The effectiveness of electrified barriers to keep large mammals out of a fenced road corridor and a campground

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16. Abstract

For this project the researchers investigated the effectiveness of electrified barriers designed to keep large mammals out of a fenced road corridor (Trans-Canada Highway through Banff and Yoho National Park) and a campground (Lake Louise Campground, Banff National Park). The barriers were designed for large ungulates (e.g. white-tailed deer, mule deer, elk, moose) and large mammal species with paws (e.g. black bear, grizzly bear). The barriers consisted of steel pipes that were partially electrified. None of the white-tailed deer, mule deer, elk, moose, black bears, grizzly bears, red foxes, and coyotes that were observed on the habitat side of the barriers crossed the electrified barriers into the fenced road corridor or the campground. A black bear attempting to exit the fenced road corridor failed to cross to the habitat side of the electrified barrier. Two red foxes and one wolverine did appear to exit the fenced road corridor to the habitat side of the electrified barrier, but these three crossings were all in winter when the voltage was likely compromised because of snow and road salt. In addition, crossings to the habitat side can be considered acceptable as they improve human safety on the main highway and keep the animals from being hit by vehicles. We conclude that, although sample sizes were limited, the electrified barriers (when voltage was adequate and when not filled with snow) were 100% effective in keeping both large ungulates and large species with paws out of a fenced road corridor and a campground.

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Note that this project and report was completed after the pooled fund study had been completed. Therefore, this project and report are classified as a stand-alone product for Parks Canada.

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DISCLAIMER

This is report submitted by the Contractor. The opinions and conclusions expressed or implied herein are those of the Contractor. They are not necessarily those of Parks Canada or other Pooled Fund sponsors.

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SUMMARY

For this project the researchers investigated the effectiveness of electrified barriers designed to keep large mammals out of a fenced road corridor (Trans-Canada Highway through Banff and Yoho National Park) and a campground (Lake Louise Campground, Banff National Park). The barriers were designed for large ungulates (e.g. white-tailed deer, mule deer, elk, moose) and large mammal species with paws (e.g. black bear, grizzly bear). The barriers consisted of steel pipes that were partially electrified. None of the white-tailed deer, mule deer, elk, moose, black bears, grizzly bears, red foxes, and coyotes that were observed on the habitat side of the barriers crossed the electrified barriers into the fenced road corridor or the campground.

A black bear attempting to exit the fenced road corridor failed to cross to the habitat side of the electrified barrier. Two red foxes and one wolverine did appear to exit the fenced road corridor to the habitat side of the electrified barrier, but these three crossings were all in winter when the voltage was likely compromised because of snow and road salt. In addition, crossings to the habitat side can be considered acceptable as they improve human safety on the main highway and keep the animals from being hit by vehicles.

We conclude that, although sample sizes were limited, the electrified barriers (when voltage was adequate and when not filled with snow) were 100% effective in keeping both large ungulates and large species with paws out of a fenced road corridor and a campground.

We summarized observations and recommendations for the design, operation and maintenance of the electrified barriers, as well as the trail cameras used for the research.

1 INTRODUCTION

Parks Canada modified or installed 4 electrified wildlife guards along on/off ramps of the Trans-Canada highway in Banff National Park and Yoho National Park, and at the entrance of a campground in Banff National Park. These locations had high traffic volume (e.g. up to hundreds or thousands of vehicles per day), and medium-high vehicle speed (16.1-<72.5 km/h (10-<45 MPH)). The electrified barriers were designed to keep large mammals (especially large ungulates and black bears and grizzly bears) out of the fenced highway and a campground.

For more background information and a review of wildlife guards and electrified barriers for wildlife see Huijser and Getty (2022, 2023).

2 METHODS

2.1 Locations

2.1.1 Sunshine Road, near Banff, Banff National Park, Alberta

At this location, a non-electrified wildlife guard (5.0 m long, 10.8 m wide) was first installed in the 1980s (personal communication Trevor Kinley, Parks Canada). In August 2020, a partially electrified barrier was installed. It consists of 3 sections (Figure 1):

1. The grounding plate (approximately 50 cm wide) with strips to protect it from snowplows. This is the metal plate in front of the barrier, on the habitat side where the animals would be approaching from.
2. A section (approximately 2.2 m wide) with alternating positive (n=5) and negative (n=5) round bars. The positive bars have white insulators.
3. A section (approximately 2.2 m wide) (far side in Figure 1, this is the highway side)) with flat bars (n=11, not electrified).

