP which includes all land and water areas, either publicly or offering public access, that are not covered by structures. Often open space also provides habitat and movement opportunities for wildlife.

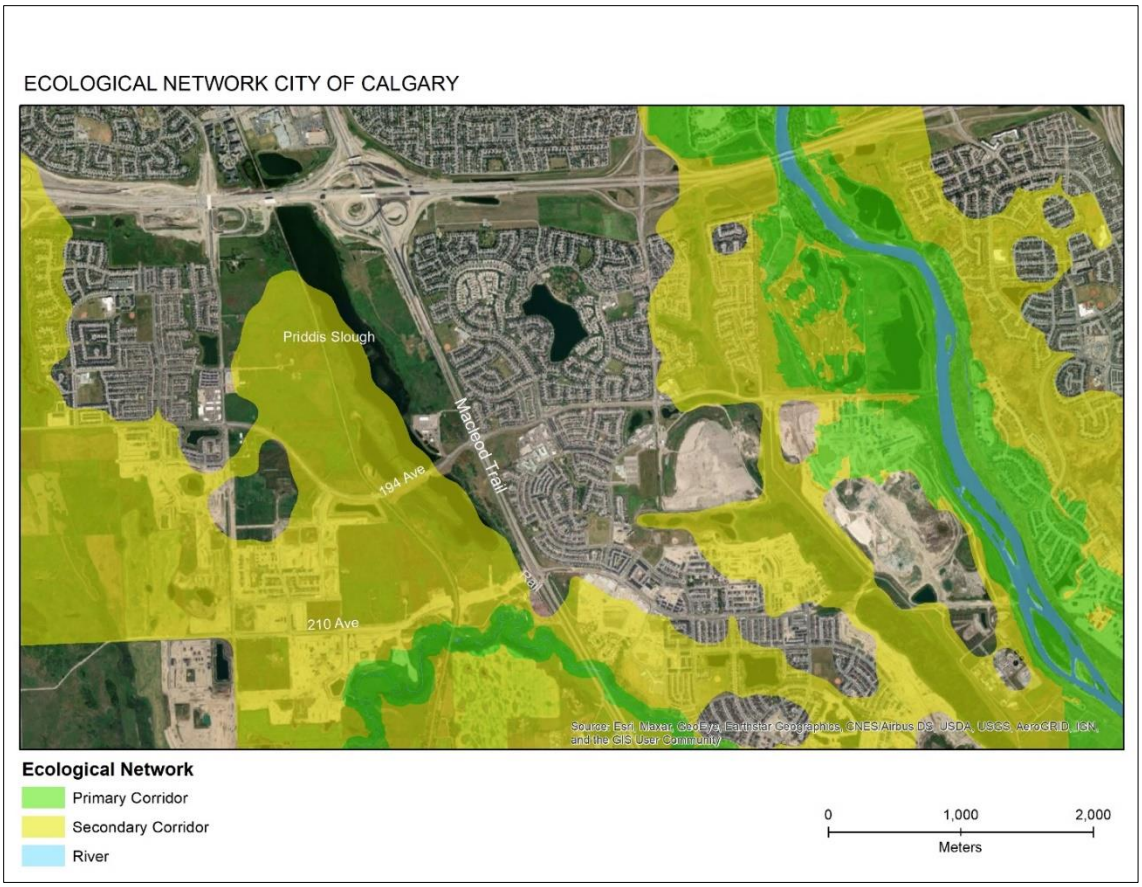


Figure 1: The City of Calgary Ecological Network with primary corridors (displayed in green) and secondary corridors (displayed in yellow). Priddis slough underpass developed to enable animal movement across 194 Ave SW.

Data sourced from the Calgary Traffic Counts System indicates that as of June 2019 there were 8,200 vehicles per day counted in a 24-hour period on 194 Ave SW crossing Priddis Slough, predominately in day lights hours (Figure 2) (The City of Calgary 2019). Modelled projections of future traffic volumes provided by The City's Transportation Data division suggest there may be more than twice the volume of traffic in this location, in the order of 18,900 vehicles per day by 2028 (The City of Calgary 2021).

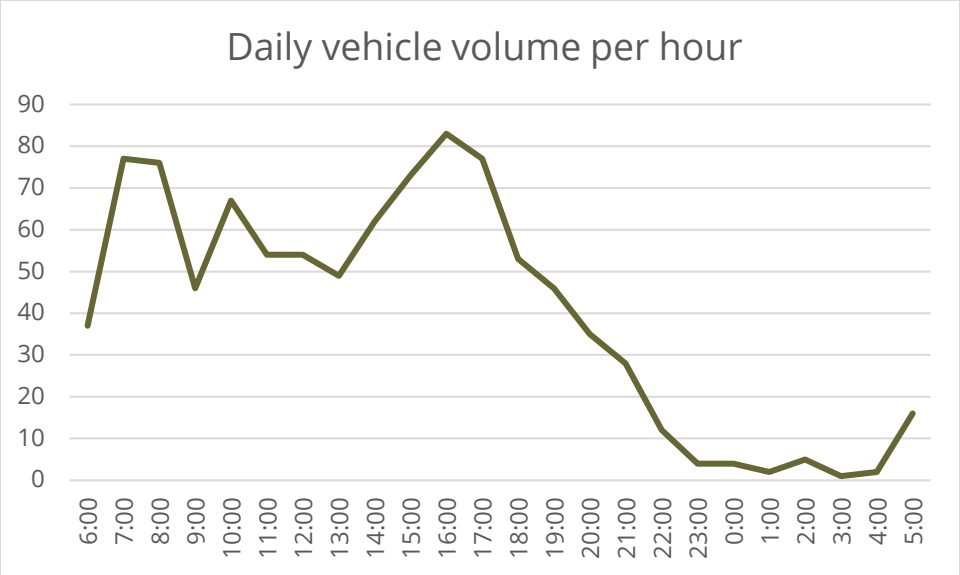


Figure 2: Point count traffic data east bound on 194 Ave SW and Belmont Street SW on June 24, 2019.

Methodology

Camera-trap

Six stealth brand camera traps were deployed, two in the Priddis Slough area (PN and PS), two in close proximity to the railway underpass (TSW, TSE), and two at the slough underpass (BSE, BSW) for one year (May 25, 2020 to May 31, 2021) (Figure 3).

