2015

Testing Fence Designs to Provide a Predator-Free Area for Boreal Caribou

Prepared by:

Craig DeMars [1,2], Kendal Benesh [1], Rob Serrouya [1], and Stan Boutin [2],

[1] Alberta Biodiversity Monitoring Institute

[2] University of Alberta, Department of Biological Sciences

Phase 2 Report

EXECUTIVE SUMMARY

Population declines of boreal caribou (*Rangifer tarandus caribou*) have been linked to increasing rates of predation ultimately facilitated by direct and indirect effects of landscape alteration within caribou range. Because of this hypothesized mechanism, habitat protection and restoration have been the primary focus of recovery efforts, yet for many rapidly declining populations, effects from these management levers will be insufficient in the short-term, compromising long-term population viability. Consequently, increasing effort has been directed toward developing and testing complementary management tools that can more immediately reduce predation rates.

One approach is to physically exclude predators from caribou using a structural barrier such as fencing. In 2014, a pilot study was initiated to test the feasibility of design options for a year-round predator exclusion fence. The study's first phase evaluated whether a structurally robust fencing design could exclude predators from a baited site. This design consisted of a 2.5 woven wire fence fitted with top and bottom aprons to inhibit animals from climbing over or digging under the fence. The design was effective in excluding wolves (*Canis lupus*), coyotes (*Canis latrans*) and lynx (*Lynx canadensis*) but was breached on two occasions by black bears (*Ursus americanus*). To prevent further incursions, the bottom apron was reinforced but it is unknown whether this modification proved effective as no further bear encounters with the fence were recorded. Because of the need for high structural integrity, a main drawback to this initial design was its high costs.

Here, we report on the study's second phase, which focused on testing whether an electric fencing design could exclude predators from baited sites in a more cost-efficient manner. After a two month pre-baiting period, a 5-m by 5-m electric fence exclosure was constructed at the same site used during Phase 1. Because of low rates of predator encounters during the first four months of monitoring, a second electric fence exclosure was constructed near Nexen's Long Lake site. At both sites, baits were replenished at regular intervals and remote cameras recorded predator encounters. Additional cameras were deployed on game trails surrounding each site to record the general presence of predators in the area and assess for potential site-specific effects related to the intensity of human presence (e.g., repeated physical presence and/or intensity of human scent). Over 242 days of monitoring, neither exclosure was breached by predators. On two occasions, black bears tested the electric fencing and in both instances, the animals appeared to receive a shock and fled the site. No other predator species were recorded physically testing the electric fencing. Overall, the number of predator detections at each exclosure was lower than expected. The relatively higher number of predator detections by game trail cameras suggests that predators may have avoided the exclosures due to the intensity of human presence at these structures.

In summary, these results suggest that the use of electric fencing may be an effective, cost-efficient option for designing a large-scale predator exclusion fence. Further testing, however,

may be required to evaluate its efficacy over varied terrain, its failure rate in terms of maintaining an electrical charge, and to estimate costs associated with fence maintenance.

ACKNOWLEDGEMENTS

We thank Rochelle Harding for logistical and conceptual support during this project. This project was funded by ConocoPhillips Canada, Devon Canada Corporation and Nexen Energy ULC. Field support was provided by Rolf Tidsbury of Gregoire Lake General Contracting and Score Fencing provided equipment and support for the electric fences. Antje Bohm assisted skilfully with data collection, fence installation and camera set-up, and database management. Finally, we thank Holger Bohm for his efforts tracking down bait for this project.

Table of Contents

Executive Summary i
Acknowledgements ii
Introduction 1
Methods 2
Results 7
Discussion 11
Literature Cited 12
Appendix A: Predator Detections by Species at the Leismer and Long Lake sites 15

INTRODUCTION

The boreal ecotype of woodland caribou is federally listed as *Threatened* under the *Species At Risk Act* due to population declines throughout much of its distribution (COSEWIC 2002). In Alberta, sustained declines in most herds have resulted in a designation of *Threatened* under the province's *Wildlife Act* (Alberta Sustainable Resource Development & Alberta Conservation Association 2010; Hervieux *et al.* 2013). Population declines are thought to be driven by increasing rates of predation, which are ultimately facilitated by direct and indirect effects of landscape alteration within and adjacent to caribou range (McLoughlin *et al.* 2003; Sorensen *et al.* 2008; Festa-Bianchet *et al.* 2011). These effects likely interact with climate change to further alter caribou-predator dynamics (Latham *et al.* 2011; Dawe *et al.* 2014).

