The Reintroduction of Orphan Badgers (*Taxidea taxus*) using the Soft-Release Method near 100 Mile House, British Columbia, Canada

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Executive Summary

Badgers (*Taxidea taxus jeffersonii*) in British Columbia are currently considered endangered both provincially and federally, with the two highest priority conservation concerns identified by the National Badger Recovery Team being road mortality and habitat loss. Highways are the leading cause of mortality for badgers in BC and for that reason, current research on these animals has been focusing on understanding how habitat configurations and limitations may be predisposing the animals to road mortality.

As part of this on-going research, 16 badgers (11F, 5M) were captured and tagged with radio-transmitters from 2007 to 2009. Individuals were tracked to determine highway interactions and life-history traits. Recruitment and natal den site selection were recorded for 11 females during three consecutive seasons.

On 11 May 2010, a radio-tagged adult female badger (BF02) was struck and killed on Highway 97 near 105 Mile in the south Cariboo orphaning three young kits. The main objective of this project was to raise the three kits (1F, 2M) in an environment where they could successfully be released back into the wild and contribute to the badger population in British Columbia.

The badger kits were captured using a baited cage trap at the natal den from 12 to 14 of May and transported to the British Columbia Wildlife Park in Kamloops. At the facility they were released together into a fenced, wood shaving and hay-lined concrete floored enclosure and were fed a mixture of carnivore diet mix, dog kibble, small mammals, and day old chicks with limited human contact. The kits body condition and weights were regularly assessed and after sufficient weight gain and body growth were fitted with intraperitoneal VHF radio-transmitters on 13 July 2010. These radio-transmitters would allow the kits to be tracked using radio-telemetry and monitored in the wild after release.

After recovery from surgery the kits were transported back to the south Cariboo on 19 July 2010. They were soft released into a 20 m × 40 m fenced enclosure where they were preconditioned with natural prey. The site selected for the enclosure was located within their mother's home range and contained existing badger and Columbian ground squirrel (*Spermophilus columbianus*) burrows. The enclosure contained native grasses and shrubs, aspen trees and large downed woody debris. Wild badgers were excluded from the site using fencing and the enclosure was monitored with remote motion-sensing cameras to ensure no wild badgers were in the enclosure. This fencing also allowed resident Columbian ground squirrels to pass freely in and out of the enclosure.

Initially the kits were fed dead Columbian ground squirrels but within two days (21 July) were being provided with live ground squirrels, which the badger kits ran down and killed above ground. The kits then carried and either cached or consumed the meal underground.

The kits started exiting the enclosure on 28-29 July 2009 but returned regularly for the next several days. On 03 August we lined the enclosure with hexagonal wire mesh (chicken wire) that prevented ground squirrels from exiting the enclosure. We left a single opening approximately 300 mm in diameter that allowed the badger kits to enter and exit freely. Only live ground squirrels were provided beyond 04 August and were supplemented into the enclosure to boost the density inside the enclosure. After 08 August no live ground squirrels were provided.

From 01 to 15 August the kits were located twice daily with an average movement of 474 meters between locations. Resident badgers were recorded by remote motion cameras in the adjacent pasture and were also recorded entering and exiting the enclosure on occasion.

The small male (OM02) dispersed approximately11 kilometers northwest from the enclosure during the week of 16- 21 August. In the early morning hours of 21 August he was picked up by a member of the public from the shoulder of Highway 97 near 111 Mile where he had been struck and killed. The remaining male and female had also dispersed approximately 10 kilometers in a generally north direction from the enclosure during the week of 16-21 August. On 21 August both juveniles were located approximately 5 km apart from each other on separate ranches along the Spring Lake road, east of 111 Mile.

Intermittent monitoring of both the male and female is on-going into fall 2010 and winter 2010/11. Both badgers appear to be healthy and are foraging primarily for Columbian ground squirrels and yellow-bellied marmots (*Marmota flaviventris*) at these locations. Winter monitoring will also record activity and movement patterns.

The implanted VHF radio-transmitters have an estimated battery life of 20 months and should allow the team to monitor the two young badgers into summer 2011 to see if they successfully overwinter and survive to contribute to the endangered badger population in the Cariboo region of BC.

Introduction

Badgers (*Taxidea taxus jeffersonii*) in British Columbia are currently considered endangered both provincially and federally, with the two highest priority conservation concerns identified by the National Badger Recovery Team being road mortality and habitat loss (*jeffersonii* Badger Recovery Team 2008). However, recovery of badgers in BC is believed to be ecologically and technically feasible if these impacts can be reduced. This approach is reflected in BC's Conservation Framework, where clearly defined scientific criteria have been used to determine priorities and the most appropriate management actions for species of conservation concern. Under the Framework, the badger has been identified as a Priority 1 species (http://www.env.gov.bc.ca/conservationframework/).

Highways are the leading cause of mortality for badgers in BC and for that reason, current research on these animals has been focusing on how habitat configurations and limitations may be predisposing the animals to road mortality. Badgers are vulnerable to highway mortality for several reasons: (1) highways are constructed in valley bottom habitats preferred by badgers; (2) badgers' large home ranges and peak movement rates coincide with peak traffic volumes; (3) roadside banks have suitable soils that are attractive to burrowing for both badgers and their prey; and (4) badgers are most active at night, when drivers have greatest difficulty seeing a small animal on the highway.

In 2007, a project was initiated by BC Ministry of Environment (MoE), Thompson Rivers University (TRU), and the BC Ministry of Transportation and Infrastructure (MoTI) to better understand the complex relationship between badgers and highways. From 2007 to 2009, 16 badgers (11F, 5M) were live-captured and fitted intraperitoneally with VHF radio-transmitters. Badgers were radio-tracked to determine highway interactions (i.e., crossing sites), as well as life-history and ecological traits, including kit recruitment and natal den site selection. It was noted that adult female BF02 had selected Highway 97's right-of-way for a natal den for two consecutive years. On 11 May 2010, the adult female was struck and killed by a vehicle near her natal den while attempting to cross Highway 97. Subsequently, an attempt was made to rehabilitate her three orphaned badger kits in captivity and release them back into the wild using the soft release method near 105 Mile in the south Cariboo region of BC.

The main biological and ecological factors that influence successful carnivore reintroductions include habitat suitability, natal habitat preference, long-term food availability, season of release, type of release (soft or hard) and source (wild-caught or captive-born) of released animals (Stamps and Swaisgood 2007, Jule et al. 2008, Peters et al. 2009).