The barrier was briefly fully operational 8-20 October 2020, but a snowplow damaged the grounding plate as the protective strips had not been installed yet. After that, the damaged grounding plate was removed which meant that the animals were less likely to receive a full shock (variable conductivity of the pavement) or they would only be delivered a full shock after making contact with both a positive and negative bar. The grounding plate was reinstalled (with protective strips) between 23-25 September 2021 (personal communication Dan Rafla, Parks Canada). The electrified components were hard-wired and thus “on” all the time. However, in winter, voltage measurements were usually zero or “low” (up to about 3-4 kV rather than 9 kV or higher), presumably because of shorting caused by snow and road salt (personal communication Dan Rafla, Parks Canada).

A trail camera was installed (HyperFire 2 Professional Covert IR) at the guard monitoring the habitat side of the barrier. To accommodate the heavy use of the cameras associated with the traffic volume, the cameras were customized with external power (solar panel and associated battery). In addition, high-capacity memory cards (64 GB) were used. Images from the camera between 30 December 2020 and 30 June 2022 were reviewed. However, there were periods where the memory card was full or the power was insufficient, and the camera stopped recording. In addition, the camera was only active from the end of the afternoon until the morning. Depending on the period, camera start times were 15:00, 16:00 or 17:00, and camera end times were 8:00 or 10:00. The total number of images reviewed was estimated at 837,325.

Figure 1: Electrified barrier, Sunshine Road, Banff National Park, Canada

2.1.2 Compound Road, near Banff, Banff National Park, Canada

At this location, a non-electrified wildlife guard (5.0 m long, 9.9 m wide) was first installed in the 1980s. An electrified mat was added in 2016, which was replaced with a partially electrified wildlife guard in 2020 (personal communication Trevor Kinley, Parks Canada).

The barrier at Compound Road has similar sections and dimensions to the one at Sunshine Road (Figure 2). This barrier did not receive a grounding plate (with protective strips) until 27 September 2021 – 1 October 2021 (personal communication Dan Rafla, Parks Canada). The electrified components were hard-wired and thus "on" all the time. However, in winter, voltage measurements were usually zero or "low" (up to about 3-4 kV rather than 9 kV or higher), presumably because of shorting caused by snow and road salt (personal communication Dan Rafla, Parks Canada).

Figure 2: Electrified barrier, Compound Road, Banff National Park, Canada

A trail camera was installed (HyperFire 2 Professional Covert IR) at the guard monitoring the habitat side of the barrier. To accommodate the heavy use of the cameras associated with the traffic volume, the cameras were customized with external power (solar panel and associated battery). In addition, high-capacity memory cards (64 GB) were used. Images from the camera between 26 December 2020 and 30 June 2022 were reviewed. However, there were periods where the memory card was full or the power was insufficient, and the camera stopped recording. In addition, the camera was only active from the end of the afternoon until the morning. Depending on the period, camera start times were 16:00 or 17:00, and camera end times were 8:00 or 10:00. The total number of images reviewed was estimated at 1,001,080.

2.1.3 Lake Louise Campground, Lake Louise, Banff National Park, Canada

At this location, an electrified mat was already present in 2011 or earlier (about 2.5 m long, 10.0 m wide). A partially electrified wildlife guard was probably installed in 2020 (personal communication Trevor Kinley, Parks Canada).

The barrier that was evaluated consists of 2 sections (Figure 3):

1. A section (approximately 2 m wide) with alternating positive (n=3) and negative (n=3) round bars. The positive bars have a yellow insulator.
2. A section (approximately 1.8 m wide, far side in image, this is the campground side)) with yellow round bars (n=11, not electrified).

