
# COEXISTENCE AND CAUTION

## Tradeoffs faced by wildlife in Chasàn Chùa (McIntyre Creek), Yukon

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## Executive summary

Chasàn Chùa, or McIntyre Creek, flows through the traditional territories of the Ta'an Kwäch'än Council and Kwanlin Dün First Nation in Whitehorse, Yukon. From its headwaters on the slopes of Mount McIntyre, the creek meanders through chains of wetlands, short canyons and forests before emptying into the Yukon River north of downtown Whitehorse. Chasàn Chùa is a place where people and wildlife coexist. Grizzly bears feed on berry bushes around rural properties, and coyotes travel along ski trails. People fish for pike at the creek's mouth, once the site of a First Nations camp. Chasàn Chùa is home to cultural and heritage sites and ongoing traditional activities. Human and wildlife interactions are a defining feature of the creek.

Chasàn Chùa is also a corridor of economically valuable land in the midst of a growing city. There is pressure for more housing and road development in and around the creek, yet limited scientific data to inform decisions about the future of Chasàn Chùa. This prompted us to research the impacts of housing and roads on wildlife around the creek. We surveyed wildlife distribution and habitat use within Chasàn Chùa, and quantified how human developments affect birds and mammals. We found a wide range of species throughout the area, even in habitats near housing and road developments. Still, these disturbances impacted each species differently. Moose avoided the most developed parts of the creek. When moose did visit heavily populated areas it was primarily at night. We only observed species at risk like grizzly bears, Lesser Yellowlegs and Rusty Blackbirds in remote areas of Chasàn Chùa, while red foxes and mule deer preferred areas with more human development. Each species that inhabits Chasàn Chùa experiences human disturbances in a different way. Rather than taking single approach to stewarding the creek and its wildlife, planners should account for the complex responses that different species have to human developments.

Important decisions in the coming decades will shape the future of the creek. On one hand, the City of Whitehorse's new Official Community Plan outlines a vision for making Chasàn Chùa a regional park. On the other, the City must plan for a population that will likely surpass 40,000 people by 2040. Chasàn Chùa could see major new developments, like expanded subdivisions in the lands bordering the creek, or upgraded road infrastructure to accommodate more traffic. Chasàn Chùa and its wildlife will also be impacted by land planning processes for the adjacent Łu Zil Män (Fish Lake) area and the broader Whitehorse Region. Chasàn Chùa is still a thriving ecosystem, and long-term planning is needed to safeguard the creek and its wildlife from harmful developments. Taking action to protect Chasàn Chùa will help Whitehorse live up to its name as the Wilderness City.



Image: A Yellow-rumped Warbler sings alongside Chasàn Chùa. Photo by Malkolm Boothroyd.

# Introduction

Across the world, residential development, roads and human infrastructure are encroaching upon wild spaces. The pace of urban sprawl is twice as fast as urban population growth, which itself has tripled in the past 50 years.[1,2] The wildlife that live around human developments face a series of tradeoffs. Losing habitat and wildlife corridors causes some species to avoid urban areas entirely.[1] Human disturbances can make wildlife flee, go silent, and spend less time feeding in favour of more time watching out for danger.[3] On the other hand, some animals find abundant sources of food in gardens, streets and landfills. In urban areas, some wildlife find shelter from hunting, and a reprieve from their natural predators. Still, wildlife that live among people must navigate the risks of vehicle collisions, pollution and predation from domestic animals.

Human developments impact species in very different ways. For example, an abundance of food and scarcity of predators has helped elk thrive in the town of Banff, Alberta, and deer proliferate around the suburbs of Victoria, British Columbia.[4,5] Species like foxes and raccoons coexist among people, while wolves, bears and caribou tend to avoid human-dominated landscapes.[6–10] Urban developments also shape how wildlife behave. Some species evade human disturbances by becoming more nocturnal, or by taking refuge in steep and hard to access habitats during the busiest hours of the day.[11–13] Complex interactions between wildlife and people are playing out across much of Northern Canada too: home to both wild landscapes and the rapidly growing footprint of human development.

The Yukon's population grew by 43% between 2001 and 2021.[14] Most of the Yukon's growth has occurred around Whitehorse, the territory's capital and largest urban centre. The footprint of Whitehorse sprawls far beyond the city's downtown core, and new subdivisions are being constructed to help house the ten thousand additional residents expected by 2040.[15] One place that could be impacted by developments is Chasàn Chùa, or McIntyre Creek. This habitat corridor is nested within Whitehorse's city limits, and the traditional territories of the Kwanlin Dün First Nation and Ta'an Kwäch'än Council. The lower sections of Chasàn Chùa are surrounded on all sides by human developments, and decision makers have considered new housing and road projects in and around the creek. We led a research project to learn more about the wildlife that use Chasàn Chùa, and understand how the existing housing and road developments impact wildlife around the creek.

Image: A young moose follows behind its mother. Trail camera photo by CPAWS Yukon.

## Key recommendations

- ✓ Avoid further development in Chasàn Chùa until park planning is finished.
- ✓ Maintain habitat connectivity between Chasàn Chùa and surrounding wild spaces.
- ✓ Accommodate the needs of wildlife in future transportation plans, and include safety precautions for wildlife and people.
- ✓ Maintain the integrity of wetlands along the creek, and preserve the terrestrial and hydrological connections among them.
- ✓ Safeguard the future of Chasàn Chùa through careful management planning.

From February 2021 to February 2022, we surveyed the distribution of birds and mammals in the Chasàn Chùa area using remotely triggered cameras, audio recorders, and snow track surveys. We aimed to document the distribution of wildlife in the area, and identify the habitats with the most species, also known as species richness. We also wanted to learn if human developments like housing and roads affect the frequency at which different species occur. The creek corridor captures a gradient of disturbance, from sparse development in the upper sections, to relatively high levels of development around the creek's lower sections. These differences allowed us to compare how wildlife responded to differing levels of development throughout Chasàn Chùa. We also analyzed wildlife occurrences across wetland and forest habitats, to understand what habitats are important to what species, and to help identify biodiversity hotspots within the creek. We hope this research can support planners and policy makers to make better informed decisions about the future of conservation and development in and around Chasàn Chùa.

**What's in a name?** The creek was originally a travel route used by Yukon First Nations Peoples as they moved between hunting and fishing areas at Lake Laberge and Łu Zil Män.[16,17] The creek's Southern Tutchone name, Chasàn Chùa, came from the copper nuggets found along the route. As Whitehorse was settled and its population grew over time, the area surrounding the creek largely remained a green space, aside from an old dump site, some mining activity and associated road development.[18,19] The creek was re-named after a prospector, and McIntyre Creek is now the name the area is most commonly known by.

In this report, we look at Chasàn Chùa through an academic scientific lens. We are aware that our approach has its shortcomings. For example, baseline data for the creek is limited, and recently collected scientific data would tell us little about past ecological changes in Chasàn Chùa. Questions like these, and many others, may be informed by the Indigenous knowledge held by Yukon First Nations. Upcoming decisions around development, land planning and stewardship should draw on scientific and traditional knowledge alike. It is our hope that this report and the data that we gathered can complement the traditional knowledge of Chasàn Chùa that is held by citizens of the Kwanlin Dün First Nation and Ta'an Kwäch'än Council.

Image: A coyote on a frozen-over section of Chasàn Chùa. Photo by Malkolm Boothroyd.

# Methods

## Study Area

We surveyed mammals and birds within a 46 square kilometre area encompassing Chasàn Chùa. The study area runs from the creek's headwaters to its confluence with the Yukon River, and includes the adjacent green spaces (Figure 1). We excluded settlement lands, private property and hydro power diversions from our study area. The area falls entirely within the municipal boundaries of Whitehorse and is the city's largest continuous wildlife area.[20] Chasàn Chùa spans a diverse range of habitats, from wetlands and damp spruce woodlands, to meadows and mountain slopes, to birch stands and subalpine forests. The upper stretches of Chasàn Chùa are sparsely developed and difficult to access, with occasional trails, old log cabins and abandoned mineshafts. As the creek flows north the surrounding land becomes more developed, with a network of ski and mountain bike trails to the east of the creek, and the Copper Haul and Fish Lake roads to the west. The creek eventually flows underneath the Alaska Highway and enters its most developed section. Here, the creek is crisscrossed by roads and trails, and bordered by Yukon University and subdivisions like Takhini, Porter Creek, Northland and Whistle Bend.

## Survey design

We monitored the occurrence and distribution of mammals using Reconyx Hyperfire 2 infrared-triggered remote cameras, and by counting tracks in the snow along survey transects in the winter (Figure 2). We recorded bird songs and calls using Wildlife Acoustics SM4 autonomous recording units. We used a stratified survey design: first dividing the study area into 41 grid cells, each one square kilometre in size, and then selecting a survey location near the centre of each cell. Sites reflected the gradient of disturbance within Chasàn Chùa: roughly half of sites were in areas with low development, and the remaining half fell in areas with moderate or high levels of development. We deployed the cameras by walking to each survey location, finding a wildlife trail within 50 metres, and placing the camera along the trail. We programmed cameras to be highly sensitive to motion, and to take three photos when triggered. A total of 41 cameras

