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Wildlife Monitoring of the Sea to Sky Gondola

As humans expand into wildlife territory, we have the potential to change the way animals interact with their environment. Behavioral changes can take different forms, such as shifting an animals' home range, the time of day that animals are active, or causing animals to avoid certain areas of human activity. Both bobcats and grizzly bears have been found to shift their home range in response to human development and activity (Chester 2014; George and Crooks 2006; Gibeau et al. 2002; Riley 2006). In a study on co-existence of wildlife and humans at close spatial scales, tigers in Napal's Chitwan National Park altered their behavior in order to avoid temporal overlap with humans (Carter et al. 2012). Grey wolves have displayed third avoidance strategy, through strongly avoiding areas of high human activity and high trail density (Whittington, St. Clair, and Mercer 2014).

While behavioral changes are not always detrimental to individuals directly, numerous studies have suggested that seemingly harmless changes can indirectly compromise the health of wildlife populations. For example, both bobcats (George and Crooks 2006; Riley 2006) and grizzly bears (Gibeau et al. 2002) altered their movement in time and space in response to human recreation. While adult males and young animals of both sexes, from both species, were less sensitive to human disturbance, adult female bears and bobcats were disproportionately affected. Increased stress on mature females suggests that human disturbance could have indirect impacts on the future health of bear and bobcat populations. Long-term wildlife monitoring is the only means to monitor these changes.

The overarching goal is to establish long-term wildlife monitoring, as a means to explore how current changes may influence wildlife populations in the future. The first step of a long-term monitoring project is to collect a baseline of data for future comparison. Changes in wildlife behavior can be studied using only a baseline, by comparing areas of high and low human activity. Differences between these areas can be used to predict the ways that animal behavior is being impacted in the present. Acknowledgement of current behavioral patterns can be used to mitigate human-wildlife conflict in areas of increased human activity.

As a mountain community, Squamish is known for its outdoor recreation opportunities, as well as for its abundance of wildlife (Toom, 2012). Squamish is one of the fastest growing populations in British Columbia, with a growth rate of 15% over 5 years (District of Squamish, 2014). Given the increasing local population and the avid tourism industry, the likelihood of humans expanding into wildlife habitats also increases. Squamish has seen increased numbers of wildlife sightings and encounters, possibly because recreational activities bring more and more people into close proximity with wildlife (Toom, 2012). The use and development of Crown Land for outdoor recreation is frequent throughout the region, and has the potential to negatively impact wildlife through introducing human traffic in remote areas. It is unclear how increasing human presence is affecting wildlife populations because there is nothing in the current laws that demand monitoring of how we may be impacting wildlife.

Although there are many other recreational uses of Crown Land, they are generally more dispersed throughout the front and backcountry and increases slowly over time. The development of the Sea to Sky Gondola introduced a rapid influx of human activity to a relatively small and previously less disturbed area. Federal and provincial laws are in place to ensure that the construction of such a project will not have significant adverse effects on the environment, through environmental assessments. However, there is no system in place to monitor how human presence may impact wildlife in the effected area. For this reason, the gondola provides a unique research opportunity. Through facilitating access to new recreational terrain, the Gondola introduces regular human traffic into previously remote wildlife habitats. The gondola provides a unique opportunity to study how animal behavior may be influenced by increased human activity, which would be more difficult to observe in areas were recreation is more dispersed.

In order to answer this question, I conducted a wildlife-monitoring project surrounding the Sea to Sky Gondola development. The goal of my research was to create a baseline of data for long-term wildlife monitoring in the area and explore ho human presence is impacting wildlife behavior. In order to achieve these goals, I posed the following questions:

(1) Does animal presence depend on human presence?
(2) Which areas are hotspots for predator activity?
(3) How do species observed compare to estimates of the environmental assessment?