Methods

In order to track badgers for a badger ecology research project adult badgers were live-captured at burrow entrances between summer 2007 and summer 2009 in the south Cariboo region of BC. A total of 16 badgers (11F, 5M) were captured and fitted with intraperitoneal VHF radio-transmitters (IMP400L, Telonics, AZ, USA) by an experienced veterinarian. Once the animals recovered they were transported back to their site of capture and released. All live-trapping and surgical implantation of transmitters followed approved standard techniques and animal care protocols (Animal Care Protocol #: TRU 2007-8 and Permit #: WL07-36484). This method of tagging allowed researchers to track and record badger movements and behaviour

across a variety of habitats near the community of 100 Mile House, British Columbia, Canada (W121.29156, N51.6531).

An adult female (BF02) radio-tagged in 2007, consecutively selected two natal dens in spring 2009 and spring 2010 only 439 meters apart along the right-of-way of Highway 97. The adult female was detected in a large burrow complex on a slope adjacent to Highway 97 on 14 April 2010 (Fig. 1). The 2010 natal den was on a steep bank only 8 meters from the shoulder of the highway near 105 Mile Lake.

Figure 1. Badger Female 02's (BF02) natal den complex along Highway 97 right-of-way, April 14, 2010.

In the evening hours of 11 May 2010 BF02 was struck and killed near her natal den while attempting to cross Highway 97. The following day it was determined that there were orphaned kits in the roadside burrow. A meeting between *jeffersonii* Badger Recovery Team members, BC Ministry of Environment and BC Wildlife Park staff was convened and it was decided that an effort would be made to capture the kits and attempt to rear them in captivity for eventual release back into the wild using the soft-release method.

At 10:30 hrs on 12 May a large cage trap (Tomahawk, Model 608.5, WI, USA) baited with raw chicken was deployed on a level surface as close to the entrance of the natal den as possible. One kit was captured each day from 12-14 May for a total of three juveniles. Trapping continued until 16 May to ensure there were no more kits in the burrow. The soil at the burrow

entrance was then swept smooth and was monitored to see if any tracks were detected post-trapping.

The kits were then transported in a large plastic transfer barrels approximately 200 kilometers south to the British Columbia Wildlife Park in Kamloops, BC (Fig. 2). The BC Wildlife Park is a Canadian Association of Zoos and Aquariums (CAZA) accredited facility that assists in preserving threatened and endangered species through education, captive breeding, and rehabilitation.

Figure 2. Custom built badger transfer barrel.

All of the badger kits arrived within one day of each other. They were weighed and physical exams were performed prior to release into their pen. They were released together into a large wood-shaving lined, concrete floored, fenced enclosure in a remote corner of the facility to limit human contact as much as possible. Hay bales were placed inside for a makeshift den (Fig. 3). Another adjacent smaller dark room accessed by a sliding door was also provided. This allowed caretakers to enter the main pen while the kits were separated in the adjacent smaller pen and place food items without the kits knowledge.

Kits were fed a mixture of Toronto Zoo Canine diet, red meat, day old chicks, small mammals and dog kibble. After 10 days, dead mice were placed in cardboard rolls and buried into soil mounds within the pen. At three weeks a small plastic pool filled with soil was provided within the pen. The kits diet was then supplemented with live mice by placing the mice in enclosed cardboard rolls and buried in the pool for the kits to detect, dig up, and consume. The kits were initially weighed once a week to assess weight gain and body condition. As they became larger and more difficult to handle and to reduce human contact the kits were then weighed opportunistically.

Figure 3. The kits were initially housed in a wood shaving and hay-lined, concrete floored pen with a chain-link fence wall to allow some light into the pen. The sliding door to the smaller dark room is on the left, June 10, 2010.

After seven weeks the kits were moved to a smaller concrete enclosure filled with a sufficient amount of soil that allowed the kits to dig and burrow (Fig. 4). In order for the kits to learn to dig and forage for prey, the practice of providing live mice in enclosed cardboard tubes buried in the enclosure was continued.

By 13 July the kits had achieved enough weight gain and body growth to allow a VHF radio-transmitter to be surgically implanted into the peritoneal cavity. Using established surgical procedures from previous badger work in British Columbia, an IMP400L (Telonics, AZ, USA) implantable radio-transmitter (85 grams) was inserted free-floating into the body cavity of each kit at the facility by wildlife park veterinarian Dave Sedgman DVM. They were then moved to the original large pen for seven days of observation and monitoring to ensure that they fully recovered before being transferred to the soft-release enclosure in the south Cariboo. On 19 July the kits were transported back to the south Cariboo where they released into a 20 × 40 meter fenced enclosure as part of the soft-release program (Fig. 5).

Figure 4. Enclosure being prepared at the BC Wildlife Park with a sufficient amount of soil to allow the kits to dig and burrow, June 10, 2010.