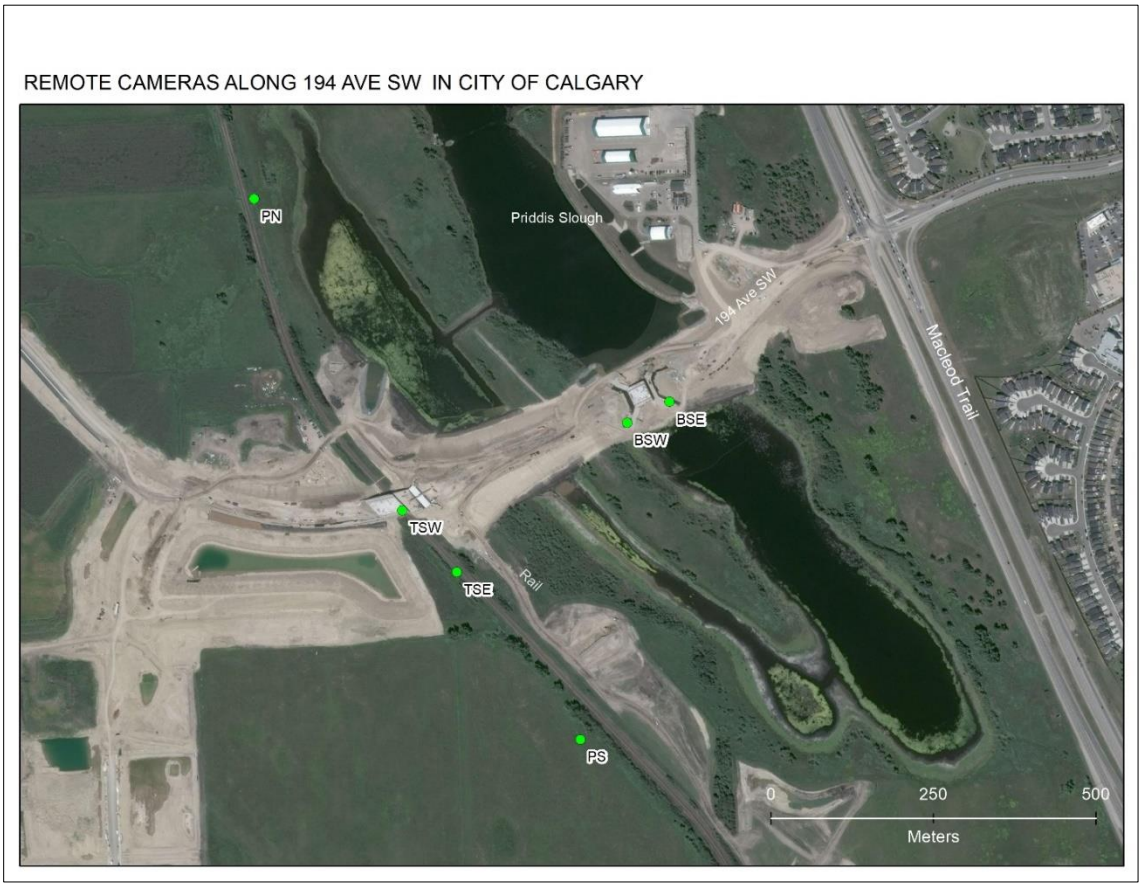


Figure 3: Camera-trap locations along 194 Ave SW, Calgary, Alberta.

Cameras were checked every six weeks to ensure they were still in-place, batteries were active and to download images for classification. Images were uploaded to the Wildtrax program developed by Alberta Biodiversity Monitoring Institute and classified by Miistakis personnel student interns and City of Calgary staff.

Image classification

Classifiers tagged each image with species and group size. Miistakis staff reviewed all tagged images that were identified as needing review (images were flagged by the classifier if they were unsure of species). In addition, images were sorted by species to enable spot check identifications.

For camera sites associated with the slough underpass (BSE and BSW) images were reviewed and the animal's movement direction across the camera was documented in the notes field of WildTrax.

We used the animal's movement direction to determine if they were crossing the road. We defined successful or attempted crossing as:

- attempted crossing: mammal detected on camera, did not cross the camera's field of view, instead returned from the direction it entered.
- successful crossing: mammal detection on the camera, crosses camera's field of view and did not immediately return.

The left and right directions documented during classification were used to determine if an animal successfully crossed using the following rules:

- Site BSE (south side of the slough underpass on the east-side railing) observations were classified as a successful crossing if:
    - animals were seen moving left across the center line of the camera; and
    - animals were seen moving to the right across the center line of the camera and did not return in the same series.
- observations were classified as an attempted crossing if:
    - animals were seen moving to the right across the center line of the camera but returned in the same series.

We used the same general rules but opposite directions for site BSW.

Analysis methodologies

Classified images were downloaded from WildTrax and reviewed for accuracy in preparation for analysis (Appendix A).

Data were aggregated into 30-minute independent events for all species and the data plotted as frequency histograms and line graphs. We plotted species presence and activity per 100 camera trap nights, species temporal patterns throughout the year, species event per camera trap site and species use of the slough underpass crossing 194 Ave SW.

Snow tracking

Protocol/timing of tracking surveys

Timing of snow-tracking surveys was dependent on winter weather conditions. Track identification was compromised on sunny days following snowfall or consecutive snow events that obscured tracks (Alexander et al., 2005). A study by Alexander et al. (2005) recorded snow tracks approximately 24 to 120 hours post-snowfall. For our survey, we used the following rules: enough snow had

accumulated for tracks to be identifiable and a minimum of twelve hours after snow stopped except when the snow was at risk of melting. In these latter cases, tracking was completed the morning following the snowfall before it was warm enough to melt.

Transects

Snow tracking surveys occurred between November 15, 2020 and April 30, 2021 to monitor wildlife movement along 194 Ave SW, the slough underpass and railway underpass.

Two transects were monitored:

- traveling west to east on the south side of 194 Ave SW (transect ID = PS)
- traveling east to west on the north side of 194 Ave SW (transect ID = PN).

Both transects were parallel to 194 Ave SW between Belmont Street SW and Macleod Trail SE (Figure 4). Six grid cells were superimposed on the transects, running in a north/south direction to record tracks on either side of the road and mitigation structures (railway underpass and slough underpass). This allowed us to determine successful and attempted crossings over the road, through the slough underpass or railway underpass (Bellis et al., 2013). For analyses, we aggregated grid cells and north-south values to represent a road, slough underpass or railway underpass crossing (Figure 4).