Because of the linkage of population declines to landscape alteration, protecting and restoring habitat have been identified as primary management levers for recovering and stabilizing caribou populations (Environment Canada 2012). However, for herds residing in highly altered ranges, achieving stability through habitat restoration will take decades, compromising the long-term viability of small, rapidly declining populations (Schneider *et al.* 2010; Hervieux *et al.* 2013). As a consequence, complementary management tools are required, particularly those that can have a more immediate impact on reducing predation rates. One approach is to use fencing or some other barrier to physically exclude predators from caribou, either seasonally or longer-term. This approach has been applied in the form of maternal penning, where parturient females give birth inside in a fenced enclosure and are released after the neonate period (Chisana Caribou Recovery Team 2010). With maternal penning, the primary objective is to protect calves during the critical neonate period – when calf predation rates are highest (Adams *et al.* 1995; Pinard *et al.* 2012) – to thereby increase juvenile recruitment, a key demographic driver of caribou population dynamics (DeCesare *et al.* 2012). An alternative method is keep a portion of the population fenced year-round (Antoniuk *et al*. 2012). As this fenced subpopulation increases in number, excess individuals are exported back into the wild population. Compared to maternal penning, year-round fencing should provide a greater demographic boost because calves are not released until at least one year of age, equating to higher juvenile recruitment, and a proportion of females are protected year-round, resulting in higher adult female survival.

In 2014, a pilot study was initiated in northeast Alberta to test the feasibility of design options for a year-round predator exclusion fence. The study's first phase entailed testing whether predators could be excluded from a baited site using a structurally robust fencing design (Serrouya *et al*. 2015). The 90-m by 90-m baited site was enclosed by 2.5 m tall woven wire fencing fitted with a 1-m tall corrugated steel top apron to inhibit climbing and a 1-m wire mesh bottom apron to prevent digging. The design proved effective in excluding wolves, coyotes and lynx; however, on two separate occasions, a black bear was able to breach the fence by prying the apron apart from the main fence. The lower apron was subsequently reinforced but it is unknown whether this retrofit was successful as no further black bear encounters were recorded at the site. A significant drawback to this design was its cost, estimated to be $183,000/km, though this cost would likely decline if a larger fence was built due to economies of scale.

In this report, we present results from the study's second phase, which focused on testing an alternative fence design to lower costs. Specifically, this phase assessed whether electric wire could prevent predator incursions to baited sites and also whether predators could be conditioned to avoid electric wire. If successful, electric wire could replace the need for top and bottom aprons on the fence design tested in phase one, which would significantly lower per km costs.

METHODS

Phase 2 commenced on 12 March 2015 when pre-baiting was initiated directly adjacent to the large (90-m x 90-m) fence constructed during Phase 1. This exclosure is located on a 1.3 ha site situated 12 km North of Conklin, Alberta and approximately 1 km from Highway #881 (hereafter, the Leismer site). Bait was placed in the northeast corner of the site, approximately 10-m from the large fence. To record predator visits, we deployed five remote cameras (Reconyx HyperFire model PC900) surrounding the baited area.

On 8 May 2015, a 5-m by 5-m exclosure was constructed at the pre-baiting area using solar-powered electric fencing (Figs. 1-2; contractor: Score Construction Ltd). The fence was a free-standing exclosure, approximately 5' high, with galvanized cross beams, bottom beams and steel posts. High-tensile, 1/8" galvanized steel wire was used to make six strands of alternating charges. An additional steel post was used to elevate the solar panel to prevent animal damage. The solar panel had an easily accessible 'on/off' switch and voltage on the wires fluctuated between 9100 and 9800 volts during May to October, and between 1300 and 9300 volts in November. The exclosure was erected in one half day and after construction five additional remote cameras were installed. Four of these cameras (Reconyx UltraFire model Xr6) recorded 30 second videos upon trigger of an infra-red sensor. A fifth camera with cellular signal (Reconyx Hyperfire model SC950C) was placed to detect any animals entering the exclosure and becoming trapped. This camera emailed crew members each time the infra-red sensor was triggered, allowing for live monitoring of the site and the prompt removal of any trapped animals.

The electric wire exclosure was baited throughout the study period with road-killed moose, trapper-killed cougars, fish, and rotten beef scraps and blood. Punctured sardine cans were also attached with metal wire to the electric fence to encourage animals to contact the fence and test whether animals become conditioned to avoid the fence on subsequent site visits. On 27 May 2015, we deployed an additional camera along the north perimeter of the large Phase 1 fence. On 3 October 2015, we began monitoring predator visits to the general area by deploying five cameras were placed on game trails surrounding the site (note: four of these were new cameras while the fifth was a camera removed from the electric fence exclosure). All cameras were checked every 2 to 34 days, and the final check and fence shut-down occurred on 9 December 2015.