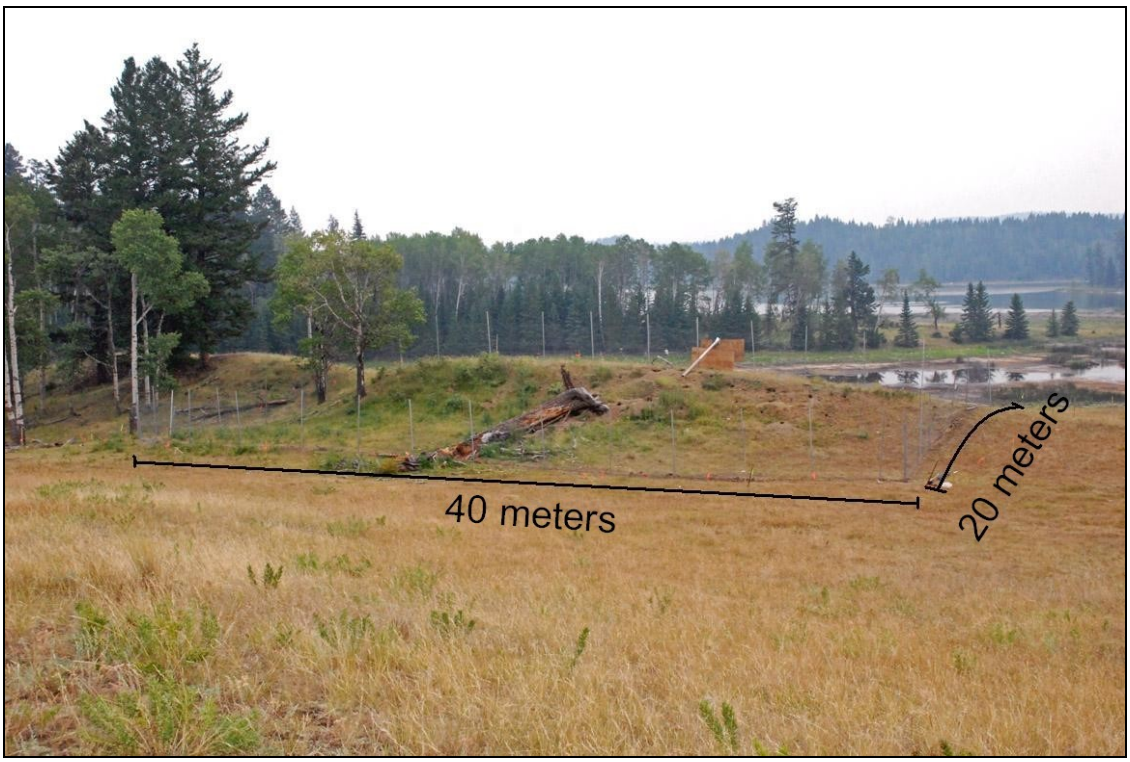

Figure 5. Overview of 40 m x 20 m fenced enclosure that three badger kits were released into, July 19, 2010.

The site selected for the enclosure was approximately 5.5 km east of the natal den site and Highway 97 on a cattle ranch in BF02's former home range in the south Cariboo region of BC. The site had been regularly visited by BF02 to forage on Columbian ground squirrels (*Spermophilus columbianus*). The enclosure encompassed an esker with a north aspect and gentle slopes (Fig. 6).

Figure 6. The enclosure encompassed a variety of micro-habitat types including live trees, shrubs, native grass and forbs, coarse woody debris, and varying slopes positions.

The east end of the enclosure contained rose bush shrubs (*Rosa acicularis*) and standing aspen trees (*Populus tremuloides*), in addition to being close to large Douglas-fir trees (*Pseudotsuga menziesii*) that provided shade mid-morning. A large piece of downed woody material was also surrounded by fencing to provide structure and shade. Columbian ground squirrels were resident inside and outside the enclosure and could pass through the tall fence. Old badger burrow complexes were located inside the enclosure and monitoring using remote motion cameras ensured no wild badgers were inside during construction.

The enclosure was constructed of 50 mm × 50 mm heavy gauge Paige wire (galvanized welded wire mesh) at a height of 1200 mm and was doubled for a total height of approximately 2400 mm. The wire fence was attached to perforated steel posts (Telespar®) using rebar tie wire. The unique configuration of the square tubing allows tubular sections of different sizes to telescope into the next larger size allowing a shorter ground section to be pounded into firm soil with a longer segment sliding into this base. This method allowed the fence posts to be installed quickly and retrieved from the site to be re-used. The posts were spaced approximately 3–4 meters apart and were anchored at the corners with two heavy gauge wire stabilizers attached to metal anchors for stability. The entire enclosure was surrounded by a portable high tensile steel electric fence to prevent livestock from rubbing on the enclosure cables and posts. The wire fence was sunk below grade using a mobile trenching machine (RTX 100, Vermeer, Iowa, USA) donated by a local rental company (Fig. 7). Depths ranged from 50 mm to 200 mm due to the varying soil and rock conditions encountered. Good soil conditions allowed the deepest trench depths along the base of the esker with shallower depths occurring in the rocky soil types along the 40 meter segment on top of the esker.

Figure 7. Jay Dickenson of Four Hearts Ranch and 100 Mile Fly Fishers operates the trenching machine creating the trench for the fence, June 25, 2010.

Attempting to keep Columbian ground squirrels released in the enclosure after 03 August we added hexagonal galvanized after weave (chicken wire) with 30 mm mesh and 900 mm in height along the perimeter of the main fence (Fig. 8). The objective of this method was to augment and increase the density of live ground squirrels within the enclosure that the kits could prey on and limit their dependence on humans for food items. Fresh water was provided by sinking a bucket level with the ground and filling up when required.

Figure 8. Inserting the hexagonal wire mesh to prevent Columbia ground squirrels from exiting the enclosure, August 03, 2010.

Remote motion cameras (RC55, Reconyx Inc., WI, USA) were used to monitor the inside of the enclosure to determine that no wild badgers were incidentally encircled during construction, determine prey presence, record kit behaviour, monitor water station use, and monitor exit and entrance sites inside the enclosure (Fig. 9).

Figure 9. Enclosure pre-monitoring was conducted using remote motion cameras to determine if any badgers were incidentally trapped within the enclosure and also to determine prey presence.

Once the kits were soft-released into the enclosure, only Columbian ground squirrels were provided for food items. We assumed that resident small mammals and ground squirrels within the enclosure would initiate a predatory response from the kits and that the provided ground squirrels would simply augment their diet. Columbian ground squirrels were trapped off-site using foot hold traps that were placed at the entrance of their burrows. These ground squirrels were collected from private ranches with landowner permission. Initially some ground squirrels were humanely euthanized and provided to the kits by placing the dead ground squirrels inside existing burrows within the enclosure when the kits were below ground. After three days (21 July), we attempted to provide approximately six live ground squirrels per day to the kits. These ground squirrels were released in view of the kits in order to initiate a predatory response. A few ground squirrels escaped and exited the enclosure or into a nearby burrow but most were ran down and killed by the kits. We attempted to ensure that all three kits were able to capture and kill live ground squirrels on a daily basis. If live capture and release of live ground squirrels were limited we still provided 2-3 dead ground squirrels/day, but started to bury them as deep as possible in existing burrows.

After one week of the kits being in the enclosure escape attempts by digging at the base of the fence were observed. On 30 July we noted that there was a 300 mm entrance/exit hole in the fence along the top of the esker that the badger kits were using. The kits still returned to the enclosure in the evenings, so we blocked all other escape attempt holes and placed a remote motion camera on either side of the fence to record the movements of the kits through the hole. At this point, the kits were entering the enclosure during evening hours in the dark, presumably expecting to be fed, and exiting in the early morning hours to explore the adjacent pasture. We

released live ground squirrels at burrows within the fenced enclosure shortly before dark with expectations that the ground squirrels would remain below ground and not explore the perimeter of the fence and find the single entrance/exit site before the kits returned that evening.

