Can photograph identification be a useful tool in the identification of Bighorn Sheep (*Ovis canadensis)* at the Kootenay Pass Feeding Station, British Columbia*?*

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1. Abstract

The use of photo-identification has been applied to marine mammals such as sea otters (*Enhydra lutris*), Humpback whales (*Megaptera novaeangliae)* and have been applied to Polar Bear (*Ursus maritimus*). Photo identification is the method of taking photographs of a universal marking on a species and using those to identify members of the herd or grouping without being invasive. With the photographs that are begin collected by these studies, researchers can compile these into a database and all researchers would be able to have access to these photos for identification in the field. I wanted to use this method of identification on Bighorn sheep (*Ovis canadensis*) and determine is this method can be used on wild herds, as well as a way to monitor a species population from a distance. The use of photo-identification on Bighorn sheep will require taking photographs of the rumps and the heads of each member of the herd that is located at the Kootenay Pass feeding station. This herd have been coming to the station for about 40 years and they have become accustom to having humans near, which makes this herd a perfect subject for this study. By testing this method on this herd, we can determine if this technique of identification can be used on wild herds and different species in the long run.

2. Acknowledgements

I would like to thank the following individuals for their assistance and guidance throughout this research project. I firstly would like to thank my research partner Sarah Beaudoin and my faulty advisor, Lui Marinelli. Secondly, I would thank to say thank you to my applied Research professor Brenda Beckwith for her writing guidance and knowledge. The last group I would thank to acknowledge would be the Nelson District Rod and Gun Club for their hospitality at the Kootenay Pass Feeding Station.

3. Introduction

The identification of specific animals in a herd or pod has been difficult for wildlife researchers due to the lack of reliable methods and techniques. Depending on the species, there have been tactics used such as collars, tracking chips, tagging, and tattoos to mark and identify wildlife (Anderson et al. 2010). These methods were commonly viewed by the public, and other researchers, as invasive. When putting tracking equipment on animals, technicians usually have to sedate the animal which can cause medical complications and, in some cases, even death (Anderson et al. 2010). For example, internal trackers can cause damage to the internal organs when they are implanted, tattoos can get infected, and collars can get stuck on tree branches and snares (Anderson et al. 2010). Using more non-invasive approaches, such as the use of unique

animal markings for identification, can monitor animal health and give researchers opportunities to leave the animals undisturbed for study purposes.

The use of photo-identification strategies began appearing in marine mammal studies over the last 20 years. Studies that have used unique markings on animals include the observations of scaring on the noses of sea otters (*Enhydra lutris)* and spot patterns on the shells of leatherback sea turtles (*Dermochelys coriacea)* (Gomez-Salazar et al. 2011). In 2006, Adam et al. (2006) used markings on the tail and dorsal fins of bottlenose dolphins *(Tursiops truncates)* to identify individuals of the pod. Scaring and coloring on the trunk of the body in most marine mammal species are used to determine the correct identification. Computer algorithms and databases are being created to cross-reference the images to identify a specific member of the species (Adam et al. 2006). Speed et al. (2007) determined that the use of computer algorithms can significantly increase the positive matches in identifying individual species. One challenge in using computer-based programs, according to Speed et al. (2007), is ensuring the photograph is taken in the correct lighting and has the proper spacing and camera angles. A false identification can result if the image is not in the correct angle or light. (Speed et al.2007).

Building on the success of marine mammal photo-identification, researchers are starting to implement these methods with land-based animal species. For example, Anderson et al. (2010) cross-referenced photographs showing spot and whisker patterns on polar bears *(Ursus maritimus)* to identify individuals using face recognition software. Although there is little documented information about bighorn sheep (*Ovis canadensis*), the species has distinguishable rumps that could be the main marker in identification, although scars and noticeable marks on the horns can also be considered as unique features.