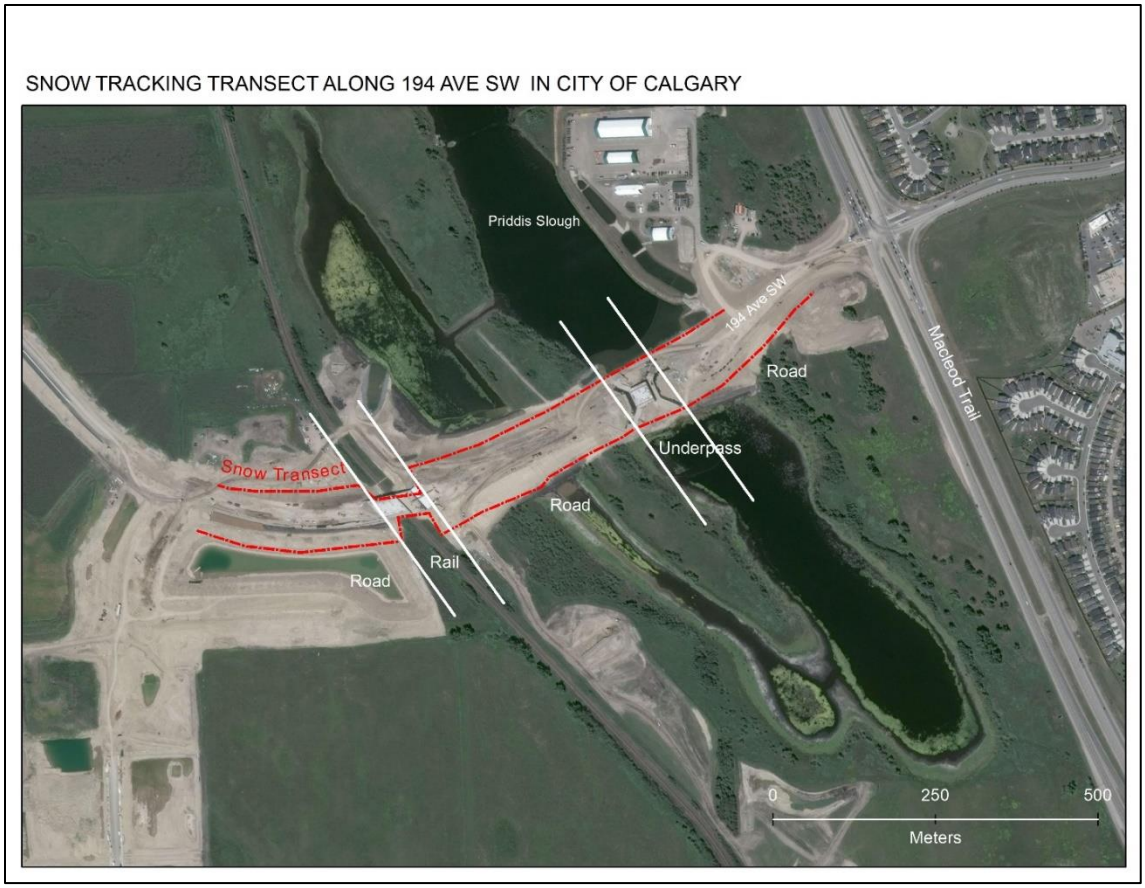


Figure 4: Snow tracking transects north (PN) and south (PS) along 194 Ave SW, with three crossing types, road, rail or underpass.

During a survey, a snow track was followed to determine if it led over the road, through the railway underpass or slough underpass. If a track led to the road and continued on the other side, the crossing was considered successful (Ford and Clevenger 2019). We also noted when successful crossings under the slough underpass occurred on solid ice rather than on the rip-rap portion of the underpass. Tracks that came toward the road, slough underpass or railway underpass but clearly turned back without crossing were classified as attempted crossings (Alexander & Waters, 2000). Tracks that were present in the area but did not go near the road, slough underpass or railway underpass were classified as an animal presence only (see below).

Deer and small mammal tracks were not identified to species but coyote and fox tracks were.

To consistently distinguish animal presence, successful crossings or attempted crossings we established the following definitions.

Attempted crossing:

- Road: mammal tracks detected leading toward 194 Ave SW within 2 meters from the road but turns and does not cross the road.
- Slough underpass: mammal tracks lead toward the slough underpass entrance but stop and turn before passing under center line mark.
- Railway underpass: mammal tracks lead toward the railroad underpass entrance but stop and turn before passing under center line mark.

Successful crossing:

- Road: mammal tracks detected leading onto the road, underpass and slough with no indication of turning around.
- Slough underpass: mammal tracks lead under the slough underpass entrance and continue on the other side.
- Railway underpass: mammal tracks lead through the rail underpass entrance and continue on the other side.

Animal presence:

- Mammal tracks detected in vicinity, but do not indicate an attempt to cross the road or through the slough underpass/railroad underpass.

Quality control

To verify track identification and prevent tracks from being recounted in subsequent surveys we used the following methods:

- Photos were taken of at least one track in each sequence as well as a photo of the animal's gait. Photos of tracks were taken with a cell phone or camera. Photos were made from directly above the track to capture all defining features and included a ruler for scale. Photo files were named with the following convention: Year-Month-Day-Grid ID-Track number in transect (e.g., 2020-11-15-3N-1; for multiple tracks in same grid, letters were added on the end). Photos were then compiled on the server in folders specific to tracking efforts.
- To ensure that tracks were not accidentally counted on multiple surveys, the tracker marked tracks that were documented on the transect by putting their footprint on the first track so the next surveyor could see that track had been

recorded. Trackers reviewed previous records prior to going into the field to help indicate where they might come across a marked track.

Analysis

Data were aggregated for all species according to a crossing type (road, slough underpass or rail underpass). We used a Poisson distribution (simulated using *rpois* function in the statistical software *R*) to estimate the probability of an animal crossing 194 Ave SW during a snow-tracking event and ran a Kruskal-Wallis test to identify differences between crossing types. We used a Dunn test to compare crossing types in pairs.

Calgary roadkill data

The City of Calgary provides roadkill data from 311 citizen reports and road maintenance crews. There were no terrestrial mammal carcasses recorded in either database during the one-year monitoring period.

Results

Camera-trap

Species detections

Camera traps detected 1,034 wildlife events representing terrestrial mammals, birds, humans, and domestic dogs (Figure 5). White-tailed deer, humans and domestic dogs were detected at all camera sites while moose, weasel, skunk and red fox were reported at only one or two camera sites. See Appendix B to review camera trap photos.

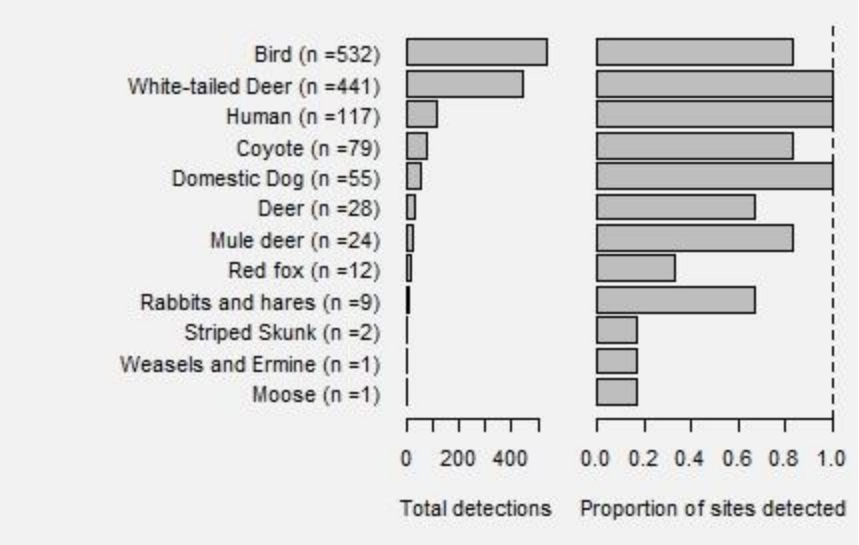


Figure 5: Independent species events on Priddis Slough camera traps for one year and proportion of sites where each species was detected.