By 02 August we started limiting the provision of dead ground squirrels and only augmented the enclosure with live ground squirrels in evenings after 03 August. On 08 August we stopped providing ground squirrels with the assumption that the kits were now foraging for themselves.

We started intensive VHF radio-monitoring of the kits outside the enclosure on 01 August and continued to 03 September. Initially we attempted to locate the kits twice a day, and once the kits started exploring several kilometers we located them at least once a day. During September and October, after the kits dispersed and remained at their respective sites monitoring occurred approximately once a week. Data collected during this period included location coordinates (UTM, NAD83), behavior, if observed, and general habitat conditions.

Results

Live-trapping

Over the course of three days three kits were captured using the Tomahawk cage trap. First captured was a female (Orphan Female 01 – OF01), then a male (Orphan Male 01 – OM01) and finally another male (Orphan Male 02 – OM02), the smallest of the litter (Table 1). The live trap was removed at 17:00 hrs 16 May after it was determined that no more kits were present. No tracks were detected on the burrow's soil mound post-trapping.

BC Wildlife Park

Initially the kits were placed in a wood shaving-lined concrete floored pen with hay bales placed in a den-like fashion. The exploratory nature of the kits soon had the bales of hay strewn about the pen that they readily burrowed into providing them with a network of tunnels.

The separation of the kits from caretakers using rooms separated by a sliding door allowed for the placement of prey items (i.e., mice in cardboard tubes) within the main pen without the kits knowledge. Once released back into the main pen the kits quickly detected and excavated the tubes and ate the mice in a short period of time. This process introduced the kits to instinctually forage for prey and be less reliant on humans for food.

The care received at the BC Wildlife Park allowed the kits to gain an average of 3.7 kg/badger over the 9 weeks they spent at the facility (Table 1). After implant surgery the kits remained at the facility for seven days where they recovered and were monitored for any complications. Their appetite and activity levels returned to normal within 24 hours.

Table 1. Weight gain (kg) for three badger kits at BC Wildlife Park from initial capture (May 12-14) to surgery date, 13 July, 2010.

	May 12-14	May 19	May 26	July 07	July 13	**Total gain**
OM01 (Oscar)	2.7	3.1	3.7	n/a	7.0	**4.3**
OM02 (Slim)	2.0	2.4	2.8	4.3	5.1	**3.1**
OF01 (Taz)	2.4	3.1	3.9	n/a	6.0	**3.6**

Soft Release / Enclosure Security/ Interactions

The kits were transported to the south Cariboo region and released into the soft release enclosure at Four Hearts Ranch on 19 July, 2010. Once inside the enclosure the kits excavated out old badger burrows and over two weeks had a network of inter-connected burrows in the center of the enclosure. Only minor escape attempts or curious digging were noted around the perimeter of the enclosure from 19 to 28 July. It was noted on the evening of 28 July that there were several escape attempts and possibly something digging from the outside attempting to gain entry. Due to the wire being bent outwards it was presumed the kits has pushed through and started the exiting/entering process on the evening of 28 July. The hole was repaired the following morning and motion cameras were placed near the largest area of digging. On the early morning hours of 30 July (evening of the 29th), a wild resident adult male attempted to gain entry into the pen, he was successful at bending the wire creating a hole at the joint of two sections of wire and partially digging under the fence to gain entry at 02:20 hrs (Fig. 10). OM01 was near the camera at 02:24 hrs and there was no evidence of aggression. The adult male was not detected leaving using the same entrance/exit hole. Both young males were recorded near the entrance hole at 03:04 hrs showing no signs of distress. At 03:47 hrs one of the juvenile males (OM02) exited through the hole followed shortly by his male sibling (OM01). It is uncertain if the large resident male entered the enclosure the night before but assume the increased digging activity around the perimeter of the fence was due to these interactions.

Figure 10. Remote camera captures resident adult male "breaking into" the enclosure at 02:20 hrs, July 30, 2010.

Within 24 hours all three kits were recorded using the exit/entrance hole. Once it was determined that kits were exiting the enclosure freely but also returning to the familiar safety of their burrow complexes to forage and explore, it was decided not to take down the enclosure until the kits stopped returning. This would allow the kits to return to the safety of the enclosure that not only afforded protection from larger predators such as coyotes and black bears, but the high fence likely deterred avian predators as well (i.e., great horned owls, *Bubo virginianus*).

Prey/Food

From 19 July to 03August the kits were provided a total of 30 dead and 35 live Columbian ground squirrels. Some live ground squirrels ran down burrows inside the enclosure and it was undetermined if kits were able to dig them up for food. Buried ground squirrels were placed at various locations in the enclosure with many being excavated right away and fed upon. All buried ground squirrels were eventually dug up and consumed, usually by the next day.

An additional 9 live ground squirrels were supplemented into the enclosure from 04 to 07 August with the finer hexagonal wire mesh in place around the perimeter of the enclosure to prevent their escape. There were ground squirrels active inside the enclosure on 08 August and the kits were returning less frequently to the enclosure so food items were no longer provided after this time.

The first detection of the kits successfully hunting came on 01 August from motion cameras that recorded the female (OF01) dragging a yellow-bellied marmot (*Marmota flaviventris*) through the entrance hole back into the enclosure (Fig. 11). She would have captured the marmot somewhere nearby on the outside of the enclosure.

Figure 11. Orphan female (OF01) returning to the enclosure with a yellow-bellied marmot that she presumably captured nearby, August 01, 2010.

Other food items that the kits may have been consumed during this exploratory time in the pasture adjacent to the enclosure included various small mammals, yellow-bellied marmots, and Columbian ground squirrels. Many shallow digs with grass nests were discovered when locating the kits indicating that voles (*Microtus & Myodes* spp.) were likely prey items (Fig. 12).

Figure 12. Grass nests were discovered in shallow digs when locating the kits, August 12, 2010.