Because of the low number of predator detections at the Leismer site during the summer, a second, identical fence was constructed near the Nexen Long Lake site, approximately 10 km east of Anzac, AB (Fig. 3; hereafter, the Long Lake site). This site was also implemented to assess whether site-specific effects were deterring predators at the Leismer site. The Long Lake site was pre-baited with rotten fish, beef scraps, blood, and sardine cans for one week prior to fence installation on 1 October 2015. Four still cameras and three video cameras were installed to record predator visits at the fence. We also deployed one baited camera on a nearby game trail. Voltage of the fence ranged from 4200 to 9200 volts. All cameras were checked every 7 to 27 days until 27 November 2015 when we discovered that all cameras recording fence visits were stolen. Data collected from 10 to 27 November 2015 were lost with the stolen cameras. The cost to set up each electric exclosure was approximately $9,000 per site, including equipment and labour.

For all camera data, we defined predator detections to be independent if ≥ 1 hour occurred between photographs. Where possible, predators were identified to the species level and we calculated the minimum number of detections for each species. We did not attempt to identify individual animals due to the lack of distinct fur patterns in some species (e.g., black bears) and because characteristics such as body size, scars, and colours may not be visible in every picture, making individual identification unreliable (Foster & Harmsen 2012).

All field work was conducted under Research Permit 54636 and Collection License 54637 issued by the Government of Alberta.

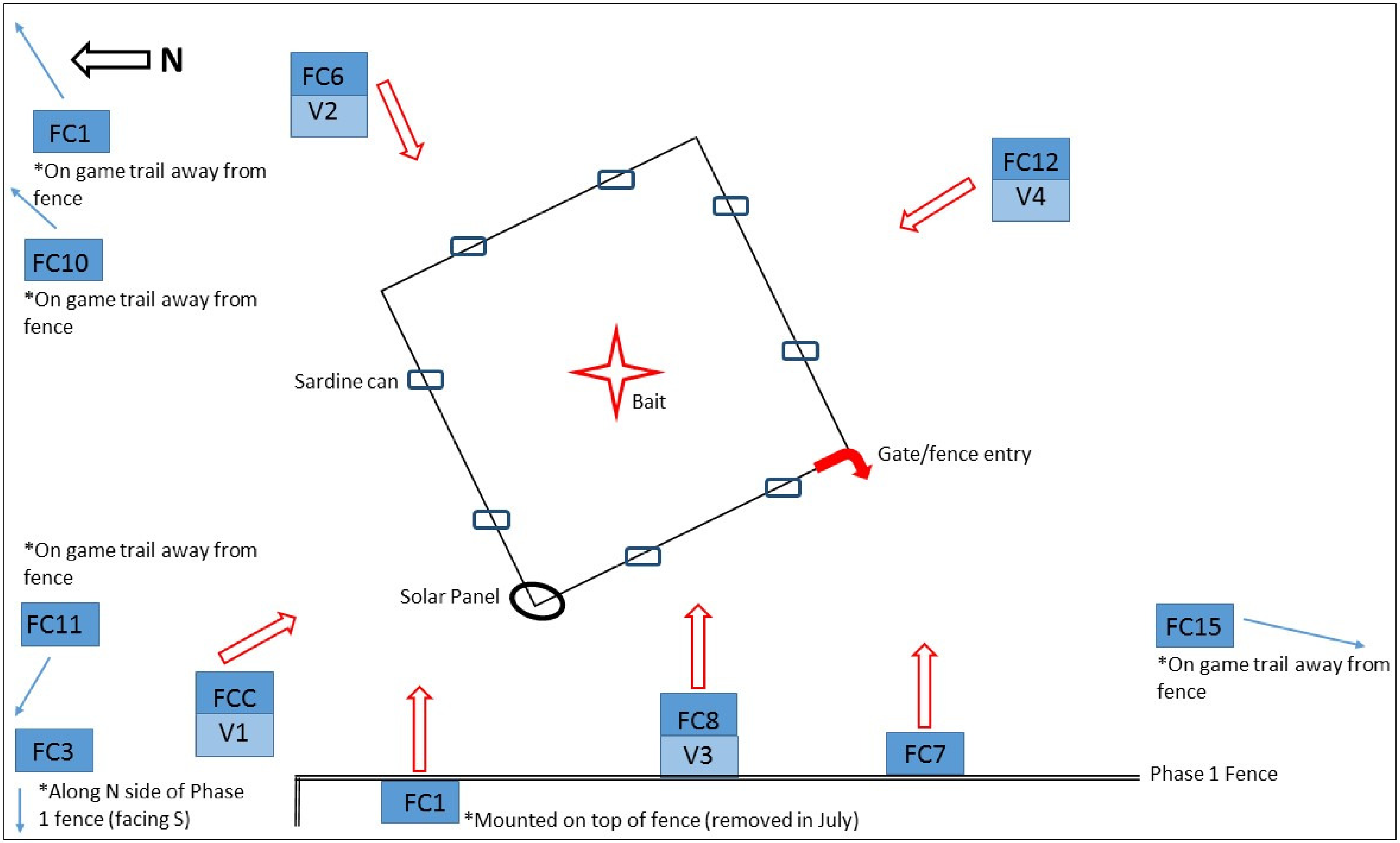

Figure 1: Design of the electric fence exclosure at the Leismer site near Conklin, Alberta. Remote cameras (FC), including those capable of recording video (V) and sending cellular images (FCC), were positioned to record predator encounters on all four aspects of the exclosure. Cameras were also deployed on game trails in the surrounding area.