For all subsequent analysis, we included terrestrial mammals but removed birds and rabbits and hares. Figure 6 shows the number of events per 100 camera trap days for terrestrial mammals at each camera site. Camera locations were relatively close together and wildlife events between cameras may not be independent— the same deer could appear on multiple cameras in a single day.

Terrestrial mammal activity was most common away from the road at camera sites, TSE, PS and PN. The other three camera trap sites, TSW, BSW and BSE are located closed to the rail underpass and slough underpass in close proximity to the road.

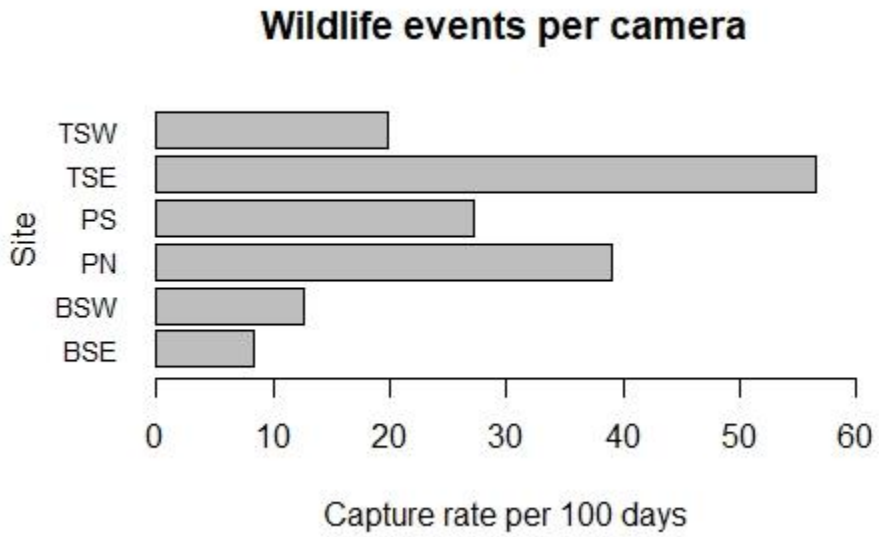


Figure 6: Capture rate of terrestrial mammals (not including domestic dogs and humans, birds, or rabbits and hares) at each camera site in Priddis slough area.

Species patterns

The most commonly observed of our target mammals were white-tailed deer, mule deer and coyote, followed by red fox and skunk (Figure 7). Monthly detections show unique patterns for each species with a summer peak for moose and weasels, summer peaks for coyote and red fox and fall peaks for white-tailed and mule deer (Figure 8).

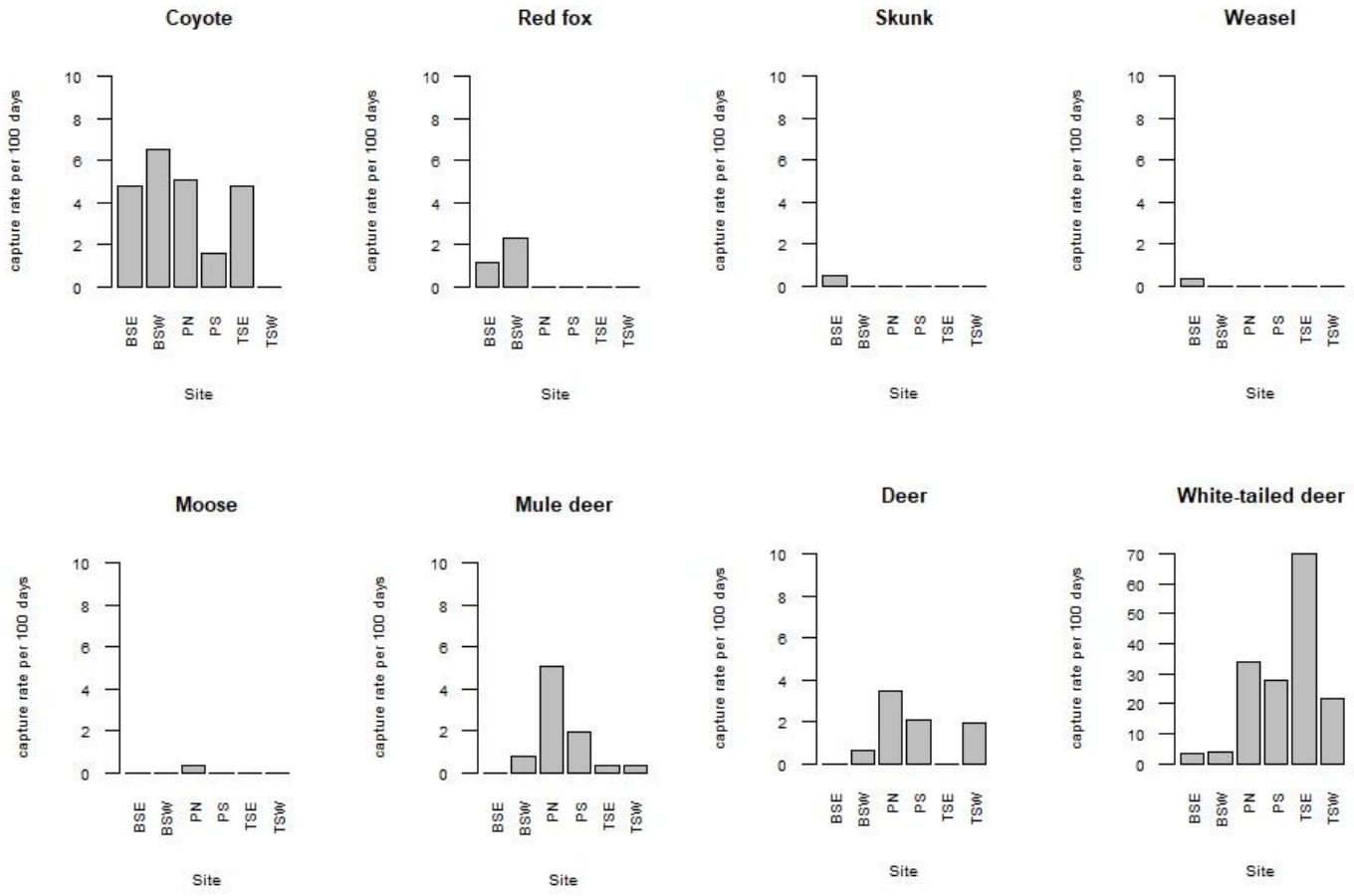


Figure 7: Species detected at each camera trap site showing per camera rate per 100 days. Vertical scale bars capture rate from 0 to 10 for comparison purposes with the exception of white-tailed deer that scales from 0 to 70.