Occasionally the kits were located within ground squirrel colonies in a burrow with a large freshly excavated soil mound and digging underground could be heard. It was presumed that in these instances the young badgers were foraging for ground squirrels. After 12 August is was noted that ground squirrels were becoming less common above ground as they were spending more time underground preparing for winter. This seasonal timing would have also played a role in allowing the kits to dig up and forage on lethargic ground squirrels in their burrows.

Another potential mammalian prey item would have been muskrats (*Ondatra zibethicus*). Both OM02 and OF01 were observed using burrows in banks along wetlands near the enclosure. They were likely exploring their new environments when encountering these burrows where resident badgers previously preyed on muskrats. It was not confirmed if the kits encountered and fed upon muskrats at these sites.

In addition, many invertebrate species, including beetles, hump-winged crickets, and grasshoppers were noted during badger monitoring in the adjacent pastures. These invertebrate species have previously been reported as diet items for badgers (Snead and Hendrickson 1942, Messick and Hornocker 1981, Lampe 1982, Newhouse and Kinley 2001).

The water bucket was monitored using motion cameras and the kits did frequent the water bucket on occasion. As the kits reduced their visits to the enclosure we determined that nearby wetlands would be sufficient for any water needs and stopped filling the bucket.

Movements and Dispersal

From 01 to 15 August the kits would move around the adjacent pasture during the day and return to the enclosure near sunset, presumably to be fed. As we reduced the availability of dead ground squirrels and only augmented the enclosure with live ground squirrels the kits

returned less often and finally stopped returning to the enclosure after 15 August. From 03 to 07 August both young males were almost always found together while the female exhibited independence from the males as early as 29 July. From 01 to 16 August the average distance moved from their previous location was:

OF01 – 460 meters
OM01 – 306 meters
OM02 – 650 meters

Both OF01 and OM02 were recorded traveling extensively away from the enclosure with at least one long distance foray totaling 2.1 and 2.9 km respectively (Fig. 13). OM01 had a lower than average distance moved from his last location but that may be biased as we could not locate him on 09 and 10 August. We likely missed his long distance movement during this period as it may have been in a northerly direction up into steep rolling terrain where the radio signal would be difficult to receive. These long distance forays and disappearance all occurred between 08–10 August and may have been attributed to visits by territorial resident male badgers during that time. Breeding season peaks around the first two weeks of August in the south Cariboo region and wide-ranging large males may have caused the kits to leave the vicinity of the enclosure for a day or two. Using remote motion cameras we determined that at least three resident badgers visited the enclosure or surrounding burrow complexes during this time period. Individual badgers were identified using their unique facial and scar patterns.

Figure 13. Map showing locations of badger kits during 01 to 16 August 2010. Outlying point locations had Columbian ground squirrel colonies in the vicinity.

Figure 14. Large resident male badger (left) pinning OM02 by the nape of the neck in a show of dominance. Badgers commonly have scars along the back of their head during breeding season, August 12, 2010.

On 12 August motion cameras recorded a resident adult male having an altercation with OM02 on a well used burrow complex above the enclosure (Fig. 14). Despite this interaction all three kits remained near the enclosure and adjacent pasture for several more days. The last known occurrences that the three young badgers exited the enclosure were:

OM02 – 15 August, 04:28 hrs
OM01 – 15 August, 23:14 hrs
OF01 – 15 August 16:40 hrs

On 16 August the kits ranged in distance from 200 m to 1,000 m from the enclosure. Dispersal did not take place until 16 and 17 August when all three kits made major movements in a northerly direction and were not located until 18 August when OM02 and OF01 were located approximately five kilometers northwest near Sucker Lake. On 21 August a member of the public picked up a young male roadkilled badger on the shoulder of Highway 97 near 111 Mile. This roadkilled badger turned out to be OM02. He had traveled a straight line distance of 11.2 kilometers from the enclosure in four days during his dispersal. Stomach contents revealed that he recently fed on a family of voles (*Microtus* or *Myodes* spp.). His body weight was 6.1 kg without the implant, a weight increase of 1.0 kg since implantation of his radio-transmitter on 13 July 2010.

Both OM01 and OF01 traveled north and northeast respectively and were located on separate ranches approximately five kilometers apart from each other along 111 Mile Creek corridor. The sites that they selected were approximately 6 km (OM01) and 11 km (OF01) east of Highway 97 and 10 kilometers north of their initial release site (Fig 15). On 01 September the male (OM01) was located in a large burrow in the midst of a ground squirrel colony, the fresh soil conditions after a rainfall revealed that he had appeared to plug five ground squirrel burrows