Methods

Study Area

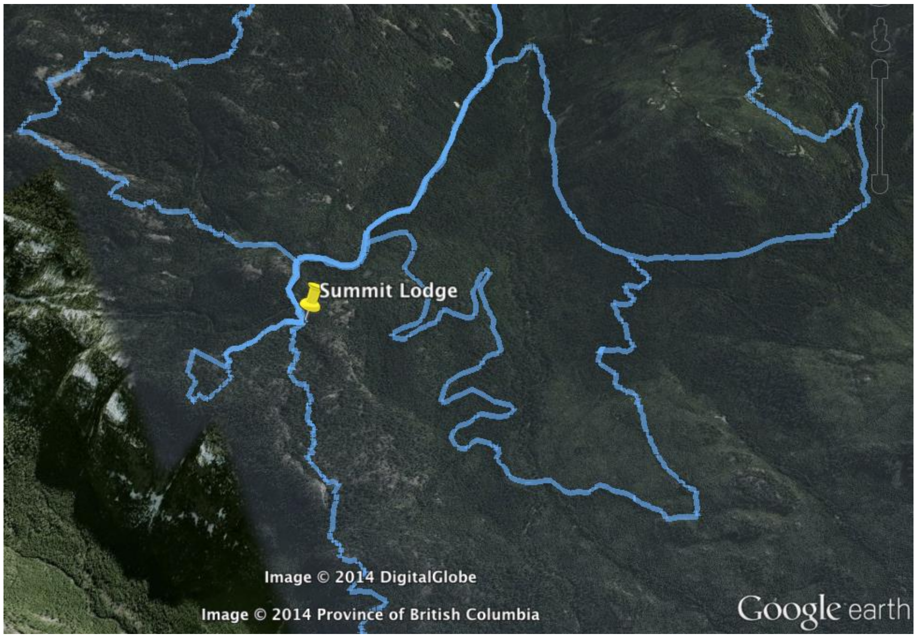


Figure 1: Map of the study area, surrounding the Sea to Sky Gondola Summit Lodge.

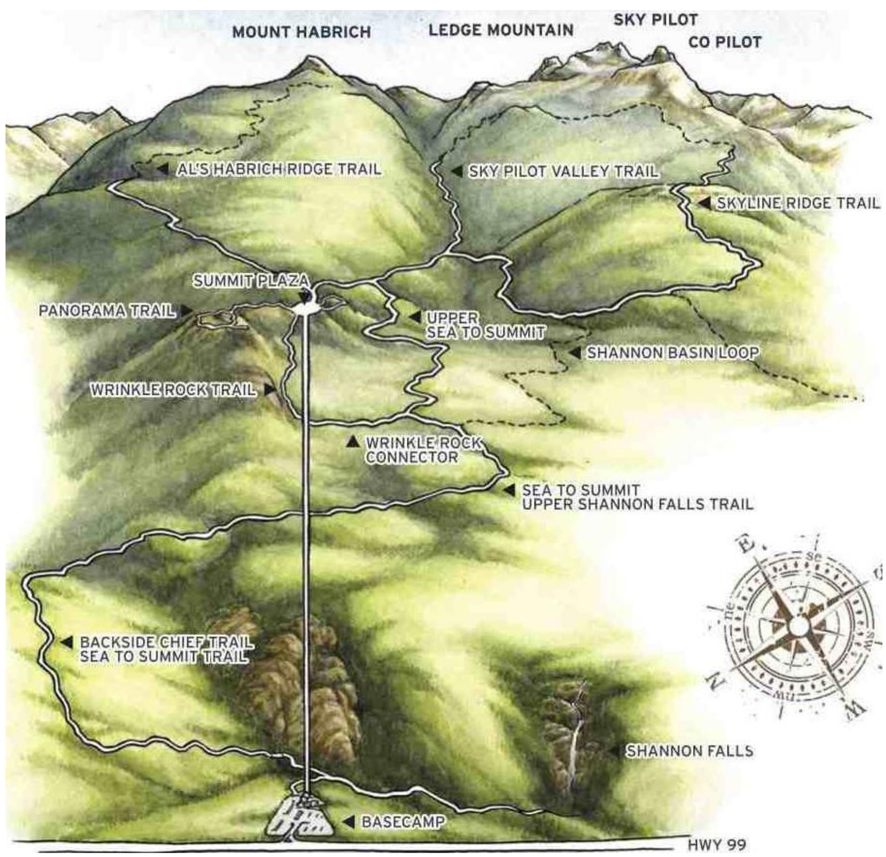


Figure 2: A labeled trail map of the Sea to Sky Gondola, excluding the Evac Route (STSG, 2014).