Figure 2: Electric fence exclosure with solar panel constructed at the Leismer study site near Conklin, Alberta. The fence is approximately 5' high and consists of six electric wires (alternating positive and negative strands), with the bottom strand ~8" from the ground. Panels are staked together using 'U' bars. Average voltage of the fence and wires was ~ 9.5 v.

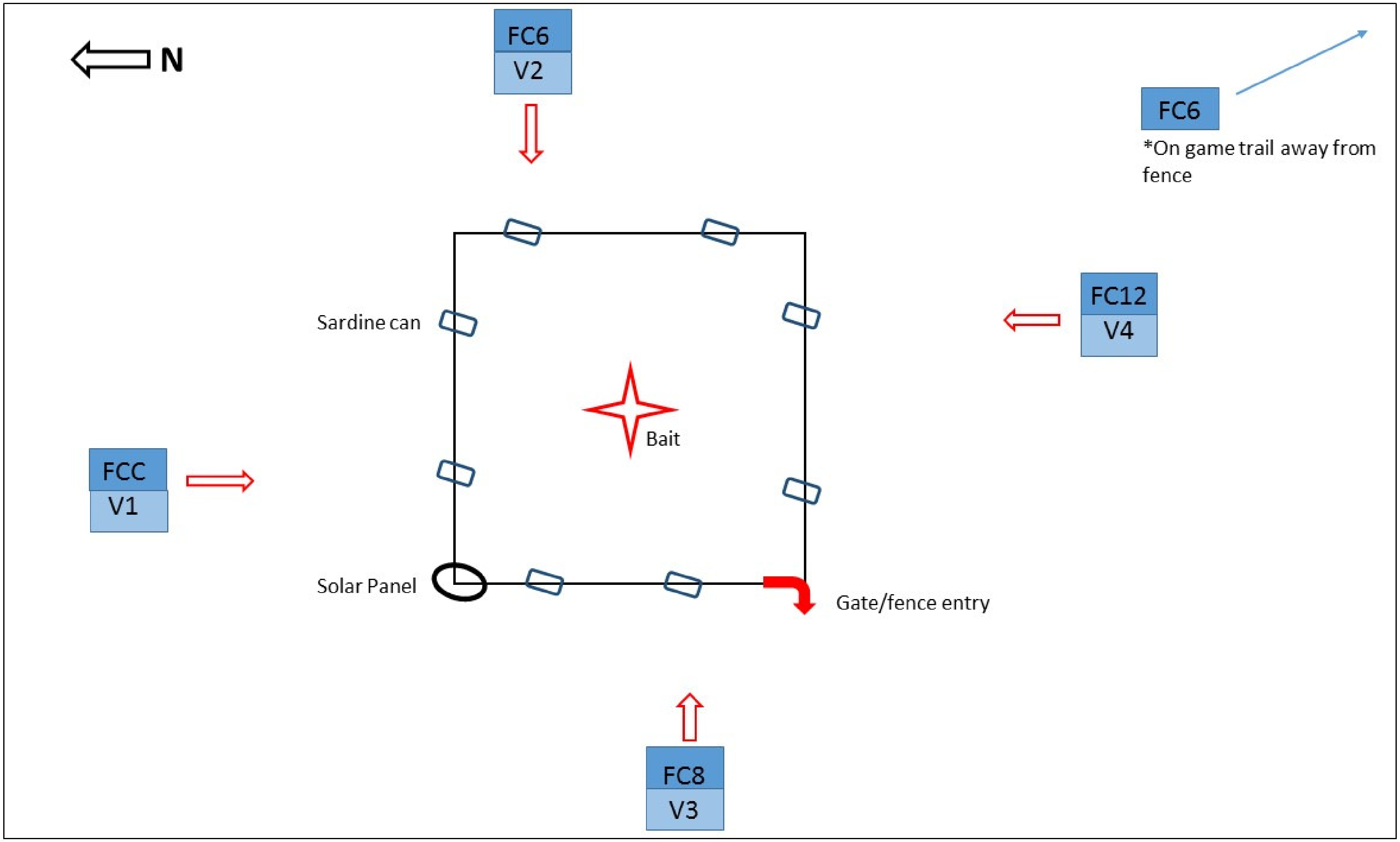

Figure 3: Design of the electric fence exclosure at the Long Lake site near Anzac, Alberta. Remote cameras (FC), including those capable of recording video (V), were positioned to record predator encounters on all four aspects of the exclosure. One additional camera was deployed on a game trail in the surrounding area.