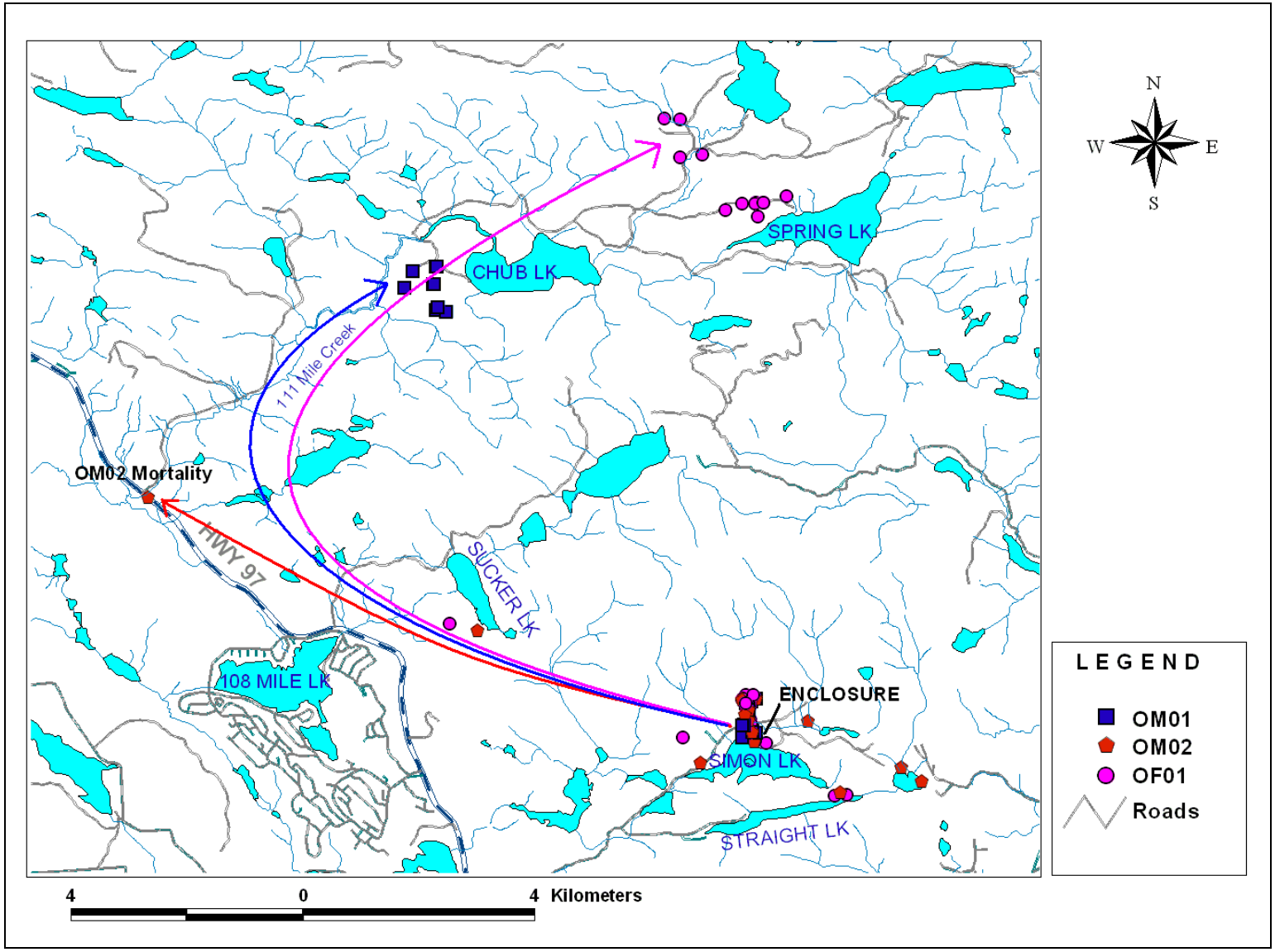

Figure 15. Map of estimated dispersal pattern for three orphaned badger kits from their soft release site in the south Cariboo, August 16-21, 2010.

and entered the network of tunnels through a single large burrow he had excavated nearby (Fig. 16).

As of 05 October, 2010 the two remaining kits have resided at locations near Chub Lake (OM01) and Spring Lake (OF01). Both sites have hayfields and pastures associated with Columbian ground squirrel colonies. The site near Chub Lake appears to have an abundant yellow-bellied marmot colony that the male appears to be targeting.

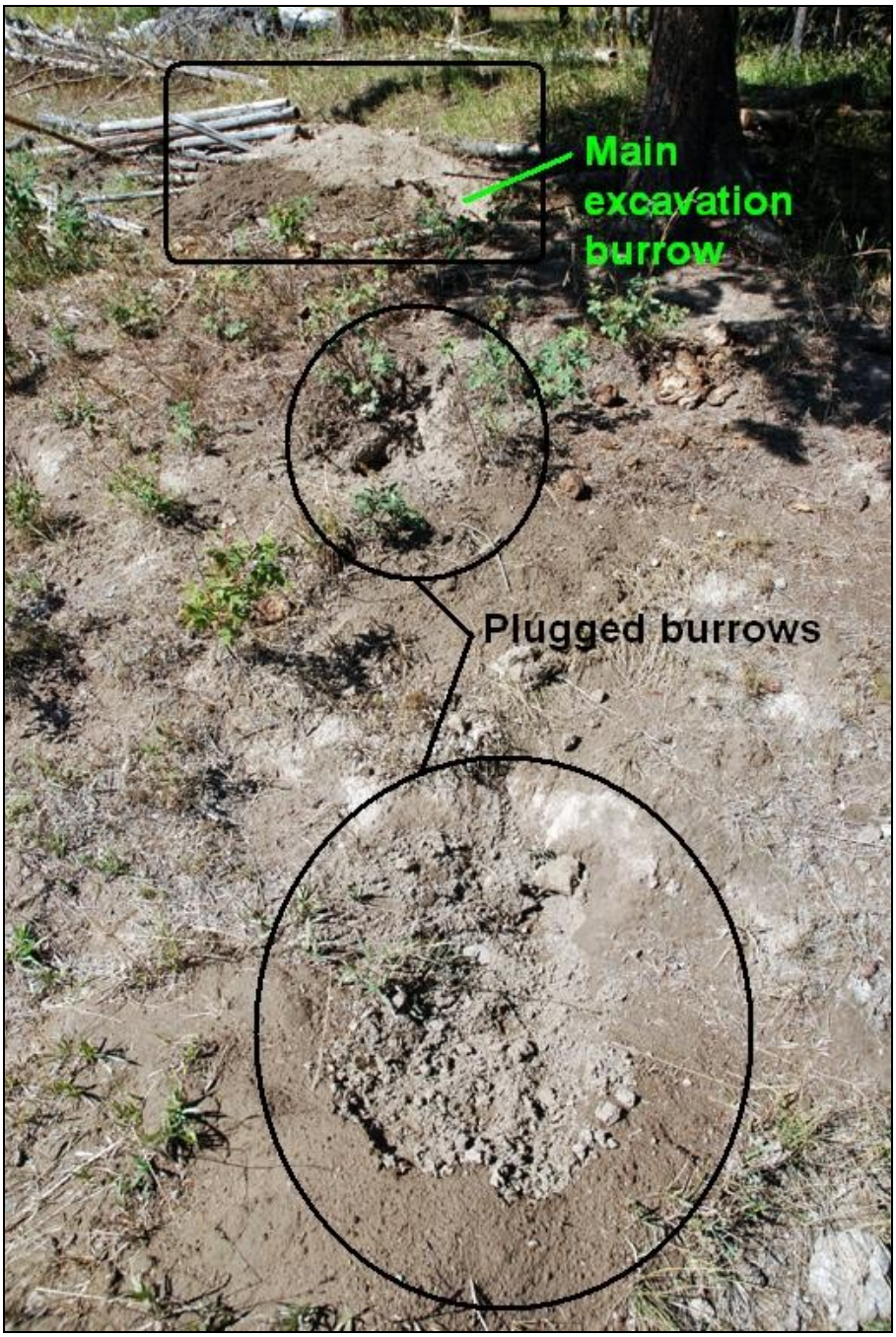

Figure 16. Two of the five plugged ground squirrel burrows and main excavation burrow as OM01 forages for Columbian ground squirrels, September 01, 2010

Discussion

Considering the endangered status of badgers in British Columbia, with possibly less than 350 adult individuals remaining in the province, protection of all individuals is crucial for the species long term survival.