This barrier does not have a grounding plate. This barrier has been operational, but the electricity was likely only turned on when the campground was operational in the summer months when bears are active (personal communication Saundi Stevens, Parks Canada). Note that the connecting fence is designed for black bears and grizzly bears and not for ungulates. Ungulates can jump this fence and enter or leave the campground anywhere, regardless of whether the electricity is turned on or off.

Figure 3: Electrified barrier, Lake Louise Campground, Lake Louise, Canada

A trail camera was installed (HyperFire 2 Professional Covert IR) at the guard monitoring the habitat side of the barrier. To accommodate the heavy use of the cameras associated with the traffic volume, the cameras were customized with external power (solar panel and associated battery). In addition, high-capacity memory cards (64 GB) were used. Images from the camera between 20 October 2021 and 30 September 2022 were reviewed. However, there were periods where the memory card was full or the power was insufficient, and the camera stopped recording. The camera was active 24 hours per day. However, the infrared flash was either malfunctioning or not activated, which meant that potential night-time images of wildlife were not interpretable. The total number of images reviewed was estimated at 579,521.

2.1.4 Lake O’Hara Road, Yoho National Park, Canada

No wildlife guard was installed prior to 2018. The electrified barrier (3.5 m long, 9.0 m wide) was installed in 2018 and consists of 1 section (personal communication Trevor Kinley, Parks Canada) (Figure 4):

1. A section with alternating positive (n=7) and negative (n=7) round bars. The positive bars have a white insulator.

The Trans-Canada Highway is in the far side of the image (Figure 4). The foreground is the habitat side. This barrier does not have a grounding plate. This barrier has been operational, but the electricity is turned off in winter when most bears are inactive. Each year, the system is likely to have been turned on sometime in April and turned off in either October or November.

Figure 4: Electrified barrier, Lake O'Hara exit, Yoho National Park, Canada

A trail camera was installed (HyperFire 2 Professional Covert IR) at the guard monitoring the habitat side of the barrier. To accommodate the heavy use of the cameras associated with the traffic volume, the cameras were customized with external power (solar panel and associated battery). In addition, high-capacity memory cards (64 GB) were used. Images from the camera between 1 October 2020 and 30 September 2022 were reviewed. However, there were periods where the memory card was full or the power was insufficient, and the camera stopped recording. The camera was active 24 hours per day. However, the infrared flash was either malfunctioning or not activated, which meant that potential night-time images of wildlife were not interpretable. The total number of images reviewed was estimated at 193,496.

2.2 Analyses

Images of all large wild mammals (including red fox, coyote, wolverine, and all larger wild mammal species) recorded by the cameras, regardless of the distance to the barrier, were selected, interpreted, and recorded into a database. The cameras were oriented so that they would at least monitor the first 2 m before the barrier on the habitat side. The road side of the barriers was not necessarily monitored (this was different between the three locations along the Trans-Canada Highway). The camera at Lake Louise campground monitored both sides of the barrier.

A distinction was made between animals that came within 2 m from the start of the barrier, and animals that stayed further away. Animals that are close to the barrier are more likely to be interested in crossing the barrier and may therefore lead to a more accurate estimate of the barrier effect. The effectiveness of the barriers was expressed as a percentage for each species, and we conducted calculations for the number of individuals, as well as the number of groups of animals. It can be argued that calculating the barrier effect based on the number of groups is more accurate than calculating it based on the number of individuals, as the behavior of animals within a group is likely dependent on the other animals in that group. If an animal, or a group of animals, was detected, then disappeared, but was then detected again within 5 minutes, it was considered 1 event resulting in 1 observation. If more than 5 minutes had passed between detections, they were considered multiple events resulting in multiple observations.

2.3 Results

2.3.1 Species Observed

There were 109 individual large wild animals observed by the wildlife cameras, regardless of the side of the barrier or the distance to the barrier (Table 1). Compound Road and Sunshine Road had the highest numbers of animals, especially white-tailed deer, mule deer, elk, and red fox. Black bears were observed at Compound Road and Lake O'Hara Road. Grizzly bears were observed at Compound Road, Lake O'Hara Road, and at the Lake Louise campground. Interestingly there was one observation of a wolverine at Sunshine Road. Partially because of the limited view of the cameras, there were no animals observed on the road side or campground side of any barrier.