RESULTS

At the Leismer site, 32 caribou predators were recorded during the pre-bait phase, including 20 wolves, one black bear and 11 coyotes (Fig. 4; Appendix A). After fence installation, only nine predators were recorded: three black bears, four wolves, and 2 unknown canids. On 4 June 2015, a female black bear and three cubs travelled past the electric fence with the female repeatedly sniffing at the fence but not touching it. On 9 June 2015, a black bear was recorded approaching the NE corner of the electric fence, licking the corner post, and then running away. Approximately 2.5 hours later, a bear again was recorded approaching the North panel of the electric fence. This individual licked a sardine can then ran away (Fig. 5). Both bears had an orange ear tag, but in the second video the tag was unidentifiable and it cannot be confirmed that it was the same bear. At least one marten (*Martes americana*) and one fisher (*Martes pennanti*) also visited the site. Two coyotes, one canid and one black bear were recorded traveling along the North side of the large fence from Phase 1 but did not engage the electric fence exclosure. Between 10 October 2015 and 25 November 2015, 16 additional predators were recorded on cameras installed on game trails surrounding the Leismer site. These species included one lynx, 11 wolves, two coyotes, and two unknown canids. No bears were recorded at either the fence or perimeter cameras after 9 June 2015.

At the Long Lake site, no predators were recorded during the week long pre-bait phase (Fig. 6; Appendix A). After fence installation, four coyotes were recorded at the electric fence exclosure but these animals did not attempt to touch the fence. At the baited camera deployed on a nearby game trail, six coyotes and two wolves were recorded over the approximately 1.5 month monitoring period.

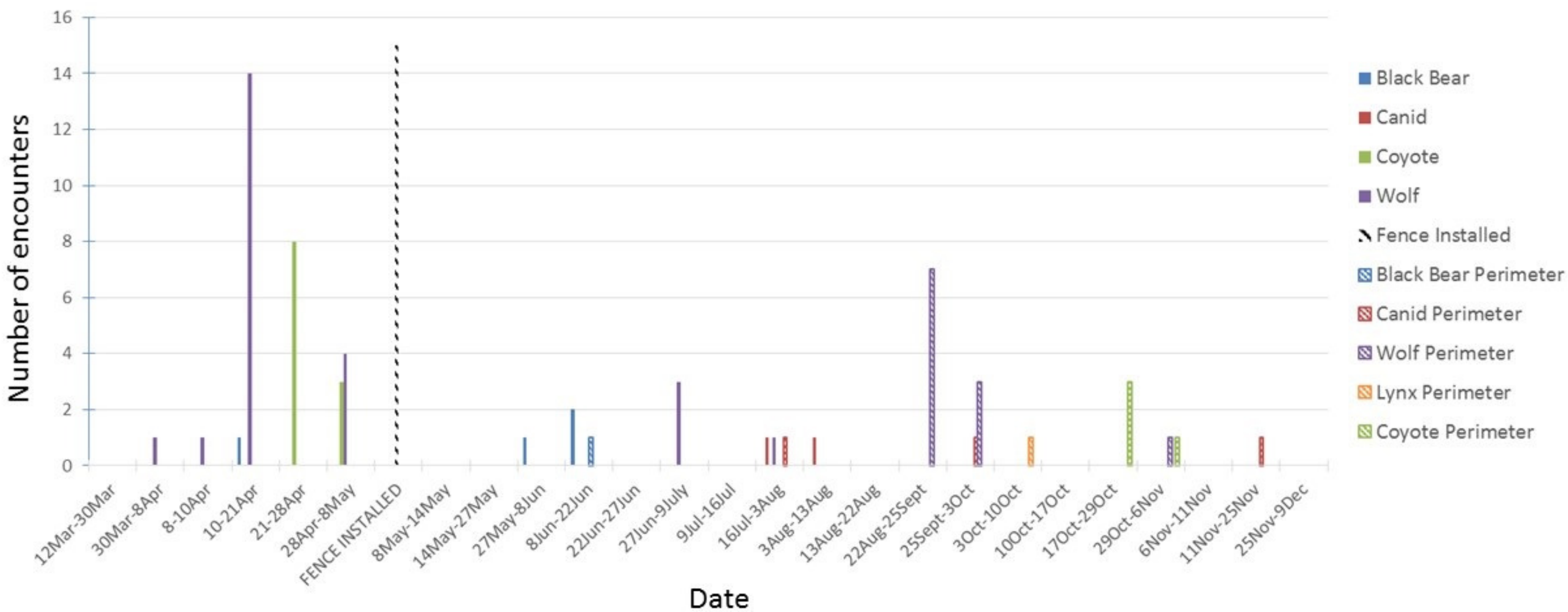

Figure 4: Predator encounters recorded at the Leismer site near Conklin, Alberta. Dashed vertical line indicates installation date of electric fence exclosure. Predator encounters designated “Perimeter” were recorded by cameras deployed on game trails in the surrounding area.