A feeding station was located in the Kootenay Pass area of British Columbia was created over 40 years ago to influence the behavior of a local herd of Rocky Mountain bighorn sheep and keep them from crossing the highway and to monitor the health of the herd members. Bighorn sheep are known to stay in mountain areas with grassy slopes, alpine meadows, and rocky cliffs. A feed station can persuade the bighorn sheep to remain in their natural habitat and can hopefully help with increasing the current number of members in the herd. This feeding station is also open to the public, which can help organizations and researchers raise awareness about bighorn sheep and wildlife in general.

The bighorn sheep arrive at the feeding station at the start of each winter and are fed three times a week by local volunteers from Nelson and Salmo and wildlife organizations in the area. According to records taken by volunteers, the herd had a population of about 30 bighorn sheep about 40 years ago but, currently, there are only 15 that are present.

In my research project I will determine the viability of applying more photo-identification studies to land mammals by tracking the bighorn sheep herd through observations of their markings. All the photos in this research paper, I have taken personally unless credited otherwise. To address this research goal, I will conduct the following objectives:

- Use repeat photo-identification to identify members of the bighorn sheep population at the feeding station.
- Determine if universal markers on animals can be used for identification,

4. Methods

4.1 Study Site

The feeding station is located on Highway 3, on the west side of Kootenay Pass approximately 10 kilometers from Salmo, British Columbia (BC). The Kootenay Pass feeding station is at approximately 1775 meters in elevation and in the Interior Cedar Hemlock dry and warm (ICHdw1) Biogeoclimatic Ecosystem Classification (BEC) Unit (Mackillop and Ehman 2016). This area is known to have cold temperatures and measurable amount of snow in the winter (Avalanche Canada.2020). The dominant tree species in this area are lodgepole pine (*Pinus contorta*), Douglas-fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*). Mammals that inhabit this area are mule deer (*Obocoileus hemionus*), cougars (*Puma concolor*), and coyote (*Canis latrans*). The feeding station is positioned about 200 meters above the highway following the trail on the north side of the highway. The trail from the road to the feeding station is about 150 meters in length.

4.2 Data Collection

Prior to collecting field data, my research partner and I reviewed and collected information based on similar studies on photo-identification methods. We also meet with our faculty advisor, Lui Marinelli, who has extensive experience in wildlife and methods for identification. This gave us

insight on how to correctly take photos of the animals, and successful identity each member of the herd every week.

My research partner, Sarah Beaudoin, and I scheduled our field collection days to occur on every Saturday of the winter season starting on December 28, 2019 and containing until February 8, 2020. We chose Saturday mornings at 10:00 am because this is one of the scheduled feeding days, and it gave us a longer period of time to collect the photographs compared the weekday feedings and managing classes. The drive to the feeding station did pose a challenge on some of the days, due to road closures or unsafe driving conditions. After arriving at the highway pullout, we then accessed the site on foot by following the set trail to the station.

After we feed the sheep, we started collecting photographs using two cameras. We singled out the most distinctive members and documented these first. For example, the rams were photographed first because there were only two of them and one of them was collared, making it easy to tell the difference between the two. The herd is wild so they did show signs of stress and fear when we were moving around, but they did get used to our presence after some time. We designated tasks between the two of us to ensure we didn't miss anything as well as reducing the human factor on these sheep. In regards to reducing the human factor on these sheep, we don't want this herd to grow too comfortable with people because that can cause higher issues with roadkill, hand feeding and petting these wild animals. We had two cameras between us so Sarah stayed on one side of the herd, and I was on the other, and we communicated throughout which herd member we took photos of and which ones we still needed. We collected photos of the rumps and heads of each member. We started with the rams, then worked on the four lambs that were present and then moved to the eight ewes. The ewes were more of a challenge to take photos of because many of them are similar and they move around a lot more compared to the rams and the lambs. One of the ewes was collared as well, and this was where we started when taking photos of the ewes. We left the site after we were confident that all the members of the herd were documented.

During the following week we would compare the photos working though the sheep in the same way as we did in the field; the rams were matched first, then the lambs, and then the ewes. Unique file names were created to accurately document each bighorn sheep and was added to a Microsoft Excel spreadsheet to summarize the data for each of the weeks. The first week that

we compared the photos, we used photos taken from previous years to determine if the sheep during the 2020 season match the ones documented in the past.