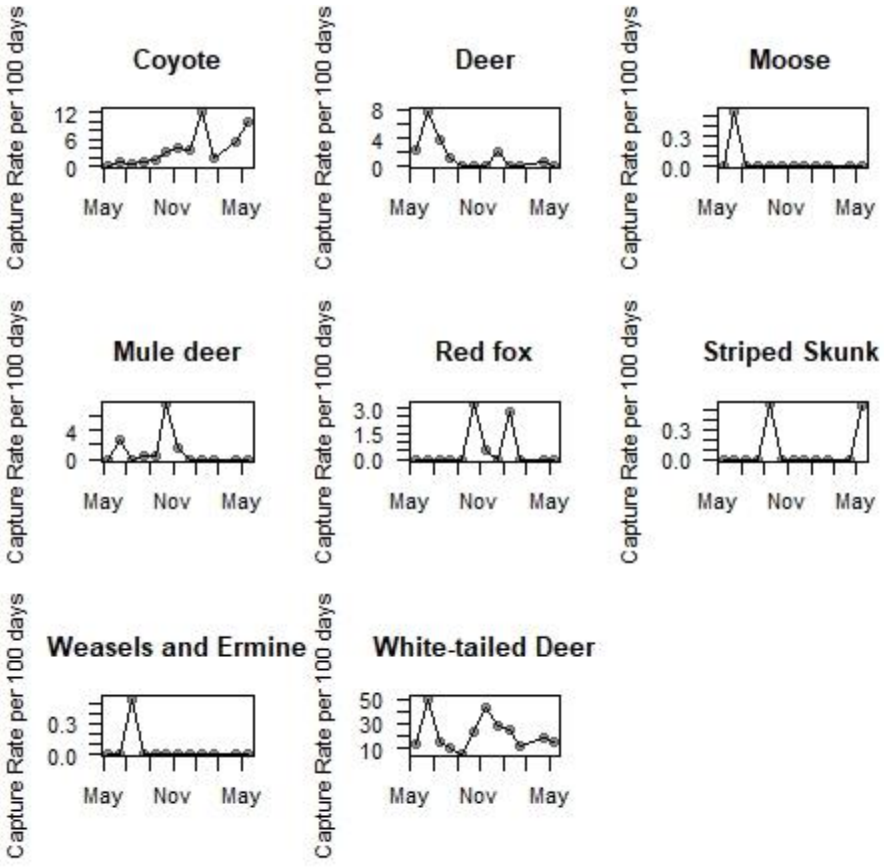


Figure 8: Species per camera rate per 100 days per month. Vertical scale bars differ among species due to different detection rates per 100 camera trap days.

Slough underpass crossing

Camera traps detected 69 terrestrial mammal events at the BSE and BSW camera sites, with 49 successful crossings and 20 attempted crossings. All terrestrial mammal species with more than one detection recorded on camera traps (coyote, white tailed deer and red fox) were documented using the slough underpass to cross 194 Ave SW. A temporal review of successful crossings per species indicates deer species only successfully crossed during the winter months (late November to early February) (Figure 9). We attribute successful crossings to snow and ice enabling deer to pass through the slough underpass and avoiding the rip-rap (Figure 10).

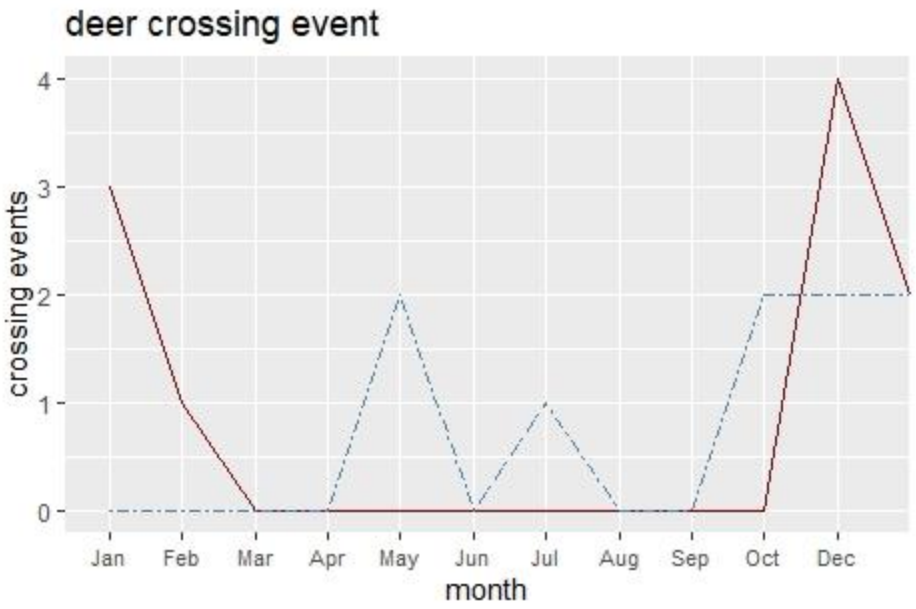


Figure 9: Twenty deer (white-tailed deer and mule deer) crossing events at the slough underpass per month. The red line is successful crossings and blue line is attempted crossings.

Figure 10: Photos of the underpass substrate and surface during summer (left panel—deer attempted but were not able to cross) and winter (right panel—deer successfully crossed).

Snow tracking

We completed 19 snow track surveys resulting in 172 total snow tracking observations (Table 1). Most species were reported as unknown due to poor conditions (Figure 11). Four domestic dog observations were removed from the analyses.

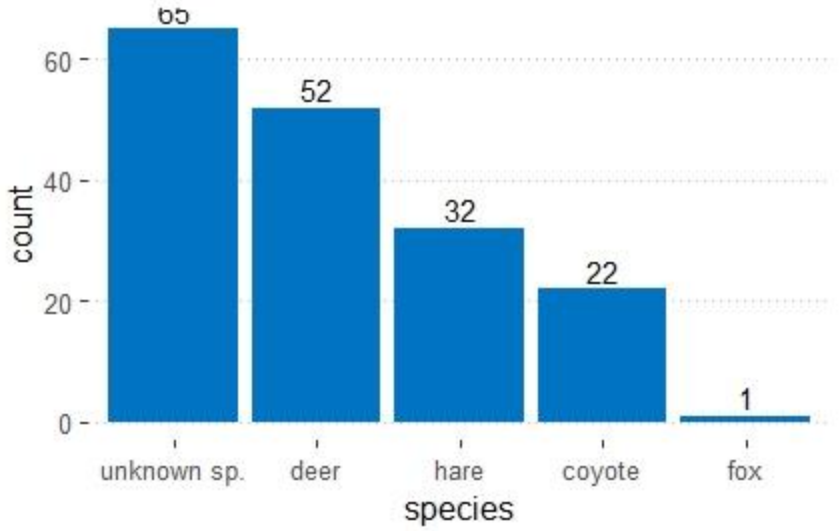


Figure 11: Species observed during snow tracking along 194 Ave SW in Calgary, AB

Table 1: Type of snow tracking event whether there was an animal observed that did not cross or attempt to cross , attempted to cross or successfully crossed.