The study area surrounds the Summit Lodge of the Sea to Sky Gondola (Figure 1). While the base of the gondola is located within the Stawamus Chief Provincial Park, the study area begins at the upper park boundary. It includes the 6 main hiking trails: Panorama, Wrinkle Rock/Evacuation Route, Sea to Summit, Al Habrich's Ridge, Skyline and Shannon Basin Loop (Figure 2).

Wildlife Monitoring

Wildlife Camera Traps

Using 8 Moultrie M990i game cameras, I found animals on trails and collected data on factors that may influence their behavior. Camera data was used to compare when an animal was present, and the factors that may have contributed to the presence or absence of the animal at that place and time. These factors included the time of animal presence, human traffic before or after it was sighted and details like the use of bikes or the presence of domestic dogs. The cameras are equipped with both motion sensing and infrared technology, and a motion detection range of up to 50m. The cameras produce no sound or light, and therefore should not influence wildlife behavior in any way. I programmed each camera to operate 24 hours/day using the FastFire Photo setting and a five second trigger delay (waits 5 seconds once first photo triggered before taking a second). Every photo taken was imprinted with an information bar, which records the date, time, temperature, moon cycle and camera ID.

Cameras were placed along the 6 main trails surrounding the Summit Lodge, and at the junction between the Evacuation Trail and Sea to Summit Trail. Camera placement began close to the Summit Lodge and radiated outwards with each new placement. Each placement was chosen with the aim of locating wildlife, rather than following a regular sampling scheme for the entire area. Cameras were moved under three circumstances: (1) two battery cycles without any wildlife sightings, (2) animal scat was found on the trail and (3) a wildlife sighting was made on the trail. Using scat and sightings as indicators, I located areas where wildlife was active. Once a camera captured wildlife, I did not move the camera.

I checked on cameras at least once a week. Each check included: (1) check battery life and change if needed, (2) remove SD card, download photos and empty card, (3) quickly scan through photos to identify any issues with camera position and (4) check that motion sensor is functioning by triggering a photo. The cameras recorded a total of 2,436 hours worth of data, from May 22nd to September 1st, 2014. During that time, 56,301 photos were taken of both humans and wildlife. Wildlife data included date, time, species and any notes regarding size, color or other features of animals. Human data included the date, time, number of individuals, recreation type (foot, bike, motorbike, quad or vehicle) and number of dogs. Individuals that were captured within the same minute but in different photos were considered as a part of the same group.

As with any remote data collection, there are a number of confounding variables with using wildlife camera traps. First, there is no way of knowing if the cameras failed to capture any animals or humans. Second, due to the fact that I was limited in time and resources, I did not use a regular sampling scheme for camera placement. Cameras were placed in order to ensure that they would capture the most animals as possible, based on the indicators mentioned above.

Field Observations
In addition to the wildlife camera trap data, I used ongoing field observations to collect data on wildlife. Through wildlife encounters and tracking animal scat, I was able to add a number of animals to the overall species list that were never captured by cameras. Wildlife encounters provided data on the date, time and specific location where an animal was present. Scat also provided the location an animal visited, but does not provide specific date or time. Scat was inspected and photographed in order to carefully identify the species.

Given that I was unable to be in the field everyday, I asked the gondola staff to report any wildlife encounters for both staff and visitors. Reports included the date, time and specific location of encounters, as well as descriptions of the animal. In cases where all necessary information was provided, I incorporated the sightings into my data.

Bird Census
Species List
Ongoing field observations of birds contributed to the creation of a species list and relative abundance counts for the entire study area. All of the data collected came from my personal observations and eBird, which is a public database for sharing and compiling bird-sighting data for specific locations. Thanks to the help of Chris Dale and a group of local birders from the Squamish Environment Society, I was able to log bird activity for 56 days. A total of 52 species have been identified within the study area.