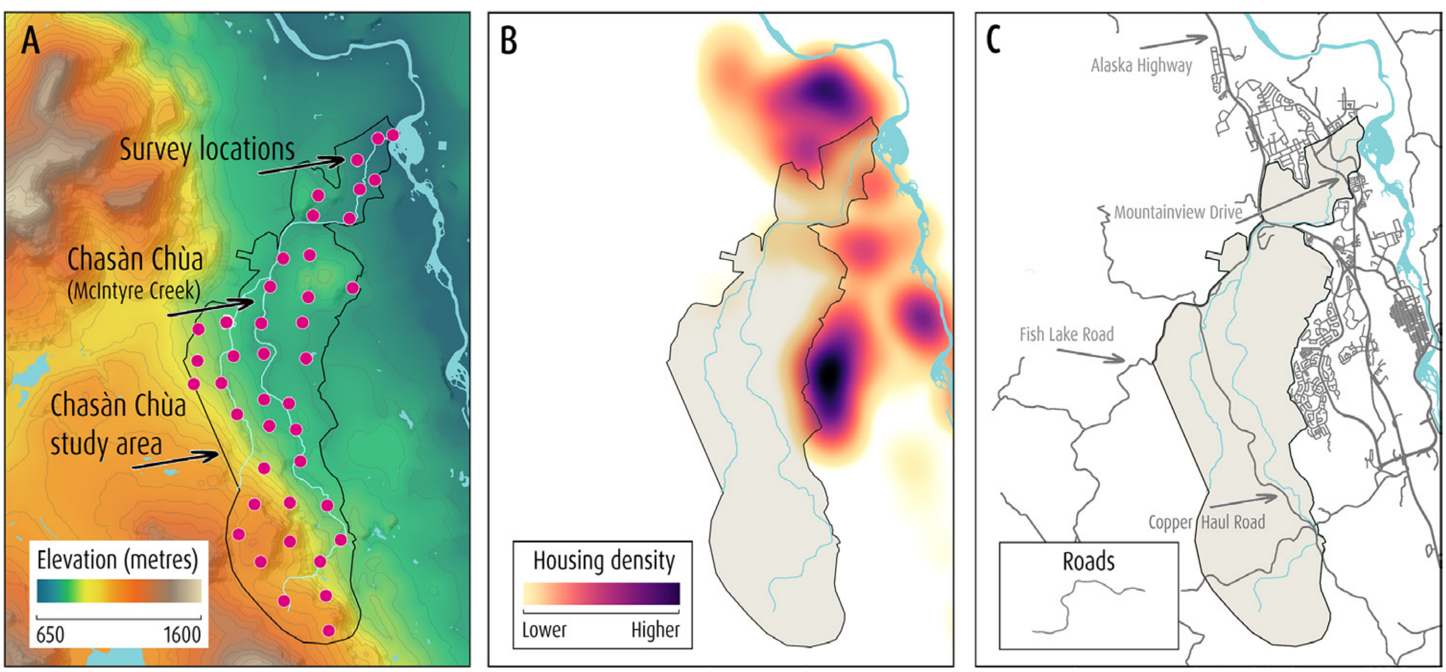



Figure 1. Chasàn Chùa begins on the slopes of Mount McIntyre and flows into the Yukon River north of Whitehorse (A). Levels of housing and road development (B and C) are highest in the creek's lower sections. Survey locations (pink dots) surrounded by most disturbance were in Lower Chasàn Chùa, downstream of the Alaska Highway. We conducted winter track surveys at 24 of our 41 sites, mainly in the lower elevation sites within the study area.

were active from May to September 2021. During May and June of 2021 we rotated nine audio recorders among the survey locations, ensuring each deployment included sites that were representative of the different levels of human development in the study area. We programmed audio recorders to record for five minutes every half hour, from midnight until 10 am. The recorders remained at each site for between six and nine days, before being moved to a new site. From each site, we randomly selected six of these five minute audio recordings from different days to analyze. Recordings were taken from between 4 am and 8 am, when breeding songbirds are most vocal. Finally, we used the website Wildtrax (www.wildtrax.ca) to process the photos and audio recordings. We manually tagged the species visible in each photo, and processed the acoustic data by listening to the recordings and identifying each species that was audible.

We completed winter track surveys by walking or snowshoeing along triangular-shaped transects (survey routes), each 1.5 kilometres in length. Snow was often waist deep, and surveys were physically demanding and time consuming. Due to unusually high snowfall levels we were unable to complete surveys in all 41 grids, and instead completed 24 surveys. We traveled in groups of two or more, often accompanied by volunteers or school groups. This allowed us to collect two sets of observations for each transect, helping to account for any observer bias from participants tallying and identifying tracks differently. For our analysis, we averaged observation totals between the two sets of observations. Where necessary, we rounded up to the nearest whole number in order to run statistical models as they require integer values. We divided each transect into 15 x 100 metre segments, and surveyors noted the tracks that fell within each segment. We counted all tracks that crossed the transect line or fell within several metres of the transect. As a result,

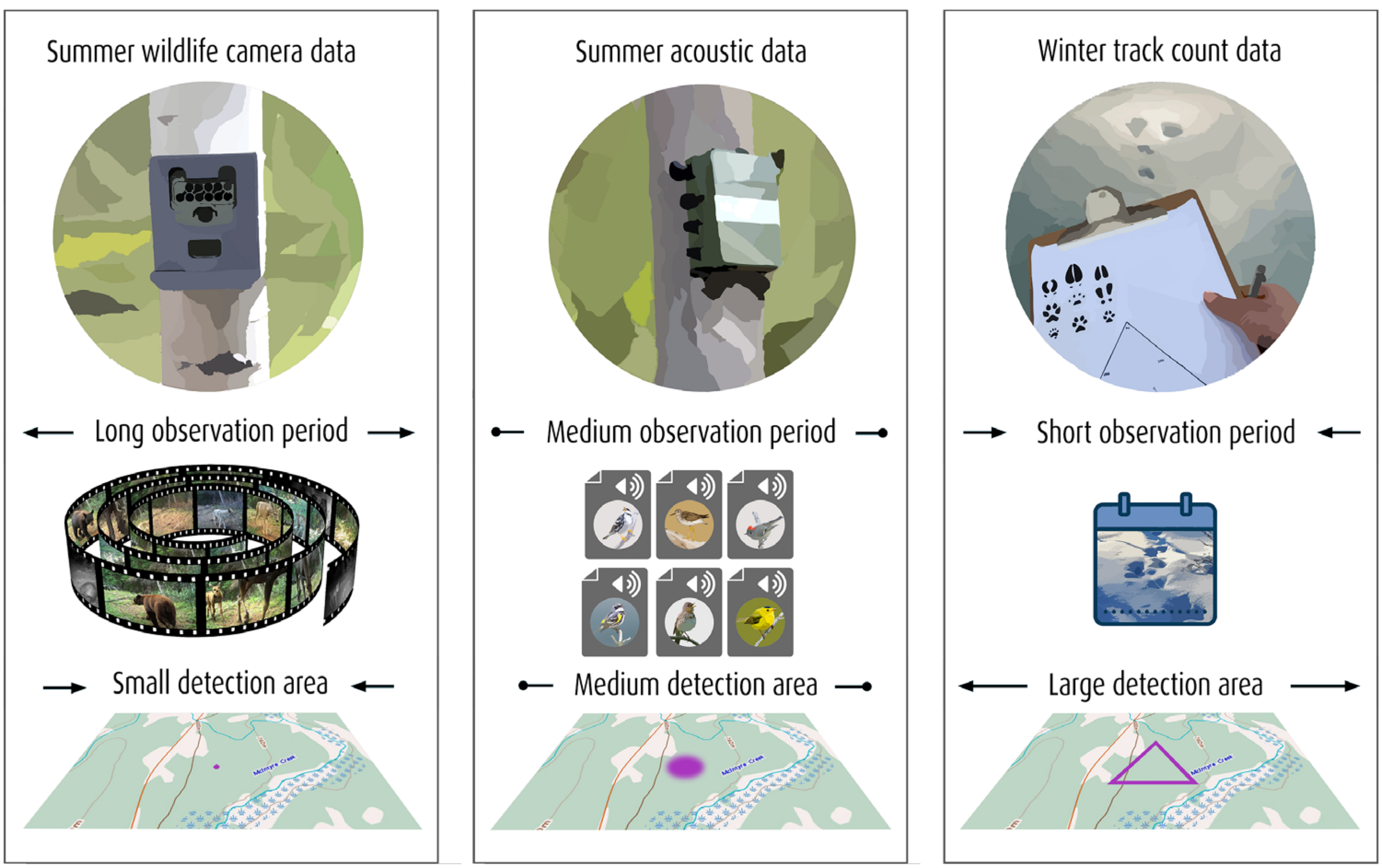



Figure 2. We collected mammal data using remote camera detections and winter track counts, and bird data using acoustic recorders. Each method had its own strengths and weaknesses. Cameras allowed us to identify mammals with high confidence, and their long battery life allowed us to monitor locations for months on end. However, in order to be detected, a mammal would have to walk directly in front of a camera, and mammals with differing body sizes and range sizes have different probabilities of being recorded. Winter track surveys allowed us to document the presence of different mammals over a large area, but some tracks were hard to confidently identify. Snowfalls also erased old tracks, so surveys only provided a snapshot of wildlife occurrences over a few days. Acoustic recorders captured data over a medium area and time period. Acoustic recorders reliably capture bird songs within a radius of ~300 metres, depending on the species, density of foliage, and interference from wind and other noises.

many of the sets of tracks we recorded would have been from the same individual. This means these data are not suitable for estimating the density of different species in different areas, but reflect the general amount of activity by species in the places we surveyed. We recorded confidences of high, medium or low for each track identification, and only analyzed those identified with a high degree of confidence.

Our study comprised three and a half months of camera observation, 19 hours of transcribed audio recordings, and 36 kilometres of transects. The data we compiled provide a comprehensive picture of the birds and mammals that inhabit Chasàn Chùa, with a few exceptions for wildlife that our survey methods were not well suited to monitor: such as bats, small rodents, and birds that rarely vocalize or are nocturnal. Our database of wildlife observations and disturbance data from Chasàn Chùa is publicly available at www.cpawsyukon.org/chasan-chua-data. Our hope is that this database lives on through further studies, forms a baseline reference for biodiversity change within Chasàn Chùa, and supports well-informed decision making about the creek's future.

## Calculating disturbance variables around Chasàn Chùa

We used preexisting spatial datasets to quantify disturbances within Chasàn Chùa. We accessed a digital map, or shapefile, of Whitehorse's road network from the Government of Yukon, and an address shapefile from the City of Whitehorse.[21] The addresses shapefile did not include new housing in Whistle Bend, or residences in the Northland and Kopper King trailer parks. To correct this, we loaded recent satellite images into the mapping software QGIS and manually added points to the address shapefile to reflect housing in these areas. We calculated the elevation at sites using Google Earth. We had hoped to analyze the effects of traffic on wildlife occurrence, as the volume of traffic on a road can determine how species are impacted by roads.[22] The City of Whitehorse and the Government of Yukon shared traffic data, but information was not available for all of the roads surrounding Chasàn Chùa, so we did not continue with this analysis.