5. Results

5.1 Data Analysis

After each of the field days, we planned a day of the week to sit down together and go through the photos from each week and match the rumps to each of the heads. There were a couple weeks where a there was one or more sheep absent, and there was a day where some of the rumps didn't get photographed. At the end of the project, we used data and photographs from prior years to determine if there were members of the herd present for more than one study period. We did find that working with two cameras during the field collection, ensured that most or all the sheep would be photographed and documented. We collected data every Saturday over six weeks from December 28, 2019 to February 8, 2020.

How many in herd and relative breakdown were first. There were 8 ewes (57% of the herd) that were documented throughout the study period (Table 1). Because we already had the understanding that there were 8 ewes, 2 rams and 4 lambs, we could notice if one was absent. All ewes were absent on 02.01.2020, but they returned to the feeding station in the next week. Although we found that, as we moved through the study weeks, the ewes were becoming much easier to identify, there were multiple ewes that looked very similar and we had to use more of the horn shaped or facial marking to determine the correct herd member.

There were only two rams in the herd (percent of total) and one of them was collared and tagged (Ram 2) (Table 2), making their identification quick. one of the rams was at the station during the site visit when no ewes were present.

There were four lambs that were present during majority of the field study period. These lambs were young, and they were easy to identify because each lamb on had a specific horn pattern and different sized and proportioned bodies. These lambs were found to be more anxious when we were around, making the photographs blurry at times, causing the identification process at the office to be harder.

Comparing our photographs to those taken in the previous year, we found multiple matches between the photographs, namely there were lambs photographed last year that are now ewes during our research project. When comparing previous data to our data, we used the number system that they went by due to we knew what our sheep looked like compared to the herd members during the past years. The ewes did show come difficulty in correctly identify in regards to there was nine in the past study year and our year only had eight (Table 3).

In addition, there were four rams in the past year compared to this year where there was only two (Table 4). 2 out of 4 of the rams were collared during the 2018/2019 study period and we only had one collared. The lambs had the same number during both of the study periods (Table 4).

6. Discussion

6.1 Interoperating the data

Through our research we were able to show that bighorn sheep can be identified with the photo identification tool. With using the rumps as identification tools, we are looking at the pattern of the brown marking going down the center as well as the size of the white patch that can cover a small section of the back end or a large portion and down to the legs. It became easy to identify the sheep in the field because we (1) compared the photos taken each week and, (2) compared the photos to the herd on site. The differences between the herd members much easier to observe as the study days continued. We were able to positively identify the rams because there were only two of them present in the herd and both rams had unique marking on the rump sections. Furthermore, one of the rams had unique scaring on the face (Figure 1) and the other ram was collared with a GPS tracking box (Figure 2). After looking at the photographs that were taken last year, and using the key marking and features associated with each ram, we can say with certainty that the rams identified in 2019 were present in the herd in 2020.

The ewes were all similar in size making their identification more challenging. One of the ewes was collared and tagged. As with all the sheep we looked for noteworthy and obvious markings on the rumps to aid in identification. My research partner and I, for example, noticed that one of the ewes had a shape of a standing bird on the rump (Figure 3). However, for many of the sheep, the patterns on the rumps were not enough for a positive identification. We also targeted the head and horn patterns. One ewe had a very straight pair of horns, which is

uncommon. There were three ewe that looked very much alike the rumps were similar in shape and size and the heads had similar marking and horn lengths. We usually saved these ewes for last because it was more of a "process of elimination" to correctly identify them. We correctly matched these three members after all the pictures were taken and we compared the photos to the previous weeks.

There were four lambs present and they were all very similar in size and horn length. The rumps on these lambs did have a large amount of fur which made it seem like the rumps were constantly changing through the field season. The increase in snow would build up on the backs of the lambs and cover some of their rump as well as when the lambs were wet it affected the looks of the rump patter. We found that the use of their heads played a key role in the identification of these members. My research partner and I did notice that one lamb seemed to have a "happy" facial expression during all the weeks of our survey, and this lamb was correctly identified each week with photos and in the field by tracking his "smile." (Figure 4). We found it easier to find a key characteristic on each lamb that we could associate to an object or mood and although this wasn't the scientific way that we wanted to use for this project, it helped us in correctly identifying each of these four, and it helped us study the rumps more because we already were able to match these lambs to the pictures each week by just the heads and their behavior.