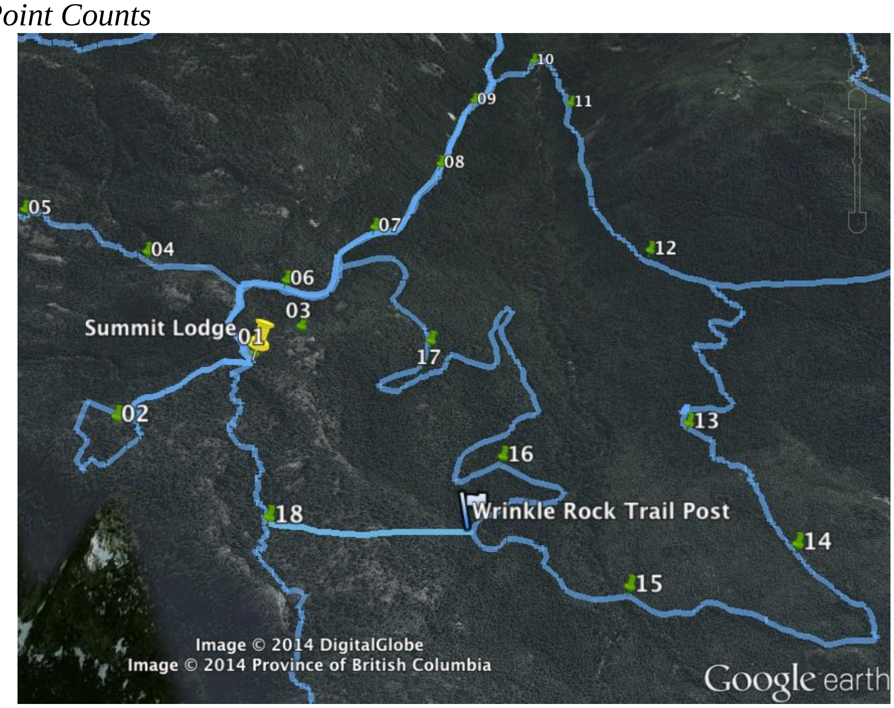
Formal Point Counts


Figure 3: Map of the study area, displaying the 18 fixed monitoring units along main trails.

In addition to ongoing field observations, I conducted formal point counts across the study area. In addition to informing the species list, a second goal was to survey spatial

bird data and create a snapshot of how species and individuals are dispersed within the study area.
The study area was divided into 18 monitoring units, spread every 450m along each of the trails, for regular surveys of both birds and vegetation (Figure 3). I followed the point count method outlined by Gregory et al. (2004) as well as Thompson and Schwalbach's (1995) review of point count methods. Each monitoring unit was 60 square meters in size, centered upon the trail or road. Point counts were conducted during the morning chorus, which began at 6:00am and continued until 9am. Upon arriving at each plot, I allowed birds to settle for 2 minutes, before conducting a 5-minute point count. During the count, I counted all individuals seen or heard within the 60m square plots. Any unidentifiable species were counted, and vocal or physical features were noted for later analysis. The additional data collected for each plot included date, start and end time, plot number, temperature and weather conditions.

Habitat Mapping

Field Observations

The majority of the 80 plant species found within the study area were observed through random field observations. It was an effective method to create the most complete species list possible, as many species can be missed through sampling smaller sections of large plots, as representative of an much larger study area.

Plot Surveys

In order to survey plant species evenly throughout the study area, and establish plots of vegetation that could be associated with bird point count results, I randomly sampled portions of each 60m square monitoring unit (Figure 3). Each monitoring unit was divided into four 30m square transects, numbered 1 to 4 by placing #1 on the Northwest corner. Within each transect, three 2m square plots were selected for vegetation sampling, with a total of 12 for each monitoring unit. Sample plots were selected by generating two random numbers between 1 and 30, the first providing the North/South distance in meters and East/West for the second. I began at the center of the monitoring unit for each measurement.

Selected plots were assessed by creating a plant species list, counting the number of individuals per species and assessing the percent cover of three vegetation types: ground, mid-level (> 2ft tall) and trees. Any selected plots that included part of the road/trail were excluded, in order to optimize the efficiency of sampling vegetation. The area of road/trail within each monitoring unit was measured. Due to large changes in elevation throughout the study area, some portions of monitoring units could not be sampled safely. In such cases, the area not sampled was measured and included in results.