The study sites reflected a gradient of human disturbances, from places surrounded by subdivisions and dense road networks, to places where the nearest house or road was over a kilometre away. We used QGIS to generate a series of disturbance metrics associated with the sites (Figure 3). For each site we calculated the housing density, distance to the nearest road and the average distance to roads. Housing density

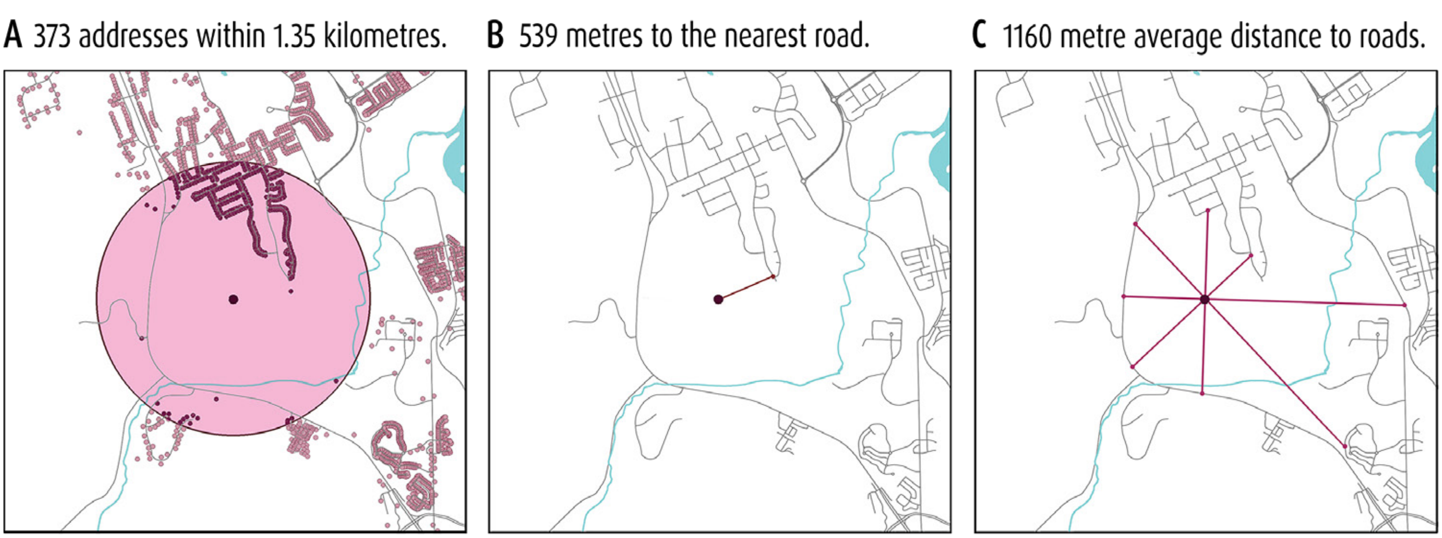



Figure 3. A densely populated site, with the three metrics we used to quantify human disturbances. A. We calculated the total number of building addresses that fell within a 1.35 kilometre buffer of each point. After testing a series of buffer sizes we determined that 1.35 kilometres returned the highest density of addresses, as smaller buffers captured too few addresses and larger buffers covered too large an area. B. We measured the shortest distance to the nearest road for each site. C. We quantified how surrounded each point was by roads by calculating the average distance to roads. We measured the distance from each survey location to the nearest road in eight directions: north, northeast, east, southeast, south, southwest, west, and northwest. If these measurements did not intersect with a road within 10 kilometres we used 10,000 metres as the value for that segment. We then calculated the average distance of the eight measurements.

was determined by the number of building addresses surrounding each site, and most addresses were residential. We also created a categorical variable for housing density, defining areas with fewer than 100 addresses within 1.35 kilometres as 'sparsely populated' and areas with more than 100 addresses as 'densely populated.' Sparsely populated sites were located far from neighbourhoods or contained only country residential development, while densely populated sites were located close to subdivisions like Copper Ridge, Whistle Bend, and Porter Creek (Figure 1). For winter track count data, we calculated the nearest road and average road distance from the midpoint of each 100 metre transect section, and the address density from the centre of each transect triangle.

## Calculating habitat variables around Chasàn Chùa

We were interested in how wildlife use different habitats within Chasàn Chùa, and whether certain habitat types were biodiversity hotspots. To investigate this, we recorded habitat characteristics at each site during the initial camera setup. We used these descriptions to create three broad habitat classifications for each site: dry forest, damp forest and wetland. We classified all sites within 50 metres of a creek or pond as wetlands, even if the exact location of the camera and audio recorder was forested (e.g., sites where a camera was mounted on a tree next to a pond). Damp and dry forests were distinguished by the dominant vegetation cover surrounding each site, and the presence or absence of moss. For example, a mossy white spruce forest would be a damp forest, and an open stand of lodgepole pines would be a dry forest. These classifications were less precise for bird data, as audio recorders can record birdsong from several hundred metres away, blurring distinctions between habitats. We only classified habitats at camera and sound recorder locations. With more foresight we could have recorded habitat types as we conducted snow surveys, though distinguishing habitats would have been challenging when the ground was covered by snow.

## Data analysis

We used generalized linear mixed effect models to test relationships between bird and mammal occurrences, and different disturbance and habitat variables. We used the total number of occurrences per species or species group over the monitoring period as the response variable. For camera data, we counted one observation for each day a species was present (e.g., a cow and calf moose that visited a camera location twice during the same day would be recorded as one moose observation). We recorded a zero if a species was never detected at a site. For acoustic data we recorded an observation as the presence of a bird species on any given recording. For snow survey data we recorded an observation for each set of wildlife tracks we identified with a high degree of confidence. In our statistical models we used the number of building addresses in the area, the distance to the nearest road, the average distance to roads, and the site's habitat classification as explanatory fixed effect variables.

Each research question was addressed with a separate statistical model (e.g., camera trap and sound data were analysed separately), but to reduce the chance of Type I errors (false positives), we included more than one variable of interest in a model. We did not execute any model selection, instead determining explanatory variables based on their biological significance and a priori study assumptions. To standardize numerical variables, we scaled each to a mean of zero. Wildlife observations at the same site and nearby locations are more likely to be similar to one another than to far away sites.[23] This is called spatial autocorrelation, and it can influence analysis results. To account for the relatedness of observations within sites, we added the survey location as a random intercept term. We did not include a site random effect when analyzing species-specific data, as the observations of a species at a site were represented by a single number, rather than multiple data points to compare among. Although we did not account for spatial autocorrelation in these models, all sites were packed into a relatively small area. This means that all sites had a high level of similarity with other sites, rather than some sites being clustered and others isolated. Our models assumed a Poisson distribution because they used count data.

# Results and discussion

From its headwaters to its outlet, Chasàn Chùa supports a diverse range of birds and mammals. We detected 15 mammal species and 55 bird species, many of which used lands throughout the creek—even in the sites closest to housing and road developments. The richness of species we found (Figure 4) demonstrates that the creek contains superb wildlife habitat, especially in the wetland areas at the heart of Chasàn Chùa.

We began by grouping all mammal species together, and all bird species together (Figure 5). When analysed together, mammals were not positively or negatively impacted by housing and road developments in Chasàn Chùa. Put another way, mammals were abundant across the whole range of development levels that exists within the creek. We recorded significantly fewer bird observations at sites that were very surrounded by roads, but the number of bird observations at different sites was not impacted by housing density or the distance to the nearest road. However, we found a more nuanced picture when we looked at how the occurrence of individual species varied depending on the level of human disturbance. While the abundance of mammals as a whole was not impacted by housing and road development, the composition of species changed in different parts of Chasàn Chùa. For example, moose, snowshoe hares and Rusty Blackbirds avoided habitats with high levels of housing and road development, while mule deer and coyotes thrived in areas with more development.


Figure 4. Chasàn Chùa supports a diverse range of species, shown in order of how frequently they were observed. Each survey method had strengths and weaknesses. For example, we detected more small mammals like squirrels, mice and ermine during our snow surveys than with cameras. These species may have eluded our cameras because of their small body size. Cameras detected larger mammals well, including bears, which would have been hibernating while we were conducting snow surveys. Acoustic recorders were best at detecting songbirds, rather than quieter birds like hawks or waterfowl. We didn't survey for bats, amphibians, fish, insects and plants. Other species like caribou, chipmunks and flying squirrels inhabit Chasàn Chùa, but weren't observed on any of our surveys.

## Mammals responded to housing in varied ways

The composition of wildlife within Chasàn Chùa changed as the remote parts of the creek gave way to habitats surrounded by housing developments (Figure 6). Snowshoe hares avoided housing developments, with 90% of summer observations and 83% of winter observations coming from sparsely populated areas. We observed large predators exclusively in remote parts of Chasàn Chùa, with no housing development and few roads. We recorded eight black bears, two grizzly bears and a single grey wolf, but these were too few observations to statistically analyze these species' occurrence patterns (Figure 7). However, other researchers have found that large predators avoid areas with high levels of human development, and this is probably the case around Chasàn Chùa as well.[24,25] In both the summer and the winter, moose avoided areas with high levels of housing development. In contrast, mule deer favoured areas with more housing development. In the summer, densely populated areas accounted for 84% of deer observations, compared to just 7% of summer moose observations. Coyotes showed no preference between sparsely and densely populated sites, and were common in both areas. Housing developments did not have a uniform effect on wildlife. Residential areas benefited some species, and displaced others.

The impacts of housing developments not only differed among species; they differed among seasons. In the summer, lynx avoided housing developments, with 94% of trail camera observations coming from sparsely