Table 1: The number of animals observed per species at each of the 4 barriers

	Individuals observed (N)				
Species	**Total**	**Sunshine Rd**	**Compound Rd**	**Lake O'Hara Rd**	**Lake Louise campground**
Ungulates					
White-tailed deer	11	6	5	0	0
Mule deer	23	6	16	1	0
Elk	58	2	56	0	0
Moose	1	1	0	0	0
Species with paws					
Black bear	3	0	1	2	0
Grizzly bear	4	0	1	2	1
Red fox	6	5	1	0	0
Coyote	2	0	2	0	0
Wolverine	1	1	0	0	0
Total	109	21	82	5	1

Mammal species smaller than red fox, coyote and wolverine were excluded from having their behavior analyzed. However, the following species were detected at or near one or more of the barriers: red squirrel, Columbian ground squirrel, and American marten.

2.3.2 Barrier Effect from Habitat Side to the Road Side or Campground

Of the 109 animals that were observed in total, 104, split in 54 groups, were observed on the habitat side (Table 2). Of these 104 animals, 24, split in 23 groups, came within 2 m of the barrier. None of the ungulates (white-tailed deer, mule deer, elk, moose) or species with paws (black bears, grizzly bears, red foxes, and coyotes) that were observed on the habitat side of the barriers crossed the electrified barriers into the fenced road corridor or the campground. The barrier effect was 100% for all species observed, regardless of the distance from the electrified barrier, regardless of whether the barrier effect was calculated for individual animals or independent groups of animals.

Table 2: The barrier effect of the electrified barriers for animals that "started" on the habitat side of the barriers.

	Any distance to guard			Within 2 m from guard		
Species	**Barrier effect (%)**	**Groups (N)**	**Individuals (N)**	**Barrier effect (%)**	**Groups (N)**	**Individuals (N)**
Ungulates						
White-tailed deer	100%	9	11	100%	6	6
Mule deer	100%	15	23	100%	5	6
Elk	100%	18	58	100%	2	2
Moose	100%	1	1	100%	1	1
Species with paws						
Black bear	100%	2	2	100%	2	2
Grizzly bear	100%	4	4	100%	2	2
Red fox	100%	3	3	100%	3	3
Coyote	100%	2	2	100%	2	2
Wolverine	Unknown	0	0	Unknown	0	0
Total		54	104		23	24

Most animals that approached the electrified barriers stopped and turned around without making any physical contact with the barrier (Figure 5, Figure 6, Figure 7, Figure 8, and Figure 9). Only one animal, a grizzly bear, appears to have received an electric shock when attempting to cross into the fenced road corridor at Lake O'Hara Road (Figure 10).

Figure 5: White-tailed deer approaches electrified barrier at Sunshine Road and turns back