Evacuation Route Monitoring

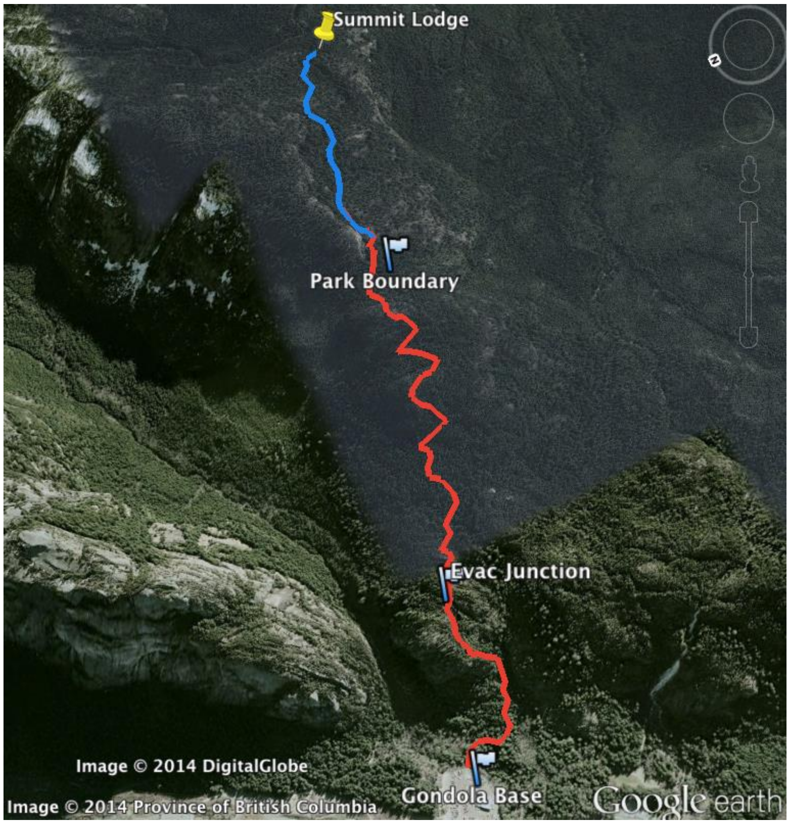


Figure 4: A map of the evacuation route for the Sea to Sky Gondola, displaying the Evac Junction site. The established portion of the trail is highlighted in blue and the un-established trail is in red.

The Evacuation Route is the fastest and most difficult path to the Summit Lodge (Figure 4). Beginning in Shannon Falls Provincial Park, the unofficial trail follows closely under the gondola. The trail is not advertised BC Parks or the gondola, but the public does use it to some extent. BC Parks asked that I monitor the established portion of the trail to indicate whether it has enough traffic to be established as an official trail to the Summit Lodge. First, I placed a camera at the Evac Junction, where the Sea to Summit Trail and Evacuation Route intercept (Figure 4), capturing photos of people hiking in both directions. The camera was moved after two battery cycles, due to the fact that many people were stopping at the junction triggering a large number of photos. Second, I divided the established portion of the trail into two sections, below and above the junction, and placed a camera along each for two weeks.

Data and Hypotheses

Does animal presence depend on human presence?

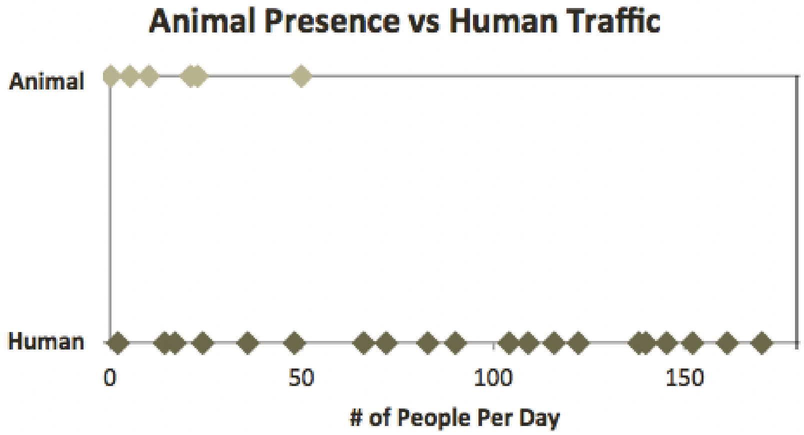


Figure 6: A prediction of the relationship between the number of people on a trail per day and animal presence. Each data point represents a camera day and animal sightings are paired with the number of people present on the day it was sighted. Unpaired data points demonstrate days were there were only people on trails. Animals are present on days of low human traffic.