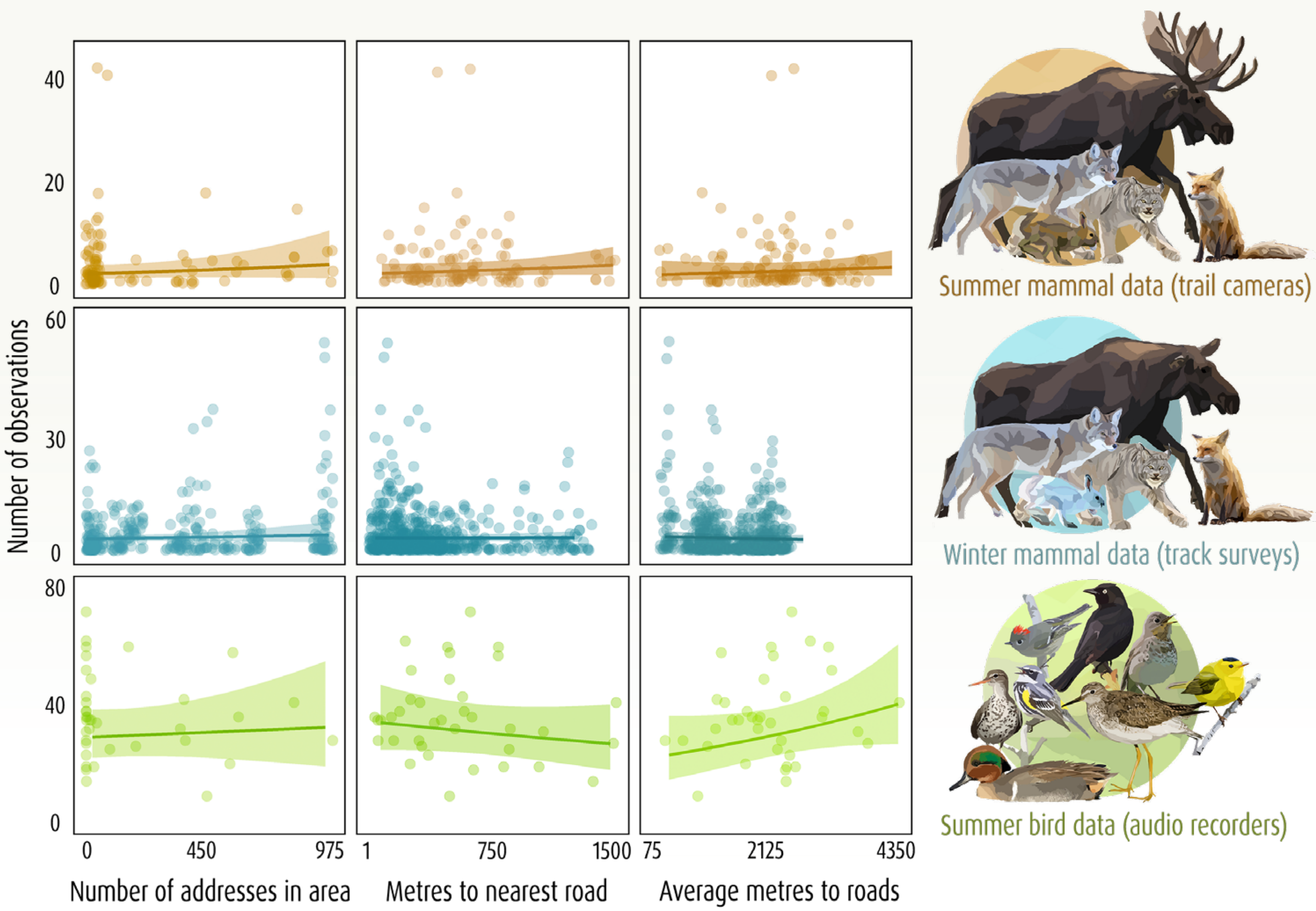



Figure 5: When we grouped bird and mammal observations together (i.e. not analyzing individual species trends) we found that wildlife occurrences were largely unaffected by housing and road development. There was only one exception: we found that birds were significantly more abundant in habitats less surrounded by roads. Otherwise, birds and mammals on the whole weren't statistically impacted by any of the disturbance variables we tested. Observations are represented by points, trends by dark lines, and the uncertainty or error by the light-coloured fill enclosing the trend line.

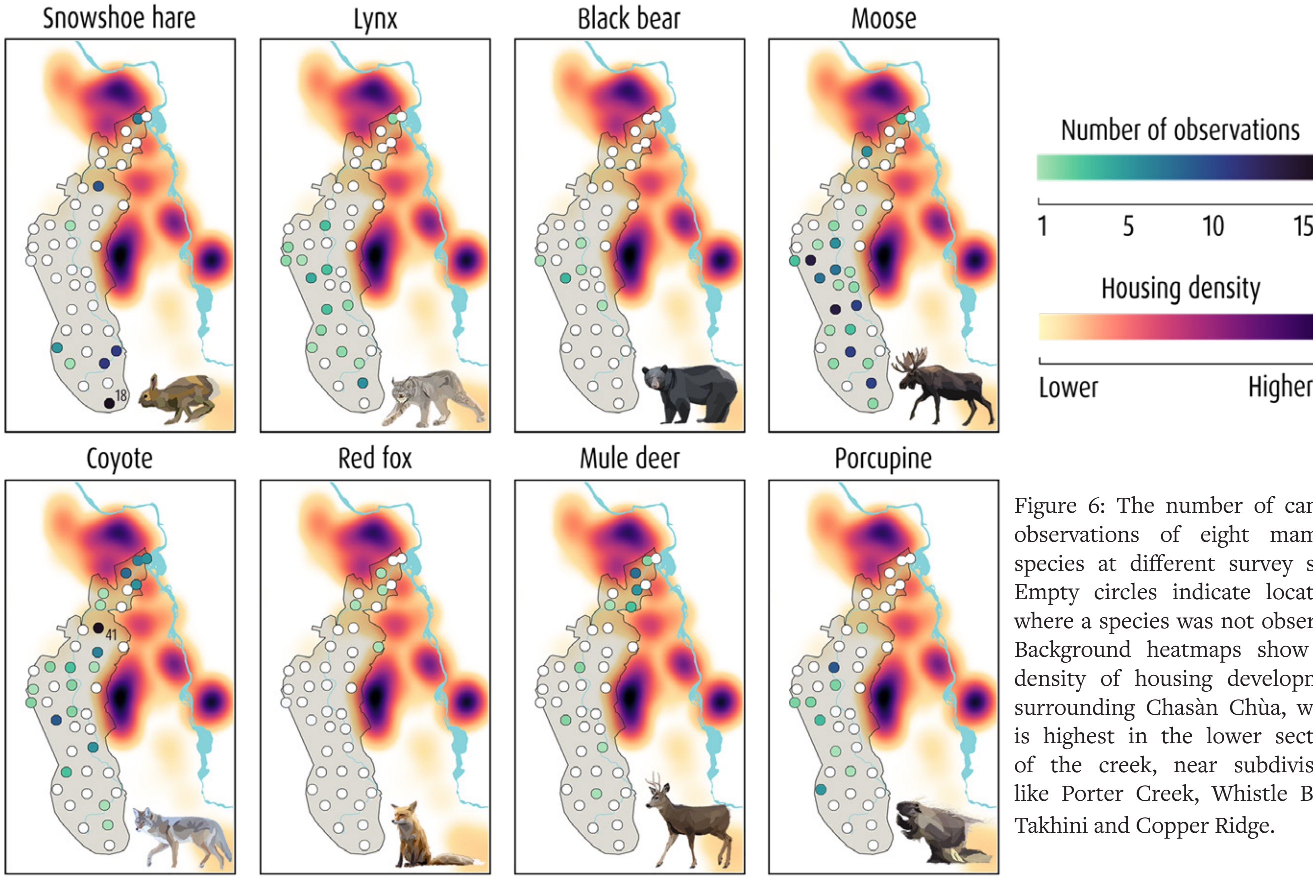



Figure 6: The number of camera observations of eight mammal species at different survey sites. Empty circles indicate locations where a species was not observed. Background heatmaps show the density of housing development surrounding Chasàn Chùa, which is highest in the lower sections of the creek, near subdivisions like Porter Creek, Whistle Bend, Takhini and Copper Ridge.

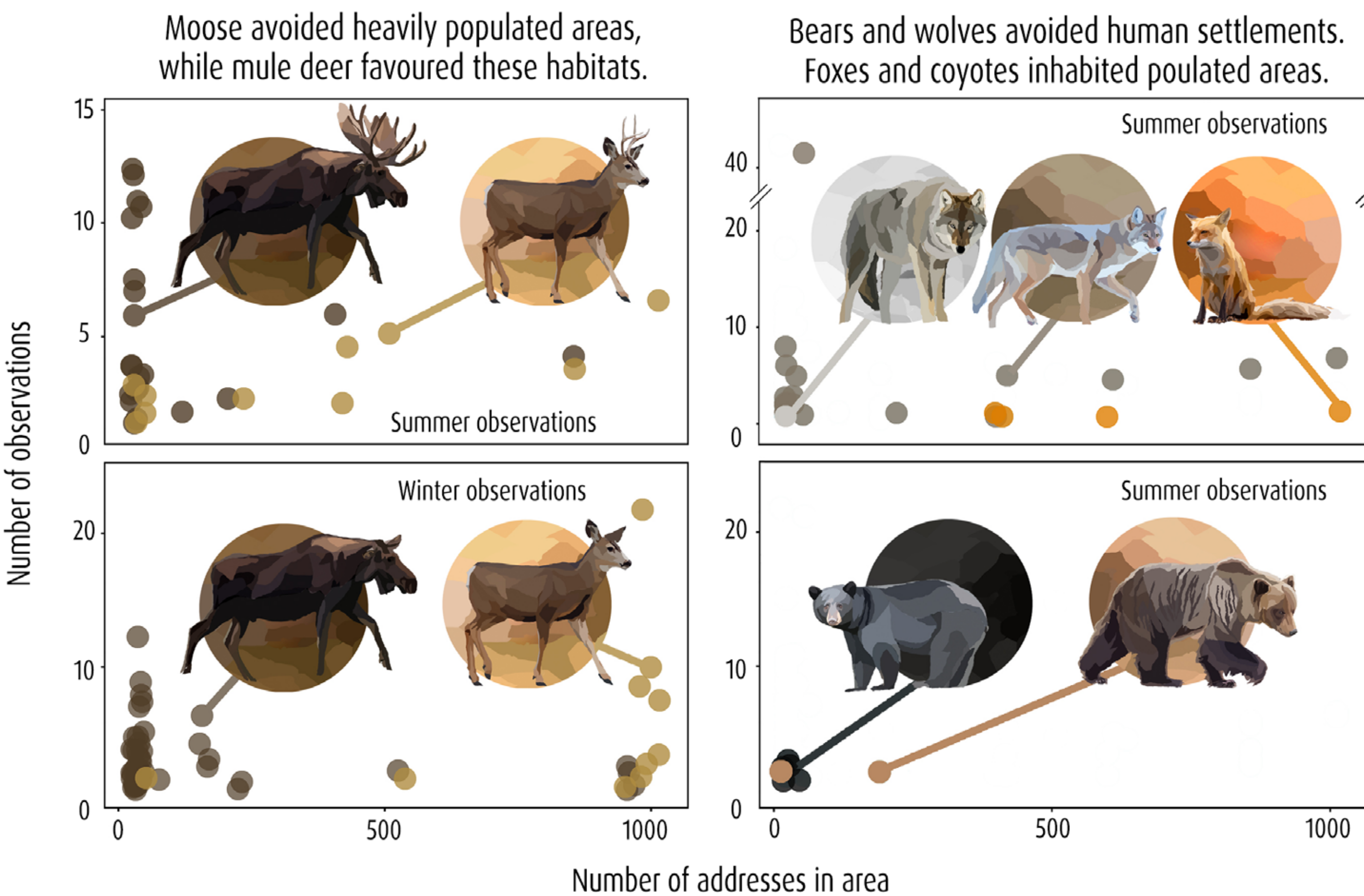



Figure 7: Observations of moose, mule deer, coyotes, red foxes, grizzly bears, black bears and wolves. We recorded more moose, wolf and bear at sites with the lowest housing density (<100 addresses within 1.35 kilometres. We observed more deer and foxes in areas with higher housing density (>100 addresses within 1.35 kilometres). Coyotes were common in areas with both high and low levels of housing development.