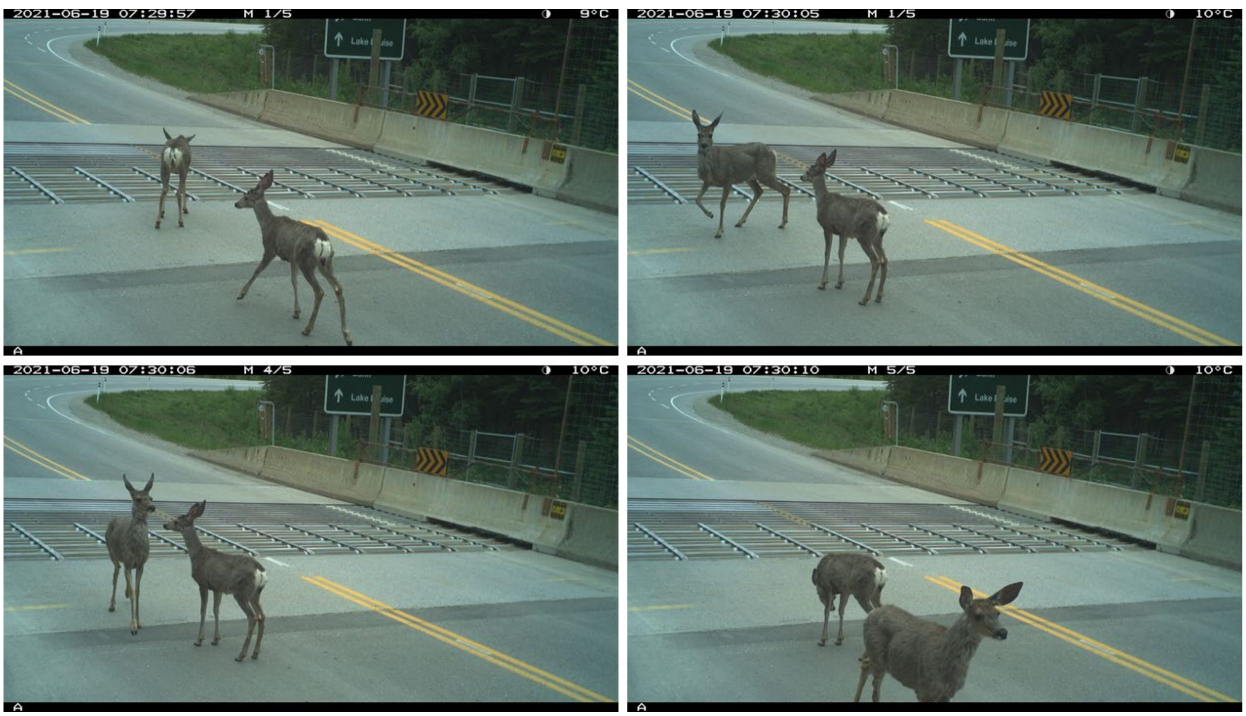

Figure 6: Mule deer approach electrified barrier at Sunshine Road and turn back

Figure 7: Elk approaches electrified barrier at Sunshine Road and turns back

Figure 8: Moose approaches electrified barrier at Sunshine Road and turns back

Figure 9: Black bear walks by electrified barrier at Lake O'Hara Road and glances at the barrier

Figure 10: Grizzly bear receives an electric shock when attempting to enter the fenced road corridor at Lake O'Hara Road

2.3.3 Barrier Effect from the Road Side to the Habitat Side

Of the 109 animals that were observed in total, 4, split in 4 groups, were interpreted to have crossed the barriers from the road side to the habitat side. These animals were not first observed on the road side of the barrier as the cameras were oriented to the habitat side of the barrier. Therefore, these animals were first observed on the barrier or on the habitat side of the barrier, but the direction of their movement and their speed was interpreted as indicating that these animals were moving from the road side to the habitat side of the barrier. A black bear attempting to exit the fenced road corridor failed to cross to the habitat side of the electrified barrier but tried to do so using the Jersey barrier (Figure 11). Two red foxes and one wolverine were interpreted as having exited the fenced road corridor to the habitat side of the barrier while running (Figure 12, Figure 13, and Figure 14). These last three crossings were all in winter when the voltage was likely compromised because of snow and road salt (usually between zero and 3-4 kV). Note that there was 1 animal, a red fox, for which it was unclear in which direction it moved and whether it had crossed the electrified barrier.

Figure 11: Black bear at Compound Road failing to exit the fenced road corridor

Figure 12: Red fox at Sunshine Road, having crossed the barrier from the road side to the habitat side

Figure 13: Red fox at Compound Road, having crossed the barrier from the road side to the habitat side

Figure 14: Wolverine at Sunshine Road, having crossed the barrier from the road side to the habitat side

2.4 Discussion and Conclusion

2.4.1 Barrier Effect of the Electrified Barriers for Large Wild Mammal Species

The number of large wild mammals that appeared at or near the electrified barriers was very low, especially the number of animals that came within 2 m of the barriers. This may be an indication that the animals know about the difficulty of accessing the fenced road corridor (or campground) and that they rarely come close and try to cross the barriers. This is supported by the findings of Huijser and Getty (2022) who found that once black bears could no longer pass through an electrified barrier around a melon patch, their presence around the melon patch dropped by 95%. Given these findings, it is quite possible that should the barriers be removed, it would result in a substantial increase in animals approaching the unmitigated gaps in the fence. In other words, it is likely that the electrified barriers are more effective than they appear based on the number of animals that approach and the number of animals that turn back.