Survey	Observed	Attempted	Crossed
1	12	0	0
2	2	1	4
3	5	0	0
4	0	0	0
5	9	1	0
6	3	0	0
7	24	7	8
8	0	0	2
9	1	0	3
10	7	1	5
11	2	1	1
12	9	9	22
13	0	1	4
14	4	0	4
15	0	0	0
16	0	1	0
17	5	0	5
18	4	0	5
19	0	0	0

Type of observation

To simulate count compositions per crossing type without overdispersion we calculated the Poisson distribution for each crossing event (Figure 12).

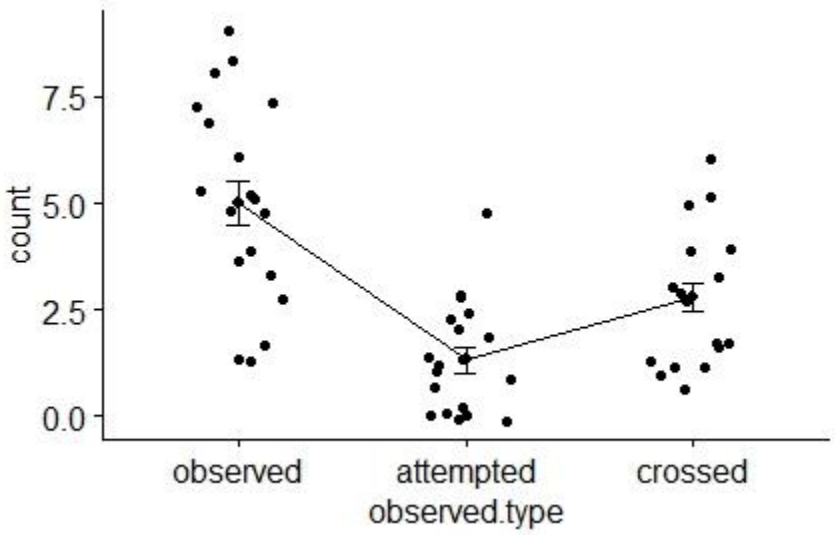


Figure 12: Animal snow tracking events (count) with all species aggregated showing mean per observation type.

We ran a Kruskal-Wallis test to find differences among snow tracking events. A significant difference (Kruskal-Wallis chi-squared = 22.417, df = 2, p-value = 1.356×10^{-5}) was found among the three snow tracking event types; animal observed, crossing attempt or successful crossing. A Dunn test indicated that a significant difference occurs between the different snow tracking event types (Figure 13). Animals were observed on 194 Ave SW more frequently than their attempted or successful crossings.

Col Mean- Row Mean	attempte	crossed
crossed	-2.056066 0.0199*	
observed	-4.721521 0.0000*	-2.665455 0.0038*

alpha = 0.05
Reject Ho if p <= alpha/2

Figure 13: Dunn test matrix of relationship between underpass crossing events

Crossing type

Of the 63 successful crossing events, we also determined how animals crossed 194 Ave SW (over the road, via the slough underpass or the railway underpass) (Table 2).

Table 2: Tally of road crossing type

Survey	Slough	Rail	Road
1	0	0	0
2	1	1	2
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	8
8	2	0	0
9	0	1	2
10	2	1	2
11	1	0	0
12	6	0	16
13	0	0	4
14	2	0	2
15	0	0	0
16	0	0	0
17	1	0	4
18	1	2	2
19	0	0	0

To simulate count compositions per crossing type without overdispersion we calculated the Poisson distribution for each successful crossing event (Figure 14).

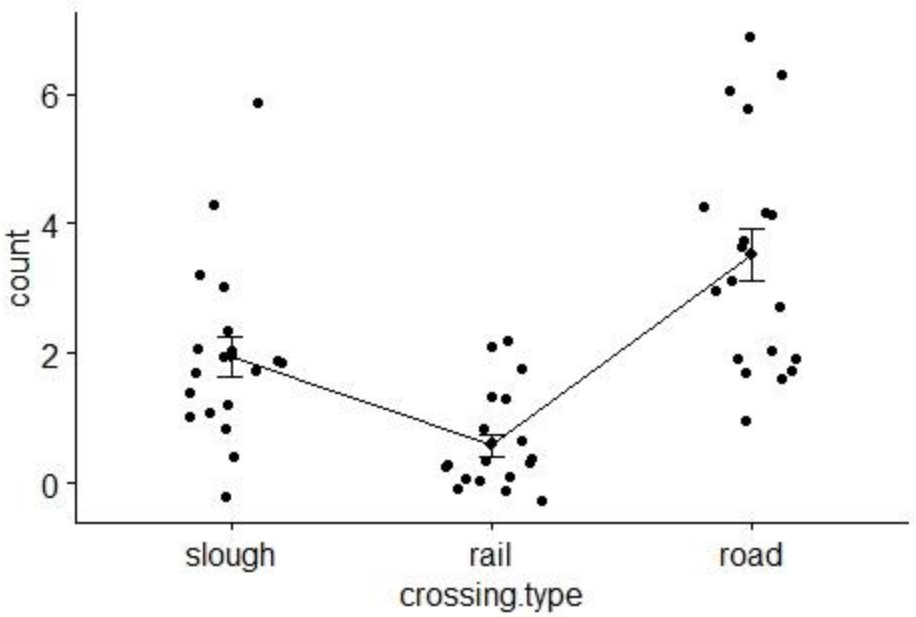


Figure 14: Animal crossing events and mean per crossing type

We ran a separate Kruskal-Wallis Test to look for differences among crossing events according to the crossing type. A significant difference (Kruskal-Wallis chi-squared = 29.954, df = 2, p-value = 3.13×10^{-7}) was found among the three options for crossing 194 Ave SW. A Dunn test determined that a significant difference occurs between road and slough underpass, road and railway underpass, and slough and railway underpass (Figure 15). Animals crossed the road more frequently over the rail underpass or slough underpass.

Col Mean- Row Mean	rail	road
road	-5.467674 0.0000*	
slough	-2.944132 0.0016*	2.523542 0.0058*

alpha = 0.05
Reject Ho if p <= alpha/2

Figure 15: Dunn test matrix of relationship between road, slough underpass or railway underpass crossing events

Conclusion/Discussion

Terrestrial species presence in Priddis Slough region

The Priddis Slough is a large permanent wetland within the City of Calgary supporting both terrestrial and aquatic biodiversity. The slough represents a component of the City of Calgary's ecological network and is classified as a secondary ecological corridor, that is connected to Pine Creek Primary ecological corridor. The slough underpass that we studied was built to help maintain hydrological function of the slough but could also support safe movement of terrestrial mammals across 194 Ave SW. Our camera trap data confirmed there are a number of terrestrial mammal species present in the area, including moose, mule deer, white-tailed deer, coyote, red fox, skunk and weasels. The most frequently detected species exhibited activity at the Priddis Slough throughout the year included white-tailed deer, mule deer and coyote.