populated areas. However, in winter housing density had no effect on lynx distribution. During winter track surveys, we frequently observed lynx tracks near areas with high levels of housing development, as well as in more remote areas. When we compared the trends of lynx occurrence between the summer and winter, we found a statistically significant seasonal difference, with lynx likelier to occur near housing developments in the winter than summer. Because we used different survey methods in the summer and winter, we suggest some caution when comparing summer and winter trends. However, a comparison of survey methods in the Kluane area found that trail camera and track count surveys yielded similar estimates of lynx density.[26] Lynx inhabiting areas near housing developments in winter could be related to the snowshoe hare population cycle.[27,28] Snowshoe hares are the primary prey source for lynx, but hare numbers were low during our study period.[29,30] As a result, lynx may have moved closer to settlements in an attempt to locate alternate food sources during the harsh winter months. Wildlife that inhabit areas near humans must navigate a series of tradeoffs, and this adaptive decision making probably changes as the availability of food and other environmental conditions shift. The impacts of housing developments on wildlife are thus not static, but continually shifting with the surrounding environment.

While the composition of wildlife within Chasàn Chùa was influenced by the patterns of human development, this was not necessarily the result of direct causes and effects. Ecosystems are webs of interactions between different species, and human disturbances that impact one species can lead to ripple effects that impact a range of other species.[31] For example, bears and wolves that venture close to human settlements risk being chased away, relocated or even killed.[32] Large predators tend to avoid human settlements, which means that herbivores like deer can find relief from predation in areas adjacent to housing developments.[25,33] Mule deer in Chasàn Chùa likely preferred habitats with higher levels of development, in part because of this 'predator shield' effect. Similarly, we found that coyotes thrived throughout Chasàn Chùa. This is likely due, in part, to the availability of human food sources near settlements, and coyotes not having to compete with wolves for resources.[34,35] The abundance of coyotes in Chasàn Chùa may in turn have displaced red foxes from these habitats. Foxes are a common sight in Whitehorse's suburbs,  but we only observed four foxes on our cameras (Figure 7). The sites where we observed foxes were all near housing developments, which are presumably the epicentres of Whitehorse's fox population. Many of the trends we observed likely result from indirect ways that human developments alter the interactions between different species.

A lynx searches for food at a property in Raven's Ridge, a subdivision within Chasàn Chùa. Photo by Peter Mather.

## Moose were more nocturnal around housing developments

We found that when moose entered areas near residential development, it was primarily at night. Across Chasàn Chùa, moose were more active at night, but this trend was especially pronounced in areas with the most housing development (Figure 8). This suggests that moose might have altered their behavior to compensate for human-driven disturbances, by being more nocturnal near residential areas. We recorded moose around wetlands in near densely populated areas at night, when neighbourhoods go quiet and traffic dies down. As Whitehorse awakens, these individuals might bed down in a safe place for the day or retreat to more remote habitats. Habitats in the most developed parts of Chasàn Chùa were desirable enough for moose to still visit them, but human activities appeared to deter moose from these areas during the day. The nocturnal moose activity we documented shows how moose can adapt their behaviour to cope with some disruptive human activities—rather than abandoning these habitats altogether. Similar adaptive behaviour has been documented in Norway, where moose were found to use habitats closer to roads mainly at night, when traffic disturbances were lowest.[36] More than sixty other mammal species from all over the world are known to respond to human disturbances by altering their behavior to be more nocturnal.[37]

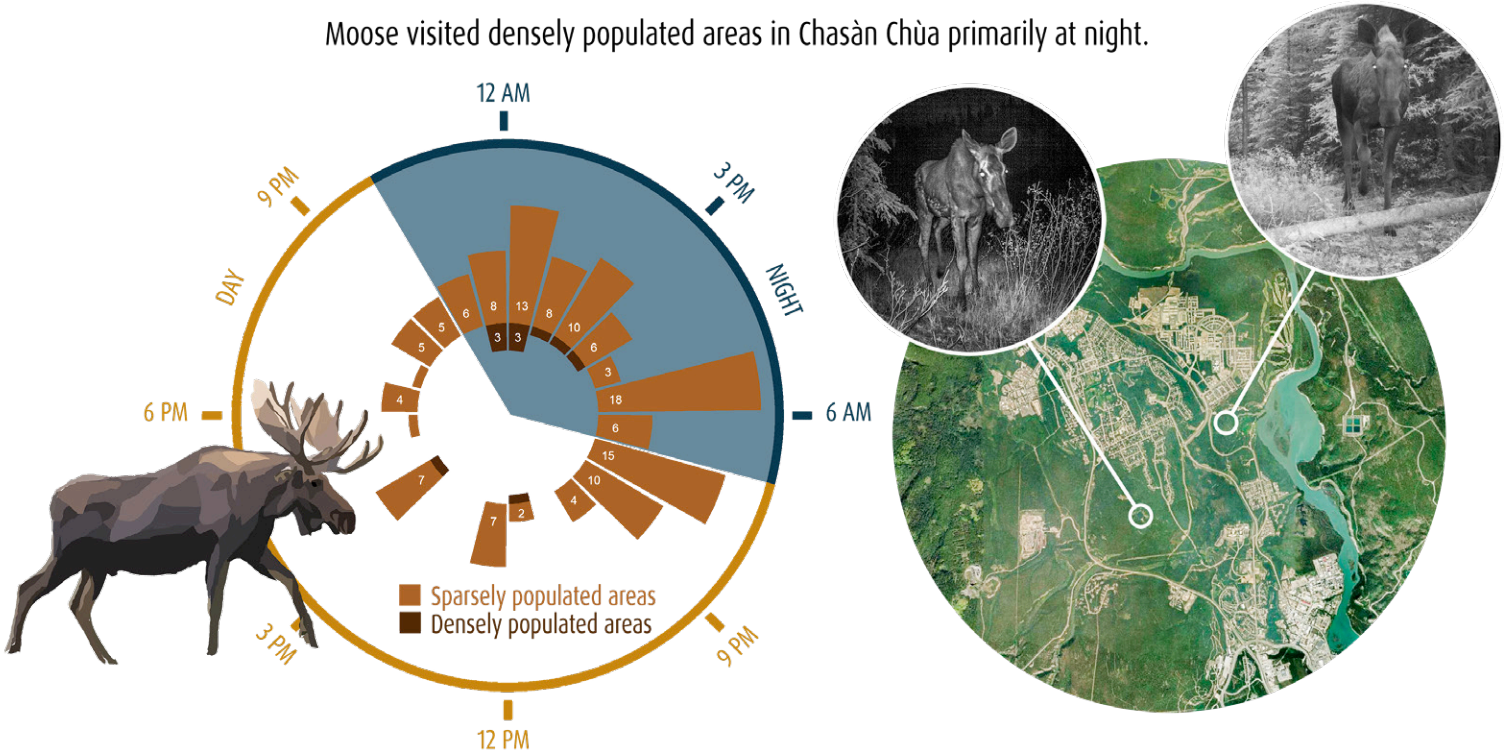



Figure 8: Left: An hourly comparison of moose occurrences between densely populated (dark brown) and sparsely populated areas (light brown). The numbers inset within bars indicate the number of moose observations in each hour. Moose were commonly observed between 10 PM and 7 AM across all locations, but this trend was more exaggerated in densely populated areas. Right: Trail camera images of moose at night near the Porter Creek and Whistle Bend subdivisions.

## Roads affected the occurrence patterns of some mammal species

We found taxonomic and seasonal differences in the relationships between wildlife occurrences and roads (Figure 9). During the summer, lynx avoided roads, while deer and coyotes favoured habitats with higher road density. During the winter, we found more moose in areas with more roads, while snowshoe hares avoided these habitats. For many species though, we found that roads had neither a positive, nor a negative effect. When we began this research project, we expected to find that roads had clear negative effects on wildlife. Our results show that, at least in Chasàn Chùa, the story is more complicated. While studies have predominantly found that roads negatively impact wildlife, roads can also have neutral or even positive effects on certain species.[38] The impacts of roads on wildlife are mediated by many other factors, such as a species body size, its movement patterns, its ability to avoid vehicles, and how roads impact other species in the ecosystem.[38] Human disturbances can drive a variety of biodiversity responses, which appears to be the case in Chasàn Chùa.

Chasàn Chùa contains a variety of roads, from major arteries like the Alaska Highway and Mountainview Drive, all the way down to the single-track gravel road that winds up the slopes of Mount McIntyre. The negative impacts of roads on wildlife tend to increase with higher traffic volumes, but only about a quarter of our sites were in areas near major roads.[22] In most of Chasàn Chùa, wildlife only encounter small roads with relatively little traffic. Small roads within Chasàn Chùa may have minimal impacts on wildlife, which in turn may have obscured potential impacts from larger roads. For example, we observed moose most