The low number of observed large wild animals resulted in a small sample size for the animals whose behavior could be evaluated. However, none of the white-tailed deer, mule deer, elk, moose, black bears, grizzly bears, red foxes, and coyotes that were observed on the habitat side of the barriers crossed the electrified barriers into the fenced road corridor or the campground. Thus, for the observed large wild animals, the barrier effect was absolute.

A black bear attempting to exit the fenced road corridor failed to cross to the habitat side of the electrified barrier. Two red foxes and one wolverine did exit the fenced road corridor to the habitat side of the electrified barrier, but these three crossings were all in winter when the voltage was likely compromised because of snow and road salt (usually between zero and 3-4 kV). In addition, crossings to the habitat side can be considered acceptable as they improve human safety on the main highway and keep the animals from being hit by vehicles.

Overall, we conclude that the electrified barriers (when voltage was adequate and when not filled with snow) were 100% effective in keeping both large ungulates and large mammal species with paws out of a fenced road corridor and a campground.

2.4.2 Design, Operation and Maintenance of the Barriers

The following observations were made:

- Snowplows or front loaders carefully maneuvered at the barriers, clearing the snow as much as possible. This does require more time and skill compared to not having a barrier in place.
- Protective strips for the grounding plates and the insulators are important; snowplows can otherwise easily damage the grounding plate, insulators, or the individual bars. The protective strips seemed to hold up through the winter.
- Some of the barriers filled up with snow in winter, making them not functional, as expected (Figure 15).

- Road salt was applied to some of the barriers to melt the snow and ice between the bars and under the bars.
- “The accumulation of snow, salt, gravel, etc. between the negative and positive charge cause it to short in winter and may cause voltage drop, or the guard can be completely covered by snow (Personal communication Dan Rafla, Parks Canada).
- During the winter, the wiring was not able to withstand the vibrations from vehicles and gravel/salt that fell between the pipes. The wiring had to be redone to a more robust standard (Personal communication Dan Rafla, Parks Canada).
- Some barriers were “washed” with a hose from a water truck after the winter.
- Keep a detailed log with dates and times of what the status of the barriers is (e.g. electricity on or off), and what the operation and maintenance issues are that may be encountered.