To ensure that we correctly identified each member of the herd at the end of the field period, we compared our results to the results of the previous researchers. We did understand that there are going to be different members each year, but we did have two rams, six ewes and 2 lambs that were present during the 2018/2019 research year and the 2019/2020 research year. The rumps and head between the members that were present during these two years didn't change at all between the years, and all the photos that were compared matched to the same ones that we had positively identified.

7. Conclusion

Photo-identification is a useful method in identification of many species and this method is growing and adapting with each study that has used it. This study that was conducted on Bighorn sheep and my research partner and I found that it was one of the best and effective ways of monitoring the herd throughout the winter months when they are at the feeding station on

Kootenay Pass. Being able to test our theory on photo-identification on the Rocky Mountain Bighorn Sheep herd showed us that it is possible to use this method on the sheep and the next step would be to conduct this study from a farther distance with wild herds.

There were a handful of limitations for this study and the main one was the traveling to the site. There were days when the roads were closed due to unsafe conditions and there was a day when one of us had vehicle complications that limited our time and myself getting to the station. Other limitations were not having extra batteries for a camera to take the photographs, or when they malfunctioned due to the cold weather.

At the end of the study we have recommendations for future studies that relate to photo-identification. For the limitation with driving and mechanically issues that occurred, carpooling and traveling with other researchers can help reduce that limitation. The other main limitation that we had was malfunctions and battery deaths of the cameras. The main recommendation that my research partner and I can make would be to have an extra camera and multiple extra batteries in the field.

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Table 1: Ewes present at the Kootenay Pass Feeding Station, from December 28 2019 to February 8 2020.

Field days	Ewes Present							
	1	2	3	4	5	6	7	8
12.28.2019	yes	no	yes	yes	yes	no	yes	yes
01.11.2020	yes	yes	yes	yes	yes	yes	yes	yes
01.18.2020	yes	yes	yes	yes	yes	yes	yes	yes
01.25.2020	yes	yes	yes	yes	yes	yes	yes	yes
02.01.2020	no	no	no	no	no	no	no	no
02.08.2020	yes	yes	yes	yes	yes	yes	yes	yes

Table 2: Rams and Lambs Present during the field study weeks at the Kootenay Pass Feeding Station

Field days	Ram Present		Lambs Present			
	1	2	1	2	3	4
12.28.2019	yes	yes	yes	no	yes	no
01.11.2020	yes	yes	yes	yes	yes	yes
01.18.2020	no	yes	yes	yes	yes	yes
01.25.2020	yes	yes	yes	yes	yes	yes
02.01.2020	yes	no	no	no	no	no
02.08.2020	yes	yes	yes	yes	no	yes

Table 3: Comparing Ewe members during the 2018/2019 study and the 2019/2020 study period at the Kootenay Pass Feeding Station

Study year	Ewe								
	1	2	3	4	5	6	7	8	9
2018/2019	yes	yes	yes	yes	yes	yes	yes	yes	yes
2019/2020	yes	no	yes	yes	yes	yes	yes	no	maybe

Table 4: Comparing Ram and Lamb members during the 2018/2019 study and the 2019/2020 study period at the Kootenay Pass Feeding Station

Study year	RAM				LAMB			
	1	2	3	4	1	2	3	4
2018/2019	yes	yes	yes	yes	yes	yes	yes	yes
2019/2020	no	no	yes	yes	yes	yes	no	no

Figure 1: Ram 1, unique scaring on the face (Photo: Sarah Beaudoin)

Figure 2: Ram 2, collared and GPS tracker

Figure 3: Ewe 2, rump that has a “bird” outline on the rump (Photo: Sarah Beaudoin


Figure 4: Lamb 3, seemed to have a “happy” behaviour