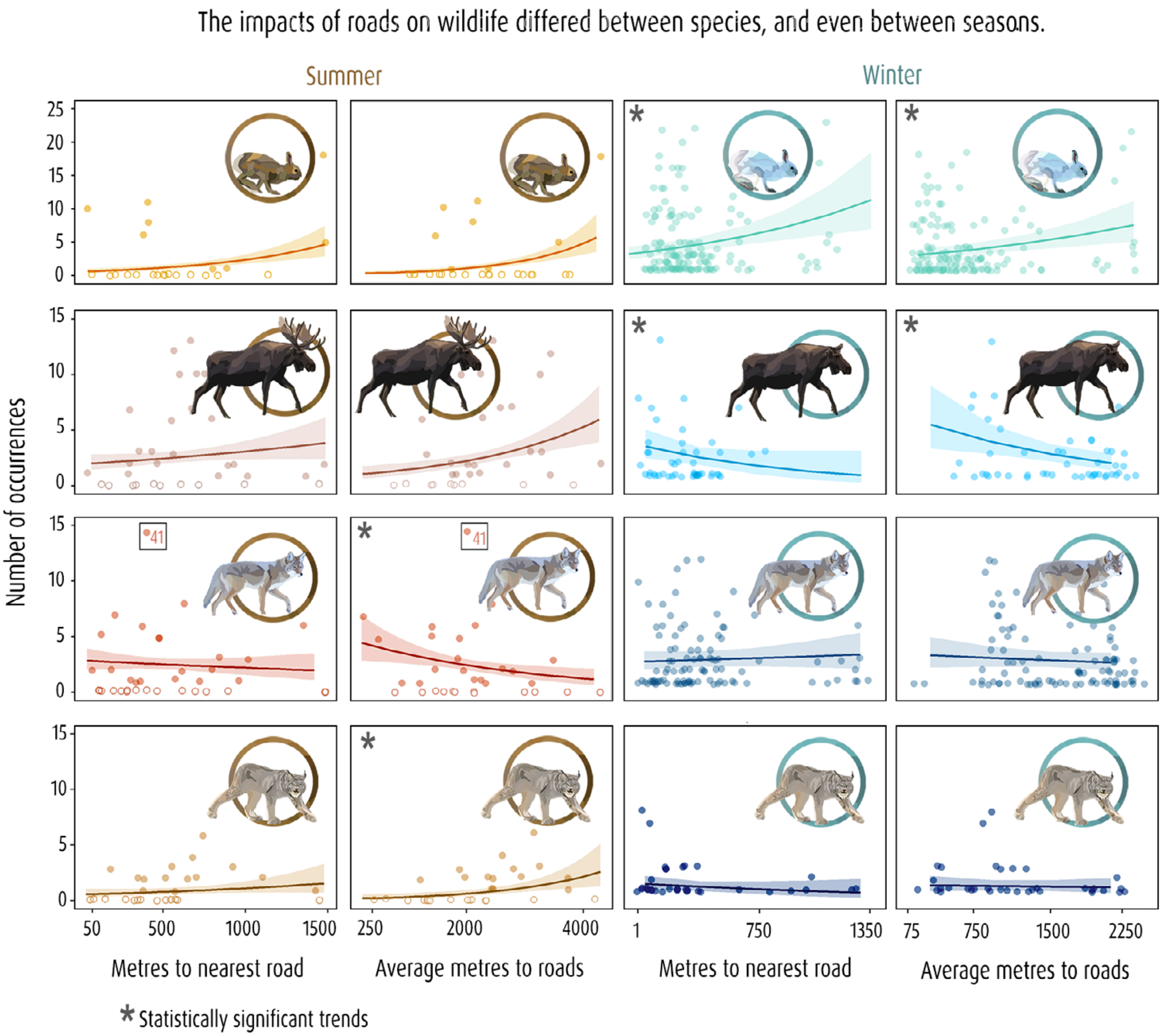



Figure 9. Wildlife occurrence patterns around roads sometimes differed between seasons. In some instances snowshoe hares and lynx avoided sites with more road disturbance, while in other cases moose and coyotes preferred sites with more road development. However, no species showed a statistically significant relationship with roads in both the summer and winter, suggesting that species may respond differently to roads at different times of year. We used two metrics to quantify the levels of road development: the distance to the nearest road, and the average distance to roads, calculated across the distances to roads in eight different directions. Summer data were collected using trail cameras, and winter data was collected through snow track surveys. Empty circles in the summer data indicate where the count of a species was zero. Snowshoe hare, moose, coyote and lynx were the only species where we recorded enough observations in both the summer and winter to properly model their relationships to roads.

frequently around wetlands in Middle Chasàn Chùa. An unpaved road with very little traffic parallels this wetland complex, so moose that foraged in these high quality habitats would also have been recorded as being near to a road. We observed very few moose in the parts of the creek with the largest roads and heaviest traffic volumes, but overall we only found neutral or positive relationships between moose and roads. Any negative impacts from major roads on moose could have been masked by moose observations near smaller roads elsewhere in Chasàn Chùa.

Another challenge in interpreting our results was the correlation between different human disturbances. The parts of Chasàn Chùa with the most road development were also the areas with the highest levels of housing development. For example, lynx avoided areas with high road and housing density, while deer preferred areas with more housing and road development. These trends likely resulted from the combined effects of housing, road and other human disturbances. Regardless of whether housing or roads had the stronger effect, it is clear that human disturbances shaped how many species experienced Chasàn Chùa.

## Vulnerable bird species occurred far from roads

We detected significantly fewer birds at sites surrounded by roads, but the distance to the nearest road didn't have an effect on bird observations (Figure 5). When we focused on individual bird species, we found that species at risk only occurred far away from roads. Species at risk are those that the Committee on the Status of Endangered Wildlife in Canada has determined to be endangered, threatened or of special concern. Two species at risk, Rusty Blackbird and Lesser Yellowlegs, we exclusively recorded at sites over 350 metres from roads (Figure 10). Another species at risk, the Olive-sided Flycatcher, was only recorded at sites that were over 500 metres from roads, and over 900 metres in elevation. Olive-sided Flycatchers occurring far from roads may have been incidental, as the mountain slope habitats they appeared to favour tended to be farther from roads than lower elevation sites within Chasàn Chùa. We also considered whether habitat preferences could also have explained why we only observed Rusty Blackbird and Lesser Yellowlegs far away from roads. These are both wetland species, and our study included wetland sites that were both near and far from roads. Within available wetland habitats, Rusty Blackbirds and Lesser Yellowlegs may have selected habitats farther from roads. However, our sample sizes were too small to find statistically significant trends. Determining whether roads negatively impact Rusty Blackbirds, Lesser Yellowlegs and other species at risk could be helpful in informing federal recovery strategies for these birds.

We only observed species at risk birds at sites far away from roads.

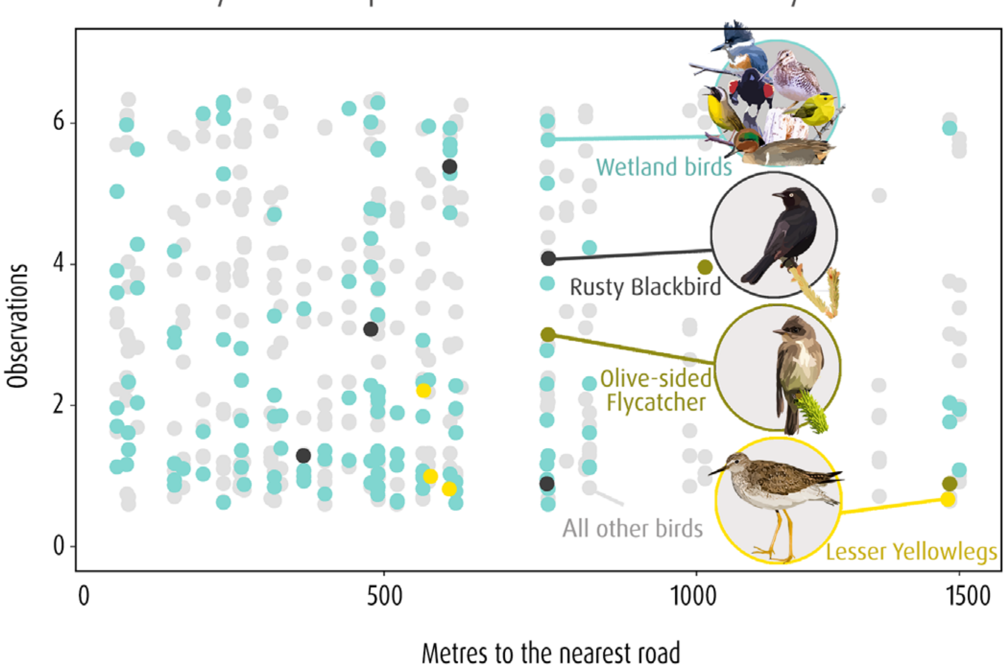



Figure 10. We only recorded Rusty Blackbirds (black dots) Lesser Yellowlegs (yellow dots), and Olive-sided Flycatchers (green dots) at sites far from roads. Other wetland birds (blue dots) and non-wetland species (gray dots) were broadly distributed throughout Chasàn Chùa, regardless of the distance to the nearest road. We did not observe blackbirds and yellowlegs in available wetland habitats near roads, suggesting that these species may have avoided these otherwise suitable habitats.

## Different habitat types supported different mammals

We analyzed wildlife occurrences across different habitat types using summer camera data. (Figure 11). We found that moose preferred wetland habitats over dry forests, affirming the importance of wetland habitats in Chasàn Chùa for this iconic large mammal. We also found that coyotes were more likely to inhabit wetlands than dry and damp forests. However, this result was highly influenced by a single wetland site where our camera recorded coyotes on 41 separate days: five times more coyote observations than the next highest site. The camera registered many images of coyote pups playing, meaning a den was likely nearby. Snowshoe hares were most likely to inhabit damp forests and the least likely to inhabit wetlands. Many studies have shown that snowshoe hare distribution is a strong predictor of lynx distribution, but we found that habitats used by lynx in Chasàn Chùa did not match that of snowshoe hares.[39,40] Lynx were relatively evenly distributed across all habitat types, with 24 observations around wetlands, the habitat type used the least by hares. Because snowshoe hare numbers were low during our study period, lynx may have had to search a broader range of habitats for alternative prey sources.