Hypothesis: Wildlife movement is affected by human presence (Figure 6). Animals are less active in areas of high human presence, and may alter home ranges to avoid these areas. A variety of species have been found to alter movement patterns in relation to human presence, such as bobcats, coyotes, grey wolves, and grizzly bears. George & Crooks (2006) found that bobcats, and to a lesser extent coyotes, exhibited both spatial and temporal displacement in response to human recreation. This was especially true for bobcats, for which the negative association with human activity was most evident for hikers, bikers and domestic dogs (George and Crooks 2006). Adult female bobcats are most sensitive to development, and began forming smaller home ranges in surrounding effected areas (Riley 2006). Whittington, St. Clair and Mercer (2014) found similar behavior in Grey Wolves, where high-use trails and roads were strongly avoided. Wolves also avoided areas of high trail and road density, regardless of trail use, which had a cumulative effect on wolf movement. Finally, Grizzly Bear behavior changes in relation to both development and human recreation. Mace et al. (2014) found that bear movement around roads was not random in relation to traffic levels. There was a threshold of human traffic that caused changes in bear movement. Chester (2014) observed that during the hiking season, Grizzlies exhibited a migration in elevation to avoid human recreational traffic. While the responses of species mentioned to human disturbance vary, it seems likely that human presence is having an impact on the movement of animals inhabiting the study area.

If the development of the gondola and increased human presence in the area is impacting animal movement, it is important to understand and attempt to mitigate said impact. Firstly, Gibeau et al.'s (2002) study on bears and Riley et al.'s (2003) study on bobcats found that adult females are disproportionately affected by human disturbance. These findings suggest that human disturbance could have an indirect impact on the health of populations in the long-term. Secondly, Frid & Dill (2002) propose a theory that suggests that human disturbance stimuli may be analogous to predation risk for some species. If so, human disturbance would have direct impacts on individuals, through habitat selection, vigilance, fleeing and parental investment, as well as indirect effects on populations and communities. Lastly, changes in animal home ranges could cause animals to move into other areas, such as the Provincial Parks that neighbor the study area. In that case, it would be important to identify such movements in order to inform BC Parks personnel and visitors.

What times of day are animals active on trails?

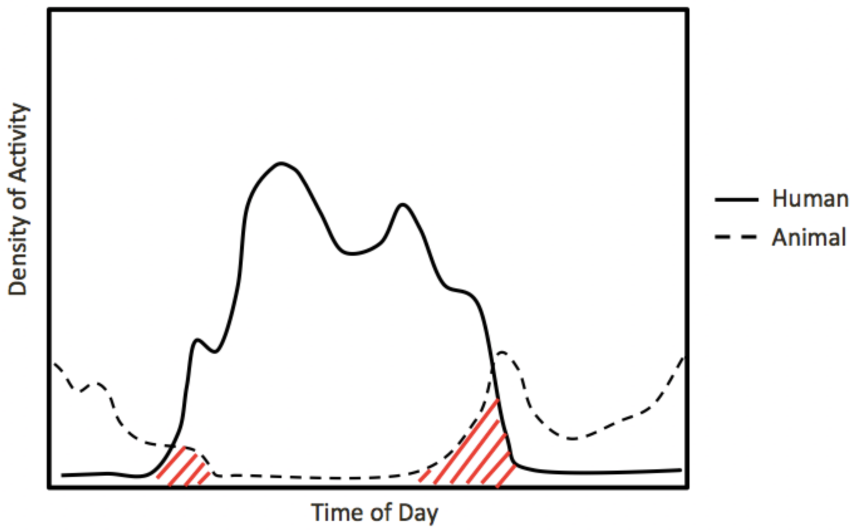


Figure 5: A prediction of the times of day during which animals are active on trails, compared to the total human traffic on the same trails. Animals are mostly present during the night and early morning.