Our results support that raising wild-born badger kits in captivity and using the soft-release method had a positive effect on the success of the reintroduction. There is evidence to suggest that captivity negatively influence an animals' capabilities to survive, and can result in a lack of appropriate 'wild' type behaviours (Rabin 2003). Another potential factor influencing reintroduced animals lack of success can include an unnatural confidence towards humans (Woodroffe 2003). We attempted to reduce human contact as much as possible and pre-condition the animals at the Wildlife Park and soft-release enclosure with natural prey (i.e., mice and Columbian ground squirrels). In addition, large soft-release enclosures with natural habitats have been attributed to keeping animals shy and wary, behaving in the same manner as animals in the wild (Maran 2004).

Several factors that influence successful carnivore reintroductions include habitat suitability, natal habitat preference, long-term food availability, season of release, type of release (soft or hard) and source (wild-caught or captive-born) of released animals (Stamps and Swaigood 2007, Jule et al. 2008, Peters et al. 2009).

Habitat Suitability / Natal Habitat Preference / Site Selection:

The site chosen for the soft-release enclosure not only included suitable badger habitat (i.e., burrowing soil and prey), but was also in their mother's home range. Natal habitat preference has been shown in situations where dispersers prefer new habitats that contain stimuli comparable to those in their natal habitat (Stamps and Swaisgood 2007). Not only was the site high quality natal habitat preferred by BF02, but also adjacent areas of suitable similar habitats were in close proximity to the release site.

The site selected gave the kits the ability to roam large areas and return to the enclosure for security and/or companionship of siblings. With the site located on a large cattle ranch, the exploratory nature of the kits allowed them to not only forage and travel in preferred grassland-type habitats but also to explore foraging opportunities along wetlands (muskrats, waterfowl), and aspen/Douglas-fir forests (voles, *Microtus* and *Myodes* spp.).

In addition, the site was located several kilometers from a major highway corridor (Highway 97) which afforded them short-term post-release protection from vehicle collisions.

Food/Prey:

Small mammals are regular prey items for badgers in North America (Messick and Hornocker 1981, Goodrich and Buskirk 1998), and by providing both dead and live buried mice in cardboard tubes at the Wildlife Park allowed the kits to be conditioned to burrowing for prey items early in their development.

The kits were then acclimatized in the soft-release enclosure and fed native prey items (i.e. Columbian ground squirrels). It was imperative that we started feeding live ground squirrels to the young kits as soon as they arrived so that they could learn to hunt and kill fossorial rodents. All dead ground squirrels were buried deep within existing burrows to cue the badgers

into burrowing for their food. Initially the young badgers had difficulty killing live ground squirrels but quickly learned. Live prey was provided until the kits were out in the adjacent pastures acquiring their own forage. Having a large colony of ground squirrels and many existing badger burrows in the vicinity of the enclosure likely attributed to their foraging success. Within three days of release OF01 had hunted, killed, and returned to the enclosure with a yellow-bellied marmot.

The landscape surrounding the enclosure had large contiguous patches of various habitat types that supported a variety of potential prey species. The diversity of small mammals across these landscapes would allow foraging opportunities between patches of Columbian ground squirrel and marmot colonies. Personal observations and landowner reports indicate that some population units of Columbian ground squirrels in the area are not yet being used by resident badgers on a regular basis and should provide the kits consistent long-term food reserves.

It was noted that the male (OM01) started plugging or backfilling ground squirrel accessory burrows while attempting to burrow down main entrances to forage on ground squirrels. This behavior has been recorded for wild badgers (Knopf and Balph 1969), and it appears the male has learned to plug burrows so ground squirrels have difficulty escaping, there also may be other benefits we are unaware of that may also induce this type of behavior (i.e., scent detection).

Season of release:

Timing was crucial to the success of the project. The badger kits were transferred to soft release enclosure late summer when Columbian ground squirrels and yellow-bellied marmots were still active. The kits had the opportunity to start foraging for prey at a critical time when ground squirrels and marmots shift from above ground activity to a state of hibernation below ground. This timing allowed the kits to learn to detect and initiate predatory behaviours above ground and then exploit lethargic prey in late summer and early fall as resident dispersing kits would.

Type of release = Soft-release method:

There has only been one attempt in BC to reintroduce an orphaned badger kit back into the wild. That project had limited success. Initially the soft-release method appeared to work well as the young badger was independent and foraging on its own for three weeks until it was predated on by an unknown predator (R. Weir personal communication). It was not determined if the young badger was successfully providing food for itself or became a victim due to starvation and poor body condition. Our orphan badger reintroduction benefitted from this previous experience by using some of the same methods and materials that were learned from our colleagues further south.

The initial plan of removing the bottom section of fencing to release the kits was pre-empted two days by the kits digging and bending the wire and releasing themselves. The use of the small entrance/exit allowed the kits to return to the relative safety of the enclosure where they felt secure. As the kits became more independent they returned to the enclosure less often. It is recommended to provide a small discrete opening instead of removing fencing, or sections of fencing when the animals are to be released. This allows the animals to return to the relative safety and comfort of the enclosure while retaining the freedom to explore and forage outside the enclosure.

Animals raised in captivity often show loss of natural behaviours including not only deficiencies in foraging/hunting but also social interactions or influence from con-specifics (Rabin 2003). Remote motion cameras revealed that as many as three resident badgers visited the enclosure and/or common burrows adjacent to the enclosure. These resident badgers were identified individually using their unique facial and scar patterns. The remote cameras captured many social interactions, including an altercation between OM02 and a resident male revealing a show of dominance by the resident male. The social and physical development of the kits was also likely influenced by the interactions between siblings; these included displays of wrestling, play, fighting (dominance), subordination, and companionship. The role that these social interactions had on the badger kits is unclear but extensive social learning was likely achieved. Having the soft-release enclosure in an area where resident badgers occurred likely benefitted the site chosen versus detracting from it.