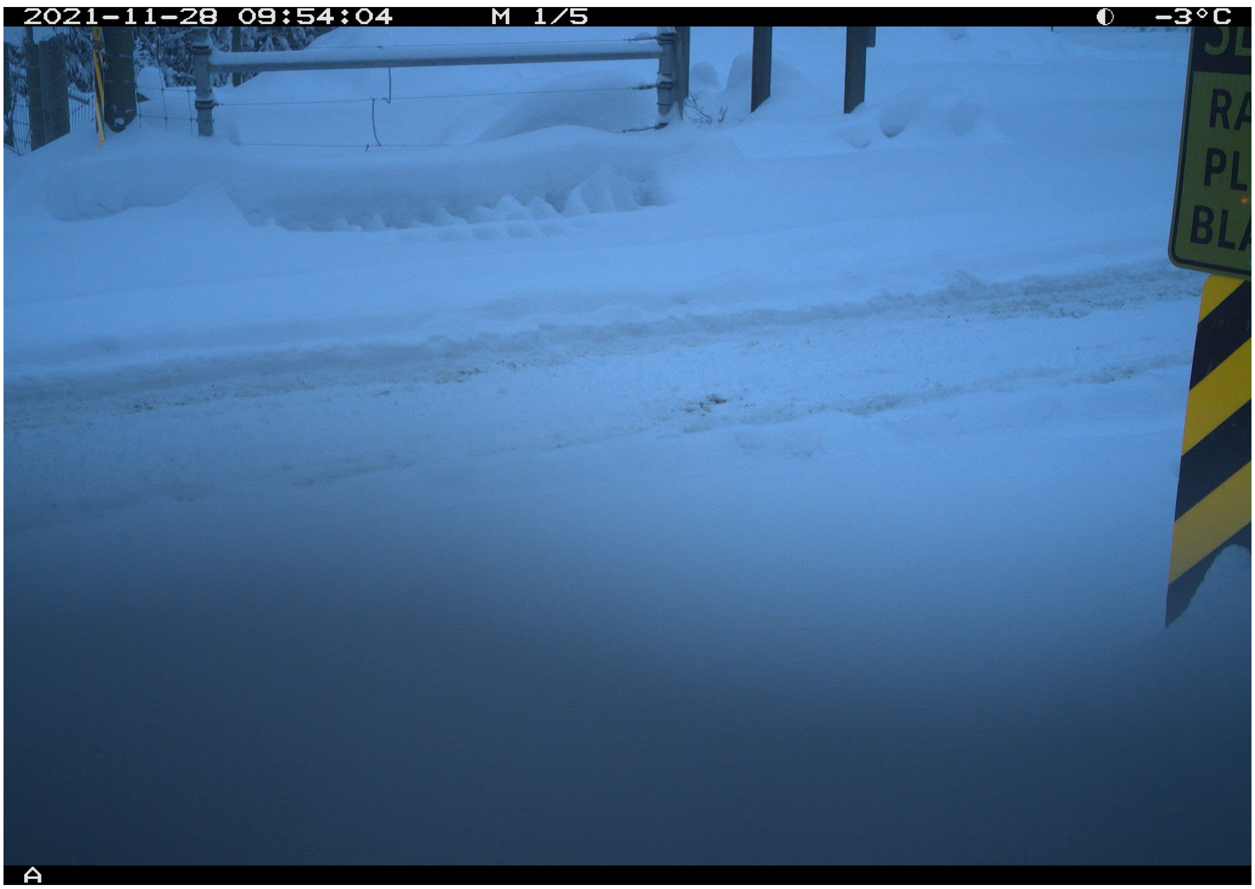

Figure 15: Snow fills up the barrier at Lake O’Hara Road, making it no longer a barrier to large wild mammals

2.4.3 Operation and Maintenance of the Cameras

The following observations were made:

- More regular camera checks are required to keep the memory cards from filling up. This is dependent on the traffic volume that varies strongly with the seasons. In some cases, especially when the camera was active 24/7, the memory cards would need to be replaced every couple of days.
- Consider programming the cameras to be active from end afternoon (after rush hour) until morning (just before rush hour) to minimize the number of images that need to be reviewed. However, there is always a risk that some animals appear at the wildlife barriers during the day when the cameras are not active.
- When programming the camera check whether infrared flash is turned on and functioning. Check a selection of the images (day- and nighttime) for each download to make sure that the camera is functional, including its infrared flash.

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1 APPENDIX: DIMENSIONS OF THE GUARDS DURING STUDY

1.1 Guards

1.1.1 Sunshine Road, near Banff, Banff National Park, Alberta

Width (across 2 lanes): 10.20 m
Total length: 5.00 m (excluding grounding plate)
Length electrified portion: 2.50 m (5 positive tubes, 5 negative tubes)
Length non-electrified portion: 2.50 m
Length grounding plate: 0.62 m

1.1.2 Compound Road, near Banff, Banff National Park, Canada

Width (across 2 lanes): 9.42 m
Total length: 5.03 m (excluding grounding plate)
Length electrified portion: 2.50 m (5 positive tubes, 5 negative tubes)
Length non-electrified portion: 2.53 m
Length grounding plate: 0.76 m

1.1.3 Lake Louise Campground, Lake Louise, Banff National Park, Canada

Width (across lane(s)): 9.90 m
Total length: 4.06 (there is no grounding plate)
Length electrified portion: 1.46 m (3 positive tubes, 4 negative tubes)
Length non-electrified portion: 2.60 m
Length grounding plate: 0.76 m
Tube diameter: 9 cm
Narrowest space between outside tube to outside tube: 15 cm

1.1.4 Lake O'Hara Road, Yoho National Park, Canada

Width (across 2 lanes): 8.95 m
Total length: 3.25 (excluding non-formal grounding plate)
Length electrified portion: 3.25 m (7 positive tubes, 6 negative tubes)
Non-electrified portion: not present
Tube diameter: 9 cm
Narrowest space between outside tube to outside tube: 15 cm
Width snowplow strip: 0.05 m