Hypothesis: Animals are most active on trails night, and more specifically during hours of low human traffic (Figure 5). I also predict that sighting times are more varied in areas of low human traffic, that are further from the gondola development. Both Riley et al. (2003) and George and Cooks (2006) found that coyotes, bobcats and deer are most active at night near areas of human development and high human traffic. Gibeau et al. (2002) found similar patterns in grizzly bears, utilizing high quality habitats close to roads and trails while humans are inactive or avoiding the area completely for habitats of lesser quality. In a study of the coexistence of humans and tigers at close proximity in Napal, Carter et al. (2012) found that tigers altered their behavior in order to reduce overlap with human presence (Figure 4). It is important to know when animals are most active, on trails in particular, in order to inform visitors of potential risks, and identify any behavior that may increase the likelihood of human-wildlife conflict. If animal behavior is shifting as they did in the tiger study, it suggests that peaceful coexistence between humans and wildlife is likely.

Does bird species composition/abundance depend on habitat type or features?

Hypothesis: Bird species composition and abundance is related to habitat type and features, such as roads or trails. Wolf, Hagenloh and Croft (2013) found that high-use of trails had a negative effect on individual abundance of birds, but that the degree of impact was directly related to surrounding vegetation. Areas with well-developed shrub and tree layers sustained higher species abundance and richness, with little to no negative impact from trail usage (Wolf, Hagenloh, and Croft 2013). Certain species are associated with occupying areas close the forest edge, such as the side of roads and trails (Wolf, Hagenloh, and Croft 2013). Hutto et al. and Keller & Fuller (1995) all found that habitat changes associated with roads and trails were less pronounced with smaller secondary and tertiary roads. Therefore, it is likely that there is a relationship between road/trial size and the composition or abundance of bird species. The ways in which birds relate to vegetation and trails is an important indicator for how bird populations may be impacted by any further development in the study area. This information can also inform how the gondola designs and constructs new trails or maintains old trails, in order to accommodate birds' habitat requirements.

Species Lists

The creation of a species list is important for two reasons. First, a species list is an essential part of creating a baseline of data for the study area. It demonstrates what species are present now, but also provides a means to observe changes in species diversity and composition over times. Second, a species list that is grounded in field observations and formal data collection can be used to evaluate environmental assessment methods. If the models used to estimate the species within the study area are appropriate, the estimated species list should overlap closely with the ground-truthed list. If there are discrepancies between them, it suggests that environmental assessment methods are not appropriate for predicting what species are present. Analyzing any differences in between my species list and the estimate could identify ways in which assessment methods may be altered in order to optimize the accuracy of results.
The environmental assessment estimates species lists of birds, mammals and amphibians/reptiles, but do not estimate plant species. I collected enough data on birds on differences between my species list and the estimate. Exciting preliminary results show that the estimate predicted 38 of the 52 species found, and an extra 13 species that have not been observed in the field.

Recommendations

Sea to Sky Gondola

I recommend that the gondola continue cataloguing data on wildlife sightings. While it will provide less data on animal behavior, any data on the movement of animals throughout the year will be useful for future monitoring of the area. Wildlife data will also inform any hotspots of animal activity that may change over time, and can be used to inform visitors of potential risks for wildlife-human interactions.

Future Research

1. Place cameras using a regular sampling scheme. It will allow for more questions to be answered through the data, such as spatial rather than just temporal questions about animal presence and absence.
2. When placing each camera, measure a grid covering the area within the cameras view. Use a large ruler, measuring height across the grid so that the size of any animals captured in a photo can be estimated accurately.

3. Lock cameras as firmly to trees as possible. I encountered one instance of an individual rotating my camera to face the forest, rather than the trail. I lost days of data. Attempt to mitigate this issue so that cameras cannot be rotated or moved from the desired position.
4. Ensure that any plants or debris surrounding a placed camera will not be able to compromise vision, even if blown out of place by wind. Weather conditions can cause unavoidable obstruction of vision. Objects within the cameras vision that move will cause the camera to take a lot of unnecessary photographs, and will drain the battery.
5. Check cameras as frequently as possible, even if photos are not downloaded every time. It is the best way to ensure that no data is lost due to unforeseen circumstances.
6. Follow the methods of the Squamish Bird Count. Divide the whole study area into polygons, and attribute all daily bird sightings to a polygon. Create a clear map and distribute to local birders, and hope they are willing to use when reporting observations. That way, you can say much more about the daily bird observations and use that data to answer spatial questions. This may require more organization than simply sharing data through eBird, given that individuals are reported as how many of each species are observed in total.

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