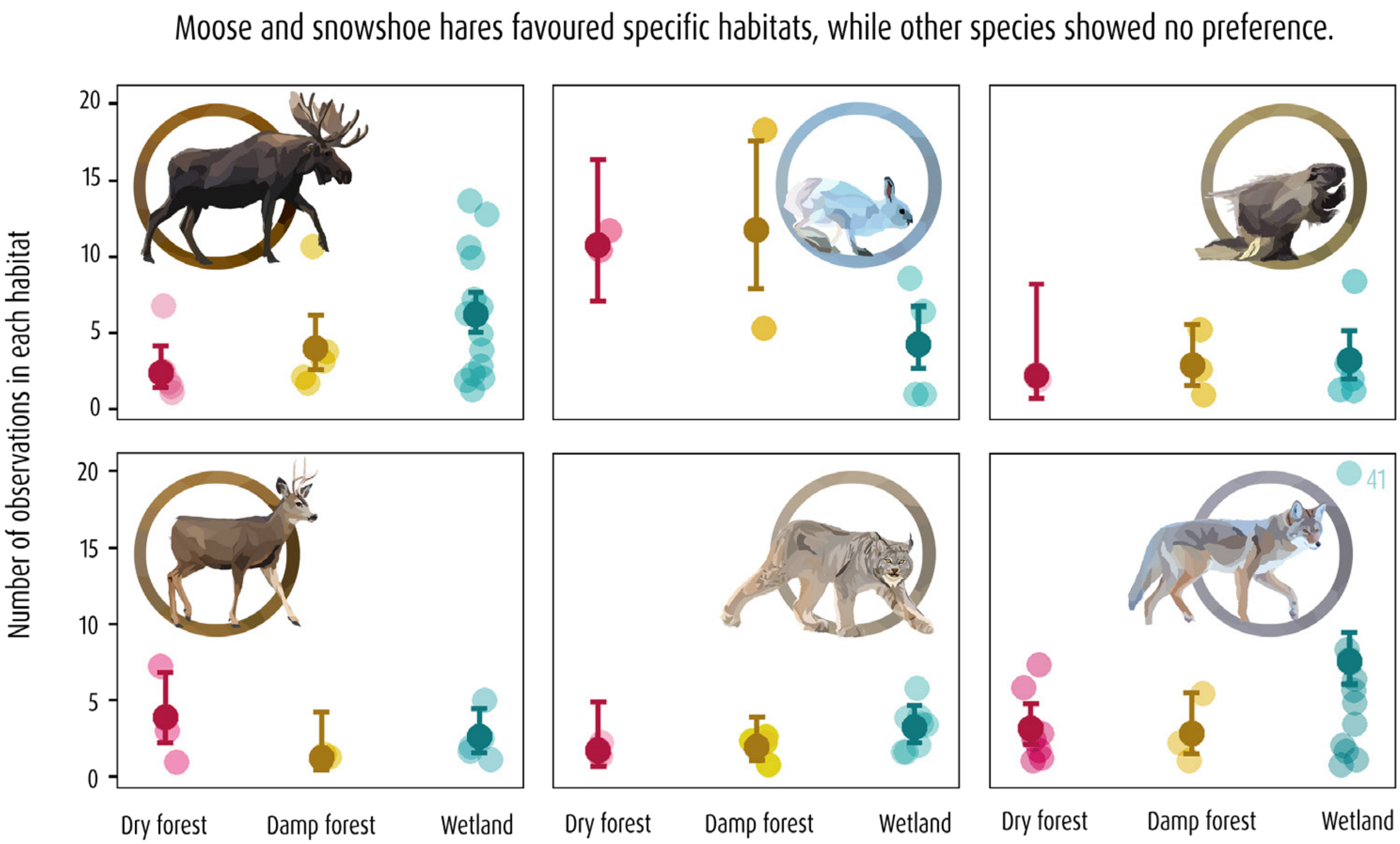



Figure 11. We found that moose preferred wetland habitats, while snowshoe hares preferred forests. Coyotes were most likely to be observed in wetlands, but result was skewed by the presence of a coyote den near a wetland site. Other mammal species showed no preference between damp forest, dry forest and wetland habitats.

## Birds favoured wetland habitats, and bird species composition changed with elevation

Bird species richness was highest at sites within or next to wetlands and creeks. We observed 21 bird species, the most species at any site in our study, near the confluence of Chasàn Chùa and the Yukon River. The large wetland complex and tracts of intact habitat at higher elevations in Upper Chasàn Chùa also had high bird species richness. These results demonstrate the importance of preserving the riparian and wetlands areas at Chasàn Chùa and maintaining a development free buffer around these areas.

The distribution of certain bird species changed with elevation. Species like Townsend's Warblers, Orange-crowned Warblers and Olive-sided Flycatchers were found primarily on the slopes of Mount McIntyre, while Yellow Warblers, Warbling Vireos, Alder Flycatchers and Fox Sparrows were only documented in the lower elevation parts of the creek. This is probably because of changes in habitat across different elevations. The most commonly recorded birds were also the most widespread, with Swainson's Thrushes, Yellow-rumped Warblers, Ruby-crowned Kinglets and Dark-eyed Juncos observed across a range of elevations. Chasàn Chùa encompasses a broad range of elevations and habitat types, which in turn supports the diversity of birds and other wildlife that we observed in our study.

## Study limitations

Our study provides a snapshot of the species richness and distribution of wildlife at Chasàn Chùa in 2021 and 2022. It is important to note that species' populations and distributions have likely changed over time, which is difficult to quantify without scientific baseline data and wouldn't be captured in this study. Further, although our study provides a strong sense of general wildlife patterns at Chasàn Chùa, there may be some fine scale wildlife distribution patterns that we weren't able to detect. Our survey points were evenly distributed throughout the Chasàn Chùa area, while development is concentrated in the lowermost parts of the creek. Future studies could follow a design with a more even distribution of sites between densely and sparsely developed areas. Other tracking methods such as GPS collaring may also detect finer-scale behavioral changes in wildlife that could be occurring. Finally, wildlife may behave differently around Chasàn Chùa than in other parts of the Yukon because of hunting restrictions within Whitehorse city limits. Hunting pressures are often highest near roads, and many species modify their use of habitats near roads as a result.[41–43] Chasàn Chùa is off limits to hunting, and the effects of road developments on wildlife could be different or more pronounced elsewhere in the Yukon, where hunting does occur. Since hunting does not occur within the survey area of this study, we advise against extrapolating our results at Chasàn Chùa to non-urban areas in the Yukon where hunting does take place.

The solitary wolf recorded during our study. Trail camera image by CPAWS Yukon.

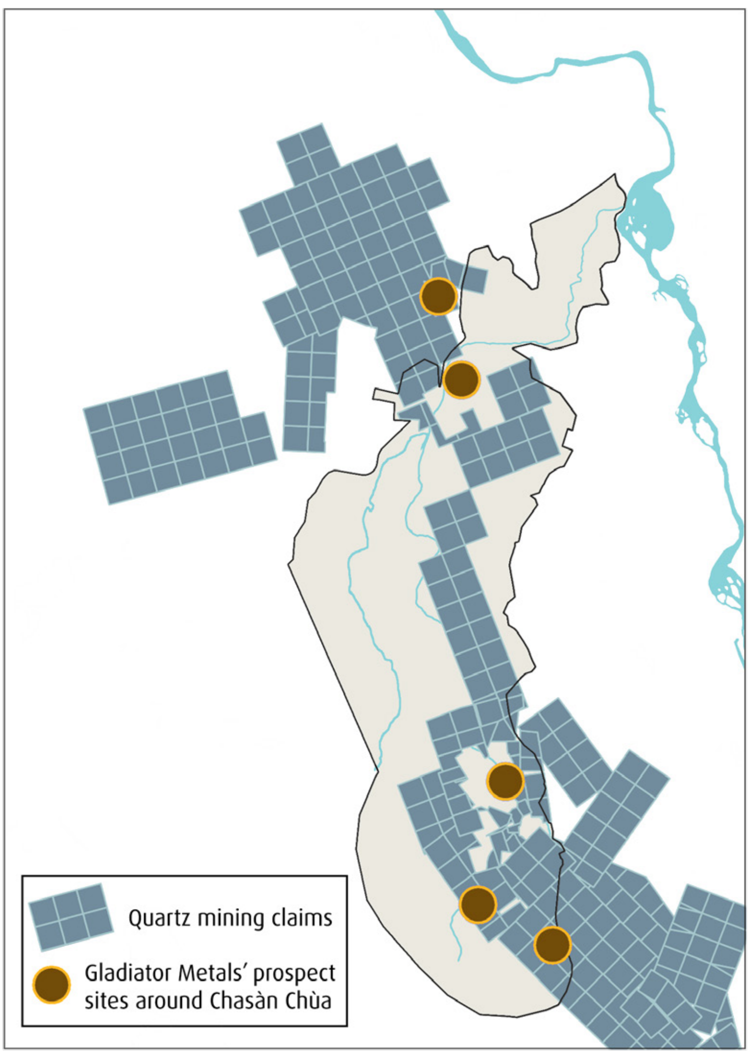
# Management recommendations

Chasàn Chùa is a sanctuary for wildlife in the heart of the Yukon's busiest community. It is critical to maintain the integrity of Chasàn Chùa in the face of Whitehorse's expanding human footprint. At the outset, decision makers should put potentially harmful developments around the creek on hold. Governments and the public should consider future challenges to the ecological and cultural values of Chasàn Chùa, and set out a broad groundwork of protections that address such concerns. Once the boundaries and general policy framework for protecting Chasàn Chùa is in place, decision makers should work on a management plan that addresses the needs of the creek in detail. The following recommendations are key to securing the protections that Chasàn Chùa deserves.

## Avoid further development while Chasàn Chùa undergoes park planning

The City of Whitehorse has pledged to designate Chasàn Chùa as a park—in partnership with the Government of Yukon, the Kwanlin Dün First Nation and the Ta'an Kwäch'än Council.[44] Such a park would be an important step in safeguarding the cultural and ecological values of Chasàn Chùa. Still, protected area status could take years to finalize. Chasàn Chùa was first identified as a candidate for a regional park in 2010, but the intervening years have seen new development pressures in and around the creek. The Government of Yukon and the City of Whitehorse should not approve new developments in Chasàn Chùa until protections for the creek are finalized and a management plan is in place.

Mineral interests in the Chasàn Chùa area.




In 2023 the Government of Yukon's withdrew Chasàn Chùa from new mineral staking and placed the creek in an administrative land reserve. This is a positive step, but does not rule out development within the 32% of Chasàn Chùa that is covered by existing mining claims. Gladiator Metals Corp holds the exploration rights to a block of claims in the Whitehorse area.[45] The company has identified a series of prospective exploration sites, including within Chasàn Chùa (Figure 12).[46] These sites are mainly in the lesser developed parts of the creek. Mining activity on these claims could bring disturbances to parts of Chasàn Chùa that supports disturbance-adverse wildlife like moose, bears, wolves and snowshoe hares. Most mining exploration projects never progress to a fully fledged mine, but exploration can still be destructive. Exploration spans a wide spectrum of work, from small-scale activities like collecting rock samples at the surface, all the way up to building roads, helicopter pads and work camps, drilling, using explosives, and excavating up to two hundred thousand tonnes of rock. Mining exploration within Whitehorse's

Figure 12. One third of Chasàn Chùa is overlapped by quartz mining claims. Little mining activity has taken place since the 1980s, but this could change. Gladiator Metals Corp has begun an exploratory drilling program south of Whitehorse, and has identified areas of mineral interest within Chasàn Chùa.

boundaries could be highly disruptive to wildlife and people alike, and would likely face substantial public opposition. The Government of Yukon should negotiate with companies to relinquish their claims within Chasàn Chùa, similar to negotiations over claims in the Peel Watershed.