Source:

Carnivore reintroduction projects using wild-caught animals were more successful than those using captive-born animals (Jule et al. 2008). These badger kits were wild and not produced by captive breeding. They had spent approximately 4-6 weeks in the burrow with maternal care and were orphaned at time when they would just start emerging from the natal den. Lack of human contact during the time in the den and limited human contact in captivity likely played an important role in their success. Both OM02 and OF01 remained quite wary of humans while OM01 did show lack of fear and curiosity towards humans on several occasions. These results may influence any development of future guidelines for reintroductions or captive breeding of badgers in BC, although little is known on the effects of pre-release experience influencing the success of individual animals (i.e., effects of hand-rearing versus dam rearing) (Jule et al. 2008). The intervention of capturing the wild kits at approximately 6 weeks old may have allowed the kits to retain their innate wild behaviours early in their development.

Movements / Dispersal:

The soft-release method appeared to work well with the young badgers only straying several hundred meters from the enclosure for the first two weeks after they were released. Adult female badgers start moving with their kits in early to mid-June and by late July the kits are almost full grown. Badgers are capable of long distance dispersals (> 100 km) and the two kits dispersed 10–12 km into suitable high quality habitat. Reports from landowners at these sites indicate that badgers are infrequent visitors and it is possible that the two kits filled unoccupied habitat free of resident adult badgers, resulting in lower dispersal distances. It is common that dispersing kits will not travel very far from their mother's territory their first fall and winter with long distance movements occurring the following summer (natal habitat preference). Other studies documenting post-release movements for translocated mustelids include fishers (*Martes pennanti*) and American martens (*Martes americana*), and were characterized by large post-release movements relative to their small body sizes, even when they were on-site acclimatized for some days before release and provided with carcasses as food (Davis 1983, Slough 1989, Proulx 1994). Davis (1983) reported that soft-release methods reduced (but did not prevent) long-distance movements in martens. The dispersal distance and age of dispersal for OM01 (9.6 km/123 days) and OF01 (10.1 km/123 days) are similar to other resident badger kits in BC, about 11 km and 106 days of age (assuming April 15 birth date) (Kinley and Newhouse 2008). Long-term monitoring of the young badgers using the VHF radio-transmitters may give us insight on

their future home range size, and if there are any further dispersal movements during summer 2011.

Survivorship:

As reported by Jule et al. (2008), the most common cause of death for reintroduced carnivores was by human means (i.e., automobile collisions, persecution). Our results are consistent with these findings as the only mortality to date was OM02. Three weeks after being released he was struck and killed by a vehicle while dispersing several kilometers from the release site. Badger-vehicle collisions are the leading cause of badger deaths in BC (Weir et al. 2003, Kinley and Newhouse 2008). On-going research in the south Cariboo on these animals has been focusing on understanding how habitat configurations and limitations may be predisposing the animals to road mortality and how to reduce this occurrence.

Conclusion:

Using the techniques described we were successful at raising three orphaned badger kits in captivity and releasing them back into their native habitat using the soft-release method. The kits learned successful hunting and foraging strategies that allowed them to thrive in the wild. The only mortality recorded to date was contributed to road mortality. Badger-vehicle collision factors are being investigated and addressed in the development of new transportation infrastructure projects throughout badger range in British Columbia.

Long-term monitoring will hopefully allow us to determine if the young badgers have learned the social skills (i.e., breeding behaviour) necessary to contribute to the local badger population. Additionally, winter monitoring in 2010/11 will reveal if the young badgers acquired enough resources and body fat reserves to successfully over-winter and survive in the south Cariboo region. As of 05 October, 2010 the male and female appear to be healthy and contributing to the recovery of badgers in British Columbia. Our results suggest that raising kits in captivity and using soft-release techniques be recommended as the method of choice for orphan badger reintroductions in North America.

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Appendix 1. Soft-Release Enclosure Photos

Appendix 1a. Trench being excavated for burying main fence below grade, June 25 2010.

Appendix 1b. Fencing material and posts ready to be erected after trench was excavated, June 25 2010.

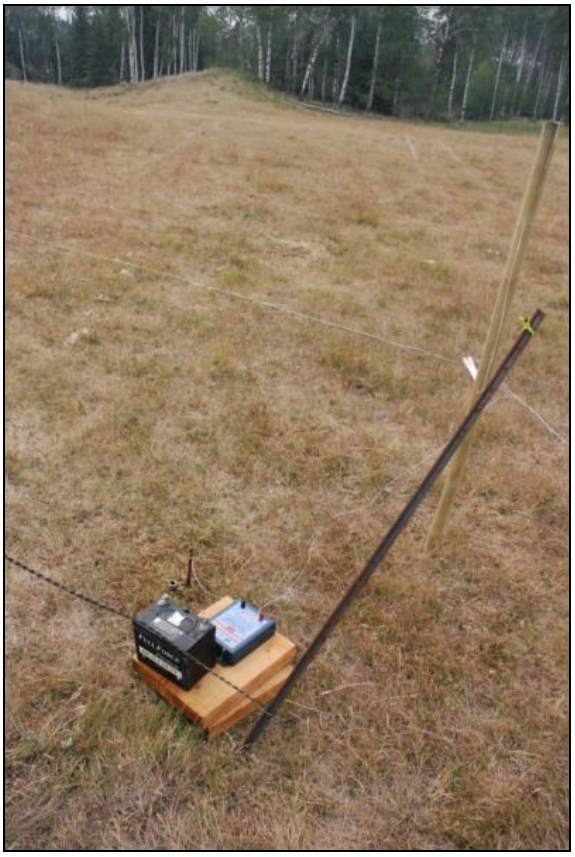
Appendix 1c. View from top of esker with perforated steel fence posts (Telespar®) ready to be setup, June 25 2010.

Appendix 1d. Water bucket buried level with ground. Wooden stick wired to fence and inserted into bucket to allow insects (grasshoppers) and small mammals to climb up, August 01 2010.

Appendix 1e . Overview of soft-release enclosure at Four Hearts Ranch, August 01 2010.

Appendix 1f. Detail of soft-release enclosure showing visible badger burrow complexes (top right) that the kits developed, August 01 2010.

Appendix 1g. View of enclosure from east looking west. Note orange ribbon and yellow fiberglass posts for electric fence around perimeter, August 01 2010.



Appendix 1h. Detail of portable electric fence setup, August 01 2010.

Appendix 1i. Overview of rehabilitated site after removal of fence and materials, October 14 2010.