Figure 5: A black bear testing the electric fence at the Leismer study site near Conklin, Alberta on 9 June 2015. The individual approaches the fence (top left), appears to touch a sardine can (top right) then receives a shock and runs away (bottom right).

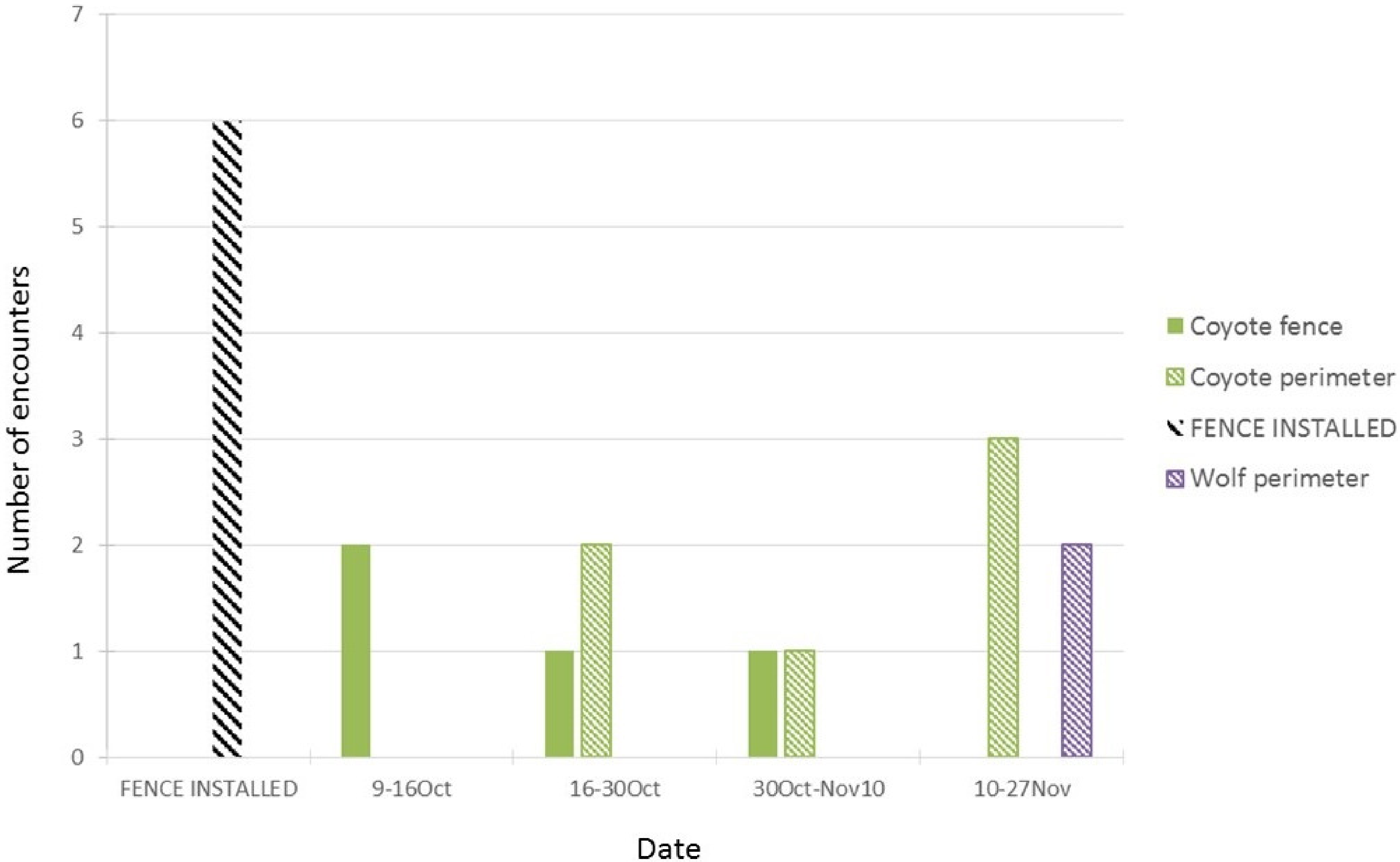

Figure 6: Predator encounters recorded at the Long Lake site near Anzac, Alberta. Predator encounters designated "Perimeter" were recorded by a camera deployed on a game trail in the surrounding area.

DISCUSSION

Electric fencing appears to be an effective method for excluding predators from a baited site. Over the combined 242 days of monitoring at the two study sites, no predators breached the electric fence exclosures to reach the bait inside. We caution, however, that our inferences are hampered by the small number of predator detections at each site. More specifically, we recorded only two instances where individual predators, both black bears, actually tested the electric fencing. Nevertheless, on both instances the electric shock received by the animal prevented further testing of the fence on each encounter. These results are promising given that black bears were able to breach the original fencing design tested in Phase 1 (Serrouya *et al*. 2015). A perceived advantage to electric fencing is the prevention of these behaviours and the behavioural response of the animal to flee after fence contact supports this idea.