## Maintain habitat connectivity between Chasàn Chùa and other wild spaces

Maintaining habitat connectivity is critical for conserving large wildlife and ensuring that species can shift their ranges in the face of climate change. To the west, Chasàn Chùa connects to the Łu Zil Män (Fish Lake) area. Across the Yukon River to the east of the creek's outlet is Chadburn Lake Regional Park, as well lands that the City of Whitehorse has slated for future housing development. It is important that future developments in and around Whitehorse do not interrupt the habitat corridors that connect these landscapes. The Kwanlin Dün First Nation and Government of Yukon are developing a Local Area Plan for Łu Zil Män, and the City of Whitehorse recently updated its Official Community Plan. The lands beyond the City's boundaries fall within the Whitehorse Land Use Planning Region, and will undergo planning in the coming years. All of these planning processes should work to maintain habitat connectivity between Chasàn Chùa and the surrounding landscape.

## Accommodate the safety of wildlife and people in future transportation planning

As with many other aspects of human disturbances, the impacts of roads are neither entirely negative, nor uniformly positive. On one hand, roads can block wildlife movements, and expose habitats to new hunting, poaching and development pressures.[41,47] Vehicles can strike and kill animals, with population-level impacts for some large mammals with low reproductive rates.[38] On the other hand, roads can help wildlife travel more quickly across landscapes.[48] Predators can use open sightlines along roads to hunt more efficiently, while herbivores often graze on the grasses and shrubs that proliferate alongside many roads.[49] Our study was not designed to capture the fine scale impacts of roads, like how wildlife behave around roads, or how roads impact movement patterns (see the section on study limitations). It is challenging to get a clear picture of the impact of existing roads on wildlife in Chasàn Chùa, let alone predict the impacts of any future road developments. Any potential road developments should be treated with caution, especially for major roads with heavy traffic volumes.

Whitehorse's growing suburban population and the prevalence of single-occupancy vehicle transport has led to traffic congestion along several of the roads into Whitehorse. In the past, the City of Whitehorse has considered building a new road through Lower Chasàn Chùa as a way to alleviate congestion. CPAWS Yukon and many community members opposed the proposal. The City removed consideration of a new road through Chasàn Chùa from Whitehorse's new Official Community Plan. However, other proposals for new roads could emerge in the future. While many species seem tolerant of the existing levels of road disturbance in Chasàn Chùa, they may only tolerate road development to a point. Other researchers have found that if road development surpasses a certain threshold, then some wildlife respond negatively.[50–52] New road development in Chasàn Chùa could create a major barrier to the movements of sensitive wildlife, or render the surrounding habitats inhospitable for these species.

We found that numerous mammals used habitats in Lower Chasàn Chùa, requiring them to cross several busy roads. This is a safety risk to wildlife as well as to drivers, especially when large mammals cross roads. Future upgrades to major roads within Chasàn Chùa should include mitigations that soften the impacts to wildlife, and reduce the risks to people. Wildlife crossing structures could allow wildlife to safely bypass roads, while lessening the risks to people from vehicles colliding with large mammals like bears, deer and moose.[53] A structure—or structures, would be most impactful on sections of road with heavy traffic, high speed limits and frequent wildlife crossings. Specific locations could be determined through setting up cameras to monitor wildlife crossings, or working with Conservation Officers to identify areas

with high rates of roadkill. City planners should also prioritize sustainable solutions to ease Whitehorse's traffic challenges, rather than widening existing roads or building new ones altogether. Some examples of alternatives include better public transport options, incentivizing active transport, and developing more services within Porter Creek and Whistle Bend so people require fewer trips into downtown Whitehorse.

## Maintain the integrity of wetlands

Wetlands and riparian areas supported the greatest diversity of wildlife within Chasàn Chùa. Preserving these habitats is important to safeguarding Chasàn Chùa's wildlife. For example, management planning for the creek should limit recreational activity within wetlands habitats. It is also critical to maintain large buffers of greenspace around creeks and wetlands. Governments should also crack down on illegal dumping, which we regularly came across while surveying near roads and parking areas around Chasàn Chùa. Garbage dumping around wetlands and riparian areas is especially concerning, given the substantial ecological value, heightened species richness in these areas, and the risk of pollution washing downstream.

Creeks and wetlands are the heart of Chasàn Chùa, but protections should not end there. Our study documented a number of species that occurred primarily in forested habitats including snowshoe hares, mule deer, Olive-sided Flycatchers and White-winged Crossbills. The home ranges of many species are far larger than a single swamp or stream, and ecological processes like water filtration and nutrient cycling also play out across large landscapes. If upland and forested habitats are degraded, the negative impacts of such ecological damage will eventually leak into wetlands as well. Safeguarding creeks and wetlands also requires protecting their headwaters, and the uplands and forested habitats that buffer them. Since healthy creeks and wetlands do not exist in isolation, decision makers should ensure that the lands bordering Chasàn Chùa are cared for as well.

Image: The autumn sun sets over Chasàn Chùa's wetlands. Photo by Malkolm Boothroyd.

## Safeguard the future of Chasàn Chùa through careful management planning

Management planning is a key to effective conservation. Such plans ensure that broad visions for conservation and stewardship are backed up with on the ground actions and policies. Management planning for Chasàn Chùa will be an opportunity for the Yukon public, First Nations and other orders of government to lay out a framework to safeguard the creek's future. This planning process should ensure that any further development within Chasàn Chùa does not endanger the creek's ecological and cultural integrity, and foster healthy relationships between people and wildlife.

There are many tools that a management plan could use to safeguard Chasàn Chùa. For example, a plan could set different zones of protection within the creek based on the sensitivity and ecological and cultural significance of different habitats. Criteria for determining habitats with the highest conservation priority could include species indicators, such as the presence of species at risk, disturbance-adverse wildlife and other vulnerable species like ground-nesting birds. Other criteria could include the vulnerability of ecosystems, for example the ability of plant communities to recover from disturbance, or the likelihood of pollutants spreading in the environment. Habitats that meet criteria for the strongest protection could be afforded additional safeguards, such as requiring people to keep dogs on leash, building boardwalks and railings to keep foot traffic to established trails, and tackling invasive species. A management plan could also limit off-road vehicle use to designated trails, and away from vulnerable habitats like wetlands.

Management planning could also identify initiatives for other governments to implement. For example, a plan could recommend strengthened policies from the City of Whitehorse around the storage of garbage and other wildlife attractants, to avoid drawing wildlife into the subdivisions surrounding Chasàn Chùa. Similar policies to promote healthy interactions between humans and wildlife have been adopted elsewhere in Canada. Squamish, BC's Official Community Plan has a section dedicated to wildlife corridors and managing attractants.[54] Canmore and Banff, Alberta have completed a management plan to foster healthier coexistence between wildlife and people in the Bow Valley.[55] This plan recommends prioritizing new developments in previously disturbed areas, while keeping development out of wildlife corridors and habitat patches. Applying these principles within Chasàn Chùa would promote conservation within Whitehorse, even as development pressures grow.

Image: A Sora, a seldom-seen rail that lives among the wetlands of Chasàn Chùa. Soras nest on the ground, putting them at risk to off-road vehicles and off-leash dogs. Photo by Malkolm Boothroyd.

## Conclusion

Our findings affirmed what many people already know—that Chasàn Chùa is a vibrant ecosystem and home to an abundance of wildlife. Our trail cameras captured photos of moose calves following behind their mothers, coyote pups wrestling, and lynx stalking through the trees. We spotted marten tracks pursuing grouse tracks, and found places where otters had slid through the snow and into the creek. Our audio recorders captured soundscapes where birdsong mixed with the sounds of the wind and the creek, or the distant noises of traffic and barking dogs. These species have lived in Chasàn Chùa since before Whitehorse was settled, and continue to call the area home even as the city has grown and human developments have encroached on these habitats.

Chasàn Chùa supports a diverse array of wildlife, but human disturbances impact how different species experience the creek. Some species appear to benefit from proximity to housing and road developments, while other species appear to avoid these areas. Our study gives a clearer picture of what these tradeoffs look like, but there are many questions our study could not address. Many of these are questions of values, like how to feel about human disturbances that advantage one species over another. It is up to people and policy makers to reflect on these dynamics as the creek's future is mapped out.

These are critical years for Chasàn Chùa. Upcoming decisions will determine how the creek is protected, and whether it stays connected to the its surrounding habitats. How we address Whitehorse's transportation challenges will determine how crowded the roads around Chasàn Chùa are, and whether wildlife can safely pass. How the Yukon resolves questions of mining development near communities will impact the ecological, recreational and cultural values that the creek holds. Whitehorse's slogan is the Wilderness City. It's fitting for a city nestled among mountains and rivers, where wildlife wander within the city's limits. Safeguarding Chasàn Chùa is key to maintaining healthy relationships between us and wild spaces.

Image: A Spruce Grouse crosses one of the many ski trails in the Chasàn Chùa area. Photo by Malkolm Boothroyd.

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Involving the community in data collection was one of the goals of the project, and we are grateful to the many volunteers who joined us to count wildlife tracks and set up trail cameras. Many people volunteered to help with field work, including Heather Ashthorn, Dustin Elliott, Tom Lips, Samuel Temidayo Osinubi, Rob Ridgen, Colin Abbott and the ACES class, Andy Preto and the Porter Creek Secondary WILD class, and Terry Milne and the Experiential Sciences class. Working so with many volunteers brought CPAWS Yukon closer to the community, and hopefully helped bring the community closer to Chasàn Chùa. We were happy to see how much people connected with the camera trap photos we shared on social media, and to hear these images brought up in the Yukon Legislative Assembly. We also hope that the project inspired people, especially the young people we worked with - and we hope that wading through waist deep snow with clipboards for hours didn't put anybody off fieldwork!

Image: Our study was made possible by dozens of volunteers, including many who wallowed through the snow for kilometres to help us count mammal tracks. Photo by Maegan Elliott.

## Author contributions

This report was written by Malkolm Boothroyd (MB) and Maegan Elliott (ME). Literature review was by MB and ME, with support from Gergana Daskalova (GD). GD wrote the data analysis section, and provided comments on each of the four drafts of the report. MB, GD and ME all contributed to the study design, along with the people included in the acknowledgments. ME coordinated the fieldwork. GD conducted the main data analysis and wrote the code for most of the report's figures. MB conducted additional data analysis and data visualization. MB designed the report's layout.

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