Terrestrial species movement across 194 Ave SW

Camera trap data and snow tracking confirm that species detected in the area are crossing 194 Ave SW using the road, slough underpass and railway underpass. The snow-tracking data indicates the most common method of crossing 194 Ave SW is on the road at grade, followed by the slough underpass and railway underpass. Animals may cross the road more commonly since it represents a large opportunity area and there is no fencing to help direct animals to the underpass. Fences are consistently found to be an important tool to direct animals to desired crossing locations (Huijser *et al.* 2008; Ford and Clevenger 2019). Currently traffic volumes along 194 Ave SW are relatively low and terrestrial mammals are not documented in roadkill databases reported to the City. But as traffic volumes increase, the risk of animal vehicle collisions will also increase. Fencing may be an option to remove animals from the road surface, as they have two other options for movement, slough underpass or railway underpass.

Snow-tracking and camera trap data both indicate that all species (at least seasonally) are using the slough underpass to cross 194 Ave SW. Use of slough underpass by terrestrial mammal species are typically influenced by diverse variables, including structure dimensions, adjacent and internal habitat, human co-use, and the time since installation (learning curve for the animals) (Huijser *et al.* 2008). The Priddis Slough underpass is supporting terrestrial mammal movement, indicating that its physical dimensions are adequate. In addition, although human activity was documented in the area, people were not detected using the slough

underpass on camera trap data nor during snow tracking. The underpass was installed in 2018; which is considered sufficient time for wildlife in the area to learn to use it (Simpson *et al.* 2016).

Camera trap data indicate that deer species are only using the slough underpass to cross 194 Ave SW during the winter months when snow/ice are present. During the summer, the underpass substrate for terrestrial mammals is large sharp rocks (rip-rap) along the toe of bridge walls and abutments. The current substrate installed to address erosion hinders deer species (and likely moose) from using the underpass. Similar rip-rap is often used as a deterrent at the end of drift fences to prevent animals from getting onto the highway right-of-way.

Supporting the ecological network

The City of Calgary has invested in infrastructure to facilitate terrestrial mammal movement across 194 Ave SW which bisects the Priddis Slough. The Priddis Slough and surrounding terrestrial habitat is a component of the City of Calgary's ecological network and has been identified as a secondary corridor that is currently linked to the Pine Creek Primary Corridor. To ensure the area continues to play a role as a corridor, new developments and roads in the areas should be designed to enable terrestrial mammal movement. New road development, such as 210 Ave SW, could impact terrestrial mammal movement between Priddis Slough and Pine Creek reducing habitat and connectivity for species detected in the area.

Recommendations

Based on the result from one year of monitoring using camera traps and snow tracking surveys in Priddis Slough area, we recommend the following:

- Continued camera trap monitoring of the area to improve our understanding of wildlife spatial and temporal activity;
- Review animal-vehicle collisions reports from 311 and from city road maintenance crews annually to identify change in the magnitude of animal vehicle collisions (AVCs) and to inform risk management.
- If AVCs start to occur (for terrestrial mammals such as deer spp., moose, coyote or red fox) consider the following actions to improve use of the slough underpass to improve animal movement and motorist safety:
    - install fencing to direct animals to the slough underpass or railway underpass and to the east side of the slough to MacLeod Trail; and,

    - placing additional small diameter drainage rock and/or soil along the abutments for ease of wildlife crossing" during ice free months.
- Continued/increased efforts of transportation planners and designers working with ecologists to better understand and facilitate wildlife movements in the ecological network.

This study also informs City of Calgary beneficial management practices for road mitigation such as:

- Highlighting the value of investing in infrastructure to facilitate wildlife movement across roads to reduce landscape fragmentation and support Calgary's ecological network.
- Designing improvements to bridge structures to facilitate terrestrial mammal movement by incorporating fencing to direct animals to the crossing structure.
- Designing improvements to bridge structures to facilitate terrestrial mammal movement by developing a substrate that facilitates terrestrial species movement.

References

Alexander, S. M., and Waters, N. M. (2000). The effects of highway transportation corridors on wildlife: A case study of Banff National Park. *Transportation Research Part C: Emerging Technologies* **8**, 307–320. doi:10.1016/S0968-090X(00)00014-0

Bellis, M. A., Griffin, C. R., Warren, P., and Jackson, S. D. (2013). Utilizing a multi-technique, multi-taxa approach to monitoring wildlife passageways in southern Vermont. *Oecologia Australis* **17**, 111–128. doi:10.4257/oeco.2013.1701.10

Ford, A. T., and Clevenger, A. P. (2019). Factors affecting the permeability of road mitigation measures to the movement of small mammals. *Canadian Journal of Zoology* **97**, 379–384. doi:10.1139/cjz-2018-0165

Heinemeyer, K. S., Ulizio, T. J., and Harrison, R. L. (2008). Natural sign: Tracks and scats. In 'Noninvasive survey methods for carnivores'. (Eds R. A. Long, J. Ray, W. Zielinski, and P. MacKay.) pp. 45–74. (Island Press.)

Huijser, M. P., McGowen, P., Clevenger, A. P., and Ament, R. (2008). Wildlife Vehicle Collision Reduction Study: Best Practices Manual. Bozeman, MT.

Liu, X., Wu, P., Songer, M., Cai, Q., He, X., Zhu, Y., and Shao, X. (2013). Monitoring wildlife abundance and diversity with infra-red camera traps in Guanyinshan Nature Reserve of Shaanxi Province, China. *Ecological Indicators* **33**, 121–128. doi:10.1016/j.ecolind.2012.09.022

Schuster, R., Römer, H., and Germain, R. R. (2013). Using multi-scale distribution and movement effects along a montane highway to identify optimal crossing locations for a large-bodied mammal community. *PeerJ* **1**, 23. doi:10.7717/peerj.189

Simpson, N. O., Stewart, K. M., Schroeder, C., Cox, M., Huebner, K., and Wasley, T. (2016). Overpasses and underpasses: Effectiveness of crossing structures for migratory ungulates. *Journal of Wildlife Management* **80**, 1370–1378. doi:10.1002/jwmg.21132

Singleton, P. H., and Lehmkuhl, J. F. (2000). I-90 Snoqualmie Pass wildlife habitat linkage assessment: Final report. Washington.

The City of Calgary (2020a). Municipal Development Plan (MDP) - 2020. Calgary, AB. Available at: calgary.ca/MDP

The City of Calgary (2019). Traffic Counts System data. Calgary, AB.

The City of Calgary (2021). Transportation Data model run for 2028 horizon. Calgary, AB.

The City of Calgary (2020b). Transportation Department Environmental Performance, 2019. Calgary, AB.