In other studies, electric fencing has proven to be an effective, cost-efficient method for excluding predators from targeted areas. For example, in agricultural settings electric fencing has proven effective in reducing or eliminating bear depredation of beehives (Huygens & Hayashi 1999; Otto & Roloff 2015). Electric fencing also prevented incursions of polar bears (*Ursus maritimus*) into field research stations (Davies & Rockwell 1986). In canids, electric fencing reduced – though did not eliminate – coyote depredation of endangered black-footed ferrets (*Mustela nigripes*) and prevented wolves from entering an enclosed cattle pasture (Lance *et al.* 2010). Note that in our study we did not record canids directly testing the electric fence and that canids did not breach the original fence design tested in Phase 1.

At each site, more predators were detected by game trail cameras than by cameras situated at the exclosure fences. This finding suggests that repeated human presence at each exclosure may have affected detection rates. In particular, the presence of human scent may explain why no canid species physically tested the fence as both coyotes and wolves are known to exhibit wariness to areas with high levels of human activity (Séquin *et al.* 2003; Theuerkauf *et al*. 2003).

A key factor in determining the viability of electric fencing as an exclusionary method over large spatial scales is whether animals become aversely conditioned to the sight of the fence. This behavioural component is necessary because sections of the electrical fence are likely to fail periodically. If resident animals are aversely conditioned to the fence, then short-term failures may not necessarily result in predator incursions. The limited number of occasions where predators tested the fence prevents a robust assessment of potential averse conditioning. However, if the two tests of the fence by black bears were by the same individual, this result suggests that predators may require repeated tests of the fence before conditioning occurs. This result also suggests that averse conditioning does occur because black bears no longer tested the fence after these initial contacts, which occurred on the same day. We further note that our use of an attractant (i.e., bait) provided a relatively strong stimulus to test the fence, and thus our results could be considered conservative. In situations where no such stimulus is present, predators may be less compelled to repeatedly test the fence and averse conditioning may therefore occur on a single visit (Davies & Rockwell 1986).

There may also be specific challenges to using solar energy for powering electric fences in northern latitudes, most notably due to fluctuating solar energy during winter months (Obydenkova & Pearce 2016). Voltage of both fences decreased during November, though it is not known if voltage would have continued to decrease throughout the winter. There are many different solar systems available for use, some of which may be more appropriate for northern environments. Bolstering the fence with additional solar panels or batteries, or experimenting with other energy storage systems may also prove effective. Further energy loss may take place due to snow accumulation on solar panels (Heidari et al. 2015), but this could be at least partially mitigated by removing snow during scheduled maintenance or immediately after significant snow fall events. Nonetheless, constructing a fence on a large scale would mean that a dedicated power source, likely connected to a primary electricity grid, would be needed.

We tested electric fencing at a small spatial scale and thus its efficacy over larger spatial scales will require further testing. Specifically, its efficacy over varied terrain, including wet areas, and during winter months, should be further investigated. This larger scale testing would also give insight into estimated rates of electricity failure and the costs associated with fence maintenance.

LITERATURE CITED

Adams, L.G., Singer, F.J. & Dale, B.W. (1995). Caribou calf mortality in Denali National Park, Alaska. *The Journal of Wildlife Management*, **59**, 584–594.

Alberta Sustainable Resource Development & Alberta Conservation Association. (2010). *Status of the woodland caribou (Rangifer tarandus caribou) in Alberta: update 2010.* Alberta Sustainable Resource Development, Fish and Wildlife Division, Edmonton, AB.

Antoniuk, T., McNeil, L., Nishi, J. & Manuel, K. (2012). Caribou protection and recovery program: Technical guuidance. Oil Sands Leadership Initiative.

Chisana Caribou Recovery Team. (2010). *Recovery of the Chisana caribou herd in the Alaska / Yukon borderlands: captive-rearing trials*. Yukon Fish and Wildlife Branch.

COSEWIC. (2002). *COSEWIC assessment and update status report on the woodland caribou Rangifer tarandus caribou in Canada.* Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Davies, J.C. & Rockwell, R.F. (1986). An electric fence to deter polar bears. *Wildlife Society Bulletin (1973-2006)*, **14**, 406–409.

Dawe, K.L., Bayne, E.M. & Boutin, S. (2014). Influence of climate and human land use on the distribution of white-tailed deer (*Odocoileus virginianus*) in the western boreal forest. *Canadian Journal of Zoology*, **92**, 353–363.

DeCesare, N.J., Hebblewhite, M., Bradley, M., Smith, K.G., Hervieux, D. & Neufeld, L. (2012). Estimating ungulate recruitment and growth rates using age ratios. *The Journal of Wildlife Management*, **76**, 144–153.