Appendix A: Camera trap data exploration

Data exploration components

Raw data exploration

Figure A1: Camera location check

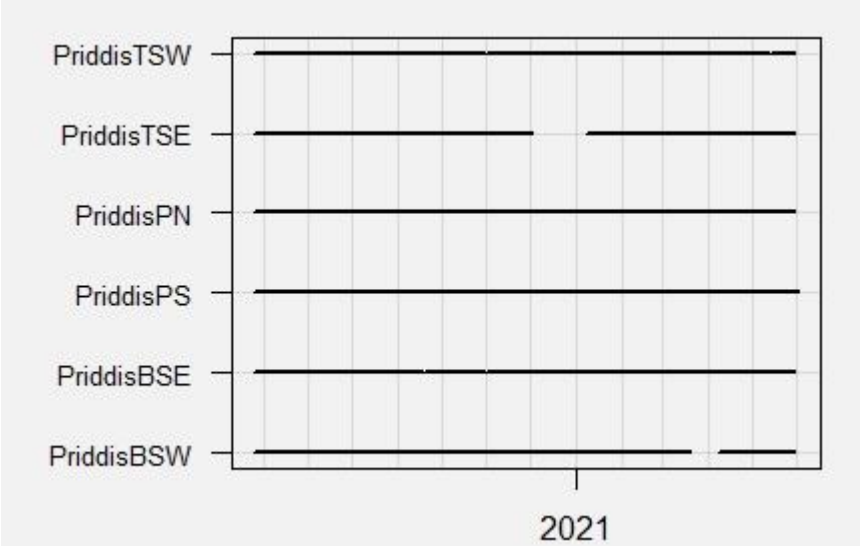


Figure A2: Camera detections. line represents periods the cameras were active, and grey vertical lines mark the beginning of each month

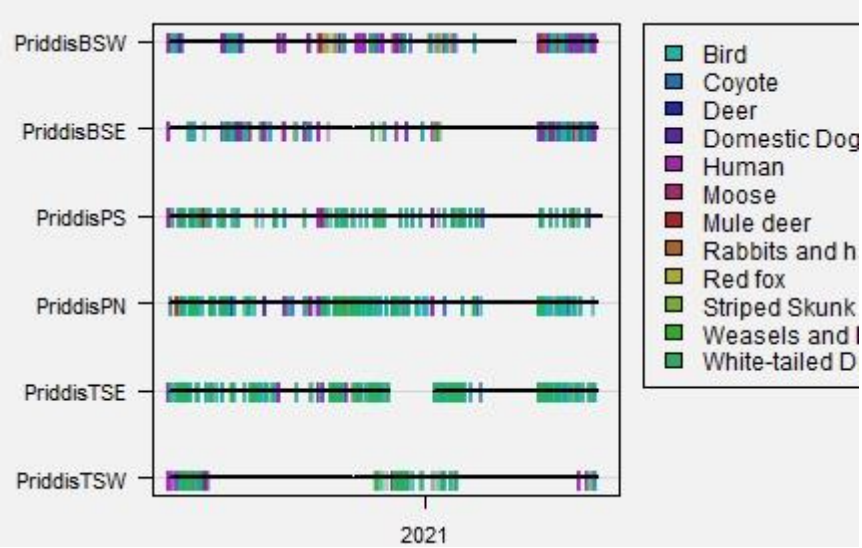


Figure A3: Check there are no camera detections occurring outside of the times camera was active. Inactive camera activity was associated with battery failure or camera damage.

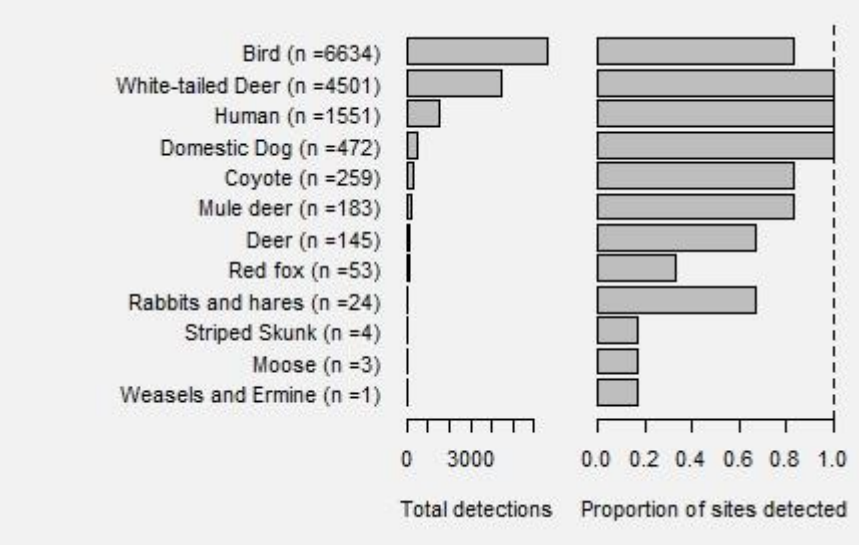
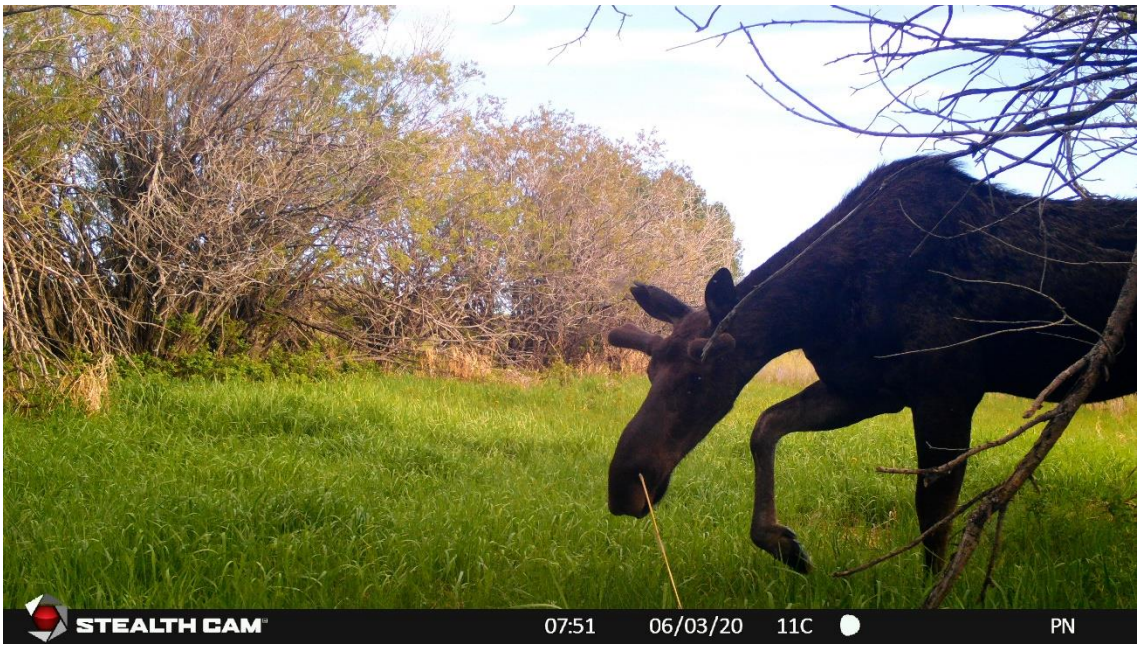


Figure A4: Species raw data count (before independent events)

Appendix B: Representative camera trap photos

Moose



Red fox

White-tailed deer moving toward underpass on ice

Mule deer

Weasel