Environment Canada. (2012). *Recovery strategy for the woodland caribou (Rangifer tarandus caribou), boreal population, in Canada*. Environment Canada, Ottawa, ON.

Festa-Bianchet, M., Ray, J.C., Boutin, S., Côté, S.D. & Gunn, A. (2011). Conservation of caribou (*Rangifer tarandus*) in Canada: an uncertain future. *Canadian Journal of Zoology*, **89**, 419–434.

Foster, R. J., & Harmsen, B.J. (2012). A critique of density estimation from camera-trap data. *The Journal of Wildlife Management* **76**, 224-236.

Heidari, N., Gwamuri, J., Townsend, T., & Pearce, J.M (2011). Impacts of snow and ground interference on photovalic electric system performance. *IEEE Journal of Photovaltaics,* ***5**, 1680-1685.*

Hervieux, D., Hebblewhite, M., DeCesare, N.J., Russell, M., Smith, K., Robertson, S. & Boutin, S. (2013). Widespread declines in woodland caribou (*Rangifer tarandus caribou*) continue in Alberta. *Canadian Journal of Zoology*, **91**, 872–882.

Huygens, O.C. & Hayashi, H. (1999). Using electric fences to reduce Asiatic black bear depredation in Nagano prefecture, central Japan. *Wildlife Society Bulletin*, 959–964.

Lance, N.J., Breck, S.W., Sime, C., Callahan, P. & Shivik, J.A. (2010). Biological, technical, and social aspects of applying electrified fladry for livestock protection from wolves (*Canis lupus*). *Wildlife Research*, **37**, 708.

Latham, A.D.M., Latham, M.C., McCutchen, N.A. & Boutin, S. (2011). Invading white-tailed deer change wolf-caribou dynamics in northeastern Alberta. *The Journal of Wildlife Management*, **75**, 204–212.

McLoughlin, P.D., Dzus, E., Wynes, B.O.B. & Boutin, S. (2003). Declines in populations of woodland caribou. *The Journal of Wildlife Management*, **67**, 755–761.

Otto, T.E. & Roloff, G.J. (2015). Black bear exclusion fences to protect mobile apiaries. *Human-Wildlife Interactions*, **9**, 78.

Obydenkova, S.V., & Pearce, J.M. (2016). Technical viability of mobile solar photovalic systems for indigenous nomadic communities in northern latitudes. *Renewable Energy*, **89**, 253 267.

Pinard, V., Dussault, C., Ouellet, J.-P., Fortin, D. & Courtois, R. (2012). Calving rate, calf survival rate, and habitat selection of forest-dwelling caribou in a highly managed landscape. *The Journal of Wildlife Management*, **76**, 189–199.

Schneider, R.R., Hauer, G., Adamowicz, W.L. (Vic) & Boutin, S. (2010). Triage for conserving populations of threatened species: The case of woodland caribou in Alberta. *Biological Conservation*, **143**, 1603–1611.

Séquin, E.S., Jaeger, M.M., Brussard, P.F. & Barrett, R.H. (2003). Wariness of coyotes to camera traps relative to social status and territory boundaries. *Canadian Journal of Zoology*, **81**, 2015–2025.

Serrouya, R., Boutin, S., Harding, R, & Bohm, A. (2015). Testing fence designs to provide a predator-free area for boreal caribou: Phase 1 reporting and planning for Phase 2. Alberta Biodiversity Monitoring Institute. 13p.

Sorensen, T., McLoughlin, P.D., Hervieux, D., Dzus, E., Nolan, J., Wynes, B. & Boutin, S. (2008). Determining sustainable levels of cumulative effects for boreal caribou. *Journal of Wildlife Management*, **72**, 900–905.

Theuerkauf, J., Jedrzejewski, W., Schmidt, K. & Gula, R. (2003). Spatiotemporal segregation of wolves from humans in the Bialowieza Forest (Poland). *The Journal of Wildlife Management*, **67**, 706.

APPENDIX A: PREDATOR DETECTIONS BY SPECIES AT THE LEISMER AND LONG LAKE SITES

Table A1: Predator detections by species recorded at the Leismer study site near Conklin, Alberta from 12 March to 27 November 2015.

	Number of Detections				
Species	Pre-bait	Fence	Fence Contact	Perimeter	Total
Black bear	1	2	1	1	5
Unknown Canid	-	2	-	3	5
Coyote	11	-	-	4	15
Lynx	-	-	-	1	1
Wolf	20	4	-	11	35
Total	32	8	1	20	61

Table A2: Predator detections by species recorded at the Long Lake study site near Anzac, Alberta from 1 October to 27 November 2015.

	Number of Detections				
Species	Pre-bait	Fence	Fence Contact	Perimeter	Total
Coyote	-	4	-	6	10
Wolf	-	-	-	2	2
Total	-	4	-	8	12